SYSTEMIQ

ONYX TRANSITION

THE TIME IS NOW

Eliminating oil supply through carbon credits

June 2023

SYSTEMIQ

ABOUT THIS REPORT

The time is now: eliminating supply of oil through carbon credits was commissioned by Onyx Transition (Onyx), a venture backed by Koru, the venture studio funded by Ontario Teachers' Pension Plan (OTPP), and produced by Systemiq. The team that developed this report comprised Mark Meldrum, Jesse Hoffman, Sophie Slot, and Anne-Wietje Zwijnen.

The team is deeply grateful to numerous colleagues and experts who have generously contributed their time and expertise to inform the report, including Taraneh Azad, Mike Batley, Scarlett Benson, Kash Burchett, Mike Hemsley, Hugo Liabeuf, Carolien van Marwijk Kooij, Nathan Renneboog, Morten Rosse, Johanna Schlüter (Systemiq); Mark Davis (Capterio); Mike Braun, Caitlin Sparks (Onyx); Darius Nassiry (WSP, embedded advisor with Onyx).

ABOUT SYSTEMIQ

Systemiq was founded in 2016 to drive the achievement of the Paris Agreement and the UN Sustainable Development Goals, by transforming markets and business models in four key systems: land use, circular materials, clean energy, and sustainable finance. A certified B Corp, Systemiq works to unlock economic opportunities that benefit business, society, and the environment; it does so by partnering with industry, financial and government institutions, and civil society.

ABOUT ONYX TRANSITION

Onyx Transition is an innovative climate investment platform. Onyx provides an attractive off-ramp for oil and gas to help decommission the world's most emissions-intensive oil assets — today — and drives the resulting proceeds into carbon-removal projects and technologies. Onyx leverages carbon markets, converting oil value into carbon value. By shutting in profitable, actively producing fields, Onyx produces additional, permanent, high-quality carbon credits that accelerate the low-carbon transition, and creates a significant new pool of capital for investment in carbon removal and climate restoration.

Onyx will 'keep it in the ground and pull it from the sky'. The platform leverages existing market mechanisms to offer a financial alternative to oil production, accelerating the transition from fossil fuels. The resulting capital is driven into climate-critical carbon removal technologies, creating a double climate benefit: avoided emissions today to finance the further removal of emissions tomorrow.

DISCLAIMER

EXECUTIVE SUMMARY

1. We need a carbon credit to help accelerate oil decline before it's too late

We need to accelerate oil decline. Electric cars, trucks, and other clean energy solutions are gaining traction. Changes in oil demand are already forecasted to shift markets into decline starting approximately 2025.[1,2] Yet the oil decline will likely be too slow. The reductions forecast for 2030 under the current rate of transition will not be enough to avoid the worst effects of climate change. To achieve a 1.5°C pathway, we need a rapid reduction in the production and use of fossil fuels – around 20% by 2030 and 60% by 2040.[1] Accelerating this contraction calls for concerted action on both oil demand and supply.

Early decommissioning of the most carbon-intensive oil fields cuts off 1-2 decades of production and delivers immediate gigaton-scale impact

Action on supply should target the most carbon-intensive oil production. While oil is a globally traded commodity, its characteristics vary widely. As one expert put it, "there is no 'standard oil.'"[a] Due to these differences, certain sources of oil are far more carbon-intensive in the emissions associated with their extraction, processing and transportation than others. The carbon emissions from oil supply (extraction, processing, transport) range anywhere from 30 to 300 kgCO2e/bbl, depending on the source.[3] That is on top of the 400-500 kgCO2e/bbl emitted from consuming a barrel of oil , for instance in a car or truck. To help accelerate the energy transition, we need to decommission the most carbon-intensive production first.

We can leverage carbon credits to decommission profitably producing, carbon-intensive oil supply. In the absence of intervention, most of these carbon-intensive fields would likely continue profitably producing for the next 10-15 years or longer, given where they sit on cost curve and forecast demand volumes.[1,3,4] Intervention is urgently required to eliminate these carbon-intensive sources of supply. Regulatory measures, such as a heightened carbon tax or a ban on production above a certain emissions intensity, could be effective. Yet their adoption and implementation can be lengthy and their impact can be muted, leaving these fields active in the meantime. A market mechanism such as a carbon credit to eliminate oil supply (EOS) offers a viable solution to create an immediate, tangible impact.

The opportunity is at gigaton-scale with immediate impact. Today, 5 Mbbl/d of oil production sites (5% of global supply) are amongst the most carbon-intensive (90th percentile based on emissions-intensity) and are located in countries where supply-side intervention can be feasibly implemented[b].[3,5,6,7,8] These are clear candidates for early decommissioning. Phasing out these barrels from the market would achieve a reduction of ~0.6 gigatons (Gt) CO_2e / year, taking into account leakage rates based on recent research[c].[9] By contrast, it is hoped that Direct Air Capture with Carbon Storage (DACCS) would be able to deliver a similar level of impact by 2040, much later than the immediate impact attainable with early decommissioning.[10]

a Source: Deborah Gordon, Senior Principal, RMI

b This market size excludes countries with poor rule of law, or excessive economic dependency or energy security linked to oil.

c Leakage rate refers to the degree to which a barrel of oil that is removed, is then resupplied by the market. There is considerable uncertainty on leakage rates. While neither 0% nor 100% leakage is realistic, to the following figures are to illustrate the full possible range of emissions impact. At 100% leakage there would still be net gains by removing the most emissions-intensive fields, c0.2 $GtCO_2e$. At 0% leakage the emissions savings are 1.1 $GtCO_2e$. A recent review of leakage using long-run supply and demand elasticities of oil and gasoline from over 30 studies over the last ~25 years produced a central estimate of leakage at 57%.

Eliminating oil supply sources will magnify demand-side efforts. As the energy transition proceeds, electric cars and trucks will become increasingly competitive with internal combustion vehicles, and e-fuels will advance to compete with heavy fuel oil in ships. In turn, oil demand from these sectors will become more responsive to changes in market price (i.e., demand will become more price elastic), a shift that is set to play out from now through 2035.[1,11,12] As oil demand elasticity grows, proactive interventions that impact price, including curtailing oil production, can further drive oil demand decline and accelerate the energy transition.

We need to prioritize actions that deliver gigaton-scale impact before 2030

Negative climate tipping points could come as early as 2030. Climate tipping points are conditions beyond which changes in a part of the climate system become self-perpetuating."[13] For instance, in a warming climate, thawing permafrost releases methane, driving more warming. These tipping points are also interconnected; triggering one can induce climate instability, heightening the risk of activating others and unleashing a potentially catastrophic cascade.[14] By 2030, temperatures could reach +1.5°C and risk triggering several climate tipping points that could set off the cascade.[13,15]

Actions before 2030 are much more valuable in limiting climate damage. In the words of Bill McKibben, when it comes to climate change, "Winning slowly is the same as losing."[16] This concept can be described as the Time Value of Carbon[d] – i.e., the impact of emission reductions at different points in time. Emissions today – before climate tipping points are crossed – exert not only a direct warming effect but also an indirect effect as they increase the risk of triggering irreversible climate tipping points. This indirect effect of early emissions is considerable. Studies conservatively estimate that climate tipping points alone could amplify the economic damage of climate change by 1.3 to 4 times, relative to estimates of the damage before considering climate tipping points.[14,17] The economic case for acting now at scale has become compelling and undisputable. We must swiftly and aggressively scale up solutions that can deliver gigaton-level impact this decade. Early decommissioning of carbon-intensive oil supply can produce this level of impact immediately.

d Note: discussions on Time Value of Carbon also typically consider the slowly fading impact of emissions as they are naturally cycled out of the atmosphere.

2. A carbon credit to eliminate oil supply (EOS) offers a unique proposition to the markets and warrants robust pricing

Carbon credits can be deployed to facilitate the early decommissioning of active carbon-intensive oil fields. To propel the Voluntary Carbon Market (VCM) to its full potential, the supply of high-integrity projects must expand. Buyer demand is growing: the push for decarbonization is leading corporates to carbon markets, to supplement decarbonization measures within their own value chains. Significant demand is expected from heavy industry where emissions abatement will be slower due to long-lived assets and limited technological alternatives. Projections of the VCM anticipate a substantial rise in annual emissions impact from 0.3 $GtCO_2e$ today[18], to 4-7 $GtCO_2e$ by 2030.[19,20] Realizing this opportunity requires a surge in high-integrity supply. Moreover, recent scrutiny of VCM projects has increased the bifurcation of the market between high- and low-quality projects.[21,22,23] These dynamics offer promising conditions for new projects and credit types that can bring more high-integrity supply to the market.

