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DRILLING TOWARDS DISASTER:

WHY U.S. OIL AND GAS EXPANSION IS INCOMPATIBLE WITH CLIMATE LIMITS

OILCHANGE INTERNATIONAL

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Oil Change International is a research, communications, and advocacy organization focused on exposing the true costs of fossil fuels and facilitating the coming transition towards clean energy.

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CONTENTS

ABBREVIATIONS USED IN THIS REPORT

°C	Degrees Celsius
Bbl	Barrel
Bp/d	Barrels per day
BECCS	Bioenergy with carbon capture and storage
BOE	Barrels of oil equivalent
CCS	Carbon capture and storage
Cf/d	Cubic feet per day
CH_4	Methane
CO_2	Carbon dioxide
CO_2e	Carbon dioxide equivalent
EIA	U.S. Energy Information Administration
EJ	Exajoule
EPA	U.S. Environmental Protection Agency
GDP	Gross domestic product
Gt	Billion metric tons / Gigatons
ITUC	International Trade Union Confederation
IPCC	Intergovernmental Panel on Climate Change
IEA	International Energy Agency
LNG	Liquefied natural gas
MBOE	Million barrels of oil equivalent
Mt	Million metric tons
NGLs	Natural gas liquids
SR15	IPCC Special Report on 1.5°C of Global Warming

PREFACE

World governments, including the United States, committed in 2015 in the Paris Agreement to pursue efforts to limit global average temperature rise to 1.5 degrees Celsius above pre-industrial levels and, at a maximum, to keep warming well below 2 degrees Celsius (°C).[1] This report is part of *The Sky's Limit* series by Oil Change International examining why governments must stop the expansion of fossil fuel production and manage its decline – in tandem with addressing fossil fuel consumption – to fulfill this commitment.

The global *Sky's Limit* report, released in 2016, found that the world's existing oil and gas fields and coal mines contain more than enough carbon to push the world beyond the Paris Agreement's temperature limits.[2] This finding indicates that exploring for and developing new fossil fuel reserves is incompatible with the Paris goals. In fact, some already-operating fields and mines will need to be phased out ahead of schedule.

Since the global *Sky's Limit* report in 2016, new scientific evidence has added urgency to this call for a managed decline of fossil fuel production. The latest report from the Intergovernmental Panel on Climate Change warns that reaching 2°C of warming would significantly increase the odds of severe, potentially irreversible impacts to human and natural systems, compared to limiting warming to 1.5°C.[3] The difference could be the wipeout or resilience of whole communities and ecosystems. The report underscores that a 1.5°C path is possible but will require "rapid and far-reaching" transitions and "deep emissions reductions in all sectors" so that carbon pollution nears zero by 2050.[4]

Unfortunately, existing climate measures aren't cutting it – literally. Current national policy pledges under the Paris Agreement would put the world on course for 2.4 to 3.8°C of warming,[5] a catastrophic outcome.

This glaring gap in ambition has been driven in part by a systemic policy omission. Over the past three decades, climate policies have primarily focused on addressing emissions where they exit the smokestack or tailpipe. Meanwhile, they have largely left the source of those emissions – the oil, gas, and coal extracted by fossil fuel companies – to the vagaries of the market.

Basic economics tells us that the consumption of any product is shaped by both supply and demand. It follows that reducing supply and demand together, or 'cutting with both arms of the scissors,'[a] is the most efficient and effective way to reduce a harmful output. Putting limits on fossil fuel extraction – or 'keeping it in the ground' – is a core yet underutilized lever for accelerating climate action.

Curbing the supply of fossil fuels does not mean turning off the taps overnight. Rather, it means stopping new projects that would lock in new pollution for the coming decades. It means managing an orderly and equitable wind-down of existing fossil fuel infrastructure and extraction projects within climate limits. It makes it possible to plan for a just transition for workers and communities.

If the world is to succeed in meeting the Paris goals, this type of comprehensive and clear-eyed approach is urgently needed everywhere, and particularly in the United States – one of the world's top producers and users of fossil fuels.

a In his seminal 1890 work, *Principles of Economics*, Alfred Marshall remarked, "We might as reasonably dispute whether it is the upper or the under blade of a pair of scissors that cuts a piece of paper, as whether value is governed by utility [demand] or cost of production [supply]." Marshall's writing inspired the title of the 2018 article in *Climatic Change* by Fergus Green and Richard Denniss, "Cutting with both arms of the scissors: The economic and political case for restrictive supply-side climate policies."

IF YOU'RE IN A HOLE, STOP DIGGING.

Oil fields near Midland, Texas. European Space Agency / NASA.

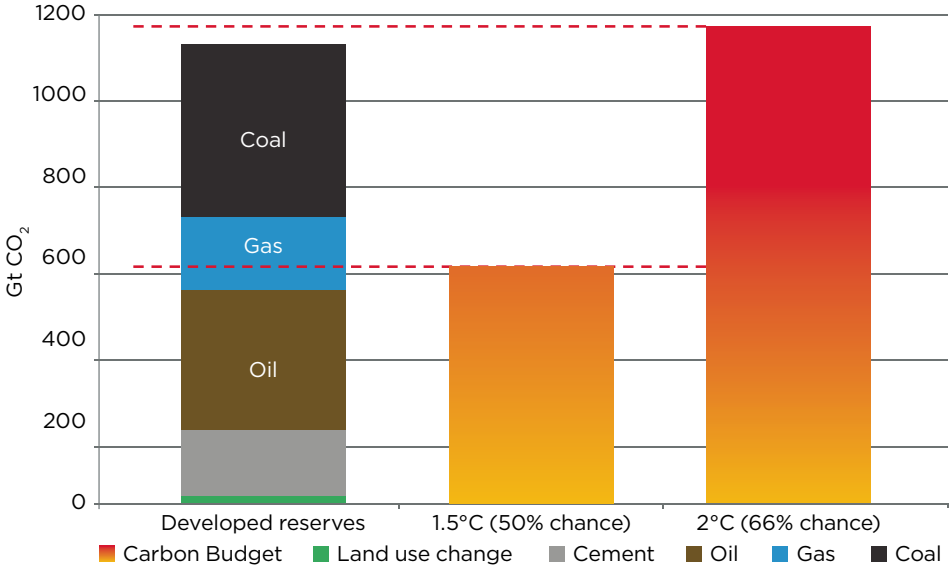
EXECUTIVE SUMMARY

Previous analysis has shown that existing oil and gas fields and coal mines already contain enough carbon to push the world beyond the goals of the Paris Agreement – to limit temperature rise to 1.5 degrees Celsius (°C) above pre-industrial levels or, at maximum, *well below* 2°C (Figure ES-1).[6] To limit catastrophic climate change, governments must manage the decline of the fossil fuel industry, and do so over the next few decades.[b]

The United States should be moving first and fastest in this direction. The United States is the world's largest oil and gas producer and third-largest coal producer.[7] It also has the resources and technology at hand to rapidly phase out extraction while investing in a just transition that guarantees a 'Green New Deal' for affected workers and communities currently living on the front lines of the fossil fuel industry and its pollution.[c]

Instead, the U.S. oil and gas industry is gearing up to unleash the largest burst of new carbon emissions in the world between now and 2050. **At precisely the time in which the world must begin rapidly decarbonizing to avoid runaway climate disaster, the United States is moving further and faster than any other country to expand oil and gas extraction.**

Figure ES-1: CO_2 Emissions from Developed Fossil Fuel Reserves, Compared to Carbon Budgets (as of Jan. 2018) within Range of the Paris Goals



Sources: Oil Change International analysis[21] based on data from Rystad Energy, International Energy Agency (IEA), World Energy Council, and IPCC

b In the 2016 global *Sky's Limit* report and in this U.S. analysis we take a precautionary approach to carbon capture and storage (CCS) and negative emissions technologies – assessing how the energy system will need to change without large-scale reliance on them. CCS has yet to be successfully deployed at scale despite major efforts. Meanwhile, scientists have identified significant social and ecological risks and governance challenges associated with large-scale use of carbon-dioxide removal technologies.

c At its core, a just transition means ensuring that nobody is left behind in the shift from fossil fuels to a clean energy economy. This process must include active government support and social protection, including wage insurance, health benefits, and pensions, for workers who lose their jobs when an oilfield or coal mine ceases operation. It must also include deep investment in new economic opportunities for affected communities. At the U.S. federal level, energy is increasingly coalescing around the concept of a Green New Deal – mobilizing mass public investment to decarbonize the U.S. economy while guaranteeing good-paying jobs in the transformation – to drive a just transition.

We offer this analysis as a warning and as a guide to U.S. elected officials and policymakers at all levels of government who remain committed to the Paris Agreement goals. If the United States is to start helping, rather than severely hindering, the world's chances at averting climate disaster, U.S. politicians at all levels must start flexing an underutilized muscle: their ability to say 'no' to the fossil fuel industry, and to steer it towards an equitable and orderly phase-out.

KEY FINDINGS

Oil & Gas: Unprecedented, Reckless Expansion

- **Between now and 2030, the United States is on track to account for 60 percent of world growth in oil and gas production, expanding extraction at least four times more than any other country.** This is the time period over which climate scientists say global carbon dioxide (CO_2) emissions should be roughly halved to stay in line with the 1.5°C target in the Paris Agreement.[8]

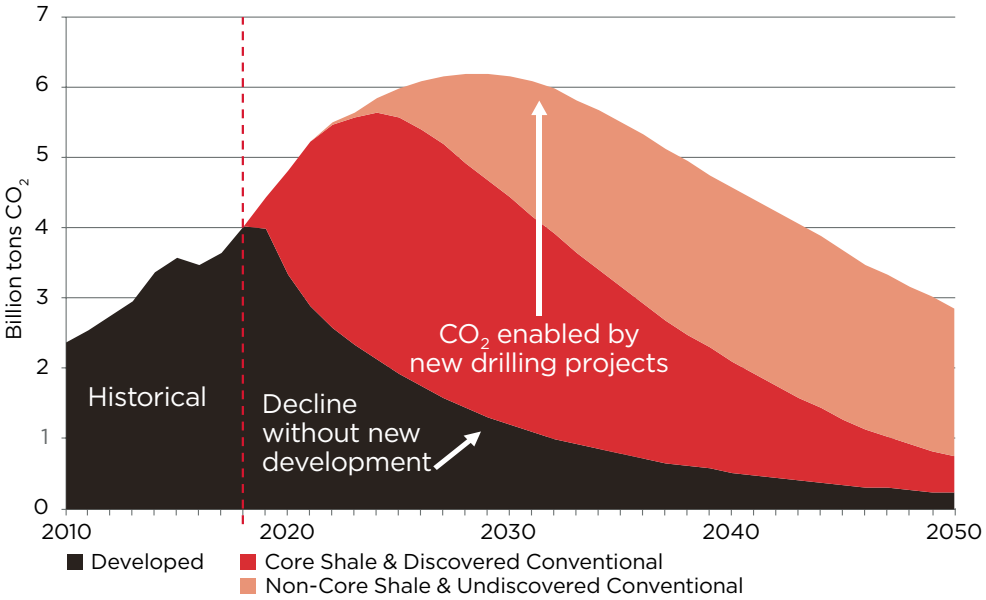
- **Between 2018 and 2050, the United States is set to unleash the world's largest burst of CO_2 emissions from new oil and gas development (Figure ES-2).** U.S. drilling into new oil and gas reserves – primarily shale – could unlock 120 billion metric tons[d] of CO_2 emissions, **which is equivalent to the lifetime CO_2 emissions of nearly 1,000 coal-fired power plants.[e]**

- **Methane leakage could increase the total climate pollution enabled by U.S. oil and gas expansion by 10 to 24 percent between 2018 and 2050,** adding 16 to 39 billion metric tons of CO_2-equivalent emissions to the 120 billion total given above.[f]

- **If not curtailed, U.S. oil and gas expansion will impede the rest of the world's ability to manage a climate-safe, equitable decline of oil and gas production.** We find that, under an illustrative 1.5°C pathway for oil and gas taken from the Intergovernmental Panel on Climate Change (IPCC), U.S. production would exhaust nearly 50 percent of the world's total allowance for oil and gas by 2030 and exhaust more than 90 percent by 2050.[g]

Oil rig operating in Williston, North Dakota. Lindsey Gira. (CC BY 2.0)

Figure ES-2: Projected Annual CO_2 Emissions of U.S.-Produced Oil and Gas, 2010-2050, by Current Stage of Development



Source: Oil Change International calculation using data from Rystad UCube (October 2018) and IPCC

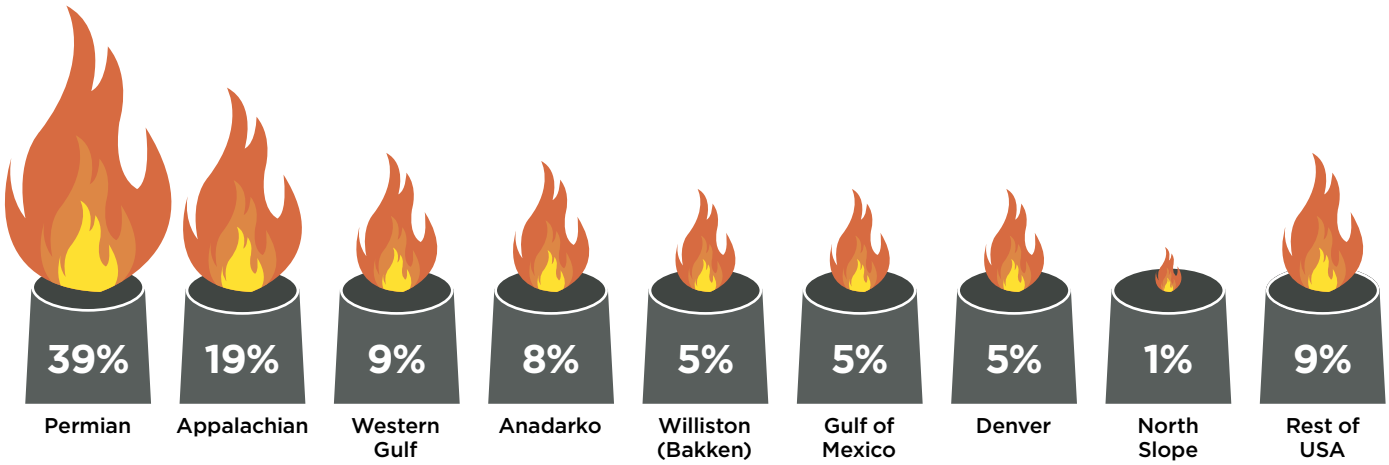
d All references to tons in this report refer to metric tons.

e CO_2 totals account for the emissions caused globally by burning oil and gas produced in the United States. The coal plant comparison is derived from Environmental Protection Agency (EPA) data (Sept. 2017 version) on the annual CO_2 emissions of an average U.S. coal plant and factors in a 30-year plant lifetime.

f This estimate is based on assuming an average methane leakage rate of 2.3 percent of U.S. gas production. The given range relates to using a 100-year or 20-year factor for the global warming potential of methane when converting to its CO_2 equivalent.

g As discussed in Section II, we compare the U.S. oil and gas production trajectory to the global trajectory for oil and gas demand in the P1 or low-energy-demand illustrative pathway featured in the IPCC 1.5°C Special Report. This is the archetypal pathway that does not rely on CCS.

Figure ES-3: Sources of CO_2 Emissions from New Oil and Gas Development, by Key U.S. Basins, 2018-2050



Source: Oil Change International calculation using data from Rystad Energy (October 2018) and IPCC

Expansion Hot Spots: The Permian and Appalachian Basins

The oil and gas industry is targeting two basins as the epicenters of its production expansion between now and 2050: the Permian Basin in Texas and New Mexico for oil and the Appalachian Basin spanning Pennsylvania, West Virginia, and Ohio for gas.

- **Nearly 60 percent of the 120 billion tons of CO_2 emissions unlocked by new U.S. oil and gas drilling from 2018 to 2050 is set to come from the Permian and Appalachian Basins (Figure ES-3).**

- The CO_2 pollution enabled by oil and gas production in the Permian Basin from 2018 through 2050 could exhaust **close to 10 percent of the entire world's carbon budget for staying within 1.5°C of warming.**[h] By its projected peak year of production, 2029, the Permian Basin could see nearly as much oil extraction as Saudi Arabia does today.[i]

Coal: Existing Mines Have Too Much Already

While U.S. coal mining is already in decline, this decline is not being managed in a way that is fast enough for the climate or fair for workers.

- If U.S. coal production is phased out over a timeframe consistent with equitably meeting the Paris goals, **at least 70 percent of U.S. coal reserves in already-producing mines would stay in the ground.**[j]

- The focus of U.S. policy towards the coal industry should be on accelerating its phase-out by 2030 or sooner while ensuring a just transition for workers and mining communities.

h We compare the emissions associated with Permian oil and gas production from 2018 to 2050 to the carbon budget for a 50 percent (one-in-two) chance of limiting warming to 1.5°C (580 Gt CO_2), as estimated in the IPCC 1.5°C Special Report.

i Oil production figures include crude oil, natural gas liquids (NGLs), and condensate, with NGLs being a significant portion of Permian production.

j The 70 percent figure is consistent with a phase-out of U.S. mining by 2030. Analyses based on both economic efficiency and equity indicate that wealthier countries like the United States should phase out coal by 2030 to align with the Paris goals.

RECOMMENDATIONS

The extreme scale of U.S. oil and gas expansion is not an accident; neither is the slowing decline of coal production. They result from ongoing policy decisions to lease federal and state lands and waters for extraction, to approve permits for new wells, mines, pipelines, and other infrastructure, to excuse air and water pollution, and to maintain billions of dollars in subsidies.

A different path is possible – if U.S. policymakers muster the political will to pursue it. Every decision around a new fossil fuel lease, permit, subsidy, or setback is an opportunity for U.S. politicians to stop fossil fuel expansion and champion a just transition to an economy powered by clean energy. This transformation will be challenging, but it is manageable. It is also the only way towards an economically secure, livable future. While all mining, including oil and gas extraction, accounted for only 1.4 percent of U.S. gross domestic product (GDP) in 2017,[9] the latest National Climate Assessment warns that worsening climate disruption driven by fossil fuel pollution could destroy up to 10 percent of U.S. GDP by the end of this century from damaged infrastructure, lost work hours, pollution-induced deaths, and more.[10]

Now is the time to chart a U.S. fossil fuel phase-out that aligns with climate limits, takes care of workers and communities on its front lines, and builds a more healthy and just economy for all in the process.

