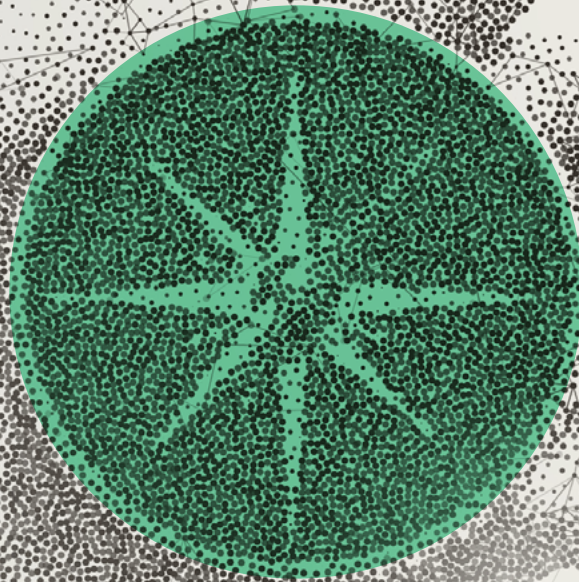




CANADA'S OPPORTUNITY PLAYBOOK:

Pathways to Strategic
Decarbonization

Part I



The Transition
Accelerator



L'Accélérateur
de transition

Canada's Opportunity Playbook:

Pathways to Strategic Decarbonization

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About The Transition Accelerator

Our Objective

The energy transition is disrupting global power. The Transition Accelerator is here to help Canada win — **economically** and **geopolitically**.

Our Work

The Transition Accelerator develops projects, partnerships, and strategies to ensure Canada is competitive in a carbon-neutral world. We're harnessing the global shift towards clean growth to secure permanent jobs, abundant energy, and strong regional economies across the country.

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.

Our Unique Approach

- We understand the current system in practice, not just in theory, identifying barriers to innovation and opportunities for change.
- We bring together industry, labour, government, Indigenous and other leaders to define shared visions of success for their sectors, regions, or communities.
- We mobilize partners to develop pathways to get there, understanding and refining them to ensure they are credible, capable, and compelling.
- We turn ideas into action and take steps down those pathways by launching projects and partnerships to build a more competitive future.

For more information or interview opportunities please contact communications@transitionaccelerator.ca

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Canada has the resources to compete in the clean energy economy but has yet to deploy them with the strategic coherence the moment requires.

Executive Summary

Decarbonizing Canada's energy system is no longer just an environmental imperative. It represents one of the main economic growth opportunities in coming years. However, successfully achieving these two objectives requires a more strategic approach to decarbonization: one that focuses on systems change rather than the incremental progress that has defined the last decade.

Instead of viewing climate change as a pollution control problem, this approach focuses on building the new systems that can contribute to the country's prosperity. And rather than treating the economy as an undifferentiated whole, which makes problems seem insurmountable, it focuses on sectoral and regional pathways that break the transformation into manageable steps.

Given the growing array of greenhouse gas reduction approaches, it can be challenging to know where to direct our efforts. Which approaches represent genuinely viable pathways to carbon neutrality that are ready for widescale deployment? Which can realistically strengthen Canada's position in global markets and promote meaningful economic development? And which are dead-end pathways that may deliver incremental, short-term emissions reductions but cannot scale to net zero and/or risk locking in carbon-intensive infrastructure?

This report addresses these questions across 14 sectors, articulating a strategic framework that identifies the pathways most capable of delivering system-level change while also capturing economic benefits for Canada along the way.

The report starts from a transition and energy systems perspective. Reaching net zero requires replacing the large-scale systems that generate emissions: the way Canadians produce and distribute electricity, move

people and goods, heat buildings, and make the materials the economy requires. These systems were built around fossil fuels. The future systems will be built around non-emitting electricity.

Working backwards from this electrified energy system, we can define the pathways that have the most potential. While it is not possible to anticipate every technological and economic development the coming years will bring, many system considerations and market signals are already clear. These indicate:

- **Electricity** will play the lead role in a decarbonized energy system. End-use electrification should be viewed as the top priority for most sectors that today rely on fossil fuels.
- **Net-zero fuels** can complement electricity in sectors where full electrification is not feasible.
- **Enhanced energy efficiency** can reduce the demand on new decarbonized energy.
- **Non-energy emissions** (waste, industrial processes, and agriculture) will require dedicated attention.
- **Residual emissions** should be driven as low as possible, with the remainder offset by carbon removal.

Adopting a strategic approach to decarbonization

Societal decarbonization is a process that will extend across multiple decades. Over this time, political priorities, economic conditions, national concerns, and the geopolitical context will continuously evolve. In acting today, we should prioritize pathways where alternative technologies are ready for wide deployment, and the potential gains for

households and industry are clear. Taking a strategic approach means we should:

1. Ensure decarbonization is integrated with the pursuit of other societal objectives, including enhanced prosperity, economic competitiveness, security, social welfare, and Indigenous reconciliation.
2. Seize electrification as the central link by building out supply and electrifying end-uses in transport, buildings, and industry.
3. Focus on creating the new rather than tearing down the old.
4. Embrace asymmetrical decarbonization. Provinces and sectors will proceed down varied pathways towards net zero at rates appropriate to their circumstances.
5. Prioritize practical steps needed to achieve decarbonization, and physical measures of progress.
6. Pay attention to costs and prices which are critical to both households and industrial competitiveness.

Taken together, these priorities point toward a clear strategic logic: move fast where the economics are compelling, build the foundations that unlock broader transformation, and avoid diverting scarce political and investment capital into battles that cannot yet be won.

Looking across 14 sectors, the assessment asks three questions of each: which pathways can deliver real system-level decarbonization, what decision-makers should do about them today, and how those actions should be sequenced. The answers determine where each sector sits across three tiers of strategic priority shown below.

Strategic Decarbonization Priorities for Canada

Immediate Priorities



Personal Mobility
(Light-duty vehicles
and mass transit)



Buildings



Electricity

Medium-term Opportunities



**Alternative
Fuels**



Aluminium



**Cement
& Concrete**



Hydrogen



**Medium and
Heavy-Duty
Vehicles**



Mining



Steel & Iron

Longer-term Plays



**Agricultural
& Agri-food**



Oil & Gas



**Chemicals &
Plastics**

This sequencing does not mean that longer-term sectors are not relevant today. Rather, it provides a clearer sense of where first to direct finite capital and policy efforts: the sectors with the most leverage to advance a competitive low-carbon economy.

At a sector level, each chapter reviews the current state of the sector, the key barriers to reaching net zero, and the technologies,

practices, and system changes most relevant to decarbonization. Various pathway elements are then evaluated against criteria covering the potential to reduce emissions, technical maturity and fit, economics, and social acceptability. Finally, the assessment assigns each pathway one of four core roles in the net-zero system.



Decarbonization Pathway

Can decarbonize the system and has several other benefits.



Enabling Pathway

Does not directly eliminate emissions but is essential to the successful deployment and performance of other pathways.



Niche Pathway

Can decarbonize a targeted sectoral or regional system.



Bridge Pathway

Serves to reduce emissions while full decarbonization options are developing and does not create an infrastructure lock-in.



Dead-End Pathway

Incompatible with a decarbonized system.

From Vision to Action

In addition to identifying where Canada should focus and in what sequence, the combination of sectoral assessments reveals a set of implementation challenges that extend beyond any single sector: the pathways are deeply interdependent, the global competition to lock in low-carbon value chains is well advanced, and the institutional capacity to coordinate across sectors at the required pace has to be built deliberately.

The urgency of getting this right comes into sharper focus in the global context. Canada's trading partners are deploying ambitious industrial policies to lock in positions in the clean energy economy. China now accounts for more than half of global solar capacity additions and 60% of global EV sales. The European Union, Japan, Korea, and India have all launched directed industrial packages. The window for Canada to establish defensible positions in sectors like battery materials, low-carbon aluminum, critical mineral processing, and EV manufacturing is open now but will not remain so indefinitely. A focused approach could secure approximately \$600 billion in annual clean energy export opportunities by 2035.[1]¹

This report argues that **Canada has the resources to compete in the clean energy economy but has yet to deploy them with the strategic coherence the moment requires**. Converting those foundations into a defensible economic position means treating the interconnected sectors in this report as a single industrial system to be built, not a set of parallel portfolios to be managed.

Reading this Report

Chapters 1 through 5 develop the transitions, energy systems and economic development perspective in greater depth. Chapter 5 presents the detailed sectoral pathway assessments that underpin the summary table on the previous page. Chapter 6 develops the implementation conditions and the choices that flow from them.

Together they offer a strategic foundation for the policy and investment decisions that will determine whether Canada builds the energy system of the future while growing its economy or arrives late to a new economy built somewhere else.

¹ All noted references can be found in the full Playbook document.

Table of Contents

Executive Summary	ii
List of Abbreviations	xi
1. Introduction.....	1
2. Accelerating System Transitions	5
3. An Energy Systems Perspective	9
4. Looking Beyond the Energy System.....	17
5. Approaching Decarbonization Strategically.....	19

Table of Figures and Tables

Figures

Figure 1. Adoption of automobiles in the United States and the effect of major global pressures.....	3
Figure 2. Adoption of electric power, automobiles, and washing machines in the United States between 1920 and 2004.	4
Figure 3. Typical S curve of technology or practice adoption and system transition.	6
Figure 4 Schematic overview of Canada's current energy system.....	13
Figure 5 Schematic overview of Canada's future energy system	15

Tables

Table 1. Diversity of Canadian provincial energy systems is illustrated through GHG emissions (per capita and per unit of GDP) and the economic value of key energy exports	11
Table 2. Where to Move First: A Strategic Sequencing of Canada's Decarbonization Priorities	21

