

SUMMARY REPORT

CANADA'S NET ZERO FUTURE

FINDING OUR WAY IN THE GLOBAL TRANSITION



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CANADIAN INSTITUTE FOR
CLIMATE CHOICES



INSTITUT CANADIEN POUR DES
CHOIX CLIMATIQUES

This report presents an overview of key insights emerging from our comprehensive assessment of net zero scenarios in *Canada's Net Zero Future*, available at: <https://climatechoices.ca/reports/canadas-net-zero-future/>

This summary aims to help decision-makers better understand the choices that face Canada on its path to net zero.

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ABOUT THE INSTITUTE

The Canadian Institute for Climate Choices brings together experts from diverse disciplines to undertake rigorous research, conduct insightful analysis, and engage a range of stakeholders and rightsholders to bring clarity to the climate challenges and transformative policy choices ahead for Canada. We are publicly funded, non-partisan, and independently governed. Learn more at climatechoices.ca



OVERVIEW

“There are undoubtedly risks ahead on Canada’s journey to net zero but also potentially big rewards—if we play our cards wisely.”

Getting to “net zero” emissions in Canada means shifting toward technologies and energy systems that do not produce greenhouse gas emissions, while offsetting any remaining emissions by removing them from the atmosphere and storing them permanently. Put simply, Canada would take as many emissions out of the atmosphere as it puts in, rather than leaving them there to trap heat and contribute to climate change.

The transition to net zero is global and gaining momentum. From the United Kingdom to China, the world’s pacesetters are embracing net zero as the benchmark for committed climate action. Major economies, including the United States, are moving to catch up.

In the decades ahead, fundamental changes to Canada’s economy and energy systems are inevitable—and they will be driven in large part by factors outside Canada’s control. As the pace of change accelerates within and outside Canada’s borders, the country’s governments and businesses can’t afford to stay out of the game.

Achieving “net zero” emissions in Canada by 2050 is an ambitious goal. Our research indicates it is doable, but getting there will require implementing policy well beyond anything seen

to date in Canada. It will also require navigating significant complexity and uncertainty.

Ultimately, this country’s path to net zero will be defined by policy choices made by all orders of government, as well as technological innovation and factors beyond domestic control, such as global market shifts and changing energy demand.

MANY PATHS LEAD TO ZERO

Our research finds there are many possible routes to net zero for Canada. This report does not recommend any specific one. Instead, it provides a clear analysis of what Canada’s options are, the drivers inside and outside Canada’s control that will matter, and the conditions that are likely to influence success.

Our analysis looks across Canada’s various potential pathways to net zero, allowing us to unpack the effect that uncertainty might have on the road ahead and to understand how Canada’s choices will affect crucial outcomes: economic, social and environmental. This approach aims to help decision makers reconcile uncertainty with the need to take decisive early action and realize emerging opportunities—and, ultimately, to make strategic and informed choices on the road ahead.

KEY FINDINGS

- ▶ **A net zero Canada is possible but requires strong policy.** There are many potential pathways for Canada to reach net zero by 2050, but reaching it depends on increased policy ambition from all orders of government.
- ▶ **Big transitions are inevitable—especially due to global trends.** The transition to net zero will drive significant change in Canada’s economy, posing challenges for some regions and sectors while also creating new opportunities. At the same time, much of this change will be driven by factors outside of Canada’s control—particularly international climate policy and global demand for oil—underlining the importance of seizing new opportunities and planning for transition.
- ▶ **Canada has competitive advantages that will create new opportunities in pursuit of net zero.** Canada is uniquely positioned to capitalize on emerging opportunities as the world pursues emissions reductions. And the transition to net zero presents opportunities for oil-and-gas-producing regions to diversify and grow their economies by capitalizing on emerging sectors.
- ▶ **Scaling up “safe bets” (low-risk solutions that are available today) is crucial to reaching 2030 and 2050 targets, and there is no reason to delay.** Across the scenarios we examine, nearly two-thirds of emissions reductions by 2030 would rely on safe bet solutions. There are advantages to moving ahead with these solutions quickly and decisively.
- ▶ **“Wild cards” (high-risk, high-reward solutions that are still in early stages of development) have an important role to play in Canada’s transition to net zero.** Wild cards have the potential to fundamentally change Canada’s path to net zero, and action is required now to ensure these solutions are ready when Canada needs them. Yet wild cards should be handled with careful attention to risk and uncertainty, as betting on the wrong pathway could jeopardize Canada’s net zero efforts.
- ▶ **Safe bets and wild cards represent two distinct policy problems that are better considered in separate policy conversations.** Too often, policy debates in Canada have led to paralysis by conflating the challenges and opportunities across safe bets and wild cards. Each is a key part of the transition to net zero, and one must not serve as a distraction from the other.
- ▶ **Engineered forms of negative emissions are a special type of wild card, best viewed as a complement to other solutions rather than a substitute.** Engineered forms of negative emissions face significant barriers and uncertainty: If Canada relies on these solutions and they fail to prove viable, it could significantly increase the costs of Canada reaching net zero, or result in missing it altogether.
- ▶ **Pathways to 2050 have far-reaching implications for the well-being of Canadians.** If managed effectively, the transition to net zero could maintain or improve the well-being of all Canadians. But this will require careful attention to mitigate uneven impacts and ensure benefits are available to everyone.