Climate leadership in the United States must include a commitment to:

- **Ban new leases, licenses, or permits** that enable new fossil fuel exploration or production, or new infrastructure such as pipelines, export terminals, or refineries – and reject existing proposals in the meantime. This would include ending new leasing of federal or state lands and waters for fossil fuel extraction.

- **Plan for the phase-out of existing fossil fuel projects in a way that prioritizes environmental justice.** This entails winding down existing fossil fuel projects first and fastest in places where they disproportionately harm vulnerable communities and pose the greatest risks to human health.

- **End subsidies** and other public finance for the fossil fuel industry.

- **Champion a Green New Deal that ensures a rapid and just transition to 100 percent renewable energy,** guaranteeing a good-paying job for every worker impacted by the phase-out of fossil fuels and investing in communities entwined in the fossil fuel economy now.

- **Reject the influence of fossil fuel industry money.**

MOVEMENT IN THE RIGHT DIRECTION

U.S. officials who embrace this comprehensive approach will be standing with communities across the United States who are already leading the way, fighting massive new gas pipelines on the East Coast, the Keystone XL, Line 3, and Dakota Access pipelines in the Midwest, new offshore oil leases and gas export terminals on the Gulf Coast, and refinery expansions and coal terminals on the West Coast.

These leaders will build on supply-side climate policies initiated towards the end of the previous administration. While the Obama administration oversaw a marked uptick in oil and gas production, the administration took steps in 2016 to pause federal coal leasing and put large areas of Arctic waters off limits for drilling, recognizing that, "[I]t would take decades to fully develop the production infrastructure necessary for any large-scale oil and gas leasing production in the region – at a time when we need to continue to move decisively away from fossil fuels."[11]

They will also join a growing list of institutions and jurisdictions acting globally and locally to limit and wind down the fossil fuel industry. The World Bank announced in 2017 that it will cease financing oil and gas extraction.[12] New Zealand recently passed a ban on new offshore licenses,[13] joining France,[14] Costa Rica,[15] and Belize[16] in limiting new drilling. Portland, Oregon, has enacted a ban on all new fossil fuel infrastructure,[17] the states of New York[18] and Maryland[19] have banned fracking, and in California's most heavily drilled county, the Arvin City Council recently voted unanimously to place the first-ever limits on new oil wells, joining six other California counties in restricting oil development.[20]

One of the most powerful – and most underutilized – climate policy levers is also the simplest: stop digging for more fossil fuels.

Hundreds march in Minneapolis to protest Energy Transfer Partners' dangerous pipeline projects. Matt Maiorana, Oil Change International.

I. THE GLOBAL CARBON BUDGET AND WHY SUPPLY MATTERS

The Paris Agreement, now officially in force and ratified by more than 170 nations, sets the goal of striving to limit global temperature rise to 1.5 degrees Celsius (°C) above pre-industrial levels and keeping it well below 2°C.[22,23] In 2018, the Intergovernmental Panel on Climate Change (IPCC) released a powerful report showing the critical importance of the 1.5°C threshold.[24] Limiting warming to this level – the higher-ambition end of the Paris goals – would significantly reduce the risks of severe and widespread damage to human communities and ecosystems (see Box 1).

While the Trump administration has withdrawn its support for the Paris Agreement, the United States is still a party to the agreement. In defiance of President Trump's attempted pull-out, a significant number of U.S. governors, mayors, and other local officials, as well as members of Congress, have pledged their continued commitment to meeting the Paris goals.[25] The recent string of deadly weather disasters in the United States – fueled by the effects of reaching 1°C of global warming to date[26] – underscore the urgency of action.

In this report, we examine why U.S. elected officials and policymakers who have committed to lead on climate, and pledged to be "still in" on Paris, must act to stop the expansion of U.S. fossil fuel production.

In this section, we review the scientific, economic, and political imperatives for tackling fossil fuel supply. In the following sections, we bring this lens to the U.S. context, examining the current trajectory of U.S. fossil fuel production (Section II), hot zones for oil and gas expansion (Section III), the urgent need for U.S. leadership towards an equitable fossil fuel phase-out (Section IV), and how U.S. politicians can and must lead (Section V).

Box 1: The Growing Case for 1.5°C as an Absolute Limit

The Paris Agreement calls for, "Holding the increase in the global average temperature to well below 2°C above pre-industrial levels and pursuing efforts to limit the temperature increase to 1.5°C above pre-industrial levels, recognizing that this would significantly reduce the risks and impacts of climate change."[27] The 1.5°C target exists within the Paris Agreement because many of the world's most climate-vulnerable nations demanded it, asserting this level of ambition as essential to their survival.[28]

Throughout this report, we emphasize climate scenarios consistent with limiting warming to 1.5°C given the latest scientific evidence on how the risks of catastrophic climate change ratchet up significantly beyond this threshold. For example, the IPCC's 2018 special report finds that limiting global warming to 1.5°C, compared with 2°C, could:[29]

- "[R]educe the number of people both exposed to climate-related risks and susceptible to poverty by up to several hundred million by 2050;"
- Result in "up to 10 million fewer people" exposed to sea level rise and related risks, while "enabling greater opportunities for adaptation;"
- "[R]educe the proportion of the world population exposed to a climate change-induced increase in water stress by up to 50%;"
- Lessen the odds of "multiple and compound climate-related … risks across energy, food, and water sectors" that "could overlap spatially and temporally;" and
- Lower the risks of "species loss and extinction," "forest fires and the spread of invasive species," and the "irreversible loss of many marine and coastal ecosystems."

These findings suggest we can significantly lessen the loss of human lives, whole communities, and ecosystems if governments interpret the upper limit of the Paris Agreement – of keeping warming "well below" 2°C – to mean limiting it to 1.5°C.

ENOUGH ALREADY: THE SCIENCE BEHIND 'KEEP IT IN THE GROUND'

Climate science shows us that *cumulative* carbon dioxide (CO_2) emissions over time are the primary determinant of how much global warming will occur. Based on evolving study of this relationship, and factoring in the effects of other greenhouse gas emissions like methane (see Box 2), scientists are able to estimate the cumulative CO_2 emissions that relate to a given temperature limit. These cumulative totals – called a 'carbon budget' – indicate a set limit to how much fossil fuel can be extracted and burned to meet global climate goals.

Several studies have shown that the vast majority of known fossil fuel reserves must stay in the ground to keep global warming below 2°C.[30] In 2016, Oil Change International produced the first analysis comparing carbon budget limits to the subset of fossil fuel reserves in already-operating or under-construction fields and mines globally.[31] We focused on these 'developed reserves' because they represent the oil, gas, and coal that fossil fuel companies have already invested in extracting: the necessary wells have been (or are being) drilled, the pits dug, and the related infrastructure constructed.

Figure 1 updates our 2016 analysis to reflect more recent carbon budget estimates from the IPCC's 2018 report on 1.5°C of global warming.[k,32] The 2°C budget shown here reflects a two-in-three chance of limiting warming to that level, the highest-probability available from the IPCC. It should not be interpreted as a 'target.' Rather, 2°C represents an absolute limit to stay as far below as possible.

The results show that the oil, gas, and coal in existing fields and mines would push the world far beyond 1.5°C while exhausting a 2°C budget as well. These conclusions account for optimistic estimates of future land use and cement manufacture emissions, which are the largest sources of non-energy emissions and more difficult to reduce than energy-sector emissions.[34]

These findings indicate that there is no room for new fossil fuel development. Meeting the Paris goals will require that governments proactively manage the decline of fossil fuel production. In practice, this means:

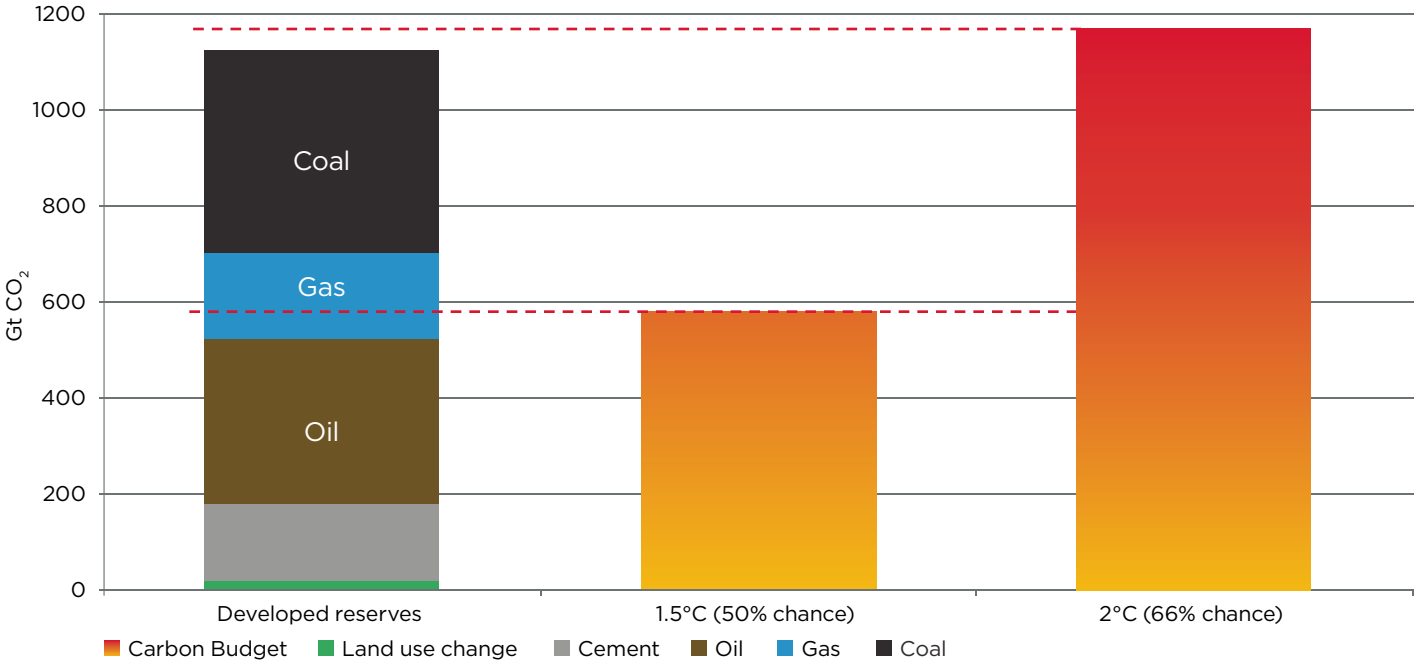
- **Governments should cease issuing licenses, leases, and permits for new fossil fuel projects** in order to stop pushing the developed reserves bar in Figure 1 even higher.

- Stopping new projects alone will not be enough to keep warming well below 2°C. **Governments must also phase out a significant number of existing projects** ahead of schedule.

Negative Emissions Are Not an Escape Hatch

A precautionary approach towards carbon capture and storage (CCS) and so-called 'negative emissions technologies' underpins these conclusions. In theory, the world could continue developing new fossil fuel reserves if paired with technologies to remove some or all of the associated carbon emissions from the atmosphere. The world could temporarily exceed carbon budgets and then use carbon dioxide removal technologies to suck excess carbon out of the atmosphere in later decades, in hopes that temperatures would eventually return to target levels. Oil companies frequently point to such scenarios to justify continued investment in fossil fuels.[35]

Figure 1: CO_2 Emissions from Developed Fossil Fuel Reserves, Compared to Carbon Budgets (as of Jan. 2018) within Range of the Paris Goals



Sources: Oil Change International analysis[33] based on data from Rystad Energy, International Energy Agency (IEA), World Energy Council, and IPCC

k The original *Sky's Limit* report used carbon budgets from the IPCC's 5th Assessment Report, which was the scientific basis for the Paris Agreement. Evolving carbon budget methodologies have since led to updated, somewhat larger estimates in the IPCC Special Report on 1.5°C (SR15). However, the authors caution that, "Uncertainties in the size of these estimated remaining carbon budgets are substantial and depend on several factors." For example, "Potential additional carbon release from future permafrost thawing and methane release from wetlands would reduce budgets by up to 100 Gt CO_2 over the course of this century and more thereafter" (IPCC, "Summary for Policymakers," p. 14). Given what the new IPCC report tells us about uncertainties in the budgets, a precautionary approach would entail aiming as low as possible below the thresholds shown in Figure 1.

However, CCS itself has yet to be proven commercially viable.[36] Reliance on negative emissions technologies, whether bioenergy with carbon capture and storage (BECCS) or the mass planting of forests, would come with significant social and ecological risks and governance challenges. Scientists Kevin Anderson and Glen Peters write in regard to bioenergy production and CCS that "both face major and perhaps insurmountable obstacles."[37]

BECCS exists to date primarily in theoretical models and may be infeasible to deploy at the scale that would be required to enable new fossil fuel development. One study estimated that it would require a CO_2 pipeline system about seven times the size of today's global fossil gas infrastructure to handle the removal of about 10 billion tons of CO_2 from the atmosphere per year using BECCS.[38] The IPCC special report notes that emissions pathways relying on both large-scale afforestation and BECCS could require "up to the magnitude of the current global cropland area" and "would pose significant food supply, environmental and governance challenges."[39] How such systems would be regulated to ensure they actually absorb more CO_2 than they create is a major uncertainty.[l]

Even if the world invests in a new industrial and/or forest-planting system of this scale, scientists are not certain that it will work out. The IPCC special report cautions that, "Carbon cycle and climate system understanding is still limited about the effectiveness of net negative emissions to reduce temperatures after they peak," and adds that, "reliance on such technology is a major risk in the ability to limit warming to 1.5°C."[40]

Betting on large-scale deployment of negative emissions technologies would be a gamble of the highest stakes.[41] If carbon budgets are exceeded, and these technologies do not work, then humanity's chance at stabilizing the climate would be gone. **Managing the decline of fossil fuels within carbon budget limits while scaling up clean alternatives offers the surest path to a livable climate.**

Box 2: Carbon Budgets, Methane, and Other Greenhouse Gases

While there are multiple greenhouse gases that affect the climate, carbon budgets apply only to the most abundant, carbon dioxide, because of the way it accumulates in the atmosphere over many decades. The budgets concept cannot be used in the same way to account for other greenhouse gases that persist in the atmosphere for shorter periods because their warming effect is different. However, when calculating the size of carbon budgets, scientists factor in emissions projections for other greenhouse gases. For this reason, we only count CO_2 when making carbon budget comparisons in this report.

However, if real-world emissions of other climate pollutants are higher than assumed in the carbon budgets, then the available carbon budget may be smaller. Methane, or CH_4, is the most abundant of these other short-lived pollutants and the most relevant to this analysis.

Methane is the main component of fossil gas. Its warming effect is 87 times greater than CO_2 over a 20-year period and 36 times greater over a 100-year period (see endnote 84). While there are non-fossil fuel sources of methane, methane is often vented into the atmosphere without combustion during the process of extracting oil, gas, and coal and operating pipelines. A peer reviewed study published in June 2018 in the journal *Science* finds that average methane leakage in the U.S. oil and gas sector is 2.3 percent of gas production. This is 60 percent higher than estimates from the U.S. Environmental Protection Agency (EPA), but could still be a low estimate.[42] Recent research from NASA suggests that 68 percent of the rise in atmospheric methane between 2006 and 2014 came from oil and gas production.[43]

With U.S. oil and gas production growing far faster, and to a far higher level, than was thought possible just a few years ago, the risk of methane emissions increasing beyond the level assumed in IPCC scenarios is significant.[m] Initiatives to reduce methane leakage in oil and gas production are helpful but may not lead to a reduction of methane emissions if production continues to expand. If reductions in methane are not achieved to the degree assumed in carbon budgets, CO_2 budgets for fossil fuel combustion may be lower than assumed.

WHY SUPPLY MATTERS: LOCK-IN, LEAKAGE, AND JUST TRANSITION

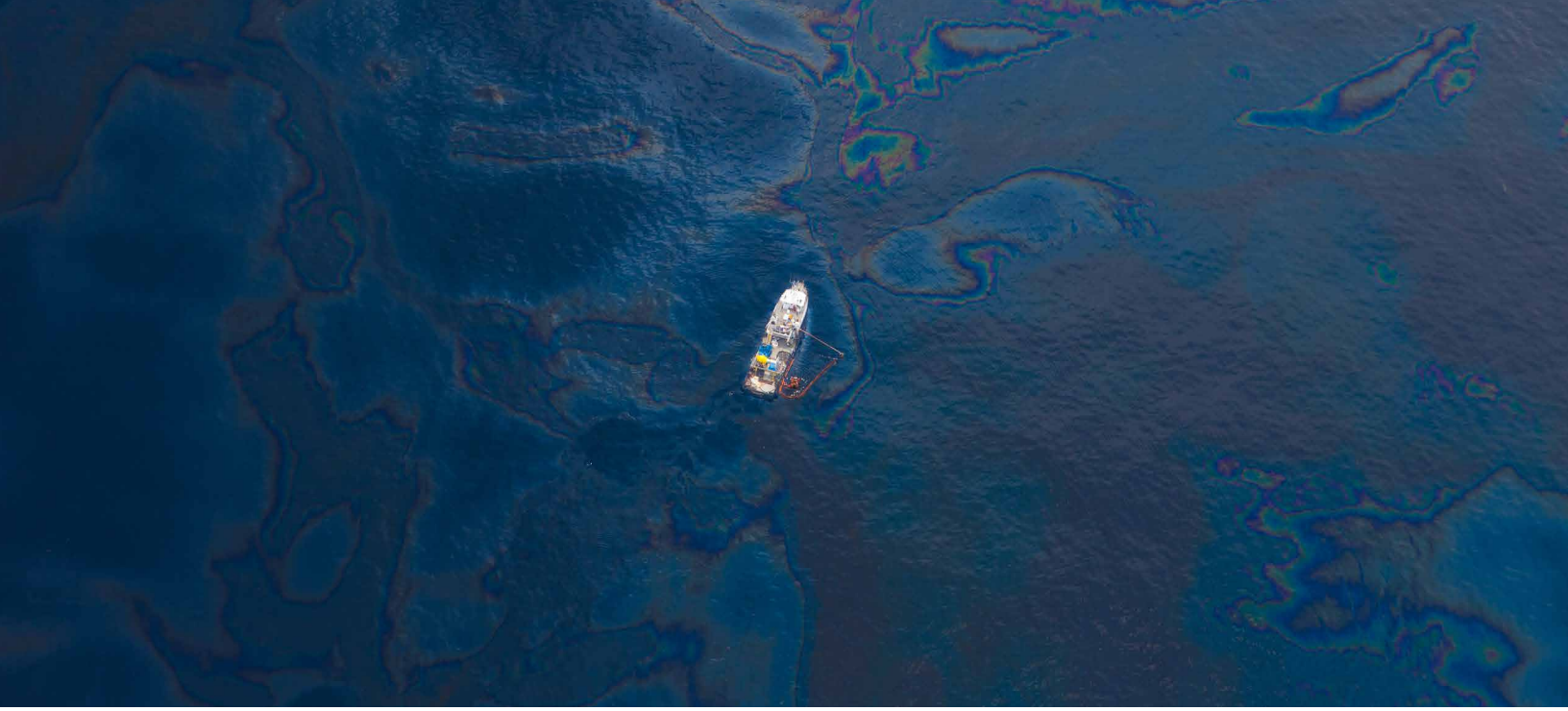
While science indicates a hard limit to how much fossil fuel can be extracted and burned, lessons from economics and politics reinforce that limiting fossil fuel supply is a key lever of climate action.

