September 2, 2025

Chris Wright
Secretary, U.S. Department of Energy
1000 Independence Avenue SW
Washington, DC 20585

Submitted electronically via regulations.gov

Re: Department of Energy Climate Working Group draft report "A Critical Review of Impacts of Greenhouse Gas Emissions on the U.S. Climate," Docket No. DOE-HQ-2025-0207.

Dear Secretary Wright:

Clean Air Task Force, Inc., ("CATF") respectfully submits these comments on the U.S. Department of Energy's (DOE) Climate Working Group's draft report entitled "A Critical Review of Impacts of Greenhouse Gas Emissions on the U.S. Climate." (Docket No. DOE-HQ-2025-0207, 90 Fed. Reg. 36150 (Aug. 1, 2025)) ("draft Climate Working Group report" or "draft report").

CATF is a nonprofit organization dedicated to advancing the policy and technology changes necessary to achieve a zero-emissions high-energy planet at an affordable cost. With more than 25 years of internationally recognized expertise on environmental policy and law, and a commitment to exploring all potential solutions, CATF is a pragmatic, non-ideological advocacy group with the bold ideas needed to address climate change and air pollution. CATF has offices in Boston, Washington, D.C., and Brussels, with staff working remotely around the world.

The draft Climate Working Group report is legally and procedurally invalid because it was created by a governmental body in violation of the Federal Advisory Committee Act.[1] The process was skewed from the start, with authors personally selected by the Energy Secretary without a fair balance in points of view, who met in secret, and which failed to disclose required committee materials. The resulting draft report therefore must be withdrawn and cannot be relied on by any federal agency for administrative actions, including rulemakings or orders.

Even more troubling, and as a result of the process that led to it, the draft Climate Working Group report suffers from numerous inaccuracies, misrepresentations, manipulations of climate science and data, and glaring omissions of relevant information. The draft report acknowledges its intentionally narrow agenda, noting that the authors "chose to focus on topics . . . that are downplayed in, or absent from, recent assessment reports."[2] In contrast to this narrow approach, the Intergovernmental Panel on Climate Change (IPCC) concluded in the Sixth Assessment, "[h]uman activities, principally through emissions of greenhouse gases, have

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[1] *See* 5 U.S.C. §§ 1001-1014.

[2] Draft Report at x.

unequivocally caused global warming."[3] Nothing in the draft Climate Working Group report disturbs that unequivocal scientific consensus. Nor does the draft report in any way refute the adverse impacts from human-caused climate change, which the IPCC found "will continue to intensify,"[4] and which are being already felt in the United States, as the Fifth National Climate Assessment concluded in finding that the "effects of human-caused climate change are already far-reaching and worsening across every region."[5]

The Climate Working Group's purported critique of these well supported and consensus scientific findings is meritless and must be disregarded in full. CATF joins its partners in urging DOE to withdraw this draft and EPA not to rely on it for any rulemaking.[6] This letter focuses on specific areas of the draft Climate Working Group report where CATF's Land Systems program has particular expertise. The term "land systems" refers to the terrestrial component of the Earth system and includes human uses of land, global cycles, and socio-economic and cultural values. CATF's Land Systems program is dedicated to pursuing the most effective uses of Earth's limited land resources to mitigate climate change, enable energy system transformation, and support livelihoods worldwide.

Throughout the sections of the draft report discussed here, the Climate Working Group repeats a scientifically unfounded and incorrect refrain – that increased levels of atmospheric carbon dioxide are categorically beneficial for plants, ecosystems, and agriculture. In reality, the myriad negative effects of anthropogenic climate change related to heat, moisture, nutrient cycling, fire, pollution, insects, disease, and other impacts have an overall negative effect on the environment, agriculture, and people. By omitting this crucial context, the report presents misleading interpretations of scientific evidence and reaches biased conclusions. These foundational errors render the report's conclusions about anthropogenic climate change incorrect and completely inappropriate for use by federal agencies in decision-making.

The remainder of this comment is organized by section of the draft Climate Working Group report.[7]

Section 2.1 – "CO_2 as a contributor to global greening" (pp. 3-6)

The draft report falsely states, or implies by failing to provide context, that (1) greening is categorically positive; (2) that it is occurring equally in all regions and for all plant types; and (3) that it will continue indefinitely into the future. These suggestions are not supported by the full breadth of scientific evidence. Moreover, the draft report's narrow focus on carbon dioxide fertilization – which is simply a reaction that plants have to the availability of carbon dioxide –

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[3] Intergovernmental Panel on Climate Change (IPCC). Climate Change 2023 Synthesis Report at 4, https://www.ipcc.ch/report/ar6/syr/downloads/report/IPCC_AR6_SYR_FullVolume.pdf [hereinafter "IPCC Synthesis Report"].

[4] *Id.* at 7.

[5] U.S. Global Change Research Program. 2023. 5th National Climate Assessment, at 1-5. https://repository.library.noaa.gov/view/noaa/61592.

[6] *See* Coalition Letter, Docket No. DOE-HQ-2025-0207 (Sept. 2, 2025) (including CATF).

