Spotlight Chapter

September 2024

THE CIRCULARITY GAP REPORT

Québec

The circular economy as a means to stay within planetary boundaries

CIRCLE ECONOMY

BEHIND THE COVER

The Manicouagan Reservoir was originally a meteorite crater; the fifth largest recorded on Earth, and is 214 million years old. Located in the Côte-Nord region, the crater, nicknamed ‘the eye of Québec’, is the emblem of the Manicouagan-Uapishka World Biosphere Reserve. Flooded by the construction of the Daniel-Johnson Dam on the Manicouagan River in 1970, the reservoir, with a surface area of 2,000 square kilometres and an average depth of 73 metres, is one of the largest reservoirs in the world in terms of volume and depth.

CIRCLE ECONOMY

We are a global impact organisation with an international team of passionate experts based in Amsterdam.

We empower businesses, cities and nations with practical and scalable solutions to put the circular economy into action.

Our vision is an economic system that ensures the planet and all people can thrive.

To avoid climate breakdown, our goal is to double global circularity by 2032.

RECYC-QUÉBEC Québec

La Société québécoise de récupération et de recyclage (RECYC-QUÉBEC) is a leader in responsible waste management in Quebec.

Since 1990, the government corporation has strived to make Quebec a model for innovative and sustainable waste management.

Their mission is to promote a circular economy and fight against climate change by encouraging best practices in waste prevention and management.

EXECUTIVE SUMMARY

Our current economic model is smashing through the planet's safe limits. Our take-make-waste mode of production and consumption is wreaking havoc on a global scale: today, six of the nine key 'planetary boundaries' that measure environmental health across land, sea and air have been crossed. Around the world, there's a growing impetus to rethink our relationship with materials to reverse this trend—especially as material use is being increasingly linked to a range of impacts, from climate breakdown and biodiversity loss to water stress. The story is no different in the province of Québec, Canada: the *Circularity Gap Report Quebec*, launched in 2021, found that Québec is still functioning within a dominantly linear model. Québec has a large material footprint of 271 million tonnes—or 32 tonnes per capita, which well-exceeds the global average—and a relatively low level of cycling and is currently barrelling past the safe limits of three environmental impacts: climate change, marine eutrophication and freshwater use.

The circular economy can be a means to return to a safe and just operating space. The *Circularity Gap Report Quebec* found that six circular scenarios—rolled out across the economy's most material-intensive sectors—can cut the province's material footprint by nearly half, bringing it down to 16.6 tonnes per person. But with its toolbox of strategies that regenerate nature, reduce pollution, minimise material use and keep resources in the loop for as long as possible—the circular economy is increasingly being recognised as a means to reach a wider range of impact goals. To this end, this report aims to build on the 2021 iteration and uncover how a circular transition in Québec could facilitate the return to a safe operating space, using the Planetary Boundaries framework as a foundation.

This analysis applies six circular scenarios to the Québecois economy to reveal their effect on six environmental impacts. These 'what if' scenarios are: 1) Design circularity into stocks, 2) Prioritise conscious consumables, 3) Strive for circular agriculture, 4) Leverage government procurement, 5) Make manufacturing circular and 6) Make mobility clean. The combined impact of these scenarios was measured for six environmental impacts: 1) Climate change, 2) Freshwater use, 3) Land use change for cropland, 4) Freshwater eutrophication, 5) Marine eutrophication, and 6) Particulate matter formation. These impacts draw from and adapt the Planetary Boundaries framework—which considers the Earth system as a whole and is not designed to be downscaled to a regional level—in order to tailor the analysis to Québec.

The circular scenarios can bring climate change and marine eutrophication closer to a safe operating space while bringing freshwater use well within the safe operating space. The other four impacts, which have not yet surpassed safe limits, could be further reduced. In particular, the scenarios would have an enormous impact on climate change, bringing Québec from 1041% above the boundary to 578% above the boundary: an absolute reduction in greenhouse gas emissions of 45%. Marine eutrophication—currently 83% above the boundary—could be substantially reduced to just 24% above the boundary. Freshwater use could be reduced from 52% above the boundary to 29% below. Although the remaining three impacts have not yet surpassed safe limits in this part of the world, reducing them further will only serve to benefit Québec:

- Land use change for cropland: From 76% below the boundary to 83% below the boundary
- Freshwater eutrophication: From 63% below the boundary to 81% below the boundary
- Particulate matter formation: From 8% below the boundary to 49% below the boundary

This report can serve as a guide for a range of stakeholders who have a role in the circular transition. Policymakers, businesses and industries, and academics will all be crucial drivers of a circular economy for Québec. Policymakers can draw on the results of this report to inform targets and specific goal-setting across various impact categories, framing the circular economy as a 'means to *many* ends' and shedding light on its efficacy beyond waste reduction. Businesses and industries can also leverage this report's results to bring their operations back within planetary boundaries and position themselves as circular frontrunners in Canada and beyond. This report's methodology also provides a jumping-off point for academics to fine-tune and expand upon. Ultimately, proactive collaboration across stakeholder groups will be crucial for the circular transition to thrive, and with systemic changes that span government, the private sector and individuals, the circular economy can become Québec's new reality.