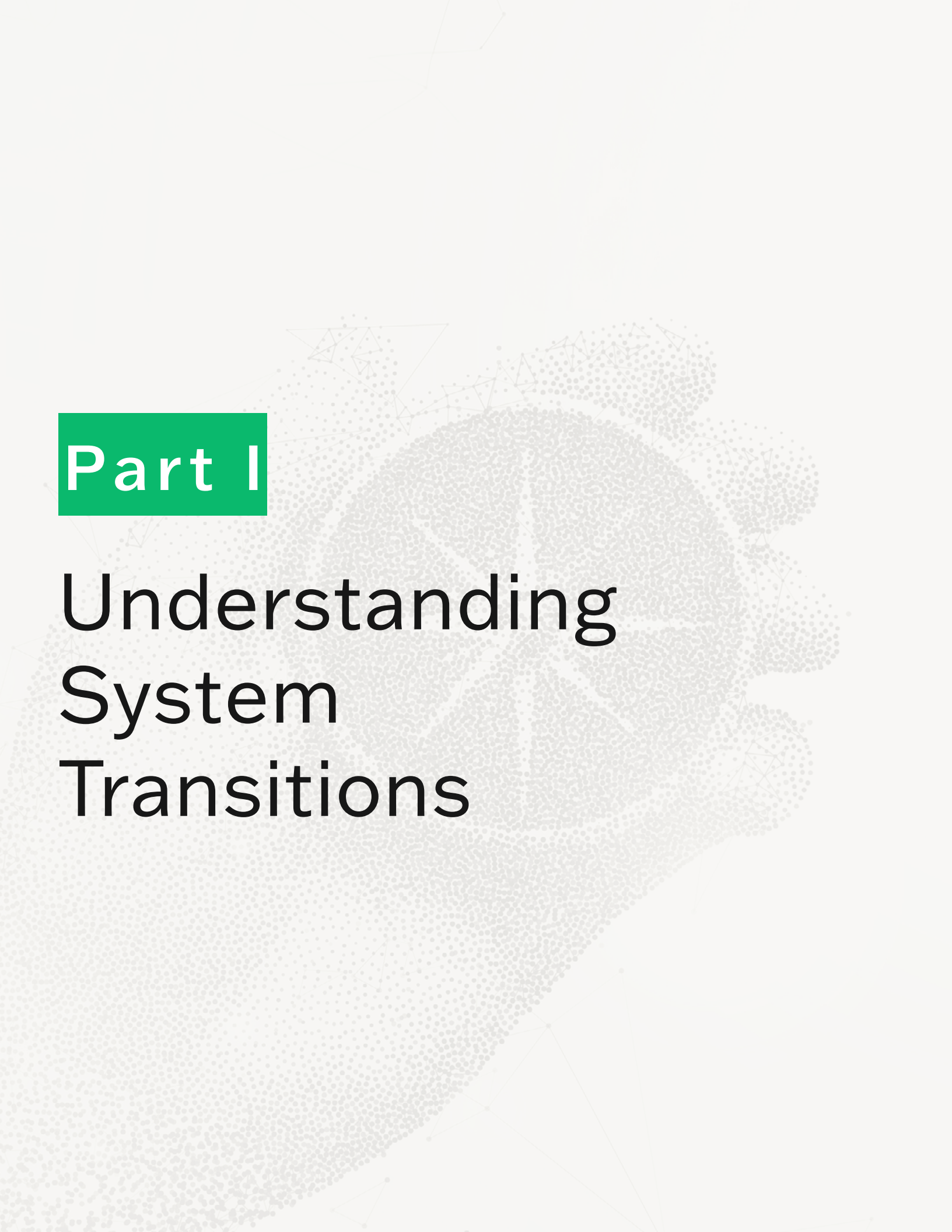
List of Abbreviations

ABBREVIATION	DEFINITION
4R	Right source, right rate, right time, right place
AB	Alberta
AER	Alberta Energy Regulator
AI	Artificial Intelligence
ASHP	Air Source Heat Pump
ATR	Autothermal Reforming
AZEHT	Alberta Zero-Emission Hydrogen Transit
B20	20% biodiesel / 80% petroleum diesel blend
BCA	Border Carbon Adjustment
BEB	Battery Electric Bus
BECCS	Bioenergy with Carbon Capture and Storage
BEV	Battery Electric Vehicle
BF	Blast Furnace
BMP	Best Management Practice
BOF	Basic Oxygen Furnace
BtL	Biomass-to-Liquids
CAD	Canadian Dollar
CCA	Capital Cost Allowance
CCS	Carbon Capture and Storage
CCUS	Carbon Capture, Utilization, and Storage
CER	Clean Electricity Regulator
CFS	Clean Fuel Standard
CI	Carbon Intensity
CO ₂	Carbon Dioxide
CO ₂ e	Carbon Dioxide Equivalent
Co-gen	Cogeneration
CORSIA	Carbon Offsetting and Reduction Scheme for International Aviation
CPKC	Canadian Pacific Kansas City
C-SAF	Canadian Council for Sustainable Aviation Fuels
CUSMA	Canada-United States-Mexico Agreement
DAC	Direct Air Capture
DRI	Direct Reduced Iron
DR-grade	Direct Reduction Grade
E10	10% ethanol / 90% gasoline blend

ABBREVIATION	DEFINITION
E85	85% ethanol / 15% gasoline blend
EAF	Electric Arc Furnace
e-fuel	Electrofuel
EPR	Extended Producer Responsibility
e-SAF	Synthetic Sustainable Aviation Fuel
ESG	Environmental, Social and Governance
E.U.	European Union
EV	Electric Vehicle
e-waste	Electronic Waste
FCEVs	Fuel Cell Electric Vehicle
FOAK	First-of-a-kind
FT	Fischer-Tropsch
GDP	Gross Domestic Product
GHG	Greenhouse Gas
GSHP	Ground Source Heat Pump
GWh	Gigawatt Hour
GWP	Global Warming Potential
H ₂	Hydrogen
H ₂ -DRI	Hydrogen-based Direct Reduced Iron
HBI	Hot Briquetted Iron
HD	Heavy Duty
HDVs	Heavy Duty Vehicles
HEFA	Hydroprocessed Esters and Fatty Acids
HEV	Hybrid Electric Vehicle
HFCs	Hydrofluorocarbons
HVAC	Heating, Ventilation and Air Conditioning
ICE	Internal Combustion Engine
ICEV	Internal Combustion Engine Vehicle
IP	Intellectual Property
IPCC	In-Pit Crushing and Conveying
IRP	Integrated Resource Plan
IT	Information Technology
kg	Kilogram
km	Kilometre
kW	Kilowatt
kWh	Kilowatt hour
L	Litre

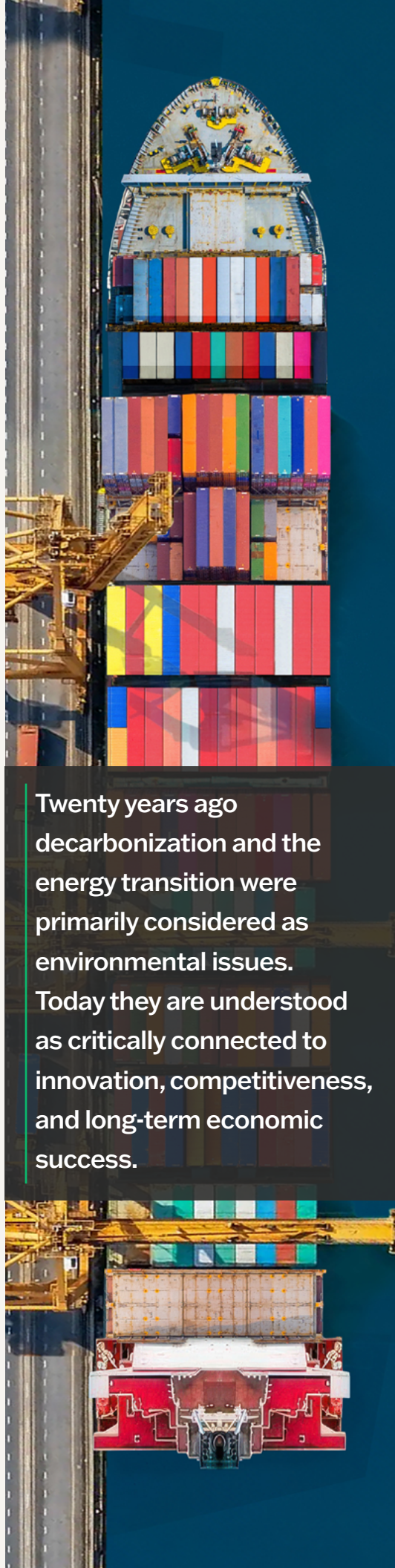
ABBREVIATION	DEFINITION
LCA	Life-Cycle Assessment
LCFS	Low Carbon Fuel Standard
LDVs	Light Duty Vehicles
LED	Light-Emitting Diode
LNG	Liquefied Natural Gas
LRT	Light Rail Transit
MB	Manitoba
MD	Medium Duty
MDV	Medium Duty Vehicle
MHDVs	Medium and Heavy-Duty Vehicles
MJ	Megajoules
MOE	Molten Oxide Electrolysis
MOU	Memorandum of Understanding
Mt	Megatonne
MURB	Multi-Unit Residential Building
MVR	Mechanical Vapour Recompression
MW	Megawatt
MWh	Megawatt hour
N ₂ O	Nitrous Oxide
NB	New Brunswick
NERC	North American Electric Reliability Corporation
NG	Natural Gas
NG-DRI	Natural Gas-based Direct Reduced Iron
NL	Newfoundland and Labrador
NO _x	Nitrogen Oxides
NRCan	Natural Resources Canada
Nox	Nitrous Oxide
NS	Nova Scotia
NT	Northwest Territories
NU	Nunavut
O&G	Oil and Gas
O&M	Operation and Maintenance
O ₂	Oxygen
OECD	Organisation for Economic Co-operation and Development
OEM	Original Equipment Manufacturer
ON	Ontario
PE	Polyethylene

ABBREVIATION	DEFINITION
PEI	Prince Edward Island
Petcoke	Petroleum Coke
PFC	Perfluorochemicals
PHEV	Plug-in Hybrid Electric Vehicle
PJ	Petajoule
PtL	Power-to-Liquids
PtX	Power-to-X
PV	Photovoltaic
QC	Quebec
R&D	Research and Development
RD	Renewable Diesel
RD&D	Research, Development and Demonstration
RNG	Renewable Natural Gas
SAF	Sustainable Aviation Fuels
SAGD	Steam-Assisted Gravity Drainage
SCM	Supplementary Cementitious Materials
SK	Saskatchewan
SMR	Small Modular Reactor
SMR	Steam Methane Reforming
SX-EW	Solvent Extraction-Electrowinning
TIER	Technology, Innovation, and Emissions Reduction
U.K.	United Kingdom
U.S.	United States of America
VOC	Volatile Organic Compound
YT	Yukon
ZETF	Zero Emission Transit Fund
ZEV	Zero-Emission Vehicle

The background features a large, semi-transparent green rectangle on the left side. Overlaid on this and the rest of the page are faint, light-gray geometric patterns, including a network of interconnected dots and lines, and a cluster of small triangles. The overall aesthetic is modern and technical.