[7] CATF is separately submitting copies of the scientific literature cited in this comment to the docket.

fails to recognize that plants need more than carbon dioxide to thrive. The draft report ignores the significant, rapid, and simultaneous changes, due to anthropogenic greenhouse gas emissions, that are impacting other environmental factors that interact to influence plant health and are likely to overwhelm the carbon dioxide fertilization effect in some regions.[8]

The draft report also disregards the broader context that greenness itself is not a complete metric of ecosystem function, nor is it unequivocally positive everywhere. In certain areas of the world like the Arctic, greening can exacerbate warming both through changes to albedo and water vapor,[9] which may accelerate feedback to the climate system through accelerated permafrost thaw[10] and increased plant respiration resulting in additional greenhouse gas emissions.[11] The draft report's authors also overlook evidence that increased greenness has significant negative implications for the water cycle,[12] including enhanced soil drying and vegetation water stress.[13]

Furthermore, different plants display differential responses to the carbon dioxide fertilization effect.[14] In other words, there are winners and losers. This effect can interrupt the ecological balance of biodiversity in natural ecosystems where nuisance species gain advantage[15] and increase risk of crop loss due to weed pressure,[16] which the draft report does not acknowledge in its discussion of agriculture. Moreover, the draft report omits or inappropriately minimizes harms to public health and welfare related to the carbon dioxide fertilization effect. These include increased human exposure to allergens from enhanced plant production of pollen[17]

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[8] *See infra* n.23.

[9] Yu, L., G. Leng, L. Yao, C. Lu, S. Han, S. Fan, 2025. Disentangling the contributions of water vapor, albedo and evapotranspiration variations to the temperature effect of vegetation greening over the Arctic, Journal of Hydrology, 646, 132331, https://doi.org/10.1016/j.jhydrol.2024.132331.

[10] Schuur et al., 2022. Permafrost and Climate Change: Carbon Cycle Feedbacks From the Warming Arctic, Annu. Rev. Environ. Resour. 2022. 47:343–71, https://doi.org/10.1146/annurev-environ-012220-011847.

[11] Maes, S.L., Dietrich, J., Midolo, G. et al. 2024. Environmental drivers of increased ecosystem respiration in a warming tundra, Nature 629, 105–113. https://doi.org/10.1038/s41586-024-07274-7.

[12] Yang, Y., Roderick, M.L., Guo, H. et al. 2023. Evapotranspiration on a greening Earth. Nature Revs. Earth & Environ. 4, 626–641. https://doi.org/10.1038/s43017-023-00464-3.

[13] Liu, Y., Li, Z., Chen, Y. et al. 2025. Global greening drives significant soil moisture loss. Commun Earth Environ. 6, 600. https://doi.org/10.1038/s43247-025-02470-3.

[14] Fleischer, K., Rammig, A., De Kauwe, M.G. et al. 2019. Amazon forest response to CO_2 fertilization dependent on plant phosphorus acquisition. Nat. Geosci. 12, 736–741. https://doi.org/10.1038/s41561-019-0404-9; César Terrer et al., 2016. Mycorrhizal association as a primary control of the CO2 fertilization effect. Science 353, 72-74. https://doi.org/10.1126/science.aaf4610.

[15] Phillips, O., Vásquez Martínez, R., Arroyo, L. et al., 2002. Increasing dominance of large lianas in Amazonian forests. Nature 418, 770–774. https://doi.org/10.1038/nature00926; Mohan, J. E., Ziska, L. H., Schlesinger, W. H., Thomas, R. B., Sicher, R. C., George, K., & Clark, J. S. 2006. Biomass and toxicity responses of poison ivy (*Toxicodendron radicans*) to elevated atmospheric CO_2. Proc. Nat'l Acad. Scis., 103(24), 9086–9089. https://doi.org/10.1073/pnas.0602392103.

[16] J. Hatfield et al., in Climate Change Impacts in the United States: The Third National Climate Assessment, J. Melillo, T. T. C. Richmond, G. W. Yohe, Eds. (U.S. Global Change Research Program, 2014), pp. 150–174. https://www.resolutionmineeis.us/sites/default/files/references/melillo-richmond-yohe-2014.pdf.

[17] Albertine JM, Manning WJ, DaCosta M, Stinson KA, Muilenberg ML, Rogers CA. Projected carbon dioxide to increase grass pollen and allergen exposure despite higher ozone levels. 2014. PLoS One 9(11): e111712,

and the risk of malnutrition for certain populations due to potential nutrient dilution of crops cultivated under high carbon dioxide concentrations.[18]

In addition, the draft report downplays the fact that greening is not occurring equally in all parts of the world, and in fact there are many areas where browning that harms ecosystems and humans is instead already occurring.[19] For example, anthropogenic climate change has contributed to the degradation of over 1.3 billion acres of drylands globally, affecting over 200 million people who live in those regions, including in the western United States.[20]

The draft report also erroneously implies that increased greenness in the recent past is an indicator that land vegetation will continue to respond similarly to increased carbon dioxide into the future by misleadingly asserting there is "no evidence" of a slowing trend while relying on only two studies.[21] This claim does not reflect scientific consensus, as multiple analyses provide contradictory evidence that a slowdown in the rate of global greening is indeed occurring.[22]

