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Bet Big

A citizen's guide to green industrial policy in Canada

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Executive summary

CANADIAN CLIMATE POLICY is slowly catching up to the central problem of fossil fuels in the economy. The production and consumption of oil, coal and natural gas underpins the global climate crisis, and the continued use of those fuels is incompatible with the net-zero emission economy we have committed to achieving by 2050. From carbon pricing to efficiency standards, Canadian governments are ramping up efforts to tackle the greenhouse gas emissions produced by fossil fuels.

Yet, to date, the question governments have failed to convincingly answer is: if not fossil fuels, then what? Workers, communities and businesses across the country remain unclear about the alternatives to the emissions-intensive industries and technologies we depend on today. Without tangible and viable alternatives to oil, gas and coal, the transition to net-zero will never achieve the political or economic momentum it requires.

What's missing from Canadian climate policy is green industrial policy, which refers to a set of state interventions to reorganize the economy away from fossil fuels and toward strategic, zero-emission industries. A state-led green industrial policy is a departure from Canada's historical preference for hands-off economic management, which favours policies like corporate tax incentives and consumer subsidies. Instead, a green industrial policy makes government the primary manager and key funder of a sustainable economy.

This report explores the policy tools that green industrial policy entails—including coordination, spending, subsidies and regulations—before turning

to a series of international and domestic industrial policy case studies. From those examples we draw six principles for effective green industrial policy:

1. A vision for the future grounded in the public interest;
2. A focus on areas of pre-existing advantage;
3. A willingness to take risks on technologies that are not yet commercially viable;
4. An emphasis on domestic capacity over foreign dependence;
5. A leading role for public coordination and investment; and
6. A concerted effort to seek and maintain a political consensus.

We illustrate the potential application of these principles using the example of the Canadian automotive sector. Internal combustion engine vehicles may be on their way out, but whether the zero-emission vehicles that replace them are made in Canada—with all the spin-off benefits that entails—hinges on a smart and far-reaching green industrial policy.

We conclude with four recommendations for the federal government to realize the full potential of green industrial policy to advance environmental, social and economic priorities:

1. **Articulate a clear economic mission** that identifies specific, strategic green industries and is consistent with the goal of net-zero emissions by 2050;
2. **Build a grassroots political consensus around the national vision** through a participatory democratic process with workers and communities across the country;
3. **Develop a comprehensive, government-led national green industrial strategy** that is focused on the net-zero mission, with consideration given to job creation, social benefits and regional diversification; and
4. **Drive the green industrial strategy with public money** to kickstart innovation, stimulate the economy and ensure, through public ownership, that the long-term benefits of greener industry flow back to the public.

Green industrial policy is not without precedent in Canada. Governments are already strategically supporting green industries using a variety

of policy levers. What's missing is a clear, overarching vision for the future with a degree of public coordination and level of public spending sufficient for achieving that vision.

Canada needs to bet big on a comprehensive strategy. With the right goal, a smart plan and an ambitious budget, we can ensure a prosperous, sustainable and inclusive future in a net-zero world.

Introduction

THE THREAT POSED by climate change is a top priority for concerned citizens and governments across Canada. Rising temperatures, biodiversity loss and more frequent extreme weather events are already affecting our well-being, while the prospect of runaway global warming is pushing the world toward a "global collapse" scenario.[1]

In fits and starts, political awareness of what must be done is emerging in Canada. Governments at all levels have begun to introduce policies, such as fuel efficiency standards and carbon pricing, to reduce demand for the fossil fuels at the root of the climate crisis. Coal power is already being regulated out of existence across the country. Internal combustion engine vehicles are being systematically replaced with zero-emission vehicles through incentives and sales mandates. Buildings are being constructed and retrofitted to neutralize emissions. In the net-zero world we aspire to live in by 2050, Canadians will use few, if any, fossil fuels in their day-to-day lives.

However, despite this progress, Canada's policy efforts do not put us on a path to a productive, inclusive, net-zero-emission economy by mid-century.[2] In part, our emissions trajectory reflects loopholes and oversights in our climate policies, such as continued subsidies for fossil fuel production for export.[3] But at a more fundamental level, Canadian governments have failed to answer the question: if not fossil fuels, then what?

This question is of great concern to workers who currently depend on the production of coal, oil and natural gas for their livelihood. Workers in industries that depend on fossil fuel consumption, such as traditional automotive and

aerospace manufacturing, fertilizers and chemicals, and steel and aluminum production, are likewise worried about a future where their skills and efforts won't be needed. Canadian climate policy must perform a dual purpose: end the use of the fossil fuels upon which so much of our economy depends and put in place alternatives for working people and their communities.

The question of what comes next is also of great concern to environmentalists and climate-minded political leaders who are vexed by the assertion that Canada cannot afford to transition away from fossil fuel-based industries any quicker than planned. The climate science is clear that we must aggressively cut emissions to avoid the worst impacts of climate change. To do so, we need alternatives to the status quo in every part of the economy, including carbon-intensive sectors like energy production, transportation, agriculture and manufacturing.

The answer to all these concerns is industrial policy and, specifically, a green industrial policy. For many workers, environmentalists and concerned citizens, industrial policy may sound like an outdated and uninteresting term. It evokes images of smokestacks and men with clipboards, but not an inclusive, sustainable economy. Yet industrial policy, which refers broadly to any state intervention in the economy to coordinate and grow strategic industries, must play a role in achieving Canada's net-zero aspirations. As a project of government, industrial policy is an inherently democratic approach to economic development that privileges the public interest over raw market forces. This is the missing foundation of Canada's climate plans.

In this paper, we explore and explain the importance of green industrial policy for Canada's climate agenda. Our goal is to provide concerned citizens, from the labour movement to the environmental movement and beyond, with a concrete understanding of green industrial policy in Canada, including policy priorities for effective climate action.

The paper begins with a conceptual overview of green industrial policy and the specific policy tools that it entails. We then turn to a series of international case studies to illustrate what an effective green industrial strategy can look like in practice. We draw further lessons from Canada's own history of industrial policy, with a focus on the oil sands. Building on these lessons, we discuss key principles for an effective green industrial policy in Canada before turning to an illustrative example of Canada's zero-emission vehicle manufacturing sector.

We conclude that a green industrial policy is the missing link for ensuring that Canada's climate ambitions are met while promoting good jobs and protecting community well-being in the future. To that end, we make a series of recommendations to the federal government.

What is green industrial policy?

AT ITS CORE, industrial policy refers to any state intervention in the economy to promote or develop a specific industrial sector, often by shifting resources away from another, less-desirable sector. Although disparaged by neoclassical economists as "picking winners and losers", industrial policy is the foundation of almost all modern economies.[4]

For example, in Canada, the oil sands industry was a project of successive governments to develop and scale up the technologies necessary for bitumen extraction. The United States, which is often viewed as an exemplary free market economy, has long employed industrial policies to support sectors such as agriculture, steel production and big tech, and is now leading a push for zero-emission vehicle manufacturing.[5]

Where industrial policy is explicitly named as such, it has historically focused on the value-added manufacturing sector. However, it can be applied to every part of the economy. An effective industrial policy increases productivity and competitiveness in a strategic sector in a manner that the market alone would be unlikely to achieve. Industrial policy also supports secondary objectives, such as regional development, job creation or environmental protection.

Green industrial policy targets industries and technologies that actively help an economy reduce greenhouse gas (GHG) emissions, including both upstream and downstream emissions. In some definitions, that may include

technologies like carbon capture and storage, which reduce emissions from fossil fuels without reducing the total amount of fossil fuels produced or consumed. A stricter definition of green industrial policy limits government interventions to industries and technologies that actively promote a zero-carbon economy by 2050. Blue hydrogen, for example, which is produced from fossil fuels, may meet the former definition but not the latter.[6]

Given the urgency of the climate crisis and the clarity provided by the 2050 net-zero target, we argue that a stricter definition should be articulated and pursued.[7] Otherwise, we risk investing in infrastructure and technologies that help reduce emissions in the short term but make the transition to net-zero emissions more challenging and more expensive in the long term. For the purposes of this report, we define green industrial policy as a set of state interventions to reorganize the economy away from fossil fuels and toward strategic, zero-emission industries.