CONTENTS

1. INTRODUCTION

The planet we live on today has been largely shaped by our world's dominant linear economy, with the extraction, transport, processing, use and disposal of materials to satisfy societal needs and wants hugely contributing to the overshoot of many planetary boundaries. In the province of Québec, Canada, this is no different: although hailed for its vast forest land and almost entirely renewable electricity production, material consumption and water use are exceptionally high, and cycling remains relatively low. And although the province boasts ambitious environmental goals and is home to a large number of circular economy initiatives—with cities like Montréal positioned as frontrunners in the transition—progress thus far has largely been made in siloes. The circular economy, if rolled out holistically across sectors and amongst various interest groups, has the power to reduce impacts across the board and bring Québec back within a safe operating space for people and planet.

Québec is responsible for high amounts of virgin material consumption. The *Circularity Gap Report Quebec,*[1] launched in 2021, found that the province is just 3.5% circular: below the global average of 7.2%. While Québec is hailed for its almost entirely renewable electricity production and vast swathes of forests, its economy is characterised by high levels of consumption and imports, large volumes of virgin resource extraction and relatively low levels of cycling—hence its low Circularity Metric. With a large material footprint of 271 million tonnes—or 32 tonnes per capita—using baseline data from 2017, the province is responsible for a significant share of environmental impacts, both at home and abroad.

Material consumption is linked to a range of environmental impacts. Material use matters: it's linked to nearly 70% of greenhouse gas emissions globally, and although climate breakdown has claimed centre-stage when it comes to discussions on the environment, the growing impact of consumption transgresses far beyond emissions. Ultimately, material use is a strong proxy for environmental damage, linked to biodiversity loss and water stress,[2] for example, in addition to climate breakdown. On a global scale, we're now surpassing six of the nine planetary boundaries crucial to life on Earth: climate change, biosphere integrity, land-system change, novel entities, and biogeochemical flows. Ocean acidification—also driven by spiralling greenhouse gas emissions—is dangerously close to its tipping point.

The circular economy offers tools to reduce impacts across the board. With its toolbox of strategies that design out waste, keep materials in use for as long as possible at their highest value and regenerate nature, the circular economy has been positioned as a key lever for change. Transitioning to a circular economy can tackle multiple impacts: the *Circularity Gap Report 2023* found that rolling out circular strategies across four key global systems—Food, the Built Environment, Manufacturing, and Mobility and Transport—can reverse the overshoot of **five** planetary boundaries, helping us return to thriving ecosystems across land, sea and air.

QUÉBEC HAS THUS FAR TAKEN A THEME-SPECIFIC APPROACH TO TACKLE ENVIRONMENTAL IMPACTS:

Climate change

The 2*030 Plan for a Green Economy* sets targets to reduce greenhouse gas emissions by 37.5% by 2030 and achieve carbon neutrality by 2050. Various policy measures support these goals. For example, Québec has been part of the Western Climate Initiative—the world's second-largest carbon market following the EU's—for the last decade, and targets companies in the industrial, electricity and fossil fuel sectors that release upwards of 25,000 tonnes of carbon dioxide equivalent (CO_2e) per year. Since 2017, businesses emitting upwards of 10,000 tonnes of CO_2e per year may enrol voluntarily, with funds directed towards climate initiatives.[3]

Water use

Building on the *National Water Policy* launched in 2002, the *Québec Water Strategy 2018–2030*[4] provides broad guidelines for achieving sustainable and equitable water management. The strategy aims to protect and restore aquatic environments—preventing any loss of wetlands and water bodies by 2030—as well as reduce total water consumption by 20% by 2025 compared to 2015 levels. This goal is especially important given the province's hefty water consumption: the average Québecer consumes more than 570 litres of drinking water per day, compared to 130 litres per day in France, for example.

Land use change

While Québec's famed forests still cover nearly half the province, they're at risk of losing some of their breadth: between 2010 and 2015, for example, the Ontario and Québec region experienced the largest loss of forest cover in Canada.[5] Now, they're protected under the *Sustainable Forest Management Strategy*, which aims to use management practices that ensure ecosystem sustainability and prevent forest degradation. The strategy also notes the need for additional provisions to protect wetlands and riparian zones. Through its *Nature 2030 Plan*, Québec also aims to increase its protected area from 17 to 30% by 2030 in a bid to bolster biodiversity and prevent land degradation.[6]

A circular economy roadmap was published in April 2024, with a focus on government action—built on a strong foundation of circular principles featured in other various policies. The *Governmental Circular Economy Roadmap 2024–2028*[7] aims to accelerate the circular transition in Québec by creating a governance framework that mobilises all government levers towards the end goal of a circular economy. This roadmap commits 24 ministries and organisations to action, prioritising five economic sectors, 22 objectives and 50 measures to help accelerate the development of Quebec's circular economy, all built on the strong foundation of circular principles featured in other various policies.

The *Quebec Residual Materials Management Policy* aims to eliminate waste through various R-strategies—including source reduction, reuse, recycling and reclamation—and bans the disposal of certain organic materials to increase recycling and recovery rates, for example. The *Québec Plan for the Development of Critical and Strategic Minerals 2020–2025*[8] sets the goal of Québec becoming a leader in the production—and recycling—of critical and strategic minerals, framing such a development as a major contributor to a green economy. The circular economy is at the heart of this plan, with recovery and reuse prioritised for tailings and asset components. Since its launch, the plan has resulted in a number of investments and initiatives, from the launch of scientific research networks and pilot projects to financial support for innovation to address the technical challenges of critical and strategic mineral development.