In other policy arenas, restrictions on the supply of harmful substances – such as tobacco and asbestos – have been widely employed as part of comprehensive strategies to reduce their damaging effects. Climate policy, however, has traditionally focused on measures to slow demand for fossil fuels while leaving their production to the vagaries of the market.[44] Where governments have intervened on the production side, it has most often been to subsidize rather than to constrain it.[n]

This is beginning to change. The World Bank announced in 2017 that it will phase out finance for oil and gas extraction, recognizing such finance as inconsistent with climate goals.[45] In 2016, the Obama administration initiated a moratorium on federal coal leasing, in part to reassess its climate implications.[46] A growing number of

l For example, bioenergy grown on the wrong soils, or replacing existing biomass, or using the wrong inputs (such as fertilizer and machinery) can emit more CO_2 than it absorbs, and CO_2 injected in the wrong geological structure may not be safe over the long term.

m The Summary for Policymakers of the IPCC SR15 states that, "Modelled pathways that limit global warming to 1.5°C with no or limited overshoot involve deep reductions in emissions of methane and black carbon (35% or more of both by 2050 relative to 2010)." IPCC, "Summary for Policymakers," In: *Global warming of 1.5°C*, p. 14.



A ship floats amongst a sea of spilled oil in the Gulf of Mexico after the BP Deepwater Horizon disaster. Kris Krüg. (CC BY-SA 2.0)

governments, including Costa Rica, France, New Zealand, Belize, and Denmark, have implemented full or partial bans on new oil and gas licensing.[47] Similar measures are currently under consideration in Spain and Ireland.[48]

For the reasons we outline below, this type of comprehensive approach will be necessary if the world is to close the dangerous gap between current action and what is required to meet the Paris goals. **Continued investment in fossil fuel extraction leads to higher emissions through the 'lock-in' of infrastructure, perverse political and legal incentives, and lower fossil fuel prices.** On the other hand, planning for the phase-out of fossil fuel assets strengthens demand-side action and makes it possible to plan for a just transition to clean energy that protects workers and communities currently entwined in the fossil fuel economy.

Prevent Further Infrastructure Lock-In

Investment in new fossil fuel extraction and infrastructure projects represents a commitment to future emissions due to the dynamics of carbon lock-in.[49] Once a company has sunk capital into a project – a pipeline, an offshore drilling rig, or a shale play – it has a financial commitment to that project for as long as it takes to turn a profit, which can be several decades for capital-intensive projects. The company will seek to recoup its investment, or at least limit its losses, as long as the prevailing market conditions cover marginal operating costs. The more capital-intensive the project, the deeper the lock-in effect.[50]

Once polluting infrastructure is built, it can crowd out cleaner alternatives even as they become cost-competitive or cheaper. For example, along the U.S. East Coast, the glut of gas supply driven by fracking in Appalachia has led energy companies to seek new customers for it. This has led to a massive buildout of new infrastructure, including pipelines, power plants, and export terminals. The power plants will be more expensive to operate than wind and solar farms,[51] yet utility customers are getting locked into long-term contracts to pay for this infrastructure by corporations taking advantage of a compliant regulatory environment.[52] In this way, supply can manufacture demand.

Governments also face higher legal hurdles to shut down polluting infrastructure after it is built, compared to rejecting its permitting in the first place. Such action may get tied up in lawsuits as fossil fuel companies seek to protect their investments, further delaying regulatory action to reduce pollution.[53]

Lessen the Grip of the Fossil Fuel Lobby

There is a political dimension to lock-in too. Governments tend to act more strongly to protect existing industries than to stimulate future ones due to their lobbying power as well as the valid fears tied up in disrupting existing jobs to build a new economy.

When politicians allow continued fossil fuel expansion, they reinforce the industry's incumbent power, which runs particularly deep in the United States. Over the past five decades, fossil fuel companies have pumped billions of dollars into federal and state lobbying and elections to sow doubt about climate science, block and weaken climate-related regulations, and distort markets in favor of fossil fuels (see Box 3). In return, oil, gas, and coal companies receive around $20 billion worth of federal and state subsidies each year.[54] When their investments face economic headwinds, the first response of the industry is often to lobby for more subsidies and bailouts.

By rejecting new infrastructure and extraction projects, politicians send a powerful signal that the fossil fuel era is ending, creating political space for stronger action to reduce demand and spur clean energy.

n For example, research led by the Stockholm Environment Institute has shown that up to half of new, yet-to-be developed U.S. oil production could be subsidy-dependent over the next several decades (see endnote 155).

Box 3: Fossil Fuel Influence Blocks Needed Action

Winding down the fossil fuel industry will require breaking the fossil fuel industry's pervasive hold over climate and energy policy and U.S. democracy.

In 1965 – more than 50 years ago – the head of the American Petroleum Institute (API) warned that, "[T]here is still time to save the world's peoples from the catastrophic consequence of pollution, but time is running out," adding that, "[Carbon] dioxide is being added to the Earth's atmosphere by the burning of coal, oil, and natural gas at such a rate that by the year 2000" the result could be "marked changes in climate beyond local or even national efforts."[55]

Wealthy fossil fuel companies like Exxon and Shell,[56] and lobby groups like API, went on to spend decades distorting and denying this science in order to block meaningful climate solutions and continue profiting from fossil fuel extraction. They continue to do so:

- From 2009 to 2010, the last period in which Congress debated major climate legislation, proposals included major concessions to fossil fuel companies – including gutting the EPA's authority to regulate climate pollution.[57] Fossil fuel interests, led by Exxon, ConocoPhillips, and Chevron, spent over half a billion dollars to weaken and defeat climate action.[58]
- The U.S. Congress and the Obama administration caved to oil and gas industry lobbying in 2015 when they lifted the four-decade-long ban on crude oil exports in exchange for temporary extensions of some renewable energy tax breaks. The lifting of the ban enabled the current drilling spree in Texas.[59]
- In the 2018 midterm elections, oil and gas companies spent huge sums to defeat state-level ballot measures. The industry spent $41 million to defeat a measure in Colorado that would have extended the setback zone between oil and gas wells and homes, schools, and other vulnerable areas to 2,500 feet.[60] Oil companies spent $8 million in a single California county, San Luis Obispo, to defeat a ban on fracking and new oil wells.[61] In Washington State, primarily out-of-state oil companies spent more than $31 million to defeat a carbon tax and just transition plan.[62]

A growing group of U.S. politicians is rejecting fossil fuel industry influence, recognizing it to be politically toxic. More than 1,300 federal, state, and local candidates and elected officials pledged to refuse all contributions from oil, gas, and coal companies during the 2018 election cycle.[63] If adequate climate solutions are to take hold, the ranks of U.S. politicians actively opposing and resisting fossil fuel influence must continue to grow.

Make Climate Policy Less 'Leaky'

In a global market, supply and demand interact to affect fossil fuel prices and, ultimately, consumption levels. Reducing fossil fuel supply or demand in one place will make fossil fuels more lucrative to produce or cheaper to use elsewhere, respectively. This effect is called carbon 'leakage,' and every climate policy comes with some degree of it.[64] For every barrel of oil either left in the ground or kept out of a car tank, global emissions go down, but the net benefit is not one-to-one. For example, a recent study by the Stockholm Environment Institute found that global oil consumption would drop by 0.2 to 0.6 barrels for each barrel of oil that California keeps in the ground.[65] Reducing demand and supply simultaneously – for example, by pairing fuel efficiency standards with cuts in oil production – makes climate policy less 'leaky' and ultimately more effective by balancing out undesired price effects. In other words, 'cutting with both arms of the scissors' maximizes emissions reductions.[66]

Make Way for a Just Transition

By allowing continued expansion of the fossil fuel economy, governments not only enable new pollution, they also entangle more workers and communities in an industry that has no viable future on a livable planet. The first step in taking care of workers and communities that will be affected by the phase-out of the fossil fuel industry is to acknowledge that this transition must occur. Only then can governments begin to plan for it.

At its core, a just transition means ensuring that nobody is left behind in the shift from fossil fuels to a clean energy economy. The International Trade Union Confederation (ITUC), which fought for inclusion of just transition in the preamble to the Paris Agreement, defines a just transition as "an economy-wide process that produces the plans, policies and investments that lead to a future where all jobs are green and decent, emissions are at net zero, poverty is eradicated, and communities are thriving and resilient."[67] As we discuss in Section IV, this process must include active government support and social protection, including wage insurance, health benefits, and guaranteed pensions, for workers who lose their jobs when an oilfield or coal mine ceases operation. It must also include deep investment in new economic opportunities for affected communities. In a political context, investing in just transition policies helps to reduce fear and resistance to the significant and rapid economic shifts that will be required to stay within agreed climate limits.

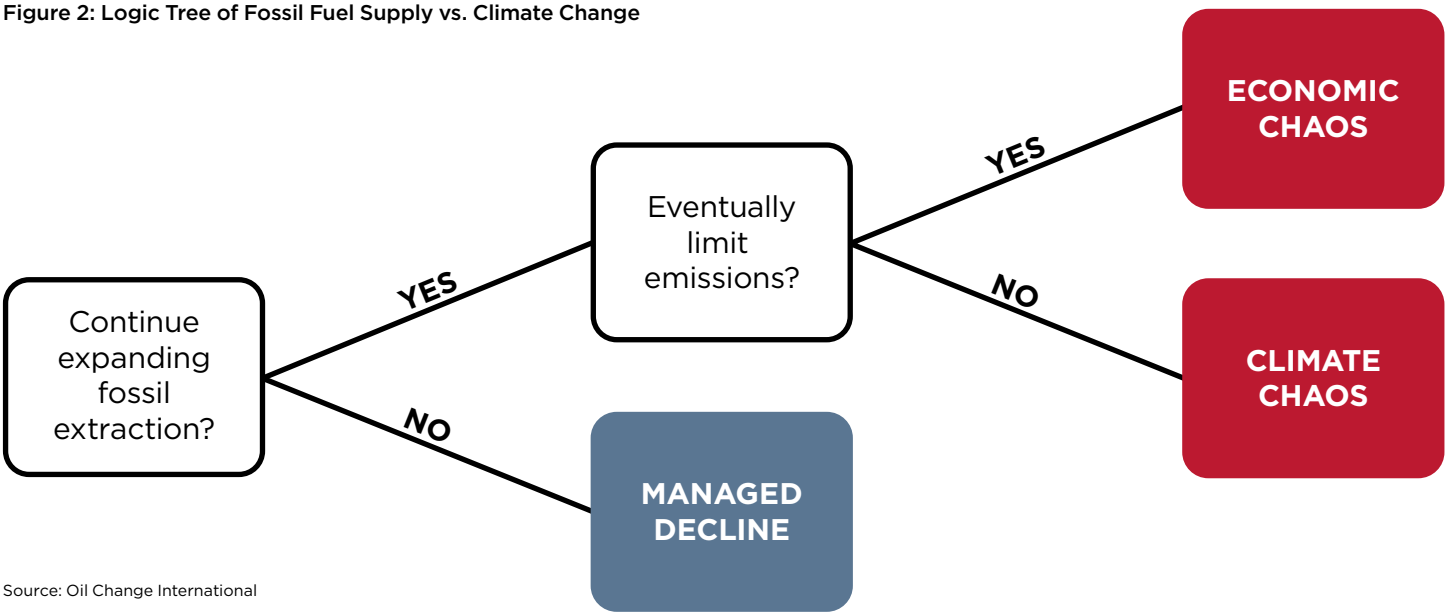
MANAGED DECLINE OR ECONOMIC AND CLIMATE CHAOS

In summary, our analysis points to three possible futures when it comes to the climate crisis, as visualized in Figure 2:

1. **Managed Decline:** We succeed in restricting new fossil fuel projects and carefully manage the decline of the fossil industry over time, while planning for a just transition for workers and communities.
2. **Economic Chaos:** We allow further fossil fuel development to continue, but eventually manage to limit emissions within carbon budgets. This would lead to a sudden and chaotic shutdown of fossil fuel production, stranding assets, damaging economies, and harming workers and communities reliant on the energy sector.
3. **Climate Chaos:** We fail to restrict emissions. New long-lived fossil fuel infrastructure locks us into a high-carbon future, causing compounding, irreparable harm for people and ecosystems around the world.

Clearly, a managed decline is the safest and most socially just path. By stopping new fossil fuel development and managing a just transition towards an economy powered by clean energy, we can achieve the brightest future. As we detail in the following section, global success in meeting the Paris climate goals could hinge on the speed at which political leaders in the United States embrace this imperative.

Figure 2: Logic Tree of Fossil Fuel Supply vs. Climate Change



Source: Oil Change International

Emergency crews respond to fires in California. Bureau of Land Management.

II. U.S. FOSSIL FUEL EXPANSION VS. THE PARIS GOALS

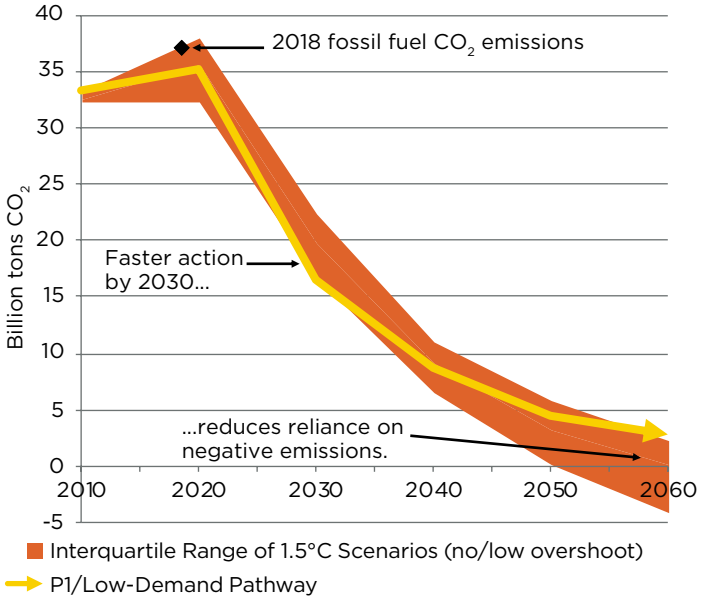
As we saw in the previous section, meeting global climate goals will require putting an end to new fossil fuel development and winding down the industry within climate limits. In this section, we examine how the current trajectory of fossil fuel production in the United States is out of step with this necessity. The United States is enabling the expansion of oil and gas production at a scale far more extreme than in any other country.

For context, it is instructive to first consider the pace of energy system transformation that aligns with the Paris goals. The IPCC special report on 1.5°C of warming indicates that global CO_2 emissions should fall by 45 percent by 2030, compared to 2010 levels, and reach net-zero around 2050 to keep warming to that threshold, based on analysis of dozens of model scenarios (Figure 3a).[68]

Hitting these benchmarks will require swift declines in fossil fuels – the primary source of emissions. As discussed in Section I, one of the biggest uncertainties in many climate scenarios is whether CCS and/or novel negative emissions technologies will be available later in the century and if so at what scale. Greater reliance on these technologies would enable a somewhat less rapid decline of fossil fuels, but at a large and irreversible cost if the technologies do not work out. The IPCC special report features four 'illustrative pathways' consistent with limiting warming to 1.5°C to represent different societal options. A key distinction between these pathways is their degree of reliance on novel negative emissions technologies: ranging from zero BECCS in the P1 pathway to a very large amount in the P4 pathway.

