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Via Electronic and Certified Mail

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Petition for Rulemaking to Remove Methane and Ethane from "Negligibly Reactive" Volatile Organic Compounds List

Dear Administrator Regan and Principal Deputy Assistant Administrator Goffman:

Pursuant to the right to petition the government as provided in the First Amendment to the United States Constitution[1] and the Administrative Procedure Act,[2] the 403 environmental justice, conservation, public health, and social justice organizations listed below, on behalf of themselves and their millions of members and supporters, formally petition the United States Environmental Protection Agency ("EPA") to remove methane and ethane from the list of compounds exempted from the definition of "volatile organic compounds" in 40 C.F.R. § 51.100(s)(1). Section 302(s) of the Clean Air Act ("CAA"), 42 U.S.C. § 7602(s), authorizes EPA to define "volatile organic compound" ("VOC") and thus determine which compounds may be regulated as VOCs in State Implementation Plans (SIPs), permitting, and other context. In general, VOCs are subject to control measures in SIPs and permits because they are precursors to ground-level ozone, commonly referred to as smog, a criteria pollutant with detrimental effects on both public health and welfare. However, since 1977, EPA has chosen to exclude certain compounds from its definition of "volatile organic compound" in 40 C.F.R. § 51.100(s)—and therefore from regulation as VOCs—by including them on a list of "negligibly reactive" compounds in 40 C.F.R. § 51.100(s)(1). But such listing decisions are not irreversible; EPA has

[1] *See* U.S. Const. Amend. I. The right to "petition for a redress of grievances [is] among the most precious of the liberties safeguarded by the Bill of Rights." United Mine Workers v. Ill. State Bar Assn, 389 U.S. 217, 222 (1967).

[2] The Center for Biological Diversity, its members, and other petitioners are "interested persons" within the meaning of the Administrative Procedure Act. *See* 5 U.S.C. § 553(e) (granting any "interested person the right to petition for the issuance, amendment, or repeal of a rule")..

consistently maintained that it has authority to "periodically revise the list . . . to add or delete compounds."[3]

EPA has exempted methane and ethane from the regulatory definition of VOC since 1977.[4] Today, studies demonstrate that methane and ethane, which are released in massive quantities, contribute appreciably to local and regional ozone levels. Metropolitan areas that are located in the same airshed as extensive oil and gas development, such as Denver and Dallas, increasingly experience high ozone levels that are partially attributable to methane and ethane emissions from upwind oil and gas operations, petrochemical facilities, and other sources. These changed circumstances necessitate a revision of EPA's exemption of methane and ethane from regulation as VOCs.

I. Action Requested

Petitioners requests the following action:

Amend 40 C.F.R. § 51.100 to remove methane and ethane from the list of organic compounds at § 51.100(s)(1) that are excluded from the regulatory definition of "volatile organic compounds."

II. History of EPA's VOC Exemption Policy

The formation of tropospheric ozone is caused by dynamic interactions involving VOCs, nitrogen oxides (NOx), and sunlight. Some VOCs react less readily than others and are therefore deemed to have a low photochemical reactivity. EPA has long recognized that even lowly reactive VOCs can have deleterious effects on public and environmental health, and that when such harmful effects are sufficiently severe, "it would be inappropriate for EPA to encourage or support increased utilization of these compounds" by excluding them from control.[5] For that reason in part, EPA initially rejected a regulatory regime that would treat VOCs differently according to the reactivities in favor of one that would focus on net VOC reductions.[6] In its 1971 guidance to states for preparing SIPs, EPA declined to include the concept of photochemical reactivity in its VOC control policy.[7] EPA reinforced this approach in 1976, when it stated that it would not consider a substitution of nonreactive VOCs for reactive VOCs a reduction in net VOC emissions for the purpose of NAAQS attainment.[8] In addition to its concern about VOCs' harmful environmental effects, EPA's skepticism of VOC substitution was also due to its findings that "almost all VOC eventually react in the atmosphere to form some oxidant."[9]

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[3] *See, e.g.*, Air Plan Approval; Kentucky: Revisions to Jefferson County VOC Definition, 85 Fed. Reg. 67,282-01, 67,283 (Oct. 22, 2020).
[4] Recommended Policy on Control of Volatile Organic Compounds, 42 Fed. Reg. 35,314, 35,314 (July 8, 1977).
[5] Recommended Policy on Control of Volatile Organic Compounds, 42 Fed. Reg. at 35314.
[6] *See* Requirements for Preparation, Adoption, and Submittal of Implementation Plans, 36 Fed. Reg. 15486, 15496 (Aug. 14, 1971).
[7] *Id.*
[8] Recommended Policy on Control of Volatile Organic Compounds, 42 Fed. Reg. 35314, 35314 (July 8, 1977) (discussing the 1976 Policy Statement on Use of the Concept of Photochemical Reactivity of Organic Compounds in State Implementation Plans for Oxidant Control).
[9] *Id.*