Part I

Understanding System Transitions



Twenty years ago decarbonization and the energy transition were primarily considered as environmental issues. Today they are understood as critically connected to innovation, competitiveness, and long-term economic success.

1. Introduction

Canada stands at a pivotal moment in its energy and economic history. The global transition away from fossil fuels is underway, reshaping industries, supply chains, and competitive positions across every major economy. How Canada navigates this multi-decade transition will determine its prosperity, energy security, and standing in the world.

The decisions that shape this transition are being made now. Governments are setting policy frameworks. Industries are committing capital. Investors are placing long-term bets. But not all courses of action are equal. Some align directly with Canada's decarbonization, economic and competitiveness objectives—they reduce costs, increase productivity, and build industrial advantage. Others do not. Getting these decisions right requires a clear-eyed view of where Canada's options stand, what is working, and where effort needs to be concentrated. That is the purpose of this report.

The report adopts a transition, energy systems, and economic development approach. Rather than treating climate change as a pollution control problem by focusing narrowly on emissions, it examines opportunities to transform the large-scale societal systems that generate these emissions. Today, major systems of social provisioning—the way we move people and goods, construct buildings, produce food, operate industry, and so on—remain dependent on greenhouse gas (GHG) emitting fossil fuels. Shifting them onto more sustainable trajectories is at the core of the net-zero challenge. This requires an understanding of how existing systems operate and the non-climate-related problems influencing their evolution. So, the focus of this report is not “tonnes to target” (although ultimately the math must add up!), but on transforming key systems into configurations compatible with net zero.

Throughout the report, we make the case that Canada's decarbonization must be closely linked to industrial and economic development goals that can ensure a prosperous future for Canadians. Building net-zero industry and services can increase the country's competitiveness and improve our quality of life.

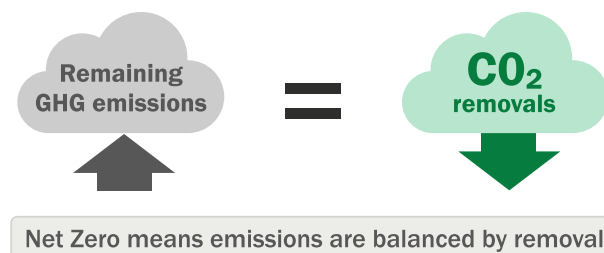
Twenty years ago, decarbonization and the energy transition were primarily considered environmental issues. Today, they are understood as critically connected to innovation, competitiveness, and long-term economic success.[2,3]

The high-level analysis presented in this report is intended to complement the more detailed and ground-up regional and sectoral pathway work undertaken by The Transition Accelerator and other societal actors, as well as more comprehensive quantitative assessments.

In the full sense, a **"transition pathway"** describes the sequence of multi-dimensional changes (to technologies, business strategies, policy and regulatory frameworks, social practices, financing, and so on) required to transform a system. Such pathways are detailed and context-dependent and differ by region and sector. Here we are concerned less with such fine-grained analysis and more with the broad strategic picture of major technical and social elements which can anchor transformative change, and the actions which can accelerate their deployment.

For the purposes of this report, we understand **"net zero"** to imply a society where any remaining GHG emissions are counterbalanced by removals. Since removal technologies involve many uncertainties, we emphasize reducing sector emissions towards zero, leaving the smallest residual to be handled through removals. Looking forward to mid-century, we assume that Canada will continue to experience economic and population growth roughly along the lines of

recent decades. Further, Canada's movement towards net zero is understood in the context of a coordinated international effort, even if progress across countries remains uneven.



The evaluation presented here is based on a review of existing literature, consultation with experts, and the practical experience of The Transition Accelerator. It presents a comprehensive high-level assessment of decarbonization pathway elements, highlighting important sectors and promising trends. Not all systems and sectors are covered, or covered in the same detail. Although the report draws on publicly available modelling work, it is not based on a specific modelling exercise. Its focus is rather to identify the broad avenues of advancement and their potential to deliver net-zero emissions along with other societal objectives.

The first version of this report appeared in January 2021. This second edition has been comprehensively updated, expanded to cover new sectors, and adjusted to reflect both advances in decarbonization and shifts in the domestic and international conjuncture that have occurred over the intervening five years.

The international landscape has shifted considerably since 2021. The wave of ambition that followed the 2015 Paris Climate Summit has met the friction of real-world pressures: the pandemic, wars, tariffs, controversies over immigration, fraying international alliances, economic challenges, and intensifying geopolitical tension have increasingly preoccupied

governments. Some countries that played a leading role in early decarbonization efforts have encountered problems such as rising electricity prices, challenges to grid resiliency as more variable renewables have been added, or lagging industrial competitiveness in low-carbon technologies. Meanwhile, fossil fuel incumbents, now alert to the structural threat the energy transition poses to their long-term revenue base, have become more organized and assertive in shaping policy debates around climate change.

Yet unexpected problems and temporary reverses are typical of large-scale societal transitions which span multiple decades (see Figure 1 and 2). Shifting the global development trajectory away from the unmitigated combustion of fossil fuels, which has powered industrial and societal development for more than 200 years, is not a simple task.

What the zoom reveals: Automobile adoption dropped sharply during the Great Depression and WWII — falling from ~60% to ~50%. Viewed alone, this looks like a failing technology. Zoom out and it's a blip in a 100-year S-curve.

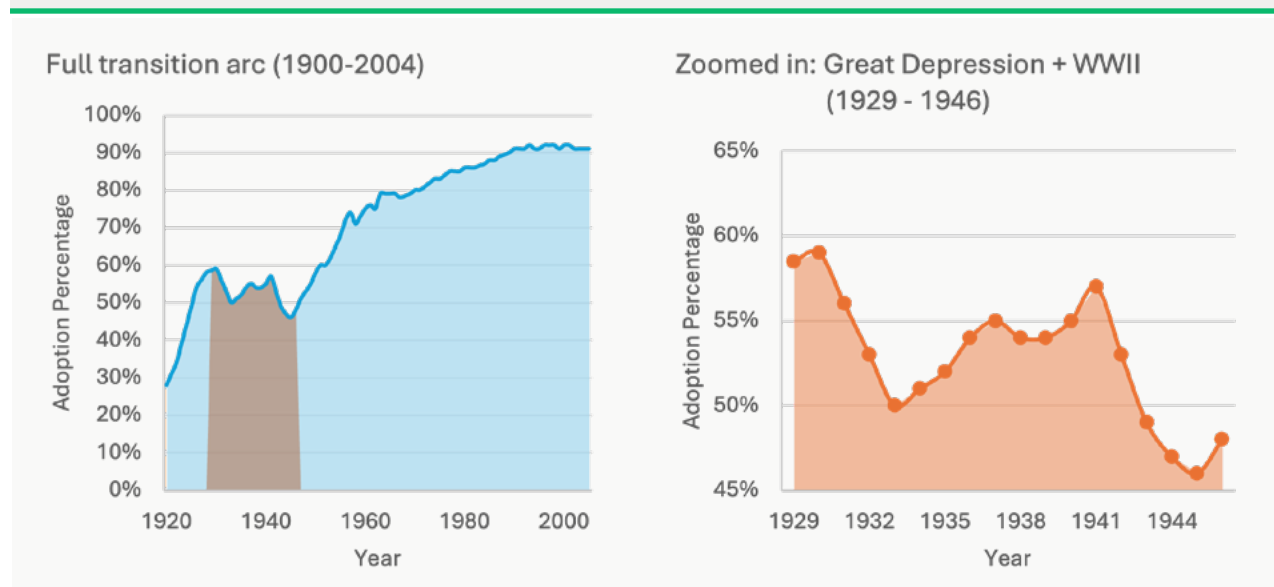


Figure 1. Adoption of automobiles in the United States and the effect of major global pressures
Adapted from Our World in Data[4]



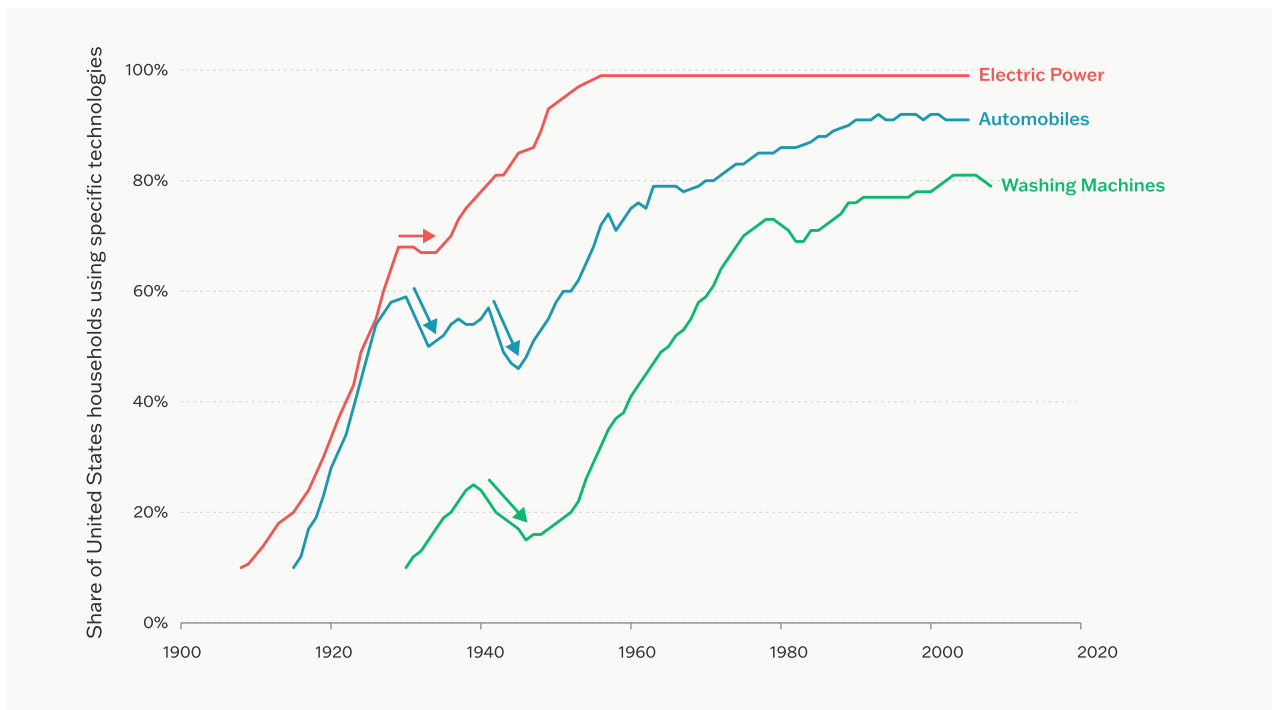


Figure 2. Adoption of electric power, automobiles, and washing machines in the United States between 1920 and 2004.