While zero-emission is a higher bar than net-zero, the government's limited resources should be focused on the industries and technologies that give us the best chance of entirely eliminating emissions. Our definition still leaves room for essential industrial inputs that may be challenging to fully decarbonize, such as agriculture, mining and steel production, while deprioritizing or excluding industries for which there are zero-carbon alternatives, such as conventional power generation. To the extent that achieving net-zero emissions will rely on some amount of carbon storage, those negative emissions must be reserved for essential inputs and not wasted on sectors for which viable alternatives exist.

A green industrial strategy is a comprehensive vision for industrial development that employs a variety of individual industrial policies, though we often use the terms interchangeably in this report.

Elements of green industrial policy

At a practical level, industrial policy is fundamentally about public coordination. More than any other actor in the economy, governments are best positioned to take a holistic view of economic development and identify where the market is failing to advance the public interest. However, to play an effective coordinating role, governments require appropriate capacity. An otherwise good industrial policy agenda can still fail without the internal technical knowledge, adequate financial resources and flexible governance structures to underpin the broader industrial strategy.

Brendan Haley, policy director at Efficiency Canada, identifies 10 institutional design principles that are necessary for government institutions to adequately lead on innovation policy, including flexibility, competence, stability and accountability.[8] Crucially, these public institutions must have a degree of autonomy from the government of the day and the private sector, while still respecting both sets of actors as important partners. Public institutions that are ephemeral, under-resourced or inherently partisan, such as the various task forces and policy councils that the Canadian government has created in the past, are not sufficient for overseeing and managing a complicated industrial transition over the long term.

With that caveat in mind, there are a wide variety of specific policies available to governments to realize an industrial strategy. Here we break down some of the most common types of industrial policies in the areas of public coordination, public spending, commercial subsidies, and regulatory measures.

Public coordination

Sector development councils bring together representatives from the public sector, private sector, organized labour and other key civil society groups to strategize and coordinate on industrial development. Canada has many private sector industry associations, such as the Canadian Association of Petroleum Producers, that largely function as lobby groups on issues of joint concern to their members. For their part, Canadian governments tend to consult with stakeholders like these but ultimately keep decision-making power at the cabinet table. What Canada lacks are truly tripartite bodies (i.e., involving government, industry and labour)—of the sort that are common in European countries such as Germany—with the mandate, resources and authority to balance competing interests and chart a shared path forward.

The federal government's short-lived Industry Strategy Council was a step in this direction, but it did not have a long-term mandate and lacked representation from labour and civil society groups.[9] More recently, the government launched a series of Regional Energy and Resource Tables to lead province-specific industrial planning.[10] While a promising step forward for industrial planning, these tables are not truly tripartite bodies and may be designed to privilege short-term political considerations over long-term strategy. In their announcement, the government refers repeatedly to a "low-carbon future," which is fundamentally different from—and occasionally incompatible with—a truly zero-carbon economy. It remains to be seen

whether these bodies are adequate for advancing a public interest agenda over short-term political and commercial considerations.

Supply chain coordination involves creating connections and managing relationships between different elements of the supply chain in a strategic sector. In the case of zero-emission vehicles, for example, supply chain coordination means ensuring that policies are in place to support and link mineral mining, parts manufacturing, vehicle assembly, global distribution, consumer purchasing, servicing, charging infrastructure and end-of-life recycling. In the absence of coordination, mismatched supply and demand can grind an industry to a halt. One type of supply chain coordination, which was adopted successfully in the Netherlands in the context of building retrofits, is the creation of "market development teams" that coordinate suppliers with consumers.[11] These teams can experiment with different formats for information sharing and procurement processes that ultimately streamline the entire industry.

Technology and business assistance programs play a similar role in helping small firms in strategic sectors commercialize. Canada's Industrial Research Assistance Program (IRAP), for example, provides financial assistance, advisory services and business connections to innovative companies.[12] This form of coordination addresses "network failures" that can inhibit the growth of otherwise viable technologies and industries.

Workforce development is a vital prerequisite for many strategic industries, especially in burgeoning high-skill areas like clean technology and the building trades.[13] While governments are generally responsible for public education, in the context of a green industrial strategy governments have a specific role to play in modeling future labour market needs and developing the public education system to deliver a sufficiently skilled workforce. Workforce development includes the college and university systems, which can be better synchronized with evolving labour markets, as well as targeted upskilling and retraining programs in strategic areas, such as programs to transition skilled oil and gas workers into related positions in cleaner industries.

Public spending

Direct investment in the clean economy means spending public money to take a public ownership position in a strategic industry. In Canada, direct investment is often managed by crown corporations that operate similar to commercial firms but with a mandate to act in the public interest. Historic-

ally, Canadian crown corporations have been most prominent in the utilities sector (e.g., in provincial electricity production and distribution), but they can, and do, operate in a wide variety of industries.[14] As part of a green industrial strategy, direct investment enables a government to accelerate the development and growth of a strategic industry while returning the benefits to the public. Direct investment can also fill in gaps in our net-zero infrastructure, such as electricity transmission, that are not well-served by existing public or private actors.

Public funding is government money provided directly to firms, usually for specific projects, without the government taking an ownership stake. The funding may be repayable (loans) or non-repayable (grants). As part of an industrial strategy, public funding can make private investments in strategic industries more attractive. Canada's Strategic Innovation Fund (SIF) is one example of a public funding institution that has provided $5.6 billion for strategic projects to date.[15] The SIF is a not specifically a green fund—public money has gone toward a liquified natural gas plant and other fossil fuel projects—but in 2020, the SIF added a Net Zero Accelerator (NZA) stream specifically targeted at emission reduction projects.

Research and development (R&D) spending, whether through grants to universities, allocations to organizations like the National Research Council, or the creation of entirely new research bodies, is another form of public investment. Publicly funded R&D is the foundation of many key technologies that are then commercialized by the private sector. In a green industrial strategy, public R&D spending can focus on cutting edge technologies that are not immediately profitable but may play a key role in decarbonizing strategic industries down the road.

Public procurement is the process by which governments acquire goods and services from the private sector. When choosing a commercial provider, governments today often prioritize the lowest cost. However, as part of a green industrial strategy government procurement can elevate the importance of both upstream and downstream emissions reductions. Government procurement makes up a significant share of the economy—around 13 per cent of GDP for most countries, including Canada—so restricting that spending to net-zero compatible businesses and technologies through "buy clean" programs can create new markets and drive deep industrial changes.[16]

Green banks or other climate-focused public financial institutions provide loans to public and private entities to invest in strategic industries and technologies. Green loans can provide favourable terms to businesses in strategic industries to scale up and commercialize. A truly comprehensive

green industrial strategy, however, would move beyond focused green banks to ensure the mandates of all financial institutions are aligned with net-zero emissions.

Green bonds are issued by governments to raise revenues for environmental spending. In short, the government borrows money, usually from the private sector, to spend on emission-reduction projects. As part of a green industrial strategy, green bonds can help mobilize private capital that would not otherwise be invested in the clean economy. Green bonds also have the benefit of ensuring that governments spend a certain amount of revenues on green initiatives instead of repurposing those funds for other priorities.

Commercial subsidies

Tax subsidies reduce the taxes (or royalties or other fees) that are paid by businesses operating in strategic industries. In Canada, for example, businesses that manufacture clean technologies pay a lower corporate tax rate than other sectors.[17] Similarly, investment tax credits reduce the tax paid by businesses on specific kinds of spending, such as for investments into emission reduction technologies.[18] As part of a green industrial strategy, tax subsidies provide incentives to the private sector to accelerate or scale up investment in strategic industries and technologies.

Consumer subsidies reduce the amount paid by consumers for goods and services produced by strategic industries. For example, zero-emission vehicle rebates or incentives for installing heat pumps in homes encourage consumers to spend money on lower-emitting technologies, the benefits of which flow back up through the supply chain. Consumer subsidies can create or grow demand for net-zero goods and services. When combined with local content requirements, subsidies can be especially beneficial for local or domestic suppliers.

Feed-in tariffs (FITs) are a subsidy specific to electricity production. The government guarantees a stable, above-market price for electricity produced from renewable sources to incentivize investment in new generating capacity. In a green industrial strategy, feed-in tariffs can sustain and encourage investment in alternative energy sources when low prices and/or short-term price fluctuations would otherwise discourage long-term investment. On the other hand, FITs can lock governments into overpaying for electricity as technology improves and the market cost of renewable energy comes down.