Relative to current credit types in the market, EOS offers a unique value proposition

Today's VCM has a portfolio of credits types and associated value propositions. A diversity of credit types, each with distinct value propositions, reflects a healthy market. Distinct value propositions will each appeal to different buyers' interests. Noteworthy credit types in the VCM today, and their respective value propositions, include:[10,18,24,25,26,27,28,29]

- Reducing Emissions from Deforestation and forest Degradation (REDD+): These projects offer high biodiversity benefits, and collectively can deliver impact at gigaton-scale today. Despite complexities surrounding their additionality and measurability, solutions are continually improving with innovative tools and mechanisms such as satellite monitoring and permanence buffer pools.
- Afforestation and Reforestation (ARR): These projects exhibit more straightforward measurability and additionality, though offer far less biodiversity impact than REDD+.
- Direct Air Carbon Capture and Storage (DACCS): These projects hold the promise of geosphere-permanence, easy measurability and clear additionality. The limitations of DACCS lie in its current high costs and hence limited deployment. Innovation promises to bring down costs and enable scale over coming decades. However, given technological advancements are needed to achieving scalability, annual emissions impact from DAC is unlikely to exceed 0.5 $GtCO_2e$ per annum before 2040.

A carbon credit to eliminate oil supply (EOS) presents a new distinct value proposition due to its permanence, and immediate impact at scale. Acting at the source of fossil fuel supply, an EOS credit provides both the benefits of geosphere permanence seen in DACCS, and the potential to achieve gigaton-scale impact before 2030, akin to REDD+.

While the additionality and measurability of EOS involve considerations specific to oil markets, such as leakage rate estimation, diligent safeguards can ensure high integrity. Managing these considerations is worthwhile because EOS credits bring superior capital efficiency to DACCS; preventing carbon from entering the atmosphere is more capital-efficient and faster to impact than releasing and recapturing it into the geosphere.

Further, buyers who are seeking to manage down and offset oil-related emissions in their operations or supply chain may be attracted to the symmetry of an EOS credit with respect to their own emissions. By acting upstream on oil supply, the credit helps to accelerate the transition away from fossil fuels.

High-integrity EOS credits should command robust pricing in carbon markets

The EOS credit outperforms on permanence and Time Value of Carbon, attributes that warrant credit premiums. Carbon credit pricing can be difficult to unpick particularly as more of the market moves to opaque OTC[e]. Still, geosphere permanence is seen to command a premium as observed for example in pricing of CCUS credits well over $100, albeit at a small market segment (<1%).[18,29]

As discussed above, a high Time Value of Carbon should drive a premium; linked to the economic damage we risk from climate tipping points, we estimate the value premium for actions before climate tipping points, relative to after, to be on the order of 1.3 to 4 times. The EOS credit outperforms on both these attributes, thus warrants robust pricing.

Certain buyers may further be attracted to the mission of accelerating the transition away from fossil fuels. Buyers may be motivated by the overarching mission served by a credit, such as ending deforestation (REDD+) or encouraging engineered carbon removals at scale (DACCS). For EOS, the mission is to accelerate the transition from fossil fuel dependency. EOS carbon credits provide a vehicle for this goal. There is likely to be a segment of buyers who place differential value on the EOS credit's specific qualities – including high permanence, scale and immediate impact (Time Value of Carbon – and the mission to accelerate away from fossil fuels. These credit buyers could lead initial demand for the credit type and spark others to follow.

In addition, while the above focuses on the voluntary carbon markets, an EOS credit could also be adopted in compliance markets. An EOS credit would offer an equally distinct value proposition to compliance markets, which also traditionally operate at measurably higher price tiers than the VCM.

****

To combat climate change effectively, we need immediate, high-impact interventions. A carbon credit to eliminate oil supply (EOS), targeting carbon-intensive oil fields for early decommissioning, meets the speed, scale and impact of the moment. It can complement the impact of demand-side efforts and help accelerate the transition away from fossil fuels. The time is now.

e OTC: Over-the-Counter deals; pricing for OTC is not transparent to the market, and generally higher than pricing of credits traded through exchanges

SYSTEMIQ

TABLE OF CONTENTS

1.

We need a carbon credit to help accelerate oil decline before it's too late

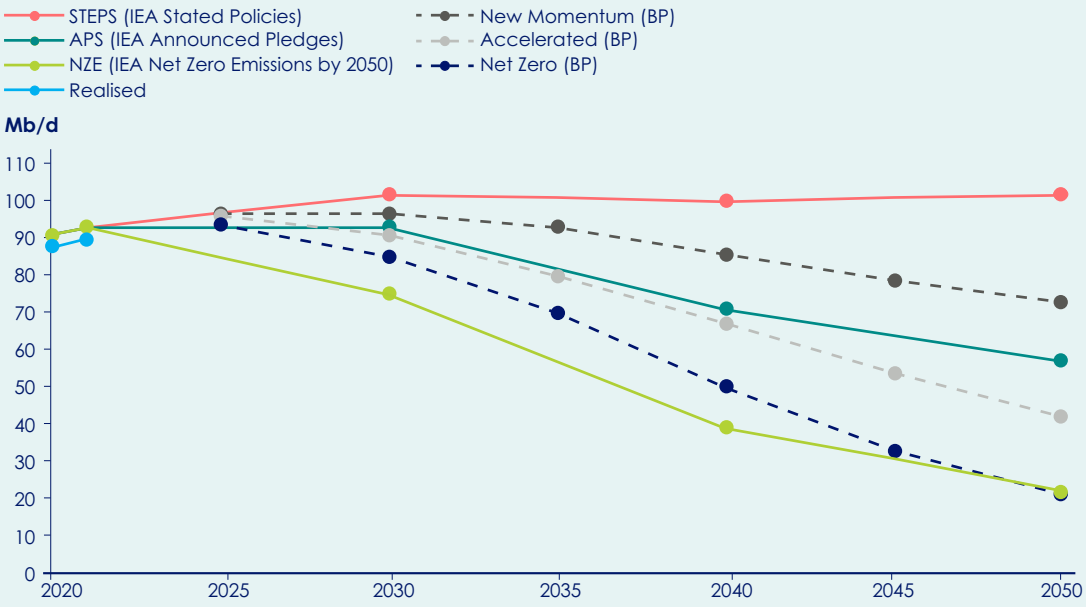
We need to accelerate oil decline

For more than a century, oil has been dominant in global energy systems. It remains the leading source of greenhouse gas (GHG) emissions, contributing around 30% globally according to the International Energy Agency (IEA).[30]

With few exceptions, oil volumes have grown steadily over time. However, now first the first time in history, these volumes are expected to plateau then shift into consistent decline. Thanks to recent technological advances, electric cars, trucks and e-fuels, are beginning to gain traction. This is already impacting demand for oil; in 2021 electric vehicles displaced demand for 1.5 Mbbl/d of oil.[31] Even the oil major BP, in its most recent energy outlook forecasts oil peaking in 2025 under all scenarios.[2]

Yet the oil decline will be too slow to avert catastrophic effects of climate change.[1,2,15] The IEA's central Announced Pledges Scenario (APS) forecasts flat demand to 2030, and around 25% reduction by 2040. In contrast, to achieve a 1.50C pathway we need a sharp contraction of oil markets – 20% by 2030 and 60% by 2040.[1]

Exhibit 1:
OIL DEMAND OUTLOOK ACROSS SCENARIOS



Sources: 1, 2

We therefore need oil markets to decline quickly. Considerable efforts are being put into demand-side policies, and these should be pursued vigorously. To accelerate the energy transition, we need to start pulling the supply lever as well. However, to date, we have been largely ignoring this lever. The IEA has underscored the importance of limiting expansion of new supply; as the IEA has noted, "No new oil and natural gas fields are needed in the net zero pathway."[1] Early decommissioning of existing supply, particularly highly emissive production, will accelerate the energy transition.