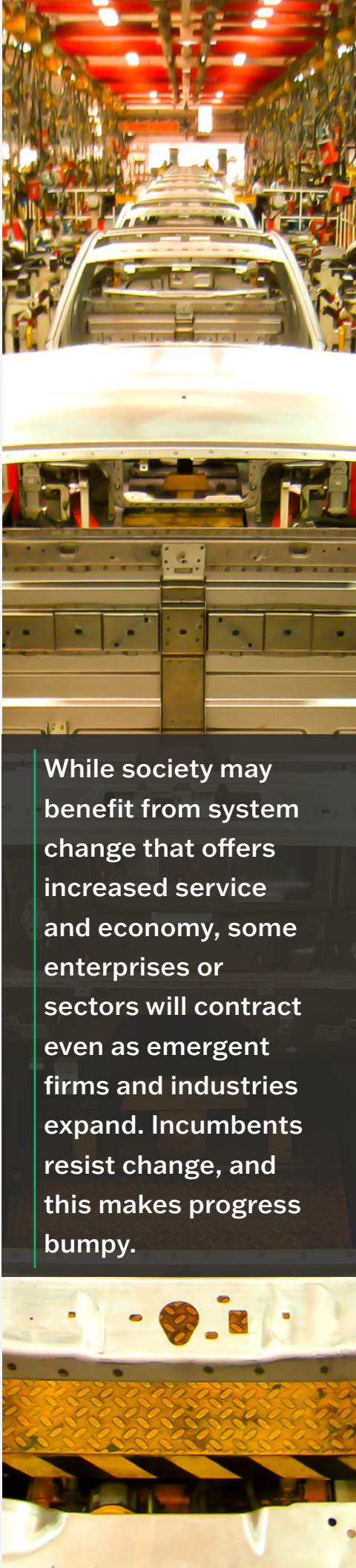
Adapted from Comin, Hobijn, and Our World in Data[4,5]

Above all, it is important to appreciate that, *despite political and economic headwinds*, the global momentum towards low-carbon technologies continues to advance. According to the International Energy Agency, global investment in clean energy (renewables, electricity grids, storage, EVs, nuclear, low-emission fuels, etc.) is now double that going to fossil fuels.[6] With sales of over 20 million units in 2025, EVs make up about 25% of global auto sales.[7] Global PV levelized costs of electricity fell 90% from 2010 to 2024, and renewable technologies and electric vehicles are now increasingly being adopted in developing countries.[8,9]

This analysis represents our best effort to systematize current understanding, set against a landscape where technologies are advancing, markets are shifting, and our collective understanding continues to evolve.

We welcome commentary and feedback that can sharpen the analysis and rectify mistakes. Through this engagement we seek to contribute to the broader societal debate about the net zero challenge and the contours of the Canada we wish to see emerge over coming decades.

The report is organized into three parts. The first deals with our basic approach, outlining what we mean by “transition” and “energy system” perspectives, briefly examining the issues of non-energy-related emissions and GHG removals, and exploring a strategic approach to decarbonization. The second part presents the analysis of specific system and sector pathway elements. And the third offers some general conclusions and implementation considerations.



While society may benefit from system change that offers increased service and economy, some enterprises or sectors will contract even as emergent firms and industries expand. Incumbents resist change, and this makes progress bumpy.

2. Accelerating System Transitions

Getting to net zero will require major changes in the large-scale systems we use to meet societal needs, including the way we produce and distribute energy, move people and goods, and build our cities.[10,11] Although change in such systems is typically incremental, there have been many dramatic transformations in the past: consider the emergence of a transport system based around the personal automobile,[12] the build-out of electricity systems to provide power for homes and businesses,[13] or the ways computing, the digital economy and AI are altering how we live today.

These “system transitions”, which may take several decades, involve interconnected changes to technologies, social practices, business models, regulations and societal norms.[12,14,15] Transitions are periods of considerable uncertainty, since it is unclear how fast change will come and which approach will pan out. They are accompanied by significant distributional impacts. [16] While society may benefit from system change that offers increased service and economy, some enterprises or sectors will contract even as emergent firms and industries expand. Incumbents resist change, and this makes progress bumpy.[17,18] Moreover, there are always multiple ways to apply new technologies, social practices, or business models, which articulate different values and/or provide alternative distributions of benefit. So, transitions inevitably involve struggles over the direction and pace of change.[19,20]

It is no surprise, then, that governments, politics, and policy play an important role in system transitions.[21,22] States may see strategic, military, or commercial advantage in emergent technological systems (for instance the development of steam ships, satellites, drones, or AI). Changes to regulatory frameworks and property rights are normally required to unleash the potential of new approaches. And incumbents and challengers alike compete actively to shape the rules in their favour.

Transitions typically pass through three stages: emergence, diffusion, and system reconfiguration.[23] *Emergence* is about developing and testing alternatives. Dissatisfaction with the established way of doing things spurs innovators to experiment. At first, new technologies are expensive and imperfect, and the designs and business models that will allow widespread adoption are unclear. Novel solutions typically emerge in protected niches, where users are willing to pay over the odds and ignore functional shortcomings. Solar cells, for example, found early application generating power for spacecraft and in remote locations. As innovators gain experience with the new technology, a combination of favorable circumstances (problems with the existing regime, changes in political or economic context) may allow a more direct challenge to the status quo.[24,25]

During the *diffusion* phase, the new approach gains adherents and improves functionality, and prices fall with economies of scale. Positive feedback loops kick in as consumers

become increasingly familiar with the new technology, infrastructure is built out, complementary innovations come to market, and more favorable policy and regulatory frameworks are put in place. As this phase advances, incumbents may become increasingly alarmed by the rapid progress of the challengers and very public struggles over the direction of change may emerge.[26,27]

Eventually, change impacts the overall configuration of the system. Sometimes, the novel elements are incorporated through realignment while important features of the previous system remain, but on other occasions a new system almost entirely replaces the old. With this *reconfiguration*, regulatory and policy frameworks become fully aligned with the new arrangements, linkages to other systems are stabilized, and challengers become the new incumbents.[28] These three phases trace out a classic S curve, where a long preparatory phase gives way to widespread deployment and ultimately system transformation (see Figure 3).

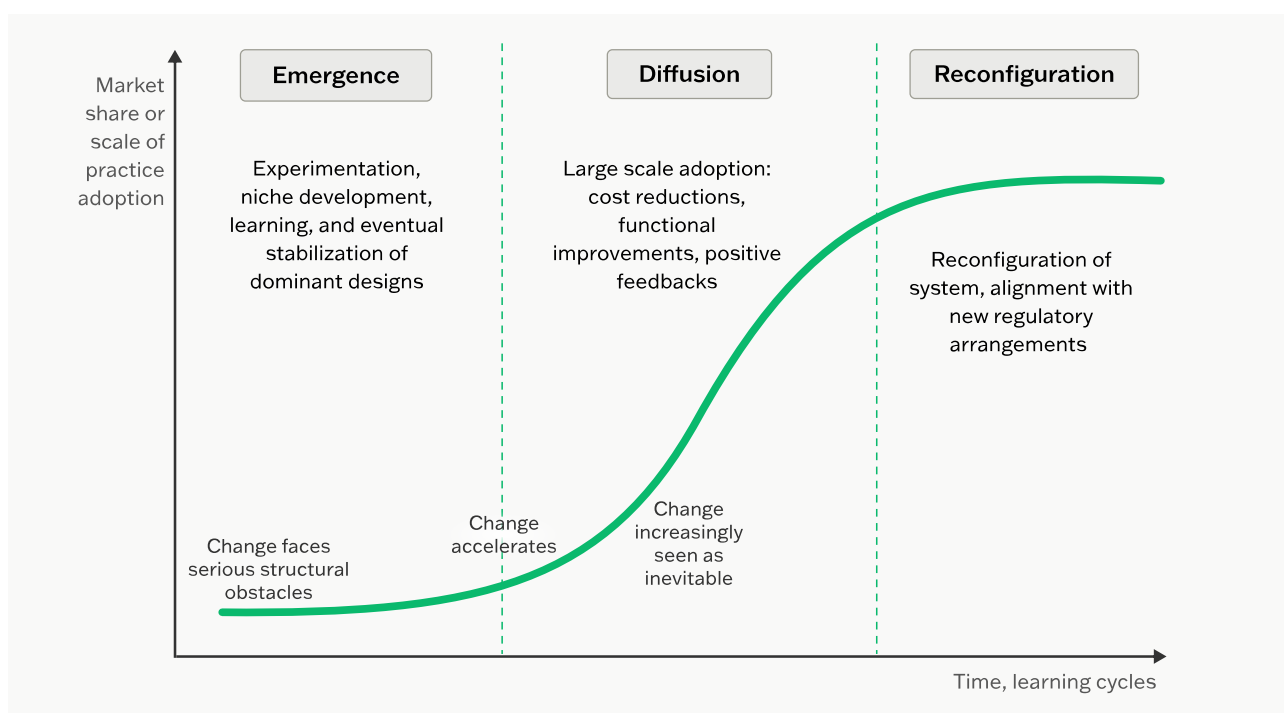


Figure 3. Typical S curve of technology or practice adoption and system transition.