Export subsidies encourage strategic industries to access international markets, often through compensation for the value of goods exported. As

part of a green industrial strategy, export subsidies can help scale up and commercialize new clean industries and technologies for a global market. Given Canada's significant export of greenhouse gas emissions via fossil fuels, export penalties for emissions-intensive goods could play a complementary role in reducing Canada's exported emissions.[19]

Regulatory measures

Environmental regulations shape the behaviour of firms to reduce emissions and protect the environment. They are an essential component of a green industrial strategy for winding down higher-emitting industries to create space for and redirect investment toward lower-carbon alternatives. The regulatory phase-out of coal power in Canada, for example, created a framework wherein public and private utilities were forced to shut down or convert coal projects to reduce emissions. A forward-looking green industrial policy will place similarly decisive limits on fossil fuel production and consumption in other sectors.

Efficiency regulations dictate how energy can be used. Requiring homes and buildings meet certain efficiency standards, for example, drives investment into technologies like heat pumps. Efficiency regulations play an especially important role in a green industrial strategy because they reduce total demand for new energy production, which reduces transition costs for governments, businesses and households. Furthermore, the benefits of efficiency standards can spill over into other jurisdictions as suppliers are forced to meet the highest bar of all the markets in which they compete.

Community benefit agreements (CBAs) are developed between the owners of an infrastructure project and the communities that will be most affected by it. A CBA may specify that a construction project employ a certain amount of local labour or subcontract to a certain number of local businesses. In the context of green industrial policy, governments can require that CBAs or similar agreements be applied to infrastructure or industrial projects to ensure that the benefits of investment in strategic industries scale up Canada's domestic capacity in those sectors while meeting diversity, inclusion and reconciliation priorities.

Border carbon adjustments (BCAs) apply the domestic carbon price to imported goods to level the playing field with domestic producers. BCAs are not a direct subsidy, but since Canada has a higher carbon price than most of its trading partners, they do privilege domestic producers and exporters. In a green industrial strategy, BCAs can play an important role

in minimizing the competitiveness impacts of decarbonizing faster than international competitors.

Toward a public interest green industrial strategy

There is significant variation in the emphasis placed by different governments on these industrial policy tools. Some countries, including Canada, the United States and the United Kingdom, have mostly followed a neoliberal, market-based model of industrial policy that emphasizes "passive supply-side policy measures."[20] This approach limits direct state intervention in the market, especially when it comes to picking winning and losing industries, to avoid creating market inefficiencies. Instead, governments have favoured economy-wide measures based on the assumption that more competitive firms will naturally rise to the top.

Under this approach, governments prefer to incentivize private investment—whether domestic or foreign—to achieve public interest objectives rather than coerce private capital or step in with direct public spending. There is a preference for corporate tax breaks, investment tax credits, consumer subsidies, public financing and public-private partnerships, which keep the risks of investing in strategic industries—if not the ultimate costs—off the government's balance sheet. This approach also includes a focus on research and development of new technologies with the hope that the private sector will take promising, state-funded technologies and commercialize them. Of course, by insulating themselves from risk, governments also forgo many of the benefits of direct investment, such as being able to offer services where they are most needed, returning profits to the public purse, and staving off commercial monopolies.

In contrast, many countries have pursued interventionist industrial policies that emphasize direct public investment.[21] For example, Finland established an array of state-owned enterprises to build capacity in capital-intensive industries. Japan and South Korea provided centrally planned, long-term public finance to scale up their value-added manufacturing sectors. Norway drove its economic restructuring through public institutions and still has the highest share of government workers in total employment among OECD countries today.[22] Germany coordinates the training system with industrial labour needs and provides public support for industrial finance. In each case, the success of their industrial policy development was grounded in

a clear national vision for the future backed by a coordinated regulatory approach and major financial commitments.

Whereas a market-based industrial policy is agnostic about which specific industries and technologies succeed, the state-led model of industrial policy identifies a focused set of strategic sectors and puts the full weight of government behind them. That doesn't mean the state-led approach is entirely inflexible. Governments must still be willing to learn and adapt priorities to new information and circumstances. However, the state-led approach privileges "managers employed by the state [to] replace, compete with, or sharply limit the discretion of private managers" in the determination of industrial priorities.[23] This idea of a "mission-oriented" industrial policy has more recently been popularized by the economist Mariana Mazzucato, who argues that "public investments are not about de-risking and levelling the playing field, but tilting the playing field in the direction of the desired goals."[24] Mazzucato is critical of narrow sectoral industrial policies (i.e., picking and supporting individual winning firms), arguing instead for more comprehensive industrial strategies like those pursued by the countries mentioned above.

Economists disagree on whether a liberal, market-based approach or public interest, state-led approach to industrial policy is more productive.[25] In theory, market-based approaches are more economically efficient (i.e., they improve overall productivity at the lowest cost) and more dynamic (i.e., they are more responsive to innovation), whereas a state-led approach is better suited to balancing multiple competing priorities, including social, environmental and geographic considerations such as regional diversification.[26]

In the context of a green industrial policy, however, the case for a publicly led approach is much clearer. First, the global industrial transformation that is already underway in response to climate change is being driven largely by environmental considerations, not only by the underlying economics. Guided by the Paris Agreement, governments around the world are pursuing industries and technologies that may not yet be competitive in the market but are essential for reducing emissions. In the context of a global economy that rewards emission reductions over strict economic efficiency, an industrial policy that is too narrowly focused on market competitiveness in the short term risks falling behind in the long term. Even worse, such a policy may lock in industries, technologies and infrastructure that will inevitably become stranded assets, such as natural gas, whether or not they are economically advantageous in the short term.

Indeed, achieving net-zero emissions requires scaling up green industries and the transformation—or complete phasing out—of other emission-intensive industries. Market incentives alone aren't sufficient to produce these changes if firms decide "they would rather forego government support than change their labor or other practices."[27] Unless the government actively manages the transition, industries will not voluntarily wind down if there is still money to be made.

Second, there is a clear goal to focus the mission: net-zero emissions by 2050. Although there are multiple pathways to achieving those emission reductions, there are universal end points in several sectors. For example, all net-zero scenarios for Canada include a significant reduction in oil and gas production, aggressive efficiency standards for homes and buildings, and the near complete phase-out of internal combustion engines.[28] Moreover, there is little doubt that sectors like renewable electricity production, green construction, and zero-emission transportation manufacturing will grow substantially in the coming decades, creating new economic opportunities. Governments need not pick winning private firms, which is a fraught political exercise, but they must identify and commit to winning sectors within which the most competitive public and private firms are given a chance to succeed. An unfocused industrial policy will fail to take advantage of the clear potential in strategic industries.

Third, given the necessary breadth and urgency of the transition, there is a serious and widespread risk that workers and communities are displaced and disenfranchised in the process. Public management of the transition is necessary to ensure bold and coordinated worker supports are in place, as well as broader supports for affected communities to minimize the social harm and maximize the social benefits of industrial transformation.

Finally, contrary to the assumptions of liberal economists, the global playing field in strategic green industries is already uneven. Countries around the world are employing aggressive green industrial strategies to get ahead in the sectors that will dominate the global economy this century. Failing to establish priorities now is setting Canada up for failure by the time many emerging technologies do become cost competitive. In the next section we look at a handful of these countries to understand the kinds of industrial policies they have employed to draw lessons for Canada.

Case studies in green industrial policy

THE EXPERIENCES OF Denmark, China and, more recently, the United States provide useful examples of green industrial strategies for Canada's consideration. As we shall see, while each country's circumstances are unique and not everything they've done has worked, there are commonalities for effective policy choices as well as certain pitfalls to avoid.

Denmark

Like much of the world, the 1970s global oil crisis devastated the Danish economy. However, unlike many Western countries, the Danish government responded by embracing an aggressive and comprehensive industrial policy to shift the country to renewable energy. The state played a leading role in developing the technological capacity to seize a first-mover's advantage in the global clean technology market. Denmark's long-term vision of industrial development focused on wind power technology in particular. By the mid-1980s, the domestic wind energy industry was flourishing and Denmark remains a global wind power leader.[29]

To get there, the Danish government used a state-owned energy utility, Danish Oil and Natural Gas (now Ørsted), to make direct investments in wind before it was competitive and to coordinate wind power development with

private actors.[30] Specific industrial policies included long-term research and development funding, grants for wind turbine manufacturers, and subsidies for offshore wind facilities. It also implemented a feed-in tariff system to encourage investment in energy infrastructure from a wide variety of sources, including households.[31] These measures were generally supported by the private sector, NGOs and environmental activists, all of whom helped offset the political influence of the private fossil fuel industry. Politicians built support for the policy among workers by prioritizing domestic manufacturing for wind turbines, which generated a significant number of industrial jobs.