RECOMMENDATIONS

We offer the following high-level recommendations for policy makers from all orders of government:

- 1** Governments should **create incentives for the widespread deployment of “safe bet” solutions**, building on policy mechanisms already in place.
- 2** Governments should **manage the risks and opportunities posed by “wild card” solutions** through a portfolio approach, backing multiple potential solutions to mitigate their high risk.
- 3** Governments should increase policy certainty by **implementing robust climate accountability frameworks**—governance structures that connect long-term emissions reduction targets to near-term policy actions through interim targets, regular and transparent monitoring and reporting, regular opportunities for course correction, and mechanisms to enhance government accountability.
- 4** Governments should work to **ensure the path to net zero is fair and inclusive**, providing targeted support so that the transition does not impose disproportionate costs or exacerbate existing barriers for different regions, sectors, workers, communities, and income groups

More detailed recommendations, informed by our in-depth technical analysis, are presented in our full report.



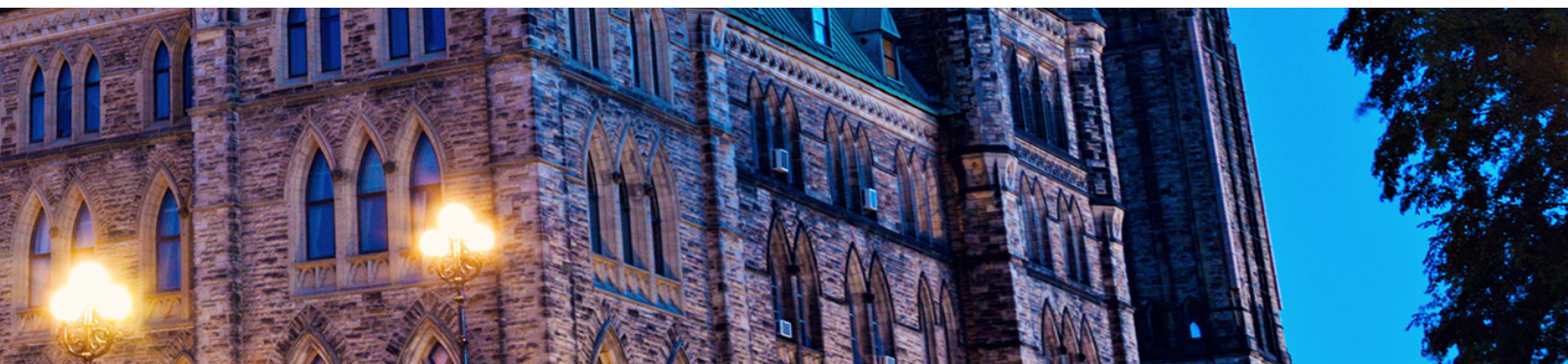
NET ZERO IS ACHIEVABLE— IF CANADA PLAYS ITS CARDS RIGHT

Our analysis found not just one pathway but multiple potential pathways for Canada to reach net zero by 2050. All of these pathways also meet Canada's 2030 target along the way.

But just because Canada can reach net zero certainly does not guarantee that it will. A significant effort will be required to meet Canada's 2030 emissions reduction target, let alone achieve the country's much more ambitious 2050 goal. Strong policies are needed to drive businesses, households, and governments to develop and implement the emissions-reducing solutions that can get Canada to its targets. And these policies must do so in ways that keep pace

with uncertain technological change and international shifts outside Canada's control.

While pursuing climate action in Canada has long been a story of ambitions outpacing outcomes, that trend may be changing. In December 2020, the federal government announced a comprehensive new climate plan that, if fully implemented, would slightly exceed Canada's 2030 emissions reductions targets and help get the country on track towards achieving its long-term goal of net zero emissions by 2050. Yet reaching Canada's net zero target will eventually require even more stringent policies from all orders of government.



