Consumption-based Targets, Carbon Budgets, & Our Progress to Net Zero

BCIT CENTRE FOR ECOCITIES

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Acknowledgements and Conditions

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Key Messages

Our global carbon budget to stay below 1.5°C global warming (from pre-industrial levels) ran out about 10 to 20 years ago, if we use the latest climate data and a reasonable likelihood of success to derive our climate targets.

This means we have potentially already committed to exceed 1.5°C global warming. Which, as the latest climate data shows, also means we have potentially already committed to catastrophic climate change. And if we have not yet committed to exceed 1.5°C – then every additional tonne of greenhouse gases (GHGs) that we emit reduces the likelihood of limiting warming to 1.5°C.

It also means the latest climate data *does **not** support*:

- The current 'gold standard' target of a 50% reduction of carbon dioxide emissions by 2030 and net zero by 2050
- Establishing a carbon budget – we have already used it up

To achieve a high likelihood of limiting warming to 1.5°C we recommend government decision makers:

1. *Revisit mitigation timelines:* Very short timelines to achieve net negative global GHG emissions still have a high likelihood of limiting warming to 1.5°C
2. *Address barriers to an accelerated mitigation timeline:* Procedures at all levels of government need to align with the rapid change that is necessary
3. *Develop/implement a comprehensive carbon dioxide removal (CDR) strategy:* Our end goal should be to return to safe atmospheric GHG levels as soon as possible
4. *Incorporate consumption-based GHG emissions in climate planning*: A consumption-based approach will help ensure global targets are met in an equitable way

The latest climate data supports climate targets such as:

- *Achieve net negative GHG emissions as soon as possible*
- *Return to safe atmospheric GHG levels as soon as possible*

Climate action on mitigating greenhouse gas emissions should aim to:

1. *Minimize energy use*
2. *Fuel switch to renewables*
3. *Minimize material impact*

The buildings sector is showing progress in all three areas, but other sectors are missing opportunities to reduce impacts by not addressing each area. Key actions needed (collectively, from all levels of government) include: (1) Expand use of environmental product declarations (EPDs) which provide lifecycle GHG emissions for building materials, to all products, including food. (2) Address trends in transportation that are *countering* mitigation efforts or delaying them, such as the increasing sales of new trucks and SUVs and the *false* labelling of natural gas (a fossil fuel) as a 'low carbon fuel'. (3) Prioritise active transportation (including e-micromobility) and electric transit far more aggressively (over EVs) to minimize energy and material use.

Background

Globally, we are exceeding our planet's ecological and climate thresholds, meaning that we are emitting more emissions than can be reabsorbed and using more resources than our planet can sustainably regenerate. In Canada, as with other affluent countries, we are contributing far more than our fair share to global impacts. There is also disparity within our communities, with affluent people contributing disproportionately to a community's footprint.

At the Centre for Ecocities we encourage governments and organizations to gain an understanding of their community's consumption-based emissions as a way of exploring their fair share of global emissions. In contrast to typical community inventories which use a territorial approach – reflecting the emissions that occur within its borders (plus electricity) – the consumption-based approach looks at the lifecycle emissions of all goods and services consumed by members of the community, no matter where they were produced globally.

For more details see – Appendix A: What are Consumption-based Emissions?

Assessment of Greenhouse Gas Targets

Figure 1 shows global greenhouse gas (GHG) emissions are about 60 gigatonnes per year (Gt/year) as of 2020. It does not matter whether a sectoral or consumption-based approach is used to add up global emissions, the total is same. It is just an accounting difference – global emissions are allocated differently, with us taking responsibility for our fair share of current emissions with a consumption-based approach.

This means that *greenhouse gas reduction targets need to be the same for consumption-based and sector-based emissions*. Global emissions need to be reduced by the same amount regardless of who the emissions are allocated to.

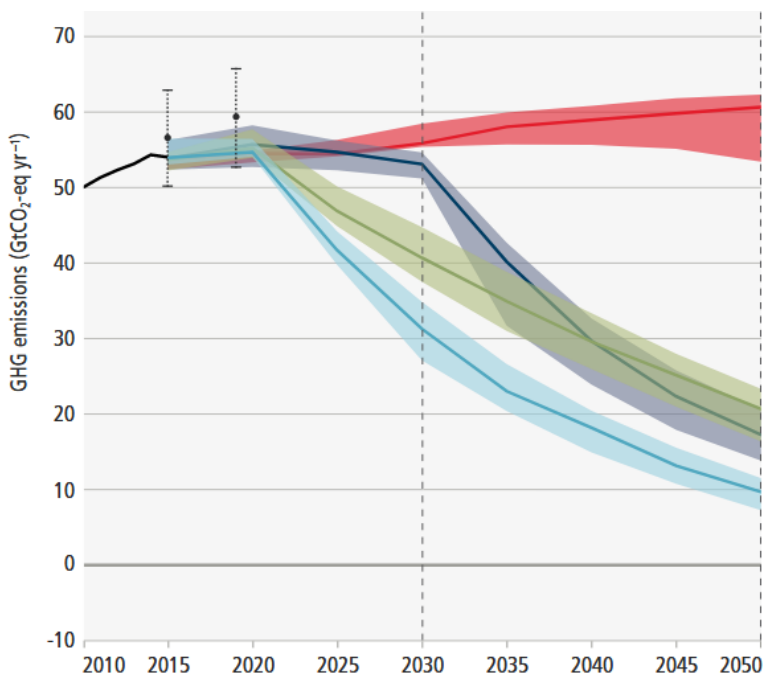

Figure 1: Global Greenhouse Gas (GHG) Annual Emissions and Reduction Pathways[1]

GHG reduction pathways are published by the Intergovernmental Panel on Climate Change (IPCC). The IPCC is a body of the United Nations, set up to compile and synthesize all the climate research from around the world. Their Sixth Assessment Report (abbreviated as AR6) is their most recent assessment. It lists reduction targets for all major GHGs combined – carbon dioxide (CO2), methane (CH4), nitrous oxide (N2O), and fluorinated gases (such as refrigerants) as well as for just carbon dioxide. The most well-known GHG reduction targets are for carbon dioxide, with a goal to limit global warming to 1.5°C above pre-industrial levels. These targets are roughly a 50% reduction by 2030 and net zero[2] by 2050 (Table 1).