Directed at businesses, the *Regulation respecting the recovery and reclamation of products by enterprises* tasks businesses that make certain products—from oils and coolants to batteries—with implementing their own recovery and reclamation programmes or adhering to approved end-of-life management programmes based on Extended Producer Responsibility. Circular economy principles also crop up in the *Action plan for responsible and sustainable tourism 2020–2025*,[9] with one axis dedicated to supporting sustainable tourism products and businesses, stimulating the development of innovative environmental solutions for tourism, and building up Québec's reputation for sustainable tourism.

A holistic circular economy roadmap that includes a range of stakeholders across the province—from industries and non-profits to residents—to link circular strategies with impact reduction across the board is still needed. The *Governmental Circular Economy Roadmap 2024–2028* plans to explore this element starting in 2026, after laying out the main elements for governmental ministries and organisations. Meanwhile, emerging discussions have nodded to the need for regional circular economy roadmaps, with RECYC-QUÉBEC launching a toolbox for municipal and regional leaders to do so.[10] By forming a coherent provincial vision, strategic direction and collective objectives, all relevant Québecois stakeholders can collaboratively drive the circular transition—and help achieve targets across impact categories and industry groups. A 2022 report on the state of play and the management of final residues from the *Québecois Bureau d'audiences publique sur l'environnement* similarly urges progress in transitioning to a circular model, indicating that 'the government should…adopt a national strategic approach for the circular economy, accompanied

by a legal and financial framework, which would obviously mark a break with the classic growth economy, but which would have the advantage of participating in the achievement of several of its sustainable development objectives.'[11]

With this in mind, this report aims to highlight the efficacy of the circular economy strategies explored in the *Circularity Gap Report Quebec* on mitigating a range of environmental impacts. It quantifies various environmental impacts on a regional scale for the province of Québec. It explores how consumption in Québec is driving the overshoot of various planetary boundaries and identifies how circular strategies—applied across sectors—can reverse these transgressions and bring us back to a safe operating space.[12] This analysis showcases how circular economy strategies can reduce environmental impacts across impact areas that typically may not consider the value of the circular economy.

2

MEASURING QUÉBEC'S IMPACT

Québec in a linear world

By measuring the world around us, we can better understand the impact our activities are having: both positive and negative. This chapter explains how our analysis has measured Québec's current environmental impacts, as well as how they can be mitigated through circular strategies. Using the Planetary Boundaries framework as a starting point, it illustrates six key impacts—climate change, freshwater use, land use change for cropland, freshwater eutrophication, marine eutrophication and particulate matter formation—and measures Québec's current impact on each. It also describes the six circular scenarios—first introduced in the 2021 *Circularity Gap Report Quebec*—that can be applied to help bring these impacts closer to a safe operating space. By measuring the impact of circular strategies in this way, the provincial government and Québecois businesses can understand where they're starting and measure future progress in a tangible way.

2.1 ASSESSMENT METHOD

This assessment aims to illustrate the effect of circular strategies on various environmental impacts for the province of Québec, based on the Planetary Boundaries framework. The Planetary Boundaries framework provides a holistic and in-depth understanding of planetary health. Created in 2009, the framework identifies the processes that regulate the stability and resilience of the Earth's systems. It illustrates nine interrelated planetary boundaries within which humanity can safely continue to thrive: crossing these boundaries increases the risk of causing irreversible environmental changes, threatening human life on Earth.[13] Today, six of the nine planetary boundaries have been crossed,[14] and we are now functioning beyond a sustainable operating space and in the 'danger zone' of irreversible change to Earth's natural life-supporting system.[15]

However, the Planetary Boundaries framework considers the Earth system as a whole, and not all boundaries can be downscaled or disaggregated to apply to regions.[16] For this reason, we used Life Cycle Impact Assessment based on the Planetary Boundaries framework,[17] regionalised to Québec by utilising spatially explicit data where needed. To ensure our data is in line with the reality of Québec, we utilised data from OpenIO Canada and Statistics Canada. For more information on the data behind this report, refer to the methodology document.

Using this methodology, we assessed how circular strategies could affect the following environmental impacts:

1. Climate change

This refers to long-term changes in temperatures and weather patterns around the world. This is measured by carbon dioxide concentration in the atmosphere, with a suggested boundary of 350 parts per million (ppm) above the pre-industrial level.[18] We've now surpassed 420 ppm of carbon dioxide in the atmosphere. Climate change has a range of severe impacts on people and planet: the melting of land-based ice (such as glaciers) and ocean waters' thermal expansion is leading to rapidly rising sea levels, causing severe flooding for coastal communities and wreaking havoc further inland—by contaminating agricultural soils with salt, causing destructive erosion and damaging natural habitats for wildlife, for example. Extreme weather events—such as severe storms, droughts and wildfires—are also occurring more frequently, putting pressure on global food systems and threatening human health.[19]