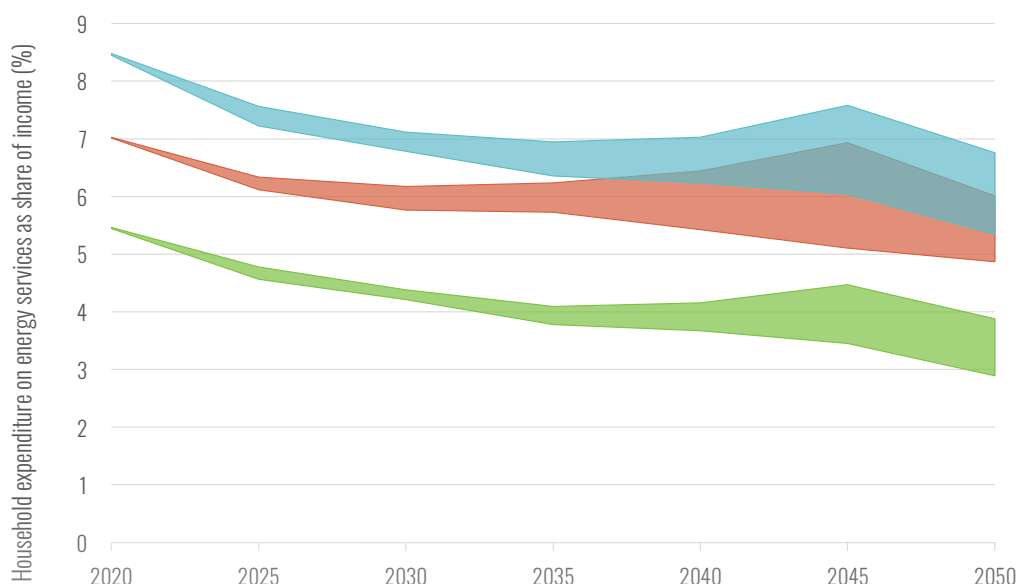
HOW THE NET ZERO TRANSITION WILL AFFECT CANADIANS

The policies that will drive Canada's net zero transition will affect how Canadians live, work, and move. In some areas, the precise nature and extent of the changes ahead remains uncertain. Some parts of the economy can reach net zero relying entirely on solutions that are available today, while others will require the advancement of technologies still in early stages of development. And while some will rely on a mix of solutions that is fairly consistent across possible pathways, for others the mix is more uncertain, depending on the evolution of technologies, global policy and markets, and domestic policy choices.

Perhaps surprisingly, as illustrated in the figure below, we find that across all the possible pathways we examine, households will spend less on energy services (for example, heating, transportation, etc.) as Canada shifts toward net zero, compared to the share of income they spend on energy services today. Despite this finding, policy makers will need to ensure people with lower incomes and marginalized groups are not disproportionately affected as the country's economy and energy systems change.

Household energy expenditure as a share of income across pathways to net zero

- Bottom 20% of the income distribution
- Middle 60% of the income distribution
- Top 20% of the income distribution



The graphic below illustrates four areas that will be particularly critical to how Canada navigates this transition: buildings, transportation, industry, and negative emissions solutions (to offset remaining emissions).



BUILDINGS

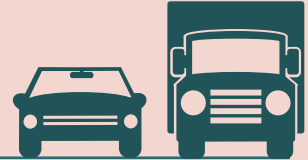
- ▶ Can rely on technologies and measures available today
- ▶ Potential pathways to net zero:
 - » Increased energy efficiency
 - » Switching to electric heat sources (e.g. heat pumps)
 - » Switching to clean gases (e.g. RNG and hydrogen)



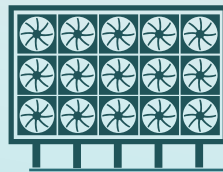
INDUSTRY

- ▶ Emissions reduction pathways are more uncertain and diverse than other sectors
- ▶ Potential pathways to net zero:
 - » Methane management
 - » CCUS
 - » Electrification
 - » Energy efficiency
 - » Production process changes

TRANSPORTATION



- ▶ Pathways to net zero for personal transportation are clear cut:
 - » Increased use of public transit and active transportation
 - » Transitioning to EVs
 - » Advancement in second-generation biofuels
- ▶ The future for heavy- and medium-duty transportation is less certain with four potential pathways:
 - » Electricity
 - » Hydrogen
 - » Biofuels
 - » Fossil fuels offset by negative emissions



NEGATIVE EMISSIONS SOLUTIONS

- ▶ Would complement other solutions, such as energy efficiency, renewables, and electrification:
 - » Could drastically change the path to net zero, should they prove viable
 - » The potential for both nature-based and engineered forms of negative emissions solutions remains highly uncertain

HOW CANADA CAN BUILD A WINNING HAND

Canada's resources, infrastructure, and know-how offer strong cards that can make for a "winning hand" in the high-stakes net zero transition. That winning hand will require both safe bets and wild cards.

Safe bets are emission-reducing technologies and solutions that are already commercially available and face no major constraints to widespread implementation. Under all the pathways we considered, safe bets do much of the heavy lifting required to get Canada to net zero. They are especially important for getting Canada to its 2030 target, driving at least two-thirds of the required reductions.

Wild cards are high-risk technologies and solutions with potentially high rewards. Significant barriers need to be overcome for these solutions to be used widely, but if that happens they could fundamentally change Canada's path to net zero. Wild cards are a potential complement to safe bets—not a substitute. They are important for unlocking the deeper, cost-effective reductions that can get Canada to its ultimate net zero target. But the role they will ultimately play

is highly uncertain. Indeed, both the size of the role they play post-2030 and the specific mix of wild card solutions vary widely across the various potential pathways to net zero.