[1] Credit: IPCC. Sixth Assessment Report.
[2] Net zero: Anthropogenic (produced by human activities) carbon dioxide emissions are balanced by anthropogenic carbon dioxide removals over a specified period.

Table 1: Greenhouse Gas Reduction Targets Published in IPCC's AR6[3]

Modelled pathways that limit warming to 1.5°C (>50%)* with no or limited overshoot have reductions of:

All GHGs (CO_2, CH_4, N_2O, fluorinated gases)	**Carbon Dioxide (CO_2)**
• 43% below 2019 levels by 2030	• 48% below 2019 levels by 2030
• 84% below 2019 levels by 2050	• 99% below 2019 levels by 2050

* Include modelled scenarios that limit warming to 1.5°C in 2100 with a likelihood of greater than 50%

As noted in Table 1, these targets correspond to modelled scenarios that limit warming to 1.5°C in 2100 with *a likelihood of greater than 50%*.

Our society has a lot of experience deriving targets for things that could result in loss of life if they fail – in the design of buildings, bridges, cars, airplanes, and many other products and infrastructure we rely on. As an example, when designing buildings and bridges, typically a factor of safety of 4 – 7 is used for sizing steel beams.[4] This means that, a steel beam would be made 4 – 7 times stronger than it needs to be to hold a predicted maximum load. This results in a probability of failure of about 0.0001% for structural steel used in buildings and bridges, or conversely, a probability of success of 99.9999%.[5] Compare this to the probability of success for the IPCC targets to limit warming to 1.5°C (Table 2). The IPCC targets are nowhere near the level expected for buildings and bridges – they have a very low probability of success in comparison.

Table 2: Probability of Success of IPCC Targets for 1.5°C vs Structural Steel

IPCC Targets for 1.5°C	**Structural Steel**
>50%	99.9999%

[3] This is referring to the Intergovernmental Panel on Climate Change's (IPCC's) Sixth Assessment Report (abbreviated as AR6) which is their most recent assessment. The IPCC is a body of the United Nations, set up to compile & synthesize all of the climate research from around the world.
[4] Source: The Engineering Toolbox
[5] Source: Proske, Dirk. Comparison of Bridge Collapse Frequencies with Failure Probabilities.

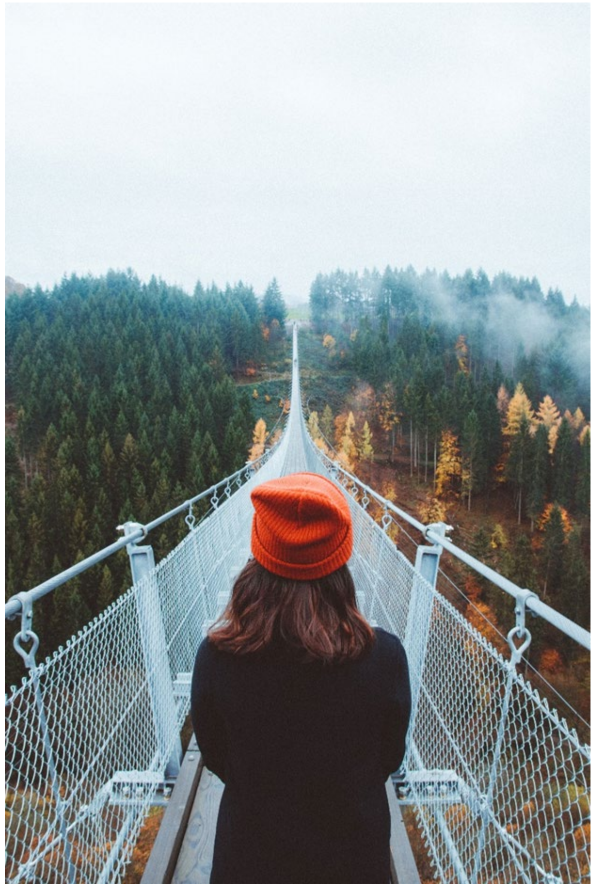

Figure 2: Which Bridge Design do You Want?[6]

If an engineer designed a bridge using the same approach as these climate targets, they would be committing what's called "a breach of their duty of care". Which means that they would have failed to meet the expectations and the risk tolerance of our society. Our society expects a very high probability of success for infrastructure and products that could cause serious injury or loss of life – everything we make must meet a similar standard as what has been shown for structural steel (it varies for different materials and situations – but is roughly similar).

One response to this comparison (Table 2) could be – can't we just aim for 2.5° or 3°C? Is limiting warming to 1.5°C unrealistic? Meaning that, if we were to maintain IPCC's mitigation pathway of net zero CO2 emissions by 2050 can we just raise the target temperature closer to a 3°C limit of global warming since this still has a high probability of success.

