RELIANCE ON CARBON CAPTURE AND CARBON REMOVAL TECHNOLGY IS A DANGEROUS TRAP: CANADA'S OIL FUTURE

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On November 1, 2021, on the stage at the COP26 meeting in Glasgow, speaking to an assembly of world leaders, Prime Minister Trudeau declared that Canada has "formally committed" to cap emissions from our country's oil and gas sector.

What Trudeau did not tell the assembled leaders is that Canada, the world's 4th largest oil producer, intends to continue expanding its oil production.

The promised "cap" relates only to the volume of emissions released into the atmosphere from oil extraction and processing activities within Canada.[1] A few days before Mr. Trudeau's announcement in Glasgow, Canada's Environment Minister Steven Guilbeault was asked about the oil and gas sector. He responded: "We are not trying to cap production. We will be capping the amount of pollution that comes from those sectors."

The Federal Government's official document published on March 29, 2022, the *Emissions Reduction Plan 2030* (ERP), confirms that none of the government's proposed new climate policies, including plans to subsidize large-scale deployment of Carbon Capture and Storage (CCUS) technology in the oil sands industry, are intended to bring about any decline in the currently projected growth of Canada's oil production.

Indeed, the text of the ERP affirms that the aim of government policy will be to continue to maximize production:

> *The government will work closely with the provinces and the sector to manage competitiveness challenges, remain attuned to evolving energy security and climate risk considerations, maximize opportunities for ongoing investment in the sector, and minimize the risk of carbon leakage. The intent of the cap is not to bring reductions in production that are not driven by declines in global demand. Mechanisms like the CCUS investment tax credit will help support decarbonization.*
>
> — *2030 Emissions Reduction Plan*, March 29, 2022, p.53 (emphasis added)

The government's plan is clear: Canada's oil production will continue to increase until other countries eventually begin to consume less oil. In the meantime, Canada's production levels will be guided solely by "global demand".

1. Canada's promised "cap" on oil and gas sector emissions

On December 7, 2023, the Federal Government published a new document titled *Regulatory Framework for an Oil and Gas Sector Greenhouse Gas Emissions Gap*.[2] It provides details of the promised emissions "cap", which will be a cap-and-trade scheme that sets a limit on the overall volume of emissions that oil and natural gas producers are permitted to release every year at extraction and processing facilities in Canada. The new scheme does not impose any limits on the growth of oil and gas production. Indeed, the document confirms that based on rising global demand Canada's oil production will continue to expand to 2030:

> *It is proposed that the legal upper bound in 2030 be set at a level that assumes the covered sources achieve technically achievable emissions reductions by 2030 for production levels aligned with the Canada Energy Regulator's Canada Net-Zero Scenario (CNZ).*
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> — *Regulatory Framework* document, December 7, 2023, p.53 (emphasis added)

The new document acknowledges that oil production in Canada will continue to increase to 2030, expanding about 17% above the 2019 level. The document cites and relies on a scenario it identifies as the "Canada Net-Zero Scenario", which is a projection showing the expected future levels of our oil production to 2030, 2040, and 2050 prepared by the Canada Energy Regulator, the government's own energy agency. The "legal upper bound" refers only to the proposed upper limit legal on greenhouse gas emissions released by oil and gas extraction operations in Canada.

This statement therefore assures the oil and gas industry that it will be able to continue expanding *production* to 2030, and that the prescribed volume of emissions reductions called for at oil and gas production sites in Canada will be "technically achievable" even while overall oil and gas production levels continue to increase. The proposed legal upper bound governing the annual level of emissions in 2030 is set about 20% to 23% below the 2019 emissions level.

The December 7, 2023 document does not include any discussion about the climate implications of allowing the continued expansion of oil production to 2030 and maintaining currently projected high levels of oil production through to 2040 and beyond.

2. Canada's future oil production: the Canada Net-Zero Scenario

Two years ago, on December 21, 2021, the Canada Energy Regulator (CER) was directed by the Minister of Natural Resources to conduct a scenario analysis to identify what future levels of oil production in Canada could be safely aligned with limiting warming to 1.5°C. The specific instructions[3] given to the CER by Minister Wilkinson were as follows:

> *… I am requesting, as the Minister responsible for the CER, that your organization undertake scenario analysis consistent with Canada achieving net-zero emissions by 2050 … The modelling should reflect a global context in which the world achieves the Paris Accord goal of limiting warming to 1.5°C …*
>
> — Letter, Jonathan Wilkinson to CER, December 16, 2021 (emphasis added)

The CER chose to prepare three scenarios, which were publicly released on June 20, 2023, in its report *Canada's Energy Future 2023*.[4] Two of the CER's new scenarios are closely modelled on scenarios developed by the International Energy Agency.[5]

The CER's "Global Net-Zero Scenario" was the only scenario that complied with the Minister's specific request for an analysis to determine what future levels of oil production in Canada over the next 20 to 30 years would be safely aligned with an effective global effort to stay within the 1.5°C warming threshold. In its report released on June 20, 2023, the CER concluded that to meet this goal, Canada's oil production must decline from 5.5 million barrels per day (bpd) in 2030 down to 2.8 million bpd by 2040 (a 50% reduction in the next decade); with a further rapid decline to 1.2 million bpd by 2050.

The CER's two other scenarios project much higher production levels. Both indicate warming substantially above 1.5°C. One of those, namely the "Canada Net-Zero Scenario", sees Canada defer any deep cuts to our oil production until after about 2040. Under this scenario, our oil production peaks at 6 million bpd in 2030 then declines slowly to 5.1 million bpd in 2040. It leads to warming of 1.7°C or above by 2100.

The CER's third scenario, which it calls its "Current Measures Scenario", does not remotely meet the Minister's stated objectives. It assumes that Canada's oil production will continue to expand for more than another 20 years, and that by 2050 it will be 6.2 million bpd, still 20% above the 2022 level. The CER report does not disclose any information at all about the impacts on the earth's climate system if global oil demand continues to rise in line with that scenario. It is clear, however, that the CER's third scenario is broadly aligned with the IEA's STEPS Scenario (see note 5) which projects warming will reach 2°C by 2050 and 2.4°C by 2100.

3. Government Ministers are misleading Canadians

In its report of June 20, 2023, the CER refrained from making any assessment or drawing any conclusions about whether the temperature outcomes in any of its three scenarios will be safe or acceptable, looking 20 or 30 years into the future. The CER offered no advice about which of its three scenarios for Canada's future oil production should guide public policy.

It is of course the responsibility of our political leadership, especially the Minister of Natural Resources, Jonathan Wilkinson, to candidly inform Canadians about which of these scenarios showing Canada's projected future oil production will be safe or acceptable. So far, the Federal Government has remained silent about that.

The *Regulatory Framework* document published on December 7, 2023, mentions only one of the CER's three scenarios, namely the "Canada Net-Zero Scenario". As the CER explained in its report of June 20, 2023, the Canada Net-Zero Scenario is modelled on the International Energy Agency's (IEA) Announced Pledges Scenario (APS). The IEA's APS Scenario assumes that any deep reductions in global oil production will be delayed until after about 2040. As a result, any chance to reach global net-zero is delayed until about 2100. The IEA has very clearly warned that the APS Scenario, if it were to guide the world's major oil producing countries, will lead to an increase in the earth's average surface temperature of 1.7°C to 1.8°C.

The Federal Government, in its public discussion document, has chosen to adopt the CER scenario, which is aligned with warming of 1.7°C and very possibly higher. It provides the following brief explanation of what the Canada Net-Zero Scenario means in terms of efforts to meet the challenge of climate change:

> *The 2030 legal upper bound is designed to align with Canada's commitment to achieve net-zero emissions by 2050. The production forecast used to develop the 2030 legal upper bound is grounded in the Canada Energy Regulator's (CER) Canada Net-Zero Forecast, which is based on a scenario where Canada and all other parties to the Paris Agreement achieve their interim and net-zero climate targets. This means that virtually all high-income countries achieve net-zero by 2050 and other large emitters like China and India reach net-zero by 2060 and 2070 respectively, as they have previously committed.*
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> — *Regulatory Framework*, December 7, 2023, Annex 1, page 10 (emphasis added)

Although the *Framework* document incorporates the Canada Net-Zero Scenario into its analysis, it omits any mention of the fact that it is aligned with warming of 1.7°C to 1.8°C. "Net-zero" means only that a country has promised that by some specified future date (for example by 2050) it will have reached a point where all its continuing emissions (also referred to as "remaining emissions" or "residual emissions") will be "captured" by Carbon Capture and Storage (CCS) technology, or otherwise fully off-set by measures that remove equivalent amounts of CO_2 from the atmosphere.

Further, the government's new *Regulatory Framework* document does not make any reference at all to the CER's other scenario, "Global Net-Zero Scenario", which is the only one of the three scenarios developed by the CER that is aligned with the 1.5°C goal. Discussion of the CER's Global Net-Zero Scenario, and of the deep near-term cuts it would require in Canada's oil production, is entirely excluded from the December 7, 2023 *Regulatory Framework* document.

Had the *Regulatory Framework* included a candid summary of the findings set out in the CER's Global Net-Zero Scenario, Canadian citizens would be able to appreciate that any remaining realistic chance we have of limiting warming to 1.5°C will require a very sharp and rapid decline of Canada's oil production between 2030 and 2040. That crucial finding has been erased from the public discussion document.

The government's declared policy is clear: Canada's production levels will be guided solely by "global demand". Having embraced that policy approach, surely the Federal Government and in particular the Minister of Natural Resources have an obligation to fully disclose to Canadian citizens the climate implications of that policy. At the very least, it requires full and candid disclosure of what the CER's Canada Net-Zero Scenario tells us, namely that even a temporary delay in adopting the accelerated pace of the decline in global oil production laid out in the IEA's Net-Zero by 2050 Scenario will drive warming to 1.7°C and above.

Our government nevertheless assures Canadians that under its Canada Net-Zero Scenario, which delays any deep cuts to oil production until sometime after 2040, "virtually all high-income countries" will meet their net-zero emissions pledges by 2050. That statement is seriously misleading. The IEA's APS Scenario merely *assumes*, without examination or verification, that

all those national net-zero pledges will be successfully met by 2050. This presumption that high-income countries will meet their net-zero commitments does not reflect any finding or analysis, or conclusion, by the IEA (and certainly not an independent assessment by Canada's CER) that all those countries, given their existing or promised future climate policies, have a realistic chance of reaching their net-zero goals by 2050. Meeting this net-zero promise is a conjecture, and even if fully met it gives us warming of 1.7°C or above.

