Statement Regarding Concerns About Certain Emerging Technologies

From Colorado Coalition for a Liveable Climate's 43 member groups and other allies

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Summary

As Colorado seeks to address the climate challenges of our time, we appreciate efforts to adopt solutions that positively impact our state. However, we have serious concerns surrounding several of the "emerging" technologies being promoted; in particular, carbon capture and sequestration, direct air capture, hydrogen, and nuclear. We are troubled by the lack of risk-analysis, cost-analysis, and impact-analysis being done in these sectors. We are also concerned that the pursuit and/or adoption of these technologies may further delay action to reduce emissions by redirecting resources and investment away from viable solutions that already exist, such as wind, solar, conservation, and stable energy-storage. We ask for a more rigorous evaluation of emerging technologies than has been presented so far, and for careful re-consideration before pursuing them further.

Carbon Management

We are concerned that "novel" carbon management methods such as Direct Air Capture and Carbon Capture are unlikely to achieve meaningful CO2 reduction at the levels needed to meet our future climate goals. Currently these strategies are prohibitively expensive and unproven on a widely deployed scale. Even if backed by substantial funding, effective implementation would require decades of research and development - a luxury we do not have. Furthermore, we are concerned that novel carbon management strategies could extend the life cycle of the fossil fuel industry by continuing dependence on oil and gas rather than phasing them out. We ask for climate mitigation efforts focused on stopping the production and consumption of fossil fuels, while also promoting growth in "conventional" carbon dioxide removal methods such as reforestation, ecosystem restoration and agroforestry.

Hydrogen

Our findings indicate Colorado should only put resources toward green hydrogen, which is produced by splitting the water molecule and uses 100% renewable energy. Blue hydrogen is produced from methane and creates more GHG emissions per unit of energy than burning coal, diesel, or fossil gas. The federal definition of "clean" hydrogen includes blue hydrogen, as does Colorado's hydrogen roadmap, hydrogen hub and HB23-1281. Hydrogen produced from methane pollutes communities, perpetuates fossil fuel extraction, and increases GHG emissions. Even green hydrogen should be used sparingly. It is inefficient, costly and unsafe in sectors such as vehicles, building heating, and power generation. Hydrogen is only economical in difficult to decarbonize sectors such as maritime shipping, aviation and industrial processes. In developing technological solutions, Colorado should pursue green hydrogen as defined by the International Energy Agency, and should not continue to include blue hydrogen in its energy roadmap or future legislation.

Nuclear

While proponents of nuclear energy claim that it is a clean and carbon-free energy source, research indicates otherwise. The development of nuclear reactors and the mining of raw materials like uranium are highly carbon intensive. The generation of nuclear power creates dangerous waste that remains radioactive for thousands of years, and no sustainable solutions exist for long term storage. Nuclear power plants also pose grave risks to surrounding communities because damage from natural or human related accidents would be catastrophic. Nuclear power is the most water-intensive form of power generation. A single 300 megawatt plant requires hundreds of millions of gallons of water per day. Nuclear power is not competitive in cost or time of deployment, and "advanced nuclear plants," including Small Modular Reactors, are so far an unproven technology. Marginalized communities surrounding nuclear power plants have been linked to higher rates of cancer, and historically bear a disproportionate burden of the environmental and health impacts of uranium mining.

Carbon Management

Overview: Carbon Management refers to a suite of emerging technologies that aim to reduce carbon emissions by developing financially and environmentally sustainable mitigation strategies. While there is a place for carbon management in the IPCC Assessment's plan for addressing climate change, it is important to highlight that these technologies provide widely variable advantages and disadvantages. We give an overview of some of the most frequently discussed carbon management technologies here, while also highlighting some of our concerns.

Carbon Dioxide Removal

The 2023 IPCC AR6 Synthesis Report states that negative emissions will be necessary in order to keep warming under 1.5°C. Carbon Dioxide Removal (CDR), both in its "conventional" and "novel" forms, will be required to meet this goal, especially to counterbalance hard to abate emissions in aviation, shipping and industry. **Even so, it must be stressed that no form of CDR, even at scale, will allow us to meet our climate goals without timely and aggressive cuts to GHG emissions. CDR should not be viewed as a "free pass" to continue burning fossil fuels at current (or increasing) levels.**

Novel CDR includes means such as Direct Air Capture (DAC), biochar, and enhanced rock weathering. DAC has received much of the focus in this sector, although it still lacks sufficient attention in scientific literature. DAC involves pulling CO2 directly from the air and then sequestering it in geological formations or reusing it. Currently, novel CDR provides less than .002 GT/CO2e per year reduction.

