23 June 2022

Dear California Air Resources Board,

On behalf of the Center for Human Rights and the Environment (CHRE), the Institute for Governance & Sustainable Development (IGSD), 350 Silicon Valley, and the Climate Reality Project California State Coalition, we thank you for the opportunity to submit comments on the California 2022 Scoping Plan (Carbon Neutrality by 2045) [hereinafter "the Plan"].

CHRE, IGSD, and others submitted prior comments in preparation of the 2022 Plan in July 2021. Below, we briefly restate the main points addressed in our earlier comments, which urged California to:

- Utilize a 20-year GWP in E3 modeling scenarios.
- Follow other states' lead and adopt the most stringent regulations possible on separator and tank systems and for pneumatic controllers, prior to the release of federal rules.
- Further research and promote investments in dairy and livestock methane emissions reduction projects (as much as $500 million per year for five years), including leaks and life cycle assessments.
- Consider any future incentives to expand manure/landfill biogas to ensure they do not have undesirable results of expansion of natural gas infrastructure, the perpetuation of fossil fuels, and/or the potential increases in livestock herd size to capitalize on such subsidies.
- Expand strategies to reduce HFCs and other F-gas end-of-life emissions.
- Add HCFCs to the CFC Compliance Offset Protocol.
- Include the Kigali Amendment to the Montreal Protocol in the 2030 HFC target projections.
- Reconsider the effectiveness of carbon offsets, which may result in over-crediting,[1] in pollution burdens on CA communities,[2] and evaluate the real climate benefits that such schemes will produce in the long-term (considering California's and other offset states' future forest fire potentials[3]).
- Release CARB's recent progress on Aliso Canyon Climate Impacts Mitigation Program.

In the newest draft Plan, we applaud the Air Resources Board for its significant strides to acknowledge and address the need for fast climate mitigation and to tackle environmental injustices presented by growing climate impacts. In order to prevent even greater injustice, it is critical to include an aggressive 2030 strategy focusing on cutting the short-lived super climate pollutants and protecting sinks. This was reiterated by Governor Newsom at the most recent Summit of the Americas in Los Angeles, where he drew attention to the "exponential and outsized opportunity to address the climate crisis through phasing out super pollutants."[4]

We share the deep concerns reflected in the environmental justice community regarding the Plan's abandonment of 2030 goals, and urge CARB to reevaluate how California can continue to be a

global leader on implementing the most aggressive and influential climate policy to slow warming while working to promote environmental justice.

We additionally gave an oral testimony at CARB's draft Scoping Plan Hearing on 23 June 2022, and encourage CARB to revisit the transcript from our testimony which offers succinct key messages.

Below we outline (1) specifics on why a 2030 timeframe is not only urgent but critical for California's 2022 Scoping Plan, (2) how we can get there, (3) why it is important to involve the communities most affected by climate change in California, and finally (4 & 5) what pitfalls to avoid.

1. 2030 targets are critical and we cannot afford to give up on them

As recognized in the Plan, the latest climate science set forth by a 2018 study by Xu Y., Ramanathan V., & Victor D. G., later included in the Intergovernmental Panel on Climate Change (IPCC) Sixth Assessment Report, warns that humans are on course to breach our 1.5°C Paris Agreement-established guardrail as soon as 2030.[5] Speed to slow warming is now a critical factor. We need to act faster than we previously thought. Warming beyond the 1.5°C guardrail increases the risk of triggering a cascade of irreversible and likely catastrophic tipping points that could lead to tragic planetary-scale effects.[6] Self-reinforcing feedbacks are already accelerating warming and unless addressed immediately risk runaway warming. The loss of Arctic sea ice—perhaps the weakest link in the chain of climate protection—is a prime illustration. It is likely the weakest links in the chain of climate protection.[7] Over the past several decades, the Arctic air temperature has been warming at four times the global average.[8] As a result, the extent of Arctic sea ice—a white shield reflecting incoming solar radiating safely back to space—is shrinking, as is the land-based snow and ice.[9] Recent research finds that the Barents Sea in the Arctic is warming 5 to 7 times the global average.[10] The accelerated loss of the Arctic sea ice has the potential to add the equivalent of a trillion tons of CO_2, or 25 years of current emissions.[11] Loss of the land-based snow and ice could double this.[12] This in turn will lead to the collapse of permafrost, and the emissions of more CO_2, methane, and N_2O, setting off a wicked cascade that will push us past planetary boundaries and into "hothouse Earth."[13]

As CARB recognizes, many communities are already experiencing the early impacts of a rapidly warming world, including intense heat domes, prolonged droughts, severe flooding from atmospheric rivers, raging climate wildfires and other extreme weather events that exacerbate already-existing health risks posed by climate change.[14] Frontline communities, many of which are in historically marginalized communities, have contributed the least to climate change but are bearing the worst of its impacts.[15] Strengthening the climate resilience of communities requires reducing risk through fast action climate change mitigation, adaptation, and societal transformation.

Leading California scientists have confirmed that California can accelerate the timeline for action on climate, and benefit economically, socially, and ecologically.[16] Through an aggressive and effective 2022 Scoping Plan, with 2030 as an immediate fast action target, CARB and California can once again set the bar for international action on climate, taking faster, more aggressive action to stop and revert climate change in the midst of our deepening climate crisis, while addressing

the immediate and urgent needs of the most marginalized and climate vulnerable communities in the State.

2. A fast mitigation agenda will get us there

The best—and indeed, *the only* strategy—that can slow warming in the near-term is to double down on cutting the short-lived super climate pollutants (super climate pollutants, or SLCPs), including methane, black carbon, hydrofluorocarbons and tropospheric ozone, as quickly as possible.