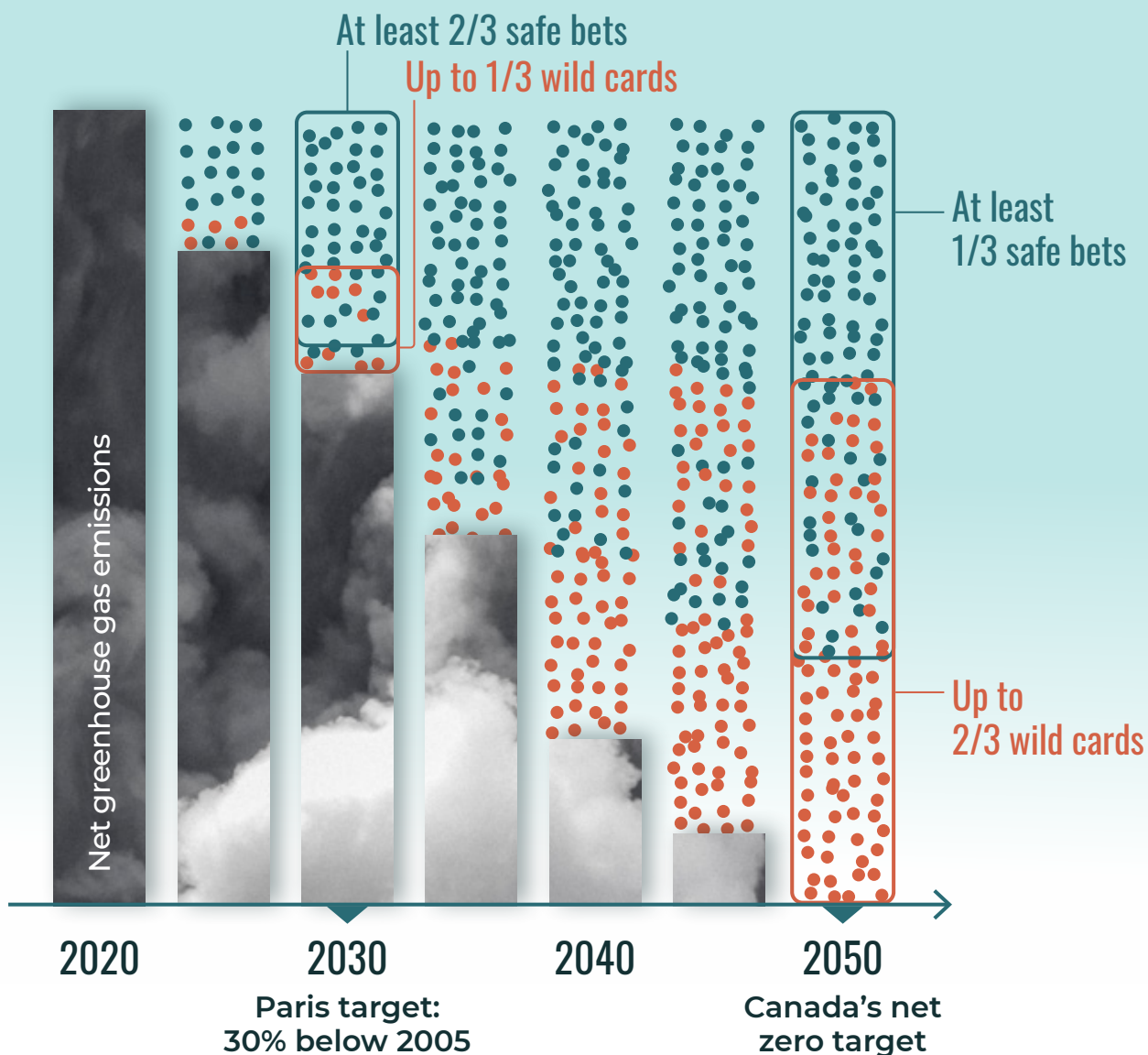
As Canada pursues its net zero goal, it is crucial that policy makers find ways to expand the use of safe bet solutions while also investing in the development of wild card solutions, so they are ready when the country needs them. The potential that wild cards hold should not be interpreted as an argument to justify any delay in the widespread implementation of safe bets, as these existing solutions are essential to achieving both Canada's 2030 target and net zero by 2050—even under pathways where wild cards prove viable. Canada needs to build a winning hand by advancing both these kinds of solutions at the same time.

Of course, addressing climate change is not a game. But the stakes are high. The risks that a changing climate poses for Canada are significant. There are also significant economic opportunities for Canada in addressing it.

A winning hand

Safe bets are critical to short-term results. **Wild cards** are important for unlocking the deeper, cost-effective reductions that can get Canada to its net zero target.