Most egregiously, the draft report's myopic fixation on global greening and carbon dioxide fertilization fails to communicate that carbon dioxide concentration is just one of many influences on plants in a changing climate. The draft report ignores the significant effects of human greenhouse gas emissions on other key regulators of plant growth, including heat, moisture, nutrients, fire, air pollution (such as increased ground-level ozone), insects, and disease that can cancel out the effects of carbon dioxide fertilization.[23] It also overlooks recent and

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https://doi.org/10.1371/journal.pone.0111712; Ziska LH. An Overview of Rising CO_2 and Climatic Change on Aeroallergens and Allergic Diseases. Allergy Asthma Immunol Res. 2020 Sep;12(5):771-782. https://doi.org/10.4168/aair.2020.12.5.771. .

[18] Kellie Schmitt, *Less Nutritious Crops: Another Result of Rising CO2*, Hopkins Bloomberg Public Health (Sept. 27, 2024), https://magazine.publichealth.jhu.edu/2024/less-nutritious-crops-another-result-rising-co2.

[19] Cortés, J., Mahecha, M. D., Reichstein, M., Myneni, R. B., Chen, C., & Brenning, A. 2021. Where are global vegetation greening and browning trends significant? Geophysical Research Letters, 48, e2020GL091496. https://doi.org/10.1029/2020GL091496.

[20] Burrell, A.L., Evans, J.P. & De Kauwe, M.G. 2020. Anthropogenic climate change has driven over 5 million km^2 of drylands towards desertification. Nat. Commun. 11, 3853. https://doi.org/10.1038/s41467-020-17710-7.

[21] Draft Report at 4.

[22] Wang et al. 2020. Recent global decline of CO2 fertilization effects on vegetation photosynthesis. Science. https://doi.org/10.1126/science.abb7772; Chen, B., Ke, Y., Ciais, P., Zeng, Z., Black, A., Lv, H., et al. 2022. Inhibitive effects of recent exceeding air temperature optima of vegetation productivity and increasing water limitation on photosynthesis reversed global greening. Earth's Future, 10, e2022EF002788. https://doi.org/10.1029/2022EF002788; Chen, Z., Wang, W., Forzieri, G. et al. Transition from positive to negative indirect CO_2 effects on the vegetation carbon uptake. Nat Commun 15, 1500 (2024). https://doi.org/10.1038/s41467-024-45957-x; Pan, N. et al. 2018. Increasing global vegetation browning hidden in overall vegetation greening: insights from time-varying trends. Remote Sens. Environ. 214, 59–72, https://doi.org/10.1016/j.rse.2018.05.018.

[23] M.E. Dusenge, A.G. Duarte, D.A. Way. 2019. Plant carbon metabolism and climate change: elevated CO_2 and temperature impacts on photosynthesis, photorespiration and respiration. New Phytologist, 221(1) 32-49. https://doi.org/10.1111/nph.15283; R. Teskey et al. 2015. Responses of tree species to heat waves and extreme heat events. Plant Cell Environ., 38 (9) (2015) 1699-1712, https://doi.org/10.1111/pce.12417; Xu, C., McDowell, N.G., Fisher, R.A. et al. 2019. Increasing impacts of extreme droughts on vegetation productivity under climate change. Nat. Clim. Chang. 9, 948–953, https://doi.org/10.1038/s41558-019-0630-6; Wenping Yuan et al. 2019. Increased atmospheric vapor pressure deficit reduces global vegetation growth. Sci. Adv. 5, eaax1396, https://doi.org/10.1126/sciadv.aax1396; Cambron, T.W., Fisher, J.B., Hungate, B.A. et al. 2025. Plant nutrient

concerning lines of evidence that such factors may already be destabilizing the global terrestrial carbon sink,[24] which has been absorbing nearly 30 percent of human carbon emissions for decades.[25] The draft report fails entirely to acknowledge that it is the complex and potentially nonlinear interactions[26] among many changing drivers of plant growth that control the net effect of carbon emissions on Earth's ecosystems. In summary, this aspect of the report completely overlooks a plethora of scientific evidence compiled across disciplines and geographies, in favor of a narrow argument to support a biased conclusion.

Section 2.1.3 - "Rising CO_2 and crop water use efficiency" (p. 6)

This section of the draft report presents a misleadingly narrow view of the literature on elevated carbon dioxide and crop water use efficiency by overlooking critical factors related to increasing atmospheric carbon dioxide that could counterbalance any potential benefits of carbon dioxide enrichment on U.S. agricultural crop yields. These factors include, but are not limited to,increased heat, drought, and flood stress, as well as spatial heterogeneity and uncertainties in estimating the effects of elevated carbon dioxide and climate change on crops.[27] Additionally, the draft report ignores that increasing plant water use efficiency does not necessarily decrease total water demand or improve hydrologic outcomes; for example, increased crop production or expansion (from systems with improved water use efficiency) could still lead to an increase in total water demand.[28]

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acquisition under elevated CO2 and implications for the land carbon sink. Nat. Clim. Chang., https://doi.org/10.1038/s41558-025-02386-y; T.M. Ellis et al. 2022. Global increase in wildfire risk due to climate-driven declines in fuel moisture. Glob. Chang. Biol., 28 (4) 1544-1559, https://doi.org/10.1111/gcb.16006; Pavlovic et al. 2025. Quantification of ozone exposure impacts and their uncertainties on growth and survival of 88 tree species across the United States. Journal of Geophysical Research: Atmospheres, 130, e2024JD042063, https://doi.org/10.1029/2024JD042063; Singh et al. 2023. Climate change impacts on plant pathogens, food security and paths forward. Nat. Rev. Microbiol. 21, 640–656, https://doi.org/10.1038/s41579-023-00900-7.