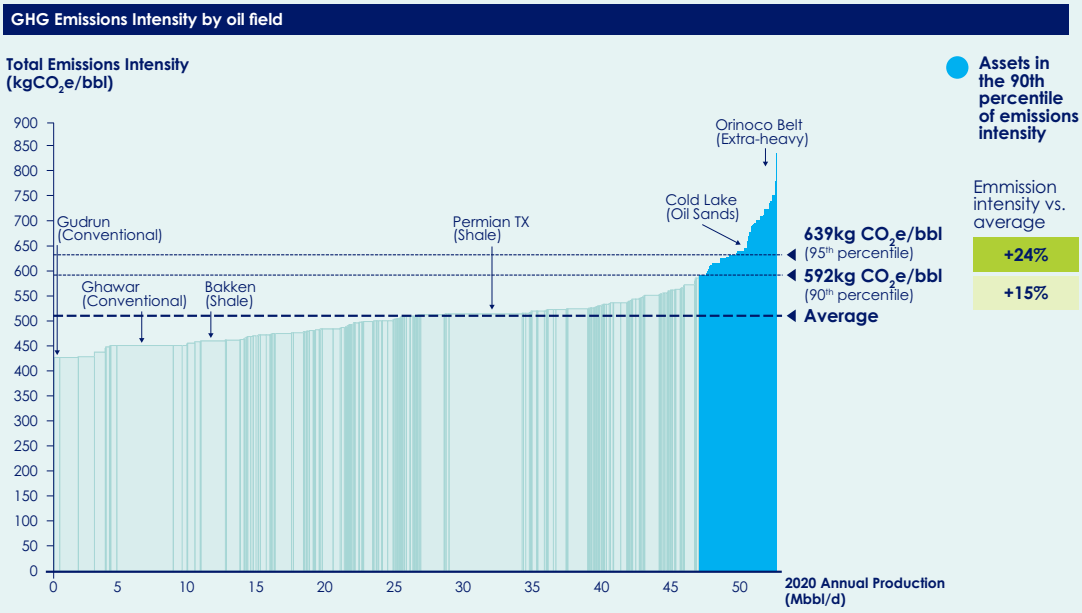
Early decommissioning of the most carbon-intensive oil fields cuts off 1-2 decades of production and delivers immediate gigaton-scale impact

Action on supply should target the most carbon-intensive oil production

While oil is a globally traded commodity, its characteristics vary widely. As one market expert put it, "there is no 'standard oil'"[f]. Due to these differences, certain sources of oil are far more carbon-intensive in the emissions associated with their extraction, processing and transportation than others. The carbon emissions from oil supply (extraction, processing, transport) range anywhere from 30 to 300 $kgCO_2e$/bbl, depending on the source. This range is mainly the result of different upstream processes and the degree of processing required based on the quality of the crude. Fields where more energy is needed for extraction and refining, such as oil sands and extra-heavy oil, are more emissions-intensive. Consumption emissions are around 400 kgCO2e/bbl. Taken together as total emissions intensity, the average barrel comes in at around 515 kgCO2e/bbl.[3]

For scale and impact, we should focus on eliminating the most carbon-intensive production first. The total emissions intensity for the 90th percentile most carbon-intensive sources is around 590 $kgCO_2e$/bbl, or 15% above the average. Even more carbon-intensive fields (e.g., Cold Lake, Alberta), which sits at the 95th percentile have total emissions intensity around 25% above the average barrel.[9] These carbon-intensive barrels of oil are clear candidates for early decommissioning in the low-carbon transition.

Exhibit 2:
GHG EMISSIONS-INTENSITY BY OIL FIELD



Note: Data covers ~60% global production, 2020; Data uses 100-yr GWP for emissions; all barrels represented in BOE. Sources: 3, 5

f Source: Deborah Gordon, Senior Principal, RMI

We can leverage carbon credits to decommission profitably producing, carbon-intensive oil supply

In the absence of intervention, given where they sit on cost curve and forecast demand volumes most of these carbon-intensive fields would likely continue profitably producing for the next 10-15 years or longer, a critical window for climate action.

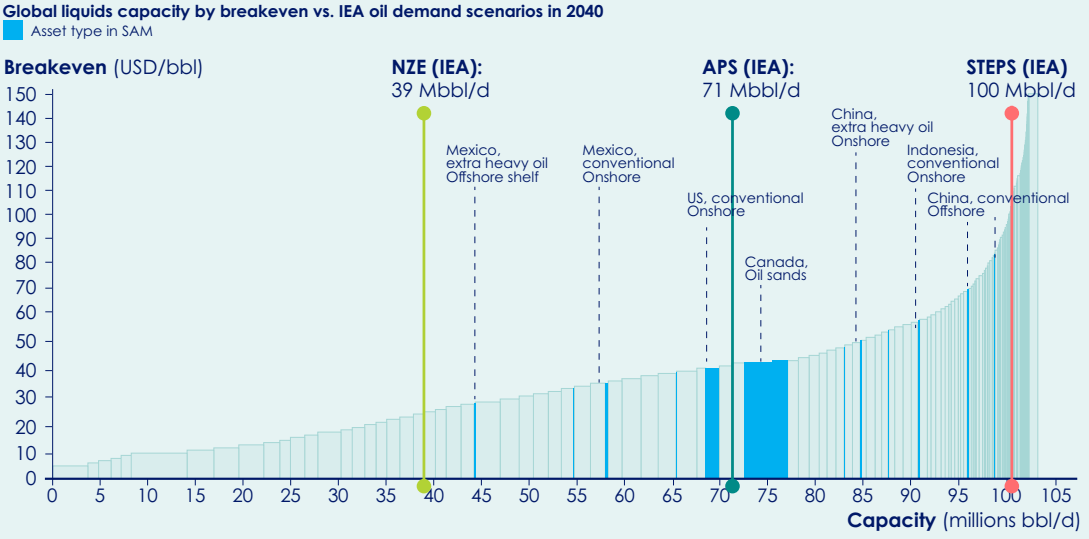
The outlook for these assets is informed by overlaying supply cost curves with forecast demand, to identify where they intersect and which fields could profitably produce for years to come. For instance, Exhibit 5 below provides a view of 2040. Highlighted in blue are the most carbon-intensive production assets. The central demand scenario (APS), shows demand for 71 Mbbl/d, and intersects the supply curve just below a block of Canadian oil sands assets, indicating that these assets would be profitably producing until nearly 2040, 17 years from now[g].[1,3,4]

Exhibit 3:

2040 OIL SUPPLY COST CURVE, WITH DEMAND VOLUMES OVERLAID UNDER DIFFERENT OIL SCENARIOS

In the APS (IEA) scenario, more than half of volume produced by the most emission-intensive assets is still economic in 2040

Global liquids capacity by breakeven vs. IEA oil demand scenarios in 2040



Note: Breakeven costs are the all in costs for well exploration, development, operation and maintenance of the asset in any given year for the operator. The impact of DD&A, income and other government taxes are also included. Carbon costs are not included in breakeven production costs. IEA Scenarios: NZE = Net Zero Emissions by 2050, APS = Announced Pledges Scenario, STEPS = Stated Policies Scenario. Asset type in SAM defined by country, Supply Segment (Other Onshore, Offshore deepwater, Offshore Shelf, Oil Sands) and Unconventional Detail (Extra Heavy Oil, Conventional, Oil sands).

Sources: 1, 3, 4

To take these carbon-intensive assets out of supply, regulatory measures such as a higher carbon tax or a ban on production above a certain emissions intensity, could be effective. Yet their adoption and implementation can be lengthy and their impact can be muted, leaving these fields active for many years. Market-led solutions can act immediately to decommission these fields early and forego years of carbon-intensive oil production. Market solutions can also complement regulatory measures if they do come, by creating multiple incentives that combine to deliver greater impact.

A market mechanism such as a carbon credit to eliminate supply of oil (EOS) creates immediate, tangible impact at scale. The sooner we move the better, as the worsening climate crisis and the frustratingly slow contraction of oil markets calls for us to act at scale immediately.

g Note: the supply cost curve does not factor any local incentives – regulatory or market-based such as a carbon credit. For a given specific field, its ability to profitably produce will depend on local factors including field-level production economics and market conditions (e.g., government policy, route-to-market infrastructure constraints, etc.).

BOX 1:

ONYX'S APPROACH TO THE USE OF PROCEEDS

Due to the historical role of fossil fuel companies with respect to the climate crisis, carbon credit buyers may perceive a reputational barrier in transacting with an oil & gas company as a counterpart. Onyx proposes that an appropriate way to address this concern would be to ensure that the use of proceeds from credit sales be directed to climate-beneficial projects, such as carbon removal or sustainable aviation fuel – i.e., investments that would have clear net climate benefit. A good framework would have an intermediary – such as Onyx Transition has proposed to be – to manage the credit proceeds toward carbon-negative investments and qualify these investment projects to ensure money is used for climate-positive purposes.

The opportunity is at gigaton-scale with immediate impact

Early decommissioning of the most carbon-intensive barrels of oil can create gigaton scale impact in terms of emissions reduction. The Oil Climate Index (OCI) database has amassed carbon-intensity data on the majority of oil production assets and can help identify the worst offenders in the 90th percentile, as seen above in Exhibit 2.

However, not every carbon-intensive oil asset would be a good candidate for a market-mechanism to eliminate production. Some of these assets are in countries with weak rule of law[h] (e.g., Turkmenistan), or countries that face other challenges such as economies overly dependent on oil[i] (e.g., Venezuela).

Filtering out assets in such countries can provide an indicative view of the serviceable addressable market (SAM), see Exhibit 3. The result is a target market that totals 5 million barrels of oil per day (Mbbl/d), or 5% of global production, a volume larger than the entire production from Iraq in 2021.[3,5,6,7,8] These figures are even slightly conservative since they are derived using the OCI database that does not yet cover the full market of oil production assets.