Figure 3: Fossil Fuel CO_2 and Energy Pathways for Limiting Warming to 1.5°C

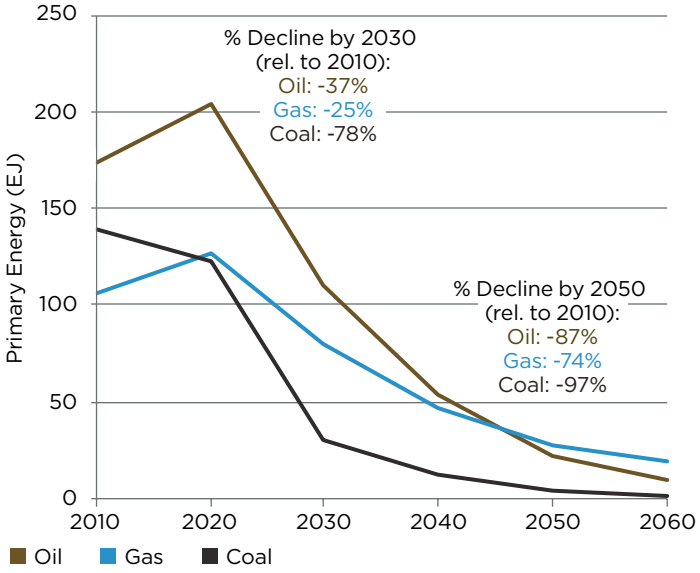
*(a) CO_2 from Energy and Industrial Processes in IPCC Pathways Consistent with Limiting Warming to 1.5°C**



**The orange area shows the 25th to 75th percentile of 53 available scenarios that keep warming to 1.5°C within this century with little to no overshoot of that threshold.*

Source: IPCC/IAMC 1.5°C Scenario Explorer and Data hosted by IIASA,[70] Global Carbon Project[71]

*(b) Decline of Oil, Gas, and Coal in the IPCC P1 Illustrative Pathway (no CCS)**



**While not relying on CCS with fossil fuels or BECCS, the P1/low-demand pathway does rely on sequestration of 246 $GtCO_2$ via planting forests. Without reliance on such large-scale afforestation, the fossil fuel declines shown here would need to occur faster.[73]*

Source: IPCC/IAMC 1.5°C Scenario Explorer and Data hosted by IIASA[72]

For the precautionary reasons outlined in Section I, we focus on the P1 pathway when making comparisons to the trajectory of U.S. fossil fuel production in the analysis that follows. In this pathway without CCS or BECCS, oil, gas, and coal peak by 2020, decline significantly by 2030, and are nearly phased out of the energy system by mid-century (Figure 3b).[69] It is important to note that, for the equity considerations further explored in Section IV, U.S. fossil fuel production and use should decline faster than these global averages.

MOVING RAPIDLY IN THE WRONG DIRECTION

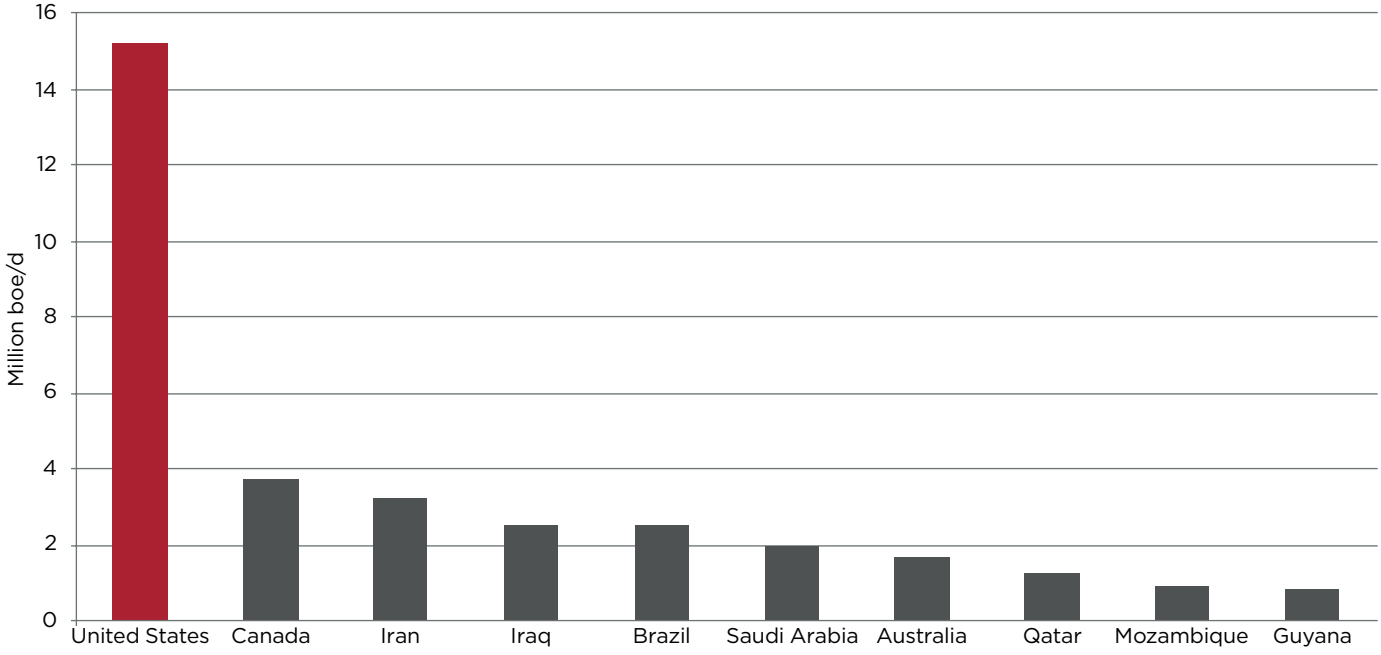
Driven by the proliferation of fracking, enabled by a massive buildout of pipeline and export infrastructure, and propped up by federal and state subsidies, oil and gas production in the United States has expanded at unprecedented rates in recent years. Production grew by 85 percent between 2010 and 2018 (in terms of barrels of oil equivalent, or BOE), making the United States the largest oil and gas producer in the world.[74] The International Energy Agency calls this growth, primarily in shale, "the largest parallel increase in oil and gas output in history."[75]

Oil pumps operate on federal land in California. John Ciccarelli, Bureau of Land Management.

Under current policies, this rapid expansion is projected to continue. Data from Rystad Energy, an independent oil and gas consultancy, indicate that U.S. oil production is on track to double by 12 million barrels per day (bp/d) between 2017 and 2030, peaking at more than 25 million bp/d. Between 2017 and 2025, U.S. gas production is on track to increase by 40 billion cubic feet per day (cf/d), peaking at close to 100 billion cf/d.[76]

Figure 4 shows that the oil and gas industry is planning to expand production more in the United States than in any other country over the coming decade. U.S. growth outpaces that of the next-closest country, Canada, by a factor of more than four. If these plans are realized, U.S. oil and gas production would be responsible for nearly 60 percent of world growth in oil and gas supply between 2017 and 2030.

Figure 4: Top Countries by Increase in Oil and Gas Production to 2030 (over 2017 baseline)



Source: Rystad Energy (November 2018)

Box 4: Methodology & Key Terms

This report relies on data from Rystad Energy for projections of future oil and gas production, both in the United States and globally. Rystad's UCube database provides production and reserves estimates for all upstream oil and gas projects in the world, both historical and through 2100. Rystad uses company reports, regulatory information, and modeling to project the volumes of oil and gas that will be commercially viable to extract over a given time period, for a given price assumption. Oil volumes include all liquids: crude oil, natural gas liquids (NGLs), and condensate. Projections in this report relate to Rystad's base case for future oil prices.

We cut off our production analysis at 2050 in this report to afford a higher degree of confidence in the projections, compared to a 2100 timeline. A 2050 cutoff also mirrors the deadline by which fossil fuel production and consumption should be approaching zero to align with climate limits. Therefore, the data analyzed in this report do not reflect the climate impact of all producible reserves in the United States. The specific basins discussed in Section III contain more reserves of oil and gas than are reflected in this report, given we consider only those reserves that would be commercially viable through 2050.

We classify oil, gas, and coal resources according to the following categories to reflect their current stage of development. We separate production projections in this way to illustrate the carbon that would be unlocked by development of new reserves, compared to the declines that would result from ceasing new development:

- **Developed:** Reserves viable to extract from projects that are already producing or under construction.[o]
- **Undeveloped:** Oil, gas, and coal that could be produced from planned or potential projects if development or exploration proceeds, including projections of likely new discoveries.

In this report's figures, we further break **undeveloped** oil and gas into sub-categories to reflect their proximity to development as well as the differing characteristics of shale oil and gas compared to conventional oil and gas.

Through 2050, the vast majority of commercially viable but not yet developed U.S. oil and gas resources are shale resources. Most of this **undeveloped shale oil and gas** is already discovered and quantified, but companies split the reserves into 'core' versus 'non-core' tiers based on their expected productivity and economics. Core reserves will likely be drilled first whereas non-core will likely be drilled later.

For **undeveloped conventional oil and gas**, reserves are traditionally divided into categories of 'discovered' versus 'undiscovered.' Discovered reserves are the estimated producible reserves in leases that companies have already explored and assessed, but for which no final investment decision has been made. The undiscovered category includes estimates of producible oil and gas in designated blocks that are yet to be leased. Through 2050, Rystad projects that this new exploration would primarily occur in the Gulf of Mexico and the North Slope of Alaska, where conventional oil and gas development has been ongoing for decades and the geology and economics of currently unsold leases are relatively well known.

In this report, we combine 'core' shale resources and 'discovered' conventional reserves into one category, while combining 'non-core' shale resources and 'undiscovered' conventional resources into another:

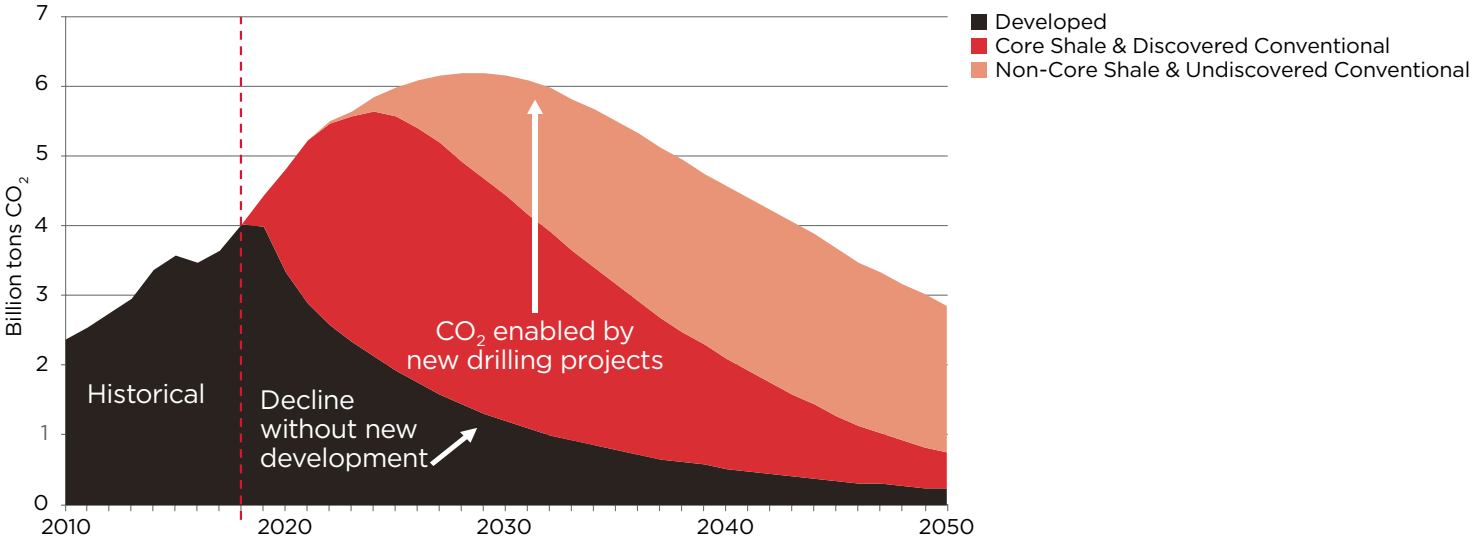
- **Core Shale & Discovered Conventional:** Reserves that are already discovered and evaluated, and already leased to a company in most cases, but for which no final development decision has yet been made. For shale oil and gas, this means reserves associated with wells that have yet to be drilled.[p] Core shale reserves are those considered closest to being drilled and expected to be most productive using current technology and current oil price expectations.
- **Non-Core Shale & Undiscovered Conventional:** This includes shale acreage that companies have under evaluation but that is not considered top-tier for productivity. This acreage may be more difficult or expensive to exploit. The production projections are therefore more speculative compared to core acreage. For conventional oil and gas, this includes resources for which field exploration has not yet been performed and estimates of the ultimate quantity of recoverable oil or gas are more speculative.

Calculating Emissions: Throughout this analysis, we count the carbon emissions that would be caused by combusting fossil fuels produced in the United States. To calculate CO_2 emissions from combustion, we use IPCC emissions factors for oil, gas, and coal respectively.[77]

Emissions of other greenhouse gases and non-combustion emissions add to the total climate impact of U.S. fossil fuel production. Boxes 2 and 5 discuss and partially quantify the additional impact of methane. Additional emissions occur in the process of extracting, transporting, and refining fuels. However, given a proportion of fuels extracted in the United States is burned in the production and processing of other fuels, combustion emission totals do capture a significant proportion of these additional CO_2 emissions. We do not calculate total, or lifecycle, emissions due to the complexity of doing so across different U.S. crude sources and the risk of double-counting emissions.[q]

o For shale this means reserves in currently producing wells or wells that have been drilled but not yet completed.
p Drilled Uncompleted wells (DUCs) are counted as developed.
q For example, a given cubic foot of gas could be extracted in one place, with the associated combustion emissions counted. But if that same cubic foot of gas is burned to power an oil pump, its emissions would also be counted as part of the lifecycle emissions of producing a given barrel of oil. This amounts to double-counting.

Figure 5: Projected Annual CO_2 Emissions of U.S.-Produced Oil and Gas, 2010-2050, by Current Stage of Development



Source: Oil Change International calculation using data from Rystad UCube (October 2018) and IPCC[78]

DRILLING THE WORLD INTO A DEEPER HOLE

Figure 5 shows the annual CO_2 emissions that would be enabled by U.S. oil and gas production through 2050 if the industry's expansion is allowed to proceed – or if it stops (see Box 4 for detailed methodology). These emissions reflect the carbon pollution that would result globally from burning oil and gas produced in the United States. The black band represents the trajectory of emissions associated with U.S. oil and gas if production is limited to already-developed projects. The red and pink bands represent the emissions that would result if the industry continues drilling into new reserves.

If new development ceases, U.S. production will begin to fall based on the natural decline rate of existing wells. The decline would be significant – nine percent annually on average between 2020 and 2050 – but it would also be a managed decline that policymakers could plan for. As discussed in Section IV, such planning can and should ensure a just transition that offers good-paying jobs to former fossil fuel workers.

However, with expansion into new oil and gas reserves, the emissions enabled by U.S. oil and gas production would *increase* by nearly 70 percent by 2030, compared to 2017 levels. Between now and 2050 – the timespan in which CO_2 emissions should be zeroing out globally – the United States would be the largest single source of new oil and gas supply in the world.

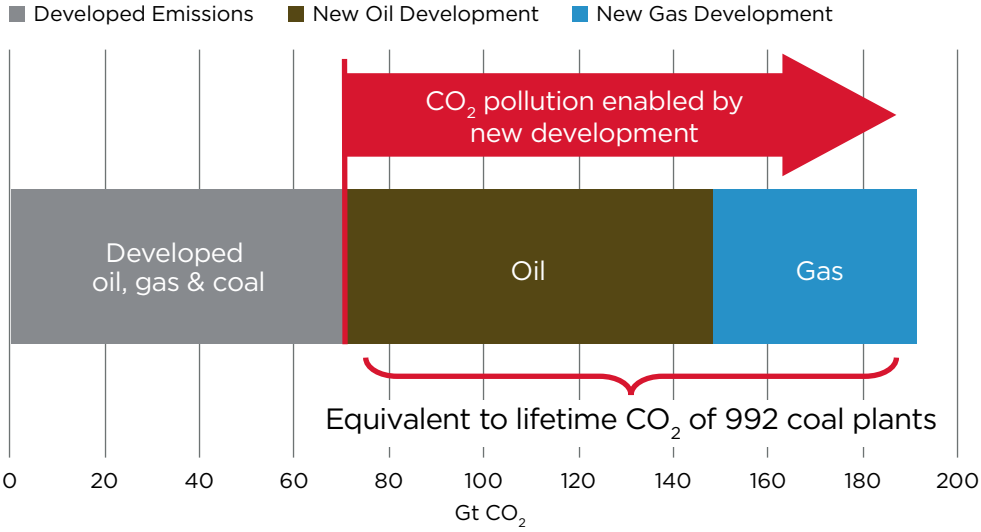
Figure 6 shows the cumulative carbon pollution that this new development would unlock through 2050. All of the emissions to the right of the red line would add to the world's stock of developed fossil fuel emissions, which already exceed safe carbon budget limits (as shown in Figure 1).

Oil expansion would enable close to 80 billion tons of carbon pollution. Gas expansion would enable more than 40 billion tons. To provide a sense of scale, the total CO_2 emissions enabled by this drilling expansion between 2018 and 2050 – 120 billion tons in total – would be equivalent to the lifetime CO_2 pollution of nearly 1,000 average U.S. coal plants.[81]

Nearly all of this expanded drilling would depend on fracking. More than 90 percent of the production from new development represented in Figure 5 would come from unconventional shale oil and gas, primarily in the Permian and Appalachian Basins, as we discuss in Section III.

Contrary to industry claims, which continue to lift up fossil gas as a "bridge fuel," expanding production and use of fossil gas is not a climate solution. While it is true that gas combustion releases less carbon pollution than coal combustion, replacing coal with gas will not produce the scale of emissions reductions needed to align with global climate goals and hinders the urgently needed transition to zero-carbon energy. Moreover, the additional methane released during fossil gas production worsens the cumulative climate pollution impact of oil and gas expansion presented in Figure 6. We discuss these issues in Box 5.

Figure 6: CO_2 Emissions Unlocked by New U.S. Oil and Gas Development, 2018-2050



Source: Oil Change International calculation using data from Rystad Energy (October 2018), EIA,[79] EPA,[80] and IPCC

Construction of the Dakota Access Pipeline near New Salem, North Dakota. Tony Webster. (CC BY-NC-SA 2.0)

Box 5: Climate Limits Require Less Gas, Not More

Methane leakage is the most widely discussed issue in the debate over the role of fossil gas in the energy transition. As discussed in Box 2, leaking methane associated with increasing oil and gas production is responsible for the majority of recent increases in the amount of methane in our atmosphere and is accelerating climate change.[82]

Methane emissions could add 10 to 24 percent to the cumulative CO_2-equivalent emissions enabled by U.S. oil and gas production from 2018 to 2050, increasing the total in Figure 6 by 16 to 39 billion metric tons of CO_2 equivalent (CO_2e). This estimate is based on an average methane leakage rate of 2.3 percent of U.S. gas production, as taken from the most recent peer reviewed study in *Science*.[83] The range of 10 to 24 percent depends on the assumption for converting methane to CO_2e.[84]

But even if methane leakage could be reduced to zero, which is virtually impossible, greater reliance on fossil gas is incompatible with climate safety. The limits of our climate system mean that we need to reduce all fossil fuel production and use, and gas is no exception. Analysis by Bloomberg New Energy Finance has found that a complete phase-out of coal by 2035 using today's combination of gas and renewables would not be sufficient to get power sector emissions onto a 2-degree trajectory.[85] We can and must make the clean energy transition with less gas not more.