[24] Forzieri et al. 2022. Emerging signals of declining forest resilience under climate change. Nature 608, 534–539. https://doi.org/10.1038/s41586-022-04959-9.

[25] Friedlingstein et al. 2024. Global Carbon Budget 2024, Earth System Science Data, 17(3), 965-1039, https://doi.org/10.5194/essd-17-965-2025.

[26] Terrer et al. 2019. Nitrogen and phosphorus constrain the CO2 fertilization of global plant biomass. Nat. Clim. Chang. 9, 684–689. https://doi.org/10.1038/s41558-019-0545-2; Jiang et al. 2020. The fate of carbon in a mature forest under carbon dioxide enrichment. Nature 580, 227–231 (2020). https://doi.org/10.1038/s41586-020-2128-9; Wieder et al. 2015. Future productivity and carbon storage limited by terrestrial nutrient availability. Nature Geosci. 8, 441–444, https://doi.org/10.1038/ngeo2413.

[27] Deryng et al. 2016. Regional disparities in the beneficial effects of rising CO2 concentrations on crop water productivity. Nature Climate Change, https://doi.org/10.1038/nclimate2995; Toreti et al. 2020. Narrowing uncertainties in the effects of elevated CO2 on crops. Nature Food. https://doi.org/10.1038/s43016-020-00195-4.

[28] Singh et al. 2020. Plant Growth Nullifies the Effect of Increased Water-Use Efficiency on Streamflow Under Elevated CO2 in the Southeastern United States. Geophysical Research Letters. https://doi.org/10.1029/2019GL086940; Xu et al. 2021. Agricultural Water Use Efficiency and Rebound Effect: A Study for China. Int J. Environ. Res. Public Health. https://doi.org/10.3390/ijerph18137151; Morrisett et al. 2023. The irrigation efficiency trap: rational farm-scale decisions can lead to poor hydrologic outcomes at the basin scale. Front. Environ. Sci. https://doi.org/10.3389/fenvs.2023.1188139; Pfeiffer & Lin. 2014. Does efficient irrigation technology lead to reduced groundwater extraction? Empirical evidence. Journal of Environmental Economics and Management. https://doi.org/10.1016/j.jeem.2013.12.002; Li & Zhao. 2018 Rebound Effects of New Irrigation

Additionally, although increasing atmospheric carbon dioxide levels can increase crop water use efficiency, this effect varies by study type. For instance, increases are generally higher in controlled laboratory studies than field studies; effects vary by crop, with larger effects for C3[29] plants than in C4 plants; and effects vary by location.[30] More importantly, the draft report fails to mention that other concurrent effects of climate change, such as heat stress, higher vapor pressure deficit, drought, and nutrient limitations, often result in decreased water use efficiency despite any effects of carbon dioxide fertilization.[31]

Section 6.8 – "Wildfires" (pp. 69-71)

The draft report's focus on declining trends in global burned area is misleading and lacks both context and nuance. The draft report fails to consider that drivers of fire on the landscape relate to complex interactions among people, fire, and climate, and that there is a lack of high-quality long-term data that would permit robustly detecting and projecting future fire regimes.[32] The draft report ignores evidence that the observed global decline in burned area is strongly related to human land management,[33] while entirely failing to consider the evidence that climate change is driving an increase in conditions that prime ecosystems for fire.[34] It also obfuscates the

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Technologies: The Role of Water Rights. American Journal of Agricultural Economics. https://doi.org/10.1093/ajae/aay001.

[29] Plants are grouped into C3 and C4 plants depending on how they photosynthesize. Unlike the C3 photosynthesis common in cool-season plants, C4 photosynthesis utilizes malate to concentrate and deliver carbon dioxide, enabling plants to keep their stomata closed for longer periods, thereby reducing water loss through transpiration during photosynthesis. The effectiveness of this adaptation varies by plant cultivar, as different varieties of the same plant species can have different photosynthetic rates, resulting in yield differences. Still plants that perform C4 photosynthesis can be more successful in high temperature and low water conditions. Sage et al. 2018. Some like it hot: the physiological ecology of C4 plant evolution. Oecologia 187(4):941–966. https://doi.org/10.1007/s00442-018-4191-6; Sanderson et al. 1996. Switchgrass as a sustainable bioenergy crop. Bioresource Technology 56(1): 83–93. https://doi.org/10.1016/0960-8524(95)00176-X.

[30] Mokhtar et al. 2025. Optimizing water-use efficiency under elevated CO_2: A meta-analysis of crop type, soil modulation, and enrichment methods. Agricultural Water Management. https://doi.org/10.1016/j.agwat.2025.109312.