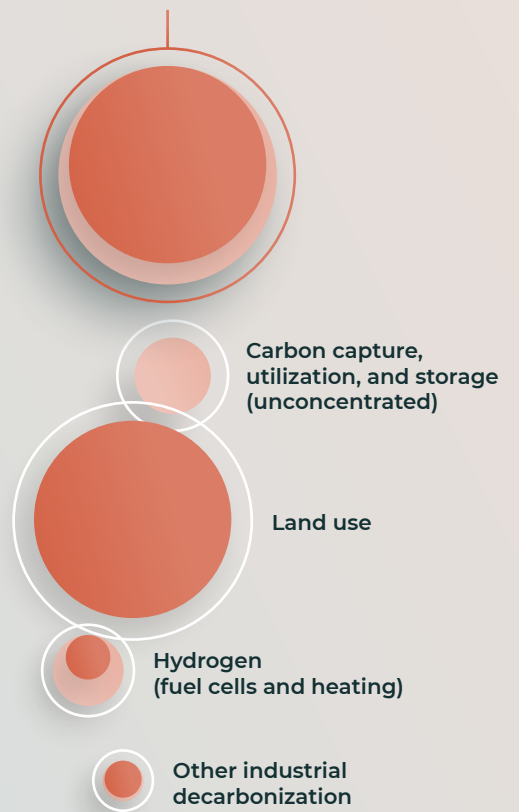
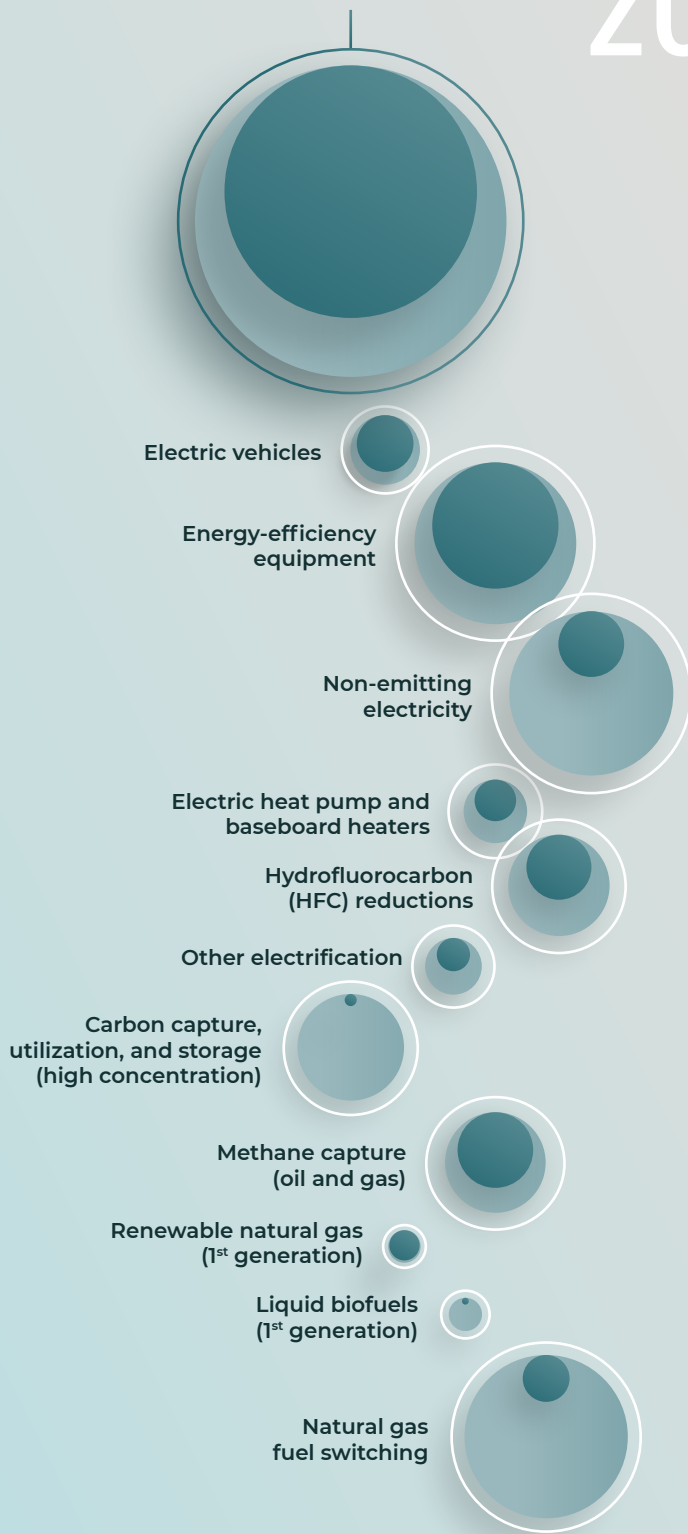
At least **two-thirds** of emissions reductions in 2030 would likely come from safe bet solutions, with less than **one-third** generated by wild cards. By 2050, these proportions could switch. In scenarios where wild card solutions prove cost-effective and scalable, they could provide up to **two-thirds** of Canada's emissions reductions by 2050.



SAFE BETS

2030

WILD CARDS

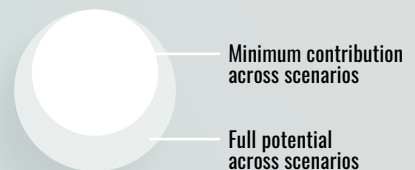


Across all the scenarios we examine, **safe bets** are expected to generate most of the reductions by 2030. **Wild cards** will not be sufficiently developed by then to play more than a supporting role.

By 2050, the contribution of emissions reductions from **safe bets** is more variable, as **wild cards** start to play a bigger part.

Safe bets: Emission-reducing technologies and solutions that are already commercially available and face no major constraints to widespread implementation.