EPA's decision to ultimately embrace a regulatory framework for VOCs based on their relative photochemical reactivities was largely a response to state actions. Despite EPA's preference to focus on positive reduction techniques that would reduce net VOC levels over the substitution approach, states began exempting compounds that were deemed to have low reactivities from their SIPs.[10] Recognizing that overbroad state exemptions led to the deregulation of compounds that contributed to downwind ozone formation, EPA undertook smog chamber studies to investigate the merits of regulating VOCs according to reactivity. These smog chamber studies were the basis of EPA's first exemptions of lowly reactive compounds from regulation, including methane, ethane, and four other VOCs.[11] The exemptions were formalized in EPA's 1977 Recommended Policy on Control of Volatile Organic Compounds ("the 1977 Policy"). Importantly, EPA labeled these compounds "negligibly reactive" because it concluded they did not "contribute significant oxidant even during extended irradiation under multiday stagnation conditions [in urban and rural settings]"—a conclusion that is demonstrably inaccurate today.[12] The 1977 Policy also established the reactivity of ethane as the de facto baseline for future decisions about "negligible" photochemical reactivity.[13] Compounds that are equally reactive or less reactive as ethane are likely to be deemed "negligibly reactive" and are exempted from VOC control requirements in SIPs.

The smog chamber studies that formed the basis of the 1977 Policy, and advances in environmental chamber technology in the late 1980s, were limited with regard to their ability to predict accurately the ozone-forming potential of a VOC. In addition, chamber studies do not take into account the amount of one VOC compared to other VOCs.

In the same policy statement in which EPA first labeled methane and ethane "negligibly reactive," it acknowledged that "smog chamber studies conducted to date are incomplete because many organic compounds have not been examined and it has been impossible to duplicate all atmospheric conditions."[14] EPA continued to recognize these significant limitations in 1996, when it wrote that "there has been no broad acceptance, within either the scientific or regulatory communities, of any single reactivity scale that could be used to make reliable predictions of the ozone forming potential of a specific VOC."[15]

Regardless, EPA continued to add negligibly reactive VOCs to the list of exemptions through 1992, when the list was formally codified at 40 CFR § 51.100(s). At the time the VOC exemption list was codified, the primary metric used by EPA to assess a compound's reactivity was K_{OH} (its rate constant for its reactivity with the OH^- radical), and the compound's MIR (Maximum Incremental Reactivity) and MOIR (Maximum Ozone Incremental Reactivity) values

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[10] *See* Revisions to the California State Implementation Plan and Revision to the Definition of Volatile Organic Compounds (VOC)—Removal of VOC Exemptions for California's Aerosol Coating Products Reactivity-Based Regulation, 70 Fed. Reg. 1640, 1644 (Jan. 7, 2005) (citing County of Los Angeles, Air Pollution Control District (1972). Rules and Regulations. Rule 66 (1966). Amended November 2, 1972).

[11] Recommended Policy on Control of Volatile Organic Compounds, 42 Fed. Reg. at 35314.

[12] *Id.* at 35315; *see infra* Part IV.

[13] Ex. 1, *Reactivity-Based VOC Control for Solvent Products: More Efficient Ozone Reduction Strategies*, at 4848.

[14] Recommended Policy on Control of Volatile Organic Compounds, 42 Fed. Reg. at 35315.

[15] U.S. Envtl Prot. Agency, Response to Comments On Section 183(e) Study and Report to Congress (1998), https://nepis.epa.gov/Exe/ZyPDF.cgi?Dockey=2000NYGX.pdf.

were consulted for validation.[16] As opposed to K_{OH}, MIR and MOIR are reactivity scales, which means that they were developed in order to "discriminate VOCs on the basis of reactivity" by estimating the grams of ozone produced per gram of VOC emissions, for example.[17] This approach to metrics changed in 2005, when EPA supplemented and updated its 1977 Policy with "Interim Guidance on Control of Volatile Organic Compounds in Ozone State Implementation Plans" ("2005 Guidance").[18] The 2005 Guidance stated that MIR measured on a per mass basis was preferred to K_{OH} as a metric for comparing the reactivities of various VOCs.[19] This change was because a compound's K_{OH} corresponds to the initial rate of a compound's reaction, so the MIR metric better captures the entire pathway of multiple chemical reactions that occur as a VOC breaks down to form ozone.