The brutal truth is that at present the annual level of global emissions from our reliance on coal, oil, and natural gas is still growing. Fossil fuel emissions account for 70% of all emissions driven by human activities. To stay on a path that gives us any realistic chance to limit warming to 1.5°C, the volume of CO_2 emissions from fossil fuel burning must decline about 35% by 2030, below the 2022 level (see Part 4 below)**.** Based on existing energy and climate policies, there is no evidence that anything remotely approaching a 35% decline, or any decline at all, is likely within the next seven years. The government's assurances that high-income countries will achieve net-zero by 2050 has no foundation in the available evidence.[6]

The misleading character of this document goes further. Even assuming Canada and other "high-income countries" successfully achieve promised net-zero targets by 2050, that does not tell us anything about the warming increases that will result. The determinative question, the crucial question, is this: <u>what additional cumulative amount of CO_2 will be released into the atmosphere over the next 26 years before all these countries finally stop releasing any further net-positive emissions</u>? The available evidence shows that by the time Canada reaches its promised "net-zero" target in 2050 the rising level of atmospheric carbon will exceed and likely far exceed the level aligned with 1.5°C (see Part 4). Oil, gas, and coal combustion is the main driver of rising atmospheric carbon. In the most favourable scenario, the IEA's Net-Zero by 2050 Scenario which assumes an extraordinary 50% cut in global oil production by 2040 (and equivalent cuts in gas and coal), the increase in the earth's average surface temperature will nevertheless rise to 1.6°C by 2050. In the absence of massive reductions in fossil fuel production, "net-zero by 2050" means net-zero in a 1.7°C or 1.9°C world.

Also, given that "net-zero" means that countries will continue releasing some *undetermined* amount of "remaining emissions" into the atmosphere even after they meet that goal, a second unanswered question is whether by 2050 all these countries will truly have the technological capacity to successfully capture the ongoing amounts of their remaining emissions which will continue to be released for decades after 2050 or remove them from the atmosphere by direct air removal technologies (CDR), which do not yet exist in any viable form.[7]

Canada is an example of the opaqueness of these supposed net-zero goals.[8] On November 18, 2020, the Federal government announced Canada's new "net-zero by 2050" goal. Details of the plan were initially set out in a report published by the Canada Energy Regulator, *Canada's Energy Future* 2020. The CER 2020 report document informed Canadians that *<u>"reaching net-zero emissions does not necessarily require eliminating all emissions"</u>* <u>by 2050</u>. It promised that by 2050, the ongoing level of Canada's remaining annual emissions (referred to as Canada's "<u>residual emissions</u>") will be offset ("<u>balanced</u>") by future technologies that it claims will have the capability to remove massive amounts of CO_2 from the atmosphere. In Canada's published plan the amount of the "remaining emissions" by 2050 is a crucial unknown that will make the

difference between a possibly safe and viable outcome (if the remaining emissions are relatively small) and one that masks a pathway to catastrophic failure.

We can only judge the prudence of Canada's plan (and of other national net-zero goals) if we know what the magnitude of the remaining emissions will be in 2050. On June 30, 2021, Parliament passed the *Canadian Net-Zero Emissions Accountability Act*. Section 7 of the legislation sets deadlines for when the government must reveal the national emissions reduction target for 2035, 2040, and 2045, each designated a "milestone" year. The Act provides that the Minister is not required to establish (or publicly reveal) Canada's "national greenhouse gas target" for the 2035 milestone year until December 1, 2024, and is not required to reveal the target for the 2045 year (that is, the expected level of Canada's "remaining emissions" in 2045) until December 1, 2034.

Canada's expansionary oil policy assumes without any analysis or scrutiny that "high income countries" will successfully install some unspecified amount of Carbon Capture and Storage technology (CCS) and direct air removal technologies that will allow them to continue burning higher levels of oil and natural gas while "capturing" enough of the remaining CO_2 emissions to meet their net-zero targets.

The Canada Net-Zero Scenario, modelled as it is on the IEA's APS Scenario, theoretically allows us to achieve "net-zero" but it will be net-zero in a much hotter world, at 1.7°C or far above that, depending on whether countries actually meet their net-zero targets, the magnitude of their "remaining emissions" by 2050, and the feasibility and effectiveness of promised future carbon dioxide removal technologies.

4. The emissions implications of following the Canada Net-Zero Scenario

Based on the available evidence, no amount of installation of CCS technology or of other envisioned future direct air removal (DAR) technologies offers any chance that we, or our children, will be able to curb the ongoing rise in global heating if we delay implementing, now, policies that will align Canada's oil production with the deep cuts in global production needed as early as 2030 and 2040 – that is, a 50% reduction in Canada's oil production by 2040, below the 2022 level.

We know, based on the most recent reports from the IPCC and other sources, that the remaining global carbon budget to keep the rise in the earth's average surface temperature to less than 1.5°C is only about 275 billion tonnes (Gt) of carbon dioxide.[9] Global emissions from combustion of oil, natural gas, and coal reached an annual level of 37 $GtCO_2$ in 2022. If we continue on the current pathway, the entire remaining carbon budget for 1.5°C will be exhausted within seven years. After 2030, all additional CO_2 emissions generated by the ongoing combustion of fossil fuels will directly contribute to driving warming above 1.5°C unless (1) they are "captured" before they are released into the atmosphere by CCS technology and securely sequestered underground, so they never reach the atmosphere, or (2) they can eventually be removed from the atmosphere by carbon removal technologies (which do not yet exist in any viable or scalable form). That is the predicament we are facing.

There is no information contained in the Canada Energy Regulator's report about how much higher global emissions from oil, gas, and coal combustion will be under the "Canada Net-Zero Scenario" (which is modelled on the IEA's APS Scenario) compared to a scenario aligned with limiting the warming increase to 1.5°C. For that kind of information, we must go to the *IEA World Energy Outlook 2023* report (October 2023).[10] It discloses full details of the projected annual level of global emissions over the period up to 2050 under each of its three scenarios:

Figure A: Annual global fossil fuel emissions by Scenario: billions of tonnes of CO_2 ($GtCO_2$)

	2022	2030	2035	2040	2050
Net-Zero by 2050 Scenario (NZE)	36.9	24.0	13.3	6.4	-
Announced Pledges Scenario (APS)	36.9	30.7	24.2	19.2	12.0
Stated Policies Scenario (STEPS)	36.9	35.1	33.0	31.6	29.6

Source: *World Energy Outlook 2023,* October 2023, World CO_2 emissions, Tables A.4a, A.4b, and A.4c at pages 268, 274, and 289.

In the case of the IEA's NZE Scenario, the top line in Figure A shows the needed very sharp decline in annual emissions from fossil fuel use. Under that scenario, the projected *cumulative* volume of additional emissions from oil, gas, and coal combustion up to 2050 is approximately 400 $GtCO_2$. Fossil fuel emissions are reduced to net-zero by 2050 (i.e., thereafter any further amounts will be "balanced' in subsequent years by CCS or direct air removal technologies). The remaining carbon budget is only 275 Gt. Therefore, in the case of the NZE scenario, the cumulative emissions by 2050 will exceed the remaining carbon budget by approximately 125 $GtCO_2$. According to the IEA's analysis, that excess amount will bring a "temporary" warming increase to 1.6°C by 2050 but that temperature "overshoot" can be rolled back to 1.4°C.[11]

In contrast, in the case of the IEA's STEPS Scenario the cumulative volume of additional emissions by 2050 will be approximately 900 $GtCO_2$, far exceeding the remaining global carbon budget. That scenario, which is based on a detailed appraisal by the IEA of the actual energy plans and existing climate measures already implemented or under development in all countries, results in a warming increase of 2°C by 2050. Further, after 2050, that cumulative amount will continue to increase by another 30 $GtCO_2$ or so every year (with the amount of the annual increases gradually falling if, and when, production levels decline) for another 30 or 40 years, or longer, until global fossil fuel consumption may belatedly be reduced to lower levels. On that basis, cumulative emissions will continue to rapidly increase, exceeding about 1200 $GtCO_2$ as early as 2060 and rising further every decade after that. If major oil and gas producing states choose to follow the STEPS Scenario, warming by 2100 will reach 2.4°C. Any attempt to eventually rectify that kind of massive temperature "overshoot" – that is, even to attempt to partially avoid the irrevocable impacts of very high heating levels – would require future deployment of carbon removal technologies on a scale that is beyond human capacity.

The middle pathway described in the IEA's APS Scenario, which delays any deep cuts in oil and gas production until we approach 2040, results in additional cumulative emissions of

approximately 650 $GtCO_2$ by 2050. Furthermore, under the APS Scenario, substantial emissions from ongoing oil, gas and coal production will continue at gradually declining levels through to 2100. That ongoing reliance of fossil fuel energy after 2050 will generate another 250 $GtCO_2$, or possibly much more, depending on the exact rate of decline after 2050.

Therefore, the APS Scenario (which provides the model for CER's own "Canada Net-Zero Scenario") offers a plan that will result in an additional 900 billion tonnes of cumulative carbon dioxide emissions between now and 2100 – resulting in about 650 $GtCO_2$ of "residual emissions" over and above the remaining carbon budget for 1.5°C. That explains why Canada's Net-Zero Scenario is aligned with warming of at least 1.7°C by 2100.

5. Carbon Capture and Storage

We are told that very large-scale deployment of carbon capture and storage technology (CCS) over the next 20 to 30 years will allow us to capture vast amounts of CO_2 at large emissions sites such as coal and natural gas-fired electricity plants *before it is released into the atmosphere* and safely secure it in deep underground storage. That, we are told, will allow high levels of fossil fuel burning to continue for decades to come.

But a careful examination of these proposed CCS schemes reveals that the quantitative scale of annual emissions that could feasibly be captured at industrial sites is small, compared to the annual level of global emissions from burning fossil fuels which, as indicated above, reached 37 billion tonnes of CO_2 in 2022. At present, carbon capture and storage (CCS) is the only existing technology that can separate and remove CO_2 gas at industrial sites and prevent it from entering the atmosphere, albeit at an enormous cost. In the case of the oil sands, CCS would capture CO_2 emissions from the flue gases where the fuel for the extraction process is combusted (at bitumen sites and at processing facilities where natural gas is burned to generate heat and steam) and thus prevent the gases from being released into the atmosphere. The captured CO_2 is compressed into an almost liquid form, then transported by pipeline and injected deep underground for permanent storage. The technology is very costly. The process itself is energy intensive.

Today in Canada's oil sands there exists only one functioning CCS facility, the Quest Project, located at Shell Canada's Scotford Upgrader near Edmonton. To place the Quest Project in context, oil sands production emissions totalled 87 million tonnes (Mt) in 2022 (mainly CO_2 but also methane and other GHGs). Conventional oil production accounted for an additional annual 39 Mt. Natural gas production and processing emissions represent another 60 Mt (B.C.'s LNG industry will soon add to that). Together with oil refining and other related activities, Canada's overall oil and gas sector emissions reached 217 Mt in 2022. The Quest Project was designed to capture and inject underground 1.2 Mt of CO_2 every year. The cost of that single project was about $1.35 billion, two-thirds of which was paid for by Canadian taxpayers.