Here are five key reasons why, with or without methane leakage, gas is not a transition fuel. This summary is adapted from the Oil Change International briefing *Burning the Gas 'Bridge Fuel' Myth*, which includes further analysis and references:[86]

1. **Breaking the Budget:** The coal, oil, and gas in the world's currently producing and under-construction projects, if fully extracted and burned, would take the world far beyond safe climate limits. Further development of untapped gas reserves is inconsistent with the Paris climate goals.

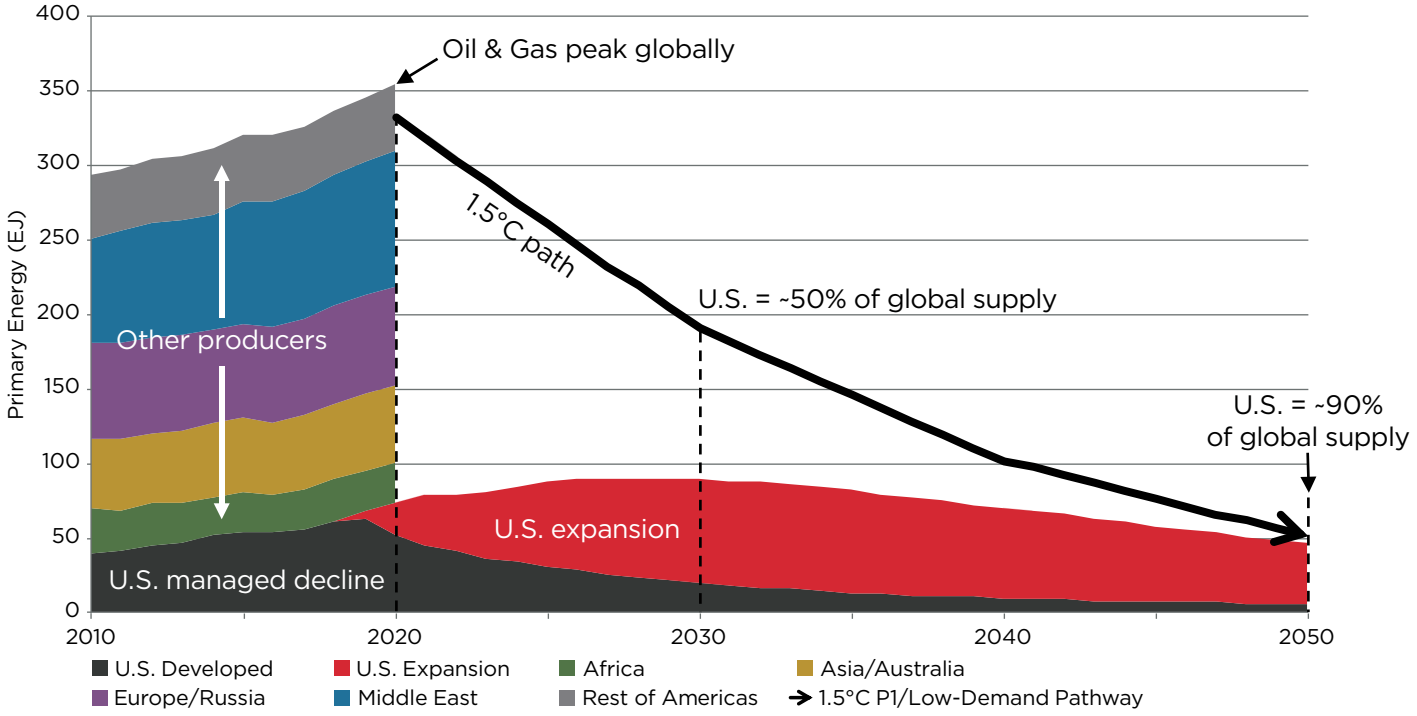
2. **Coal-to-Gas Switching Is Ineffective:** Climate goals require that the power sector be decarbonized by mid-century. This means that both coal and gas must be phased out from the power sector. Even as other sectors may continue some reliance on gas, overall gas use must be reduced.

3. **Gas and Renewables Compete:** Wind and solar are now cheaper than coal and gas in many regions. This means new gas capacity competes with new wind and solar rather than old coal.

4. **Gas Is Not Needed in the Clean Energy Transition:** Claims that more gas capacity is required for renewable energy development are exaggerated. Most grids are far from renewable energy penetration levels that would require back-up. Developing the flexible generation capacity to support high levels of renewable generation is more about power market design than adding or maintaining fossil fuel capacity.

5. **New Infrastructure Locks in Emissions:** Multibillion-dollar gas infrastructure built today is designed to operate for decades to come. Given the barriers to closing down infrastructure ahead of its expected economic lifespan, it is critical to stop building new infrastructure, the full lifetime emissions of which will not fit within Paris-aligned carbon budgets.

Figure 7: Global Oil and Gas Use in a 1.5°C Low-Demand Pathway, Compared to Projected U.S. Oil and Gas Production, 2010 to 2050



Sources: Oil Change International analysis based on data from Rystad Energy (November 2018) and IPCC/IAMC 1.5°C Scenario Explorer and Data hosted by IIASA[87]

IMPEDING A GLOBAL MANAGED DECLINE

In Figure 7, we compare the potential wind-up of U.S. oil and gas extraction to the steady global wind-down of oil and gas modeled in the 1.5°C-aligned IPCC pathway introduced in Figure 3b. Under this pathway, U.S. oil and gas production is set to take up an increasingly disproportionate share of the total global allowance for oil and gas. By 2030, U.S. production would consume nearly half of the global oil and gas budget. By 2050, U.S. supply would exhaust nearly 90 percent of the global budget.

Managing the decline of oil and gas within climate limits will require action from all of the world's major producers. However, in the scenario above, other countries could find it nearly impossible to wind down their production quickly enough to compensate for the growth in U.S. production. The United States would be pushing the burden of phasing out oil and gas onto other countries, forcing them into a potentially impossible choice: shut down their production at a pace that could cause domestic economic or social chaos, or allow the United States to push the world over the brink of climate chaos. If other countries are not able or willing to compensate for U.S. 'energy dominance,' U.S. communities would pay the price in terms of climate devastation and economic chaos.

As we discuss in Section IV, the scenario in Figure 7 would be deeply inequitable and, as such, increase the odds of global failure in meeting the Paris goals. In an equitable wind-down of the fossil fuel industry, wealthy producers such as the United States would be leading in phasing out fossil fuel production and consumption, not leading in expanding them.

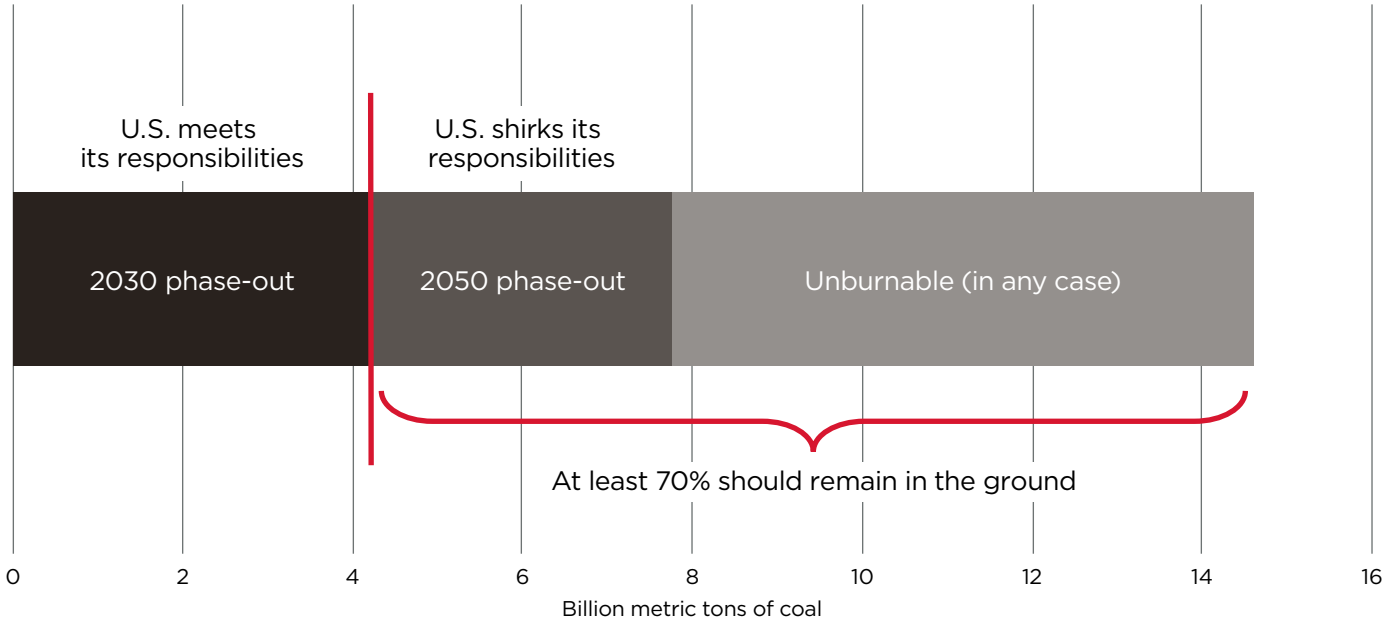
TOWARDS A FASTER U.S. COAL PHASE-OUT

In this section, we have focused first on U.S. oil and gas production because of the dramatic pace at which it is moving in the wrong direction. But U.S. policies towards coal production also bear great significance for the climate: The United States is still the world's third-largest coal producer, behind China and India.[88] The rates of global oil and gas decline represented in Figure 7 depend on an even faster global phase-out of coal.

In the United States, coal production and use are already in decline. Production peaked in 2008 and has fallen by one-third over the past decade, driven by declining power demand and competition from gas and renewable energy. It is now cheaper on average for U.S. utilities to build new wind and solar projects than to operate *existing* coal plants.[89] While most coal mined in the U.S. is burned domestically for electricity, U.S. coal exports have increased year-to-year since 2016. However, a significant ramp-up of exports would require building more export infrastructure, which communities on the U.S. West Coast have successfully resisted over the past decade.[90]

Due to these dynamics, the decline of the U.S. coal sector is likely to continue, regardless of the Trump administration's attempts to reverse it. However, leadership is needed to ensure this decline is fast enough and fair – meaning it aligns with climate goals and provides a just transition for mining communities.

Figure 8: U.S. Developed Coal Reserves, Compared to Cumulative U.S. Production under 2030 and 2050 Coal Phase-out Scenarios



Sources: Oil Change International analysis[r] based on data from EIA[96] and IPCC[97]

Existing Mines Have Too Much Already

Major new mines are no longer being developed in the United States. But mining companies continue to seek new or expanded leases on federal and state lands, as well as new permits, in order to expand or maintain the production of existing mines.[91] Around 40 percent of all U.S. coal production comes from federally leased land, compared to roughly 20 percent of U.S. oil and gas production.[92]

If federal and state policies towards coal mining were aligned with climate goals, new leases and permits would no longer be issued. Figure 8 shows that existing U.S. mines already contain far more coal than the United States can extract under a coal phase-out timeline aligned with the Paris goals.

According to the U.S. Energy Information Administration, currently producing U.S. coal mines contained nearly 15 billion metric tons of recoverable coal at the start of 2018.[93] If the United States were to phase out coal mining by 2050, in line with the global rate of coal decline from the IPCC P1 pathway (Figure 3b), then only half of those developed reserves would be minable.

However, analyses based on both economic efficiency and equity show that wealthier countries like the United States should phase out coal much faster than the global average to meet their responsibilities under the Paris goals.[94] The Powering Past Coal Alliance, which includes 28 national governments, is calling for countries within the Organization for Economic Cooperation and Development and European Union to phase out coal in their power sectors by 2030 at the latest.[95] If U.S. coal mining is to be phased out by 2030, declining on a straight line from 2017 production levels, more than 70 percent of coal reserves in existing mines would remain in the ground.

Ceasing New Leasing Is a Logical Next Step

At the federal level, the Obama administration took a step in the right direction in 2016 by putting a moratorium on new coal leases on federal lands and ordering a comprehensive review of the impacts of the federal coal program, including climate impacts. The Trump administration revoked the moratorium and ditched the associated policy review a year later.[98,99] However, across several recent court rulings, federal judges have ordered the Department of Interior to more thoroughly assess the climate pollution impact of its leasing policies.[100] For example, in 2017, the U.S. Court of Appeals for the 10th Circuit found that the Bureau of Land Management was "irrational" in finding that four massive new coal leases in the Powder River Basin, which unlocked 2 billion tons of new coal reserves, would have no effect on the climate. The court chastised the agency's review for ignoring "basic supply and demand principles."[101] The court agreed with environmental plaintiffs that keeping large amounts of coal in the ground would have an effect in reducing coal consumption, and that the climate benefits of not leasing the coal should have been factored into the agency's decision.

Federal and state permitting officials should heed recent court rulings and the clear science and immediately cease new leases and permits that expand existing mining operations. If U.S. policy towards coal mining were aligned with climate safety, it would focus on phasing out mining by 2030 or sooner. Managing such a rapid transition will not be easy, particularly for the workers and communities on its front lines, but it is necessary. By ignoring or denying this need, and pursuing policies to slow the decline of mining, policymakers squander time and resources that could be used to plan for an equitable and orderly transition.

r We apply different decline assumptions to model a 2030 versus 2050 phase-out. For 2030, we assume a straight-line decline from 2017 production levels to zero. For 2050, we apply the global rates of coal decline given in the IPCC's P1/low-demand model pathway. As shown in Figure 3b, this pathway also assumes a fast decline to 2030, such that 78 percent of global coal use is phased out relative to 2010 levels. Due to their cost-optimizing logic, the vast majority of model scenarios for keeping temperature rise within range of 1.5°C include a rapid coal decline between now and 2030. This is why the additional quantity of reserves mined under the 2050 scenario is less than double the 2030 estimate despite the phase-out taking more than twice as long.

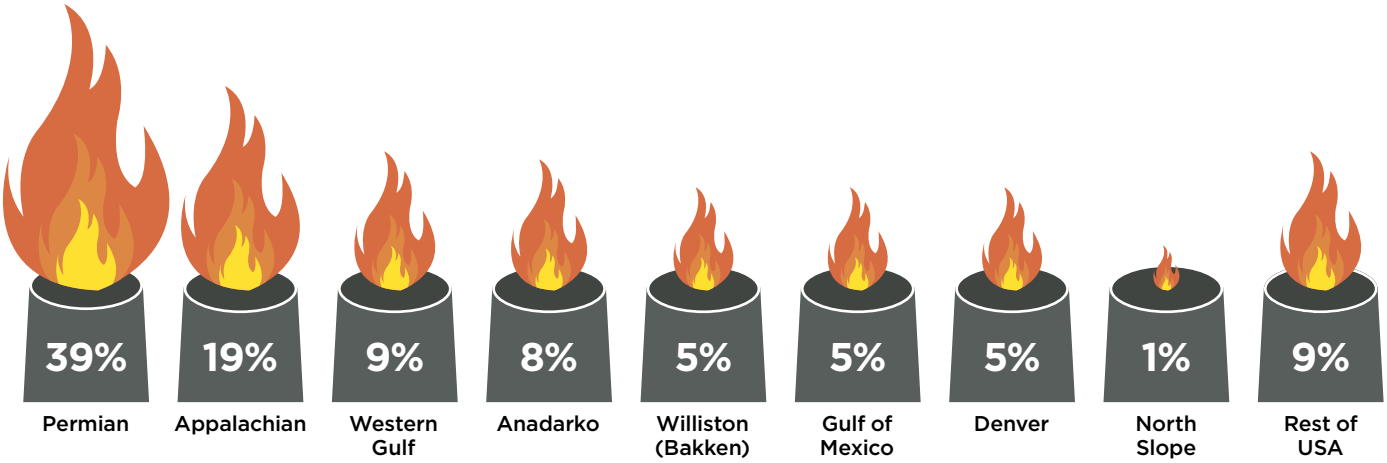
A haul truck transports coal at the North Antelope Rochelle opencut coal mine in Campbell County, Wyoming. Peabody Energy. (CC BY 3.0)

III. MAPPING U.S. OIL AND GAS EXPANSION THREATS

In this section, we look at major basins that could be the most significant sites for oil and gas industry expansion in the United States. The Permian and Appalachian basins hold the largest projected volumes of undeveloped oil and gas resources. Further development in these two basins could cause nearly 60 percent of CO_2 emissions enabled by U.S. oil and gas expansion from 2018 through 2050 (Figure 9). We briefly describe these basins and estimate the climate threat posed by their further exploitation, based on the methodology described in Box 4.