Targets and Thresholds

Before exploring a higher temperature target, the difference between a target and a threshold should first be defined. A target is something we can aim for, like throwing a dart at a dart board. Whereas a threshold is something we need to be on one side of or the other, such as the surface of

[6] Credit: Michael Heuser, Unsplash

the water for a diver. The surface of the water represents a threshold that must be crossed in order for the diver to breathe. It doesn't matter if this diver is 3m below the surface or 1m below the surface, they can't breathe until they cross the threshold of the surface. With climate change, *targets should be set to keep us a safe distance from a threshold*.

Climate tipping points are physical processes that are most likely irreversible once a threshold has been passed (at least within a time scale that is meaningful to us). The process continues once we pass the threshold regardless of what we do. Figure 3 lists different climate tipping points along with the estimated temperature at which the tipping points are expected to be crossed (red dots) and the uncertainty range in the temperature estimates for crossing the tipping points (red shaded areas).

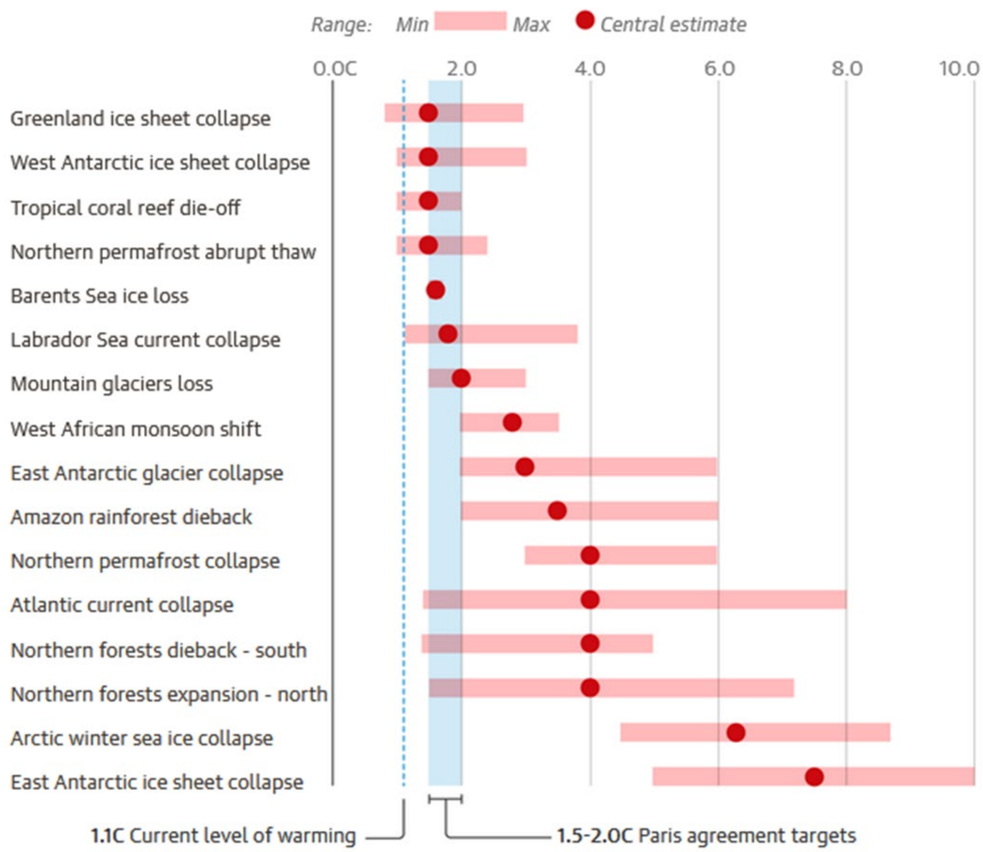

Figure 3: Climate Tipping Points[7]

The 'current level of warming' is shown to be 1.1°C (blue dotted line); we are higher than that now – as of January 2024 warming is estimated at about 1.3°C, taking the average of multiple sources.[8]

[7] Credit: The Guardian – Source: Armstrong McKay, D. Exceeding 1.5°C global warming could trigger multiple climate tipping points.
[8] Estimates vary depending on the source and the methodology used – e.g. global warming estimates by five groups are listed and discussed in the 'Comparisons with Other Groups' section found here.

Figure 3 shows we have already potentially crossed 4 tipping points – we are within the uncertainty range of the estimated temperature where these tipping points are crossed. By 1.5°C we are right at the estimated temperature for 5 tipping points – and will have potentially crossed 5 more. Meaning that *1.5°C is a threshold to stay below to avoid catastrophic climate change and should not be set as a target*.

There are also more near-term societal impacts from climate change such as:

- Water scarcity and drought
- Physical impacts from extreme weather such as heat events, flooding, severe storms
- Impacts (of the above) on agriculture

Below are two quotes from IPCC's Sixth Assessment Report as examples of current impacts.

"*Climate-related extremes have affected the productivity of all agricultural and fishery sectors, with negative consequences for food security*."

Climate change is contributing to "*roughly half of the world's population experiencing severe water scarcity for at least one month per year*."

These impacts are already being experienced now at current levels of warming – many people are struggling to find enough water for themselves, their crops and livestock, for at least part of the year.

The IPCC's Sixth Assessment Report also warns of what we can expect in future scenarios with continued warming, such as:

"*Agricultural droughts are projected to be at least twice as likely at 1.5°C global warming, [and 3 times] more likely at 2°C warming*."

"*Even with current, moderate climate change vulnerable people will experience a further erosion of livelihood security that can interact with humanitarian crises, such as displacement and involuntary migration, and violence and armed conflict, lead[ing] to social tipping points*."