As the Plan recognizes, SLCPs, because of their strong global warming potential and short residence time in the atmosphere (compared to CO_2), present a unique opportunity to rapidly reduce warming in the near-term. Dr. Gabrielle Dreyfus, IGSD's Chief Scientist, was the lead author on a study published last month in the Proceedings of the National Academy of Sciences stressing the importance of a "dual strategy" (short-term SLCP reductions to complement long-term CO_2 reductions) to limit warming well below 2°C. The study concludes that decarbonizing the fossil fuel sector will have a short-term downside: removing cooling sulphates (aerosols) from the atmosphere that are currently masking the warming effects of already-emitted CO_2 and will lead to "weak, near-term warming" that could exceed the 1.5°C level by 2035 and the 2°C level by 2050.[17] Concurrently cutting super pollutants is essential for having a fighting chance of staying below the 1.5°C guardrail.[18]

Super climate pollutant reduction technologies deliver immediate cooling benefits, reduce health impacts, slow global warming, and help us avoid irreversible climate tipping points. These technologies directly achieve CARB's mission "to promote and protect public health, welfare, and ecological resources." Some examples of technologies not covered in the Plan include the use of landfill biologically active covers, selective breeding of cattle, and biogas end-use electrification. Others may be researched and considered for short-term implementation. Roughly 60% of the available targeted measures for methane have low mitigation costs (defined as less than US$21 per tonne of CO_2e for GWP_{100} and US$7 per tonne of CO_2e for GWP_{20}), and just over 50% of those have negative costs in that the measures pay for themselves.[19] Abatement technologies exist, they can be cost-effective in implementation, and they can work to quickly reduce warming in the near-term. We recommend that CARB accelerate its efforts to cut the short-lived super climate pollutants to get California back on track to achieve 2030 targets.

It is important to note that CARB is currently not on track to meet the 2030 super climate pollutant targets outlined in SB1383.[20] Further, the focus on super climate pollutant targets, especially methane, do not receive adequate attention in the final version of the Plan and are largely absent from the Executive Summary, despite California's commitment to SLCP emission reductions. The super pollutant reduction element of the 2022 Scoping Plan needs to be a prominent, front-and-center message, and serve as a key pillar of California's climate strategy going forward. Governor Newsom stated at the recent Summit of the Americas, that super pollutants such as methane "have not broken through in terms of consciousness, [and that] even the State's 40% reduction target may not be enough."[21] The 2022 Scoping Plan should bring super pollutants forward as a principal strategy.

In addition to matching the momentum of the "methane moment", California has the opportunity to guide the country and the world in implementing these fast mitigation strategies that will slow the self-reinforcing feedbacks and keep the world from breaching irreversible tipping points. The United States signed the Global Methane Pledge (GMP) at the 26th Conference of the Parties,[22] and as of 17 June 2022, has set additional goals to act on the GMP in the energy sector.[23] The Biden Administration has created a *U.S. Methane Emissions Reduction Plan* earlier this year outlining aggressive actions to prioritize deep methane reductions.

To avoid overshooting the 1.5°C guardrail, which could occur as early as 2030,[24] and reach 2030 emissions reduction goals across the United States and California, a short-lived climate pollutant strategy complementary to deep decarbonization is critical. Delaying such progress to 2045 risks upsetting the conditions that sustain human life across much of the planet. CARB must steer global climate action by repositioning California to maximize near-term (by 2030 and beyond) climate action, and help the world avert the irreversible destabilization of our climate system.

3. The need to protect front-line communities

We applaud CARB for including environmental justice concerns regarding HFCs/refrigerant replacements and energy efficiency upgrades. As recognized in the Plan, HFCs are a short-lived climate pollutant, and their reduction provides atmospheric and local cooling benefits. It is also noteworthy that CARB officially acknowledged and recognized that the cause of disproportionate environmental burden on vulnerable communities is the result of historic discriminatory policy and redlining. However, CARB *should* continue to further incorporate environmental justice approaches into the Plan, while also looking at how short-lived climate pollutant reductions can help advance environmental justice goals.

There are many overlaps between high emissions of short-lived climate pollutants (super climate pollutants, or SLCPs) and communities most affected by poor air quality, including impacts from toxic air, extreme heat, and other climate impacts, resulting in adverse health and economic impacts.[25] These are due to, for example, the lack of adequate and affordable infrastructure to promote cooling, and proximity to polluting industries, transport or port infrastructure, where key SLCPs and volatile organic compounds (VOCs) are emitted in large quantities. Many of these impacted areas are predominantly low-income communities or communities of color, that over time and without adequate public policy to revert their predicament, have become sacrifice zones victims of perpetual environmental racism and discrimination.[26] CARB rightly prioritizes disadvantaged communities in the draft 2022 Scoping Plan, but can and should reconsider timelines for complete phasing down of SLCPs that have clear impacts on the most climate-vulnerable communities, such as the phasedown of oil and gas production which has serious and direct impacts on air quality for fenceline communities. The draft 2022 Scoping Plan delays the phasing out of oil extraction to 2045, but recent studies show that the United States and other oil-producing nations must phase out of oil production by 2034 to stay within the 1.5°C guardrail agreed upon in the Paris Agreement.[27] California is setting the bar on many decarbonization actions to the benefit of disadvantaged communities, and can take even more aggressive action on SLCP phasedowns in the 2022 Scoping Plan to realize immediate benefits for the most climate-vulnerable.

We urge CARB to prioritize the voices and strategies put forth by the most affected people and areas (MAPA), and where community demands exceed CARB's jurisdiction, to work with other State agencies to support local calls for climate action as set forth in Chapter 5 of the Plan.

We would also like to commend CARB for its recent proposal in the State budget to expand the use of remote sensing technology to identify key polluters and we urge CARB to incorporate community engagement in the use and design of such technology, in order that community voice and direct engagement contribute to the State's accountability measures to control emitters. Such incorporation of community participation in remote sensing actions and use of technology, particularly of super-emitters, will facilitate increased transparency and accountability, ensuring that California is on track to meet the climate targets set out in SB32 and SB1383.[28]

4. Greenhouse gas (GHG) capture and sequestration should be considered as a strategy supplementary to mitigation and adaptation, not in place of mitigation

One strategy to limit overshoot of 1.5°C levels is to employ greenhouse gas capture systems.[29] This is recognized in the Plan in the form of carbon capture and sequestration (CCS), with bioenergy with carbon capture and storage (BECCS) as a subset of the CCS category. We urge CARB to reconsider BECCS as a climate solution, as BECCS is not carbon neutral in the critical near-term, leaving a carbon deficit for several decades to a century—with immediate and significant health risks falling on nearby communities. BECCS also poses a risk to food security if land is used to generate biomass instead of food production.[30] For detailed information on its adverse human rights and environmental impact, *see* Bloomer L., Sun X., Dreyfus G., Ferris T., Zaelke D., & Schiff C. (2021) *A Call to Stop Burning Trees in the Name of Climate Mitigation*, Vermont Journal of Environmental Law 23.