2. Freshwater use

This refers to the extraction or withdrawal of water from a range of freshwater sources, from rivers and lakes to groundwater aquifers and reservoirs. This water is used for various human purposes. It includes water that's consumed and not returned to the source—to irrigate crops, for example. Water mismanagement can have a range of negative impacts on surrounding ecosystems, both aquatic and terrestrial: these include wildlife death and migration, habitat loss, biodiversity loss, salination, soil degradation and groundwater contamination, to name a few.[20]

3. Land use change for cropland

This refers to the conversion of natural ecosystems—such as forests and wetlands—to cropland, typically measured as hectares converted per year. This often happens as urban areas expand, thus encroaching on agricultural land—which then results in pressure to convert natural land to cropland to boost agricultural capacity.[21] This boundary aims to prevent irreversible ecosystem damage and preserve habitats' ability to provide vital ecosystem services, from stabilising the climate and nurturing biodiversity to purifying water. Surpassing this boundary has a range of negative consequences: an increased risk of flooding, biodiversity loss, decreased resilience and

greenhouse gas emissions, among them. Because of the emissions associated with land use change, this impact is closely linked to climate change.

4. Freshwater eutrophication[22]

This refers to a process where freshwater bodies—lakes, rivers and ponds—become oversaturated with nutrients: nitrogen and phosphorus in particular. These nutrients come from a variety of sources—agricultural runoff, industrial wastewater and municipal sewage, for example—and act as fertiliser for aquatic plants, which grow rapidly. As these plants die and decompose, they deplete oxygen levels in the water, posing a threat to aquatic organisms. Freshwater eutrophication thus has negative consequences on biodiversity, can trigger 'fish kills' and can even taint drinking water.[23]

5. Marine eutrophication[24]

This refers to eutrophication taking place in marine ecosystems. The process is similar to freshwater eutrophication: as algae dies and decomposes, it depletes oxygen in the water, making it difficult for marine life to survive—creating so-called ocean 'dead zones' with severe effects on biodiversity. This process also produces large amounts of carbon dioxide, lowering the water's pH in a process called ocean acidification—a key planetary boundary.[25] Acidification has a range of negative impacts: slowed growth of fish and shellfish—meaning reduced catch for fisheries—and decreased storm protection from coral reefs.[26]

6. Particulate matter formation

This refers to tiny particles—both solid and liquid—suspended in the air, stemming from both natural processes (volcanic eruptions and wildfires, for example) and human activities (such as industrial activities, transport and agriculture). Particulate matter degrades air quality—particularly in urban areas—and can pose a significant threat to human health when inhaled. It may also damage ecosystems when deposited, contaminating water bodies and impacting agricultural yields. Particulate matter formation is also closely tied to climate change: some particles absorb sunlight and therefore contribute to the warming of the planet's atmosphere.[27]

Each impact was quantified for Québec using a consumption-based approach, and then compared to the sustainable limit, referred to from now onwards as the 'Safe Operating Space' for the province.[28] To measure these impacts, we first figured out which impacts can be regionalised: climate change, for example, doesn't need to be regionalised and can simply be downscaled from its global boundary using Québec's population, while land use change for cropland is spatial in nature and needs customised data and boundaries for the province.

After establishing the current impacts and where they lie with respect to the Safe Operating Space, the scenarios—each containing a range of circular strategies—were applied (see Section 2.2). Doing so reveals the extent to which the combined scenarios reduce each environmental impact.

2.2 CIRCULAR STRATEGIES

The *Circularity Gap Report Quebec*, using 2017 data, measured a baseline for material consumption and studied the impact of six 'what-if' scenarios comprising a range of circular strategies (summarised in Table one on pages 16–17). Although these strategies vary widely, they all contribute to a common goal: decoupling Québec's economy from virgin material consumption. They do so through a combination of **narrowing, slowing, regenerating** and **cycling** material flows: that is, using less, using longer, making clean and using again. The *Circularity Gap Report Québec*'s analysis forms the basis of this report's impact assessment.

- **Narrow flows—Use less:** The amount of materials (including fossil fuels) used in the making of a product or in the delivery of a service are decreased. This is done through circular design, greater resource efficiency or increasing the usage rates of materials and products. In practice: Sharing and rental models, material lightweighting (mass reduction), multifunctional products or buildings, energy efficiency, digitisation.
- **Slow flows—Use longer:** Resource use is optimised as the functional lifetime of goods is extended. Durable design, materials and service loops that extend life, such as repair and remanufacturing, both contribute to slowing rates of extraction and use. In practice: Durable material use, modular design, design for disassembly, reuse, repair, remanufacturing, refurbishing, renovation and remodelling over building new structures.
- **Regenerate flows—Make clean:** Fossil fuels, pollutants and toxic materials are replaced with regenerative alternatives, thereby increasing and maintaining value in natural ecosystems. In practice: Regenerative and non-toxic material use, renewable energy, regenerative agriculture and aquaculture.
- **Cycle flows—Use again:** The reuse of materials and products at end-of-life is optimised, facilitating a circular flow of resources. This is enhanced with improved collection and reprocessing of materials and optimal cascading by creating value in each stage of reuse and recycling. In practice: Design for recyclability (both technical and biological), design for disassembly, reuse and recycling.