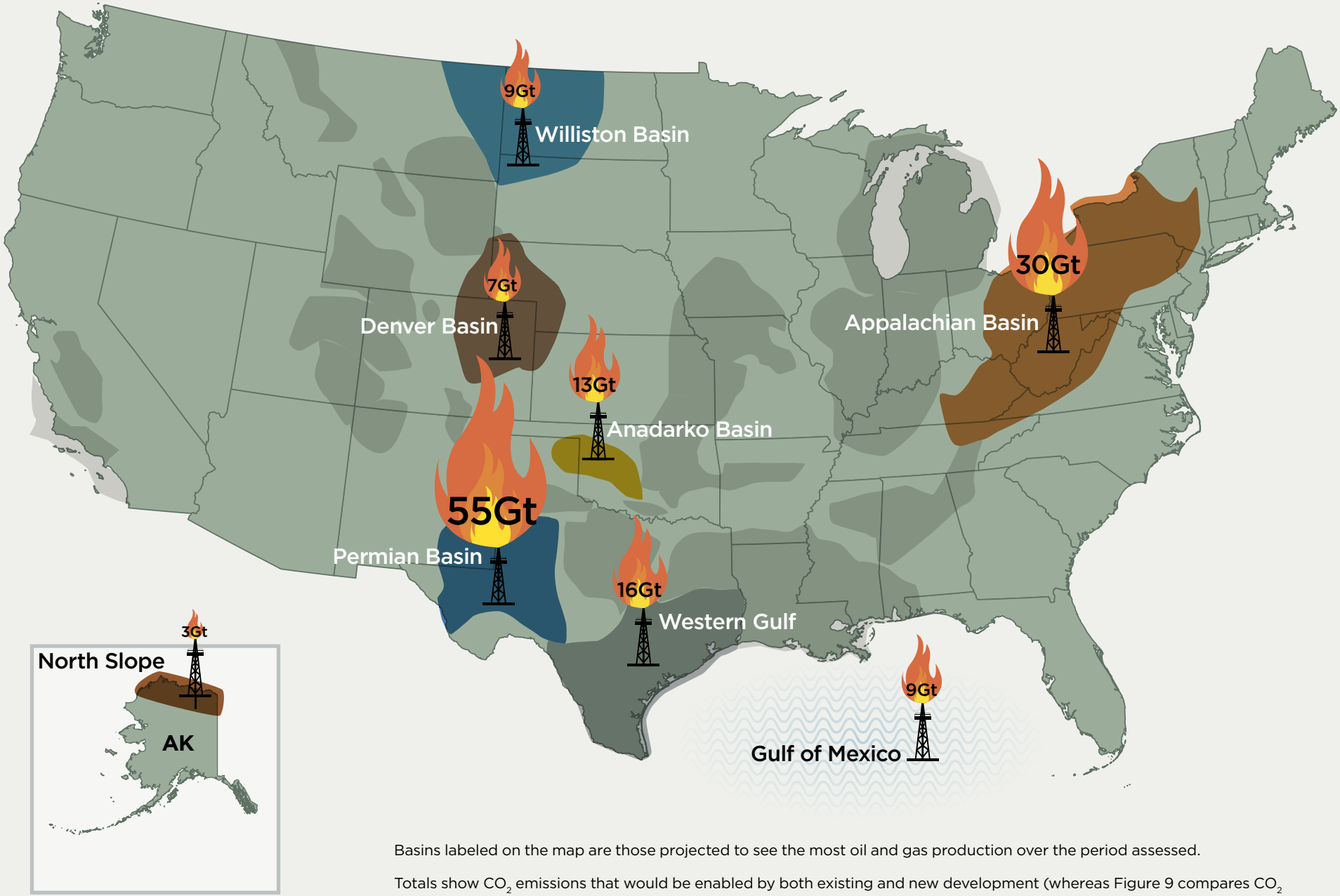
Staging area in Ohio for construction of the Rover gas pipeline. Ted Auch. May 3, 2017. Provided by FracTracker Alliance, fractracker.org/photos.

Figure 9: Sources of CO_2 Emissions from New Oil and Gas Development, by Key U.S. Basins, 2018-2050



Source: Oil Change International calculation using data from Rystad Energy (October 2018) and IPCC

Map 1: Major U.S. Oil & Gas Basins Showing CO_2 Emissions from Projected Total Production, 2018-2050
Gt = Billion metric tons of CO_2



Basins labeled on the map are those projected to see the most oil and gas production over the period assessed.

Totals show CO_2 emissions that would be enabled by both existing and new development (whereas Figure 9 compares CO_2 emissions from new development only.)

Shaded areas in the Lower 48 states show the less productive basins in the Rest of USA. Total emissions for Rest of USA = 20 Gt.

Source: Oil Change International calculation using data from Rystad Energy (October 2018) and IPCC

PERMIAN BASIN

The Permian Basin is America's most prolific oil basin. Located in northwestern Texas and the southeast corner of New Mexico, it is primarily drilled for oil through hydraulic fracturing or 'fracking,' but the same wells produce a lot of associated gas and natural gas liquids.

The Permian Basin holds the greatest potential for new oil and gas development in the United States and in the world.[s] The basin could be the source of nearly 40 percent of the emissions enabled by production of currently undeveloped oil and gas in the United States between now and 2050.

Emissions from burning the oil and gas in core shale and discovered conventional Permian reserves alone would amount to over 29 billion tons of CO_2 (Figure 10). The emissions from all currently developed and undeveloped oil and gas that could be produced and burned by 2050 could amount to close to 55 billion tons of CO_2. This is close to 10 percent of the total global carbon budget for a 50 percent chance of keeping warming within 1.5°C.

Liquids production, which includes crude oil, natural gas liquids, and condensate,[t] is projected to grow to around 11.8 million barrels per day (bpd) by the late 2020s, from 4.6 million bpd in 2018. At its projected peak year – 2029 – the Permian Basin is expected to be producing more liquids than Russia, or any other major oil producing country except for Saudi Arabia (Figure 11). Gas production is projected to reach over 19 billion cf/d by the same time, up from 8 billion cf/d today.

Companies

More than 100 companies have stakes in Permian oil and gas production. Table 1 lists the top ten companies. These ten companies could be responsible for around 55 percent of all the oil and gas produced in the basin between 2018 and 2050.

Potential Limits to Expansion

The production growth projected for the Permian Basin can only happen with the help of new pipeline and export terminal infrastructure. The availability of sand and water for fracking also poses challenges to the growth trajectory.[102]

An aerial view of frac sand mining in Wisconsin. Use of sand for fracking in the Permian Basin could rise by 200 percent by the early 2020s. Ted Auch, with aerial support from LightHawk. Oct 16, 2013. Provided by FracTracker Alliance, fractracker.org/photos.

Pipelines and Export Terminals

Three major oil pipeline expansions are underway today and a new NGL pipeline is also under construction. Five more major oil pipelines are planned as are expansions of existing networks. Many of these pipelines will link to new oil export capacity planned primarily in the Corpus Christi and Houston areas.

Additionally, one new gas pipeline is currently under construction and up to six more are planned. These would primarily serve planned and under-construction liquefied natural gas (LNG) export terminals along the Gulf Coast.

Sand and Water

Around 90 million tons of sand for fracking could be required annually in the Permian Basin by the early 2020s, up from 30 million tons in 2017. Dozens of new sand mines are opening in Texas, with production expected to more than double to 50 million tons per year in the next couple of years.[103]

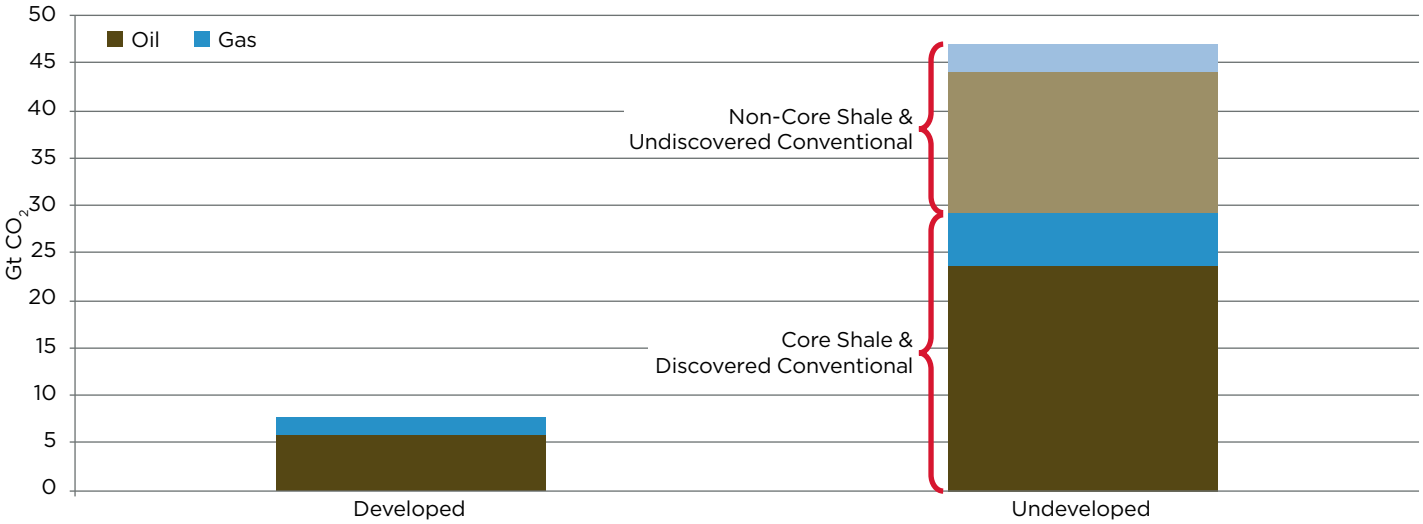
A study conducted in 2017 by researchers at Duke University found that the water intensity of fracked wells in the Permian increased 770 percent from 2011 to 2016, more than in any other basin in the United States. Water use per well in the Permian has grown from an average of 1.3 million gallons in 2011 to over 11 million gallons in 2016. While oil and gas production per well has also increased in this period, the ratio of water intensity to energy produced has increased 125 percent.[104]

Bringing the Permian Basin in line with climate and environmental limits will require a major realignment of political will within Texas, New Mexico, and the United States. In 2018, New Mexico elected a new state lands commissioner, Stephanie Garcia Richard, whose opponent received funding from oil companies including Chevron. Garcia Richard, who pledged to make "protecting our environment the priority," will have authority over oil and gas drilling decisions in state lands that overlap the Permian Basin in New Mexico.[105]

s Counting undeveloped reserves that are projected to be produced between 2018 and 2050.

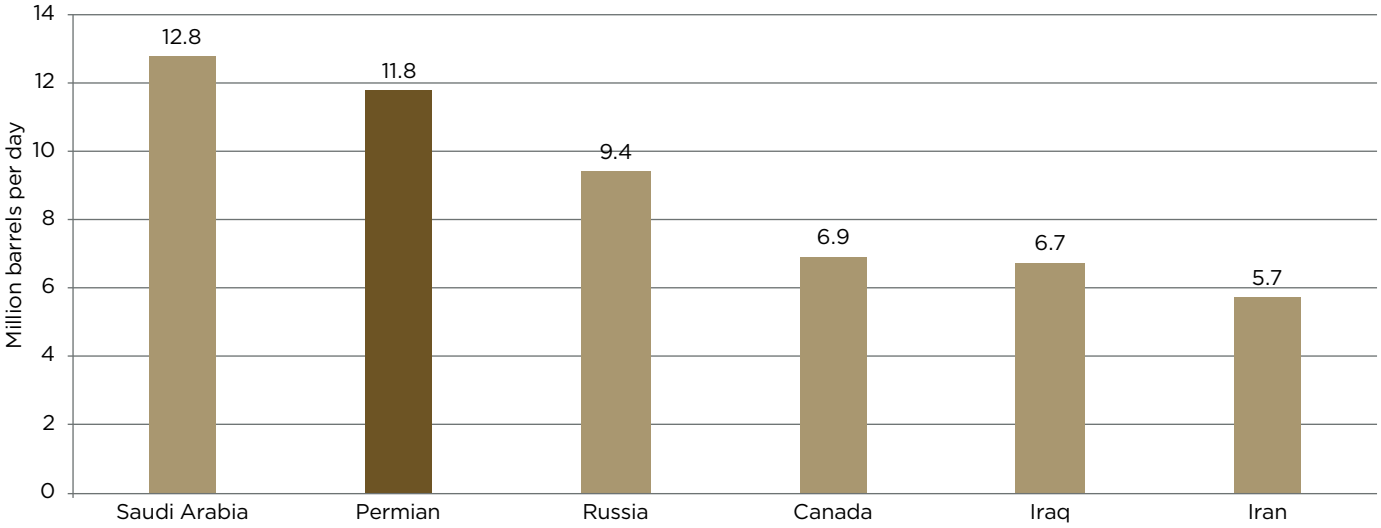
t Throughout this report, references to oil production volumes include all three liquids (crude oil, NGLs, and condensate), as is customary in energy reporting. We use the term "liquids" in this section given NGLs represent a significant proportion, nearly 30 percent, of Permian and Appalachian Basin liquids production projected over this time period.

Figure 10: Projected CO_2 Emissions from Developed and Undeveloped Oil & Gas Produced in the Permian Basin, 2018-2050



Source: Oil Change International calculation using data from Rystad Energy (October 2018) and IPCC

Figure 11: Permian Liquids Production in Projected Peak Year (2029) Compared to Major Oil Producing Countries



Source: Rystad Energy (October 2018)

Table 1: Top Ten Oil & Gas Producers in the Permian Basin

Company	Estimated Permian Oil & Gas Production 2018-2050 (MBOE)
Chevron	9,650
Pioneer Natural Resources	9,024
EOG Resources	7,377
Concho Resources	7,238
ExxonMobil	7,134
Royal Dutch Shell	4,821
Devon Energy	4,390
Anadarko	4,363
Occidental	4,282
Diamondback Energy	4,099
Total	62,378

Source: Rystad Energy (October 2018)

A fracking rig operating next to the Ohio River in Marshall County, WV. Ted Auch, with aerial support from SouthWings and pilot Dave Warner. Jan 2018. Provided by FracTracker Alliance, fractracker.org/photos.

APPALACHIAN BASIN

The Appalachian Basin is America's most prolific fossil gas basin. Production is primarily focused in Pennsylvania, West Virginia, and Ohio. State bans on fracking implemented in New York and Maryland in 2014 and 2017 respectively have prevented the further proliferation of drilling.

The Appalachian Basin is dominated by the Marcellus and Utica shale plays. The Marcellus is the biggest, located primarily in southwestern and northeastern Pennsylvania as well as in northwestern West Virginia and eastern Ohio. The Utica lies below the Marcellus in those three states. A small amount of conventional (non-fracked) production occurs across the basin today, but there is almost no expansion potential for conventional production. Some 60 percent of gas production in the basin is projected to come from Pennsylvania.

As Figures 12 and 13 illustrate, Appalachian Basin production has grown rapidly over the past decade, and this rapid growth is set to continue.

Gas production in the basin has grown aggressively since 2010, reaching nearly 28 billion cf/d in 2018, up from just 3 billion cf/d in 2010. In the absence of state or federal action to constrain expansion, gas producers are projected to continue this aggressive rate of growth for most of the coming decade, reaching over 40 billion cf/d by 2025 and maintaining that level into the mid-2030s (Figure 13).

Liquids produced in the Appalachian Basin are primarily natural gas liquids. Production could grow from around 800 thousand bpd today to around 1.3 million bpd at its peak. NGLs are primarily processed into petrochemical feedstocks. Several new processing plants are planned in western Pennsylvania and the Ohio Valley. This is triggering a boom in plastics production at precisely the time when plastic pollution is being recognized as a global crisis and solutions are being sought to reduce plastic consumption and waste.[106]

Companies

More than 75 companies have stakes in Appalachian oil and gas production. Table 2 lists the top ten. These ten companies could be responsible for around 68 percent of all the oil and gas (mostly gas) produced in the basin between 2018 and 2050.

Potential Limits to Expansion

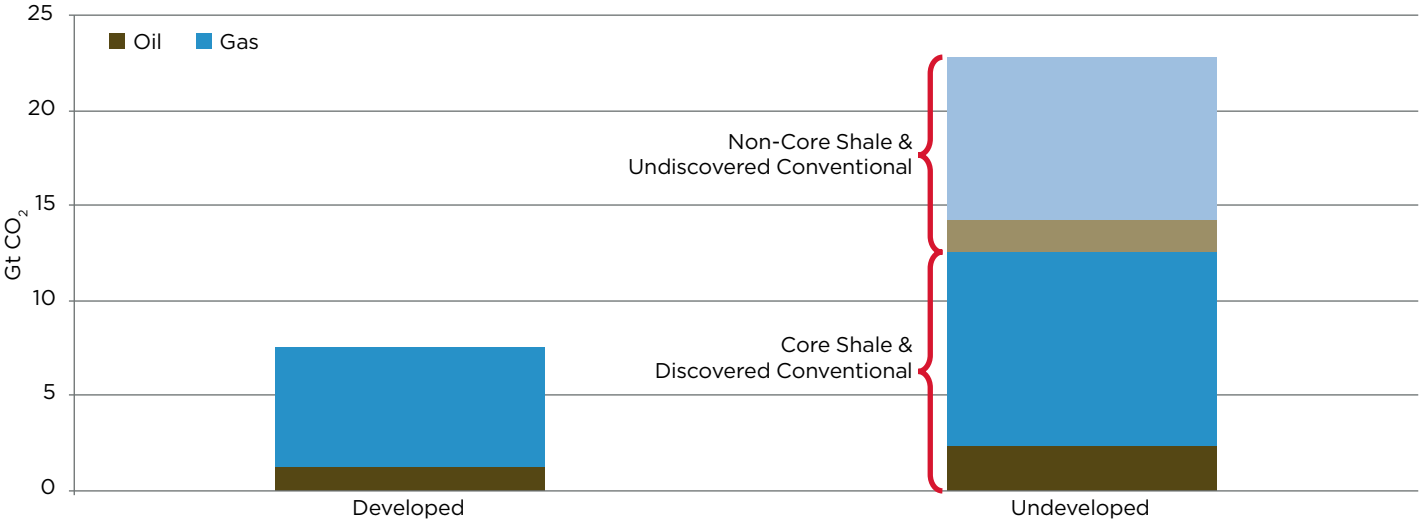
Gas companies have relied on a massive buildout of pipeline capacity to enable production growth in the Appalachian Basin. Over a dozen major projects have been completed recently and several are currently under construction. Many of these projects connect to pipeline networks feeding LNG export terminals on both the East and Gulf Coasts.