A 2018 study by Dr. Mary Booth explains that BECCS is only a useful climate strategy if these two conditions are met:

> "Biomass must genuinely be material left over from some other process; and cumulative net emissions, the additional CO2 emitted by burning biomass compared to its alternative fate, must be low or negligible in a timeframe meaningful for climate mitigation."[31]

States other than California have recognized the short-term emissions increase in deploying BECCS, and have thus issued stricter regulations in considering biomass as a renewable resource. Colorado requires that biomass must be "GHG neutral" within five years to be eligible as a renewable resource. Virginia caps the number of biomass energy credits that may be used for its renewable portfolio standards (RPS), and requires that existing stand-alone biomass plants permanently retire by 2028.[32] We urge CARB to consider the progress made in other states, and adopt the strictest regulations possible for any limited use of biomass energy with carbon capture and sequestration. We additionally encourage CARB to carefully review the legitimacy of the underpinning science of studies that argue for such technologies to be adopted as some of these studies (including on the validity of BECCS) have recently been called to question.[33]

Reliance on CCS in general must be carefully considered in the shift to decarbonization. Placing too heavy of an emphasis on this strategy may in turn perpetuate use of fossil fuel infrastructure, when funding may be better directed elsewhere to cut emissions and adapt to committed warming.

Carbon capture and sequestration must be considered as a final strategy to limit overshoot of our goals in hard-to-abate sectors.[34] This is further described in the letter from 73 climate and environmental justice organizations.

5. The Cap-and-Trade System, particularly its Compliance Offset Program, should be informed and guided by the latest development in emission metrics, carbon pricing, and environmental integrity standards

We applaud CARB for reevaluating the role of its cap-and-trade system in achieving its goal of reducing GHG emissions by 40% below the 1990 target by 2030, in light of achieving the emission reduction targets set out in the 2017 Scoping Plan ahead of schedule. As the draft 2022 Scoping Plan states, the Cap-and-Trade program will play a smaller role if new climate policies or legislation are introduced. Decreasing reliance on the Cap-and-Trade Program is a welcome sign that industry is prepared to take on greater responsibility for their GHG emissions.

However, to ensure that the Cap-and-Trade Program, particularly the Compliance Offset Program, remains a robust tool for achieving California's climate goals, it would be better served if it were informed and guided by the latest evolving metrics in measuring the climate impacts of SLCPs and standards that ensure the environmental integrity of offset credits. A study by Allen, M. *et. al.* shows that using GWP_{100} to calculate the impact of offsetting methane emissions with CO_2 reduction or removal projects will result in global temperature increase 45 years after project implementation. On the other hand, offsetting CO_2 emissions with methane mitigation projects will result in an increase in global temperature on all timescales beyond 45 years.[35] For more information on the effect of metrics in estimating climate impacts of SLCPs, particularly methane, nitrous oxide, and HFCs, *see* Dreyfus, G., Xu, Y., Shindell, D.T., Zaelke, D., & Ramanathan, V. (2022) *Mitigating climate disruption in time: A self-consistent approach for avoiding both near-term and long-term global warming*, PNAS 119.

Moreover, carbon pricing should reflect not only the supply and demand for allowances but also the social impact of continued GHG emissions. Environmental experts vary on the optimal carbon price to adequately account for the social cost of greenhouse gas emissions but have recommended prices ranging from US$50 to US$417. We urge CARB to consider the social cost of carbon and other GHGs as identified by the U.S. Interagency Working Group on the Social Cost of Carbon and Other GHGs and include measures for their inclusion in this Plan.

Finally, we urge CARB to also consider improving the Offset Protocols under their Compliance Offset Program. The Program, in its current iteration, is vulnerable to 'adverse selection', where only projects that are likely to have reduced emissions without the program are undertaken. This poses a risk for offset projects to be non-additional and creates a doubt as to the environmental integrity of offset credits. Thus, this Plan should consider measures to conduct an objective and scientifically credible investigation of additionality to further strengthen California's Cap-and-Trade system.

6. Conclusion: California can and should do more, especially to cut near-term warming

California has been, is, and will continue to be, a world leader in the climate and environmental justice space. On July 9th 2021, Governor Newsom requested the California Air Resources Board

to consider how California may reach carbon neutrality by 2035, narrowing the timeline by 10 years to achieve climate success in the *nearer* future.[36]

The latest draft 2022 Scoping Plan can still be improved to meet the call of the Governor's urgency *to do more, to do it faster and to do it better*, not only helping California meet its climate targets and alleviate climate impacts for Californians, but also to help guide and steer governments around the world to do what is urgently needed to address our deepening planetary climate emergency.[37] By regulating and reducing emissions of short-lived climate pollutants more aggressively, in line with 2030 targets, CARB can protect public health, welfare, and the ecological resources of California, and set the bar even higher for national and global action on climate. We urge CARB to explore each and every way possible for the 2022 Scoping Plan to best serve meeting 2030 goals, particularly through the most effective strategy that science indicates, the aggressive reduction of short-lived climate pollutants, as our planet, and our most climate-vulnerable communities depend on it.

Respectfully submitted,

Durwood Zaelke
Kristen Taddonio
Valerie Fajardo
Amelia Murphy
Caitlan Frederick
Institute for Governance & Sustainable Development
5800 MacArthur Blvd NW
Washington, DC 20007
Zaelke@igsd.org

Jorge Daniel Taillant
Lian Beckstead
Center for Human Rights and the Environment
jdtaillant@gmail.com

Antonina Markoff
Coordinator, Climate Reality California State Coalition
antoninamarkoff@gmail.com

Janet W. Cox
Legislation/Policy Director
350 Silicon Valley

References

[1] Badgley G., Freeman J., Hamman J.J., Haya B., Trugman A.T., Anderegg W.R.L., Cullenward D. (2021) *Systematic over-crediting in California's forest carbon offsets program*, GLOBAL CHANGE BIOLOGY, 28(4) 1433-1445, 1433 ("By design, California's program awards large volumes of offset credits to forest projects with carbon stocks that exceed regional averages. This paradigm allows for adverse selection, which could occur if project developers preferentially select forests that are ecologically distinct from unrepresentative regional averages. By digitizing and analyzing comprehensive offset project records alongside detailed forest inventory data, we provide direct evidence that comparing projects against coarse regional carbon averages has led to systematic over-crediting of 30.0 million tCO2e (90% CI: 20.5 to 38.6 million tCO2e) or 29.4% of the credits we analyzed (90% CI: 20.1 to 37.8%). These excess credits are worth an estimated $410 million (90% CI: $280 to $528 million) at recent market prices. Rather than improve forest management to store additional carbon, California's offsets program creates incentives to generate offset credits that do not reflect real climate benefits.").