So just as with the climate tipping points, the more near-term societal impacts are also indicating that we are approaching a threshold that we need to stay below.

Our trajectory, based on our current level of projected climate change mitigation efforts globally, puts us on track to reach:

- 1.5°C global warming within about 10 years[9]
- 2°C global warming in about 20 – 25 years[10]

We are not on a path that will mitigate catastrophic climate change.

[9] Source: IPCC. Sixth Assessment Report.
[10] Source: NASA. What Does Global Land Climate Look Like at 2°C Warming.

Revisiting Current Targets

Regarding the question posed earlier – can we still aim for net zero CO2 emissions by 2050 knowing that global warming may rise much higher than 1.5°C? The answer is a definite 'no', the data indicates we need to stay below 1.5°C. In fact, the data indicates 1.5°C global warming is a threshold we need to stay below, and we should be setting a target well below. However, 1.5°C is the lowest target listed in IPCC's Sixth Assessment Report so we will continue to use it, but keep in mind *the data shows that we should be aiming lower than 1.5°C*.

To derive a climate target with a reasonable probability of success we can apply the value used in the example of structural steel, 99.9999%. This is a reasonable expectation – this is the level of risk society expects.

Global Warming Between 1850–1900 and 2010–2019 (°C)		Historical Cumulative CO_2 Emissions from 1850 to 2019 ($GtCO_2$)					
1.07 (0.8–1.3; likely range)		2390 (± 240; likely range)					
Approximate global warming relative to 1850–1900 until temperature limit (°C)[a]	Additional global warming relative to 2010–2019 until temperature limit (°C)	Estimated remaining carbon budgets from the beginning of 2020 ($GtCO_2$) *Likelihood of limiting global warming to temperature limit*[b]					Variations in reductions in non-CO_2 emissions[c]
		17%	*33%*	*50%*	*67%*	*83%*	
1.5	0.43	900	650	500	400	300	Higher or lower reductions in accompanying non-CO_2 emissions can increase or decrease the values on the left by 220 $GtCO_2$ or more
1.7	0.63	1450	1050	850	700	550	
2.0	0.93	2300	1700	1350	1150	900	

[a] Values at each 0.1°C increment of warming are available in Tables TS.3 and 5.8.

[b] This likelihood is based on the uncertainty in transient climate response to cumulative CO_2 emissions (TCRE) and additional Earth system feedbacks and provides the probability that global warming will not exceed the temperature levels provided in the two left columns. Uncertainties related to historical warming (±550 $GtCO_2$) and non-CO_2 forcing and response (±220 $GtCO_2$) are partially addressed by the assessed uncertainty in TCRE, but uncertainties in recent emissions since 2015 (±20 $GtCO_2$) and the climate response after net zero CO_2 emissions are reached (±420 $GtCO_2$) are separate.

Figure 4: Table SPM.2 from IPCC's Sixth Assessment Report

Focusing on the row highlighted yellow in Figure 4, the global carbon budgets to limit warming to 1.5°C for different likelihoods (or probabilities) are shown from 17% up to 83% as of January 2020. For example, as of January 2020 we could have emitted another 500 GtCO2 globally and have a 50% likelihood of limiting warming to 1.5°C, 300 GtCO2 gave us an 83% likelihood, and so on. We need to extrapolate out to get the carbon budget for a likelihood of 99.9999% and correct for the current year – which means we want to take off about 45 GtCO2 from the budget for each year since 2020.

As of January 2024, this results in a carbon budget of about 50 $GtCO_2$, which we will use up in about 1.1 years. Meaning we should reach net zero carbon dioxide emissions globally by early 2025 or earlier.

But we're not done yet – refer to the red ovals below the table. There are uncertainties listed of +/- 770 $GtCO_2$ (550 + 220 $GtCO_2$) that are only partially accounted for in the carbon budgets in the table and another +/- 440 $GtCO_2$ (20 + 420 $GtCO_2$) that are not accounted for in these estimates at all.

If we account for these additional uncertainties, then *our global carbon budget to stay below 1.5°C warming ran out about 10 to 20 years ago*.

To summarise – if we use a reasonable likelihood of success to derive our climate targets (the same likelihood that is standard practice in designing a bridge or a building) then our global carbon budget to stay below 1.5°C warming ran out about 10 to 20 years ago.

This means we have potentially already committed to exceed 1.5°C global warming. Which also means we have potentially already committed to catastrophic climate change. And if we have not yet committed to exceed 1.5°C – then every additional tonne of greenhouse gases that we emit reduces the likelihood of limiting warming to 1.5°C.

It also means the data does ***not*** *support:*

- *The current 'gold standard' target of a 50% reduction of carbon dioxide emissions by 2030 and net zero by 2050*
- *Establishing a carbon budget – we have already used it up*

Note that the term 'climate budget' (not 'carbon budget') is being used by some in referring to a framework for tracking greenhouse gas emissions for a given year by an organization – similar to how finances are currently tracked. A climate budget is completely different than a carbon budget, however, climate budgeting guidelines may encourage the use of a carbon budget to set annual greenhouse gas emission limits. As shown above, climate data indicates that our global carbon budget has been used up – therefore we recommend using another method for setting annual greenhouse gas emission limits.

IPCC's targets for carbon dioxide emissions aimed at limiting warming to 1.5°C with a likelihood of greater than 50%, are often referred to as 'science based' targets. However, as shown above, the data does not in fact support these targets.

In order for a target or threshold to be considered 'science based' it needs to:

- be based on science
- meet society's expectation of risk

The second point is where the IPCC's targets fail. No one is going to walk out onto a bridge that has almost the same likelihood of collapsing as it does to stay standing, so why would we consider setting targets at that level for climate change, which has the potential to wipe out our society as we know it.