Today, EPA uses reactivity scales to put the substitution principle for VOCs into practice.[20] However, EPA's positions on the reliability of reactivity scales have been contradictory. For example, in January 2005, the EPA expressed uncertainty regarding whether reactivity scales can serve as an accurate basis for a nationwide regulatory scheme, given that "reactivity depends on the characteristics of the environment as well as the compound, [but] scales are developed to represent a particular set of environmental conditions in certain geographic locations."[21] Yet, later that same year, the EPA wrote in its updated VOC Control Policy for SIPs that "[s]everal reactivity metrics derived from airshed models . . . appear to be robust over different regions of the country."[22] At the same time, EPA acknowledged that there continued to be "important differences exist in [the scales'] geographical representativeness."[23]

When EPA clarified its use of reactivity scales in 2005, it did not revisit its initial decisions to de-list methane and ethane. The measurements that were used to justify the addition of methane and ethane to the negligibly reactive list in 1977 were based on studies of oxidant formation in VOC-limited conditions, and EPA acknowledged that ozone formation under NO_x-limited conditions had not been well studied.[24] While it has traditionally been understood that rural areas tend to be NO_x-limited while urban areas have higher VOC:NO_x ratios, such assumptions—assumptions that are built in to reactivity metrics—do not hold true across all locations. Contemporary research has shown that rural oil and gas fields may fluctuate between being NO_x-limited and VOC-limited at different seasons or different times of the day, on account of meteorological conditions and NO_x emissions from production activity.[25]

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[16] Interim Guidance on Control of Volatile Organic Compounds in Ozone State Implementation Plans, 70 Fed. Reg. at 54050.
[17] *Id.* at 54047.
[18] *See id.*
[19] *Id.* at 54050.
[20] *Id*.
[21] Revisions to the California State Implementation Plan and Revision to the Definition of Volatile Organic Compounds (VOC)—Removal of VOC Exemptions for California's Aerosol Coating Products Reactivity-Based Regulation, 70 Fed. Reg. 1640, 1646 (Jan. 7, 2005).
[22] Interim Guidance on Control of Volatile Organic Compounds in Ozone State Implementation Plans, 70 Fed. Reg. at 54048.
[23] *Id.*
[24] Recommended Policy on Control of Volatile Organic Compounds, 42 Fed. Reg. 35314, 35316 (July 8, 1977).
[25] Joel Minor, *Completing the Bridge to Nowhere: Prioritizing Oil and Gas Emissions Regulations in Western States*, 34 Stan. Envtl. L.J. 57, 65 (2015) (citing Ex. 2, *Winter Ozone Formation and VOC Incremental Reactivities in the Upper Green River Basin of Wyoming*, at 262).

Despite these contradictions, there are legitimate justifications for EPA's contemporary VOC substitution policy.[26] These justifications are twofold. First, the substitution principle is meant to focus state control efforts on programs that reduce emissions that significantly contribute to ozone formation. Second, it is meant to incentivize the use of negligibly reactive compounds in the place of highly reactive compounds in industry processes, and to encourage the development of negligibly reactive compounds.[27]

III. Listing methane and ethane at § 51.100(s)(1) is inconsistent with the VOC exemption policy and leads to violations of the ozone NAAQS.

Neither of the two justifications for EPA's VOC exemption policy are met by including methane and ethane on the "negligibly reactive" list. The first justification—to focus control efforts on compounds that significantly affect ozone concentrations—is not met because methane and ethane, when the amount of these substances which are emitted are considered, significantly contribute to ozone formation along Colorado's Front Range and other parts of the country. The second justification—to incentivize the development of negligibly reactive compounds to be used in the place of more highly reactive compounds—is not met because the sources of methane and ethane cannot engage in the type of compound substitution described by the 2005 Guidance, and therefore the inclusion of methane and ethane on the "negligibly reactive" list does not prevent more highly reactive compounds from being used in their places. Moreover, because methane is a potent greenhouse gas that contributes to global warming, methane emissions have serious impacts on human and environmental health. Ethane can cause headache, nausea, vomiting, dizziness, and lightheadedness. Very high levels can cause suffocation from lack of Oxygen. Ethane is also a highly flammable gas and a dangerous fire hazard.[28] Because of these impacts, it is inappropriate to exempt methane and ethane from regulatory control.