[2] Cushing L., Blaustein-Rejto D., Wander M., Pastor M., Sadd J., Zhu A., Morello-Frosch R., (2018) *Carbon trading, co-pollutants, and environmental equity: Evidence from California's cap-and-trade program (2011–2015)* PLOS MED 15, 1-20, 1 ("Moreover, the majority (52%) of regulated facilities reported higher annual average local (in-state) GHG emissions since the initiation of trading. Neighborhoods that experienced increases in annual average GHG and co-pollutant emissions from regulated facilities nearby after trading began had higher proportions of people of color and poor, less educated, and linguistically isolated residents, compared to neighborhoods that experienced decreases in GHGs.").

[3] *See* Mulkern A. C., (28 April 2022) Calif. cap-and-trade revenues fund corporate upgrades E&E NEWS; *see also* Mulkern A. C., (13 May 2022) Wildfires eat up $1.9B of Calif. cap-and-trade revenue E&E NEWS; *and* Choi-Schagrin W., (23 August 2021) Wildfires are ravaging forests set aside to soak up greenhouse gases NEW YORK TIMES.

[4] *See:* Office of Governor Gavin Newsom (10 June 2022) *RECAP: California on the World Stage at Summit of the Americas*, Statements and Releases.

[5] Xu Y., Ramanathan V., & Victor D. G. (2018) *Global warming will happen faster than we think*, Comment, NATURE 564(7734): 30–32, 30–31 ("But the latest IPCC special report underplays another alarming fact: global warming is accelerating. Three trends—rising emissions, declining air pollution and natural climate cycles—will combine over the next 20 years to make climate change faster and more furious than anticipated. In our view, there's a good chance that we could breach the 1.5 °C level by 2030, not by 2040 as projected in the special report (see 'Accelerated warming'). The climate-modelling community has not grappled enough with the rapid changes that policymakers care most about, preferring to focus on longer-term trends and equilibria."). *See also* Arias P. A., *et al.* (2021) Technical Summary, *in* CLIMATE CHANGE 2021: THE PHYSICAL SCIENCE BASIS, *Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change*, Masson-Delmotte V., *et al.* (eds.), TS-9 ("Timing of crossing 1.5°C global warming: Slightly different approaches are used in SR1.5 and in this Report. SR1.5 assessed a likely range of 2030 to 2052 for reaching a global warming level of 1.5°C (for a 30-year period), assuming a continued, constant rate of warming. In AR6, combining the larger estimate of global warming to date and the assessed climate response to all considered scenarios, the central estimate of crossing 1.5°C of global warming (for a 20-year period) occurs in the early 2030s, ten years earlier than the midpoint of the likely range assessed in the SR1.5, assuming no major volcanic eruption. (TS.1.3, Cross-Section Box TS.1)") *and* Matthews H. D., Tokarska K. B., Rogelj J., Smith C. J., MacDougall A. H., Haustein K., Mengis N., Sippel S., Forster P. M., & Knutti R. (2021) *An integrated approach to quantifying uncertainties in the remaining carbon budget*, COMMUN. EARTH & ENVIRON. 2: 1–11, 5 ("It is worth noting however, that the spread of our [remaining carbon budget (RCBs)] estimate does include negative values, with a 17% chance that the RCB for 1.5 °C is less than zero (i.e. is already exceeded). This outcome could arise due to current and/or unrealised future warming being at the higher end of their respective distributions, or in the case that the current non-CO_2 forcing fraction is small or negative owing to very strong current aerosol forcing. In this case, we would expect 1.5 °C to be exceeded even in the absence of additional emissions, and any future emissions between now and the time of net-zero CO_2 emissions would cause temperatures to rise further above this threshold.").

[6] *See* IGSD's Background Note: The Need for Fast Near-Term Climate Mitigation to Slow Feedbacks and Tipping Points: *Critical Role of Short-lived Super Climate Pollutants in the Climate Emergency*, for more information on the science of the need for fast mitigation and the role of SLCPs in quickly reducing warming.

[7] Molina M., Ramanathan V., & Zaelke D. (9 October 2018) *Climate report understates threat*, BULLETIN OF THE ATOMIC SCIENTISTS ("The UN's Intergovernmental Panel on Climate Change's Special Report on Global Warming of 1.5 degrees Celsius, released on Monday, is a major advance over previous efforts to alert world leaders and citizens to the growing climate risk. But the report, dire as it is, misses a key point: Self-reinforcing feedbacks and tipping points—the wildcards of the climate system—could cause the climate to destabilize even further. The report also fails to discuss the five percent risk that even existing levels of climate pollution, if continued unchecked, could lead to runaway warming—the so-called "fat tail" risk. These omissions may mislead world leaders into thinking they have more time to address the climate crisis, when in fact immediate actions are needed. To put it bluntly, there is a significant risk of self-reinforcing climate feedback loops pushing the planet into chaos beyond human control."). *See also* Lenton T. M., Rockstrom J., Gaffney O., Rahmstorf S., Richardson K., Steffen W., & Schellnhuber H. J. (2019) *Climate tipping points—too risky to bet against*, Comment, NATURE 575(7784): 592–595, 592 ("In our view, the consideration of tipping points helps to define that we are in a climate emergency and strengthens this year's chorus of calls for urgent climate action — from schoolchildren to scientists, cities and countries."); Witze A. (10 September 2020) *The Arctic is burning like never before — and that's bad news for climate change*, NATURE NEWS ("Wildfires blazed along the Arctic Circle this summer, incinerating tundra, blanketing Siberian cities in smoke and capping the second extraordinary fire season in a row. By the time the fire season waned at the end of last month, the blazes had emitted a record 244 megatonnes of carbon dioxide — that's 35% more than last year, which also set records. One culprit, scientists say, could be peatlands that are burning as the top of the world melts."); *and* Fox-Kemper B., *et al.* 39 (2021) *Chapter 9: Ocean, Cryosphere and Sea Level Change*, in CLIMATE CHANGE 2021: THE PHYSICAL SCIENCE BASIS, *Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change*, Masson-Delmotte V., *et al.* (eds.), 9-48 ("The SR1.5 assessed with *high confidence* that there is no hysteresis in the loss of Arctic summer sea ice. In addition, there is no tipping point or critical threshold in global mean temperature beyond which the loss of summer sea ice becomes self-accelerating and irreversible (*high confidence*).").