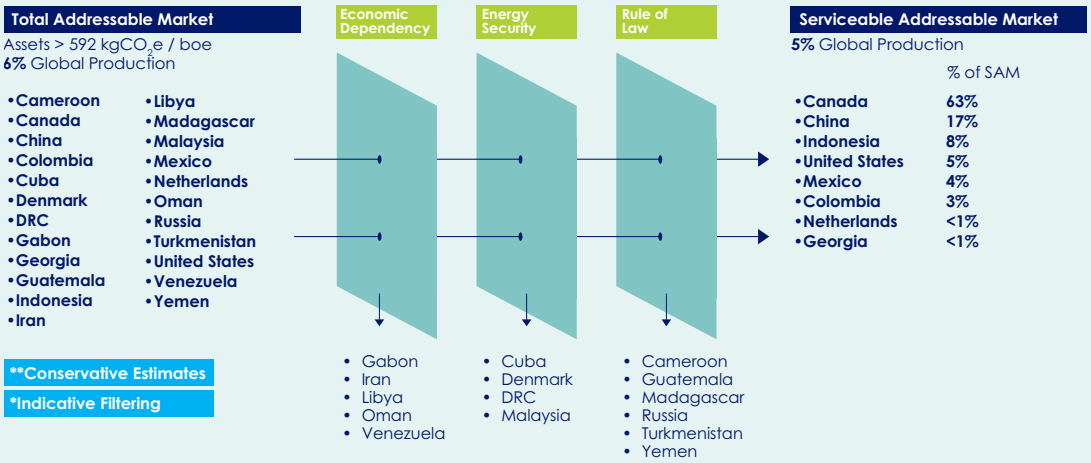
Most assets in this serviceable addressable market are in Canada (3 Mbbl/d) and China (0.8 Mbbl/d) with smaller shares of assets in Indonesia, the US, Mexico and Colombia.

h Rule of Law' is determined through the World Bank's Worldwide Governance Indicators. Any country that has consistently been performing within the worst 20th percentile for the 'Rule of Law' indicator (which captures the quality of contract enforcement) is exclude from the serviceable market.

i Economic dependency is assessed using a country's oil rents as share of GDP as a proxy. Petrostates, countries with >10% oil rents in their GDP, are excluded from the serviceable market.

Exhibit 4:

TOTAL AND SERVICEABLE ADDRESSABLE MARKET FOR ACCELERATED DE-COMMISSIONING OF OIL



Notes: ***Indicative Filtering:** Illustrative simplification of the real world, with best estimate thresholds for economic dependency, energy security and rule of law (see notes). Selecting a real-world asset for accelerated decommissioning incorporates asset-specific economics, emissions intensity, and jurisdictional policy and regulations.

Filters: **Economic dependency:** Excludes countries where >10% of GDP is dependent on oil production; they are less likely to be supportive jurisdictions to early closure.
Energy security: Excludes countries where phasing out the high emissions intensity oil fields would result in a substantial decrease in domestic oil production as share of domestic oil consumption.
Rule of Law: Excludes countries that are seen to have a poor rule of law, especially quality of contract enforcements; this creates risks to guarantee permanent asset closure.
****Conservative Estimates:** The OCI+ database is the best available source for complete oil asset emissions intensity (production + consumption). The 2020 figures are used to be comparable with World Bank indicators. They represent ~60% of global oil production. Therefore, the actual market size is almost certainly larger than estimated figures.

Sources: 3, 5, 6, 7, 8

The net carbon impact of eliminating a source of oil depends on the carbon-intensity of the eliminated oil production asset, and the degree to which that oil is resupplied by the market – known as the leakage rate. Phasing out the full 'serviceable addressable market' of high carbon-intensive oil would achieve a reduction of anywhere from 0.2 – 1.1 gigatons (Gt) CO_2e per year, depending on leakage rates.

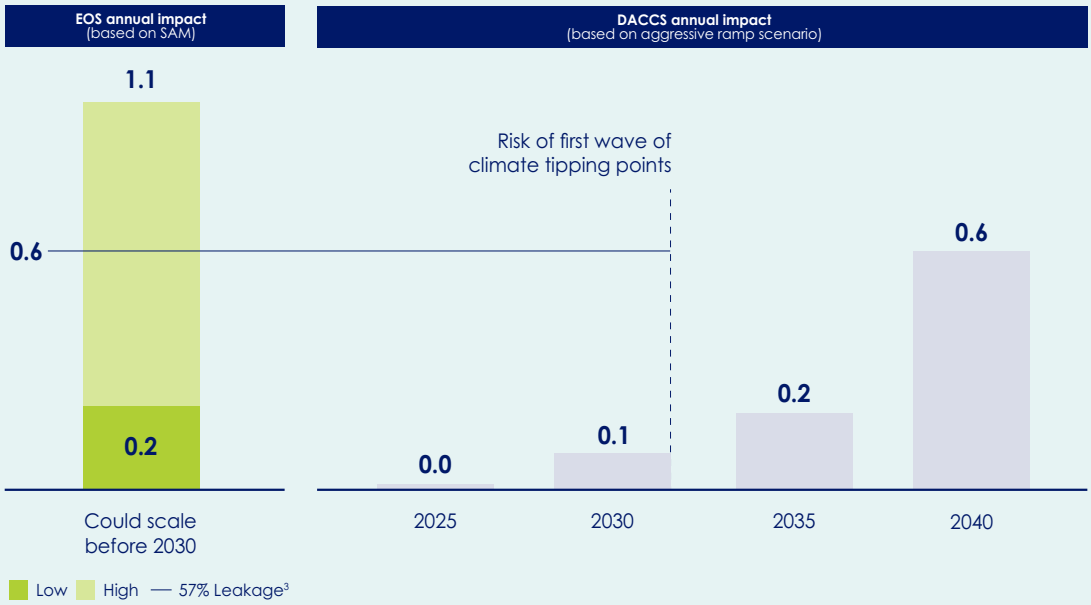
The range represents the full range of leakage rates, from 0 – 100%. While neither 0% nor 100% leakage is realistic, the figures are provided to illustrate the full possible range of impact. Even with 100% leakage, which is not supported by data or research, there is 0.2 Gt CO_2e emissions savings per year on the assumption that any resupplied barrels are of market average carbon intensity.

We can narrow the view on expected leakage. A recent review of leakage using long-run supply and demand elasticities of oil and gasoline from over 30 studies over the last ~25 years produced a central estimate of leakage at 57%.[9] This leakage rate, applied to removing the entire 5 Mbbl/d in the SAM, would result in reduction of approximately 0.6 GtCO_2e per year.

To put this in context, the same level of annual impact could be delivered by DACCS only by roughly 2040 – 17 years from now – assuming an aggressive technology development and implementation pathway.[10] DACCS technologies are still in their infancy and require technological advancements before they can be scaled up at manageable cost. By contrast, early decommissioning of oil fields does not require technological advancement or face supply chain constraints. Early decommissioning of oil could scale to deliver gigatons of emissions impact before 2030.

Exhibit 5:

EOS AND DACCS ANNUAL EMISSIONS IMPACT



Sources: 3, 5, 6, 7, 8, 9, 10

Eliminating oil supply sources will magnify demand-side efforts

Demand elasticity – and hence the long-term rate of leakage – will change over time. As the energy transition proceeds, electric cars and trucks will become increasingly competitive with internal combustion vehicles, and e-fuels will advance to compete with heavy fuel oil in ships. In turn, oil demand from these sectors will become more responsive to changes in market price (i.e., demand will become more price elastic).