A. Methane and ethane significantly contribute to ozone formation.

Tropospheric (or "ground-level") ozone is regulated under the NAAQS as a "criteria" air pollutant harmful to public health and welfare. Ozone causes a variety of respiratory problems in humans ranging from coughing and chest pain to hospitalizations and permanent lung damage, and premature mortality.[29] The formation of tropospheric ozone is caused by dynamic interactions involving VOCs, NOx, and sunlight. In 2015 EPA set the ozone NAAQS at 70 ppb (parts per billion) measured as the 3-year average of the annual fourth-highest daily maximum 8-

[26] *But see* Ex. 1, *Reactivity-Based VOC Control for Solvent Products: More Efficient Ozone Reduction Strategies*, at 4848 (discussing some problems inherent in a system that embraces the substitution principle, namely: 1) Most of the compounds on the list have limited application and therefore do not have acceptable substitutes, 2) The system "result[s] in scarce scientific and economic resources being diverted into determining whether a few compounds are slightly above or below [the baseline], an exercise with little overall value to atmospheric quality," and 3) The "'bright-line' approach causes very different treatment of compounds that are virtually identical in their ozone-generating potential" and conversely, "compounds with quite different reactivity (very reactive versus just above ethane) are treated as if they were the same").

[27] Interim Guidance on Control of Volatile Organic Compounds in Ozone State Implementation Plans, 70 Fed. Reg. at 54048.

[28] *See* Ex. 3, New Jersey Department of Health and Senior Services' Hazardous Substance Fact Sheet for Ethane.

[29] Ex. 4, *Global health benefits of mitigating ozone pollution with methane emission controls*, at 3990.

hour concentration. The previous standard, set in 2008, was 75 ppb. Much of the U.S. regularly exceeds both the 70 ppb and 75 ppb standards and has been designated as nonattainment areas. Nonattainment areas are subject to regulations to reduce the emissions of VOC and NOx.

Methane and ethane are significant precursors to tropospheric ozone. EPA clearly acknowledges that methane is an ozone precursor.[30] Methane alone is responsible for approximately 20 ppb of global background tropospheric ozone.[31] Further, studies have identified that increasing global methane concentrations from anthropogenic emissions contribute to elevated tropospheric ozone levels.[32] A 2008 study showed that reductions in methane emissions would result in lower tropospheric ozone concentrations.[33] That study also indicated that reduced methane emissions would result in more pronounced ozone reductions in methane emission source regions and in high NOx areas.[34]

Ethane has also been established as a critical contributor to ozone formation, particularly as ethane emissions have increased substantially in recent years.[35] Ethane's contribution to ozone formation is most acute during the summer and in oil and gas production regions.[36] Methane and ethane are the most prevalent ozone precursors. Recently, atmospheric concentrations of methane and ethane have increased due to anthropogenic emissions, especially those related to oil and gas development, resulting in increased ozone formation. Though this dynamic is global, methane and ethane also contribute more acutely to ozone pollution in specific regions, including nonattainment areas. In order to sufficiently ameliorate ozone pollution, methane and ethane should be regulated as ozone precursors.

i. Methane and ethane are far more prevalent than any regulated VOCs and any other exempted compounds.

Methane and ethane are present globally and in ozone nonattainment areas in substantially higher concentrations than any other exempted compounds. Methane is the simplest and most common hydrocarbon in the atmosphere and the primary component of natural gas. Global average atmospheric methane concentration was 1,872 ppb as of June 2020.[37] Methane is more prevalent in the atmosphere than any listed VOC by at least two orders of magnitude, and even more common still than any other exempted compounds. Ethane is the second most abundant atmospheric hydrocarbon and component of natural gas and has a global

[30] Ex. 28, EPA, Integrated Science Assessment for Ozone and Related Photochemical Oxidants (April 2020)("2020 ISA") at pages lxiv & n.2, ES-2, IS-12, and app.1 1-1 (all identify methane as well as NOx, CO, and VOCs as ozone precursors). Page IS-15 notes that "There is an approximately linear relationship between anthropogenic methane emissions and tropospheric ozone…."

[31] Ex. 5, *Consideration of methane emissions in the modelling of ozone concentrations in chemical transport models*.

[32] Ex. 6, *The impact of air pollutant and methane emission controls on tropospheric ozone and radiative forcing: CTM calculations for the period 1990-2030*, at 1732.