Examples of *science based targets that the data does support could be*:

- Achieve net negative[11] greenhouse gas emissions as soon as possible
- Return to safe atmospheric greenhouse gas levels as soon as possible – for example, less than 350 parts per million of carbon dioxide in the atmosphere has been proposed as a threshold to get below.

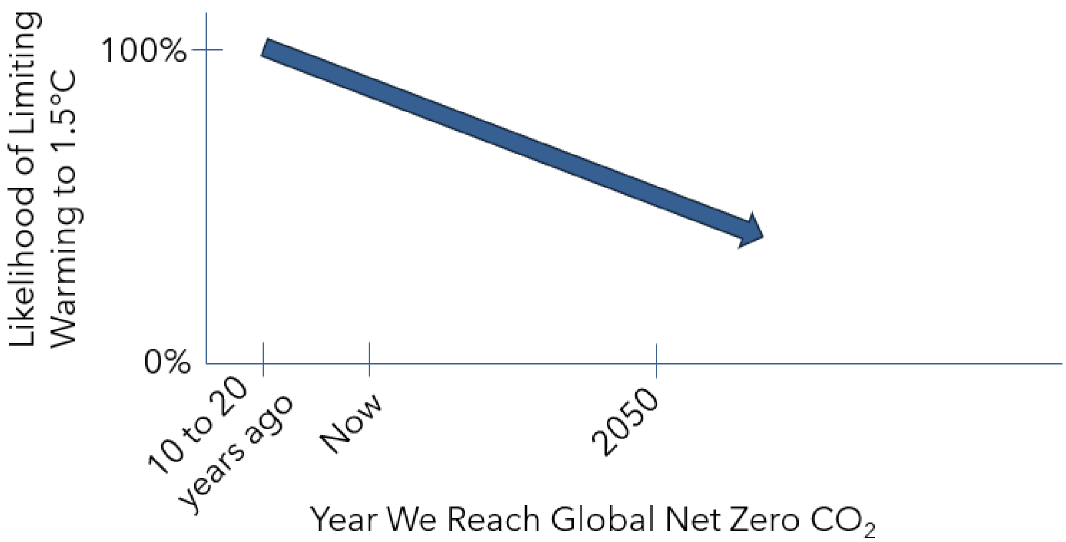

Figure 5: Likelihood of Limiting Warming to 1.5°C Versus Year Global Net Zero[12] Carbon Dioxide Reached

Figure 5 summarizes graphically (roughly) the relationship between the likelihood of limiting global warming to 1.5°C and the year global net zero carbon dioxide emissions are reached. For example, if we magically reach global net zero emissions tomorrow – we are a little under 100% certainty of limiting warming to 1.5°C. The odds of limiting warming to 1.5°C are still heavily in our favour if we act now to get to net zero as soon as possible.

The longer we take to reach net zero, the farther we slide down the line and by 2050 the likelihood of limiting warming to 1.5°C is about the same as a coin toss.

Many people are wrongfully under the impression that meeting the IPCC targets (for limiting warming to 1.5°C – roughly a reduction of 50% by 2030 and net zero by 2050) will guarantee that

[11] Net negative: Anthropogenic (produced by human activities) carbon dioxide emissions are less than anthropogenic carbon dioxide removals over a specified period.
[12] Net zero: Anthropogenic (produced by human activities) carbon dioxide emissions are balanced by anthropogenic carbon dioxide removals over a specified period.

we stay below 1.5°C warming. Many people wrongfully think the “100%” referred to in Figure 5 corresponds to reaching net zero by 2050.

It is not surprising that there is a lot of confusion about this. The IPCC targets themselves are not very clear – recall there’s that little “>50%” in brackets above the targets (Table 1). This is referring to the massive risk shown in Figure 5 associated with reaching net zero by 2050. Unfortunately, the majority of references to the IPCC targets don’t even mention the risk. This is the case for media, for climate advisory organisations, and even a lot of scientific papers.

Figure 5 shows the reality of the situation we are in. Planners and decision makers need to know this in order to understand the risks they are taking in their mitigation timelines to reach net zero and to address the need to change their procedures to accommodate a meaningful timeline – a much shorter timeline. The public needs to know this in order to support decision makers to act on a meaningful timeline to reach net zero.

To conclude we have a few recommendations for government decision makers:

1. *Revisit mitigation timelines:* Very short timelines to achieve net negative global GHG emissions still have a high likelihood of limiting warming to 1.5°C
2. *Address barriers to an accelerated mitigation timeline*: Procedures at all levels of government need to align with the rapid change that is necessary
3. *Develop/implement a comprehensive carbon dioxide removal (CDR) strategy:* Our end goal should be to return to safe atmospheric GHG levels as soon as possible
4. *Incorporate consumption-based GHG emissions in climate planning*: A consumption-based approach will help ensure global targets are met in an equitable way

Climate Action Progress and Recommendations

To assess progress on reducing greenhouse gas emissions across key sectors (buildings, transportation, consumables (non-food), and food) the following framework will be used:

1. Minimize energy use
2. Fuel switch to renewables
3. Minimize material impact

The framework reflects what has been happening in the buildings sector. The sector is showing comprehensive movement in the right direction – minimizing demand for energy so that demand can more easily be met with renewables and minimizing the impact from raw material use. Other sectors are missing opportunities to reduce impacts by not addressing all three areas.

In Canada some of the actions listed below are driven by provincial and some by local/regional governments.