[31] Zhu et al. 2023. Rising temperatures can negate CO2 fertilization effects on global staple crop yields: A meta-regression analysis. Agricultural and Forest Meteorology. https://doi.org/10.1016/j.agrformet.2023.109737; Zhang et al. 2024. VPD modifies CO2 fertilization effect on tomato plants via abscisic acid and jasmonic acid signaling pathways. Horticultural Plant Journal. https://doi.org/10.1016/j.hpj.2023.07.005; Li et al. 2025. Declining Contribution of Plant Physiological Effects to Global Drought Characteristics With Rising CO2 Using State-of-the-Art Earth System Models. Earth's Future. https://doi.org/10.1029/2024EF005548; Wang et al. 2020. Recent global decline of CO2 fertilization effects on vegetation photosynthesis. Science 370 (6522), 1295-1300. https://doi.org/10.1126/science.abb7772.

[32] Bowman et al. 2020. Vegetation fires in the Anthropocene. Nat. Revs. Earth & Environ. 1, 500-515, https://www.nature.com/articles/s43017-020-0085-3.

[33] Andela et al. 2017. A human-driven decline in global burned area. Science 356(6345) 1356-1362, https://www.science.org/doi/full/10.1126/science.aal4108.

[34] Jones, M. W., Abatzoglou, J. T., Veraverbeke, S., Andela, N., Lasslop, G., Forkel, M., et al. 2022. Global and regional trends and drivers of fire under climate change. Reviews of Geophysics, 60, e2020RG000726. https://doi.org/10.1029/2020RG000726.

finding that global frequency of extreme wildfires has increased more than two-fold over the past 20 years.[35]

Moreover, the draft report fails to present relevant statistics on fire in the United States. For example, it ignores the fact that *high severity* burned area has significantly increased across most ecoregions of the United States over the past several decades, with an eightfold increase observed in the western region, and that this increase is linked to warmer and drier fire seasons.[36] Although human-environment interactions affect specific wildfire risks in some regions, it is very likely negative impacts of fire will worsen in the future due to climate change.[37]

<u>Section 9.1 - "Econometric Analyses" (pp. 104-105)</u>

This section of the draft report presents only evidence from limited studies – those that use land values and cash rents as proxies for farmers' adaptation to climate change (for instance, with higher values indicating farmer choices like crop choice or planting timing are helping maintain yields under changing climate conditions). As a result, the general conclusions drawn by the authors from this limited body of literature about the consideration of carbon dioxide fertilization misrepresent the full breadth of what the literature actually illustrates, the multifaceted motivations and costs of farmer adaptation, and the broader range – and heterogeneity – of factors beyond carbon dioxide fertilization, and possible climate impacts on U.S. agriculture.

The scientific literature demonstrates that farmer adaptation is shaped by multiple biophysical, economic, institutional, and personal factors.[38] More robust econometric approaches account for these multiple constraints, integrating crop models, nonlinear yield responses, and farmer decision data to capture how climate stressors interact with farmer land management decisions.[39] These approaches, which the draft report ignores, help inform how to support agriculture to be resilient to changing climate conditions, including to droughts and floods, and other negative impacts of climate change beyond carbon dioxide fertilization.

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[35] Cunningham et al. 2024. Increasing frequency and intensity of the most extreme wildfires on Earth. Nat. Ecology & Evolution 8, 1420-1425, https://doi.org/10.1038/s41559-024-02452-2

[36] Parks & Abatzoglou. 2020. Warmer and Drier Fire Seasons Contribute to Increases in Area Burned at High Severity in Western US Forests From 1985 to 2017. Geophysitcal Research Letters, https://doi.org/10.1029/2020GL089858.

[37] Halofsky, J.E., Peterson, D.L. & Harvey, B.J. 2020. Changing wildfire, changing forests: the effects of climate change on fire regimes and vegetation in the Pacific Northwest, USA. Fire Ecol. 16, 4. https://doi.org/10.1186/s42408-019-0062-8.

[38] Castellano & Moroney. 2018. Farming adaptations in the face of climate change. Renewable Agriculture and Food Systems. https://doi.org/10.1017/S174217051700076X.

[39] Su & Chen. 2022. Econometric Approaches That Consider Farmers' Adaptation in Estimating the Impacts of Climate Change on Agriculture: A Review. Sustainability. https://doi.org/10.3390/su142113700; Manono et al. 2025. A Review of the Socio-Economic, Institutional, and Biophysical Factors Influencing Smallholder Farmers' Adoption of Climate Smart Agricultural Practices in Sub-Saharan Africa. Earth. https://doi.org/10.3390/earth6020048; Li et al. 2025. Predicting changes in agricultural yields under climate change scenarios and their implications for global food security. Scientific Reports. https://doi.org/10.1038/s41598-025-87047-y.

Section 9.2 – "Field and laboratory studies of CO_2 enrichment" (pp. 105-106)

This section of the draft report fails to consider the full breadth of impacts from anthropogenic carbon dioxide emissions, the complete body of evidence on crop yields, the likely long-term effects of climate change on food production and agriculture, and impacts on crops beyond soybean, maize, and wheat.