[8] Jacobs P., Lenssen N. J. L., Schmidt G. A., & Rohde R. A. (2021) *The Arctic Is Now Warming Four Times As Fast As the Rest of the Globe*, Presentation at the American Geophysical Union Fall Meeting, A13E-02 ("We demonstrate the Arctic is likely warming over 4 times faster than the rest of the world, some 3-4 times the global average, with higher rates found both for more recent intervals as well as more accurate latitudinal boundaries. These results stand in contrast to the widely-held conventional wisdom — prevalent across scientific and lay publications alike — that the Arctic is "only" warming around twice as fast as the global mean."); *discussed in* Voosen P. (14 December 2021) *The Arctic is warming four times faster than the rest of the world*, SCIENCE.

[9] Druckenmiller M. L., *et al.* (2021) *The Arctic*, BULL. AM. MET. SOC. 102(8): S263–S316, S280 ("September is the month when the minimum annual sea ice extent occurs. In 2020, this average monthly ice extent was 3.92 million km2 (Fig. 5.8b), the second lowest monthly extent in the 42-year satellite record. On 15 September, the annual minimum Arctic sea ice extent of 3.74 million km2 was reached; this was also the second lowest on record. The September monthly extent has been decreasing at an average rate of −82,700 km2 per year since 1979 (−13.1% per decade relative to the 1981–2010 average; Fig. 5.8c)."). *See also* Pistone K., Eisenman I., & Ramanathan V. (2014) *Observational determination of albedo decrease caused by vanishing Arctic sea ice*, PROC. NAT'L. ACAD. SCI. 111(9): 3322–3326 ("The Arctic has warmed by nearly 2 °C since the 1970s, a temperature change three times larger than the global mean (1). During this period, the Arctic sea ice cover has retreated significantly, with the summer minimum sea ice extent decreasing by 40% (2)."); *and* Jansen E., *et al.* (2020) *Past perspectives on the present era of abrupt Arctic climate change*, NAT. CLIM. CHANGE 10: 714–721, 714 ("Annual mean temperature trends over the Arctic during the past 40 years show that over this period, where satellite data are available, major portions have warmed by more than 1 °C per decade (Fig. 1a, red colours and outlined portion; a warming of 4 °C within 40 years is hereafter referred to as 1 °C per decade). … Using a criterion based on the speed of near-surface air temperature warming over the past four decades, we find that the current Arctic is experiencing rates of warming comparable to abrupt changes, or D–O events, recorded in Greenland ice cores during the last glacial period. [During the last glacial period (120,000–11,000 years ago), more than 20 abrupt periods of warming, known as Dansgaard–Oeschger (D–O) events, took place18,19.] Both past changes in the Greenland ice cores and the ongoing trends in the Arctic are directly linked to sea-ice retreat—in the Nordic Seas during glacial times and in the Eurasian Arctic at present. Abrupt changes

have already been experienced and could, according to state-of-the-art climate models, occur in the Arctic during the twenty-first century, but climate models underestimate current rates of change in this region.").

[10] Isaksen K., Nordli Ø., Køltzow MA., Aaboe S., Gjelten HM., Mezghani A., Eastwood S., Førland E., Benestad RE., Hanssen-Bauer I., Brækkan R., Sviaschschennikov P., Demin V., Revina A., & Karadasheva T. (2022) *Exceptional warming over the Barents sea* NATURE SCIENTIFIC REPORTS 12(9371): 1-18, 11. ("The increasing temperature rates for the Northern Barents Sea region are exceptional on the Arctic and global scale and correspond to 2 to 2.5 times the Arctic warming averages and 5 to 7 times the global warming averages (Fig. 7).").

[11] Pistone K., Eisenman I., & Ramanathan V. (2019) *Radiative Heating of an Ice-Free Arctic Ocean*, GEOPHYS. RES. LETT. 46(13): 7474–7480, 7477 ("This heating of 0.71 W/m^2 is approximately equivalent to the direct radiative effect of emitting one trillion tons of CO_2 into the atmosphere (see calculation in Appendix A). As of 2016, an estimated 2.4 trillion tons of CO_2 have been emitted since the preindustrial period due to both fossil fuel combustion (1.54 trillion tons) and land use changes (0.82 trillion tons), with an additional 40 billion tons of CO_2 per year emitted from these sources during 2007–2016 (Le Quéré et al., 2018). Thus, the additional warming due to the complete loss of Arctic sea ice would be equivalent to 25 years of global CO_2 emissions at the current rate.").

[12] Wadhams P. (2017) A FAREWELL TO ICE: A REPORT FROM THE ARCTIC, Oxford University Press: Oxford, United Kingdom, 107–108 ("Warm air over an ice-free Arctic also causes the snowline to retreat. … This of the same magnitude as the sea ice negative anomaly during the same period, and the change in albedo is roughly the same between snow-covered land and snow-free tundra as it is between sea ice and open water. Nobody has yet published the calculations for tundra as Pistone and her colleagues did for sea ice, but the similarity of the magnitudes means that snowline retreat and sea ice retreat are each adding about the same amount to global warming.").

[13] Lenton T. M., Rockstrom J., Gaffney O., Rahmstorf S., Richardson K., Steffen W., & Schellnhuber H. J. (2019) *Climate tipping points—too risky to bet against*, Comment, NATURE 575(7784): 592–595, 594. *See also* Steffen W., *et al*. (2018) *Trajectories of the Earth System in the Anthropocene*, PROC. NAT'L. ACAD. SCI. 115(33): 8252–8259, 8254 ("This analysis implies that, even if the Paris Accord target of a 1.5 °C to 2.0 °C rise in temperature is met, we cannot exclude the risk that a cascade of feedbacks could push the Earth System irreversibly onto a "Hothouse Earth" pathway. The challenge that humanity faces is to create a "Stabilized Earth" pathway that steers the Earth System away from its current trajectory toward the threshold beyond which is Hothouse Earth (Fig. 2). The humancreated Stabilized Earth pathway leads to a basin of attraction that is not likely to exist in the Earth System's stability landscape without human stewardship to create and maintain it. Creating such a pathway and basin of attraction requires a fundamental change in the role of humans on the planet. This stewardship role requires deliberate and sustained action to become an integral, adaptive part of Earth System dynamics, creating feedbacks that keep the system on a Stabilized Earth pathway (Alternative Stabilized Earth Pathway).").