Buildings

Minimize energy use

Progress is being made on the Energy Step Code (in BC), Passive House and Net Zero Energy Standards being more broadly adopted.

Fuel switch to renewables

Progress is being made on the Zero Carbon Step Code (in BC) and Net Zero Energy Standard being more broadly adopted.

Minimize material impact

Some jurisdictions are shifting to requirements for whole building lifecycle assessments (LCA), using environmental product declarations (EPDs, which provide product level lifecycle greenhouse gas emissions), and embodied carbon requirements. There is also a shift to increased circularity with some local governments adopting deconstruction and reuse requirements.

Buildings – *What is needed*

(collectively, from all levels of government)

- Accelerated adoption of policy/standards and broader reach – e.g. include targets for retrofits of existing buildings
- Broad adoption of right-sized, high density/multifamily housing as a strategy to minimise energy use, material use and built area
- Electrification of construction/retrofitting
- Measures to counter efforts by fossil fuel companies to stall electrification

Transportation – *Positive Impacts*

Minimize energy use

By far the best way to reduce the impact of transportation in our cities is to eliminate the need for private vehicles, and the best way to do that is to reconfigure our cities into complete, compact communities. Goals for complete compact communities are being included in an increasing number of strategic level government plans and in BC all signatories of the Province's Climate Action Charter have committed to developing complete, compact communities. However, urban sprawl dependent on private vehicle use continues to be developed.

Mode share for active transportation and transit is increasing in many communities and remote virtual work has now become the norm in many workplaces and educational institutions.

Combined, complete compact communities, mode shift, and remote virtual work have the potential to greatly reduce energy use.

Fuel switch to renewables

Most jurisdictions are working on vehicle electrification.

Minimize material impact

We can expect to see some future reductions in vehicle ownership through expansion of active transportation, transit, car and bike share.

Transportation – *Negative Impacts*

Minimize energy use

Larger vehicle sizes and a focus on private vehicle electrification are missing huge opportunities to minimize energy use (see details below).

Fuel switch to renewables

Adoption of falsely labelled "low carbon fuels" has delayed electrification (see details below).

Minimize material impact

Larger vehicle sizes and a focus on private vehicle electrification are missing opportunities to minimize impacts from material use (see details below).

Vehicle sizes are increasing:

Figure 6 shows the trend of the percentage of new vehicle sales in Canada that are trucks and SUVs increasing from 57% in 2010 to 83% in 2022.[13] This trend continues back down to the 1990s when trucks and SUVs accounted for less than 30% of the total vehicle fleet.[14]

[13] Source: Statistics Canada

[14] Source: Équiterre. The Rise of Light-Duty Trucks in Canada: Reversing The Trend.

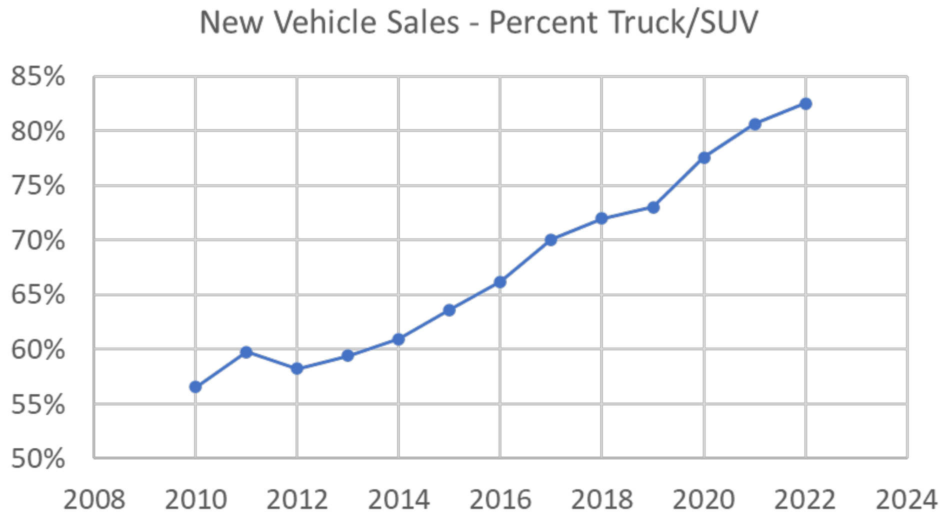

Figure 6: Percentage of New Vehicle Sales in Canada that are Truck/SUV

The average truck or SUV weighs about 65% more than the average car and the weight of a vehicle is a pretty good indicator of how much energy it will use. A vehicle that weighs twice as much as another vehicle is going to use roughly twice the energy – assuming the vehicles are powered the same.

The increase in vehicle size is offsetting gains made through efficiency (hybrids) and electrification. It is also increasing the impact from materials – bigger vehicles equal more materials – offsetting potential gains made in reducing vehicle ownership.

Electric vehicles still use a lot of energy:
Table 3 shows that the weight of an average passenger only accounts for about 5% of the total weight in a car and about 3% in a truck or SUV.

Table 3: Passenger Weight as a Percentage of Total Weight (single occupancy)

	kg	Passenger %
Avg Passenger	70	
Avg Car	1500	4.5
AVG Truck/SUV	2500	2.7
Transit Bus		Up to 50%

If you recall from the previous section – weight is a pretty good indicator of energy use. For these cases in Table 3 (not accounting for engine efficiency), roughly 95% of the energy goes into moving the car and 5% into moving the passenger - and for the truck, 97% of the energy goes into moving the truck and 3% into moving the passenger.

The objective is to move people, not the vehicle - *almost all the energy used to power private vehicles is wasted*.