[33] Ex. 7, *Characterizing the tropospheric ozone response to methane emission controls and the benefits to climate and air quality*, at D08307.

[34] *Id*.

[35] Ex. 8, *Reversal of global atmospheric ethane and propane trends largely due to US oil and natural gas production*, at 490.

[36] *Id*.

[37] NOAA Global Monitoring Laboratory: https://esrl.noaa.gov/gmd/ccgg/trends_ch4/.

average atmospheric concentration of approximately 0.5 ppb.[38] Ethane is at least as common as any regulated VOC and substantially more common than any other exempted compounds, methane excepted. Both methane and ethane concentrations have risen considerably since industrialization. Methane concentrations have increased by a factor of 2.5 since the pre-industrial era, and ethane concentrations have roughly doubled over the same period.[39]

Though the increased prevalence of atmospheric methane and ethane are global, both compounds occur in much higher abundance locally. The recent growth of oil and gas production, and especially natural gas extraction through hydraulic fracturing, have accelerated increases of atmospheric methane[40] and ethane.[41] These increases are more acute in regions proximate to oil and gas development and have important and deleterious effects on ozone pollution in regional airsheds. Regions at high elevations and where there is downwelling of air from the free troposphere are especially likely to experience changes in surface ozone.[42] A 2016 study in *Nature Geoscience* found that global ethane concentrations, which had declined from 1970 to 2005, abruptly halted and reversed that decline between 2005 and 2014.[43] The study attributed that reversal and increase to oil and gas development in North America, noting that ethane concentrations were highest over the Central and Eastern U.S. Further, the study suggested high and increasing concentrations of ethane likely contribute to significant ozone pollution in regions proximate to oil and gas operations.[44]

ii. Methane and ethane contribute to nonattainment of the ozone NAAQS, especially near oil and gas operations.

Recent studies indicate that regionally-sourced methane and ethane emissions from oil and gas operations contribute measurably to regional ozone pollution.[45] A 2018 study concluded that oil and gas-sector C_2-C_5 alkanes, a group that includes ethane, alone contributes 0.27% of the Northern Hemisphere's tropospheric ozone burden.[46] The study also found that ozone enhancements from C_2-C_5 alkanes were greatest over oil and gas-producing regions in Colorado, Kansas, and the Texas-Oklahoma panhandle, with the greatest enhancements modeled along the Colorado Front Range. There, the study estimated that ozone enhancements due to these

[38] Ex. 9, *Fugitive emissions from the Bakken shale illustrate role of shale production in global ethane shift*, at 4617.
[39] Ex. 10, *Preindustrial atmospheric ethane levels inferred from polar ice cores: a constraint on the geologic sources of atmospheric ethane and methane*, at 214.
[40] Ex. 11, *Reduced biomass burning emissions reconcile conflicting estimates of the post-2006 atmospheric methane budget*.
[41] Ex. 8, *Reversal of global atmospheric ethane and propane trends largely due to US oil and natural gas production*; Ex. 9, *Fugitive emissions from the Bakken shale illustrate role of shale production in global ethane shift*, at 4617.
[42] Ex. 12, *Management of Tropospheric Ozone by Reducing Methane Emissions*, at 4685.
[43] Ex. 8, *Reversal of global atmospheric ethane and propane trends largely due to US oil and natural gas production*.
[44] *Id*.
[45] *See* Minor, J. *Completing the Bridge to Nowhere: Prioritizing Oil and Gas Emissions Regulations in Western States*, 34 Stan. Envtl. L.J. 57 (2015) (summarizing studies from Wyoming, Utah, Colorado, and Texas and concluding that because "alkanes, including methane and ethane, contribute to ozone formation when abundant . . . EPA should amend its definition of 'VOC' to include methane and ethane").
[46] Ex. 13, *Atmospheric and Air Quality Implications of C_2-C_5 Alkane Emissions from the Oil and Gas Sector*.

emissions exceeded 4 ppb.[47] Emissions of ethane from the Bakken region have been identified as likely contributors to local ozone enhancements and ozone enhancements at larger geographic scales.[48] A 2013 study of ozone pollution in the Uintah Basin in Utah found that ethane, despite being relatively less reactive than other present VOCs, was likely a significant contributor to ozone production in the region.[49] That study showed that ethane accounted for seven to eleven percent of maximum incremental reactivity at study sites, substantially more than many regulated VOCs.[50] Similarly, the Energy Dynamics Laboratory of the Utah State University Research Foundation conducted a Uinta Basin Winter Ozone and Air Quality Study. They found that "CH_4 is usually considered non-reactive due to its relatively slow reaction rates, but at such elevated levels [2.7 – 5.5 parts per million], CH_4 could be a significant player in atmospheric photochemistry of ozone formation in the Basin."[51]