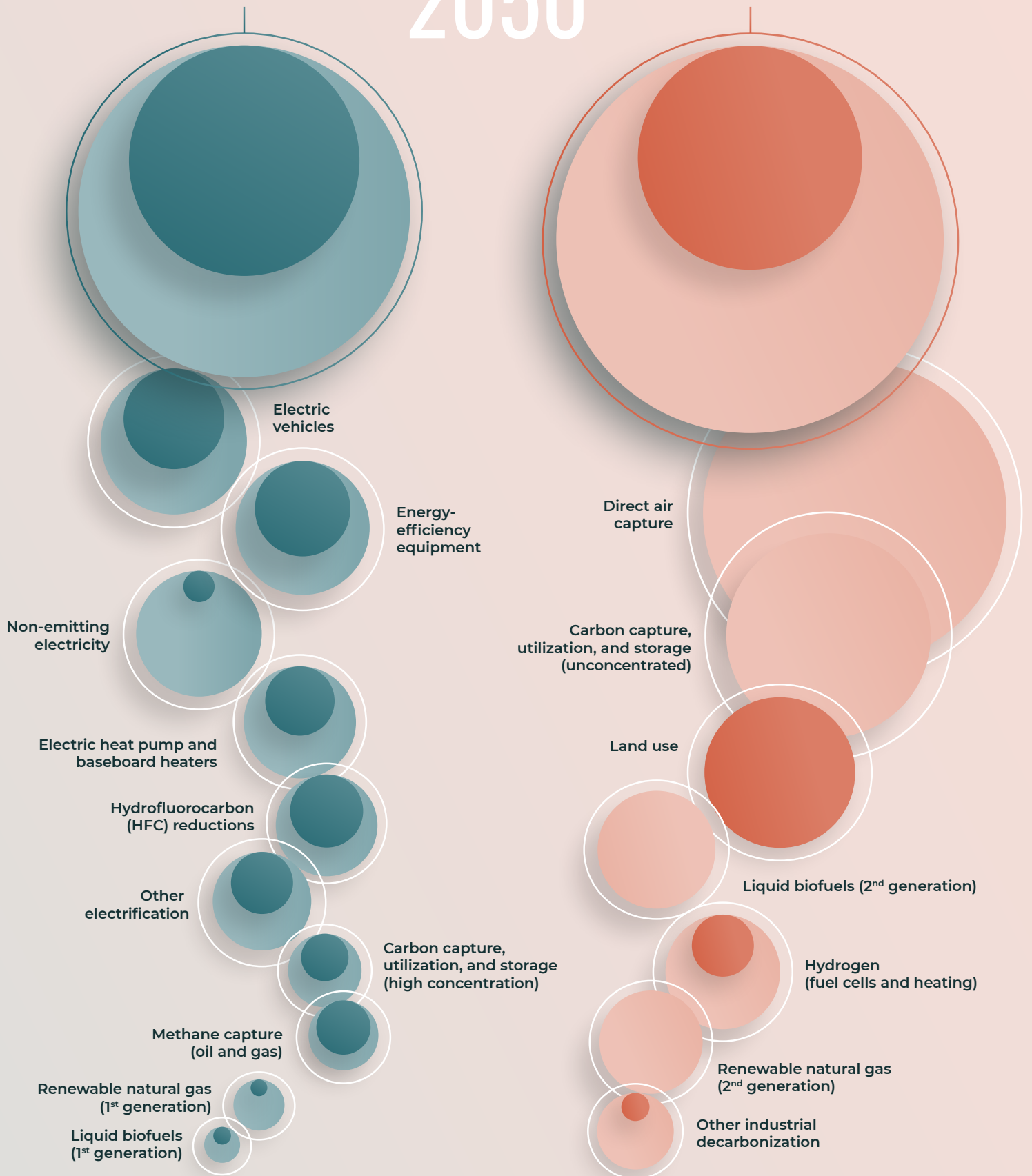
Wild cards: Solutions that may come to play a significant and important role on the path to net zero, but whose ultimate prospects remain uncertain.



SAFE BETS

2050

WILD CARDS



OIL AND GAS FACES A PRECARIOUS FUTURE

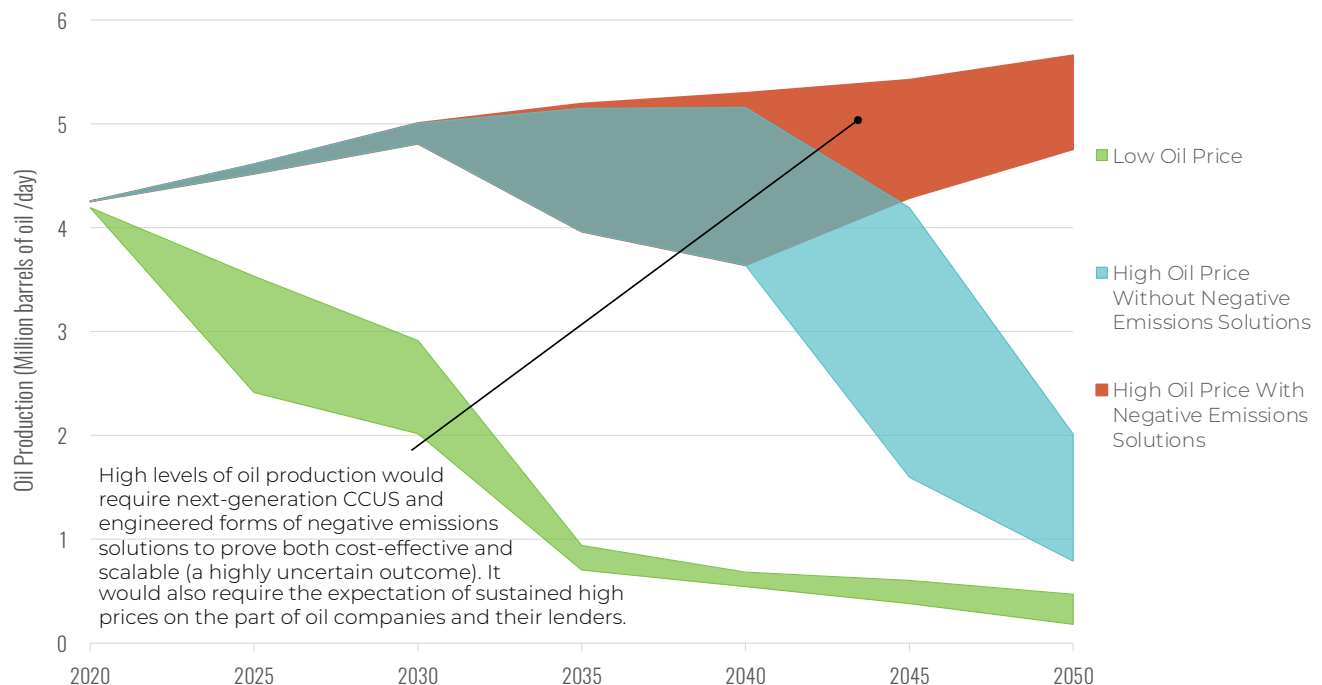
We find that Canadian oil and gas production will be determined first and foremost by global forces. Factors such as increasing EV sales or climate policy action abroad could suppress prices and domestic production independent of any choices Canada makes.