Compare this to a transit bus where passengers can account for up to 50% of the total weight – more than 10 times higher than a single occupancy private vehicle. In order for a private vehicle to compete with a fully loaded transit bus it needs to be a similar size or smaller than the options shown in Figure 7.

Figure 7: Examples of Private Vehicles with a Similar Passenger to Vehicle Weight Ratio as Transit: an electric scooter and an electric unicycle (also called an EUC or eWheel)

We still need EVs. Our cities are designed around private vehicles and its going to take time to shift that. For now, we need to maximize the shift to active transportation (including e-micromobility) and electric transit, and shift incentives to light weight EVs.

Falsely labelled "low carbon fuels":
Compressed natural gas (CNG, a fossil fuel) has been promoted as a 'low carbon fuel' by some transit authorities. It's true that CNG emits less direct greenhouse gas emissions than diesel, but CNG engines are lower efficiency than diesel. The net result is that a CNG bus emits about the same greenhouse gas emissions as a diesel bus.[15]

Adopting CNG has delayed the electrification of transit in many jurisdictions. We are at least a decade behind where we could be in transitioning our transit fleets to electric. In 2016 – almost 8 years ago - Europe put 25,000 electric buses on the road and China put 130,000 electric buses on the road and they have continued to scale up from there.

The promotion of CNG as a "low carbon fuel" has also been very damaging to the climate literacy of the public. We get questions about this, for example, asking how much someone's personal footprint is being lowered by them taking a CNG bus (instead of diesel) or why electric heat pumps are being promoted for space heating while CNG is being promoted for transit.

It has also damaged the reputation of the transit authorities – a lot of people are well aware that this is nothing more than greenwashing.

[15] Source: MJB & A. Comparison of Modern CNG, Diesel and Diesel Hybrid-Electric Transit Buses: Efficiency & Environmental Performance.

Unfortunately, the case for liquid natural gas (LNG, a fossil fuel) as a marine fuel is not much better. Using a 20-year global warming potential (GWP) and factoring in all LNG lifecycle emissions, there is no climate benefit from using LNG instead of marine diesel.[16]

Natural gas is not a "low carbon fuel" and the promotion of it is keeping us on a path to increased global warming.

Transportation – *What is needed*

(collectively, from all levels of government)

- Accelerate transition to complete, compact communities
- Metrics for system level efficiency (e.g. kWh/passenger-km)
- Prioritize active transportation (including e-micromobility) and electric transit over private EVs and accelerate new infrastructure
- Push back against misinformation and greenwashing
- Environmental product declarations (EPDs) and product labeling to drive market transformation (this would likely require international collaboration as Canada is a relatively small market)

Consumables (non-food)

Minimize energy use, fuel switch to renewables and minimize material impact

The majority of the impact from consumables is in supply chains, which for many products is global, so it's certainly more of a challenge for local/regional governments to have influence. There has been some limited opportunity for influence over local businesses through building codes and bylaws.

There are the beginnings of a shift to circularity with share, reuse, repair initiatives but to really have a chance at making products circular they need to be designed to be circular. So again, we have the issue of dealing with global supply chains.

Consumables – *What is needed*

(collectively, from all levels of government)

- Environmental product declarations (EPDs) and product labelling to drive market transformation through procurement policy, education and awareness. It is pretty hard for us to buy low carbon products without any way to identify them.
- More regulation – materials that have no chance of ever becoming circular need to be phased out

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[16] Source: International Council on Clean Transportation. The climate implications of using LNG as a marine fuel.

Food

Minimize system waste

Currently about 58% of the food produced in Canada is wasted.[17] There is a huge opportunity to make our food system more efficient and minimize demand by addressing food waste.

There is progress on food waste initiatives by local governments – groups like 'Love Food – Hate Waste' and Second Harvest are shining a spotlight on the issue.

Shifting diets & fuel switching to renewables

Local governments are promoting low carbon diets through procurement and other initiatives.

Minimize material impact (e.g. from soil, fertilizer, manure, etc.)

Most of the impact from food is from the management of materials on farms – soils, fertilizer and manure management.

Local and organic farming is being promoted as a way to support farms with better practices and lower emissions but "local and organic" doesn't necessarily correspond to lower greenhouse gas emissions.

However, local production does shorten supply chains which can be part of a strategy to reduce food waste.

Food – *What is needed*

(collectively, from all levels of government)

- Environmental product declarations (EPDs) and product labeling to drive market transformation through procurement. We can't support good farming practices with low/no GHG emissions if we don't have a way of identifying them.
- Tackle food waste – much more needs to be done to reduce food waste
- Promotion of regenerative agriculture – a set of farming practices that enhance the health of the land and in doing so, builds up carbon in the soil. The agriculture sector has the potential to drastically reduce emissions by shifting to these practices, becoming net zero or even net negative emissions. There are already farms producing food this way but again, it is very difficult to support good farming practices if we don't have a way of identifying them.
- Promotion of lower carbon meat production – in addition to promoting a shift to more plant-based diets to reduce demand for meat, there are also strategies to reduce emissions from meat production. One of the most promising are dietary supplements for animals to reduce the methane produced as they are digesting food. By implementing known techniques, studies show that a drastic reduction in methane from livestock could be achieved.[18]

[17] Source: Second Harvest. The Avoidable Crisis of Food Waste.
[18] Source: World Resources Institute. 7 Opportunities to Reduce Emissions from Beef Production.

Appendix A: What are Consumption-based Emissions?

Since the late 1990s, governments have typically created greenhouse gas (GHG) emissions inventories using an 'in-boundary' or 'sectoral' approach. These inventories evaluate emissions from sources within a particular region and, where relevant, include emissions from out-of-region grid electricity and waste management.