More recently, a 2019 study published in the *Journal of Geophysical Research* estimated that methane emissions from oil and gas production in the Colorado Front Range contributed to two percent of ozone pollution within the region.[52] In 2019, the Denver Metro/Northern Front Range was reclassified as a 'Serious' nonattainment area for the 2008 ozone NAAQS. This has significant implications for ozone nonattainment. For example, Colorado's attainment demonstration for the 2008 ozone NAAQS serious nonattainment area modeled ozone at 75.9 ppb.[53] In this context, a two percent difference is extremely significant.

Moreover, the two percent estimate referenced above is an average contribution. Regional methane emissions may contribute to substantially more than two percent of ozone pollution on days when the Denver Metro exceeds ozone standards.[54] Ethane is also prevalent in emissions from Northern Colorado, and contributes an average of 2.6% to 4.1% to regional ozone production, likely even more during periods of high ozone pollution.[55]

There are several atmospheric conditions and regional airshed patterns that likely animate this dynamic. First, ozone standard exceedance in the Denver Metro frequently occurs when wind patterns push air from oil and gas operations in the Denver Julesburg Basin, laden with higher concentrations of methane and ethane, into the Denver area. As mentioned above, the global average methane concentration is approximately 1,870 ppb, but methane concentrations sometimes exceed 3,000 ppb in the Denver area. Second, VOCs (including methane and ethane) react to produce ozone at higher rates when exposed to more intense and longer duration of UV radiation from sunlight. UV exposure is highest during long, cloudless summer days, and is

[47] *Id.* at 88.
[48] Ex. 9, *Fugitive emissions from the Bakken shale illustrate role of shale production in global ethane shift.*
[49] Ex. 14, Emissions Inventory Report, in Utah Dep't Of Envtl. Quality, 2012 Uintah Basin Winter Ozone & Air Quality Study: Final Report, at 175.
[50] *Id.*
[51] Ex. 27, Uinta Basin Winter Ozone and Air Quality Study, Final Report, at 7.
[52] Ex. 15, *Acyl peroxy nitrates link oil and natural gas emissions to high ozone abundances in the Colorado Front Range during summer 2015*, at 2336.
[53] 2020 Attainment Demonstration Modeling for the Denver Metro/North Front Range Serious Ozone State Implementation Plan at 28.
[54] Personal communication from Detlev Helmig (Oct. 1, 2020).
[55] Personal communication from Detlev Helmig (Nov. 10, 2019).

higher in the Colorado Front Range because of its altitude. Third, a 2019 study using airshed modeling and aerial and field observation linked photochemical production of ozone from formaldehyde and acetaldehyde, two highly reactive compounds, to a precursor process of regional methane oxidation.[56] All three of these conditions are often concurrent in the summer and during periods when Denver exceeds ozone pollution standards.[57]

Emissions and concentrations of methane and ethane are elevated in airsheds near oil and gas development in other parts of the country, as well. Aerial observation data from 2015 showed high regional abundance of methane and ethane near five oil and gas plays in North Dakota, Colorado, Texas, and Louisiana.[58] A 2016 study showed that oil and natural gas development in the Eagle Ford shale formation in Texas was responsible for ethane abundance 5 to 100 times higher than the typical clean air background.[59] More specifically, published data from 2017 showed that storage tank leaks contributed to 55% of ethane emissions in Eagle Ford.[60] Such high levels of regionally emitted ethane may produce significant localized ozone pollution and may contribute to surges beyond ozone standards in the nearby San Antonio nonattainment area. Though the Bakken shale play in North Dakota is not directly proximate to any ozone nonattainment areas, alkane emissions, including high concentrations of ethane, from Bakken have been shown to increase downwind ozone concentrations by up to 4 ppb during peaks. Another study from 2014 found that oil and gas emissions, including high concentrations of methane and ethane, from the Barnett shale play in Northern Texas resulted in 8% more ozone components than a control area. The study noted that emissions from Barnett contribute to ozone concentrations downwind in Dallas-Fort Worth. The Dallas region was designated as a 'Serious' ozone nonattainment area in 2019 for the 2008 NAAQS and is also 'Marginal' ozone nonattainment under the 2015 NAAQS. Because of the "strong coupling" between methane increases and ozone levels, scientific evidence confirms that reducing methane emissions is an "efficient option" for reducing ozone concentrations.[61]

B. Including ethane and methane on the negligibly reactive list does not incentivize industry to develop less reactive substitute compounds.