If we follow the pathway described in the IEA's STEPS Scenario which assumes that all current emissions reduction policies are fully implemented between now and 2050, but which does not foresee any deep cuts in oil, natural gas, or coal burning over that period, global fossil fuel combustion emissions will remain at very high levels – 31.6 Gt CO_2 annually by 2040 and 29.6 Gt in 2050 (see Figure A above).

No plausible scale of achievable CCS installations worldwide could ever offset those projected very high levels of annual emissions, up in the range of 20 – 30 $GtCO_2$ every year. The IEA's Net Zero by 2050 Scenario, which is based on a pathway to limit warming to 1.5°C and which calls for rapidly increasing CCS capacity by 2050, relies on capturing as much as 6 billion tonnes of CO_2 annually by 2050.[12] Scaling up capture of even close to that global capacity of 6 $GtCO_2$ will take another 20 years. In 2022, the entire amount of CO_2 captured globally was 42 million tonnes, a fractional amount. In the NZE Scenario, annual capture is projected to reach 1.0 billion tonnes of CO_2 by 2030, rising to 3.7 $GtCO_2$ annually by 2040.

Assuming that ambitious scale-up of CCS is fully achieved by 2050, the cumulative amount of CO_2 that will be "captured" over the next 26 years will be about 70 $GtCO_2$. Yet in the case of the IEA's APS Scenario where globally we delay any deep cuts in fossil fuel production for several more decades (which provides the modelling framework for Canada Net-Zero Scenario) over the same period to 2050 we will release an additional 650 $GtCO_2$ into the atmosphere.

6. Carbon Dioxide Removal

"Overshoot" is a term that describes an increase in average global surface temperature above 1.5°C. A "high overshoot" refers to an increase above 1.6° but not exceeding 1.8°. It is now unavoidable that some amount of overshoot is going to occur. Once that has occurred, and if we seek to ever bring temperatures back down to a safe level, the only solution will rest on future development of Carbon Dioxide Removal (CDR) technologies.

The required CDR technologies do not yet exist or exist only in very small-scale experimental forms. We have no assurance that these schemes will be viable on the vast scale envisioned. The capability and purpose of the promised CDR technologies is fundamentally different than CCS. CCS captures CO_2 at emitting facilities, before it is released into the atmosphere. In contrast, CDR has the capability to remove CO_2 from the atmosphere after it has been released.

One prominent CDR scheme, called Bioenergy with Carbon Capture and Storage (BECSS), envisions that we will grow crops on a massive scale that will absorb CO_2 from the air in the growing season. These crops will then be harvested and burned, and through that combustion process the CO_2 embedded in the plants will be released and captured by CCS, then compressed and injected underground for permanent storage.

Other proposed CDR technologies, still at the concept or early development stage, envision chemical processes and materials that would directly absorb CO_2 out of the air (direct air capture combined with CCS, referred to as "DACCS"). There are experimental prototypes of some of these ideas. Huge unanswered questions remain about the viability of scaling up these schemes, as well as their costs and high levels of energy use. Other than very small-scale experimental prototypes, direct air removal technology does not exist.

In its Net-Zero by 2050 Scenario aligned with the 1.5°C warming limit, the IEA estimates that, by 2050, we may have developed the global capacity to remove about 1.7 $GtCO_2$ from the atmosphere every year[13] – a relatively small amount compared to the annual level of emissions from the current high level of annual fossil fuel emissions (37 $GtCO_2$). By 2050, the cumulative

level of emissions already released into the atmosphere will exceed, and may far exceed, the remaining carbon budget for 1.5°C[14]. Some future removals will be essential. Of that estimated 1.7 $GtCO_2$ amount, about one-third will be by DACCS and the balance by BECSS**.** In its recent report published on November 23, 2023, the IEA gives this explicit caution that assuming much higher levels of future carbon removals, over and above 1.7 Gt, is unrealistic:

> *CO_2 removal via DAC is not an unlimited resource, and the level of DAC in the NZE Scenario is likely to be close to the upper bound of what is practicable by 2050.*
>
> — IEA, *The Oil and Gas Industry in Transition*, section 231 at page 94 (emphasis added)

Once warming exceeds 1.5°C, rising for example to 1.7°C or above, the scale[15] of the emissions "removals" that would be required in future to roll us back to a more survivable level of warming using envisioned CDR technologies is enormous:

> *Obtaining net-negative CO_2 emissions requires massive deployment of carbon dioxide removal (CDR) in the second half of the century, on the order of 220 (160-370) $GtCO_2$ for each 0.1°C degree of cooling (based on the assessment of the likely range of the transient response to cumulative CO_2 emissions …*
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> — IPCC AR6 Working Group III, Chapter 3 section 3.5.2.1 (emphasis added)

To roll back warming by just 0.1°C we would need to "remove" from the atmosphere about 220 $GtCO_2$, which at current rates of burning coal, oil, and natural gas is equivalent to about five years' worth of accumulated emissions.

The IEA explains in its report *A Net-Zero Roadmap: A Global Pathway to Keep the 1.5°C Goal in Reach* that with even a relatively limited amount of "overshoot", for example if warming reaches 1.7°C, an effort to roll back that higher level of temperature by even 0.2°C would require that we (our children and grand-children) rely on CDR technologies to remove over 5 $GtCO_2$ every year during the second half of this century, seeking to achieve total removals of about 250 $GtCO_2$ by 2100.[16] The IEA concludes that removals on that enormous scale would require 2 billion tonnes of removals by BECCS and 3.3 billion tonnes of removals by DACCS, every year. The report notes: "That is equivalent to the entire energy sector emissions of the United States today":

> *Capturing 2 $GtCO_2$ per year from bioenergy facilities would require gathering, processing, combusting, capturing, and transporting and storing the emissions from bioenergy produced on roughly 135 million hectares (Mha) of land – slightly less than the total area of Peru, the 20th largest country in the world. As sustainable bioenergy feedstock is spread thinly and widely, so are bioenergy facilities, and connecting them with CO_2 transport infrastructure and suitable storage sites would be a huge challenge in logistical terms.*
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> — IEA, *A Global Pathway to Keep the 1.5°C Goal in Reach*, section 3.3.3. at p. 153

In the case of DACCS technologies, which in the IEA's example would need to capture 3.3 billion tonnes of CO_2 from the air every year (in addition to 2 billion tonnes of removals every

year by BECCS), there are multiple challenges. Capturing 3.3 billion tonnes of CO_2 directly by DACCS would require filtering 0.1 % of the atmosphere every year. The report provides some details of the economic and energy costs of that extraordinary proposal:

> *At this scale, DACs would consume around 30 EJ of energy annually, just below the current total energy consumption in the industry sector in the European Union, Japan, and United States combined. If the energy required for the deployment of DACS was provide by solar PV, this would require around 4.5 Mha of land for solar PV and DACS facilities, which is roughly equivalent to the land area of Denmark. … Removing 2 Gt with BECCS and 3.3 Gt with DACS each year by the end of the century would cost around USD 1-3 trillion per year (in 2022 dollars), 50% more than was invested in fossil fuel supply in 2022.*
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> — IEA, *A Global Pathway to Keep the 1.5°C Goal in Reach*, section 3.3.3. at p. 154

The massive scale of the required BECCS infrastructure would require allocating a substantial share of the world's available croplands (and water resources) to grow sufficient biomass material to be burned in these future facilities to extract their CO_2 – which will compete with demand for land and water to support global food supply. We are already seeing worsening drought conditions and escalated temperatures that are adversely affecting crop yields.

This envisioned 5 $GtCO_2$ of carbon removal by BECCS and DACCS every year by 2050, even if it could be fully achieved, could remedy, or roll back, only a very limited amount of temperature "overshoot" (in this case a temperature rise in the range of 0.2°C above the 1.5°C warming limit). But if we continue through 2030 and 2040 to produce and burn the high levels of coal, oil, and natural gas shown in the STEPS Scenario, which reflects our current energy and climate policies, global average surface temperature by 2050 will have already reached 2°C. We will by 2050 still be releasing into the atmosphere 30 $GtCO_2$ annually, so that the cumulative emissions will continue to grow in amounts that far exceed even the annual 5 billion tonnes of annual removals promised by carbon capture and storage (CCS) and direct air removal (DAC) schemes.

In a more recent report published on November 23, 2023, entitled *The Oil and Gas Industry in Transitions*[17] the IEA warned all countries against "excessive expectations and reliance on CCUS":

> *If oil and natural gas consumption were to evolve as projected under today's policy settings (i.e., as shown in the IEA's STEPS Scenario), this would require an inconceivable 32 billion tonnes of carbon captured for utilization or storage by 2050, including 23 billion via direct air capture to limit the rise to 1.5°C.*
>
> — IEA *Oil and Gas Industries in Transitions*, November 2023, p. 15

Removals of that magnitude would require over US$3.5 trillion in annual investments from today through to mid-century, which is an amount equal to the annual average revenue of the oil and gas industry in recent years. If global oil and gas consumption to 2050 were to follow the business-as-usual scenario shown in the IEA's STEPS Scenario, any technological solutions to our predicament are "inconceivable".

In another recent report, *Direct Air Removal: A key technology for net zero,* published in June 2023, the IEA assessed the current state of development of direct air removal technology and the prospects that it will be able to achieve large-scale carbon removals by 2050.[18] It summarizes existing research and refers specifically to a series of 18 scenarios, all of them theoretically aligned with limiting warming to 1.5°C, that were used in the pathbreaking *IPCC Special Report on Global Warming to 1.5°C,* published in October 2018. The IEA notes that the amount of CO_2 emissions captured and stored annually using BECCS and DACCS in the IPCC's 2018 scenarios is in the range of 3.5 – 16 $GtCO_2$ annually. In contrast, the IEA's own recent assessment is that annual removal capacity could reach 1.7 $GtCO_2$ by 2050.