But as the figure below and the infographic on page 15 illustrate, even if global oil prices were to rise and stay high, a number of other conditions and outcomes would have to come to pass for Canadian oil and gas production to be consistent with net zero.

While Canada can affect some of these outcomes, others depend on forces outside Canada's control. The vulnerability of the Canadian oil and gas sector to larger, uncertain global and market forces underscores the need for oil-producing regions to diversify their economies. Fortunately, they can do so by capitalizing on emerging opportunities on the path to net zero.

Many of the sectors critical to the net zero transition present opportunities to Canada's oil-producing regions and call on their existing resources, skills, and know-how. These include hydrogen, biofuels, and non-emitting electricity, to name a few.

Canadian oil production under low and high global price scenarios for oil across pathways to net zero



Factors affecting Canadian oil and gas production on the path to net zero

Canadian environment

Price of oil expectations

Do Canadian oil and gas companies and their lenders **expect high oil prices**, justifying investments in production capacity?

Yes

No

Emissions intensity of production

Are Canadian oil and gas companies able to make investments that successfully **drive down their emissions intensity** of production?

Yes

No

Availability of negative emissions

Do technologies like direct air capture and advanced forms of CCUS prove **cost-effective and scalable** and get widely deployed in Canada?

Yes

No

Global environment

Global offsetting

Are other countries using negative emissions at scale **to offset emissions** associated with their continued consumption of fossil fuels?

Yes

No

Global climate policy

Are other major economies significantly lagging Canada in their climate policy implementation such that they **continue to consume fossil fuels**, thereby driving severe climate change?

Yes

No

Significant sustained long-term production

Significant production decline over time

CAPITALIZING ON CANADA'S COMPETITIVE ADVANTAGES

Our analysis finds that many of the solutions core to a net zero transition could become important growth areas for Canada. For example, Canada could become a leading exporter of the minerals and metals required to produce the clean technologies (such as electric vehicle batteries) that other countries pursuing lower emissions will seek. Other potential growth sectors include hydrogen, biofuels, lithium and uranium mining, small modular reactors, and geothermal energy. And negative emissions solutions may themselves present economic opportunities, especially given the unique potential for geological storage of carbon dioxide in Western Canada.

Tapping these opportunities will require careful management of risks and uncertainty. We cannot be sure which technologies will emerge to dominate or how global markets will evolve. But nor can decision makers afford to wait until this uncertainty is resolved.

Many of the resources and products already produced across the country will still be in demand in a net zero world—and in many cases, demand may increase. In all the scenarios we examined, resource sectors such as agriculture, forestry, and mining see continued growth, as do manufacturing sectors like vehicles, chemicals, steel, cement, metals, and paper.



A TALE OF THREE ENERGY SYSTEMS

Canada has more promising options than most in the net zero transition. Our scenario analysis identified three distinct energy systems that could emerge in Canada's net zero future.

Of course, how Canada's energy system will evolve depends on uncertain factors like technological developments, global policy choices, and evolving market conditions. One of these energy

systems could come to dominate, or there may be a mix of them across sectors and regions—an outcome predicted under a number of the pathways we examined. The following pages illustrate these three systems and the factors that will influence them.





3 distinct net zero energy systems are possible in Canada.

One could eventually dominate, or a mix of systems could emerge.

FACTORS affecting how our energy systems will evolve:

Within Canada's control

- Domestic policy
- Infrastructure
- Land-use priorities
- Research, development and demonstration

Outside Canada's control

- Technology adoption abroad
- Global market trends
- Global climate policy
- Technological innovation

Canada has more ADVANTAGES than other countries in pursuit of net zero:

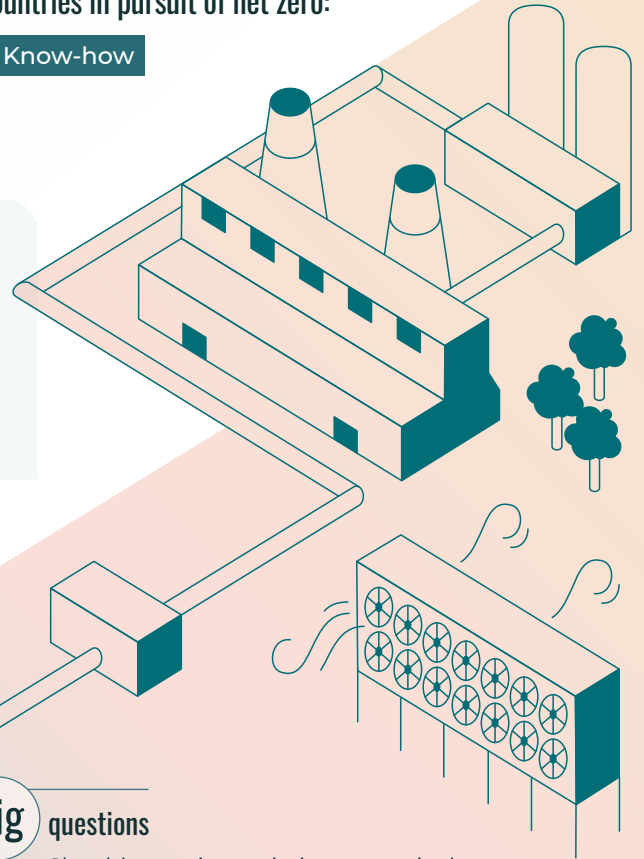
Resources | Land mass | Infrastructure | Know-how