- DAC is extremely expensive. Cost estimates vary widely - between $250-600 per ton of CO2 captured. Even after extensive research and development, research indicates the cost is unlikely to fall below ~ $100 per ton of CO2 captured. To reach the IPCC's *minimum* recommendation of removing 2 Gigatons/CO2e per year, at the current minimum cost of $250 per ton, a 500 billion dollar annual investment would be required.
- Even with significant support, DAC will take several decades to be environmentally viable at the scale needed. DAC would need to increase efficiency and scale up in size at a rate of 10,000 times current levels by 2030 to fit into GHG reduction goals.
- Separating CO2 from the air is an energy intensive process, requiring 1200 kilowatt hours per ton of CO2. If DAC activities are powered by fossil fuels, the process holds little value due to the reintroduction of GHGs.

Although some novel CDR technologies are promising, we do not agree with the current push for increased implementation of DAC. DAC lacks effectiveness and the long term viability needed to be a significant part of our GHG reduction goals. Investing large amounts of energy and financial capital into DAC is likely to prove unwise given the landscape of more accessible solutions and the dwindling window of opportunity for decreasing emissions.

Conventional CDR includes removing carbon through "natural" methods such as coastal ecosystem restoration, reforestation, agroforestry and soil carbon sequestration, all of which also enhance biodiversity and ecosystem functions. We advocate for additional research and legislation focussed on conventional methods of CDR.

- "There is substantial mitigation and adaptation potential from options in agriculture, forestry and other land use… that could be upscaled in the near term across most regions (high confidence). Conservation, improved management, and restoration of forests and other ecosystems offer the largest share of economic mitigation potential…"(2023 IPCC report).

- Conventional CDR methods also increase and enhance ecosystem services like local air quality improvements, opportunities for recreation, and health of the local ecosystems. It is estimated that additions to ecosystem services could add over $30 trillion dollars per year to the global economy.
- Ecosystem services also correlate with social benefits like therapeutic services, spiritual connections, and social satisfaction.
- Conventional CDR currently provides the removal of 2 Gigatons/CO2e per year.

Carbon Capture and Sequestration (CCS)

CCS aims to reduce carbon emissions by capturing them, mainly from industrial facilities and power plants, while redirecting them from entering the atmosphere. CCS has become a frequent topic of discussion as a possible tool for meeting greenhouse gas reduction targets and mitigating the effects of climate change. In 2022, the federal Inflation Reduction Act earmarked billions of dollars of funding for CCS by incentivizing these technologies through the introduction of sizable tax credits.

Before moving forward with CCS, we believe the following factors should be considered:

- CCS technologies are still in their developmental research phases and years from operating on the scale needed to have a significant effect on atmospheric CO2 concentrations.
- To scale up to the level needed to have a meaningful impact, CCS would require an estimated 5 trillion dollar investment.
- Despite being in development for 50 years, CCS technologies lack consistent carbon-negative results.
- The IPCC report (Pg 69) shows that the annual greenhouse gas emissions reductions from solar and wind energy combined are almost 15 times as much as reductions from CCS, while costing a fraction as much.
- To date, 73% of carbon capture has been used for enhanced oil recovery - a method of reinjecting CO2 into the ground to extract more oil and gas.
- There is a lack of scientific consensus surrounding the viability of CCS.
- Carbon capture technology carries an "energy penalty." This means that a greater energy input – 10% to 40% more on average – is required where carbon capture systems are in place.
- Injecting CO2 into the ground for purposes of sequestration has the potential to induce earthquakes.
- Pipelines used for the transfer of CO2 pose a public safety risk. Previous incidents of pipeline ruptures have demonstrated the hazards of CO2 exposure.
- In a perfect scenario - where carbon capture technology develops enough to be implemented at a large scale and to operate at 90% effectiveness - it would only result in a reduction of 14-18% of total carbon emissions.

Summary:

Although carbon management technologies appear to align with the wider goal of addressing climate change, this growing field is rife with unknowns. DAC and CCS are decades away from wide scale implementation, and their ability to effectively limit carbon emissions is a point of concern. Moving forward with these strategies would include deferring much needed resources from areas such as solar and wind infrastructure, building out electric power distribution systems, scaling up transportation charging networks, enhancing innovations in rechargeable battery technologies, and increasing energy efficient housing. Moving forward with the implementation of DAC and CCS risks extending the lifespan of the fossil fuel industry - a move that puts us in grave risk of not meeting our climate targets.

Further recommended reading on carbon management

Hydrogen

Background
Oil and gas companies, along with utilities that are fossil fuel intensive, created the "Clean Hydrogen Future Coalition" in 2021, urging the Biden administration to increase policy support for a wide range of hydrogen uses. Gas companies are testing the use of hydrogen blended with natural gas. Colorado has a Hydrogen Roadmap for development of hydrogen in Colorado and is involved in planning for a regional hydrogen hub. It is time to take a closer look at the long term implications of hydrogen.