Denmark's early adoption of clean energy technology enabled the country to pursue more aggressive environmental policies in turn. For example, in 1992 Denmark became one of the first countries to implement a carbon tax that, at US$26 per ton today, is still among the highest in the world.[32] More recently, Denmark has pushed to phase out coal power and to transition the transportation system away from internal combustion engine (ICE) vehicles. Zero-emission vehicles (ZEVs) are exempt from registration taxes while registration taxes on low-efficiency ICE vehicles have increased. Taxes and fees in turn fund green investment projects. Roughly 40 per cent of revenues generated through the carbon tax system are reinvested in environmental programs.[33]

Most recently, the country has committed to systematically eliminating high carbon activities in its economy. In 2020, Denmark mandated climate assessments in every new piece of legislation.[34] In 2021, the country co-launched the Beyond Oil and Gas Alliance (BOGA) to put pressure on governments around the world to phase out oil and gas production.[35]

Throughout the long process of shifting away from fossil fuel use and production, the government has collaborated with labour unions to ensure that skilled workers in the fossil fuel industry are transitioned to employment in other sectors.[36] Denmark's strong industrial policy, backed by a robust social safety net, meant that the country did not need to have the "just transition" debate many other countries are struggling with today.

Given the strong role of the state in Denmark's decisive transition both into wind power and out of fossil fuels, as well as its commitment to protecting and collaborating with the broader public, Denmark exemplifies the state-led, public interest model of green industrial policy described in the previous section. One of the best indicators of success in Denmark is that, by the early 2000s, roughly 80 per cent of Denmark's wind turbines were owned by over 150,000 Danish families, which meant the benefits of the national wind project were widely shared.[37] Moreover, the wind industry now accounts for

33,000 direct jobs or about one per cent of the labour market—comparable to the oil industry in Canada—with the economic benefits spread out among a variety of regions in the country.[38] On the climate side, Denmark has made major strides in cutting emissions by 23 per cent between 2005 and 2021, exceeding the European average reduction of 16 per cent.[39]

Despite these gains, Denmark is not on track to meet its ambitious goal of reducing GHG emissions to 70 per cent below 1990 levels by 2030. To meet this target, the country will need climate and green industrial policies that look beyond the energy sector toward industries that are more challenging to decarbonize, such as animal farming and fishing.[40] Nevertheless, thanks to its visionary green industrial policy, Denmark has a strong foundation in place both to ramp up its climate policies and to compete in a cleaner global economy in the coming decades.

China

China's poor record on human rights, labour and environmental protection notwithstanding, the country has implemented a range of green industrial policies that could be strategically emulated in Canada. To begin with, China has not accepted that cheap labour and low-cost manufacturing will be its strategic advantage in the long-term. Instead, China is pivoting to become a global leader in value-added green technology manufacturing while simultaneously pushing policies to reduce urban air pollution[41] and to reduce the country's energy dependency on other countries.[42] Given the substantial public investment that China has made in its green industries and the centrally planned nature of its economy, China's green industrial policy generally falls into the state-led model described in the previous section.

China is a significant coal consumer, but since the turn of the century the country has made a concerted effort to augment its renewable energy supply, especially following its 12th five-year plan spanning 2011–15.[43] To increase its clean energy supply, China devoted substantial resources towards wind and solar photovoltaic (PV) power, providing subsidies and direct R&D funding for green technologies as well as fiscal incentives like income tax breaks and customs duties exemptions for renewable energy products. Chinese governments have introduced feed-in tariff programs at the national and provincial levels. The country has also mandated a national cap on energy consumption and coal output. Altogether, these subsidies amount to well over US$50 billion.[44]

These measures have significantly altered the composition of China's energy sector. Solar PV production alone increased from 128 megawatts (MW) in 2005 to 10,852 MW in 2010.[45] Overall, the proportion of electricity that is generated from wind, solar and hydro power increased from 22 per cent in 2008 to 37 per cent in 2018.[46] As a result, coal consumption in the country has plateaued since 2013, despite large increases in total energy use.[47]

China has also made significant strides in zero-emission vehicle manufacturing. According to the UN Environment Programme, China is now "one of the most ambitious promoters of electric mobility and, clearly, the most important one outside the OECD."[48] To scale up its domestic ZEV industry, China provided direct R&D funding and generous consumer subsidies—amounting to US$9,200 per vehicle from the central government and further subsidies from regional governments—in addition to mandating ZEV quotas and strict fuel efficiency requirements for manufacturers. Furthermore, the Chinese government undertook procurement policies whereby multiple levels of government "purchased electric vehicles for government fleets and made their procurement mandatory for bus and taxi companies."[49] Historically, every major auto manufacturer in China was state-owned, although some newer companies, especially those competing in global markets, are private.[50]

Notwithstanding the gains it has achieved through its green industrial policy, China's approach has not been perfect. First, despite the strides it has made in its reduction of coal consumption, China's coal elimination policies "appear to be inadequate for achieving the IPCC 1.5°C or even 2°C maximum-warming goals," which would require the early retirement of coal plants and the cancellation of future mining projects.[51] In general, China is trying to seize the benefits of a growing global market for clean technologies without making a commensurate effort on its emission reduction policies.

Second, unlike Denmark, China's support for the workers and communities impacted by its transition into cleaner industries has been inconsistent. While some researchers have pointed to the Chinese government's compensation, re-employment and re-training of coal workers impacted by the green transition,[52] others have suggested that the energy transition in China has caused "severe social injustice due to the lack of policies to alleviate negative impacts from the central government."[53] These difficulties show that, despite the relative success of China's green industrial policy, its governance model poses social and political risks.

United States

The United States has long had a de facto industrial policy focused on industries like agriculture and national defence. However, the United States has recently begun a shift toward a government-led green industrial policy, with a focus on zero-emission vehicle manufacturing. After coming into power in January 2021, President Joe Biden's administration quickly established its commitment to the environment, re-joining the Paris Agreement on the first day of his presidency. Biden later announced a "whole of government" approach to addressing climate change, one element of which was a commitment to greening American transportation by ramping up ZEV adoption and infrastructure development.[54] As an immediate measure for encouraging ZEVs, Biden signed an executive order calling for the "conversion of the federal government's vehicle fleet—approximately 645,000 vehicles in 2019—to be all electric and American-made."[55]

In August 2021, Biden signed an executive order outlining a strategy to reduce private and commercial vehicle emissions, setting a target of making half of all new cars ZEVs by 2030 and introducing new long-term fuel efficiency and emissions standards, beginning in 2023.[56] These standards, the White House suggested, would reduce roughly 2,000 megatonnes of carbon dioxide per year while delivering "around US$140 billion in net benefits" over the life of the program.[57] To ensure adequate support for ZEVs, Biden sought to provide public investment in ZEV infrastructure and fiscal incentives for ZEV purchases. His bipartisan *Infrastructure Investment and Jobs Act*, signed into law in November 2021, provided US$7.5 billion for developing a national network of EV chargers, jump-starting Biden's plan to build 500,000 chargers throughout the United States by 2030.[58] Additionally, Biden's *Build Back Better Act*, passed by the U.S. House of Representatives in November 2021, sought to provide ZEV consumer tax credits of up to US$12,500 per vehicle, including a US$4,500 credit for vehicles assembled domestically by unionized workers.[59] Though that bill never passed the senate, in August 2022 the U.S. passed the *Inflation Reduction Act*, which included US$369 billion in climate spending. That figure was a "product of compromise both in terms of its scale and scope" compared to the *Build Back Better Act*, but the *Inflation Reduction Act* still provides unprecedented support for renewable energy generation in the country and includes a US$7,500 tax credit for new EVs.[60]

The Biden administration's efforts to reduce vehicle emissions and cultivate ZEV manufacturing and consumption is one component of a broader climate plan that includes efforts to wind down coal power and decarbonize

heavy industry. Internal combustion engine vehicles are the largest single source of greenhouse gas emissions in the United States (28 per cent of the national total).[61] In the global context, light duty vehicles in the United States account for 30 per cent of carbon emissions from passenger road vehicles worldwide.[62] Transforming vehicle manufacturing is, therefore, an integral part of America's efforts to mitigate global warming.