Adapted from Victor, Geels and Sharpe, 2019[77]

Approaching the climate challenge from the perspective of system transitions brings to the fore issues that can help the design of transformational pathways and the formulation of supportive policy. In the first place, while it is common to talk about “the energy transition” as a single phenomenon, decarbonizing the economy will actually involve a series of interrelated transitions across distinct sectoral systems: personal mobility, freight movement, agri-food, and more.[10,11] Each has its own dynamics and different obstacles and enabling factors. Moreover, climate change is not the only problem in these systems, nor is it typically the most powerful driver of change. Cost pressures, competitiveness, demographic shifts, security concerns and technological disruption often exert more immediate influence. Thus, effective decarbonization strategy must work with these forces, not in spite of them.

Some sectors are already being disturbed by powerful disruptive currents that go well beyond climate policy. The auto sector is being reshaped by electric and autonomous vehicles, as well as by new mobility platforms like ride-hailing apps. Housing is under pressure from an affordability crisis that is forcing a rethink of how and where Canada builds.[29-32] Integrating decarbonization initiatives with solutions to broader challenges, including Canada's drive to diversify trade and build economic resilience in light of evolving geopolitical tensions, is therefore critical.

Other policy implications of a transition approach to reaching net zero include:

- Accelerating system changes that achieve net zero (and other societal objectives) should be the focus of policy design, rather than trying to secure the lowest-cost incremental GHG reductions by a specified date. In many cases the cheapest or most

obvious abatement opportunities are not part of a transformational pathway, and investing in them wastes time and resources that can better be devoted to more strategic efforts.

- Policy should be attuned to the particularities of the **sector** and **region** under consideration. Only in this way can it empower innovators and target the specific barriers that are preventing change. Agri-food, personal mobility, and buildings involve different technologies, actors, and regulatory frameworks, and specific pathways and policy supports are required in each context.
- An understanding of transition phases (emergence, diffusion, reconfiguration) can help guide the design of the policy mix at each stage of the transformational process (see Box on the next page). A vast array of policies, including R&D support, infrastructure investment, regulations, tax measures, subsidies, and public education can be applied. At a certain point, phase-out measures may be required, including retirement dates for specific processes, fuels, or technologies, as well as measures to compensate those disadvantaged by change. But mistakes in timing the introduction of such measures can be counterproductive.
- At the appropriate moment, governments must be prepared to back particular technologies and social and business practices that can accelerate net-zero pathways and economic development. Although there is understandable hesitation about “picking winners”, governments need to fill a central role in focusing investment on the most promising options, funding critical infrastructure, reducing uncertainty for private investors, and facilitating economies of scale. Despite the rhetoric about “letting the market

- decide”, governments have always made choices about technological options—especially large-scale energy technologies. The Trans-Canada Highway, the nuclear industry, and oil sands development all required deliberate public commitment. The task is now to apply that same resolve to the technologies and infrastructure of the next energy system.[21,22,33,34]
- While international factors (including climate agreements, technological advances, globally integrated supply chains, geopolitical rivalries, and trade tensions) will impact the pace and orientation of change in key sectors, national governments still retain powerful levers to influence development trajectories.[21,34]

Focusing policy to accelerate change at different transition phases

EMERGENCE

Policy Goal: encourage emergence of alternatives that can potentially lead to system transformation capable of delivering net zero GHG emissions and other societal goals.

Policy Approach: support portfolio of R&D focused on particular sector/problems; fund experiments and demonstration programs; articulate visions of the most promising alternatives to coordinate actors; facilitate knowledge sharing across target sectors; fund intermediary actors to network innovators and develop best practices; encourage early application niches (for example, through public procurement).

DIFFUSION

Policy Goal: accelerate improvement and large-scale deployment of novel approaches that can lead to positive system transformation.

Policy Approach: encourage economies of scale, ‘learning by doing’, and the availability of complementary technologies; support development of standards and codes; support build out of core infrastructure; stimulate demand with purchase subsidies and public procurement; mobilize investment with grants, loans, tax incentives; apply regulations and fiscal measures to raise pressure on incumbents and create market opportunities for new entrants; conduct public education; assist those disadvantaged by changes or less able to enjoy collective benefits.

RECONFIGURATION

Policy Goal: carry through the transformation of the system to achieve net zero and other societal objectives.

Policy Approach: stabilize new institutional and regulatory frameworks; encourage complementarities with other systems; phase out old system elements including compensation, retraining, and regional development.



Energy producers have become a significant component of the Canadian economy, providing jobs, export earnings, and investment opportunities—which is an important consideration for developing transition pathways.

3. An Energy Systems Perspective

Applying an energy systems perspective, which tracks energy and related material flows through the economy, casts important light on critical features of the net-zero challenge. Energy systems involve the harvest of renewable and non-renewable environmental resources (crude oil, uranium, wind, solar radiation, etc.), the conversion of energy into useful forms (gasoline, diesel, electricity), and transport to where it is needed (by rail, pipeline or electricity grids), in order to drive the devices (cars, furnaces, lights) which deliver services (transport, heat, light) to end users (individuals, households, businesses).[35]

Canada's energy system is large, diverse, and heavily fossil-fuel dependent. The largest sources of primary energy exploited in Canada today are fossil fuels (coal, oil and natural gas), uranium, and rivers that generate hydroelectricity, as well as some biomass, wind and solar.[36] Coal is used for electricity production, to provide industrial heat, and (as coke) as a reducing agent in metallurgy. Oil is refined into fuels for transport and industry (and some electricity generation) or for non-energy products (chemicals, plastics, lubricants, asphalt, etc.). Natural gas contributes to electricity production, heating for industrial processes and in commercial and residential settings, fertilizer production, and it is used within the energy sector itself (for example, in the oil sands).

Uranium is converted into fuel for nuclear power plants. Biomass is mainly used for electricity production in the pulp and paper sector and to make liquid biofuels for transport. Electricity generated from hydro, wind, solar, nuclear, gas or oil powers residential, commercial, and industrial end-uses such as lighting, cooling, heating, motors, and compressors.[37]

Ultimately, consumers value energy for the wide range of services it provides. At the same time, energy producers have become a significant component of the Canadian economy, providing jobs, export earnings, and investment opportunities—which is an important consideration for developing transition pathways.

Among the most important features of Canada's energy system are that:[38,39]

- The country is a large *net energy exporter*, producing far more energy than it uses. In 2025, Canada exported 87% of its oil production and 46% of natural gas production; the vast majority of these exports went to the United States (97% of natural gas and 90% of crude oil).[40,41] International exports of uranium, coal, and electricity are also significant (90%, 81% and 6% of Canadian production respectively).[42,43,44]
- *The greenhouse gas intensity of the Canadian economy is high* in comparison to that of many other developed countries. Exploiting Canada's comparative economic advantages (abundant land and natural resources) over the past century has led to great prosperity but has left legacy challenges as we move into a carbon constrained world.

- *Electricity supply systems are already substantially decarbonized*, with approximately 80% of generation coming from low carbon sources (principally hydro and nuclear).[45]
- The energy systems of Canadian provinces are highly diverse. Contrasting resource endowments and economic development trajectories, combined with decentralized constitutional arrangements, have led to different energy profiles. Provincial electricity systems have varied generation assets, ownership structures, and regulatory regimes. Electricity has served as a lever for regional economic development, and provinces are hesitant to integrate with neighbouring jurisdictions. Indeed, with the pull of markets to the south, north-south electricity trade is more developed than east-west connections.

This last point—regional variation—conditions the first three features of Canada's energy system described above, for exports differ by province, as do the GHG intensities per GDP and per capitan (see Table 1).

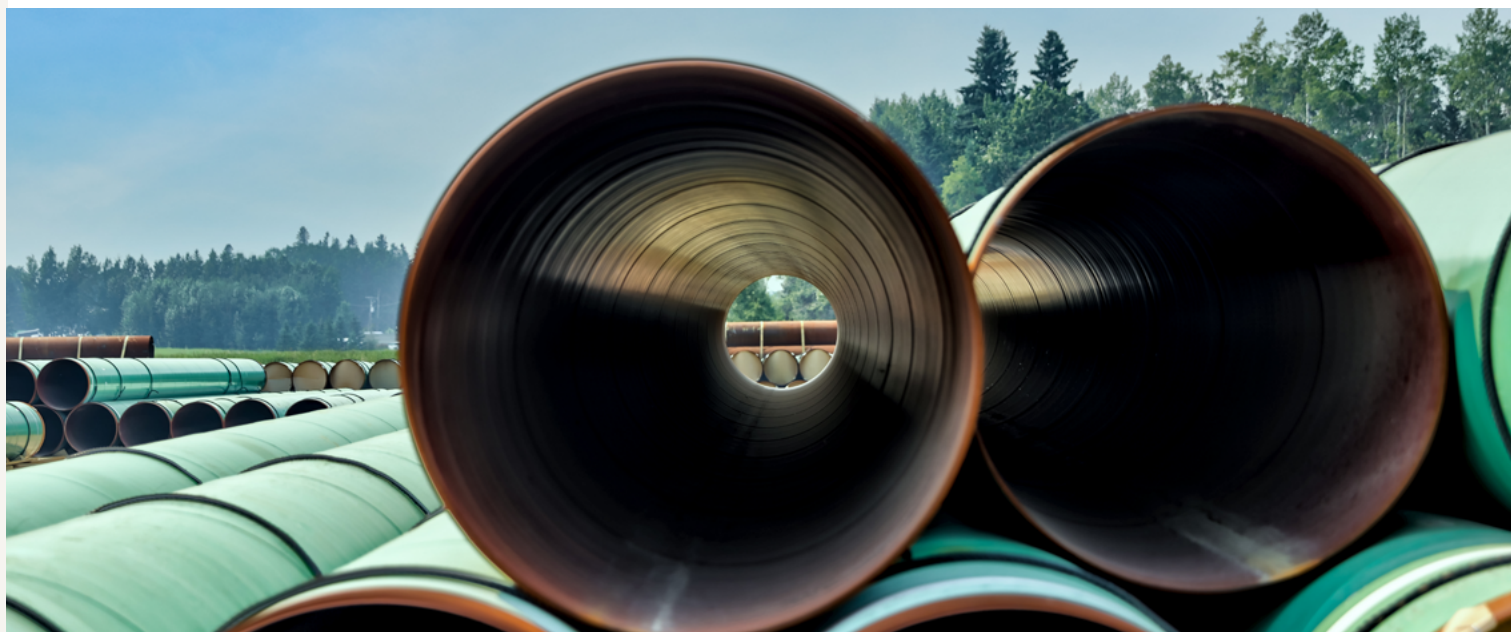


Table 1. Diversity of Canadian provincial energy systems is illustrated through GHG emissions (per capita and per unit of GDP) and the economic value of key energy exports