The construction of the Atlantic Coast and Mountain Valley pipelines through West Virginia, Virginia, and North Carolina has been slowed by legal challenges on behalf of impacted communities and environmental violations by the pipeline builders themselves.[107]

A lack of pipeline capacity could constrain production growth in northeastern Pennsylvania, as the state of New York has denied permits for projects such as the Constitution Pipeline.[108] Permit delays in New Jersey have also held up the PennEast Pipeline.[109]

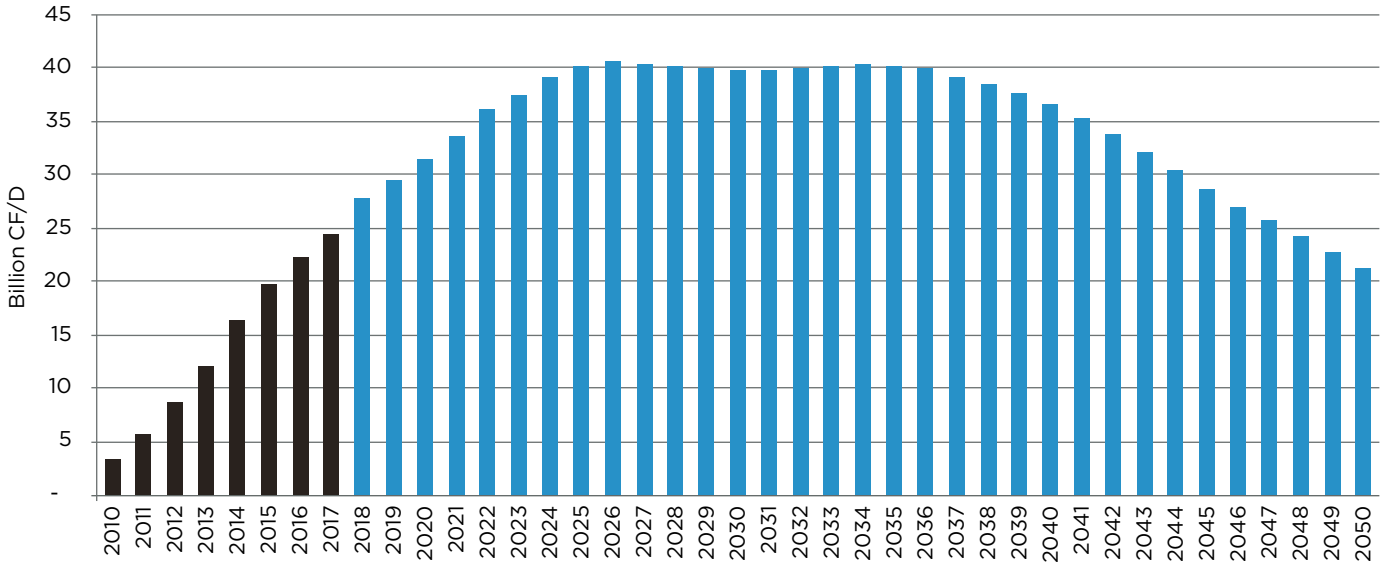
While fracking bans in New York and Maryland have placed some limits on production, the impacts of aggressive production growth and pipeline construction are being felt across the region through air and water pollution, industrialization of rural communities, and related health effects.

Figure 12: Projected CO_2 Emissions from Developed and Undeveloped Oil & Gas Produced in the Appalachian Basin, 2018-2050



Source: Oil Change International calculation using data from Rystad Energy (October 2018) and IPCC

Figure 13: Historic and Projected Gas Production in the Appalachian Basin



Source: Rystad Energy (October 2018)

Table 2: Top Ten Oil & Gas Producers in the Appalachian Basin

Company	Estimated Appalachian Oil & Gas Production 2018-2050 (MBOE)
EQT Corporation	8,916
Cabot Oil and Gas	6,297
Southwestern Energy	6,126
Ascent Resources, LLC	6,123
National Fuel Gas	5,586
Gulfport Energy	3,432
Range Resources	3,381
CNX Resources Corporation	3,014
Royal Dutch Shell	2,979
Chesapeake	2,778
Total	48,632

Source: Rystad Energy (October 2018)

OTHER KEY BASINS

Significant expansion potential also exists in basins primarily located in North Dakota, areas of Texas outside of the Permian Basin, Louisiana, Oklahoma, the Gulf of Mexico, and the Rocky Mountain states of Colorado and Wyoming.

Western Gulf Onshore

This basin encompasses the Eagle Ford shale play in southwest Texas, as well as significant ongoing production from legacy conventional oil and gas wells along the Gulf Coast in Texas and Louisiana.

The Eagle Ford holds the majority of undeveloped reserves in the basin, nearly 22 billion BOE of oil and gas. Over 50 percent of all the undeveloped reserves in the basin are core shale reserves. It is primarily a liquids basin with significant quantities of associated gas. Over 40 percent of the liquids are condensate or NGLs. Burning all the currently undeveloped oil and gas in the basin would produce over 10 billion tons of CO_2.

The top five companies operating in the Western Gulf Basin are: EOG Resources, ConocoPhillips, Magnolia Oil & Gas, BP, and Lewis Energy Group.

Anadarko Basin

The Anadarko Basin contains several shale plays and some legacy conventional oil and gas production. It is primarily located in Oklahoma with some activity in Texas and Kansas and a very small amount in Colorado. The largest undeveloped reserves are in the Woodford and Meramec shale plays, also known as the SCOOP-STACK shale plays, in Oklahoma.

There are nearly 22 billion BOE of undeveloped oil and gas in the basin. Over 55 percent of this is core shale reserves. The undeveloped reserves are mostly liquids but with substantial associated gas. About 60 percent of the liquids are condensate and NGLs. Burning all the currently undeveloped oil and gas would produce over 9 billion tons of CO_2.

Flaring from oil and gas drilling in the Bakken Formation in North Dakota. Nick Lund. May 28, 2014. Provided by FracTracker Alliance, fractracker.org/photos.

The top five companies operating in the Anadarko Basin are: Devon Energy, Climarex Energy, Continental Resources, Newfield Exploration, and Gulfport Energy.

Williston Basin (Bakken)

The Williston Basin primarily contains the Bakken-Three Forks shale play. It is located mostly in North Dakota with some activity in eastern Montana and South Dakota.

There are nearly 15 billion BOE of undeveloped oil and gas in the basin. About 55 percent of this is core shale reserves. It is primarily an oil play with some associated gas and NGLs. Burning all the currently undeveloped oil and gas would produce over 6 billion tons of CO_2.

The top five companies operating in the Williston Basin are: Continental Resources, Hess, Whiting Petroleum, Marathon Oil, and EOG Resources.

Gulf of Mexico

The Gulf of Mexico is the primary offshore oil and gas production zone in the United States, including shallow, deep, and ultra-deep-water basins. Most of the projected growth in the region is expected to come from deep water drilling. All the area is in federal waters of the outer continental shelf. Oil is more prolific than gas in these basins.

There are just over 13 billion BOE of undeveloped conventional oil and gas in the Gulf of Mexico. Forty-five percent of this is discovered while the rest is modeled to be discovered following lease sales scheduled by the federal government. Burning all the currently undeveloped oil and gas would produce nearly 6 billion tons of CO_2.

President Trump ordered a new schedule of annual lease sales in the Gulf of Mexico and rescinded rules for blowout prevention, which the Obama administration had developed in response to the Deepwater Horizon disaster.[110] This may accelerate exploration and development of currently undiscovered reserves in the coming years. The same executive order aims to open the Outer Continental Shelf in the Atlantic and Arctic oceans to drilling.

The top five companies operating in the Gulf of Mexico are: Shell, Chevron, BP, Equinor, and Anadarko.

The Denver Basin

The Denver Basin is primarily located in Colorado, with some activity in Wyoming and a small amount in Nebraska. It is dominated by the Niobrara shale play, particularly in the Wattenberg and Denver-Julesburg sub-basins in northeastern Colorado.

There are nearly 14 billion BOE of undeveloped oil and gas in the basin. Over 60 percent of this is core shale reserves. It is primarily an oil play with substantial associated gas and NGLs. Burning all the currently undeveloped oil and gas would produce nearly 6 billion tons of CO_2.

The top five companies operating in the Denver Basin are: Anadarko, Noble Energy, HighPoint Resources, Extraction Oil & Gas, and SRC Energy.

The North Slope of Alaska

The North Slope is Alaska's most active oil and gas basin. The basin includes the Arctic National Wildlife Refuge, which Congress recently opened to drilling (see Box 6). It is primarily an oil play with some associated gas. Much of the gas produced today is injected into oil wells to stimulate production, as there is little gas demand in the region and no access to gas markets outside of Alaska. A massive proposed gas pipeline and LNG terminal, the Alaska LNG Project, would change that if built, and would lead to new development of gas wells that are currently uneconomic.[111]

The North Slope's undeveloped conventional oil and gas is mostly undiscovered although planned lease sales in the next few years could trigger new development, as could the LNG project if it is built. Undeveloped oil and gas in the basin is estimated at over 4 billion BOE. Emissions would amount to nearly 2 billion tons of CO_2. This includes some of the estimates for the Arctic Refuge discussed in Box 6.

The top five companies operating in the North Slope of Alaska are: ConocoPhillips, ExxonMobil, BP, Caelus Energy, and Repsol.

Box 6: Exploiting the Arctic National Wildlife Refuge

The debate over oil and gas drilling in the Arctic National Wildlife Refuge has raged for over half-a-century.[112] The area is sacred to the Gwich'in people who rely on the natural resources of the coastal plain for their way of life.[113] With Arctic temperatures rising faster than anywhere on earth, their way of life is already threatened.[114] Opening the refuge to drilling can only compound those impacts.

Congress removed restrictions on drilling in the refuge as part of the tax bill passed in December 2017. As a result, the Department of Interior is preparing at least two lease sales before 2024.

While the U.S. Geological Survey (USGS) has estimated total mean technically recoverable oil reserves in the refuge to be around 7.7 billion barrels, the potential for production depends on many factors.[115] The Rystad Energy database models production in the refuge based on an expectation of lease sales starting in 2020[u] and continuing into the 2070s. As there is no history of drilling in the immediate area, Rystad's projections are based on USGS data and the history of production elsewhere in the North Slope Basin, as well as on the base case expectation of future oil prices. The lack of site-specific data means that production projections are more speculative than those in the rest of this report.

The database projects that production would not begin in the refuge until 2034. By 2050, the cutoff point for the analysis in this report, Rystad projects that nearly 600 million BOE of oil and gas, mostly oil, could be produced from leases in the refuge. Emissions from combusting that oil and gas would amount to over 200 million tons of CO_2.

These figures are preliminary and based on limited data, as described. The development timeline could accelerate or slow to a halt depending on economic and regulatory factors. Initiating extraction activity in the refuge opens the possibility of decades of extraction and potentially much more pollution than is described here because we cut off projections at 2050.

The opening of the Arctic Refuge to oil and gas exploration constitutes a fundamental denial of the path the United States must take to avoid climate catastrophe. Encouraging production growth in a remote and pristine environment from the mid-2030s and beyond stands in direct opposition to how U.S. leaders must respond to the growing climate crisis.

u Some reports indicate a lease sale could happen in 2019. The bill states that at least two sales should happen by 2024.

Oil rig operating next to a walk and bike way in the Signal Hill area of Los Angeles. Sarah Craig/Faces of Fracking. (CC BY-NC-ND 2.0)

Other U.S. Areas

Outside of these basins, expansion activity is dispersed in several smaller shale plays and some conventional oil and gas formations. Significant activity is ongoing outside of the basins discussed above in Louisiana, Oklahoma, and the Powder River Basin in Wyoming, among others. While California's status as a major oil producing state is fading, producers there continue to apply for new permits. Political leaders in California are coming under increasing pressure to stop new permitting and chart the state's transition off oil production to show the climate leadership they have pledged (see Box 7).

Around 26 billion BOE of undeveloped oil and gas is estimated to be in these basins. Burning all of it would lead to over 10 billion tons of CO_2.

Not included in these figures is the oil and gas that may lie in federal waters off the Atlantic coast and in the Chukchi and Beaufort seas in the Arctic. The Trump administration's April 2017 executive order called for new lease sales in these areas. Little is currently known about the quantities of oil and gas that may be viably produced in these areas, so we do not provide figures here. We do know, however, that opening these areas to exploration makes no sense from a climate perspective and is vehemently opposed by many state governments and citizens in coastal states and across the United States.

Box 7: How California Can Lead the Way Towards a Managed Decline

Political leaders in California have been particularly vocal in their commitment to the Paris goals. California has been among the leading U.S. states in growing renewable energy and strengthening fuel efficiency, most recently leading a coalition to defend vehicle efficiency standards from the Trump administration's rollbacks. Despite this, California remains a top U.S. oil producer and has no plan in place to manage its transition off oil and gas extraction, even in state-controlled lands and waters. California could set an example of urgently needed U.S. and global leadership by committing to phase out its fossil fuel production in line with climate limits.

A report released in May 2018 by Oil Change International and 14 environmental justice and climate groups proposes and analyzes three key steps California's leaders can take to chart a just transition off extraction:[116]

- **Cease issuing permits for new oil and gas extraction wells.** This would limit new oil and gas production in California, as required by the Paris goals, whereas business-as-usual permitting could enable extraction of an additional 560 million barrels of oil from 2019 to 2030.
- **Implement a statewide health and safety buffer zone in which existing wells are phased out as quickly as possible.** This would begin a proactive managed decline in a way that prioritizes the health of historically overburdened communities. Nearly 8,500 active oil and gas wells across California operate within 2,500 feet of homes, schools, and hospitals – a proximity linked to the greatest exposure to toxic air pollution.
- **Plan for and fund a just transition.** This must involve providing wage insurance, career training, and other support for people whose livelihoods are affected by the economic shift.

By establishing such policies, California would become the first significant oil producer to commit to phasing out extraction, a move that would put pressure on others to follow suit. These steps would spur significant reductions in carbon emissions, protect the health of local communities unfairly harmed by extraction now, and provide a predictable pathway around which to plan a just and equitable economic transition.

IV. THE U.S. SHOULD LEAD IN PHASING OUT FOSSIL FUELS

The data in previous sections underscore that managing the decline of U.S. fossil fuel production will be critical to global success in staying within climate limits. This is true not only because of the sheer tons of carbon that continued U.S. fossil fuel expansion could unlock, but also because of the way it could cripple efforts to forge an equitable fossil fuel phase-out.

In this section, we take a step back from detailed data analysis to discuss why the United States has a responsibility to become a world leader in phasing out fossil fuel use and production, and to lay out some policy principles that could guide that transition in an equitable way. Effective global leadership must include robust planning and investment in a just transition at home, so that people and communities whose livelihoods and local economies are entwined in the fossil fuel industry now reap the benefits of the necessary shift to renewable energy.

EQUITY IS AT THE CORE OF EFFECTIVE CLIMATE POLICY

The IPCC's report on 1.5°C of warming finds that:[117]

> Social justice and equity are core aspects of climate-resilient development pathways that aim to limit global warming to 1.5°C as they address challenges and inevitable trade-offs, widen opportunities, and ensure that options, visions, and values are deliberated, between and within countries and communities, without making the poor and disadvantaged worse off.

The report states that not only are social justice and equity desirable, they are essential: Most models "could not construct pathways characterized by lack of international cooperation, inequality and poverty" that were able to limit warming to 1.5°C.[118]

Equity must be a core consideration in managing the phase-out of fossil fuels – not only because it is morally right but also because it could be the difference between global success or failure in realizing the rapid cuts in emissions that are needed.

FOR GLOBAL EQUITY, LEAD IN PHASING OUT DEMAND AND SUPPLY

The Lofoten Declaration

Signed by more than 500 civil society organizations and leaders from 76 countries, the Lofoten Declaration affirms that, "[I]t is the urgent responsibility and moral obligation of wealthy fossil fuel producers to lead in putting an end to fossil fuel development," and that, "In particular, leadership must come from countries that are high-income, have benefitted from fossil fuel extraction, and that are historically responsible for significant emissions."[119] In addition to the United States, wealthy fossil fuel producers that should be heeding this call include Norway, Canada, Germany, Australia, and the UK.

It is a core principle of international climate policy that countries historically responsible for emitting the most climate pollution, and that have the most resources to invest in solutions, have the greatest responsibility to move first and fastest in reducing emissions. By this measure, the United States should be leading the world in deep emissions cuts: It is the world's biggest historical climate polluter and the world's largest economy.

How might we approach equity in phasing out the *supply* of fossil fuels as part of a comprehensive approach to reducing emissions? As seen in Section I, carbon budget limits leave no room for new fossil fuel development anywhere in the world. That means that the essential supply-side equity question is this: Which countries and regions should move first and fastest in phasing out *existing* extraction projects?

The following two principles offer a guide to answering this question:[v]

- **Transition first and fastest where it is least disruptive:** In particular, this would include countries that are relatively wealthy and least economically dependent on extraction. Such countries are best-positioned to invest in a robust transition plan for fossil-fuel-dependent workers and regions in a way that minimizes social and economic disruption. By contrast, poorer countries where people still lack basic human needs, where government revenues are highly dependent on extraction, and/or where a high proportion of jobs are tied to extraction face the steepest transition challenges.

v These principles are drawn from a forthcoming paper on supply-side climate equity by Greg Muttitt of Oil Change International and Sivan Kartha of the Stockholm Environment Institute. The paper will suggest a framework for approaching an equitable and just phase-out of fossil fuel extraction.

A large fire erupts at the Chevron Refinery in Richmond, California. At least 15,000 sought treatment at area hospitals. Stephen Schiller. (CC BY-NC 2.0)

This is not to discount the fact that many people in the United States and other wealthy nations also lack human needs due to domestic inequality. Rather, this points towards wealthier countries' greater capacity to shift resources towards an equitable transition, which will also provide an opportunity to address underlying social and economic inequities.

- **Respect human rights and safeguard local environment:** Extraction that violates human rights or Indigenous sovereignty, or that damages people's health or livelihoods – for example, by contaminating water used for drinking or agriculture – should be prioritized for rapid closure. Whether in coastal Louisiana or Los Angeles, the tar sands of Alberta, the Amazon forest of Ecuador, or the Niger Delta, fossil fuel projects that violate international norms of human rights or labor and environmental standards should never have been permitted in the first place and should be phased out first.