EPA asserts that the exemption list incentivizes industry to substitute negligibly reactive compounds in place of compounds with higher reactivity. This purpose is not well-suited by

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[56] Ex. 16, *Chemical characteristics and ozone production in the Northern Colorado Front Range*, at 13397.
[57] Ex. 17, *Separation of methane emissions from agricultural and natural gas sources in the Colorado Front Range*, at 3990; Ex. 18, *Volatile organic compounds and ozone in Rocky Mountain National Park during FRAPPE*, at 499.
[58] Ex. 19, *Quantifying methane and ethane emissions to the atmosphere from Central and Western US oil and natural gas production regions*, at 7725.
[59] Ex. 20, *Analysis of non-methane hydrocarbon data from a monitoring station affected by oil and gas development in the Eagle Ford shale, Texas*, at 1.
[60] Ex. 21, *Quantifying alkane emissions in the Eagle Ford Shale using boundary layer enhancement*, at 11163.
[61] *See* Ex. 6, *The impact of air pollutant and methane emission controls on tropospheric ozone and radiative forcing: CTM calculations for the period 1990-2030*, at 1745 (modeling the effect of various emissions reductions scenarios on global ozone levels from 1990-2030, and concluding that for the scenario where maximum feasible emissions reductions were modelled across all ozone precursors included in the study, one third of the predicted ozone reductions were attributable to reductions in methane emissions alone).

exempting methane and ethane, which are the primary components of natural gas. Incentivizing development of less reactive compounds is pertinent to specialized industrial processes and relatively rare compounds used for very specific purposes. Among both regulated VOC and exempted compounds, methane and ethane are uniquely abundant. Regardless of whether methane and ethane are included on the negligibly reactive list or de-listed, it does not seem feasible that industry would revert to more reactive compounds or develop less reactive compounds to substitute for the primary components of natural gas.

Not only does including methane and ethane on the "negligibly reactive" list fail to incentivize regulated industries to use or invest in lowly reactive compounds, it may have the opposite effect of penalizing regulated entities that have already taken steps to reduce their VOC emissions. Oil and gas companies have already invested substantial capital in developing methods to capture or limit releases of natural gas. Major oil and gas companies opposed a rollback of methane emissions regulations because they had already devoted substantial time and resources to developing control technologies and monitoring protocols to curb methane emissions, particularly from natural gas leaks. De-listing and regulating methane and ethane as ozone precursors would incentivize companies to put those controls in place and continue improving them. Further still, controlling natural gas leaks, which are primarily constituted of methane and ethane, would also reduce emissions of already regulated VOC ozone precursors also present in natural gas, such as butane and propane. Finally, ozone nonattainment is expensive, by imposing costs on human health and affected industries. Places like the Denver area have borne both of these costs through many nonattainment designations over many years. Addressing nonattainment by de-listing and regulating methane and ethane and capitalizing on existing control technologies could expedite Denver's attainment of ozone standards, to the benefit of residents' health and industry subject to existing nonattainment regulation.

Co-benefits of proposed action

De-listing methane and ethane from the "negligibly reactive" list would bring co-benefits for human health and the environment, and EPA has previously expressed its willingness to consider such co-benefits when making listing decisions.[62] In the past, EPA has considered the Global Warming Potential, SNAP Program Acceptability findings for ozone-depletion potential, and toxicity data for compounds it has considered for the "negligibly reactive" regulatory exemption. Reduction of methane and ethane would positively contribute to efforts to reduce global warming and stratospheric ozone depletion.[63] Methane is the anthropogenic greenhouse

[62] *See, e.g.*, Air Quality: Revision to the Regulatory Definition of Volatile Organic Compounds—Exclusion of cis-1,1,1,4,4,4-hexafluorobut-2-ene (HFO-1336mzz-Z), 83 Fed. Reg. 61127, 61130 (Nov. 28, 2018) ("The EPA reserves the right to exercise its judgment in certain cases where an exemption is likely to result in a significant increase in the use of a compound and a subsequent significantly increased risk to human health or the environment").