It is important to recognize that the much higher estimates of emissions removals published in 2018 by the IPCC in its *Special Report* (i.e., extending up to as much as 16 $GtCO_2$ per year) did not reflect any assessment of the *economic or technological feasibility* of achieving those much higher removals, or of the limits on available land and water resources and renewable energy to support that kind of massive scale-up of BECCS and DACCS. They merely calculate the volume of annual removals (the future "negative emissions") that would be needed to limit warming to 1.5°C to offset the excess volume of emissions that we are projected to release over the coming decades. More recently, in *Climate Change 2022: Mitigation of Climate Change* released in April 2022, the IPCC has published a new assessment of carbon removals achievable by 2050, examining what it calls "feasibility challenges". It acknowledges that, in the case of DACCS technology, achieving removals above 3.0 $GtCO_2$ per year is highly uncertain.[19]

The recent *Production Gap* report[20] published in November 2023 also takes a hard look at the *feasibility* of achieving these higher levels of carbon removal by BECCS and DACCS. Based on studies that have assessed the "feasible potential" of carbon removal technologies, including a study that developed an "expert consensus" based on a survey of knowledgeable experts, the *Production Gap* report finds that carbon removals relying on these "novel" technologies could reach 3.0 $GtCO_2$ per year by 2050 (moderately higher than the IEA's 1.7 Gt estimate). While acknowledging that its 3.0 Gt estimate lies within the range of "feasibility potential", the *Production Gap report* nevertheless concludes that it remains "highly uncertain whether the new technology will become viable at scale" and capable of achieving even that more modest level of removals described as feasible. Adopting the precautionary principle, the new *Production Gap* report recommends that governments and policy makers should not rely on the expectation that the full amount of removals by BECCS and DACCS characterized as "feasible" will actually prove possible. In addition**,** the report accepts that an additional 2.2 $GtCO_2$ per year of removals may be feasible by means of "afforestation" and other conventional land-based methods that do not rely on the new technologies. But they too are subject to significant uncertainties.

7. Afforestation and reforestation: the limits of nature-based solutions

Nature-based methods of carbon removal include planting new forests, the reforestation of previously deforested areas (referred to as A/R), wetland restoration, soil carbon sequestration, and other strategies aimed at preserving and enhancing carbon storage in ecosystems and on agricultural lands.[21] As noted above, The *Production Gap* report estimates that removal of 2.2 $GtCO_2$ per year may be feasible by these nature-based methods of increasing sequestration, with projected cumulative removals of 224 $GtCO_2$ between now and 2100. The IEA's *Direct Air*

Removal report (June 2023) gives a range of 0.5 to 5.0 $GtCO_2$ per year. However, it is broadly acknowledged that a major uncertainty underlying heavy reliance on nature-based solutions is the "impermanence" of methods that aim to preserve and enhance storage in terrestrial or aquatic ecosystems. The risk is successfully stored land carbon could be subsequently lost back to the atmosphere as a result of future disturbances such as wildfires and deforestation. A recent paper[22] by climate scientists Damon Matthews and Kirsten Zickfeld, published on March 17, 2022, points out that portraying nature-based mitigation activities as equivalent to and interchangeable with fossil fuel CO_2 emissions reductions rests on the implicit assumption that the "removed carbon" will be permanently sequestered:

> *This is a critical assumption that has not been well acknowledged in the literature to date; indeed, anything less than permanent storage would result in only a temporary climate benefit that would not match the multi-century to millennial-scale warming caused by fossil fuel CO_2 emissions. However, the permanence of carbon storage in natural ecosystems cannot in reality be guaranteed, given its vulnerability to both human-driven (e.g., deforestation or other land-use change) and climate-related (e.g., wildfire, drought, or insect) disturbances that could occur at any time in the foreseeable or unforeseeable future.*
>
> — D. Matthews and K. Zickfeld, et al., "Temporary nature-based carbon-removal can lower peak warming in a well-below 2°C scenario", *Communications Earth & Environment* (2022) 3:65, p. 4.

The authors of this paper warn that we should assume that *some or all this carbon storage* by nature-based solutions will be temporary and then ask: to what extent will temporary carbon sequestration contribute to meeting our goal of halting the earth's rising surface temperature? Their study is based on an estimate that removals by nature-based methods could reach a maximum removal rate of 3.64 to 10.4 $GtCO_2$ per year and that cumulative removals in the range of 81 $GtCO_2$ to 316 $GtCO_2$ over the next three decades could be achievable. They conclude that removals on that scale, even if temporary, can reduce "peak" warming by 0.04°C to as much as 0.17°C during the critical years between 2040 and 2060. That is a critical period because, as we approach 2050 and if we are by then in the final stages of successfully achieving very deep reductions in oil, gas, and coal production (but have not quite reached net-zero emissions), the cumulative level of CO_2 in the atmosphere will still be rising and during that decade be reaching its highest point ever. Some amount of temporary "overshoot" above 1.5°C is unavoidable. Climate scientists have warned that every 0.1°C of warming above 1.5°C will bring irrevocable loss and destruction to natural systems. A reduction of peak warming by even $1/10^{th}$ of a degree will be significant.[*]

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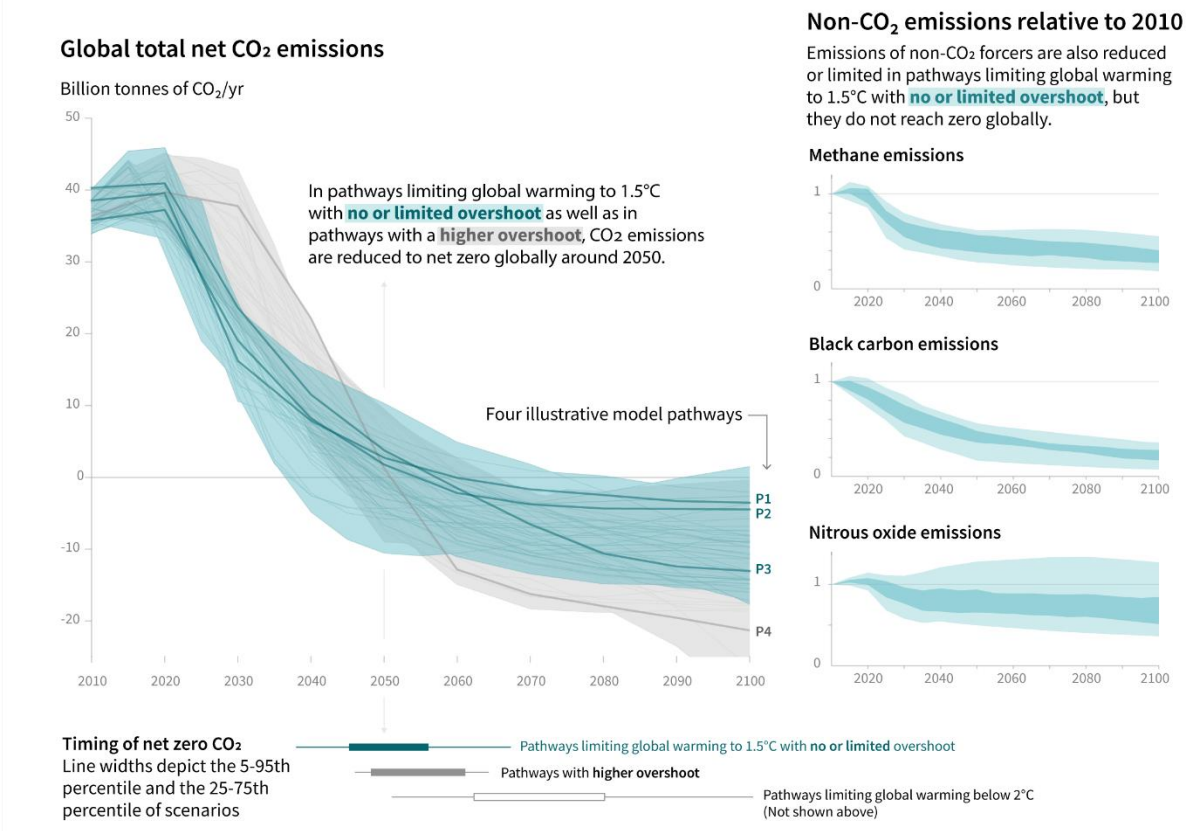
[*] Although these seemingly incremental temperature increases might appear insignificant (authoritative reports confirm that the increase in average global surface temperature reached 1.2 °C in 2022), the actual impacts on human health and on natural systems are already severe. Deadly heat waves are already more frequent, more intense, and last longer even in temperate regions. The town of Lytton in south-central British Columbia reached 49.6°C on June 29, 2021, breaking the previous Canadian temperature record by an extraordinary 4.6°C. The town was consumed by wildfire the following day. This "heat dome" lingered for about seven days and accounted for 618 heat-related deaths in B.C. It also brought a massive kill of marine life in shallow tidal waters and salmon streams along B.C.'s Pacific Coast.

However, if high levels of carbon emissions from fossil fuel combustion continue to 2040 and beyond, the promised benefit of nature-based carbon removals will be completely lost. The relatively modest scale of removals by A/R in that case will be very quickly offset by the ongoing release of higher levels of CO_2 from oil, gas, and coal burning. In that event, the only effect of nature-based carbon removal will be to slightly delay the onset of a particular higher level of warming. According to the study by Matthews and Zickfeld et al, reaching the 1.5°C warming level will occur about one year later and we will pass the 2°C threshold about 2 to 8 years later.

8. Consequence of failing to achieve deep cuts in fossil fuel emissions by 2030

It was not until December 2015, when the Paris Agreement was negotiated, that countries, including Canada, agreed "*to pursue efforts to limit the temperature increase to 1.5°C."* Recognizing that the newly stated 1.5°C goal would require much deeper and faster reductions in global emissions, the parties to the Paris Agreement in 2015 requested that the IPCC prepare a report on the impacts of warming to 1.5°C and on the measures needed to meet that goal. Three years later, on October 7, 2018, the *IPCC Special Report on Global Warming to 1.5°C* was published.[23]

Figure B: Global emissions pathways



Source: *IPCC Special Report on Global Warming of 1.5°C*, figure SPM.3a.

The *Summary for Policy Makers* sets out the main findings of the report. It includes the graph reproduced in Figure B, which depicts the massive cuts required to avoid a catastrophic outcome. One core finding reported in the *Special Report* was that all releases of CO_2 into the atmosphere must reach net-zero by 2050 to give us a 66% chance of reaching the 1.5°C goal. "Net-zero" means that, beyond 2050, no additional CO_2 can be safely added to the *cumulative* amount of CO_2 that by then will already have been released into the atmosphere. It is the cumulative emissions that are driving the heating of the earth.

A second core finding was that to give us a realistic chance to achieve the goal of net-zero by 2050 aligned with limiting warming to 1.5°C, the annual level of global emissions must be reduced 50% below the 2018 level by 2030.

The total annual level of global CO_2 emissions is given on the vertical axis of the graph, measured in billions of tonnes of carbon dioxide per year ($GtCO_2$). Only carbon dioxide emissions are represented on the main graph. They currently exceed 40 $GtCO_2$ annually, of which 37 Gt[24] were from fossil fuels in 2022. Non-CO_2 emissions are depicted separately on the right-hand side.

Four mitigation pathways are highlighted, which are identified as P.1, P.2, P.3. and P.4. Each offers a different combination of energy policy, technologies, and land use strategies to achieve the hoped-for net-zero outcome by 2050. Importantly, each of the depicted pathways relies on deploying Carbon Dioxide Removal methods (CDR) to a different degree. And while all four Pathways project an eventual decline in fossil fuel consumption, they envision markedly different rates of decline.