Despite the promised benefits of Biden's strategy, it has been met with resistance both domestically and internationally. Disputes in the senate and pressure from trading partners, including Canada, resulted in watered-down green policies in the *Inflation Reduction Act*. In general, Biden's aspirations for green industrial policy have not yet achieved the political consensus that Denmark attained democratically or that China imposed unilaterally. Thus, even though the U.S. is one of the most important auto producers in the world, it is too early to say whether the U.S. ZEV industry will achieve the dominance of the Danish wind industry or Chinese solar industry.

Summary

There are five key lessons that Canada can take away from these three cases (and from a variety of other cases around the world that we have encountered in our research).

First, a successful green industrial strategy requires a clear vision—or "mission," to use Mazzucato's term—including goals, pathways and public institutions capable of delivering. For Denmark, China and the United States, that vision is global leadership in wind power, green manufacturing and zero-emission vehicles, respectively. In each case, the government is pursuing disruptive technologies that threaten existing industries in some way but are wise investments in the long term. Moreover, each country created strong public institutions to put the full weight of government behind the mission. In Canada, a consensus is coalescing around certain green industries, including zero-emission vehicles, as we discuss below, but public institutional and financial support for these sectors pales in comparison to international competitors.

Second, successful green industrial strategies build on pre-existing advantages, whether geographic or economic. Denmark's location on the North Sea is well-suited to wind power. China is turning its existing manufacturing capacity toward new industries. The United States is the second largest vehicle manufacturer after China and leads the global technology

industry. Canada must build on its areas of distinct advantage, both at the regional and national levels.

Third, successful green industrial strategies emphasize domestic capacity over foreign dependence. Denmark, China and the U.S. are all globalized, trade-exposed economies, but their competitive advantage comes from strong domestic capacity in technology development and green manufacturing. Denmark's feed-in tariffs, China's local preferences for procurement, and U.S. "Buy American" policies are all clear examples of governments privileging domestic industry to give it a leg up when competing internationally.

Fourth, successful green industrial strategies prioritize public funding and mandates over commercial subsidies and incentives. China's preponderance of state-owned enterprises is well-known, but Denmark also orchestrated much of its wind development through public companies and through public stakes in private energy projects. For its part, the U.S. has employed an array of industrial policy tools, with a focus on public procurement and market-based policies like investment tax credits. It remains to be seen whether this approach will drive industrial investment on a sufficient scale. Whatever the particular policy instrument, the key point is that public spending is part of a market-shaping strategy to create long-term supply and demand in strategic sectors.

Finally, for green industrial policies to succeed over the long term, they require political buy-in. China has achieved buy-in through authoritarian leadership, whereas Denmark has built public support by sharing the benefits of the transition with workers, households and communities. In the United States, that consensus has yet to be achieved, putting the country's industrial policy at risk. Given the long time horizons of most industrial policy, political consensus must not only be won initially but also maintained over time.

Lessons from Canada's past

BEFORE WE PRESENT our case for a forward-looking Canadian green industrial strategy, it is worth reflecting on Canada's own history of successful industrial policy. While decidedly not "green," Canada's response to the Second World War and, decades later, efforts by successive governments at the federal and provincial levels to transform Canada into an oil superpower offer additional lessons for our climate-focused efforts today. We touch briefly on lessons from the war before diving deeper into the oil sands case.

The second world war

When Canada joined the war in 1939 it quickly set about transforming the economy to support the war effort. The whole process is well-documented in Seth Klein's *A Good War*, which explores how, in short order, the federal government created 28 new crown corporations and empowered the public sector to manage the entire supply chain for war materials.[63]

Klein highlights 14 lessons for climate action from his study of the war.[64] Most importantly, from the perspective of industrial strategy, the Canadian government:

- Embraced state-led economic planning to ensure the right kinds of industry were prioritized;

- Created public institutions where the private sector was unable or unwilling to transition quickly enough; and
- Spent as much as was necessary to achieve its goals.

The underlying thread in this analysis, much like the successful international examples discussed above, is the clarity of purpose and a willingness to shape markets to serve public goals. In the face of an existential threat, successful governments do whatever it takes to win. From the outset, Canada's war response was aggressive, comprehensive and put the public interest above private profit.

That mission-oriented mindset is also evident in Canada's successful efforts to scale up oil sands development.

The oil sands

The work of identifying and mapping Alberta's oil reserves was undertaken by the federal Geological Survey of Canada in the late 19th century and a robust conventional oil industry emerged in the first half of the 20th century.[65] Like many resource industries, the oil sector was vulnerable to a boom-and-bust cycle that brought both prosperity and hardship to affected communities. A supply glut in the 1950s was particularly scarring and forced many oil companies to reduce operations below their productive capacities. As a result, leaders in the industry initially resisted oil sands development, fearing it could create similar supply-side crises or create competition for conventional oil production.[66] As conventional oil reserves declined through the 1960s, the oil industry began to relax its opposition to the oil sands, but still favored incremental, private sector-led development.

Ironically, the interest of Canadian governments in promoting the oil sands was triggered by the same global oil crisis that kicked off Denmark's transition to wind power in the 1970s.[67] During that time, a dwindling global oil supply, coupled with the Canadian oil industry's reluctance to innovate, pushed government leaders to pursue far-reaching, long-term policies to transform the Albertan oil industry.

Newly elected Alberta Premier Peter Lougheed was a key champion of a strong government-led approach to developing the oil sands. Lougheed predicted that conventional oil reserves would last only 12 years from the time he was elected, necessitating swift, decisive action to preserve Alberta's energy supply. His vision included raising government revenues from con-

ventional oil production in order to fund the research and development of longer-term oil sands technologies.[68] Noting that his job was "not a popularity contest," Lougheed dramatically raised provincial royalties on conventional oil production against the protests of the oil industry.

Using these revenues, in 1974 Lougheed created the Alberta Oil Sands Technology and Research Authority (AOSTRA), a crown corporation tasked with developing technology for accessing unconventional oil. AOSTRA focused on a variety of in situ (in place) methods of oil mining and eventually determined that steam-assisted gravity drainage (SAGD) was the most commercially viable alternative to surface mining. SAGD involves heating up an unconventional oil reserve, which is trapped in sticky sand, by pumping in steam until the oil thins out enough to pump out.[69]

Despite enthusiasm over SAGD during its testing phase in the 1980s, the oil industry doubted the commercial viability of the technology and no industry partners agreed to jointly fund its testing facilities. AOSTRA's mandate required it to receive 50 per cent of its funding from the private sector, so the lack of industry confidence jeopardized the entire project. Ultimately, the Government of Alberta broke its own rules and fully funded SAGD testing with roughly $115 million (in 2019 dollars) in construction costs without matching funds.[70] Once constructed, SAGD technology proved far more effective than industry consultants had initially projected and industry partners later agreed to match government funding for further testing.

The technical breakthrough provided by AOSTRA enabled oil sands development, but additional industrial policies were necessary to commercialize the industry. Alberta heavily discounted royalties on oil sands projects, for example, which encouraged SAGD production to scale up more quickly than it would have otherwise. The first commercial-scale in situ SAGD plant only came online in 2000 but by 2007 there were a number of functioning projects. By 2019, roughly 40 years after the provincial government made it a priority, roughly 80 per cent of reserves in Alberta's oil sands used in situ methods and over 80 per cent of in situ recovery used SAGD.[71]

For its part, the federal government has provided a wide variety of tax incentives and other subsidies to the oil industry to encourage exploration, development and export.[72] Altogether, the industry benefits from subsidies on the order of $5 billion per year.[73] The federal government has also taken a direct stake in projects like the Trans Mountain Expansion (TMX) project to facilitate further oil production and export.

The "success" of the Canadian oil sands has come at incredible cost to the environment. Tailings ponds and spills from oil transportation have

contaminated vast areas of land and waterways with negative effects on biodiversity and human health, not to mention the greenhouse gas emissions created by the production and consumption of oil.[74] With that caveat in mind, the role that Canadian governments have played in developing and commercializing in situ extraction technology offers one more important lesson for facilitating innovation and growth in strategic green sectors today.