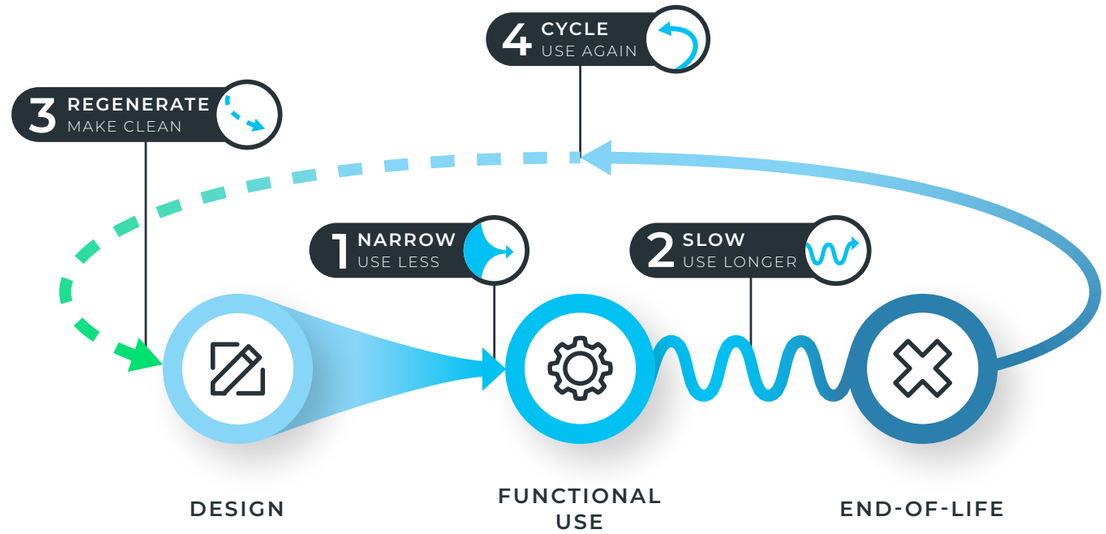

Figure one depicts the four strategies to achieve a circular economy: narrow, slow, regenerate and cycle.

SCENARIOS, INTERVENTIONS & STRATEGIES

	INTERVENTIONS	STRATEGIES	IMPACT AND MATERIAL FOOTPRINT
1. DESIGN CIRCULARITY INTO STOCKCS	**1.1 Use less, cycle more**	• Reduce floor space for residential and commercial buildings • Reduce raw material extraction • Cycle construction and demolition waste • Increase renovation and maintenance	Circularity rises from 3.5% to **4.4%**. Reduction of material footprint by **11%**, decrease to **241.2** million tonnes. Co-benefits: Reduction in GHG emissions, increased availability of space for community use or renaturation.
	1.2 Champion natural and lightweight materials	• Swap out emissions-intensive cement for regenerative timber • Avoid overdesigning and prioritise functionality	
	1.3 Decrease residential energy use	• Promote passive house design • Prioritise local renewable energy • Implement energy efficient technologies	
2. PRIORITISE CONSCIOUS CONSUMABLES	**2.1 Shift to bio-based consumables**	• Prioritise the choice of consumables from a life-cycle perspective • Favour synthetic textiles over animal-based ones	Circularity rises from 3.5% to **4.2%**. Reduction of material footprint by **4.4%**, decrease to **259.2** million tonnes. Co-benefits: Reduced plastic pollution, less discharge of chemical pollutants, lower water consumption.
	2.2 Rewire current modes of consumption	• Purchase items meant to last • Bolster minimum warranties and resale business models • Reduce the consumption of fast fashion • Improve textile cycling	
	2.3 Ramp up recycling	• Increase the recycling of industrial paper and plastic waste	
3. STRIVE FOR CIRCULAR AGRICULTURE	**3.1 Make agricultural production circular**	• Use agricultural waste for livestock fodder, and use livestock manure as fertiliser	Circularity rises from 3.5% to **4%**. Reduction of material footprint by **12.3%**, decrease to **237.6** million tonnes. Co-benefits: Reduced land use resulting in the creation of nature reserves, increased biodiversity, carbon sequestration and water purification.
	3.2 Shift towards plant-based diets	• Decrease consumption of animal protein	
	3.3 Consume less	• Eliminate waste throughout the supply chain • Reduce eating beyond caloric needs	
	3.4 Valorise organic waste	• Reuse organic waste, such as sludge • Boost energy recovery from waste	