This graph confirms that, six years ago, we understood that any delay in starting to implement deep, absolute reductions in the annual level of global emissions would unavoidably result in our becoming increasingly dependent on achieving future "negative emissions" (carbon removal) on a massive scale. When the IPCC's *Special Report* was released in October 2018, the analysis assumed that in P1, P2, and P3 significant cuts in global emissions would begin by 2020. In fact, they have not yet started to decline. Total emissions continue to grow in 2024. The longer the delay, the greater will be our reliance on carbon removal technologies. The salient marker is the horizontal line designated "O", with the annual amount of carbon removals required after 2050 indicated in descending layers, reaching 10 $GtCO_2$ in P3 and exceeding 15 $GtCO_2$ in P4.

CO_2 accounts for most of human-caused emissions, more than 70% of the total (the other approximate 30% of human-caused emissions comprise methane and other GHGs). The CO_2 emissions are of paramount concern not only because of their scale, but because, unlike methane and some of the other GHGs, once CO_2 is released into the atmosphere it remains there for centuries. For that reason, in terms of what is in our power to control, the rising CO_2 atmospheric concentration is irreversible, in the absence of carbon removal technologies.

P.1 is described in the report as a mitigation plan aimed to reach net-zero by 2050 with minimal reliance on CDR technology. The *Summary Report* says this about the P.1 pathway: "Afforestation is the only CDR considered; neither fossil fuels with CCS nor BECCS are used" (emphasis added). "Afforestation" refers to large-scale projects that plant new forests and expand existing forest cover, and includes other changes to land use, restoration of wetlands, and

changes in agriculture that would enhance the natural capacity of the earth's surface to absorb carbon from the atmosphere. P.1 does not depend on future large-scale deployment of other envisioned future CDR technologies, such as BECCS or other direct air removal schemes.

In the case of P.4, which assumed the start of any deep emission cuts is delayed until after 2030, the required negative emissions (carbon removals) exceed 15 $GtCO_2$ by about 2060. The underlying point, well known to the Government of Canada six years ago, is that delays in implementing deep emissions cuts, or adopting a pathway that allows a shallower rate of decline, would require that after 2050 we will be able to achieve carbon removals in the range of 5 Gt – 15 Gt every year until the end of this century. We have no assurance that even the very low end of that range is feasible.

9. A façade hiding a terrible future

In the case of Canada, our national government has declared it will play no role in determining or guiding Canada's oil and gas production levels to 2030 and 2040 or beyond. Our government accepts that our future oil, gas, and LNG production will be decided solely by market prices and market demand. Oil companies and their shareholders will decide how much oil will be produced in Canada and exported. So long as prices are high enough, higher levels of crude oil will be produced and exported. Our government will intervene only to "cap' emissions during the oil extraction process in Canada, but it will not limit production levels. As the *Regulatory Framework* document published on December 7, 2023, affirms, the 'cap' has been carefully designed to ensure it does not result in any reduction in oil production. The cap is a façade.

The only assurance our Federal Government offers to Canadians that we might eventually move away from this fateful heating of the earth's surface is the hypothetical scenario (the "Canada Net-Zero Scenario") which is based on a supposition or conjecture that after a prolonged delay, as we approach 2040, countries worldwide may start to impose more stringent policies that might by 2100 be able to limit warming to 1.7°C.

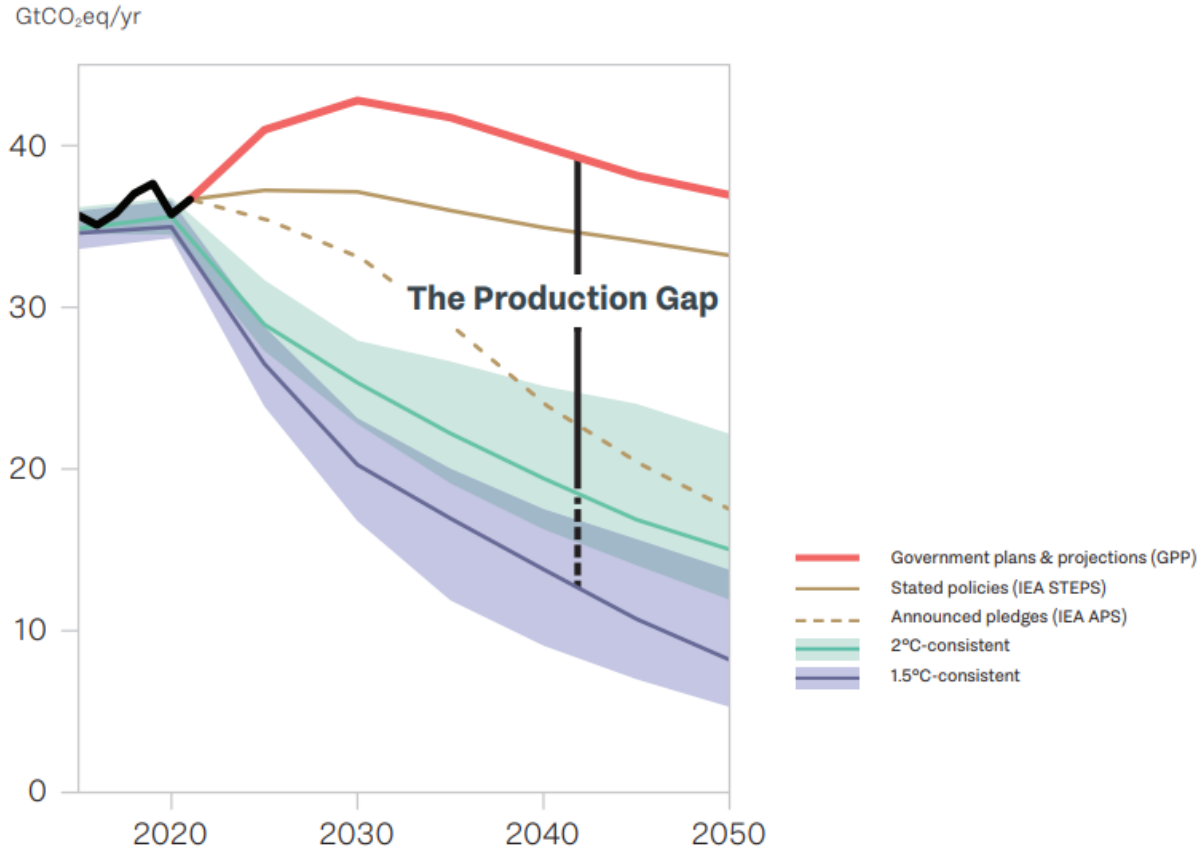
But even that promise is a facade. The government has been clear that the projected pathway for Canada's oil production depicted in the Canada-Net Zero Scenario (aligned with warming of 1.7°C) does not represent our real policy: our actual policy is that if global oil demand continues to increase and remains at high levels over the next 10 or 20 years, Canada's production levels will be much higher, guided solely by "global demand".

To understand the full implications of our government's real intentions, we must be guided by the available evidence showing the likely future path of global oil production based on the current plans of governments and major oil producers. The relatively benign outcome presented in the Canada Net-Zero Scenario is starkly contradicted by much higher production levels shown in all recent analyses by reputable and authoritative sources.

One obvious warning is found in the IEA's own recent *World Energy Outlook 2023* report. The IEA's STEPS Scenario projects that global oil production will peak before 2030 but will then continue, at around 100 million bpd, through to 2050 – that is aligned with warming of 2°C by 2050 and at least 2.4°C by 2100.

Another sharper warning was given on November 8, 2023, when the UN Environmental Programme and the Stockholm Environmental Institute released their bi-annual *Production Gap Report 2023* (see note 20). Figure C below reproduces a graph from the new *Production Gap Report* which shows the magnitude of global fossil fuel emissions based on current government plans and projections (top red line). The path that the world's 20 major producer countries (including Canada) are presently following will, by 2030, bring annual emissions from reliance on fossil fuels to about 44 $GtCO_2eq$, far above even the levels shown in the IEA's STEPs Scenario.[25]

Figure C: Global fossil fuel production



Source: *Production Gap Report,* November 8, 2023, Figure 2.1 at page 19.

In contrast, the IEA's Net-Zero by 2050 Scenario, which offers a pathway to limit the warming increase to 1.5°C, requires that overall emissions from oil, natural gas, and coal combustion decline to 24 $GtCO_2$ by 2030 and down to 13.3 $GtCO_2$ by 2035 (see Table A on page 7 above).

To the extent emissions from fossil fuel burning exceed those much lower annual levels, all the cumulative excess amounts will have to eventually be "removed" from the atmosphere by direct air removal technologies (DACS) or by BECCS (massive bioenergy schemes that burn material and capture the CO_2 and sequester it permanently underground).

No public inquiry process in Canada has ever examined whether this policy of continuing high oil production levels to 2030 and 2040 guided solely by "global demand" can possibly be reconciled with keeping the rise in the earth's average surface temperature to less than 1.5°C. The final report of a three-month inquiry held in early 2022 by the Parliamentary Standing Committee on Natural Resources, which was supposedly looking at the benefits of public subsidies to support the deployment of CCS technology at oil sands extraction sites, avoids any discussion about Canada's oil production levels and it is completely silent about the climate implications of failing to achieve deep reductions within the next decade.[26]

The IEA's APS Scenario (the model for the CER's Canada Net-Zero Scenario) is depicted by the diagonal dotted line shown in Figure C. Three of the world's leading climate scientists warned in April 2021 that the concept of "net-zero emissions", if it is used to justify the continued high levels of oil, coal, and natural gas use, is a "dangerous trap" (*Climate Scientists: concept of net-zero is a dangerous trap*, James Dyke, Robert Watson, and Wolfgang Knorr, April 22, 2021). Their article was an indication of growing alarm among climate scientists that the term "net-zero" is a mask for plans to continue high levels of oil and natural gas production.[27]

Conclusion

Our government holds out the promise that "virtually all high-income countries" will achieve net-zero by 2050, but those promises are essentially meaningless unless they disclose the amount of "residual emissions" that they will still be releasing by that date. In the absence of that kind of information, we have no way of assessing whether there is any realistic chance that the ongoing volume of remaining emissions by 2050 ("residual emissions") can ever be effectively offset by CCS and future envisioned carbon removal technologies.

As I have sought to explain in this discussion, the available evidence shows overwhelmingly that technologies with the capability to remove CO_2 directly from the atmosphere might, at best, be able to remove about 5 $GtCO_2$ annually by the second half of this century. The IEA has cautioned that annual removals of 1.7 $GtCO_2$ are "likely to be close to the upper bound of what is practicable by 2050."