The draft report cites the Ainsworth and Long (2020) paper on the Free-Air CO_2 Enrichment (FACE) experiments to draw incomplete conclusions related to crop yield. Carbon dioxide emissions affect not only the carbon dioxide concentrations in the atmosphere but also the broader climatic conditions in which plants grow. Therefore, the full effect of carbon dioxide emissions must be accounted for when assessing the impacts of carbon dioxide pollutant emissions on plants and crop productivity. Dr. Long himself did just that when rebutting the overly narrow and misleading conclusion drawn from the Ainsworth and Long study in the draft Climate Working Group report by stating, "[W]hen account is taken of the accompanying changes in tropospheric ozone, temperature, atmospheric water vapor pressure deficit and extreme drought, heat and flooding events then the overall effect of GHG driven climate and atmospheric change [on crop yields and quality] is strongly negative."[40] Long's correction of the draft Climate Working Group report's conclusions is consistent with the finding of Duffy, et al. (2018) that the negative impacts of increasing carbon dioxide and temperature are likely to outweigh any positive fertilization effects in the long term.[41]

The FACE experiments and most other laboratory experiments that this draft report relies on also cannot account for the effects of all biotic stresses associated with carbon dioxide fertilization and a changing climate on crop growth and yield. For example, this section of the draft report excludes any mention of the scientific evidence showing that weeds and plant pests that increase under climate change pose additional threats that increase the risk of crop loss.[42]

In the discussion of soybean, maize, and wheat, the draft report misleadingly reports only global average values for changes in plant growth and yield associated only with the limited effects of carbon dioxide fertilization based on dubious findings from a source (CO2Science.org) that has not been published in a peer-reviewed scientific publication. Extensive research on the effects of recent climate change on crop yields demonstrates the importance of also examining the climate-related effects by region. For example, observational studies show negative impacts on maize and wheat yield in most major producing regions and globally between 1980 and 2008

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[40] Tandon, et al. 2025. Factcheck: Trump's climate report includes more than 100 false or misleading claims. 9.2 Field and laboratory studies of CO2 enrichment. CarbonBrief. https://interactive.carbonbrief.org/doe-factcheck/index.html (quote from Steven Long given to Carbon Brief as supporting evidence).

[41] Duffy et al. 2018. Strengthened scientific support for the Endangerment Finding for atmospheric greenhouse gases. 363 Science 6427. https://doi.org/10.1126/science.aat5982.

[42] Hatfield et al. 2014. Climate Change Impacts in the United States: The Third National Climate Assessment, J. Melillo, T. T. C. Richmond, G. W. Yohe, Eds. (U.S. Global Change Research Program, 2014), pp. 150–174; C. A. Deutsch et al. 2018. Increase in crop losses to insect pests in a warming climate. Science 361, 916–919. https://doi.org/10.1126/science.aat3466; Tito et al. 2018. Global climate change increases risk of crop yield losses and food insecurity in the tropical Andes. Glob. Change Biol. 24, e592–e602. https://doi.org/10.1111/gcb.13959.

compared to what would have happened without climate change; results for rice and soybean yield were mixed with both increases and decreases.[43]

Another important area of research neglected by the draft Climate Working Group report is the negative impact of elevated ground-level ozone (O_3) on plant growth. Carbon dioxide emissions are often accompanied by emissions of ozone precursors (carbon monoxide, volatile organic compounds, and oxides of nitrogen). Ground-level ozone formation can also increase under higher temperatures. Many studies show adverse effects of ozone on crop yield at the global scale and in the Northern Hemisphere.[44] For example, increased tropospheric ozone levels decreased estimates of global yield for soybean (8.5 to 14 percent), wheat (3.9 to 15 percent), and maize (2.2 to 5.5 percent) in 2000 with estimated economic losses in the billions of dollars.[45] The adverse impacts of ozone on tree species are well documented in the literature, but ignored in the draft report.[46] Moreover, a modeling study highlighted the important relationship between policy actions that reduce carbon dioxide emissions and ozone-driven productivity losses. Specifically, estimated ozone productivity losses decline by as much as 16 percent (for crops) and 13 percent (for tree species) under modelled carbon dioxide pollution control standards on power plants.[47]

Finally, this section of the draft report has an overly narrow focus on three commodity crops: soybeans, maize, and wheat. Comprehensive agricultural assessments must consider the impacts on other crops. For example, it has been documented that the productivity and quality of perennial crops, such as the global fruit supply, are impaired by the changing climate.[48] In addition, recent research shows that total factor productivity – a measure of agricultural efficiency based on the output generated given inputs – is likely to decrease when measured

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[43] Porter & Xie et al. 2014. Food Security and Food Production Systems. In: Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel of Climate Change, C. B. Field et al., Eds. (Cambridge Univ. Press, 2014) pp. 485–583. https://www.ipcc.ch/site/assets/uploads/2018/02/WGIIAR5-Chap7_FINAL.pdf; Lobell et al. 2011. Climate trends and global crop production since 1980. Science, 333(6042), 616-620. https://doi.org/10.1126/science.1204531.