Adapted from the National Inventory Report 1990-2023 and the Canadian International Merchandise Trade Web Application using annual export data for the year 2025[46,47]

Province or Territory	GHG Emissions (tonnes CO ₂ e)		Value of Energy Exports (millions of \$CAD)				
	Per capita	Per million \$ of GDP	Oil (Crude & Refined Petroleum Products)	Natural Gas (Gas & Liquids)	Coal	Electricity	Uranium
Newfoundland and Labrador	14.6	196	7,817	0	0	78	0
Prince Edward Island	9.1	158	0	0	0	0	0
Nova Scotia	13.2	231	19	2	0	0	0
New Brunswick	13.1	237	8,295	624	0	262	0
Quebec	8.9	136	3,959	52	0	580	0
Ontario	10.0	140	1,641	608	109	920	602
Manitoba	14.4	226	633	32	0	443	0
Saskatchewan	60.5	655	11,408	137	0	55	2,321
Alberta	55.3	583	122,232	11,711	732	42	0
British Columbia	10.8	145	3,426	5,143	6,766	671	0
Yukon	14.6	160	0	0	0	0	0
Northwest Territories	31.4	262	0	0	0	0	0
Nunavut	17.3	145	0	0	0	0	0
Canada	17.1	234	159,431	18,310	7,607	3,051	2,923

From the perspective of analysing the transition of the energy system in Canada (see Figure 4), the following features of the current system are worth bearing in mind:

- *The critical dependence of most sectors on end-use combustion of fossil fuels*, including almost the entire transportation system, much of the heating in residential and commercial buildings, and various major industries.[23]
- *The significant energy losses across the system*, including the energy consumed by the oil and gas industry itself, combustion losses (shed as heat in internal combustion engines and thermal power generation), and end use inefficiencies (for example, poorly insulated buildings).[39]
- *The relatively centralized nature of current fuel and electricity production*, where a few main nodes (oil refineries and electric power plants) feed energy through networks to millions of consumers.
- *The necessity for real-time balancing of supply and demand in electricity systems* which becomes an increasing challenge as more variable generation (wind and solar) is integrated onto the grid.[48,49]

- The significance of *spatial distribution*: oil or wind can only be harvested where they are found, which may be far from markets; and infrastructure constraints (pipeline and electricity grid congestion) matter.
- *There is no ideal form of energy*: all have a mix of costs and benefits (economic, social, and environmental) that must be assessed and balanced.[48]

Political-economic dimensions of Canada's energy system that pose challenges for the transition to net zero include:

- The weight of the oil and gas industry in the economy and public decision-making, especially in specific regions (jobs, investment portfolios, and political influence).
- Substantial (and constitutionally protected) provincial control over resources development which makes policy harmonization at the federal level difficult.
- Close economic integration with the United States (with its on-again/off-again climate policy) which must be a consideration in policymaking.



IMPORTS & EXPORTS

ENERGY SOURCES

ENERGY CARRIERS

ENERGY END-USE

Canada is a major net energy exporter.

- Roughly **70% of oil and gas** production is exported, almost entirely to the United States.
- Around **81% of uranium** is exported.
- Wood pellets** are a significant biomass export, primarily to Europe.
- Electricity imports and exports** occur at the margins, varying by province and season.

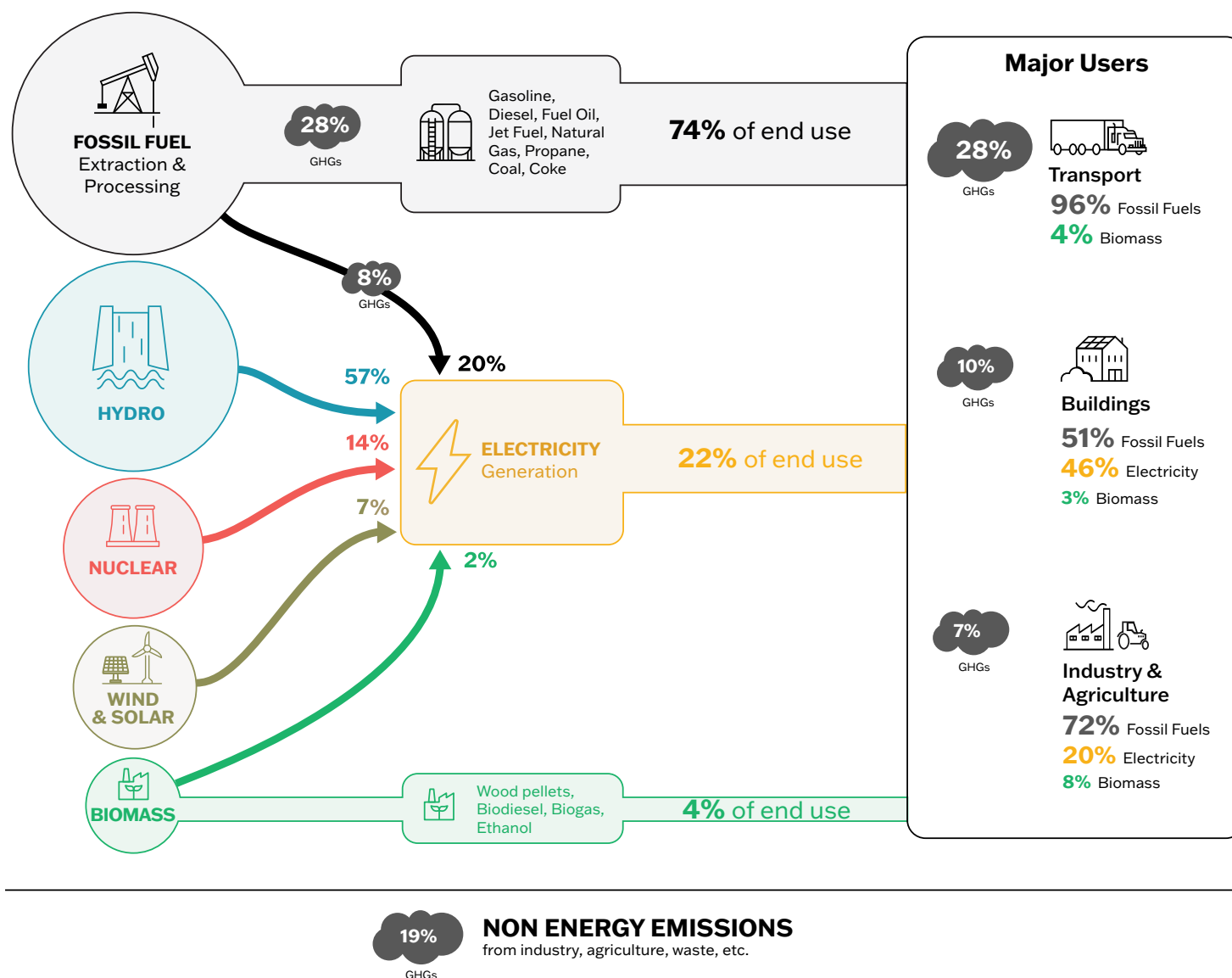


Figure 4 Schematic overview of Canada's current energy system.[43,57–61]

An energy system perspective can also tell us something about the net-zero energy systems of the future. We cannot anticipate every technological or economic development decades in advance, but some basic parameters are clear.[50-52] And knowing something about where we need to end up is important for defining pathways to get there.

A conceptual model of a net-zero energy system for Canada is presented in Figure 5. There are five essential elements of this system:

1. At its heart is a greatly enhanced role for decarbonized electricity in delivering end-use services, particularly for transport, building heating, and industrial operations.[50,53] Electricity is the most versatile of current energy forms and can be efficiently converted to a wide range of uses. Society is already wired up through the grid. In Canada, electricity is 80% decarbonized and we know multiple ways to generate more net-zero electricity, including hydro, wind, solar, biomass, geothermal and other renewables, nuclear, and fossil fuels with carbon capture and storage (CCS).
2. Hydrogen or zero-emission fuels serve as additional energy carriers in sectors where electrification is difficult or expensive (for example, heavy freight transport and industrial heat).[52,54]
3. Biofuels will have applications in industry, agri-food and perhaps some transport markets (for example aviation fuel). But issues with feedstocks and competition from other land uses may limit their contribution.
4. Residual domestic uses of fossil energy, including the fossil fuel extraction and processing industries, incorporate low carbon energy, CCS, and negative emissions to achieve net zero. Remaining fossil fuel exports and/or energy exports originally derived from fossil sources (for example, hydrogen or electricity) will have net-zero production profiles.
5. Dramatic changes in technologies, business models and social practices in end-use sectors—including substantial increases in energy efficiency[53]—will have allowed the essential phase-out of distributed fossil fuel end-use in transport, buildings, and industry.

It is not possible today to be precise about the relative importance of the elements in this conceptual schema. Technological developments, the evolution of relative costs, social acceptance, international circumstances, and political choices will influence future deployments. How much hydro versus nuclear, wind, solar, and so on will there be in the electricity mix? What proportion of energy needs in each end-use sector will be provided by electricity versus low-carbon fuels? What proportion of hydrogen will come from electrolysis, or from methane reforming with CCS and offsets? How centralized or decentralized will energy provision be? What scale of (production-emission-free) fossil energy exports will remain? Which negative emission approaches will prove viable? Answers to these and many other questions remain undetermined. The structure of existing systems places significant constraints on likely outcomes, and modelling can help explore the range of possibilities, but these issues will ultimately be resolved by technological, economic, social and political processes over multiple decades.