[14] Romanello M., et al. (2021) *The 2021 report of the Lancet Countdown on health and climate change: code red for a healthy future*, THE LANCET 398(10311): 1619–1662, 1619–1620 ("The 44 indicators of this report expose an unabated rise in the health impacts of climate change and the current health consequences of the delayed and inconsistent response of countries around the globe—providing a clear imperative for accelerated action that puts the health of people and planet above all else…. Through these effects, rising average temperatures, and altered rainfall patterns, climate change is beginning to reverse years of progress in tackling the food and water insecurity that still affects the most underserved populations around the world, denying them an essential aspect of good health.").

[15] *See generally*: Islam N. & Winkel J. (2017) *Climate Change and Social Inequality*, United Nations Department of Economic and Social Affairs Working Paper No. 152.

[16] Kammen D.M., Matlock T., Pastor M., Pellow D., Ramanathan V., Steyer T., Stokes L., & Ventura F. (2021) *Accelerating the timeline for climate action in California*, THE CLIMATE CENTER, 2-3 ("California must now accelerate its climate policy innovation and implementation timelines to decarbonize the economy more rapidly. Still, decarbonization measures, while essential, will take two to three decades to have an impact on the steeply warming curve. The need for speed is great and it is a race against time to keep warming from shooting past 2°C well before 2050. Given the likelihood that warming will cross the 1.5°C threshold within the next 10 years, 14 and the fact that current greenhouse emissions are about 49 gigatons of CO_2eq per year globally, relying just on deep decarbonization is not enough anymore to limit warming well below 2°C. We need to pull on three levers to bend the warming curve

before it reaches 2°C. 1. The first lever, of course, is zero emissions of CO_2. 2. The second lever involves drastic reductions in super pollutants that are short-lived—black carbon, methane, tropospheric ozone, and hydrofluorocarbons (HFCs). These super pollutants are about 30 to 2000 times more potent than CO2 in trapping infrared heat. Black carbon is soot emitted by mostly diesel engines and lives in the air for a week; its heat-trapping power is 2000 times that of CO_2. HFCs used as refrigerants are also about 2000 time more potent. Collectively these super pollutants are responsible for about 40% of warming globally. Reducing methane emissions by half, reducing soot emissions by 80% with soot-free vehicles such as electric vehicles, replacing currently used HFCs with zero- to low-warming potential refrigerants, and decreasing sources of methane emissions such as leaks from natural gas pipes, food, and other landfilled organic waste, if implemented now, can cut the rate of warming over the next 2 to 3 decades by half.").

[17] Dreyfus G. B., Xu Y., Shindell D. T., Zaelke D., & Ramanathan V. (2022) *Mitigation climate disruption in time: A self-consistent approach for avoiding both near-term and long-term global warming*, PROC. NAT'L. ACAD. SCI. 119 (22) e2123536119, 1-8, 1 ("We find that mitigation measures that target only decarbonization are essential for strong long-term cooling but can result in weak near-term warming (due to unmasking the cooling effect of co-emitted aerosols) and lead to temperatures exceeding 2°C before 2050. In contrast, pairing decarbonization with additional mitigation measures targeting short-lived climate pollutants (SLCPs) and N2O, slows the rate of warming a decade or two earlier than decarbonization alone and avoids the 2°C threshold altogether. These non-CO2 targeted measures when combined with decarbonization can provide net cooling by 2030, reduce the rate of warming from 2030 to 2050 by about 50%, roughly half of which comes from methane, significantly larger than decarbonization alone over this timeframe.").

[18] Dreyfus G. B., Xu Y., Shindell D. T., Zaelke D., & Ramanathan V. (2022) *Mitigation climate disruption in time: A self-consistent approach for avoiding both near-term and long-term global warming*, PROC. NAT'L. ACAD. SCI. 119 (22) e2123536119, 1-8, 1 ("We find that mitigation measures that target only decarbonization are essential for strong long-term cooling but can result in weak near-term warming (due to unmasking the cooling effect of co-emitted aerosols) and lead to temperatures exceeding 2°C before 2050. In contrast, pairing decarbonization with additional mitigation measures targeting short-lived climate pollutants (SLCPs) and N2O, slows the rate of warming a decade or two earlier than decarbonization alone and avoids the 2°C threshold altogether. These non-CO2 targeted measures when combined with decarbonization can provide net cooling by 2030, reduce the rate of warming from 2030 to 2050 by about 50%, roughly half of which comes from methane, significantly larger than decarbonization alone over this timeframe."). See also Ou Y., Roney C., Alsalam J., Calvin K., Creason J., Edmonds J., Fawcett A. A., Kyle P., Narayan K., O'Rourke P., Patel P., Ragnauth S., Smith S. J., & McJeon H. (2021) *Deep mitigation of CO2 and non-CO2 greenhouse gases toward 1.5 °C and 2 °C futures*, NATURE COMMUN. 12: 6245, 4 ("CO2 abatement only cannot achieve the 1.5 °C target under all modeled 1.5 °C pathways but achieves the 2 °C target if reaching net-zero CO2 by 2030 under 2 °C pathways; CO2-driven GHG abatement achieves the 1.5 °C target if reaching net-zero CO2 by 2032 under 1.5 °C pathways or achieves the 2 °C target if reaching net-zero CO2 by 2045 under 2 °C pathways; Comprehensive GHG abatement achieves the 1.5 °C target if reaching net-zero CO2 by 2053 under 1.5 °C pathways or achieves the 2 °C target if reaching net-zero CO2 by 2075 under 2 °C pathways.").