Promises that CCS and CDR deployment in Canada can protect our children from warming above 1.5°C while we continue to increase our oil production in line with rising global demand are untethered from the reality we are facing. The essential and immediate requirement to give us any remaining chance to limit warming to 1.5°C is that global oil production must be reduced 50% by 2040 and about 75% by 2050. Equivalent cuts must be achieved in the case of natural gas and coal production. If that does not happen, no feasible amount of deploying CCS technology or CDR can alter the outcome.

NOTES

1. Oil sands emissions from oil extraction and production activities within Canada (referred to as the "upstream emissions") account for less than 15% of the total life-cycle emissions released by every barrel of oil Canada produces. The other 85% of the emissions per barrel (the "downstream emissions") occur after we export our oil when it is refined and combusted as fuel in vehicle engines and released into the atmosphere as tailpipe emissions: see Pembina Institute, February 2020: https://www.pembina.org/reports/the-oilsands-in-a-carbon-constrained-canada-march-2020.pdf. Canada's reported national emissions do not count the downstream share.

On October 14, 2022, a consortium of nine oil sands producers (who account for 90% of Canada's oil sands production) announced a total of $24.1 billion will be spent between now and 2030 on emissions reductions in the oil sands: see https://pathwaysalliance.ca/news-release-22oct14/: of that $16.5 billion will be allocated to deployment of CCS technology (almost half of which, $7.1 billion, will be funded by Canadian taxpayers through subsidies paid by the Federal Government). The producers have declared they will reduce their aggregate upstream emissions by 22 Mt of CO_2eq annually by 2030. A recent analysis by the Pembina Institute concluded that CCS could possibly achieve annual emissions reductions of 7 Mt – 15 Mt in the oil sands sub-sector by 2030: "Getting on Track: a primer on challenges to reducing carbon emissions in Canada's oil sands: https://www.pembina.org/reports/getting-on-track.pdf ; also March 21, 2022: https://www.pembina.org/reports/decarbonizing-canadas-oil-and-gas-supply.pdf.

Capturing 15 Mt annually by 2030 by rapid adoption of CCUS at production sites in Canada will do nothing to halt the ongoing increase in the overall volume of emissions released into the atmosphere by our oil production, which will continue to grow as our production and exports increase. The increase in downstream emissions will far exceed any small reductions in the upstream share at production sites and facilities in Canada.

2. *Regulatory Framework for an Oil and Gas Sector Greenhouse Gas Emissions Cap*, December 7, 2023. Annex 1 appended to this document confirms details of the projected increase of oil and gas production in Canada by 2030, including newly developed LNG production in B.C. It promises that by 2030 the level of emission at oil sands extraction and upgrading sites will be reduced by 20 million tonnes (Mt) per year, with a portion of that reduction to be achieved by CCS technology (the annual level in the oil sands sub-sector was 87 Mt in 2022). In addition, emissions at conventional oil sites will be cut by1 Mt (their annual level was 39 Mt in 2022). Natural gas production and processing emissions will be reduced by 6 Mt (they reached 60 Mt in 2022). Also, the scheme promises a 33 Mt reduction in the annual level of methane emissions released by oil and gas operations.

The promised emissions reduction under the new "emissions cap" is described as offering a 35% to 38% cut of total oil and gas sector emissions by 2030, below the 2019 level. However, the "legal upper bound" only requires actual emissions reductions by 2030 in the range of 20% to 23% below the 2019 level (representing a cut of about 40 million tonnes CO_2eq below 2019). For the balance of the promised emissions cuts (equivalent to an additional 20 Mt CO_2eq) oil and gas producers under this scheme will have the option

instead to acquire "compliance units", which will enable them to use "offset credits" promising that equivalent emissions reductions will be achieved in other sectors of the Canadian economy (i.e., reforestation) or, alternatively, oil and gas producers may make a financial contribution to a "decarbonization funding program" in lieu of further reducing their emissions. Accordingly, the actual emissions reduction by 2030 at oil and gas productions sites may be only about 20% to 23% below the 2019 level. *The Regulatory Framework* document is found at: https://www.canada.ca/en/services/environment/weather/climatechange/climate-plan/oil-gas-emissions-cap/regulatory-framework.html

3. Letter December 16, 2021, Minister Wilkinson to the CER: https://www.cer-rec.gc.ca/en/about/news-room/whats-new/2021/canadas-energy-future-report-minister-letter-to-cer-16-december-2021.pdf

4. Canada Energy Regulator (CER), *Canada's Energy Future 2023*, June 23, 2023: https://www.cer-rec.gc.ca/en/data-analysis/canada-energy-future/2023/canada-energy-futures-2023.pdf

5. The IEA's pathbreaking Net-Zero by 2050 Scenario ("NZE Scenario") was first published on May 18, 2021. It analyzed the required reductions in oil, natural gas, and coal combustion to 2050 that would be aligned with a 50-50 chance to limit warming to 1.5°C. Since then, updated versions of the NZE Scenario were published in October 2022 and most recently in September 2023: https://iea.blob.core.windows.net/assets/9a698da4-4002-4e53-8ef3-631d8971bf84/NetZeroRoadmap_AGlobalPathwaytoKeepthe1.5CGoalinReach-2023Update.pdf

The IEA's "NZE" Scenario concluded that a *23% reduction* in global oil production would be required by 2030, down to 77 million barrels per day (bpd), and that a 50% cut to 44 million bpd must be achieved by 2040. A further decline to 24 million bpd by 2050 is required to align with 1.5°C. Furthermore, to meet that goal, 70% of the remaining 24 million bpd of oil production by 2050 will have to be used in applications where *the fuel is not combusted and so does not result in any direct CO_2 emissions* (used to produce chemical feedstocks, lubricants, and asphalt). By 2050, oil must have very limited use as a transportation fuel except for aviation. The CER states that its own "Global Net-Zero Scenario", which it claims is aligned with the 1.5°C goal, is modelled on the analysis adopted by the IEA in its NZE Scenario.

The IEA's second scenario, called the "Announced Policies Scenario" (APS), was first published in 2022 and revised in 2023. The APS Scenario offers a much slower transition away from fossil fuels. It projects the path of global oil production based on "promised" additional future policies and goals by multiple countries which, if fully implemented, would gradually reduce global oil consumption, but at a much slower pace. But the APS Scenario is highly speculative because it is based on promised future measures that have not yet been developed, or funded, or enacted by regulations, and it therefore remains aspirational. The APS scenario if it is followed leads to warming of 1.7°C.

The IEA's Stated Policies Scenario ("STEPS") projects the expected future path of oil demand over the next 30 years based *on existing energy policies*. The STEPS scenario counts the benefit of all promised new carbon-reduction measures that have already been announced by governments and this scenario *assumes* all the announced future measures will be fully implemented. STEPS reflects the pathway we are presently following. Under the STEPS Scenario global oil production continues to increase to 103 million bpd by 2030 and flatlines at that level to 2050. It aligns with 2°C warming by 2050 and 2.4°C by 2100.

6. The *UN Emissions Gap Report 2023*, released November 20, 2023, provides this negative assessment of progress being made even by the richest countries to meet their promised net-zero targets:

> *Overall, however, limited progress has been made on key indicators of confidence in net-zero implementation among G20 members, including legal status, the existence and quality of implementation plans, and alignment of near-term emissions trajectories with net zero targets. Most concerning, none of the G20 members are currently reducing their emissions at a pace consistent with meeting their net zero targets. (emphasis added)*

The *Emissions Gap Report***,** published annually by the United Nations Environment Programme (UNEP), confirms that global emissions are continuing to increase. Total emissions in 2022 were 57.3 $GtCO_2$ (up from 55.3 Gt in 2018). Emissions have continued to increase over the past 6 years, except for a brief "dip" in 2020 during the Covid pandemic due to the temporary collapse of economic activity that year. Even with the full implementation of all unconditional NDCs (emissions reduction commitments made by individual countries under the 2015 Paris Agreement, referred to as "Nationally Determined Contributions") global emissions by 2030 are projected to be 55 $GtCO_2$, which will be no appreciable reduction at all over the past 10 years. To stay on a pathway to limit the warming increase to 1.5°C, global emissions must decline to a level of 33 $GtCO_2$ by 2030, which would require a reduction of 23 Gt (a 42% reduction below the 2022 level). The *Emissions Gap Report 2023:Broken Record*, published November 20, 20023, is found at: https://wedocs.unep.org/bitstream/handle/20.500.11822/43922/EGR2023.pdf?sequence=3&isAllowed=y

7. The pledged "net-zero" targets do not disclose any details showing what the level of *remaining emissions* will be in these countries by 2050 (all of which will have to be fully "captured" by CCS or subsequently removed from the atmosphere by carbon dioxide removal (CDR). The UN Environment Programme's *Production Gap Report* published November 20, 2024, notes at page 53 that the net-zero pledges made by many countries "do not specify how much they will depend on CDR, nor the level of residual emissions they plan to maintain when they achieve net-zero CO_2 and GHG targets (Buck et al, 2023b)" (emphasis added). Without that information, it is impossible to assess the plausibility of these net-zero pledges. If "residual emissions" are very high, the amount of carbon removal required by 2050 will far exceed the capacity of promised future CDR technologies.

8. Before Canada's *Net-Zero Emissions Accountability Act* was passed into law in June 2021, the Parliamentary Standing Committee on Natural Resources examined the proposed legislation. Only two elected Members of the Committee, Green Party MP Elizabeth May

and the Bloc Quebecois MP serving on the Committee, recommended that the government be required to disclose without delay an estimate of what the annual level of Canada's "remaining emissions" will be by 2050, based on the government's proposed climate policies. All the other MPs on the 12-member Committee rejected the proposal. Canadian climate scientist Kirsten Zickfeld (one of the world's leading experts on the relationship between rising greenhouse gas emissions and warming and a lead author on the IPCC 2018 report) filed a written submission to the Committee that warned of the risks posed by a climate plan that relies heavily on future "emissions removals": https://www.ourcommons.ca/Content/Committee/432/ENVI/Brief/BR11354997/br-external/ZickfeldKirsten-e.pdf. In her submission Dr. Zickfeld cited an article, *Beyond "Net-Zero": A Case for Separate Targets for Emissions Reduction and Negative Emissions*, Duncan P. McLaren, et al., Front. Clim., 21 August 2019. The McLaren article is found at: https://www.frontiersin.org/articles/10.3389/fclim.2019.00004/full.