This will play out in the coming years, between now and 2035. Electric cars are on the edge of unsubsidized competitiveness with internal combustion engine vehicles; sticker price parity is forecast to be reached around 2025.[12,31,36] Electric trucks will follow with total cost of ownership[j] parity around 2030 in leading markets.[12,38] Cars and trucks together represent the lion's share of oil demand at 43%.[30]

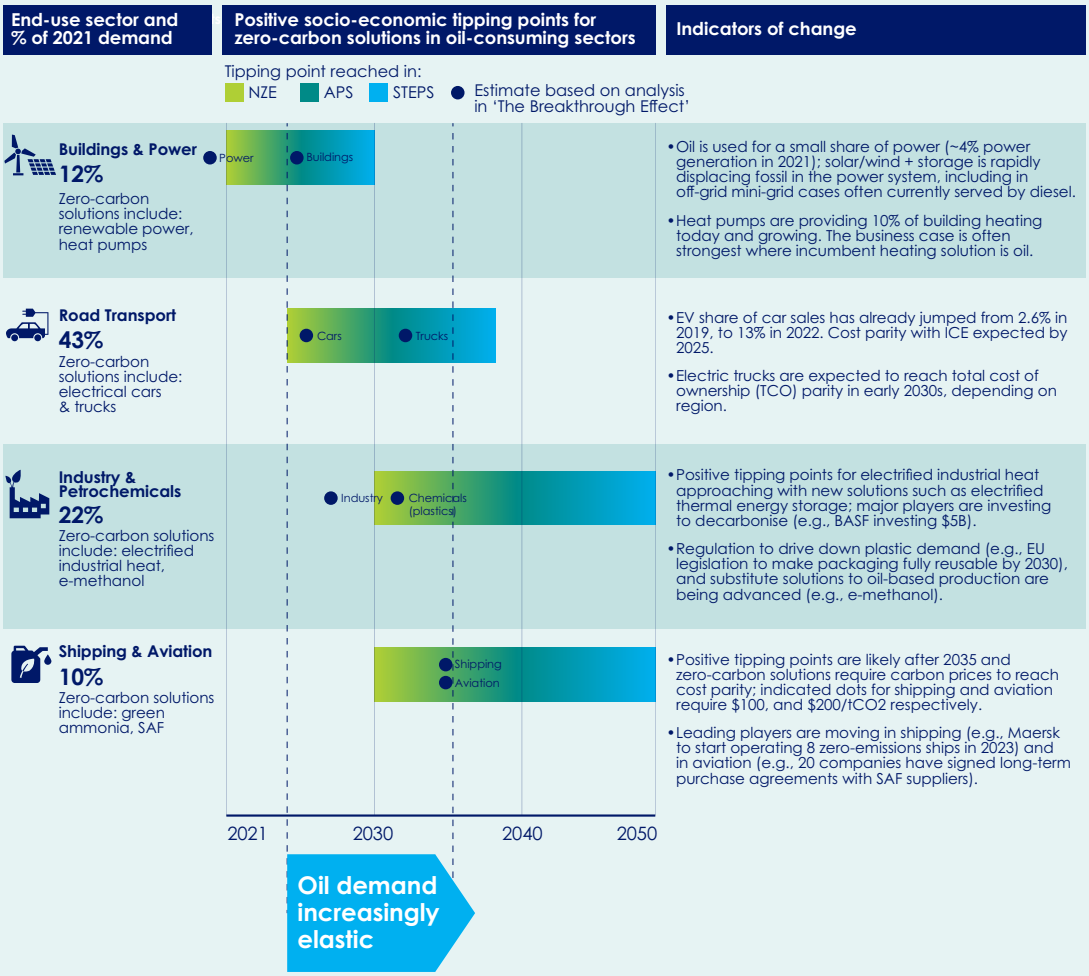
Other sectors will follow, for example clean alternatives to oil-based fuels could become mainstream in aviation and shipping by 2035.[12,43]

The availability of these increasingly competitive substitutes lowers switching costs for customers and should make oil demand more elastic. As oil demand elasticity grows, proactive interventions that impact price – including curtailing oil production – can further drive oil demand decline and accelerate the energy transition.

j In trucks, buyer decision is more informed by total cost of ownership. In passenger cars, studies have indicated that sticker price is the predominant indicator of buyers seeing EVs as a competitive alternative to ICE.

Exhibit 6:

PROJECTED TIMING OF POSITIVE SOCIOECONOMIC TIPPING POINTS FOR CLEAN ENERGY SOLUTIONS IN OIL END-USE SECTORS



Positive tipping point status determined by comparing IEA forecast end-use sector oil demand to 2021demand: if demand for a given year is higher than it was in 2021, the sector is considered pre positive tipping point.
If demand for a given year is almost equal to demand in 2021, the sector is considered near tipping point. If demand in a given year is lower than demand in 2021, the sector is considered positive tipping points.

1 Other estimates are summarized in 'The Breakthrough Effect', for sources see Systemiq (2023) 'The Breakthrough Effect'.

Sources: 1, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43

We need to prioritize actions that deliver gigaton-scale impact before 2030

Negative climate tipping points could come as early as 2030

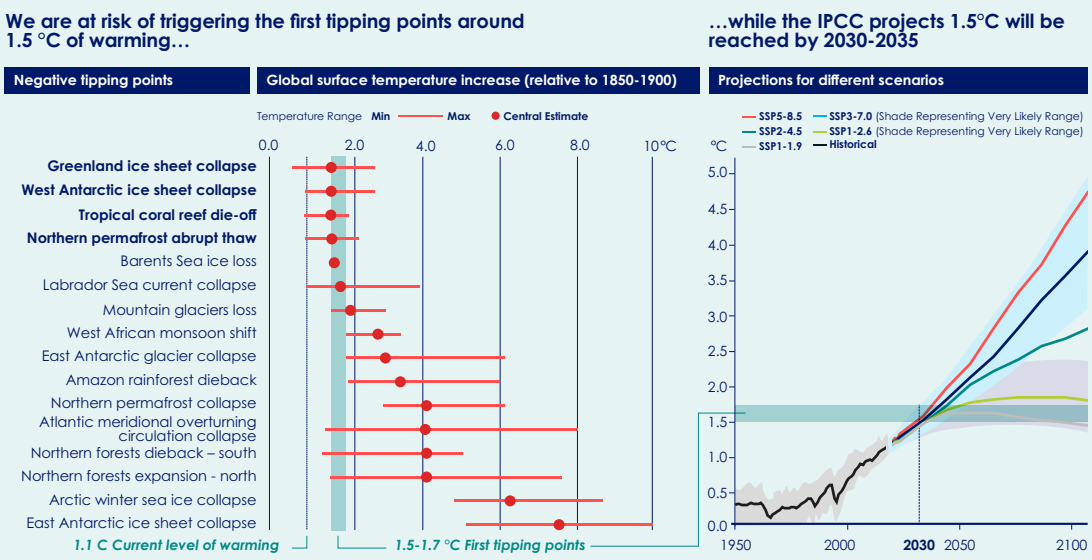
"Climate tipping points are conditions beyond which changes in a part of the climate system become self-perpetuating."[13] For instance, in a warming climate, thawing permafrost releases methane a highly potent greenhouse gas, driving more warming and unleashing a destructive feedback loop.

Climate tipping points are also interconnected; triggering one can induce climate instability, heightening the risk of activating others and unleashing a potentially catastrophic cascade. One potent example is that should the Greenland ice sheet collapse, this measurably increases the risk of triggering one of the most damaging climate tipping points, collapse of AMOC[k], a critical north-Atlantic ocean current at the foundation of much of our global climate.[14]

The stark reality is that the first wave of climate tipping points are looming dangerously close. Under certain emissions pathways temperatures could reach +1.5°C as early as 2030. At this temperature we risk triggering the first four climate tipping points that could set off the cascade.[13]

Exhibit 7:

ESTIMATED TEMPERATURE RANGES FOR TRIGGERING NEGATIVE CLIMATE TIPPING POINTS AND IPCC TEMPERATURE CHANGE PROJECTIONS



Sources: 13, 15

k AMOC: Atlantic Meridional Overturning Circulation.

Actions before 2030 are much more valuable in limiting climate damage

In the words of Bill McKibben, when it comes to climate change, "Winning slowly is the same as losing."[16] This is particularly relevant in the face of the looming risk of a cascade of irreversible climate tipping points. As a result, solutions that enable us to win early and fast hold more value in mitigating climate change than those that take decades to make a significant dent in emissions.

This dynamic can even be quantified using a metric known as the Social Cost of Carbon, which quantifies the economic damage caused by the effects of GHG emissions. Present day emissions exert not only a direct warming impact, but also a dangerous indirect effect: contributing to triggering irreversible climate tipping points. Conservative estimates from studies suggest that climate tipping points would amplify the economic damage of climate change by 1.3 to 4 times.[13,17]

The clear and compelling course of action is to minimize the emissions that could trigger climate tipping points. The emissions in question are an immediate, present concern. The economic case for acting now at scale is compelling and undisputable.

Solutions that only start to significantly impact emissions in future decades run the risk of being too late to help avert these climate tipping points. This crucial aspect of the Time Value of Carbon has been notably under-analyzed and not yet properly priced into carbon credits, yet it must be given the spotlight given the time-bound dynamic of the climate crisis.

We must swiftly and aggressively scale up solutions capable of delivering gigaton-scale impact in this decisive decade. Early decommissioning of carbon-intensive oil supply can produce this level of impact immediately.

2.