	INTERVENTIONS	STRATEGIES	IMPACT AND MATERIAL FOOTPRINT
4. LEVERAGE GOVERNMENT PROCUREMENT	**4.1 Make public procurement circular**	• Ensure publically-purchased goods have extended lifetimes and high recycled content • Increase the resource efficiency of procurement and public health care	Circularity jumps from 3.5% to **4%**. Reduction of material footprint by **7.9%**, decrease to **249.6** million tonnes. Co-benefits: Galvanised private
5. MAKE MANU-FACTURING CIRCULAR	**5.1 Make manufacturing resource-efficient**	• Implement process improvements and material substitutions across sectors • Reduce scrap metal production • Commit to sustainably sourced biomass	Circularity rises from 3.5% to **3.8%**. Reduction of material footprint by 9.1%, decrease to **246.4** million tonnes. Co-benefits: Strong reductions in GHG emissions, economic benefits for the manufacturing industry.
6. MAKE MOBILITY CLEAN	**6.1 Car share and shift to public transport**	• Support car sharing to reduce the vehicle fleet • Increase public transport use through improved train and bus connections	Circularity rises from 3.5% to **3.7%** Reduction of material footprint by 6.6%, decrease to **253.1** million tonnes. Co-benefits: Reduced GHG emissions, improved air quality, greater access to mobility through improved sharing and public transport systems.
	6.2 Travel less	• Support remote working opportunities where possible • Virtualise interaction	
	6.3 Design for the future of circular mobility	• Promote lightweight vehicle design • Design for repair and follow predictive maintenance	
	6.4 Cycle better and extract fewer raw materials	• Focus on extending vehicle lives • Cycle automotive batteries • Increase the use of cycled materials in vehicle production	
	6.5 Make mobility emissions-free	• Phase out fossil-based engines and electrify transport	
7. COMBINED	**THE POWER OF COMBINED INTERVENTIONS**		Circularity rises from 3.5% to **9.8%**. Reduction of material footprint by 48.2%, decrease to **140.4** million tonnes.

Table one gives an overview of the scenarios modelled in the Circularity Gap Report Quebec, *which form the basis of the impact assessment.*

3

THE CIRCULAR ECONOMY'S POTENTIAL

Living within the planet's safe limits

Now that we've outlined our methodology, it's time to dive into the results. This chapter quantifies Québec's transgression of planetary boundaries and explores how six circular scenarios—that range across sectors and entertain the 'what if'—could reduce key environmental impacts and bring Québec back within a safe operating space. Building on the insights provided by the analysis in the *Circularity Gap Report Quebec*, this chapter presents a path forward and illustrates the role of the circular economy in holistic impact reduction.

Québec is currently transgressing three of the six explored environmental impacts: climate change to a great extent and marine eutrophication and freshwater use to a lesser extent. By applying the six circular scenarios, all six impacts can be reduced, with the most significant improvements achieved for climate change, marine eutrophication and freshwater use—the three impacts where change is most crucial for Québec. While two of these impacts—climate change and marine eutrophication—transgress safe limits even after the application of the circular scenarios, the potential reductions are significant. Figure two displays the results of the combined scenarios on each environmental impact.

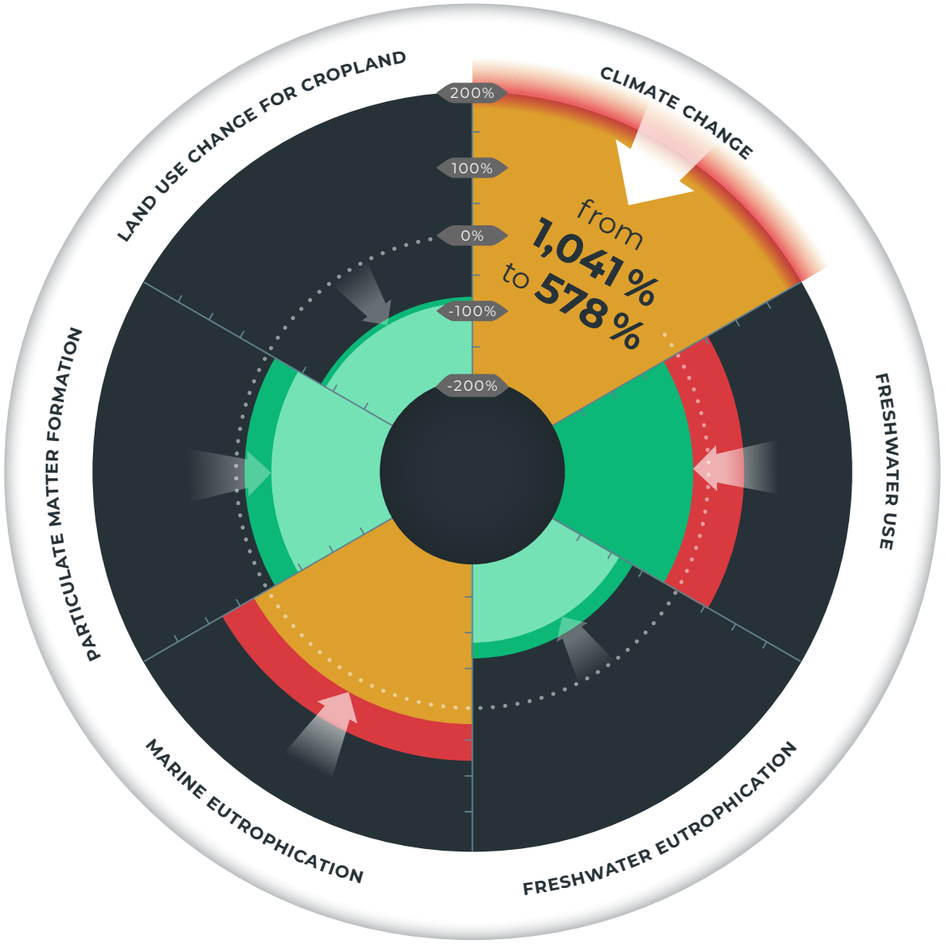

Figure two visualises the impact of applying circular strategies to a range of environmental impacts in Québec.