[19]United Nations Environment Programme & Climate & Clean Air Coalition (2021) GLOBAL METHANE ASSESSMENT: BENEFITS AND COSTS OF MITIGATING METHANE EMISSIONS, 10 ("Roughly 60 per cent, around 75 Mt/yr, of available targeted measures have low mitigation costs2, and just over 50 per cent of those have negative costs – the measures pay for themselves quickly by saving money (Figure SDM2). Low-cost abatement potentials range from 60–80 per cent of the total for oil and gas, from 55–98 per cent for coal, and approximately 30–60 per cent in the waste sector. The greatest potential for negative cost abatement is in the oil and gas subsector where captured methane adds to revenue instead of being released to the atmosphere. (Section 4.2)"; "Less than US$ 600 per tonne of methane reduced, which would correspond to ~US$ 21 per tonne of carbon dioxide equivalent if converted using the IPCC Fifth Assessment Report's GWP_{100} value of 28 that excludes carbon-cycle feedbacks.").

[20] *Discussed in* (2021) *2022 Scoping Plan Update – Short - Lived Climate Pollutants Workshop* (California Air Resources Board presentation, 8 September 2021).

[21] *See:* Office of Governor Gavin Newsom (10 June 2022) *RECAP: California on the World Stage at Summit of the Americas*, Statements and Releases.

[22] Secretariat of the United Nations Framework Convention on Climate Change (2 November 2021) *World Leaders Kick Start Accelerated Climate Action at COP26*, Press Release ("Today is also the first time a COP in recent history has hosted a major event on methane, with 103 countries, including 15 major emitters including Brazil, Nigeria and Canada, signing up to the Global Methane Pledge.").

[23] White House (17 June 2022) *U.S.-EU Joint Press Release on the Global Methane Pledge Energy Pathway*, Statements and Releases ("Today, the United States, the European Union, and 11 countries launched the Global Methane Pledge Energy Pathway to catalyze methane emissions reductions in the oil and gas sector, advancing both climate progress and energy security.").

[24] Xu Y., Ramanathan V., & Victor D. G. (2018) *Global warming will happen faster than we think*, Comment, NATURE 564(7734): 30–32, 30–31 ("But the latest IPCC special report underplays another alarming fact: global warming is accelerating. Three trends—rising emissions, declining air pollution and natural climate cycles—will combine over the next 20 years to make climate change faster and more furious than anticipated. In our view, there's a good chance that we could breach the 1.5 °C level by 2030, not by 2040 as projected in the special report (see 'Accelerated warming'). The climate-modelling community has not grappled enough with the rapid changes that policymakers care most about, preferring to focus on longer-term trends and equilibria.").

[25] Islam S. N. & Winkel J. (2017) CLIMATE CHANGE AND SOCIAL INEQUALITY, United Nations Department of Economic & Social Affairs Working Paper No. 152, 2 ("[T]he relationship between climate change and social inequality is characterized by a vicious cycle, whereby initial inequality makes disadvantaged groups suffer disproportionately from the adverse effects of climate change, resulting in greater subsequent inequality. The paper identifies three channels through which the above process unfolds. First, inequality increases the exposure of the disadvantaged social groups to the "adverse effects of climate change" ("climate hazards," for short). Second, given the exposure level, inequality increases the disadvantaged groups' susceptibility to damages caused by climate hazards. Third, inequality decreases these groups' relative ability to cope with and recover from the damages they suffer. The paper presents evidence supporting each of these three channels.").

[26] Cushing L., Blaustein-Rejto D., Wander M., Pastor M., Sadd J., Zhu A., Morello-Frosch R., (2018) *Carbon trading, co-pollutants, and environmental equity: Evidence from California's cap-and-trade program (2011–2015)* PLOS MED 15, 1-20, 1 ("Moreover, the majority (52%) of regulated facilities reported higher annual average local (in-state) GHG emissions since the initiation of trading. Neighborhoods that experienced increases in annual average GHG and co-pollutant emissions from regulated facilities nearby after trading began had higher proportions of people of color and poor, less educated, and linguistically isolated residents, compared to neighborhoods that experienced decreases in GHGs."). *See also* Cushing L., Wander M., Morello-Frosh R., Pastor M., Zhu A., (2016) A PRELIMINARY ENVIRONMENTAL EQUITY ASSESSMENT OF CALIFORNIA'S CAP-AND-TRADE PROGRAM, Program for Environmental and Regional Equity at University of Southern California; California EPA (2021) POLLUTION AND PREJUDICE.; The Digital Shcolarship Lab and the National Community Reinvestment Coalition, NOT EVEN PAST: SOCIAL VULNERABILITY AND THE LEGACY OF REDLINING, Nelson R.K., Ayers E.L. (eds.).; *and* Godoy M. (2020) *In U.S. Cities, The Health Effects of Past Housing Discrimination Are Plain to See*, NPR.

[27] Calverly D., Anderson K. (2022) PHASEOUT PATHWAYS FOR FOSSIL FUEL PRODUCTION WITHIN PARIS-COMPLIANT CARBON BUDGETS, Tyndall Centre University of Manchester, 54. ("For our central scenario (50% chance of 1.5°C), the final redistribution that balanced equity with delivery sees oil and gas production in the wealthiest (Group 1) nations reduce by 50% in just six years, and cease by 2034.").

[28] See a recently-published guide for journalists on covering methane and investigating specific sources: McIntosh T. (6 February 2022) *GIJN's Guide to Investigating Methane — A Key to Fighting Climate Change,* GLOBAL INVESTIGATIVE JOURNALISM NETWORK.

[29] Intergovernmental Panel on Climate Change (2022) *Summary for Policymakers*, in CLIMATE CHANGE 2022: MITIGATION OF CLIMATE CHANGE, *Contribution of Working Group III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change*, Shukla P. R., *et al.* (eds.), SPM-32 ("All global modelled pathways that limit warming to 1.5°C (>50%) with no or limited overshoot, and those that limit warming to 2°C (>67%) involve

rapid and deep and in most cases immediate GHG emission reductions in all sectors. Modelled mitigation strategies to achieve these reductions include transitioning from fossil fuels without CCS to very low- or zero-carbon energy sources, such as renewables or fossil fuels with CCS, demand side measures and improving efficiency, reducing non-CO2 emissions, and deploying carbon dioxide removal (CDR) methods to counterbalance residual GHG emissions. Illustrative Mitigation Pathways (IMPs) show different combinations of sectoral mitigation strategies consistent with a given warming level. (*high confidence*) (Figure SPM.5) {3.2, 3.3, 3.4, 6.4, 6.6}.").