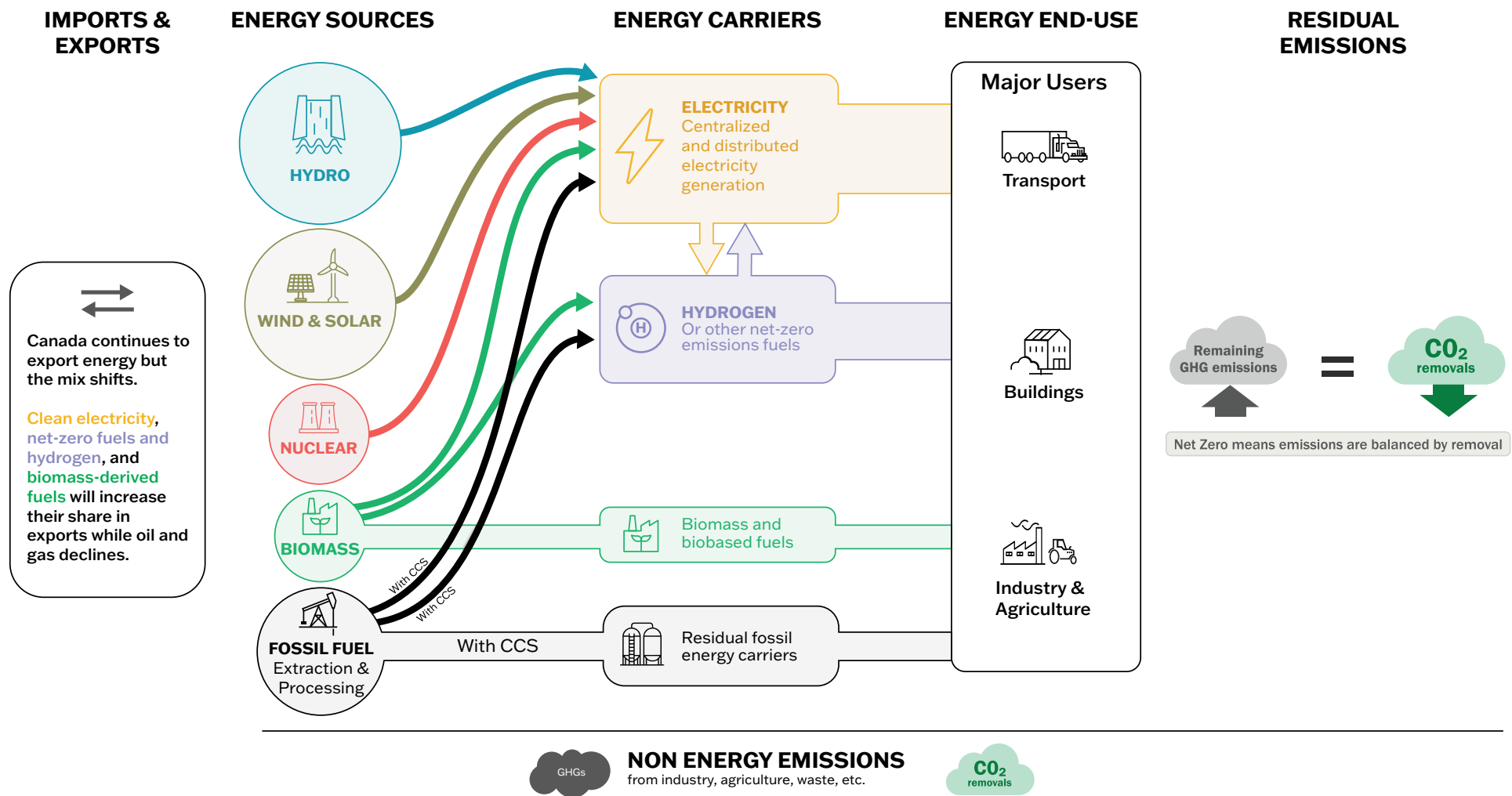


Figure 5 Schematic overview of Canada's future energy system.[43,57–61]

Despite these uncertainties, several things are clear:

- Since end-use energy requirements are to be shifted from fossil fuels to electricity, we will ultimately need greater electricity supply. Moreover, the growth of population and economic activity over several decades will leave us with more needs to service. Thus, moving towards net zero requires the phased buildout of the electricity system. The good news is that we do not need to replace the full energy content of the displaced fossil fuels (“joule for joule”) because of the inherent efficiency of electric end-use devices such as electric motors or heat pumps as compared to fossil fuel combustion. Nevertheless, Canada is looking at doubling or more its current electricity generation over coming decades.
- The relative significance of elements in the schema will vary across Canada, depending on the provincial resource base and economic trajectory, and there are opportunities for provinces to leverage their comparative advantages in developing distinctive low-carbon trajectories (hydro serves for energy storage in Quebec, hydrogen can be produced cheaply from methane in Alberta, Saskatchewan has important uranium reserves, etc.).[55]
- As new electricity generation capacity always imposes costs, be they economic, social, or environmental, further improving efficiency in many end-use sectors will be important.
- Since electrifying everything is not practical, we will need some other low-carbon energy carriers.[56] Enhancing research and development, demonstration projects, and infrastructure investment for hydrogen, ammonia, and low carbon fuels is therefore warranted.





Although the journey to net zero is primarily about building systems that avoid GHG emissions, it will also involve some application of “negative emission” approaches that remove carbon dioxide from the atmosphere.



4. Looking Beyond the Energy System

Some Canadian GHG emissions are not directly related to energy use, but stem from industrial processes and products (7.7%), agriculture (7.9%), and waste (3.3%).^[46] These emissions, which are entangled with a variety of existing systems of provisioning, may be particularly challenging to address. Industrial processes include the production of iron, steel, and cement (the critical structural materials of industrial society), and the manufacture of chemicals. Industrial products include fluorinated gases used in refrigeration, air conditioning and heat pumps, as well as other industrial and commercial applications. Agricultural emissions are generated by livestock operations (from enteric emissions and manure) and cropping practices (fertilizers, agricultural soils). Landfill and wastewater treatment facilities also generate substantial GHG emissions.

Moving towards net zero, system transformations must successfully address both energy and non-energy emissions, and these will be discussed together in subsequent sections of this report.^[39,46]

Although the journey to net zero is primarily about building systems that avoid GHG emissions, it will also involve some application of “negative emission” approaches that remove carbon dioxide from the atmosphere. This will be required to offset residual emissions that prove technically challenging or too expensive to eliminate. For example, if carbon capture and storage is applied to fossil energy production and use, or to control industrial process emissions, residual emissions of perhaps 10% will have to be offset by removals. And while accidental methane releases associated with fossil energy production and usage can in principle be reduced to low levels, negative emissions approaches may be required to deal with these.

Moreover, even if all fossil energy usage stops, or novel exploitation techniques completely avoid GHG releases, negative emissions approaches may ultimately be required to draw down

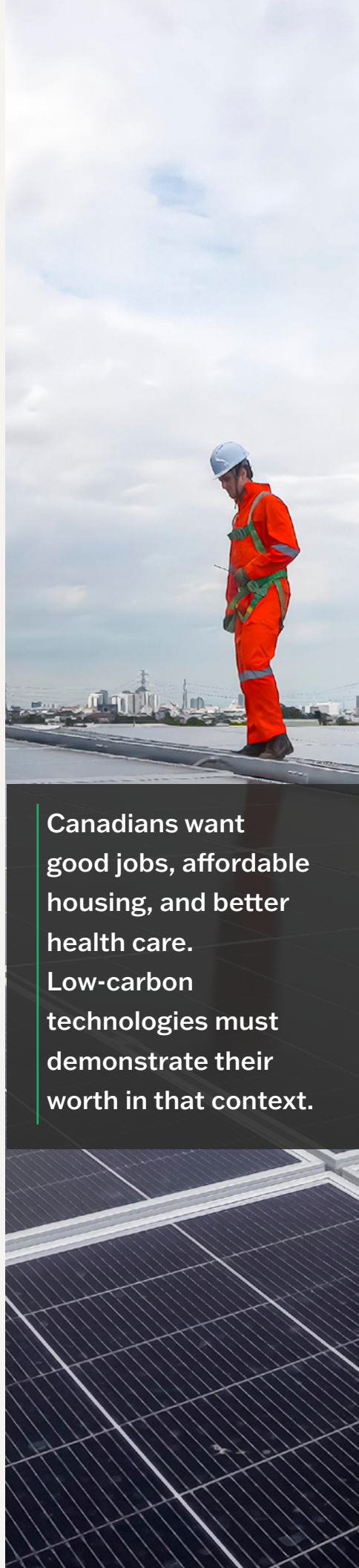
atmospheric GHG concentrations. Most integrated assessment models indicate these approaches will be needed in the second half of this century if the impacts of climate warming are to be kept within a manageable range.[10,11] Although some argue that these models have not accounted for more dramatic demand-led systems changes that might avoid the need for negative emissions, the longer climate action is delayed, the more potential significance they acquire.[62]

A wide array of negative emission approaches has been suggested, including:

- Large-scale reforestation and afforestation. As trees grow, they absorb carbon dioxide and convert it into standing biomass. If the forest remains undisturbed, the carbon is locked away from the atmosphere.[63]
- Increased retention of carbon in soils through changes to agricultural practices and/or the wide scale incorporation of biochar.[64,65]
- Bioenergy with carbon capture and storage (BECCS), where biomass energy facilities apply CCS to trap the carbon dioxide drawn down by plant growth underground.[66]
- Direct air capture (DAC), where CO₂ is extracted from ambient air and sequestered underground or used as an input for industrial processes.[67]

But there are many other potential approaches, including enhanced weathering (where geologic processes that absorb CO₂ are accelerated) or pyrolysis of organic waste and sequestration of the resultant oil.[68,69]

Each approach has different potential as well as difficulties or drawbacks. For afforestation and reforestation, concerns are with the vulnerability of sequestration to fires, pest and disease attack, or human activities, as well as the availability of land. The ultimate potential for organic carbon retention in soils remains uncertain, while there is still little systematic research on biochar. BECCS is currently expensive; energy is required to collect dispersed feedstocks; and there are doubts about the availability of bio-resource feedstocks without negative land use impacts. Air capture is currently very expensive and energy-intensive but could ultimately be linked to synthetic fuel production. Other approaches are possible, but there are persistent doubts about the funding of removal activities, the scale at which they could be undertaken, and possible negative environmental impacts. Several recent reports provide an overview of negative emission approaches and the frameworks required for their governance.[70-73]



Canadians want good jobs, affordable housing, and better health care. Low-carbon technologies must demonstrate their worth in that context.