By the first criterion, the United States should be a global first mover in phasing out extraction, just as it must lead in cutting end-of-pipe emissions. In addition to being the largest economy in the world, the U.S. economy is diverse. All mining, including oil and gas extraction, accounted for only 1.4 percent of the country's gross domestic product (GDP) in 2017.[120] While phasing out the fossil fuel industry will be challenging for all workers on its frontlines, less than one half of one percent (0.3 percent) of the U.S. labor force is currently employed in fossil fuel extraction.[121] The United States has adequate resources to invest in a just transition – and guarantee a Green New Deal that provides good-paying jobs to former fossil fuel workers – if political leaders make it a priority. For example, eliminating federal and state fossil fuel subsidies could free up $20 billion each year to redirect towards transition support for workers and economic diversification.[122]

In an equitable global pathway towards climate stability, the United States should be phasing out oil, gas, and coal extraction at a pace significantly *faster* than the global rates of decline given in the model 1.5°C pathway discussed in Section II. **For example, the United States moving first and fastest would imply it phasing out coal mining by 2030 or sooner and winding down oil and gas extraction well before 2050.**

The second criterion suggests a way to prioritize where fossil fuel projects should be phased out first within the United States. For example, extraction should cease on the ancestral tribal lands of Indigenous nations, where such operations violate their sovereignty. Mountaintop removal coal mining linked to the destruction of

waterways and severe health impacts in Appalachia should be prioritized for phase-out, as should neighborhood drilling happening within several hundred feet of homes and schools in primarily low-income areas and communities of color in Los Angeles and other parts of California. This is far from an exhaustive list of areas where fossil fuel production is violating people's health and human rights, but rather points towards ways in which the criteria discussed here could be applied.

FOR DOMESTIC EQUITY, INVEST IN AN AMBITIOUS JUST TRANSITION

The pace and ambition of investment in building up the clean energy economy can and should match the pace and ambition of phasing out the fossil fuel economy. In the words of the ITUC, "Transformation is not only about phasing out polluting sectors. It is about creating new clean industries, new jobs, new investment and the opportunity for a more equal and just economy."[123]

In contrast to the guaranteed humanitarian and economic disaster of runaway climate change, this is the only path that affords a livable future.[124] For example, the Fourth National Climate Assessment projects that, without adequate action, warming could cost U.S. workers $155 billion in lost wages and cause tens of thousands of premature deaths annually by the end of this century.[125]

With deep investment and political commitment – including holding new industries accountable to providing good-paying, unionized jobs – the clean energy transformation has the potential to deliver a brighter future. A 2017 study by Heidi Garrett-Peltier at the Political Economy Research Institute found that every $1 million shifted from oil, gas, or coal production towards clean energy will create a net increase of five jobs in the short-to-medium term.[126] A 2015 study commissioned by the Labor Network for Sustainability found that U.S. policies to reduce greenhouse gas emissions substantially by 2050 would lead to an average net gain of more than 550,000 jobs per year from 2016 to 2050 – in energy efficiency programs, renewable energy production, the manufacturing of electric cars, and more – while leading to net savings for U.S. families through lower electricity, transportation, and heating costs.[127]

This type of investment is overwhelmingly popular: Pew Research Center polling from 2018 found that close to 90 percent of U.S. adults want more solar panel and wind turbine farms.[128] A fall 2018 poll of U.S. voters indicated that two-thirds support guaranteeing a job "building energy-efficient infrastructure" to every unemployed U.S. worker.[129]

Markets alone will not drive this transformation at the speed required to meet climate goals or in a just and equitable way. Politicians must put policies in place that match the ambition required by science, that protect workers employed in the extraction economy now, and that target new economic opportunities towards communities where fossil fuel jobs are phased out. While the exact scope and terms of just transition policies should be negotiated with affected workers and communities and union representatives, and reflect their vision of a brighter future, we lay out broad elements of effective policies in the following section.

A Process of Social Dialogue

Economic and technological transition is nothing new, but the climate crisis requires that it occur at an unprecedented scale and pace. A rapid decline of U.S. fossil fuel production will affect thousands of workers, their families, and specific communities that currently depend on the industry for their livelihoods, and they need a seat at the table from the very beginning. The ITUC and case studies of transition experiences from around the world pinpoint early social dialogue between government policymakers, employers, workers, unions, and frontline communities and organizations as a core element of effective just transition planning.[130]

Given the pace of change that is required, federal, state, and local policymakers should waste no time in establishing inclusive planning bodies. Their mandate could include envisioning what a responsive just transition process can and should look like and mapping out the policies and resources required to support it. Both Scotland and Canada have established Just Transition Task Forces at the federal level to plan for the phase-out of those countries' coal industries.[131] At every level, such fora should learn from and lift up community-based efforts that are already leading the way towards equitable and resilient local clean energy economies.[132]

Guaranteed Protection for Workers

Many workers in the U.S. fossil fuel industry are familiar with the boom-and-bust cycle of extraction, dictated by shifting prices, technologies, and corporate profit margins. Coal mining jobs have long been in decline. Since 2011, 30,000 coal mining jobs have disappeared, with the sector employing around 50,000 workers as of 2018.[133] Between the end of 2014 and 2016, oil and gas drillers shed nearly 50,000 jobs in response to the crash in oil prices. As of 2018, 152,000 workers were employed directly in oil and gas extraction.[134] Just over 320,000 workers are additionally employed nationally in support activities for extraction.[135]

A managed and just decline of extraction must guarantee adequate social protection, including wage insurance, health benefits, and pensions, to support workers and their families as they transition to new sectors – not leave them behind. As Tony Mazzocchi of the Oil, Chemical, and Atomic Workers union (now part of the Steelworkers) put it in 1993, "Paying people to make the transition from one kind of economy – from one kind of job – to another is not welfare. Those who work with toxic materials on a daily basis ... in order to provide the world with the energy and the materials it needs deserve a helping hand to make a new start in life."[136]

A recent Washington State ballot initiative that would have established a carbon tax and just transition program provides a model for what social protection policies could look like. While defeated in the wake of record-high spending by oil companies that opposed it, the initiative had broad support among both unions and environmental justice communities. It proposed providing full wage replacement, health benefits, and pension contributions for all fossil fuel workers within five years of retirement, and for younger workers for each year of service up to five years. It also would have provided wage insurance for up to five years for workers with more than five years of service, which would cover any shortfall in pay between their previous and new jobs.[137]

Job Training and Re-employment

In recent years, solar and wind have been among the fastest growing U.S. industries.[138] Wind power jobs have more than doubled since 2013, reaching 105,000 in 2017.[139] The solar industry employed just over 250,000 Americans in 2017, a growth of 75 percent since 2013 despite a slight downturn last year. At only 2 percent of overall U.S. energy generation, solar employs twice as many workers as the coal industry and nearly as many as the gas industry.[140] An additional 2.2 million Americans are employed in jobs related to energy efficiency.[141]

A just transition must ensure that fossil fuel workers can access jobs in these growing sectors – and that new jobs provide equivalent or better pay and benefits.

To help access new sectors, support would include retraining for workers who may need new skills, as well as job placement assistance for those with skills that are easily transferable to clean energy and infrastructure jobs. In many regions, such programs can build upon existing union apprenticeship programs and community college programs that have already begun serving this need. Jeremy Brecher of the Labor Network for Sustainability has proposed that transition assistance should cover up to four years of education or training, including tuition and living expenses.[142] Washington State's transition proposal would have covered up to two years of retraining costs, including community or technical college tuition.[143]

New jobs are not necessarily a win for workers if they do not provide family-sustaining wages, good benefits, job security, and a right to unionize. Many new clean energy jobs are not yet unionized and, depending on the type of job, may not yet provide the same level of wages or benefits as jobs being lost in fossil fuel sectors. Wage insurance is only a stop-gap answer. It is critical that climate justice and environmental advocates show solidarity with the labor movement in holding emerging clean energy industries accountable to providing 'high-road' jobs. If advocates wait until a sector is established to address job quality, then lower wages and working standards could get locked in, undermining the promise of a just transition.

Targeted Community Investments

The economic burden of transitioning away from the fossil fuel economy will be concentrated in communities where extraction and related industrial processes such as refining are currently centered. Just transition planning at the federal and state levels should ensure that investments in economic diversification target these regions. With coal mining, for example, this transition will disproportionately affect specific counties in states such as West Virginia, Wyoming, Kentucky, and Pennsylvania. With oil and gas extraction, the same holds for states such as Texas, Oklahoma, Pennsylvania, Louisiana, Colorado, North Dakota, and California.[144]

Some existing federal and state policies provide a blueprint to build on. The POWER+ Initiative, launched under the Obama administration, began coordinating federal investment in community-based education, economic development, and job training programs in regions hit hard by the declining economics of the coal industry.[145] A more robust federal transition policy could build on this template.

In New York State, lawmakers established a $30 million fund in 2016 to support communities facing power plant closures. The Huntley Coalition, a labor and environmental alliance formed in response to the anticipated closure of the Huntley

Community members installing a large solar array in Polk County, Nebraska, in the path of the Keystone XL pipeline. Jason Shald, 350.org. (CC BY-NC-SA 2.0)

coal-fired power plant in Tonawanda, NY, fought for the creation of the fund while also organizing their working class community to benefit from it. The funding provided money for their town, school district, and county to replace lost revenues from the plant closure for five years, protecting public education jobs and funding.[146]

It is important to recognize that many of the regions most encoiled in the fossil fuel economy at present have higher unemployment and greater poverty compared to regions with more diverse economies. Where the fossil fuel industry provides jobs and local revenue, it also leaves a legacy of pollution, with the related health and environmental costs borne disproportionately by low-income people, communities of color, and Indigenous communities. The transition to renewable energy provides an opportunity to address these historic wrongs and develop more equitable and resilient local economies.

Resources

It will require money to provide wage assistance, benefits, and job retraining for workers and to invest in communities on the front lines of the shift to a climate-safe economy. A recent study by the Political Economy Research Institute (PERI) estimated that a transition program for currently fossil fuel-dependent workers and communities, including compensation insurance, retraining support, relocation allowances, fully guaranteed pensions, and community transition support, could cost $600 million annually over 20 years.[147] This may be a modest estimate, given it assumes a high proportion of workers will age into retirement.

Politicians have numerous options for funding just transition initiatives if they make it a priority. For example, as noted previously in this report, ending subsidies to the fossil fuel industry would free up billions of dollars per year in federal and state budgets. An Oil Change International study of the path towards winding down oil extraction in California found that a modest 'just transition fee' on oil production could cover up to five years of wage replacement and four years of college tuition for all workers currently employed in oil and gas extraction in the state.[148] In Portland, Oregon, voters recently approved a ballot initiative to create a $30 million annual fund for clean energy infrastructure and jobs, targeted at underserved communities and funded by a small tax on the city's wealthiest retail corporations.[149]

Tom Brewster Photography/Bureau of Land Management. (CC BY 2.0)

Even if transition costs run significantly higher than indicated by the PERI study, their potential price tag pales in comparison to the mounting costs of climate change in the United States.[150] For example, Hurricanes Harvey, Maria, and Irma caused $265 billion in total damage in 2017.[151] The annual cost of just transition policies estimated in the PERI study would equal less than one percent of the price tag for 2017 hurricane disasters alone.

TOWARDS A GREEN NEW DEAL

In the 2018 midterm elections, a diverse group of new U.S. House members was elected on climate platforms that included championing a Green New Deal and opposing new fossil fuel infrastructure projects. This emergence of new climate leadership on Capitol Hill, spurred on by youth-led grassroots organizing driven by the Sunrise Movement, has since led 45 Members of Congress (and counting) to support Congresswoman Alexandria Ocasio-Cortez's proposal to establish a Select Committee for a Green New Deal, with the goal of developing a plan to decarbonize the U.S. economy within 10 years in a way that addresses entrenched economic, racial, and regional inequities.[152]

While the exact ingredients of a Green New Deal have yet to be defined, the basic premise is to pursue a mass mobilization of people and public resources, including a universal jobs guarantee and other social programs, to create a 100-percent renewable electricity grid and zero out U.S. emissions. Modeled in theory after President Roosevelt's New Deal that used mass public investment to bring the United States out of the Great Depression, the vision of a Green New Deal is to mobilize rapid climate action with deep, large-scale investment that ensures shared prosperity.[153]

The growing momentum behind the Green New Deal concept suggests the potential of advancing climate goals and economic and social justice together. For the United States to meet its responsibility to become a world leader in phasing out fossil fuel use and extraction, it must also lead in large-scale investment in building a just and equitable clean energy future.

V. RECOMMENDATIONS: A CHECKLIST FOR CLIMATE LEADERSHIP

As the world's carbon budget rapidly dwindles, achieving the Paris goals will require that governments stop the expansion of fossil fuel production, starting now, and manage its decline over the next few decades. Climate leadership in this direction is arguably needed more urgently in the United States than anywhere else, as the U.S. oil and gas industry gears up to swing a giant wrecking ball through global climate goals.

If the United States is to start helping, rather than severely hindering, the world's chances at averting climate disaster, U.S. politicians at all levels must start flexing an underutilized muscle: their ability to say "no" to the fossil fuel industry, and to steer it towards an equitable and orderly phase-out. Comprehensive climate policy – whether at the Congressional, state, or other levels – must by definition include action to tackle the supply side of the problem, in addition to boosting renewable energy and cutting fossil fuel demand.

The good news is that opportunities for action are abundant. **Every decision around a new fossil fuel lease, permit, subsidy, or setback represents an opportunity to say "no" to new expansion and show leadership towards the Paris goals.**

CHECKLIST FOR U.S. CLIMATE LEADERSHIP

Climate leadership in the United States must include a commitment to:

- **End new leasing and permitting:** Ban new leases, licenses, or permits that enable new fossil fuel exploration or production, or new long-lived infrastructure such as pipelines, export terminals, or refineries – and reject existing proposals in the meantime. Given existing fossil fuel projects already push the world beyond safe climate limits, licensing their expansion is incompatible with climate leadership. At the federal level, ending new leasing of federal lands and waters for fossil fuel exploration or extraction would be a logical first step. Banning leases and permits for new fossil fuel exploration or production, as Maryland and New York have done for fracking, or for new fossil fuel infrastructure, as the city of Portland has done, would be the most comprehensive approach.

  Meanwhile, any new fossil fuel project typically requires a series of permits at the local, state, and federal levels, providing numerous levers for climate leaders to oppose and reject them. Climate leaders can also amend federal and state statutes that grant eminent domain to corporations seeking to build new fossil fuel infrastructure across private property and the sovereign lands of Tribal Nations, which cannot be considered in the public interest.

- **Plan for the phase-out of existing fossil fuel projects in a way that prioritizes environmental justice:** A significant portion of oil and gas fields and coal mines will need to be retired early in order to meet global climate goals. The ramp-down of existing fossil fuel projects in the United States should start in places where extraction disproportionately harms vulnerable communities and poses the greatest risks to human health (often one in the same). For example, this could mean working towards a faster

phase-out of coal production by first ending the most destructive form of it: mountaintop removal mining. A policy proposal championed by environmental justice groups in Los Angeles provides another model for oil and gas: They are pushing city and state leaders to enact a 2,500-foot buffer zone around homes, schools, and hospitals in which no new wells could be permitted and existing wells would be phased out.[154]

- **End subsidies and other public finance for the fossil fuel industry:** Any policy that lowers the cost of fossil fuel production incentivizes more extraction. A study by the Stockholm Environment Institute found that nearly half of all new, yet-to-be-developed oil produced in the United States over the next several decades will depend on subsidies, given oil prices of $50/bbl.[155] The U.S. Congress moved in the wrong direction in 2018 by significantly expanding a tax break that will incentivize more production from enhanced oil recovery methods.[156] Federal and state subsidies to oil, gas, and coal companies are estimated to be around $20 billion annually.[157] This amounts to an irresponsible investment of public money in making the climate problem worse, fueling costly disasters from super-charged hurricanes to killer wildfires. Climate leadership must include a commitment to end these subsidies, redirecting funds toward solutions for a just transition to clean energy.

- **Champion a Green New Deal that ensures a rapid and just transition to 100% renewable energy:** The pace and ambition of investment in building up the clean energy economy can and should match the pace and ambition of phasing out the fossil fuel economy. For this transition to be just, it must guarantee support and good-paying jobs for former fossil fuel workers, invest in communities entwined in the fossil fuel economy now, and address longstanding inequities. An equitable clean energy transformation, via a Green New Deal or otherwise, must center the needs of low-income communities, Indigenous communities, and communities of color, which have long borne the brunt of fossil fuel pollution.

- **Reject the influence of fossil fuel industry money:** The money and influence of the oil, gas, and coal industries should have no place in U.S. politics. This would send a strong signal that the industry no longer has moral or political license to hold sway over U.S. climate policy.

LOCAL-TO-GLOBAL MOMENTUM IS GROWING

U.S. officials who embrace a comprehensive approach to climate action, and take steps to curb extraction, will bolster momentum in this direction both globally and locally.

Public opinion polling continues to show Americans across the country strongly prefer to meet our energy needs by investing in new renewable forms of energy over expanding fossil fuel production.[158] Communities across the country, including in traditionally conservative locales, have risen up to slow and stop fossil fuel projects from moving forward. Across the world, a growing list of jurisdictions is taking steps to align energy decisions with climate limits:

- Costa Rica and France have placed full bans on new oil exploration, while New Zealand and Belize have prohibited new offshore exploration, and Denmark has banned new onshore exploration.[159]

- Spain and Ireland, which recently became the first country to divest public funds from fossil fuels, are also considering proposals to ban new licenses for oil and gas extraction.[160]

- Across the United States, city councils, mayors, state legislatures, and governors have also begun to take steps away from fossil fuels, from banning new permits for fossil fuel infrastructure to rejecting pipelines to putting extraction near people's homes off limits.

U.S. leaders who recognize the stark science of climate change have a moral responsibility to steer U.S. policy in the only climate-safe direction, towards a managed and just transition off fossil fuel production. **One of the most powerful – and most underutilized – climate policy levers is also the simplest: stop digging for more fossil fuels.**

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