Summary
Depending on how it is produced, hydrogen may have some promise in the future in reducing emissions from hard to decarbonize sectors. However, currently at least 99% of the hydrogen being produced actually increases greenhouse gas emissions. The development of "green" hydrogen is in its early stages and still extremely expensive. For all but the most difficult to decarbonize sectors, solar and wind power are more fitting energy sources. Hydrogen is not a good replacement for fossil gas in home use or in generating electricity; it would increase cost and safety concerns while decreasing efficiency.

The facts about hydrogen:
- **Fossil fuel companies are already producing a massive amount of hydrogen, which creates more greenhouse gasses than the whole nation of Germany**.
- Hydrogen is extremely flammable, susceptible to combust in even small concentrations.
- Hydrogen is the smallest and lightest molecule known to humans, making it more difficult to contain than other gasses.
- Hydrogen leaks could cause a chemical reaction that increases the amount of methane in the atmosphere. Hydrogen is known as an indirect greenhouse gas, with a global warming potential more than 5 times higher than CO_2.
- The practice of blending hydrogen with natural gas is expensive and dangerous; see numerous peer reviewed studies cited in this report by Physicians for Social Responsibility.
- There are two technologies to produce hydrogen: 1) splitting the water molecule and 2) splitting the methane molecule using steam methane reformation (SMR). Hydrogen produced by splitting the methane molecule using SMR is known as "gray" hydrogen. If carbon capture is used during SMR to reduce greenhouse gas emissions, it is called "blue" hydrogen. ***"Blue" hydrogen causes more emissions per unit of energy than burning diesel, coal or natural gas.*** **What Colorado calls "clean" hydrogen or "low-carbon" hydrogen is currently mostly "blue" hydrogen**, (i.e. "hydrogen from SMR with CCS" – see the Hydrogen Roadmap, p. 3).
- The only hydrogen defined by the International Energy Agency as "green" hydrogen is produced using water that is powered by renewable energy. **Currently less than 0.02% of hydrogen produced globally is "green"**.
- Pure hydrogen cannot be transported in existing pipelines, which don't have systems for detecting hydrogen leaks and are not equipped to handle the higher flammability and leakage rates of hydrogen.
- Building a hydrogen pipeline can cost up to 68% more per mile than a fossil gas pipeline.
- Suncor's hydrogen producing plant at the Commerce City refinery was the initial cause of a cascading series of failures in December 2022 that resulted in a 3-month shutdown.

Colorado's "Low-Carbon Hydrogen Roadmap" recommends pilot projects to blend hydrogen in existing infrastructure to streamline the permitting processes. Developing pilot projects that burn hydrogen for power generation in existing gas turbines and use Colorado's existing gas storage facilities creates serious public health and safety concerns due to Hydrogen's chemical composition. This Roadmap is largely for the development and use of “blue” hydrogen, since “green” hydrogen is still too expensive. We believe these factors warrant further consideration before Colorado continues to expand hydrogen production and infrastructure.

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With thanks to Susan Saadat and Sara Gerson, the authors of the report *Reclaiming Hydrogen for a Renewable Future*, from Earthjustice’s Right to Zero campaign. Many of the facts and studies cited above come from this report.

Nuclear Power and Small Modular Reactors

Background:
Nuclear energy is frequently touted by industry advocates as a low-carbon energy source to transition away from fossil fuels. While nuclear proponents have claimed that nuclear power is an attractive energy alternative for coal-transitioning communities such as Pueblo, Moffatt and Routt counties, nuclear proposals have received a great deal of backlash from frontline communities. In 1979, Colorado experienced its first failed attempt at nuclear, with the Fort St. Vrain power plant. Fort St. Vrain was so fraught with operational problems that it had to be shut down after a decade to cut financial losses. Over 14 tons of toxic waste are still being stored at that plant 33 years later. In Pueblo, there is a strong community-led effort to halt proposals to replace the “Comanche 3” coal plant with twelve NuScale Small Modular Nuclear Reactors (SMRs). In 2011, a similar attempt to bring nuclear power to Pueblo was rejected due to community concerns in wake of the Fukushima-Daiichi disaster.

We believe Colorado’s troubled history with nuclear power, in addition to the concerns outlined below, should be considered before policymakers pursue experimental nuclear technology for Colorado’s coal-transitioning communities.