5. Approaching Decarbonization Strategically

Societal decarbonization is a process that will extend across multiple decades. Over this time, political priorities, economic conditions, national concerns, and the geopolitical context will continuously evolve. Surprises and reverses are inevitable. It is therefore imperative that those interested in advancing progress towards a net-zero future adopt a strategic approach that focuses on the most important elements while adapting continuously to these changing circumstances. In the Canadian context it is particularly important to:

- **Ensure decarbonization is integrated with the pursuit of other societal objectives**, including enhanced prosperity, economic competitiveness, security, social welfare and Indigenous reconciliation. Canadians want good jobs, affordable housing, and better health care. Low-carbon technologies must demonstrate their worth in that context. Support for electricity system build out, value-added transformation of natural resources (mining and processing critical minerals), and manufacture of low-carbon technologies (EVs, heat pumps, electrical system components, etc.) creates a foundation for future affluence, gives us tools to decarbonize our domestic economy, and can strengthen political coalitions favoring more vigorous action.
- **Seize electrification as the central link by building out supply and electrifying end-uses in transport, buildings and industry.** With the costs of renewable technologies (especially solar and increasingly batteries) continuing to fall, rapid advances in end-use electric devices (vehicles and heat pumps), and increasing digitalization (including AI and robotics), some commentators have begun to talk of an “Electro-tech revolution”.[74] This extends the benefits of the earlier wave of 20th century electrification (lighting, industrial equipment, refrigeration and air conditioning, domestic appliances) to new areas of social life, enhancing the convenience,

- reliability, cleanliness and efficiency of energy services. In coming decades, enhanced electrification will be both a key to industrial competitiveness and the cornerstone of the net-zero economy.
 - **Focus on building the new rather than tearing down the old.** For decades activists have highlighted risks of climate change and decried the fossil-fuel-based energy system. Today, the priority should be implementing practical solutions. So long as oil and gas remain Canada's major export earner and world demand for fossil fuels is strong, the industry is unlikely to be constrained by domestic political action. Instead, the focus should be on rolling out the new, demonstrating the benefits of electric end-uses with higher performance and driving down their costs. As fossil fuel dependence is eroded on the demand side domestically and globally, the balance of forces between old and new energy systems and the associated political calculus will shift, and the transition can accelerate.
 - **Embrace asymmetrical decarbonization.** Provinces and sectors will proceed down varied pathways towards net zero at rates appropriate to their circumstances. Policies should be adapted to these differentiated conditions and needs, and should reflect the transition readiness of specific sectors and regions. Enforcing a "one size fits all" approach sparks delays and division. Where solutions are ready, policy should accelerate mass deployment. Where solutions are not yet mature, policy can support R&D, experimentation, and measures to prepare eventual market transformation.
 - **Prioritize practical steps needed to achieve decarbonization.** All too often government plans and strategies "float in the air", without realistic consideration of the material steps required to effect change.
- Plans and targets should be operationalized in material terms (for example, the number of new homes to be fitted with electric heating) and identify the specific steps required to achieve a goal (regulatory changes, capital mobilization, supply chain development, work force training, and so on). Progress indicators should track the real state of market transformation (for example the proportion of new car sales that are electric) and not anticipated tons of emission reductions from a hypothetical business-as-usual scenario.
- **Pay attention to costs and prices.** Costs are critical to industrial competitiveness and prices matter to households. Today, low-carbon solutions are often more expensive than fossil-fuel-based alternatives. In the short term, prices are largely given, but over time they are influenced by investment. Learning rates (the price fall with doubling of deployment) and economies of scale can dramatically transform relative costs. Policy can help drive down the price of new technologies through public procurement, temporary production or consumption subsidies, regulations, and other mechanisms. Carbon pricing works in the opposite direction by raising the cost of carbon-intensive fuels. But, it remains politically divisive. So a cornerstone of decarbonization initiatives should be measures to drive down costs of low-carbon technologies to encourage market transformation. Moreover, if rising electricity prices are not to become an Achilles heel of decarbonization, careful attention must be paid to the systematic buildout of the grid, the mix of selected generation technologies, the phasing of the deployment of end-use electric technologies, and how electricity system improvements are financed.

Taken together, these priorities point toward a clear strategic logic: move fast where the economics are compelling, build the foundations that unlock broader transformation, and avoid diverting scarce political and investment capital into battles that cannot yet be won.

The sections of this report that follow translate this logic into sector-by-sector assessments. But before that analysis, Table 2 distils this report's overall strategic posture into a single view: which sectors warrant

priority action now, which require foundational investment to prepare for future deployment, and which are better served by provisional support and monitoring.

The ordering is deliberate. Electricity grid buildout sits at the top not because other sectors are unimportant, but because a decarbonized, expanded grid is the precondition for progress across almost everything else. Where the economics and technology are ready, the task is deployment at speed and scale.

Table 2. *Where to Move First: A Strategic Sequencing of Canada's Decarbonization Priorities*

Sectors	Priority Actions	Economic Competitiveness Advantage
Immediate Priorities for Strategic Decarbonization		
Electricity	Accelerate grid buildout and regional interties; scale wind, solar, hydro, and nuclear; invest in storage and demand management. Prioritize grid financing mechanisms that keep electricity affordable as the grid scales. The long-run cost benefits to households and industry depend on how infrastructure costs are structured and recovered.	High Canada's low-cost, reliable, low-carbon electricity is a significant competitive advantage in a world where energy price volatility and carbon intensity are becoming more important to industrial location decisions.
Personal Mobility (Light Duty Vehicles & Mass Transit)	Drive rapid EV adoption. Invest in charging infrastructure, procurement incentives, and electrified transit systems that reduce household transportation costs for urban commuters who don't own a vehicle.	High Canada can secure a competitive position in EV and battery supply chains, and manufacture of transit equipment, drawing on established manufacturing capacity, skilled labour and access to critical minerals.
Buildings	Deploy heat pumps widely, focusing on contexts where they are cost competitive, including households currently on expensive heating fuels such as oil, propane, and electric baseboard. Expand retrofit programs. Ensure new buildings are built to avoid the need for future retrofits.	High Supports large-scale skilled employment. Can develop export potential in low-carbon building materials, retrofit solutions, and construction expertise.

Sectors	Priority Actions	Economic Competitiveness Advantage
Medium-Term Opportunities for Accelerated Progress		
Aluminum	Electrify process heat; accelerate adoption of inert anode technology to eliminate process emissions; leverage Canada's low-carbon electricity advantage.	High One of Canada's strongest near-term industrial positions. Access to cheap, reliable hydro power gives Canadian aluminum producers a durable advantage on both cost and carbon intensity as global buyers place greater weight on supply chain resilience and embodied emissions.
Medium & Heavy-Duty Vehicles	Accelerate deployment of battery-electric MDVs through fleet procurement and depot charging investment, while supporting demonstration and early deployment of battery-electric and hydrogen fuel-cell HDVs. Invest in charging corridors and hydrogen fuelling infrastructure, with attention to bringing down costs over time in applications where total cost of ownership can become competitive.	Medium Canada already has manufacturing capacity and commercial vehicle supply chain relationships. The near-term advantage is to build domestic capability through fleet electrification, transit buses, drivetrain systems, and charging infrastructure, with the potential to translate domestic scale into export strength.
Alternative Fuels	Support R&D and pilot-scale production; develop regulatory frameworks; prioritize aviation and marine applications where electrification is not viable and where cost premiums can be absorbed or structured through long-term procurement agreements.	Medium Long-term opportunity in alternative fuels. Canada's agricultural and forestry base provides potential feedstock advantages. The competitive opportunity is to secure an early position in sustainable aviation fuel and other biofuel supply chains as global buyers begin locking in long-term procurement.
Hydrogen	Near-term action should focus on building up demand for strategic uses and on reducing production costs as scale increases. Fund demonstration projects; develop export strategy; prioritize applications where electrification is not viable such as industrial heat and heavy transport.	High Canada's abundant clean electricity, low-cost natural gas, and access to Atlantic and Pacific export routes give it a credible position as a future low-carbon hydrogen supplier. The opportunity is economic and strategic as allied economies look to diversify energy imports and build more secure supply relationships.
Steel & Iron	Support early electric arc furnace deployment and invest in R&D and pilot projects for hydrogen-based direct reduction. Technology is not yet cost-competitive; priority action should focus on demonstration, infrastructure and market development, rather than near-term cost savings.	Medium Canada is able to combine clean electricity with access to key upstream inputs—an advantage that is likely to become more important as procurement standards tighten and buyers become more conscious of embodied carbon.

Sectors	Priority Actions	Economic Competitiveness Advantage
Cement & Concrete	Support CCS pilot programs; promote low-carbon cement formulations and material efficiency in construction. The construction sector is highly price-sensitive, and low-carbon cement currently carries a cost premium that flows into building costs—policy support for adoption is essential to avoid passing costs to end users prematurely.	Medium A technical expertise opportunity to build globally transferable capabilities in CCS integration and low-carbon cement formulation. That creates potential to compete as a technology, investment, and project partner in the construction sector under growing pressure to decarbonize.
Mining	Electrify mining operations and pilot hydrogen equipment where appropriate. Remote electrification requires high upfront capital but can deliver long-run fuel cost savings and reduces exposure to diesel price volatility.	Medium Canada's critical mineral base is a major competitive asset. The opportunity is to secure and maximize its value as allied economies rebuild supply chains around more reliable, lower-carbon sources.
Long-Term Plays to Monitor and Prepare		
Chemicals & Plastics	Electrify process heat where feasible and support demonstration of electrified steam crackers and carbon capture at chemical facilities. Scale up mechanical and chemical recycling infrastructure, standardize plastics labelling and collection, and expand and improve extended producer responsibility (EPR) programs. Advance research into low-carbon feedstocks (low-carbon hydrogen, captured carbon, and biomass) to displace fossil-based inputs over the long term.	Low Longer-term, Canada's clean electricity and natural gas access could position it to compete in electrified chemical production and low-carbon hydrogen-based feedstocks, though most core decarbonization technologies remain in pilot or demonstration phase.
Agri-Food	Reduce nitrogen fertilizer emissions; improve livestock management practices; accelerate adoption of precision agriculture.	Medium With an existing strong export position in agri-food, the competitive opportunity is to stay ahead of tightening carbon and sustainability requirements in high-value markets, protecting access and strengthening its position in premium segments.
Oil & Gas	Drive methane emission reductions; electrify upstream operations; integrate CCS at major facilities.	Medium Canada's oil and gas sector remains a major economic asset with established infrastructure and market relationships. A competitiveness concern is to maintain access to markets where emissions intensity increasingly affects value.