A carbon credit to eliminate oil supply (EOS) offers a unique proposition to the markets and warrants robust pricing

Carbon credits can be deployed to facilitate the early decommissioning of active carbon-intensive oil fields, and thereby reduce the risk of triggering climate tipping points

To propel the Voluntary Carbon Market (VCM) to its full potential, the supply of high-integrity projects must expand. Buyer demand is growing: the push for decarbonization is leading corporates to carbon markets, to supplement decarbonization measures within their own value chains. Significant demand is expected from heavy industry where emissions abatement will be slower due to long-lived assets and limited technological alternatives. Projections of the VCM anticipate a substantial rise in annual emissions impact from 0.3 $GtCO_2e$ today,[18] to 4 – 7 $GtCO_2e$ by 2030.[19,20] Realizing this opportunity requires a surge in high-integrity supply.

Moreover, recent scrutiny of VCM projects has increased the bifurcation of the market between high- and low-quality projects.[21,22,23] This is also driving further improvements in crediting and verification methods.

These dynamics offer promising conditions for new projects and credit types that can bring more high-quality supply to the market. Further, new credit types support a diversity of propositions on the market. This is a healthy attribute as each will appeal to different buyers' interests, and collectively a portfolio of different credit types can deliver on multiple target outcomes.

Relative to current credit types in the market, EOS offers a unique value proposition

Today's VCM has a portfolio of credit types, and associated value propositions

Carbon credits have a number of pre-requisites: represent real reductions in emissions, are independently verifiable and unique[l]. Carbon credits today are also evaluated on the following criteria:[25,26]

- **Additionality:** The emissions impact would not have occurred in the absence of the project and associated climate finance.
- **Measurability:** Emissions reductions must be quantifiable using recognised methodologies and project-specific data. Emissions reductions also need to be adjusted to account for leakages.
- **Permanence:** Projects remove or prevent tCO_2e from entering the atmosphere for at least as long as the emitted gas is contributing to climate change.
- **Co-benefits:** In addition to the carbon benefit, projects can demonstrate a positive socioeconomic impact and/or contribute to the enhancement of environmental quality, e.g., biodiversity.

l **Real:** Projects are proven to have genuinely taken place. **Independently Verifiable:** Emissions reductions proposed for certification must be monitored, verified, and approved by an authorised independent third party. **Unique:** Only one carbon credit can be associated with a single reduction or removal of 1 tCO_2e. Credits must be stored and retired in an independent registry.

The Time Value of Carbon, i.e., the ability for near-term ramp-up to facilitate scale impact before climate tipping points has not yet been explicitly factored in the market. We would argue that it should be a key consideration, particularly in light of the need to avert catastrophic climate tipping points. Carbon markets should incentivize action into solutions that can act at scale in the near-term and thereby help to prevent climate tipping points. On these criteria, there is a vast range of performance across carbon credits on the market today. There can be poor performance for a given credit in any credit type, depending on the project.

At the same time, at the high-quality end of the market, certain credit types may be fundamentally better positioned to achieve higher performance than others; in such cases a credit can outperform on certain criteria.

To understand the distinct value proposition of an EOS credit, it is helpful to understand the proposition of credits in the market today. Three notable credit types and their respective value propositions are as follows[m]:[10,18, 24,25,26,27,28,29]

- **Reducing Emissions from Deforestation and forest Degradation (REDD+):** These are projects that avoid planned and unplanned deforestation. They tend to be differentiated on co-benefits, namely protecting biodiversity. Despite complexities[n] surrounding their additionality and measurability, solutions are continually improving with innovative tools and mechanisms such as satellite monitoring and permanence buffer pools.
- **Afforestation and Reforestation credits (ARR):** These are projects that restore tree cover in areas where the primary forest has disappeared. High-quality projects can have very clear additionality. Relative to REDD+ there are trivial biodiversity benefits[o].

  Because trees take a number of years to reach their rapid growth stages when they absorb peak volumes of carbon, and we have not already planted ARR projects that will deliver gigatons of reductions in the future, this credit type is less likely to provide scale reductions before 2030.
- **Direct Air Carbon Capture & Storage (DACCS):** These are projects that extract CO2 from the atmosphere and store it in geological formations. DACCS projects have clear case of additionality, measurability can be straightforward though not exclusively[p] and these projects deliver geosphere permanence.

  The credits provide a relatively small early market that enables this new technology to mature and reduce in costs over time. The aspiration is that DACCS can scale by 2050 to play an important role in achieving net zero. Impact this decade while the technology is still maturing will be minimal.

An indicative profile of the respective characteristics for these three notable credit types is seen in Exhibit 9 below. The exhibit also illustrates how a high-integrity credit to eliminate oil supply (EOS) would distinguish itself.

m Other credit types include for example: soil carbon, blue carbon, biochar, household devices and fuel efficiency, carbon capture utilisation and storage (CCUS).

n Many factors affect deforestation which can create complexity. The complexity also differs between planned and unplanned; where management planes are available additionality and measurability are easier than otherwise.

o Virgin forest holds a richness in biodiversity, while planted forest provides only trivial amounts.

p Even DACCS can face complexities in measurability, for example where the project is being powered from the national power grid, determining the correct electricity carbon intensity to apply can be nuanced.

Exhibit 8:

NEAR-TERM PERFORMANCE OF SELECTED CREDIT PROJECTS

1 All carbon credits issuances listed globally by the four major registries, which is almost all of the VCM (from Berkeley database, last update: February 2023);
2 Indicative price estimates by Abatable as of August 2022: over-the-counter prices from multiple marketplaces and benchmarks provided by CBL Xpansiv, S&P Platts, CME, Allied Offsets were considered.
3 Reducing Emissions from Deforestation and forest Degradation;
4 Direct Air Carbon Capture and Storage;
5 Eliminating Oil Supply

Sources: 10, 18, 24, 25, 26, 27, 28, 29

A carbon credit to eliminate oil supply (EOS) presents a new distinct value proposition due to its permanence, and immediate impact at scale

An EOS carbon credit acts at the source of fossil fuel supply, upstream from the emissive activities in processing, transportation and combustion. The credit brings together:

a. **Permanence:** EOS credit delivers geosphere permanence (similar to DACCS). Early decommissioning of productive oil fields creates an economic barrier to re-developing them in the future even if oil prices increase.[q] Permanence can be enhanced with legal restriction on the mineral rights to prevent future extraction.

b. **Time Value of Carbon:** Unlike DACCS, eliminating oil supply does not require any technological advancement or have any supply chain constraints. It can ramp-up now and deliver gigaton-scale impact this decade to help avoid triggering climate tipping points.

This combination of outperforming characteristics – on permanence and Time Value of Carbon – is unique in the market today. A high-integrity EOS credit would also perform well on additionality as it would apply to economically active fields, and measurability, based on the following considerations.

q This is because developing an oil field is capex heavy. Drilling costs alone are in the order of hundreds of thousands of dollars per day and facilities and connections to market cost tens to hundreds of millions of dollars. The economics of recommissioning variably depleted oil fields should be the subject of further research and analysis.

Additionality: Could be determined using multiple methods and safeguards together, including:

- Field-specific open-book calculations, with actual in-year metrics applied.
- Oil field production plans based on reserves audited by federal regulators, not dissimilar to an approach used for REDD+ credits focused on planned deforestation.
- Observation of analogue local fields, matched based on cost and oil type.

Measurability: The primary element to be addressed in measurement of an EOS credit is leakage – namely to what degree the oil is resupplied by the market, and the carbon-intensity of the resupplied oil. A high-integrity credit can be achieved through a combination of robust methodology, conservative estimates and safeguards, such as[r]:

- Regular assessment retro-actively of regional oil supply and consumption.
- Regular evaluations of supply and demand elasticity.
- Conservative estimates of leakage applied as a safeguard.
- Independent monitoring, reporting and verification (MRV) of emissions reduction through reserves auditing and asset emissions measurement and supplemented by models used by regulators, where appropriate.

Managing additionality and measurability to achieve high-integrity credits is worth the effort as it is highly capital efficient in delivering geosphere sequestration relative to DACCS or even CCUS. Preventing carbon from entering the atmosphere is more capital-efficient than releasing and recapturing it into the geosphere.

Co-benefits: The co-benefits of an EOS credit principally comprise land reclamation, ecosystem revitalization and improvements in air and water quality.

Without intervention, land reclamation of oil fields rarely occurs[s] and there is concern that fields which operate right up until they are unprofitable will be left stranded with no reclamation.[44,45,46,47] An EOS credit can create an incentive – or even a requirement – for oil field owners to deliver reclamation as part of the carbon credit project. This would be a meaningful achievement as reclamation costs for oil sands stretch into the billions[t].

Mission: Part of the distinct value proposition for an EOS credit is the mission it serves: an accelerated shift away from fossil fuels. This mission may be one that resonates with credit buyers whose own emissions are linked to oil – in their operations, supply chain or as customers use their products.

r Methods for measurement must be further researched and validated; accredited standards have not yet been developed or adopted by the major carbon registries.

s In 50 years of oil sands production, to date only 0.1% of land has been reclaimed.

t For example, tailing ponds clean-up and reclamation costs for the Alberta oil sands were estimated at $38 billion (2016 data)

BOX 2:

CARBON CREDIT TO DECOMMISSION COAL POWER

A core principle of EOS credits is leveraging climate finance to accelerate the transition by paying for early decommissioning of fossil assets. This same principle is being applied in coal, with a focus on early decommissioning of coal power plants in the Global South.