Overview of Our Concerns Regarding Nuclear Power and Small Modular Reactors:

- **Nuclear power creates waste that remains radioactive for thousands of years.** A nuclear plant generates electricity from radioactive material that must be replaced every 18-24 months. This spent fuel is high-level radioactive waste which must be isolated for thousands of years. Presently, the U.S. has over 85,000 metric tons of spent nuclear fuel from commercial nuclear power plants, an amount which grows by about 2,000 metric tons each year.
- **Small modular reactors would generate more radioactive waste than conventional nuclear power plants.**
- **There is no good solution for processing or storing radioactive waste, and most of it would likely be kept onsite.** Despite decades of effort, the United States does not currently have a permanent disposal facility for high-level nuclear waste. As a result, spent nuclear fuel is stored in pools or in dry casks at reactor sites.
- **Nuclear plants have the highest water requirements of any energy generating technology, requiring water both for energy production and for cooling spent fuel.** For energy production, a single 300 megawatt small modular reactor operating at 90% capacity would withdraw between 160 million and 390 million gallons of water daily.
- **The damage from an accident at a nuclear power plant could be catastrophic, and the risk is heightened by increasing natural disasters due to climate change. Nuclear reactors and waste storage pools are also vulnerable targets for terrorist attacks.**

- **Nuclear power plants have been linked to higher rates of cancer.** Studies have shown statistically significant increases in childhood leukemia near nuclear power plants. In the United States, regulations limiting radiation exposure are based on the damage radiation causes in adult males; however, females and children are affected more by radiation exposure.
- **Nuclear power is not competitive in cost or time of deployment.** While renewable energy and battery storage are rapidly increasing in technological capacity and decreasing in cost, the cost estimate for small modular reactors is rising dramatically, despite receiving billions in Federal subsidies. The timeline of deployment for NuScale Small Modular Reactors is also highly uncertain and continues to be delayed, with the earliest estimates predicting NuScale reactors won't produce electricity until at least 2029**.**
- **The safety advantages of "Advanced nuclear plants", including Small Modular Reactors, are so far unproven.** The Union of Concerned Scientists found that the new designs they analyzed "are not likely to be significantly safer than today's nuclear plants. In fact, certain alternative reactor designs pose even more safety, proliferation, and environmental risks than the current fleet." A modular design means the plant has several smaller and less powerful reactors instead of one large reactor; such a design increases the probability of failure in one or more modules.
- **Nuclear power poses environmental justice concerns.** Far too often, nuclear reactor proposals target disproportionately impacted communities such as Pueblo, Colorado.These communities are often low-income, working class communities concerned about tax and job loss from coal plant retirement.
- **Nuclear power plants require uranium which must be mined and enriched. Marginalized communities bear a disproportionate burden of the environmental and health impacts of uranium mining and enriching.** In the United States, uranium mining has a tragic history of exploiting and devastating Indigenous communities. Over 500 uranium mines were established on Navajo land, and 4 million tons of uranium were extracted from these mines, between 1944 and 1986. Due to lasting contamination in the land, air, and water from these mines, the communities that surround them still experience high rates of serious health impacts from uranium exposure.

Colorado Coalition for a Liveable Climate Member Groups:

1. 350 Colorado
2. Be the Change
3. Citizens for a Healthy Community
4. Clean Energy Action
5. Climate Reality Project Denver Chapter
6. Climate Reality Project Northern Colorado Chapter
7. Colorado Call to Action
8. Colorado Chapter, Global Catholic Climate Movement
9. Colorado Interfaith Power and Light
10. Colorado Jewish Climate Action
11. Colorado Renewable Energy Society
12. Colorado Rising
13. Community for Sustainable Energy
14. Coop Members Alliance
15. Denver Catholic Network
16. Ekar Farm
17. Empower Our Future
18. EnergyShouldBe.Org
19. Energy Smart Colorado
20. Estes Valley Clean Energy Coalition

21. Fort Collins Sustainability Group
22. Healthy Air & Water Colorado
23. Indivisible Colorado Action Network
24. Larimer Alliance for Health, Safety & the Environment
25. Lookout Alliance
26. Mental Health and Inclusion Ministries
27. Natural Capitalism Solutions
28. North Range Concerned Citizens
29. Our Children's Trust Colorado
30. Renewables Now Loveland
31. Resilient Denver
32. Rocky Mountain Peace and Justice Center
33. San Luis Valley Ecosystem Council
34. Save EPA
35. Solar United Neighbors of Colorado
36. Sustainable Resilient Longmont
37. The Alliance Center
38. The Climate Mobilization – Colorado
39. Together Colorado
40. Unite North Metro Denver
41. Western Slope Conservation Center
42. WildEarth Guardians
43. Wind and Solar Denver

Additional Groups:
Colorado Sierra Club
PSR Colorado - Physicians for Social Responsibility