9. The report of Working Group 1 to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change (WG1 AR6) provides an updated assessment of the remaining carbon budget. The findings summarized in the Summary for Policy Makers at Table SPM.2 show that the remaining carbon budget with a 67% likelihood of limiting warming to 1.5°C is 400 $GtCO_2$. This 400 $GtCO_2$ number was calculated as of January 2020 and therefore must be reduced to account for four more years of ongoing emissions since that time, at the rate of approximately 40 $GtCO_2$ every year. Recent carbon budget studies undertaken in 2023 calculate that the remaining carbon budget, from the beginning of 2024, is now 275 $GtCO_2$. "Remaining Carbon budget 2023", Copernicus, December 5, 2023, gives the remaining carbon budget with a 50% likelihood to limit global warming to 1.5°C as 275 $GtCO_2$, from the beginning of 2024: https://essd.copernicus.org/articles/15/5301/2023/.

10. International Energy Agency (IEA), *World Energy Outlook 2023*, October 24, 2023. The data showing projected combustion emissions to 2050 for oil, natural gas, and coal are found in Annex A at pp. 268, 274, and 280 respectively for the STATS Scenario, APS Scenario, and the Net-Zero by 2050 Scenario: https://iea.blob.core.windows.net/assets/26ca51d0-4a42-4649-a7c0-552d75ddf9b2/WorldEnergyOutlook2023.pdf.

11. The IEA's *Net Zero Roadmap* report at page 63 explains how it is possible for "limited overshoot" to 1.6°C to be reduced to 1.4°C by 2100. In the case of the IEA's Net-Zero by 2050 Scenario, global oil production declines by 75% by 2050, accompanied by deep cuts in coal and natural gas use. Global energy sector emissions are reduced to net zero by 2050, which means that after that date continuing residual gross emissions can be "balanced" by CCS capacity which reaches 6 $GtCO_2$ by 2050 and by some limited carbon removal capacity (BECCS and DACS reach an annual removal capacity of 1.7 Gt per year by 2050).

Because the NZE Scenario calls for very rapid cuts in fossil fuel emissions over the next 26 years, by 2050 the cumulative amount of atmospheric carbon that exceeds the 1.5°C warming threshold is relatively limited and does not require any large-scale reliance on future CDR technologies. In this case, the temperature reduction is caused by two effects that do not depend on CDR. One is the effect of "strong reductions in methane emissions to 2050". Unlike carbon dioxide, methane dissipates from the atmosphere over a relatively short period of time. Accelerated reductions in methane emissions before 2050 result in a

marked decline in the warming effect of methane over the following decades. That strong effort to cut methane emissions accounts for 0.1°C of the cooling between 2040 – 2100. The second effect is that temperatures are reduced as the land and oceans begin to draw down atmospheric carbon after 2050. Once human activity ceases releasing more CO_2 into the atmosphere, absorption of atmospheric carbon into the oceans and biological uptake into forests and plants (which can only occur very slowly over decades and centuries) accounts for the other 0.1°C of cooling between 2050 and 2100.

12. The *World Energy Outlook 2023* report (October 24, 2023) provides the IEA's estimates of the achievable built-up of global CCS capacity by 2050. The data in Table A.4c on page 280 of that report shows that in the case of the Net-Zero by 2050 Scenario, the total amount captured is 6 $GtCO_2$ by 2050. The amount captured globally by 2030 is estimated at 1.0 $GtCO_2$, rising to 3.7 Gt by 2040. In the less ambitious Announced Policies Scenario (APS) based on much slower action, total CCS captured reaches 441 million tonnes (Mt) by 2030 and 3.7 $GtCO_2$ by 2050. Under the STEPS Scenario, which reflects current policies, total CCS capture is only 116 Mt by 2030 rising to 401 Mt in 2050. The IEA's report *Net-Zero Roadmap: A Global Pathway to Keep the 1.5°C Goal in Reach*, (September 26, 2023) examines the number of CCS projects currently operating worldwide or under construction, as well as those at the "advanced development stage" and at the "concept and feasibility" stage. This analysis finds that "if all the CO_2 capture projects in the pipeline are realized, CO_2 capture capacity would expand more than eight-fold, rising from 45 Mt today to reach nearly 400 Mt per year in 2030" (page 39), which is equivalent to about 1% of current global fossil fuel emissions. The *Net-Zero Roadmap* report provides details of the much faster pace and scale of the build-up of CCS capacity that would be needed to meet the envisioned target of 6 $GtCO_2$ captured annually by 2050 (page 182).

13. Carbon removals of 1.7 $GtCO_2$ by 2050 are given in Table A.4c of the IEA's *World Energy Outlook 2023*. Removals by BECCS and DACS are also discussed in section 2.6.2 at page 162 in the IEA's *Net Zero Roadmap: A Global Pathway to keep the 1.5°C Goal in Reach* (September 2023). Page 102 of the *Net-Zero Roadmap* reviews the potential build-up of CCS and CDR capacity to 2050: https://iea.blob.core.windows.net/assets/9a698da4-4002-4e53-8ef3-631d8971bf84/NetZeroRoadmap_AGlobalPathwaytoKeepthe1.5CGoalinReach-2023Update.pdf. The IEA's November 23, 2023 report, *The Oil and Gas Industry in Net Zero Transitions*, cautions that the level of DAC in the NZE Scenario (1.7 $GtCO_2$) is likely to be close to the upper bound of what is practicable by 2050: https://iea.blob.core.windows.net/assets/f065ae5e-94ed-4fcb-8f17-8ceffde8bdd2/TheOilandGasIndustryinNetZeroTransitions.pdf

14. Even the IEA's very low-emissions scenario (the 1.5°C-aligned Net-Zero by 2050 Scenario) concludes that the increase in the earth's average surface temperature will reach 1.6°C by 2050 (see Note 11). In 2023, the hottest year ever recorded, the temperature increase reached 1.48°C, measured against the pre-industrial baseline (average temperature for 1850-1900): https://climate.copernicus.eu/copernicus-2023-hottest-year-record. However, climate scientists adopt 1.2°C as an accurate measure of long-term warming up to 2023, which is based on a process of averaging temperatures over recent decades to eliminates short-term fluctuations between individual years. The 1.2°C figure represents average surface temperature of the entire earth's surface including air temperatures over the oceans, which

are generally cooler than over the land surface. In fact, temperature increases vary significantly between different regions. Canada's Arctic region and the entire north polar region has already warmed more than 3°C within the past 40 years.

15. The IPCC's Working Group III Report published in April 2022 provided an assessment of the emissions removals (net-negative emissions) that would be needed to reduce global temperature by 0.1°C or 0.2°C: see Intergovernmental Panel on Climate Change Sixth Assessment Report (AR6), Working Group III: Mitigation of Climate Change (2022), Chapter 3, section 3.5.2.1 "Overshoot and Net-Negative CO_2 Emissions", at page 354.

16. The amount of carbon removals required to rectify a "high overshoot" (above 1.6°C but below 1.8°C) is discussed in *A Net-Zero Roadmap: A Global Pathway to Keep the 1.5°C Goal in Reach* in section 3.3.3 at pages 152-154: "What would it take to bring temperatures back to 1.5°C?". The IEA's analysis concludes that removals of 5 $GtCO_2$ every year between 2050 and 2100 would be required to bring temperatures back from 1.7°C down to 1.5°C. The IEA cautions that this estimate, which would require removals of 5 $GtCO_2$ every year, exceeds its own assessment that achievable carbon removal capacity by 2050 may be no greater than 1.7 billion tonnes. In its subsequent report, *The Oil and Gas Industry in Transition*, published on November 28, 2023, the IEA again cautioned that annual removals of 1.7 $GtCO_2$ is "likely to be the upper bound of what is practicable". Removals of 5 Gt per year may be far beyond the capacity of the envisioned future technologies.

17. IEA, *The Oil and Gas Industry in Net Zero Transitions*, November 28, 2023: https://iea.blob.core.windows.net/assets/7a4b0c4e-d78c-4a8e-998c-6cde10a4e49b/TheOilandGasIndustryinNetZeroTransitions.pdf

18. IEA, *Direct Air Capture: A key technology for net-zero* (June 2023): https://iea.blob.core.windows.net/assets/78633715-15c0-44e1-81df-41123c556d57/DirectAirCapture_Akeytechnologyfornetzero.pdf.

19. *IPCC Climate Change 2022: Mitigation of Climate Change, Working Group III contribution to the Sixth Assessment Report* (April 2022). Chapter 7 at Table 7.3 summarizes the "technical potential" of BECCS (p. 776). The technical potential given is 0.5 – 11.3 $GtCO_2$ per year, with a mean of 5.9 $GtCO_2$ per year. That estimate of the overall range does not assess the feasibility of achieving these levels. With respect to land resources required, Chapter 7 at p. 83 cites one study which concludes that achieving removals at the high end of the range (11.3 $GtCO_2$ per year) would require using 24% to 46% of the world's available arable and crop land to provide the required volume of plant material to supply the BECCS facilities. Clearly, the high end of the "potential" range has no air of reality given global food supply demands for arable land, water supply, and other competing needs, for example, the need to preserve grasslands and forested lands to protect existing carbon sinks.

Appendix III to the report at section A.III.II.2.3 "Feasibility of Mitigation Scenarios" (p. 1877) examines what it describes as "five feasibility dimensions" including technological, economic, and other constraints relating to land and water resources and energy supply required to support proposed future levels of carbon dioxide removal. Proposed future levels of CDR deployment are assessed and ranked as indicating low, medium, or high "levels of

concern" whether achieving those higher levels of carbon removal is "feasible/plausible". Scale-up of BECCS to 3 $GtCO_2$ per year is ranked with a "medium" level of concern as to whether it is feasible. In comparison, the feasibility of scale-up of BECCS to as much as 7 $GtCO_2$ per year is ranked with a "high" level of concern.