This sectoral approach does not provide a complete picture of a community's impact on global climate change. It misses the climate impacts associated with the many goods a community consumes, because many of them are produced in other regions, often on other continents. It also excludes the "out of boundary" impacts residents and local businesses have while they are travelling outside of their community. In contrast, the consumption-based emissions inventory (CBEI) quantifies all consumption-related GHG emissions attributable to a population.

It remains important to track local emissions through the sectoral inventory, for example, to monitor the emission intensity of local industrial and commercial activity. However, consideration of consumption-based emissions facilitates an understanding of global emissions resulting from local consumption habits. The CBEI will help inform and encourage strategies that maximize global, not just local emission reductions. It also provides the opportunity to engage stakeholders in understanding the broader emission impacts of their lifestyles and behaviours and can thus more effectively mobilize emission reduction actions. The distinction between the sector-based (i.e. sectoral) inventory and the CBEI is visualized in Figure 8.

For the communities we've worked with in Canada, their consumption-based emissions are about double their sector-based emissions. In Canada we import a lot into our cities and typically our cities are not big manufacturing hubs.

If we looked at cities elsewhere in the world, such as in Asia where there is a lot more manufacturing, their sector-based emissions would be much higher and could even be higher than their consumption-based emissions.

In Canada we have off-shored a lot of our manufacturing and the associated GHG emissions along with it. With a consumption-based approach we can take responsibility for the emissions we have moved offshore.

Globally there is growing interest in consumption-based emissions: BCIT Centre for Ecocities has prepared CBEIs for over 30 communities; C40 Cities[19] has developed over 80 CBEIs for communities; Canada has a national CBEI;[20] and in 2022 Sweden agreed to include consumption-based emissions in its climate targets, the first country to do so.[21]

[19] C40 Cities is a global network of about 100 mayors from around the world that are collaborating on the climate crisis
[20] Access Canada's CBEI here
[21] Read more on Sweden's consumption-based emissions commitments here

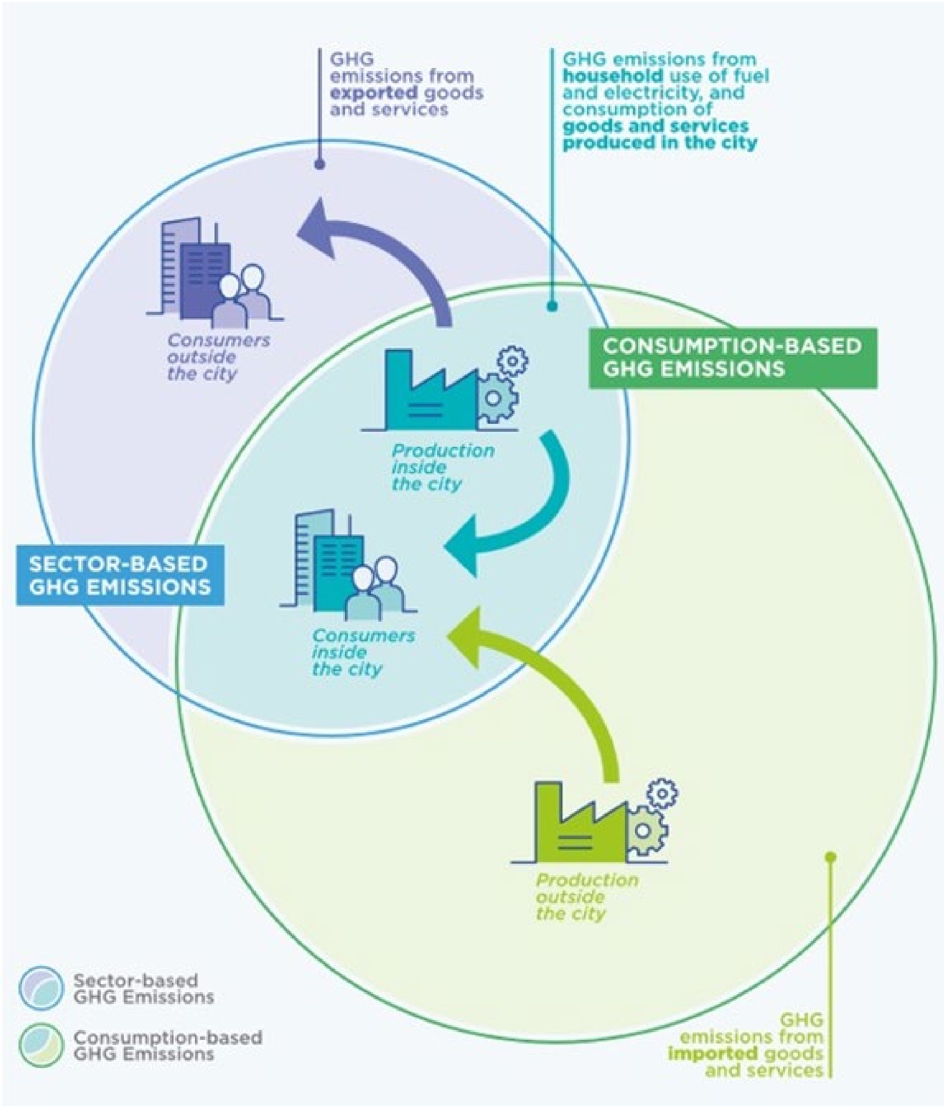

Figure 8: Comparison of Sector-based Emissions with Consumption-Based Emissions[22]

[22] Credit: C40 Cities