The oil sands case illustrates that "[p]ublic capital can take greater risks on capital intensive infrastructure projects that lack market precedent from the use of novel technology."[75] In other words, governments can and must lead where the private sector is unwilling to take the risk of developing strategic technologies or industries. Moreover, even where the private sector plays an important role as a partner in a strategic sector, the public interest should override industry reluctance and obstructionism. When the Alberta oil industry resisted the pivot to the oil sands, the government increased royalties and used those revenues to drive innovation itself. The government was unafraid of intervening to take ambitious measures when they were deemed strategically necessary.[76] Had the governments of Alberta and Canada directed that enthusiasm toward climate-safe alternatives instead, Canada would be in a much more advantageous position today.

Principles for a Canadian green industrial strategy

AS WE TURN to the question of how best to pursue a Canadian green industrial strategy, we reflect on the takeaways from our international and domestic case studies. In summary, the six lessons drawn from those examples are:

1. Establish a clear vision (mission) for the future grounded in the public interest;
2. Focus on areas of pre-existing advantage;
3. Take risks on technologies that are not yet commercially viable;
4. Emphasize domestic capacity over foreign dependence;
5. Lead with public coordination and funding, followed by subsidies and incentives; and
6. Seek and maintain a political consensus.

These principles are reflected in a recent report by Mariana Mazzucato, which was commissioned by the government of British Columbia.[77] To help that province achieve its "mission-led economic plan," Mazzucato makes a number of high-level recommendations to the government, including:

- Communicating a targeted, measurable and time-bound economic mission;
- Driving direct public investment through a provincial crown corporation;
- Ensuring the public and private sectors share in both the risks and rewards of innovation; and
- Conducting ongoing public engagement to maintain political buy-in.

Specific policy recommendations include establishing new local supply chains and applying conditions on procurement contracts to maximize the impact of private investment in terms of innovation, job creation and other social benefits. In sum, Mazzucato's recommendations for B.C. align with and expand on best practices from other countries and offer a useful model for the rest of Canada to adopt.

In this section, we discuss each of our six principles in that broader Canadian context.

Establish a clear vision (mission) for the future grounded in the public interest

The end goal is clear enough: Canada must aggressively reduce emissions in line with a net-zero economy by 2050. The challenge lies in determining the best pathway. While there are multiple approaches that Canada can theoretically take to achieve net-zero, each of them requires immediate, decisive action in certain sectors.[78]

At present, Canada has no consensus vision for the economy in 2050. While the government has passed net-zero legislation and has put in place modest industrial subsidies in a variety of green industries, it has also approved new fossil fuel projects with productive timelines beyond 2050.[79] The government's own *2030 Emissions Reduction Plan* foresees significant fossil fuel production into the future.[80] Ambiguity about industrial direction makes it difficult for workers, communities and the private sector to make smart, long-term decisions that are consistent with a net-zero future. If there is no industrial alternative to turn to, workers are unlikely to support a regulatory transition away from fossil fuels.

In part, these contradictory policies reflect the well-documented regulatory capture of the Canadian state by the fossil fuel industry.[81] There are serious political risks to fighting one of the most profitable sectors of the economy.

Nevertheless, mission-oriented policy must be grounded in a vision that puts the public interest first.

A clear vision need not be overly prescriptive. We can't know in advance what mix of technologies will be necessary to achieve net-zero or how the Canadian economy will perform in 30 years. There is also significant risk in betting everything on the wrong pathway.[82] Moreover, a truly democratic economic vision must have room to grow and evolve.

A guiding vision need only be specific enough to guide high-level investment and policy decisions: for example, an economy that (1) produces and consumes only zero-emission energy; (2) creates wealth through sustainable natural resource production, value-added manufacturing and a highly educated digital service economy; and (3) is made up of human-scale communities linked with zero-emission transit options. With context like that in mind, we can bet on a variety of key industries and prospective technologies with the expectation that enough of them will pan out to make up for the ones that don't.

Focus on areas of pre-existing advantage

As attractive as some green industries are in theory, trying to create a competitive, productive sector from scratch is more costly and less likely to succeed than building on existing expertise and capacity. Canada's efforts to compete in "mature, mass production technologies" like solar panel manufacturing will always be an uphill battle given the enormous head start of larger economies like China.[83] That doesn't mean Canada can't and shouldn't have any domestic capacity in those industries. Maintaining some domestic capacity in strategic supply chains is an important consideration for economic resilience. However, these industries are unlikely to be the cornerstones of Canada's emerging green economy.

In contrast, Canada is already a world leader in a number of areas that are poised for growth, which are the areas that most experts agree Canada should focus on moving forward. Writing in 2012, Marc Lee and Amanda Card identified a number of areas of strategic priority for Canada's clean economy, including green building construction and retrofitting, transportation, green manufacturing and waste management.[84] In 2020, Canada's Industry Strategy Council, which was commissioned by the Minister of Innovation, Science and Industry Canada, identified four areas of focus for Canadian industrial policy moving forward: digital services, environmentally-sustainable resource

production, high-value manufacturing, and agri-food production.[85] Also in 2020, academic Ryan Katz-Rosene identified four priority areas for Alberta: renewable energy, regenerative agriculture, oil and gas well reclamation, and the value-added development of hydrogen.[86] In 2022, the Sustainable Prosperity Institute identified seven possible areas of competitive advantage for Canada in a clean economy: medium- and heavy-duty zero-emissions vehicles, alternative proteins, aluminum, mass timber, green chemistry, hydrogen, and carbon capture, utilization and storage.[87]

In every case, Canada is either already a leader in the sector (e.g., agriculture, mining, transportation), has the infrastructure necessary to grow the sector (e.g., digital green services, hydrogen) and/or has no choice but to develop a domestic industry in order to achieve its emissions goals (e.g., building retrofits).

To date, Canada has made investments in each of these areas. The latest federal budget, for example, included nearly $4 billion for a "critical minerals" strategy and approximately $1 billion for agricultural clean technology and emission-reduction programs.[88] While promising, the scale of funding is inadequate, given the urgency of the transition, as we discuss in more detail below. More troubling, however, are the investments that the government is making in lower-carbon technologies that are not consistent with a net-zero emission economy. Existing advantages alone should never outweigh the climate imperative. Unmitigated climate change will be far costlier in the long term than any investment that we make today to reduce emissions.[89]

One clear example of Canada's comparative advantages taking precedence over the urgency of emissions reductions is the pressure from the incumbent oil and gas sector to invest in a blue hydrogen economy. Green hydrogen, which is produced from renewable sources, is a textbook example of a promising technology with burgeoning global demand that is not yet commercially viable. Public investment at this stage is crucial to developing the sector. In contrast, blue hydrogen, which is typically produced using natural gas, is already on the cusp of commercial viability but is only modestly less emissions-intensive than the fossil fuels used to produce it.[90] The main advantage of blue hydrogen is that it uses Canada's existing oil and gas infrastructure. Indeed, the federal government's hydrogen strategy makes explicit the argument that hydrogen provides "a future pathway to utilize [oil and natural gas] assets," whether or not that makes sense from a climate perspective.[91]

The government's interest in carbon capture, utilization and storage (CCUS) technology is similarly concerning. CCUS may be necessary for certain

industrial sectors that are irreplaceable in a net-zero economy, such as steel and cement production. Government support for those sectors may be justified. However, the government's CCUS focus, to date, has been grounded in a commitment to ongoing oil and gas production and coal combustion. The fact that Canada is competitive in a sector is no reason to pursue it in the context of a green industrial strategy. Canada's strategic focus must be limited to the overlap between (a) industries that are competitive and (b) industries that are necessary for a (global) net-zero economy. Those high-priority industries include, but are not limited to:

- Renewable energy production and transmission;
- Zero-emission transportation, including private and commercial vehicles and mass transit;
- Lower-emission agriculture, with a focus on plant-based alternatives to meat;
- Net-zero building construction, including retrofitting of existing buildings;
- Zero-emissions industrial processes, such as steel and aluminum production;
- Sustainable forestry;
- Mining and recycling of critical minerals for clean technology; and
- Digital green services.