The most recent such initiative is the Energy Transition Accelerator (ETA), spearheaded by US climate envoy John Kerry. It aims to create a jurisdictional carbon crediting mechanism for developing nations to accelerate their energy transitions[48]. Another form of climate finance – not carbon credits – seeking the same outcome is the Just Energy Transition Partnerships (JET-P). JET-P deals are large multi-lateral climate finance agreements focused on accelerating coal closure. Deals are under discussion with between Global North countries (the "donors") and Global South countries including in South Africa, Vietnam and Indonesia.[49,50,51]

Considering the urgency and scale of the climate crisis, and the ambitions for the VCM to deliver 4+ $GtCO_2e$ impact by 2030, there is a need and room for both coal and oil early decommissioning credits. These solutions, that use carbon finance to accelerate the economy out of the age of fossil fuels, will be critical to a fast transition.

High-integrity EOS credits should command robust pricing in carbon markets

The EOS credit outperforms on permanence and Time Value of Carbon, both attributes that warrant credit premiums

Carbon credit pricing can be difficult to delineate as more of the market moves to opaque OTC[u]. Still certain pricing trends can be observed in the market. Two observable trends relevant to a high-quality EOS carbon credit:

- **High-quality:** Within a given credit type, the integrity of projects can vary widely. Though it has not always been the case, high-integrity projects now command higher prices. Higher-integrity can be linked with more recent standards and methodologies including stringent safeguards, e.g., conservative estimates, leakage risk monitoring, re-baselining from after-the-fact observation and verification. Recent concerns about the integrity of large-scale nature-based projects have contributed to this effect, creating a bifurcation in the market between high-quality and low-quality credits.

  With the measures outlined above, an EOS credit can achieve high-quality and command the warranted higher pricing.

- **Geosphere permanence:** Carbon stored in the geosphere brings inherent permanence benefits[v]. This variable is likely one driver of the very high pricing seen for CCUS and DACCS credits[w].

  EOS credits deliver the same geosphere permanence benefits of CCUS and DACCS, but do it with much higher capital efficiency – it is more capital efficient to prevent carbon from entering the atmosphere than to release and recapture it into the geosphere.

u OTC: Over-the-Counter deals. Pricing for OTC is not transparent to the market, and generally higher than pricing of credits traded through exchanges.

v Forests for instance face multiple risks, e.g., burning, destruction by insects. Buffer pools are being applied to forest projects to improve permanence, however geosphere is still seen as inherently more permanent.

w Note, geosphere permanence would not be the only variable driving CCUS and DACCS pricing. Buyers may see some value in helping to advance nascent technology. DACCS will be earning a removals premium. Also, both only represent a miniscule fraction of the market, so it is only select few buyers who have shown a willingness to pay the very high prices of CCUS and DACCS.

One more attribute that does not have an observable trend in the market, but should, and supports robust pricing for the EOS credit:

- **Time Value of Carbon:** As outlined, there should be more value placed on impacting emissions before 2030 to help stave off climate tipping points. This should be as much as 4 times more valuable than impacting emissions later. Projects and credit types can ramp-up and deliver gigaton-scale impact before 2030 should command a premium from those who want to see this impact happen.

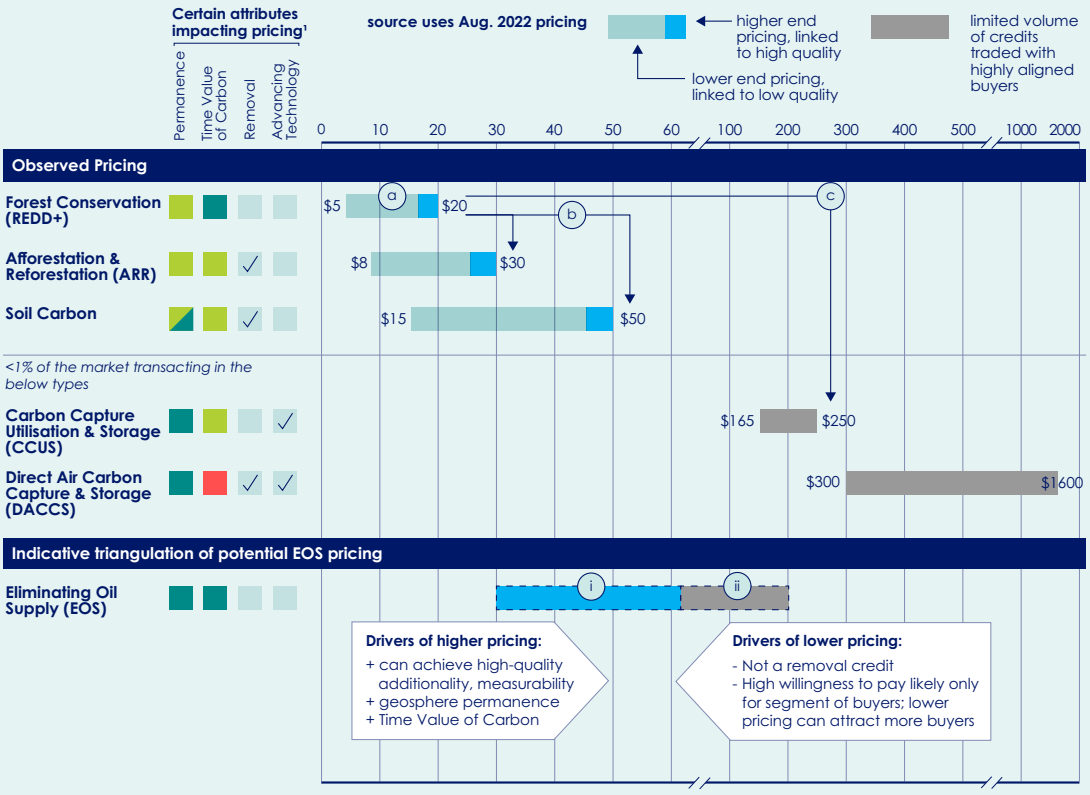
  With enough climate finance flows, the EOS credit type can scale to achieve such impact. There is no hindrance to scaling such as required technological advancement or supply chain constraints, as can be the case for certain solutions, for instance DACCS.

A high-quality EOS credit would perform well across criteria, and outperform on geosphere permanence and Time Value of Carbon. This proposition should command robust pricing.

Exhibit 9 below illustrates an indicative triangulation of potential pricing. It draws on observed pricing of existing credit types and shows what this implies about how certain attributes are valued by the base of the market and for certain small segments of buyers and what this points to when mapped to the EOS credit attributes.

Exhibit 9:

OBSERVED MARKET PRICING OF CERTAIN EXISTING CREDIT TYPES AND INDICATIVE TRIANGULATION OF POTENTIAL EOS PRICING



(a) **High(er) additionality & measurability:**

Within a credit-type, higher integrity warrants higher pricing (~2-4x). Note: some of the pricing differences within credit types will be linked to differences in broader market pricing at time of transaction.

(b) **Removals:**

Removals generally command a premium (~2-4x). We can observe this directly within NBS with ARR pricing higher than REDD+ (where ARR is also discounted for lack of biodiversity benefits), and within geosphere: CCUS vs. DACCS.

(c) **Geosphere:**

Geosphere permanence seems to command a premium as seen in CCUS and DACCS, although today's high prices reflect a willingness to pay to help advance immature technology; also note these credit types are only transacted by a very small segment of buyers representing <1% of today's market activity.

(i) **Broader base of buyers:**

The lower end of this range is indicatively drawn from taking the prices of credit types traded at significant volumes in the market – REDD+, ARR – with a focus on the high-integrity versions & pricing, then adjusting for a geosphere permanence premium, which is hard to isolate hence figures are a broad range.

(ii) **Small segment of well aligned buyers:**

Similar to CCUS and DACCS, there may be a segment of buyers for whom the proposition of EOS resonates particularly strongly and who demonstrate a willingness to pay higher prices.

1 'Permanence' and 'Time Value of Carbon' are criteria on which any credit can be scored; 'Removal' and 'Advancing technology' are aspects of certain credit types.

Source: underlying market pricing of existing credits from Abatable

Certain buyers may further be attracted to the mission of accelerating away from fossil fuels

Buyers may be motivated by the overarching mission served by a credit, such as ending deforestation (REDD+) or encouraging engineered carbon removals at scale (DACCS). For EOS, the mission is to accelerate the transition from fossil fuel dependency. EOS carbon credits provide a vehicle for this goal. There is likely to be a segment of buyers who place differential value on the EOS credit's specific qualities – including high permanence, scale and immediate impact (Time Value of Carbon – and the mission to accelerate away from fossil fuels. These credit buyers could lead initial demand for the credit type and spark others to follow.