SYSTEM 1

Fossil fuels + negative emissions

Fossil fuels continue to provide much of our energy

Emissions are offset by negative emissions solutions, requiring both engineered and nature-based solutions



Upsides

- Avoids need to replace existing fossil fuel infrastructure
- Less structural change in the economy

Downsides

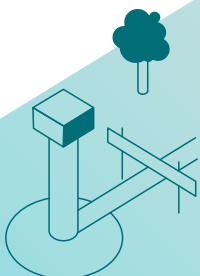
- Burning fossil fuels has **negative health and environmental consequences**
- May only **delay the transition** to another system (may need the negative emissions for other uses later)
- Avoiding structural change may mean **lost opportunities**

Barriers

- Technology is only at **demonstration stage**, would need to prove cost-effective and scalable; other countries' investment in it is still uncertain
- Would require a **massive build out** of negative emissions facilities and infrastructure
- Would require development of a **large and complex** offset trading system
- Public sees solution as **risky**

Big questions

- Should negative emissions capacity be reserved for the net negative emissions many global assessments say is necessary in the latter part of this century **to avoid severe climate change?**
- How should health impacts from air pollution in this system **affect Canada's choices?**



SYSTEM 2

Biofuels

Energy comes primarily from “second-generation” biofuels made from plants and waste (such as switchgrass and wood waste)

- Can use **existing fossil fuel infrastructure**
- Could generate **negative emissions** where biofuel combustion emissions were captured and sequestered, helping to **offset emissions elsewhere**

Upsides

Downsides

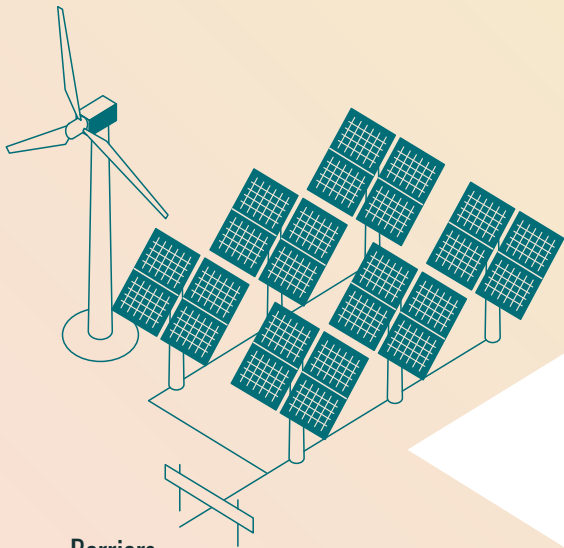
- **Social equity and justice challenges** associated with the large land-use footprint
- Land conversion requirements would also have **significant environmental impacts**

Big questions

- What are the implications of Canada going it **more alone** with this system?
- How should this system's **land-use footprint** affect Canada's choices?

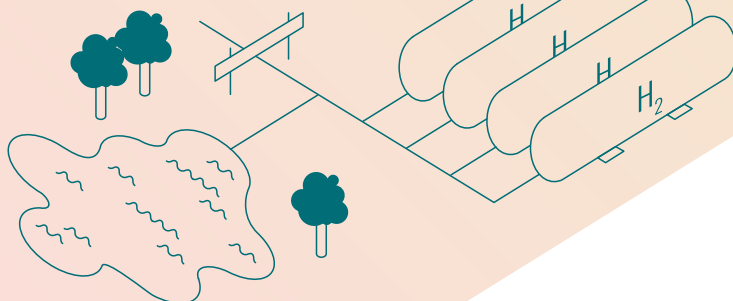
Barriers

- Few countries can do this at scale, so Canada would likely **be going it alone**
- **Massive** land use footprint, with **implications** for food production, biodiversity, Indigenous peoples
- Serious questions about the **viability and ultimate costs** of the technologies



Barriers

- Highly complex **to build and operate**
- Utility business models or mandates would have to **evolve**



SYSTEM 3

Electrification + hydrogen

Emissions-free electricity is the dominant form of energy, with hydrogen used in areas that are difficult to run on electricity

- **Lower air pollution** than in other systems
- **Potential export opportunities**, as this will be the type of net zero energy system most commonly adopted abroad

Upsides

Downsides

- **Big departure** from the status quo
- Some types of electricity generation and transmission infrastructure may be **more vulnerable** to effects of climate change

Big questions

- What implications does **the logistical complexity** of realizing this system have?
- What could **affect Canada's ability** to compete globally for export opportunities?



Paul Zizka, a kayaker on Goat Pond, AB (Traditional territory of the Blackfoot/Niitsítapi, Ktunaxa ʔamakʔis, Stoney and Tsuu Tʔina)