Achieving a net-zero economy by 2050 will require targeted efforts in these areas; especially in areas that are difficult to decarbonize but remain essential in a zero-carbon economy, such as agriculture. For the industries that are largely incompatible with the 2050 goal, such as fossil fuel production, the government should be thoughtfully winding them down rather than indefinitely propping them up. Starting the decades-long wind-down process now is imperative to avoid a sudden crash in the future.

Take risks on technologies that are not yet commercially viable

In each of the strategic areas identified above, there are multiple technological pathways to net-zero. The role of governments is not to pick the correct tech-

nology up front but to create an environment in which a variety of different technologies and approaches can be tried to determine the most viable path forward. Governments cannot shy away from projects with a low likelihood of success. Likewise, where a project is not succeeding, governments cannot be afraid to pull the plug. As Mazzucato notes, when it comes to technological innovation, "for every success there will likely be many failures."[92]

To that end, governments have a role to play in providing basic research and funding demonstration projects for new technologies and related approaches for reducing emissions. Once technologies are proven, governments then have a role to play in accelerating commercialization, as they did for in situ oil sands development, and in creating public and/or private markets for these goods and services. At all stages, governments must play a key coordinating role by identifying and tackling supply chain bottlenecks and other network failures. Successful commercialization depends on sufficient funding, sufficient coordination with other elements of the supply chain and sufficient market demand.

Importantly, governments must focus their efforts where the private sector is not. Incentivizing or coordinating investment where the private sector was likely to make the investment anyway, or where they could be regulated to do so, has a much smaller impact than giving promising alternatives a leg up. For example, subsidizing extraordinarily profitable oil companies to adopt CCUS is a much less effective use of money than simply requiring the industry to do so at its own expense through regulation.

Emphasize domestic capacity over foreign dependence

Significant domestic capacity is required to accelerate Canada's decarbonization efforts. Canada must be able to produce strategic goods and services without having to wait for other countries to lead. Moreover, domestic capacity is necessary to take advantage of a growing global clean economy. Companies that are owned, controlled and headquartered in Canada "become magnets for suppliers, partners, talent and investors... and they spread those benefits broadly throughout the economy" to an extent that foreign firms do not.[93]

That doesn't mean disengaging from our trading partners. Leaning on green industrial policies in other countries can be beneficial for domestic emissions reductions. For example, China's subsidies for domestic solar manufacturers make imported solar panels significantly cheaper for Canadian firms and households to adopt. In areas in which Canada is unlikely to

compete, such as in solar manufacturing, it makes sense to take advantage of the investments made by other countries—provided those inputs can be proven to be produced without forced labour or other human rights abuses. Productive capital investments by foreign firms can also help achieve many of the objectives of a green industrial strategy, including green job creation and regional diversification, as with the $5 billion investment by Amsterdam-based auto conglomerate Stellantis and Korean technology firm LG Energy Solution in a battery manufacturing facility in Windsor, Ontario.[94]

However, being overly dependent on foreign imports and investment poses three significant challenges to a green industrial strategy. The first is a lack of control and coordination. When Canada sets out a vision and industrial mission for the future, it must have the tools to realize the goal. Dependence on foreign governments and multinational firms subjugates our industrial strategy to actors who cannot be enlisted to advance the domestic agenda.

Second, while foreign firms may create good jobs for Canadian workers, they also take advantage of Canada's highly educated, highly skilled workforce to extract value out of the country. When domestic knowledge and skills are tied up in creating value for foreign interests, that leaves behind less talent to advance domestic innovation and production.

Third, exposing smaller domestic firms to unbridled international competition can stifle the growth and development of strategic sectors. There are areas of potential strategic advantage where Canada may need to insulate less-competitive industries while they scale up. This is especially true in cases where Canada is trying to build domestic capacity to insulate against international supply chain shocks. Achieving a vibrant, net-zero economy by mid-century requires a commitment to domestic industries that may be more expensive in the short term but promise longer-term benefits.

Unfortunately, when it comes to privileging domestic firms in strategic industries, Canada has largely tied its hands through free trade and investment agreements. Many of these agreements explicitly prevent governments from implementing local content requirements or even from introducing new public institutions in otherwise commercial sectors.[95] A Canadian green industrial strategy will have to work around these limitations, renegotiate these agreements or be prepared to pay compensation to aggrieved foreign investors.

Nevertheless, Canada's efforts to scale up domestic industries should be viewed in the context of international efforts to achieve a net-zero global economy. Canada's industrial strategy should not come at the expense of international solidarity. Rather, it should be complemented by technology

transfers, climate finance and other aid to developing countries. A domestic climate and green industrial plan will only succeed if we are helping the rest of the world pull in the same direction, both to ensure international climate targets are met and to create a global market for Canadian clean exports. Indeed, a failure by rich countries like Canada to help less-developed countries decarbonize puts the entire global effort at risk.

Lead with public coordination and funding, followed by subsidies and incentives

Incentives to the private sector are often based on the assumption that increasing demand for an environmental good will automatically create supply without considering the need for coordination. For example, building retrofit incentives that aren't complemented by a commensurate public investment in training will fall flat. There are massive looming skills shortages in the building trades and creating more demand alone will not automatically produce an adequate supply of labour—and certainly not on the timeline necessitated by the climate crisis.[96]

An incentives-based approach also leaves the power in the hands of the market to decide which investments will be made. If the market is unwilling to buy in for self-interested financial reasons, the environmental and social potential of a new industry or technology may go unrealized. Conversely, incentives often provide money for investments that would have been made anyway, which means that those public funds could be better spent elsewhere.

Industrial policy expert Dani Rodrik argues that governments should provide the "missing public inputs" to innovation.[97] For example, a prerequisite for many new renewable energy projects is a smart, interprovincial electricity grid. To make the biggest impact, governments should prioritize building new transmission infrastructure and creating a regulatory environment that enables further private investment in renewables. A thoughtful green industrial strategy considers the entire supply chain and focuses public intervention in the areas where the private sector is most likely to come up short.

Sector development councils, government departments and other public institutions can play several important roles on this front. For example, public bodies can coordinate the training pipeline, both in terms of the number of workers and where they are located, with future labour market needs in a given industry. Governments can also identify the infrastructure or technology gaps that public investment is best suited to address.

In the areas in which public investments are needed, the amount of money must be significant enough to drive changes in the industry. According to Finance Canada, to achieve a net-zero emission economy by 2050, Canada needs "between $125 billion and $140 billion of investment every year" compared to the $15–25 billion being spent on the clean economy today.[98] This $100-billion-per-year investment gap will not be closed through incentives to the private sector alone. Rather than depending on private partnerships in key areas, governments cannot be afraid to make direct investments in the form of grants, equity stakes and through public institutions such as crown corporations.

As Klein notes, Canadian political leaders generally aren't afraid to spend money in the right places—the Net Zero Accelerator being a prime example—but we need public money "at a scale well beyond what any political party has campaigned on to date."[99] Mazzucato's assessment of the B.C. government's direct investment programs similarly concludes that "while $500 million is a significant amount of capital, in the context of the B.C. economy it remains a relatively small sum."[100] Canadian governments have been hesitant to lead financially, but there is no substitute for public spending power.

There still is an important role for subsidies and incentives in this model. Among other benefits, targeted subsidies can help scale up promising technologies and firms in strategic industries. However, to be most effective, these policies should supplement a publicly coordinated, publicly funded mission. Market-based policies alone lack the necessary focus to drive transformative industrial change.

Seek and maintain a political consensus

We have written elsewhere about the importance of a "just transition" for Canada, which refers to a framework for minimizing the harm to workers and communities of transitioning away from fossil fuels while maximizing the social benefits of the shift to a clean economy.[101] Thinking about industrial change through a justice lens is important for redressing social inequities and for building and maintaining a political consensus over time. Without it, projects with long time horizons face significant political risk from changes in public and government priorities.

Fundamentally, building a political consensus requires a recognition that good policy alone is insufficient for achieving a productive, inclusive net-zero

economy. Effective leadership is an integral requirement of green industrial policies, both in local and national contexts. Inviting communities to map out their own visions for the future is one approach to creating buy-in for a transformative industrial mission. To maintain that buy-in, communities must also see their input meaningfully incorporated into government priorities and they must ultimately share in the benefits over time. An industrial strategy that fails to create widespread social benefits may not maintain collective support, which puts at risk the objective of reducing carbon emissions in the long term.