[44] Porter & Xie et al. 2014. Food Security and Food Production Systems. In: Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel of Climate Change, C. B. Field et al., Eds. (Cambridge Univ. Press, 2014) pp. 485–583. https://www.ipcc.ch/site/assets/uploads/2018/02/WGIIAR5-Chap7_FINAL.pdf.

[45] Avnery et al. 2011. Global Crop Yield Redutions due to Surface Ozone Exposure: Crop Production Losses and Economic Damage in 2000 and 2030 under Two Futures Scenarios of O3 Pollution. https://mauzerall.scholar.princeton.edu/publications/global-crop-yield-reductions-due-surface-ozone-exposure-2-year-2030-potential

[46] Pavlovic et al. 2025. Quantification of ozone exposure impacts and their uncertainties on growth and survival of 88 tree species across the United States. Journal of Geophysical Research: Atmospheres, 130 (e2024JD042063). https://doi.org/10.1029/.

[47] Capps et al. 2016. Estimating potential productivity cobenefits for crops and trees from reduced ozone with U.S. coal power plant carbon standards, J. Geophys. Res. Atmos., 121, 14,679–14,690. https://doi.org/10.1002%2F2016JD025141 (although this study modelled a pollution control standard that did not go into effect, its scientific analysis and conclusions remain sound).

[48] Bhattacharjee et al. 2022. Impact of Climate Change on Fruit Crops - A Review. Current World Environment, 17(2), 319. https://cwejournal.org/pdf/Vol17No2/CWE_Vol17_No2_p_319-330.pdf.

across all of U.S. agriculture (including crops, livestock, and goods and services) in coming years due to the impacts of climate change even if current trends in technological advancements in agriculture continue, with climate causing total factor productivity to decline back to 1980 levels by 2040.[49]

Taken together, the full weight of scientific evidence demonstrates overwhelmingly that this part of the draft report is misleading and draws, or implies, false conclusions based on incomplete information. Current research also affirms EPA's Endangerment Finding conclusion that "the body of evidence points towards increasing risk of net adverse impacts on U.S. food production and agriculture over time, with the potential for significant disruptions and crop failure in the future."[50] This underscores the scientific folly of the draft report's narrow focus on greening and the carbon dioxide fertilization effect; and the importance of considering the full direct and indirect effects of carbon dioxide emissions on plant growth and crop yields.

<u>Section 9.3 – "Crop modeling meta-analyses" (pp. 106-107)</u>

This section of the draft report presents a misleading, overly narrow scope of literature and fails to consider important factors and impacts related to crop responses and damages from climate change across different crops in the United States.

Only two papers are presented here, and as a result, the section fails to account for or discuss the wide range of factors that impact crop yields and quality. The draft Climate Working Group report completely ignores the broader crop modeling meta-analysis literature which indicates that crop yields are influenced by a wide range of factors related to climate change, including non-linear processes such as extreme heat events that can disproportionately affect yields at certain crop stages and pest and disease impacts, that interact in ways that amplify total crop damage.[51] This literature demonstrates detrimental effects on crops, including decreased

[49] Liang et al. 2017. Determining climate effects on US total agricultural productivity. Proc. Natl. Acad. Sci. 114, E2285–E2292 (2017). https://doi.org/10.1073/pnas.1615922114.

[50] 74 Fed. Reg. 66495, 66498 (Dec. 15, 2009).

[51] Hicke et al. 2022. Chapter 14: North America. In: Climate Change 2022: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change. https://www.ipcc.ch/report/ar6/wg2/chapter/chapter-14/; Li et al. 2025. Predicting changes in agricultural yields under climate change scenarios and their implications for global food security. Scientific Reports 15, 2858. https://doi.org/10.1038/s41598-025-87047-y; Hultgren et al. 2025. Impacts of climate change on global agriculture accounting for adaptation. Nature 642. https://doi.org/10.1038/s41586-025-09085-w; Tran et al. 2025. Climate change impacts on crop yields across temperature rise thresholds and climate zones. Scientific Reports 15, 23424. https://doi.org/10.1038/s41598-025-07405-8; Hu et al. 2024. Climate change impacts on crop yields: A review of empirical findings, statistical crop models, and machine learning methods. Environmental Modelling & Software 179, 106119. https://doi.org/10.1016/j.envsoft.2024.106119; Zhu et al. 2023. Rising temperatures can negate CO2 fertilization effects on global staple crop yields: A meta-regression analysis. Agricultural and Forest Meteorology 342, 109737. https://doi.org/10.1016/j.envsoft.2024.106119.

crop nutritional value,[52] resilience and increased risk to pests and diseases,[53] and decreased crop yields due to elevated vapor pressure deficit,[54] cloud and ozone effects,[55] and other factors.[56]

Section 9.4 – "CO_2 fertilization and nutrient loss" (pp. 107-108)