CLIMATE CHANGE

How the scenarios reduce this impact

All six circular scenarios tackle greenhouse gas (GHG) emissions—the primary driver of climate change—in a range of ways. GHG emissions, such as carbon dioxide, are largely produced when fossil fuels are combusted for energy, which is then used to power transport, manufacture the products we use day-to-day and heat and cool homes (just to name a few). Our scenarios primarily reduce the demand for final products through strategies that **narrow** material flows—thus reducing the demand for virgin materials and their extraction, processing, transportation and use, processes heavily linked to emissions. Materials are also kept in use for longer, reducing the need for new production. At their end-of-life, materials and products are cycled—a process generally less emissions-intensive than using virgin materials.

How much the scenarios reduce this impact

The combined scenarios have an enormous impact on GHG emissions. Québec is currently **1041% above the safe limit for climate change**—but applying the scenarios together could bring it to 578% above the safe limit. This equals an absolute reduction in GHG emissions of 45%. Although more needs to be done to bring Québec's emissions back within a safe operating space, the circular solutions presented in this report can get the province halfway there. This result also highlights the severity of Québec's contribution to climate change and thus underscores that systemic solutions will be necessary to combat it. For comparison, on a global scale, the climate change planetary boundary is transgressed by 191%.[29]

Which targets these scenarios can help achieve

As noted, Québec boasts ambitious climate goals: through its *2030 Plan for a Green Economy*, the province aims to cut GHG emissions by 37.5% by 2030 compared to 1990 levels and achieve carbon neutrality by 2050 through a variety of measures. As the results show, the circular economy transition could achieve an emissions reduction of 45% compared to 2017 levels, supporting Québec in achieving its 2030 goal. The province has already rolled out a range of measures that may also help achieve these targets: its participation in a cap-and-trade (C&T) system through the Western Climate Initiative, which limits emissions from large industrial emitters. These companies are required to hold permits for their emissions, and there are mechanisms in place to encourage emission reductions and trading of permits. The C&T system is linked to a carbon pricing mechanism that sets a per-unit price for GHG emissions, which emitters must pay if they exceed their allowance.[30] Beyond these measures, Québec also boasts renewable energy targets, energy efficiency programmes and transportation policies, all working towards reducing GHG emissions across different parts of the economy.[31, 32] Although our scenarios include many measures already being pursued in Québec, such as those just mentioned, they go even further by ultimately centring on reducing the consumption—and thus production—of materials. To this end, they illustrate how Québec could fundamentally reimagine its reliance on materials and redefine its relationship with the materials it does need.

FRESHWATER USE

How the scenarios reduce this impact

Just as virgin material use is linked to GHG emissions, it's also a huge driver of freshwater use. Let's look at this through the lens of mobility, for example. Producing and refining transportation fuels—such as gasoline—requires huge amounts of water, with one litre of gasoline requiring as much as six litres of water to produce.[33] And while eschewing gasoline vehicles in favour of electric ones will substantially cut emissions—and reduce the water footprint of gas production—doing so won't be enough to minimise overall environmental impacts: producing batteries for electric vehicles[34] is also a highly water-intensive process. This is why our *Make mobility clean* scenario aims to minimise the number of vehicles needed on the road in the first place and presents strategies to keep them in use for as long as possible and recycle components at their end-of-life. Applying circular interventions to the agrifood sector also proved to be impactful: shifting to plant-based diets and reducing reliance on water-intensive synthetic fertilisers, for example, have significant impacts on water consumption.

How much the scenarios reduce this impact

The combined scenarios have a crucial impact on freshwater use. Québec is currently **52% above the safe limit**—but applying the scenarios together could bring it to 29% **below** the safe limit. This underscores the importance of circular strategies, applied across sectors, in helping Québec remain within planetary boundaries in an often overlooked area: freshwater consumption.

Which targets these scenarios can help achieve

Reducing freshwater use is a key goal for Québec, with the *2018–2030 Quebec Water Strategy* aiming to promote sustainable water use and reduce water consumption by 20% by 2025, compared to 2015 levels.[35] To help achieve this, various policies, regulations and initiatives have been rolled out to better manage freshwater use to stay within sustainable limits. Québec's *Water Conservation and Efficiency Program* aims to ensure the sustainable use of water resources in several sectors of activity, primarily water management infrastructure, agriculture and energy production.[36] Price mechanisms are also used to promote sustainable water use. A fee is levied on activities such as water bottling, utilising 75,000 litres or more daily, irrespective of whether the water is sourced from natural surroundings or distribution systems. This fee plays a crucial role in water resource management, prompting companies to appreciate the significance of water conservation.[37] Our scenarios showcase how reducing the demand for virgin material extraction in Québec can reduce freshwater use, both within Québec and beyond.

LAND USE CHANGE FOR CROPLAND

How the scenarios reduce this impact

Land use change for cropland is primarily the result of growing agricultural demand, driven by a number of factors: population growth, shifting dietary patterns, dietary composition and soils being rapidly depleted of nutrients. Growing crops to feed livestock, for example, is particularly land-intensive and inefficient, with research suggesting that a global shift to plant-based diets could reduce agricultural land use by as much as 75%.[38] Our scenarios aim to reduce this impact through changes in diet—prioritising plant-based proteins and limiting caloric intake—as well as eliminating avoidable food waste along the value chain. These strategies will ensure crops grown are used as efficiently as possible and that nothing is unnecessarily wasted—resulting in less land converted for new cropland.