As land rights holders, Indigenous Peoples must play a central role in mapping out and leading Canada's green industrial policies. Thoughtful industrial policies can advance reconciliation efforts, whether through support for Indigenous-owned businesses, targeted public investment in Indigenous communities or job creation programs for Indigenous Peoples. Among the calls to action of the Truth and Reconciliation Commission is a demand that "communities gain long-term sustainable benefits from economic development projects."[102]

Resistance to green industrial policy will come from predictable places. The oil and gas industry in Canada has resisted and obstructed climate policy and can be expected to do so for as long as it retains its political power.[103] Political movements skeptical of government intervention will also dispute specific industrial policies, especially where they involve direct public spending. There is no quick fix for these political challenges, but history offers some lessons for Canada. It is much easier to build political coalitions around specific technologies or specific projects (e.g., public transit investments), which provide clear and concrete benefits to specific communities, rather than policies with diffuse benefits (e.g., carbon pricing).[104] Public institutions insulated from short-term political considerations can play an important role in ensuring and communicating the long-term public benefits of projects.

Opportunities in zero-emission vehicle manufacturing

WHAT COULD A green industrial policy look like in practice? In this section, we apply the six principles discussed above to the specific example of the zero-emission vehicle manufacturing industry, which will be a key element of any Canadian industrial mission moving forward. The auto industry is a large, mature and competitive sector of the Canadian economy—it contributes over $10 billion to Canada's GDP and directly employs well over 100,000 people.[105] For Canada to meet its net-zero target by 2050, we need a wholesale changeover from international combustion engine vehicles to zero-emission consumer and commercial alternatives. Transitioning the auto sector is both a supply and demand issue for Canada.

While that changeover is likely inevitable on the consumer side as major automakers around the world shift to ZEVs, there is no guarantee that the Canadian auto industry will share in the benefits. At present, very few Canadian plants manufacture ZEVs. By 2026, only a handful of Canadian-made options are slated to be on the market.[106] An active industrial policy that encourages ZEV manufacturing can make the difference between a contraction and expansion of the industry, with all of the social and economic spinoffs that entails.[107] Modern auto manufacturing drives innovation in a wide variety of other industries, including "robotics, artificial intelligence,

sensors, telecommunications, new materials and advanced manufacturing processes."[108]

The federal government has acknowledged the importance of domestic ZEV manufacturing, but its "hands-off, fingers-crossed" industrial policy over the past two decades has resulted in shrinking production and a smaller workforce.[109] Until recently, the government's main policy interventions have focused on consumer subsidies, sales mandates, efficiency standards and charging infrastructure, all of which increase the likelihood of ZEVs ending up on the road but none of which directly support the domestic manufacturing sector. In contrast, Canada's major competitors when it comes to ZEV production, including the U.S., China and Germany, are all employing aggressive industrial policies to grow their domestic ZEV capacity to take advantage of a growing global market.

Canadian governments have started to respond. In the past two years alone, the Strategic Innovation Fund has helped attract billions of dollars in foreign investment into the sector, including projects from Ford, General Motors and Honda.[110] The Government of Ontario's new Automotive Modernization Program is funding dozens of small- and medium-sized parts manufacturers.[111] However, there are many untapped opportunities to realize the full potential of the sector.

A comprehensive green industrial strategy for Canada's auto sector must apply the six principles discussed above, starting with a more complete vision. Although the mission to replace ICE vehicles with ZEV alternatives in the coming decades is clear enough, there is no unified vision for where those vehicles will come from. Will Canada be a significant producer of ZEVs by 2050, or will we be content to meet our targets mainly through imported vehicles? If it's the former, the mission must consider the entire supply chain to ensure Canada has the needed capacity at every stage to maximize opportunities in the sector.

Second, while the Canadian mission should establish a complete supply chain for ZEVs, efforts should focus on the specific links in the ZEV supply chain in which Canada is best positioned to compete globally, including commercial vehicle design, computer systems, parts manufacturing and final assembly.[112] Canada is also well-positioned to compete at all stages of battery production, from mineral mining to precursor materials to component manufacturing to final assembly. Carving out niches is an important step in solidifying Canada's role in the rapidly evolving industry.

Third, Canada must take risks on unproven technologies that may yet transform the transportation industry. A proposed hydrogen trucking dem-

onstration project is one such investment, but, as noted above, long-term success depends on governments backing a wide variety of prospective technologies with the expectation that many of them will not work out. Recent federal budgets have taken steps in this direction, including through investments in artificial intelligence in the area of connected and autonomous vehicles.[113] More ambitious "moon shot" projects are needed.

Fourth, while Canada is home to many large parts manufacturers, such as Magna, Canada's domestic capacity in automotive assembly is largely dependent on foreign investment by major international (mainly American) automakers. While foreign investment will inevitably play an important role moving forward, there are other links in the ZEV supply chain where direct public investment is sorely needed. Public research and development can play a key role in advancing the domestic ZEV industry, as can industrial policies to scale up smaller, ZEV-focused firms that are competing with international automakers. In general, governments should be identifying and plugging holes in the domestic ZEV supply chain.

Fifth, governments must play a key role in coordinating the transition to ZEV manufacturing in Canada. The complexity of emerging supply chains compounded by the speed of industrial transformation necessitates a steady hand to oversee and manage the sector. Where the private sector is moving too slowly, or obstructing efforts to transition to ZEVs, governments cannot be afraid to intervene. For example, if private firms shut down Canadian plants, governments can step in with public money to nationalize those facilities and revive them for strategic purposes.

Finally, a successful green industrial policy in the auto sector will ensure a just and productive transition for all the workers and communities that are impacted by the shift to ZEVs. In the absence of government interventions to protect the livelihood of workers, this necessary shift to a cleaner transportation system risks displacing thousands of workers (and their families and communities) at every stage of the supply chain, from oil refiners to assembly technicians to mechanics. Ensuring that the benefits of new investment flow through to workers (and that the costs of moving away from ICE vehicles are shared fairly) will go a long way toward building political consensus for the mission.

Recommendations

GREEN INDUSTRIAL POLICY is the missing piece in Canada's climate action puzzle. Government interventions in the economy to scale up strategic industries while managing the decline of the fossil fuel sector will be necessary to reduce emissions in line with a net-zero economy by 2050 while ensuring the Canadian economy is productive and inclusive in the future. Canada already employs a wide variety of green industrial policies, but they are insufficiently coordinated and funded, given the urgency of the climate crisis.

Writing 10 years ago for the CCPA, Marc Lee and Amanda Card made 12 recommendations for the federal government related to green industrial policy.[114] Some of their recommendations, such as the imposition of a national carbon pricing system, have been implemented successfully. Many others, however, have been adopted without sufficient financial or regulatory support to be successful. The rest have been missed entirely. These outstanding proposals form the basis for our own recommendations, which we have simplified into four key priorities for the federal government.

1. **Articulate a clear vision for a clean economy** that is consistent with net-zero emissions by 2050 and grounded in the democratic process. The vision must include the winding down of the fossil fuel industry and the scaling up of strategic green industries (rather than a "clean economy" in the abstract). Once articulated, the vision must be realized concretely through legislation and regulation that, among other priorities, establishes a deadline for oil and gas production.

2. **Build a grassroots political consensus around the national vision** through a participatory democratic process with workers and communities across the country. Different communities and regions will have different priorities but they can still inform the national vision and shape regional and community-level implementation strategies. Commissions, agencies and other government bodies that are insulated from the political process can play an important role in building and maintaining broad-based support for industrial change over the long term.

3. **Develop a comprehensive, government-led national green industrial strategy** that is focused on the net-zero mission, with consideration given to job creation, social benefits and regional diversification. The urgency of the climate crisis requires immediate action in a wide variety of areas. Governments must bet big on a portfolio of the most promising industries and technologies, especially where the private sector has been reluctant to make these types of investments.

4. **Drive the green industrial strategy with public money** to kickstart innovation, stimulate the economy and ensure, through public ownership, that the long-term benefits of greener industry flow back to the public. Private capital should be leveraged where possible, but the government cannot afford to wait for the private sector to lead on strategic priorities with long time horizons. Ambitious, mission-oriented public projects, such as an aggressive national retrofitting strategy for homes and buildings, can drive demand for new industries and rally public support behind the broader goal.

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