This section's proposed conclusion that "CO_2-induced warming will be a net benefit to U.S. agriculture" is contrary to the scientific literature. Specifically, the scientific literature does not support the draft report's idea that agricultural management can fully "offset" the decreased protein and nutrient content and associated public health risks caused by elevated carbon dioxide levels.[57] Impacts related to increased atmospheric carbon dioxide and climate change, like heat stress, high vapor pressure deficit, and drought, can exacerbate nutrient dilution and diminish yield.[58] Elevated carbon dioxide-induced nutrient dilution (and the potential subsequent significant human nutrient deficiencies) represents a real and ongoing risk to public health, which the draft report fails to adequately consider. For example, Smith and Myers (2014) estimated that reduced zinc, protein, and iron levels in C3 crops under anticipated 2050 carbon dioxide levels could cause zinc deficiencies in 175 million people, with 122 million more deficient in protein, with 1.4 billion women of childbearing age and children at-risk of losing

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[52] Hicke et al., *supra* note 51; Beach et al. 2019. Combining the effects of increased atmospheric carbon dioxide on protein, iron, and zinc availability and projected climate change on global diets: a modelling study. Lancet Planetary Health. https://doi.org/10.1016/S2542-5196(19)30094-4; Dong et al. 2018. Effects of Elevated CO2 on Nutritional Quality of Vegetables: A Review. Frontiers in Plant Science. https://doi.org/10.3389/fpls.2018.00924.

[53] Hicke et al., *supra* note 51; Deutsch et al. 2018. Increase in crop losses to insect pets in a warming climate. Science. 361(6405), 916-919. https://doi.org/10.1126/science.aat3466; Wolfe et al. 2018. Unique challenges and opportunities for northeastern US crop production in a changing climate. Clim. Change 146(1-2), 231-245. https://doi.org/10.1007/s10584-017-2109-7; Zhang et al. 2019. Changes in Temperature and Precipitation Across Canada. In: Canada's Changing Climate Report. Government of Canada, Ottawa, Ontario. https://natural-resources.canada.ca/sites/www.nrcan.gc.ca/files/energy/Climate-change/pdf/CCCR-Chapter4-TemperatureAndPrecipitationAcrossCanada.pdf.

[54] Novick et al. 2024. The impacts of rising vapour pressure deficit in natural and managed ecosystems. Plant, Cell & Environment. https://doi.org/10.1111/pce.14846; López et al. 2021 Systemic effects of rising atmospheric vapor pressure deficit on plant physiology and productivity. Global Change Biology. https://doi.org/10.1111/gcb.15548.

[55] Proctor. 2021. Atmospheric opacity has a nonlinear effect on global crop yields. Nature Food. https://doi.org/10.1038/s43016-021-00240-w; Pei et al. 2024. Long-term trajectory of ozone impact on maize and soybean yields in the United States: A 40-year spatial-temporal analysis. Environmental Pollution. https://doi.org/10.1016/j.envpol.2024.123407.

[56] Zhao et al. 2017. Temperature increase reduces global yields of major crops in four independent estimates. PNAS. https://doi.org/10.1073/pnas.1701762114; Tigchelaar et al. 2018. Future warming increases probability of globally synchronized maize production shocks. PNAS. https://doi.org/10.1073/pnas.1718031115.

[57] Ebi & Ziska. 2018. Increases in atmospheric carbon dioxide: Anticipated negative effects on food quality. PLoS Med. https://doi.org/10.1371/journal.pmed.1002600; Zhu et al. 2018. Carbon dioxide (CO2) levels this century will alter the protein, micronutrients, and vitamin content of rice grains with potential health consequences for the poorest rice-dependent countries. Science. https://doi.org/10.1126/sciadv.aaq1012; Kaspari & Welti. 2024. Nutrient dilution and the future of herbivore populations (20240 Trends in Ecology & Evolution. https://doi.org/10.1016/j.tree.2024.05.001; Schmitt, *supra* note 18.

[58] Zhu et al. 2023. Rising temperatures can negate CO2 fertilization effects on global staple crop yields: A meta-regression analysis. Agricultural and Forest Meteorology. https://doi.org/10.1016/j.agrformet.2023.109737; Zhang et al. 2024. VPD modifies CO2 fertilization effect on tomato plants via abscisic acid and jasmonic acid signaling pathways. Horticultural Plant Journal. https://doi.org/10.1016/j.hpj.2023.07.005.

dietary iron in countries with high anemia prevalence.[59] Nutrient dilution in crops cannot be assumed to be offset by changes in yield or easily solved through vaguely described adaptation strategies without addressing the underlying causes and effects of climate change that are harmful to U.S. agriculture.

Conclusion

The draft Climate Working Group report is not only the result of a process that violates the Federal Advisory Committee Act, but it is woefully deficient scientifically and technically, and it must be withdrawn by the Department of Energy. As noted here, the draft report's myopic focus ignores the bulk of scientific evidence and the full context and implications of the impacts of anthropogenic climate change. The resulting conclusions are neither comprehensive nor compelling. This draft report does not reflect the best scientific information on greenhouse gas emissions or the effects of climate change, either globally or in the United States. No federal agency can rely on its skewed and misleading conclusions for any decision-making purposes.

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[59] Smith, M.R. & Myers, S.S. 2018. Impact of anthropogenic CO_2 emissions on global human nutrition. Nature Clim. Change. 8, 834–839. https://doi.org/10.1038/s41558-018-0253-3.