How much the scenarios reduce this impact

Québec's land use change for cropland falls within a safe operating space: 76% below the safe limit. This means that the area of forests and other natural ecosystems being converted to cropland still falls within a limit that is deemed sustainable. However, applying the circular scenarios reduces this impact even further, bringing it down to 83% below the boundary.

Which targets these scenarios can help achieve

As strongholds of biodiversity, vital carbon sinks and regulators for water systems, natural ecosystems provide crucial services for people and planet, and protecting them is paramount. Between 2010 and 2015, Québec experienced some of the highest rates of forest cover conversion to cropland in Canada.[39] Now, the province is rolling out measures to combat this in an effort to combat the negative impacts that the continuation of this trend would spark. Québec's land use planning considers the protection of land and biodiversity, for example, through local regulations concerning zoning and development control.[40] The province also has protected areas, with the aim of conserving natural ecosystems and mitigating the various factors driving cropland expansion.[41] Our scenarios aim to reverse the trend of natural ecosystem conversion to cropland by reducing the demand for cropland.

OTHER IMPACTS

Freshwater eutrophication and particulate matter formation both fall within the safe operating space in Québec—but reducing pressures even further on these impacts is still important. The circular scenarios pull all three environmental impacts further from the boundary: freshwater eutrophication falls from **63% below the boundary to 81% below the boundary**, and particulate matter formation from **8% below the boundary to 49% below the boundary**. Marine eutrophication exceeds safe limits in Québec, at **83% above the boundary**. The circular scenarios could bring this down to **24% above the boundary**.

4

THE WAY FORWARD

Québec has the potential to transform its economy, with the aim of staying within the planet's safe limits. By embracing circular strategies across six key areas—the built environment, consumer choices, agriculture, procurement, manufacturing and mobility—the province can tackle a number of pressing environmental concerns: climate change, freshwater use, land use change for cropland, freshwater eutrophication, marine eutrophication and particulate matter formation. As of this moment, Québec is transgressing three of the six environmental impacts explored: climate change, marine eutrophication and freshwater. Our analysis found that the circular transition could have a transformative impact, lessening pressures on all six impacts, with the most significant improvements made for those transgressing safe limits. Although the circular strategies do not bring all of the transgressing impacts back within the safe operating space, the potential for reducing them is still significant.

All stakeholders will have a role to play in the circular transition. Policymakers, businesses and industries, and academics alike will have unique roles and responsibilities, and the results of this report can be interpreted and leveraged to guide their various goals.

- **Policymakers** can use this research to identify key levers for impact reduction and leverage the results to prioritise actions accordingly. The results provide evidence of the many benefits of the circular economy, which can be integrated into Québec's recently launched roadmap as it progresses and develops new targets. As circular strategies can be leveraged to reach a variety of impact goals, this research nods to the importance of a holistic transition, given interlinkages between various impacts and the cross-cutting nature of circular strategies. In this sense, policymakers across various domains may further investigate how circular strategies can be integrated into various action plans to deliver on existing targets—such as those for land management and water use, for example—as well as having targets in their own right. Québec's government may also continue to measure, monitor and evaluate progress on the circular economy, using a fit-for-purpose framework that captures all aspects of circularity. This can allow the province to tackle the full extent of its environmental impacts while gauging how successful various policy instruments are at achieving environmental goals. Collaboration with various industry groups will also be key to operationalising the circular strategies studied in this report.
- **Businesses and industry stakeholders** can also use the results of this research to discern how circular strategies can help them achieve their existing impact goals. It can inspire a business model or strategy that remains within sustainable limits across a range of environmental impacts and helps form a safe and just space for all. As political momentum to tackle environmental impacts grows—and as conscious consumers increasingly 'vote with their wallets'—businesses will be compelled to make changes. Those who keep their finger on the pulse and adopt circular business models or ways of working have a unique opportunity to position themselves as frontrunners, showing others what's possible. Collaboration within and across systems will be essential for the transition. To effectively operationalise cross-cutting circular strategies, businesses and industries cannot act in a vacuum.
- Québec-based **Academics** can use this research as a jumping-off point, both fine-tuning the methodology and expanding it to apply to other environmental impact categories. The analysis may also be expanded to investigate economic and social impacts—such as labour market impacts—in more detail. Academics in Québec can also apply this methodology to other Canadian provinces to collaborate on shared ecosystems or other world regions to showcase the power of the circular economy beyond provincial borders.

THE CIRCULAR ECONOMY OFFERS AN IMPORTANT OPPORTUNITY FOR QUÉBEC

The *Circularity Gap Report Quebec*, as well as this report, showcase the province's large material footprint, low secondary material use, and transgression of three planetary boundaries. While Québec has its work cut out, it also stands to benefit hugely from the transition: the circular economy has been posited as a means to boost human health and wellbeing—offering new and improved jobs,[42] if the transition is designed with this in mind—in addition to mitigating environmental impacts. Québec is well-positioned to take on this challenge: its growing network of circular experts and grassroots initiatives cropping up at both the municipal and provincial levels, alongside its vast nature reserves, make it a perfect incubator for change.

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