In addition, while the above focuses on the voluntary carbon markets, an EOS credit could also be adopted in compliance markets. An EOS credit would offer an equally distinct value proposition to compliance markets, which also traditionally operate at measurably higher price tiers than the VCM.

CONCLUSION

The clock is ticking and the time to act is now. As oil markets nudge towards decline, the current pace of transition will yield only trivial reductions by 2030, which are insufficient in the face of the mounting climate crisis. We need to accelerate oil decline; this calls for concerted action on both demand and supply.

A supply side intervention could take the most carbon-intensive sources of oil out of production, first. Without an intervention these assets would continue profitably producing for 10–15 years or longer. While regulation could intervene, this can take many years or see its impact muted. We do not have time to wait and see; we need to act. Carbon credits can eliminate oil supply from carbon-intensive oil production now. Such a supply-side intervention magnifies the impact of on-going demand-side efforts, providing a potent two-fold strategy to accelerate oil decline.

This compelling prospect could reach gigaton-scale impact before 2030, which is precisely the type of solution we need to prioritise to help stave off climate tipping points that loom dangerously close. Actions this decade are what will make the difference as to whether we trigger a destructive cascade of climate tipping points. This is the right type of action.

Within the carbon markets, a credit to eliminate oil supply (EOS) brings a unique proposition to the table. By targeting the source of fossil fuel supply, EOS credits deliver the benefits of geosphere permanence seen in DACCS and can reach gigaton-scale impact before 2030. EOS credits can perform well on additionality and measurability with the right safeguards in place. Moreover, the mission inherent in this credit – to accelerate the transition away from fossil fuels – will inevitably resonate with certain buyers.

A high-integrity EOS credit warrants a premium price. Its dual strengths – geosphere permanence and high Time Value of Carbon – should drive its market value. Furthermore, the mission of accelerating the transition away from fossil fuels should invite a higher willingness to pay.

In summary, to combat climate change effectively, we need immediate, high-impact interventions. A carbon credit to eliminate oil supply (EOS), targeting carbon-intensive oil fields for early decommissioning, meets the speed, scale and impact needed at this moment in addressing the climate crisis. It can complement the impact of demand-side efforts and help accelerate us to a world without fossil fuel dependency. The time is now.

ENDNOTES

1 IEA, "World Energy Outlook 2022," 2022.

2 BP, "Energy Outlook 2023," 2023.

3 RMI, "Oil Climate Index plus Gas Model v.2.0.0," 2023. [Online]. Available: https://ociplus.rmi.org/. [Accessed 26 4 2023].

4 Rystad Energy, Supply curve, 2022.

5 BP, "Statistical Review of World Energy," 2022.

6 World Bank, "Oil Rents," 2023. [Online]. Available: https://data.worldbank.org/indicator/NY.GDP.PETR.RT.ZS. [Accessed 1 2 2023].

7 World Bank, "Worldwide Governance Indicators," 2022. [Online]. Available: https://info.worldbank.org/governance/wgi/.

8 IEA, "Cuba," 2023. [Online]. Available: https://www.iea.org/countries/cuba. [Accessed 26 04 2023].

9 Prest et al., "Estimating the emissions reductions from supply-side fossil fuel interventions," 2023.

10 Energy Transitions Commission, "Mind the Gap: How Carbon Dioxide Removals Must Complement Deep Decarbonisation to Keep 1.5C Alive", 2022.

11 Systemiq, "The Paris Effect - COP26 Edition," 2021.

12 Systemiq, "The Breakthrough Effect," 2023.

13 Armstrong, McKay et al., "Exceeding 1.5°C global warming could trigger multiple climate tipping points," Science, 2022.

14 Cai et al., "Risk of multiple interacting tipping points should encourage rapid CO2 emissions reduction," Nature Climate Change, 2016.

15 IPCC, "Climate Change 2022: Mitigation of Climate Change," 2022.

16 Rollingstone, "Bill McKibben: Winning Slowly Is the Same as Losing", 2017.

17 Dietz et al., "Economic impacts of tipping points in the climate system," PNAS, vol. 118, no. 34, 2021.

18 So et al., "Voluntary Registry Offsets Database, Berkeley Carbon Trading Project, University of California, Berkeley," 2022.

19 Bloomberg BNEF, "Long-term Carbon Offsets Outlook 2023," 2023.

20 Trove Research, "Future Demand, supply and Prices for Voluntary Carbon Credits - Keeping the Balance," 2021.

21 Shell and BCG, "The voluntary carbon market: 2022 insights and trends," 2023.

22 World Bank, "State and Trends of Carbon Pricing 2022," World Bank. https://openknowledge.worldbank.org/handle/10986/37455 License: CC BY 3.0 IGO, Washington, DC, 2022.

23 Carbon Credits, "Carbon Prices Today," 9 2 2023. [Online]. Available: https://carboncredits.com/carbon-prices-today/. [Accessed 9 2 2023].

24 IEA, "Direct Air Capture," 2022.

25 BeZero, "BeZero Carbon Rating," 2022.

26 Sylvera, "Carbon Ratings," 2022. [Online]. Available: https://www.sylvera.com/. [Accessed 2022].

27 Sylvera, "REDD+ Framework," 2022.

28 Sylvera, "ARR Framework," 2022.

29 Abatable, "Voluntary Carbon Market - Carbon Prices Summary Table," 2022.

30 IEA, "World Total Energy Supply By Source," 2022. [Online]. Available: https://www.iea.org/data-and-statistics/charts/world-total-energy-supply-by-source-1971-2019.

31 Bloomberg BNEF, Zero-Emission Vehicles Progress Dashboard, 2022.

32 Energy Transitions Commission, "Degree of Urgency: Accelerating Action to Keep 1.5C on the Table," 2022.

33 IRENA, "Renewable solutions in end-uses: Heat pump costs and markets," 2022.

34 IEA, "Heat Pumps Technology deep dive," 2022.

35 IEA, "Electric Vehicles: Technology deep dive," 2022.

36 Energy Transitions Commission, "Making Clean Electrification Possible," 2021.

37 Consumer Reports, "Electric Vehicle Ownership Costs: Today's Electric Vehicles Offer Big Savings for Consumers," 2020.

38 Mission Possible Partnership, "Making Zero Emissions Trucking Possible," 2022.

39 Systemiq, Center for Global Commons, "Planet Positive Chemicals," 2022.

40 European Commission, "European Green Deal: Putting an end to wasteful packaging, boosting reuse and recycling," 30 11 2022. [Online]. Available: https://ec.europa.eu/commission/presscorner/detail/en/ip_22_7155.

41 Ship and Bunker, "28 Countries speak in favour of 2050 net zero target at IMO working group," 2022. [Online]. Available: https://shipandbunker.com/news/world/488343-28-countries-speak-in-favour-of-2050-net-zero-target-at-imo-working-group.

42 Maersk, "A.P. Moller - Maersk will operate the world's first carbon neutral vessel by 2023 - seven years ahead of schedule," 2021. [Online]. Available: https://www.maersk.com/news/articles/2021/02/17/maersk-first-carbon-neutral-liner-vessel-by-2023.

43 Mission Possible Partnership, "Making Net-Zero Aviation Possible," 2022.

44 Pembina Institute, "Fifty years of oilsands equals only 0.1% of land reclaimed," 13 October 2017. [Online]. Available: https://www.pembina.org/blog/fifty-years-oilsands-equals-only-01-land-reclaimed. [Accessed 24 February 2023].

45 Shareholder Association for Research and Education, "Investor Brief: Canada's Oil Sands tailings reclamation: an unfunded liability?," 2020.

46 S. Cox, "The Narwhal," 18 June 2020. [Online]. Available: https://thenarwhal.ca/ranch-energy-bankruptcy-401-orphan-wells-dumped-on-b-c-cleanup/. [Accessed 18 April 2023].

47 National Resources Defence Council & Environmental Defence, "One trillion litres of toxic waste and growing: Alberta's tailings ponds".

48 US Department of State, "U.S. Government and Foundations Announce New Public-Private Effort to Unlock Finance to Accelerate the Energy Transition", 2022.

49 European Commission, "France, Germany, UK, US and EU launch ground-breaking International Just Energy Transition Partnership with South Africa", 2021.

50 European Commission, "Political Declaration on establishing the Just Energy Transition Partnership with Viet Nam", 2022.

51 US Embassy and Consulates in Indonesia, "United States Supports the Launch of the Just Energy Transition Partnership (JETP) in Indonesia", 2022.