[30] Bloomer L., Sun X., Dreyfus G., Ferris T., Zaelke D., & Schiff C. (2022) *A Call to Stop Burning Trees in the Name of Climate Mitigation*, VT. J. ENVTL. LAW 23: 94–123, 107 ("Lastly, large-scale deployment of BECCS would impact food and water security, which could intensify social conflicts. The IPCC Special Report on Climate Change and Land warns that high implementation of BECCS (11.3 GtCO2 yr-1 in 2050) could increase the population at risk of hunger by up to 150 million people. The competition between food and bioenergy crops would hit low- and middle-income countries hardest, partially because of increased food prices.") *See also:* Intergovernmental Panel on Climate Change (2020), *Summary for Policymakers* in CLIMATE CHANGE AND LAND, Masson-Delmotte V. *et al* (eds.), D.2.3 ("Some mitigation options can increase competition for scarce resources including land, water and biomass. Consequently, these can also reduce adaptive capacity, especially if deployed at larger scale and with high expansion rates thus exacerbating existing risks in particular where land and water resources are very limited. Examples include the large-scale or poorly planned deployment of bioenergy, biochar, and afforestation of naturally unforested land. (high confidence) {12.5, 17.3}"), E.1.1 ("While many mitigation options have environmental co-benefits, including improved air quality and reducing toxic waste, many also have adverse environmental impacts, such as reduced biodiversity, when applied at very large scale, for example very large scale bioenergy or large scale use of battery storage, that would have to be managed (medium confidence). Almost all mitigation options face institutional barriers that need to be addressed to enable their application at scale (medium confidence). {6.4, Figure 6.19, 7.4, 8.5, Figure 8.19, 9.9, Figure 9.20, 10.8, Figure 10.23, 12.3, Figure 12.4, Figure TS.31}").

[31] Booth M. S. (2018) *Not Carbon Neutral: Assessing the Net Emissions Impact of Residues Burned for Bioenergy*, ENVIRON. RES. LETT. 13: 1–10, 8 ("For bioenergy to offer genuine climate mitigation, it is essential to move beyond the assumption of instantaneous carbon neutrality. The [net emissions impact (NEI)] approach provides a simple means to estimate net bioenergy emissions over time, albeit one that tends to underestimate actual impacts. The model finds that for plants burning locally sourced wood residues, from 41% (extremely rapid decomposition) to 95% (very slow decomposition) of cumulative direct emissions should be counted as contributing to atmospheric carbon loading by year 10. Even by year 50 and beyond, the model shows that net emissions are a significant proportion of direct emissions for many fuels."). *See also* Sterman J. D., *et al.* (2018) *Does Replacing Coal with Wood Lower CO_2 Emissions? Dynamic Lifecycle Analysis of Wood Bioenergy*, ENVIRON. RES. LETT. 13: 1–10, 8 ("Scenario 2 shows the realistic case with the combustion efficiency and supply chain emissions estimated for wood pellets (supplementary table S5), again assuming 25% of the biomass is harvested by thinning. Because production and combustion of wood generate more CO2 than coal, the first impact of bioenergy use is an increase in atmospheric CO2. Regrowth gradually transfers C from the atmosphere to biomass and soil C stocks, leading to a carbon debt payback time of 52 years; after 100 years CO2 remains 62% above the zero C case.").

[32] Bloomer L., Sun X., Dreyfus G., Ferris T., Zaelke D., & Schiff C. (2022) *A Call to Stop Burning Trees in the Name of Climate Mitigation*, VT. J. ENVTL. LAW 23: 94–123, 115 ("Colorado passed a law in 2021 requiring that biomass must be "GHG neutral" within five years to be eligible as a renewable resource. In March 2020, Virginia passed the Clean Economy Act, which requires Virginia's power producers to reduce their emissions to zero by 2050 and transition to clean energy. The Act excludes woody biomass from its definition of eligible sources for Virginia's RPS and defines "zero-carbon electricity" as "electricity generated by any generating unit that does not emit carbon dioxide as a by-product of combusting fuel to generate electricity.").

[33] *See* Roth S., (23 June 2022) *Is a Michigan energy firm using dark money to influence California's climate plans?* LA TIMES.

[34] Intergovernmental Panel on Climate Change (2022) *Summary for Policymakers*, in CLIMATE CHANGE 2022: MITIGATION OF CLIMATE CHANGE, *Contribution of Working Group III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change*, Shukla P. R., *et al.* (eds.), SPM-47 ("The deployment of CDR to counterbalance hard-to-abate residual emissions is unavoidable if net zero CO2 or GHG emissions are to be achieved. The scale and timing of deployment will depend on the trajectories of gross emission reductions in different sectors.

Upscaling the deployment of CDR depends on developing effective approaches to address feasibility and sustainability constraints especially at large scales. (high confidence) {3.4, 7.4, 12.3, Cross-Chapter Box 8 in Chapter 12}").

[35] Allen M., Tanaka K., Macey A., Cain M., Jenkins S., Lynch J., Smith M. (2021) *Ensuring that offsets and other internationally transferred mitigation outcomes contribute effectively to limiting global warming,* ENVIRON. RES. LETT. 16(2021) 1-9, 2 ("For example, suppose a party or non-state actor A decides to emit 1 t CO2-equivalent of methane, a potent but short-lived climate pollutant (SLCP), that they had otherwise pledged to avoid emitting. Instead, A decides to pay B to sequester 1 t CO2-equivalent of a very-long-lived, cumulative pollutant like CO2. Although it has no impact on nominal aggregate CO2 -equivalent emissions calculated using GWP100 , this transaction results in an increase in global temperature for approximately 45 years, and lowered temperatures thereafter (purple line in figure 1(a)). If, conversely, A decides to offset the emission of 1 t of CO2 by paying B to avoid emitting 1 t CO2-equivalent of methane, global temperatures are increased on all timescales greater than 45 years (purple line in figure 2(a)) [7–9].").

[36] Office of Governor Gavin Newsom (09 July 2021) *Governor Newsom Holds Virtual Discussion with Leading Climate Scientists on State's Progress Toward Carbon Neutrality,* Press Release.

[37] *Discussed in* The Times Editorial Board (2022) *California needs to slash carbon pollution. Its pie-in-the-sky plan falls short,* THE LOS ANGELES TIMES.