The IPCC Working Group III report uses that approach to identify those scenarios in which the level of carbon dioxide removal and sequestration (CDR) exceeds the "medium concerns" threshold with respect to the feasibility of deployment. Applying that measure, the maximum threshold for BECCS is 3 $GtCO_2$ per year. A discussion of how this feasibility threshold is applied in the IPCC's April 2022 report is found in the Supplementary Materials appended to a recent article, "No new fossil fuel projects: the norm we need", Fergus Green et al., *Science*, May 30, 2024: https://www.science.org/action/downloadSupplement?doi=10.1126%2Fscience.adn6533&file=science.adn6533_sm.pdf

20. *Production Gap Report 2023*: https://productiongap.org/wp-content/uploads/2023/11/PGR2023_web_rev.pdf. This biennial report, first issued in 2019, documents the misalignment between currently planned fossil fuel production and the much lower global production levels consistent with limiting warming to 1.5°C and 2°C. It is prepared by Stockholm Environmental Institute, Climate Analytics, E3G, International Institute for Sustainable Development (IISB), and United Nations Environmental Program. In sections 2.3-2.5 it reviews available expert evidence about the "feasibility" limits of carbon capture and atmospheric removal technologies. The following quote summarizes the report's findings about the extent to which recent 1.5°C-aligned scenarios rely on carbon removals by BECCS and by A/R:

> *First, the majority of the AR6-assessed scenarios rely on extensive CDR, mostly through bioenergy combined with carbon capture (BECCS) and afforestation/reforestation (A/R) Creutzig et al., 2021; Fuss et al, 2018). Based on a systemic literature review, Fuss et al., (2018) estimated upper "sustainable" limits of 5 billion tonnes of CO_2 per year ($GtCO_2$ /yr) for BECCS and 3.6 $GtCO_2$ /yr for A/R by mid-century, due to the negative side-effects such as competition for land and loss of biodiversity. Thus, C1 and C3 scenarios relying on BECCS and A/R exceeding those levels were excluded.*
>
> *Second, most IAMs do not adequately capture real-world constraints on regional CO_2 storage potential and injection rates, which influence model reliance on CCS coupled with fossil fuel use (fossil-CCS), and direct air carbon capture and storage, BECCS, and direct air capture and storage (DACCS) (Grant et al., 2022). Therefore, a mid-century limit on 8.6 $GtCO_2$ /yr has also been imposed, based on the "investable" CCS potential as estimated by Grant et al. (2022) when accounting for real-world financial, contractual, and institutional constraints.* (emphasis added)
>
> — *Production Gap Report 2023*, Online Appendix at p.10 (https://productiongap.org/wp-content/uploads/2023/11/PGR2023_Appendix.pdf)

The above references to the "AR6-assessed scenarios" and specifically to "C1 scenarios" refers to a group of scenarios assessed by the IPCC Sixth Assessment Report which achieve global net-zero by 2050 and are aligned with limiting warming to 1.5°C. Taking into account the "constraints" that will limit future levels of carbon removal, the *Production Gap* report

provides two new scenarios for the reduction of coal, oil, and gas production to 2050 that take into account feasibility limits.

The first scenario, called the "Median pathway", assumes that BECCS capacity reaches 2.8 $GtCO_2$ per year by 2050, DACCS capacity reaches 0.25 Gt per year, and land use sequestration (A/R) reaches 2.2 Gt per year. In addition, global CCS capacity (capture at large emitting sites before the emissions are released into the atmosphere) reaches 2.2 Gt by that date (substantially less than the IEA's projected build-up of CCS capacity to 6 $GtCO_2$ by 2050). Based on the assumption that those amounts of removal and capture can be successfully achieved by 2050, the "Median pathway" would require that by 2050 oil and gas production be reduced by 67% and 54% respectively to limit warming to 1.5°C.

The report cautions, however, that capture and removals on that scale, although it is within the range of "feasibility", is "highly uncertain". The *Production Gap* report therefore proposes a second scenario, which it refers to as its "Median low-CDR pathway". It assumes much lower levels of future carbon capture and carbon removal (see the report Table 2.2 at page 26). Relying on that more cautious scenario, the "Median-low" pathway would require that by 2050 oil and gas production be reduced by 76% and 77% respectively to limit warming to 1.5°C. That result indicating a required 77% reduction in global oil production by 2050 is very close to the findings in the IEA's "Net-Zero by 2050 Scenario".

21. Council of Canadian Academies, *Expert Panel on Canada's Carbon Sink Potential*, December 2022: https://cca-reports.ca/wp-content/uploads/2022/12/Carbon-Sinks_EN_Final.pdf. This report by a panel of fifteen experts examines the prospects for enhancing carbon storage and reducing emissions in Canada's forests, wetlands, grasslands, agricultural lands, and costal zones. It estimates that the overall cost-effective mitigation potential (i.e., carbon sequestration or emissions reductions) could reach approximately 40 Mt CO_2e per year by 2030, which the Panel notes is equivalent to about 6% of Canada's current annual emissions. The report however addresses the high level of uncertainty about the attainable future level of removals by proposed nature-based climate solutions (NBCSs). The report also warns of the risk of very large-scale emissions releases from Canada's vast landscape, driven by rising temperatures, wildfires, and deforestation: "the global climate risks of increasing (and accelerating) emissions from Canada's terrestrial, aquatic, and coastal ecosystems are substantial – in contrast to the more modest benefits of NBSCs" (Section 7.4, page184). That warning was given in 2022. During 2023, wildfires on an unprecedented scale across Canada released 1.7 billion (Gt) tonnes of CO_2 into the atmosphere, representing 25% of total global wildfire emissions for 2023: https://atmosphere.copernicus.eu/2023-year-intense-global-wildfire-activity. That single fire season release was equivalent to (and would completely offset) about 40 years of envisioned future carbon removals at the rate of 40 Mt CO_2 per year.

22. H. Damon Matthews and Kirsten Zickfeld, et al, "Temporary nature-based carbon-removal can lower peak warming in a well below 2°C scenario", *Communication Earth & Environment*, March 17, 2022, https://www.nature.com/articles/s43247-022-00391-z. Three of the authors of this paper have also published a commentary on their research about the temporary character of nature-based carbon removal in an article in *The Conversation*, March 30, 2022, Matthews, Zickfeld, and Luers, found at

https://theconversation.com/planting-trees-can-help-the-climate-but-only-if-we-also-stop-burning-fossil-fuels-179549.

The IEA's report, *Direct Air Capture: a key technology for net zero*, June 2023, assesses the "permanence" of carbon removal by Afforestation/Reforestation as "low". The *Emissions Gap Report 2023* describes the permanence of nature-based carbon removal in highly qualified terms, as lasting for "decades to centuries". In contrast, CCS and atmospheric removal technologies (i.e., BECCS, DACCS) all depend on permanent, deep underground storage to ensure that the sequestered CO_2 will never be re-released into the atmosphere.

23. IPCC *Special Report on Global Warming to 1.5°C*, October 7, 2018: The findings about the four mitigation Pathways P1, P2, P3, and P4 and related evidence about the scale of the emissions removals that would be required to limit warming to *1.5°C* are summarized in the 24-page Summary for Policy Makers (SPM), found at: https://www.ipcc.ch/site/assets/uploads/sites/2/2022/06/SPM_version_report_LR.pdf. Canada, along with other governments, approved the text of the SPM. The Government of Canada was therefore fully aware, six years ago, of the conclusions set out in the SPM showing the massive amount of future carbon removals that would be required to offset even modest delays in cutting fossil fuel production.

24. Fossil fuel CO_2 emissions reached 37 Gt in 2022, according to the IEA's *Net-Zero Roadmap* report. *UN Emissions Gap Report 2023* gives a slightly higher number: it reports global fossil fuel CO_2 emissions reached 38.5 Gt in 2022. Except for a brief interval in 2020 during the economic shutdown brought by Covid, and a brief downturn after the 2008 financial collapse, the level of fossil fuel emissions has been increasing every year for decades.

25. The *Production Gap* data includes both CO_2 emissions released when these products are burned as fuel and, in addition, other GHG emissions including methane released during the upstream oil and gas production process. The emissions data in this report is given as CO_2eq, indicating that methane and other GHGs are included in the 44 $GtCO_2$eq figure. The atmospheric warming effect of the methane and other gases is converted into an "equivalent" amount of CO_2.

26. From February to April 2022, the Parliamentary Standing Committee on Natural Resources held a series of public hearings which it described as "A study of a plan to cap oil and gas sector emissions". The Committee has 12 members: 6 Liberal Party Members of Parliament, 4 Conservatives, 1 member from the NDP, and 1 Bloc Quebecois. The Committee's report was released December 20, 2022. With respect to the question about the future level of global oil demand and the future path of Canada's production, the Committee provided only this vague answer: *"Witnesses presented varying analyses of the future demand for oil and gas products and whether Canada's production would rise or fall* ("The Question of Production", page 10) https://www.ourcommons.ca/Content/Committee/441/RNNR/Reports/RP12159695/rnnrrp07/rnnrrp07-e.pdf. The report merely noted that there are different opinions about whether in future oil production will "rise or fall".

At the Committee hearing on February 9, 2022, Tim McMillan, the CEO of the Canadian Association of Petroleum Producers (CAPP), testified that the IEA "*expects oil to grow from its current 100 million bpd by another 6% out to 2040"*. McMillan's testimony was based on the IEA's Stated Policies (STEPS) Scenario which is aligned with warming of about 2.5°C. McMillan made no mention of the extreme level of global warming that will accompany that projection of continuing high levels of oil use. Witnesses representing oil and gas producers supported CAPP's position, advocating that there be no limits on the continued expansion of Canada's oil and gas production. Directly contradicting that view, multiple other witnesses including leading experts and scholars on energy sector emissions and climate science referred the Committee specifically to the IEA's Net-Zero by 2050 Scenario which warns that deep reductions in global oil production are essential to limit warming to 1.5°C.

In its 60-page report, the Committee omitted any reference to the evidence given at the hearings regarding the emissions and climate implications if global oil production does continue to expand. It provided a summary (see page 12 of the report) of what it described as the "varying" estimates of future levels of oil production under different scenarios, ranging from a 4.5% rise to 2050 (under the IEA's STEPS Scenario) to a 70.1% decline (under the IEA's Sustainable Development Scenario). The report does not make any reference to the IEA's more stringent Net-Zero by 2050 Scenario. The report also excluded any mention of the rising global surface temperatures that accompany those scenarios. During the hearings, only 2 MPs on the 12-member Committee (Charlie Angus, NDP MP for Timmins-James Bay in Ontario, and Mario Simard, Bloc Quebecois MP for Jonquiere) questioned witnesses about the climate implications of ongoing oil production growth. The 10 Conservative and Liberal Committee members were silent on that issue. A video record of the testimony and questioning at the Committee hearings is available online. Witness McMillan's testimony (CEO of the Canadian Association of Petroleum Producers) is found at https://parlvu.parl.gc.ca/Harmony/en/PowerBrowser/PowerBrowserV2/20220221/-1/36426

When it released its report in December 2022, the Committee conceded that the Canada Energy Regulator had been unable to provide an answer to the most important question: "*the CER acknowledges that it does not have an energy model that is consistent with Canada's goal of achieving net-zero emissions by 2050*" (page 12). The CER had been instructed on December 16, 2021, to develop a model of that kind (see Note 2) but the CER's "Global Net Zero Scenario" (modelled on the IEA's "Net-Zero by 2050 Scenario" and aligned with meeting the 1.5°C goal) was not publicly released until June 20, 2023. Therefore, when the Committee released its report in December 2022, the Committee was fully aware that it had seen no evidence from the CER showing that planned further increases in Canada's oil production could possibly be consistent with limiting global warming to 1.5°C.

27. *Climate scientists: the concept of net zero is a dangerous trap,* James Dyke, Robert Watson, and Wolfgang Knorr, *The Conversation,* April 22, 2021: https://theconversation.com/climate-scientists-concept-of-net-zero-is-a-dangerous-trap-157368