[63] *See, e.g.*, Ex. 22, *Increasing global agricultural production by reducing ozone damages via methane emission controls and ozone-resistant cultivar selection*, at 1286 (explaining that "CH_4 abatement . . . provides an attractive 'win-win' policy opportunity for both climate change and air pollution mitigation goals, as CH_4 controls would reduce radiative forcing of climate while simultaneously achieving the health and agricultural benefits associated with surface O_3 reductions").

gas with the second-greatest contribution to radiative forcing, after carbon dioxide.[64] Methane's lifetime of nine years in the atmosphere not only contributes to its GWP, but also makes it liable to contribute to ozone depletion in the upper stratosphere,[65] which in turn carries human health risks from increased UV penetration such as immunosuppression, dermatological effects, cancer, and ocular damage.[66] While ethane's lifetime is much shorter at 58 days, and at 0.32 its GWP is less than methane's, ethane still contributes to climate change.[67]

Conclusion

Although methane and ethane may have low photochemical reactivities, methane and ethane emissions are fundamentally dissimilar to emissions of other VOCs that are exempted from regulation on account of their reactivities. Specifically, methane and ethane are highly prevalent, so they significantly contribute to ozone formation despite having low reactivity values. In addition, exempting methane and ethane from regulation does not prevent more reactive compounds from being used in their place in the oil and gas industry, and it does not incentivize the development of even less reactive compounds.

Because of these circumstances that are particular to methane and ethane, Petitioners requests for EPA to remove methane and ethane from the list of compounds at § 51.100(s)(1) that are excluded from regulation as VOCs on account of being "negligibly reactive."

Thank you for your consideration.

Sincerely,

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[64] Ex. 23, *Air quality impacts from oil and natural gas development in Colorado*, at 13.
[65] Ex. 24, *Atmospheric methane and global change*, at 196 ("Numerical models of atmospheric chemical and physical processes generally find that increasing methane concentrations result in a net ozone production in the troposphere and lower stratosphere and net ozone destruction in the upper stratosphere").
[66] Ex. 25, *Global Change: Ozone Depletion, Greenhouse Warming, and Public Health*, at 115.
[67] Ex. 26, *Lifetimes, direct and indirect radiative forcing, and global warming potentials of ethane (C_2H_6), propane (C_3H_8), and butane (C_4H_{10})*, at 3.

198 methods
350 Bay Area Action
350 Bucks County
350 COLORADO
350 Conejo / San Fernando Valley
350 Everett
350 Fairfax
350 Hawaii
350 Humboldt
350 Maine
350 Mass Metro North Node
350 New Orleans
350 Sacramento
350 Seattle
350 Silicon Valley
350 Tacoma
350 Triangle
350 Ventura County Climate Hub
350 West Sound Climate Action
350.org
350Hawaii
350Kishwaukee
350MA Berkshires
350Marin
350NJ-Rockland
350PDX
Alabama Interfaith Power & Light
Alachua Audubon Society
Alameda County Interfaith Climate Action Network
Alaska Community Action on Toxics
Alaska PIRG
Algalita
Allamakee County Protectors - Education Campaign
Alliance for Climate Education (ACE)
Alliance To Halt Fermi-3
Already Devalued and Devastated Homeowners of Parsippany
Animals Are Sentient Beings, Inc.
Animas Valley Institute
Apalachicola Riverkeeper
Athens County's Future Action Network, acfan.org aka Athens County Fracking Action Network
Aytzim: Ecological Judaism
Azul
Back Country Excursions LLC
Backbone Campaign
Battle Creek Alliance/ Defiance Canyon Raptor Rescue
Beaver County (PA) Marcellus Awareness Community

Benicians for a Safe and Healthy Community
Berks Gas Truth
Berkshire Democratic Brigades
Berkshire Environmental Action Team, Inc.
Better Path Coalition
Beyond Extreme Energy
Beyond Plastics
Beyond the Bomb
Big Reuse
Breast Cancer Action
Breast Cancer Prevention Partners
Breathe Easy Susquehanna County
Breathe Project
Bucks Environmental Action
Buddhist Global Relief
Businesses for a Livable Climate
California Communities Against Toxics
Californians for Western Wilderness
Call to Action Colorado
Carolina Biodiesel, LLC
Catholic Divestment Network
CatholicNetwork.us
CDTech
Center for Biological Diversity
Center for a Competitive Waste Industry
Center for a Sustainable Coast
Center for Environmental Health
Center for International Environmental Law (CIEL)
Center on Race, Poverty & the Environment
Central California Asthma Collaborative
Central California Environmental Justice Network
Central Valley Air Quality Coalition
CEO Pipe Organs/Golden Ponds Farm
Change Begins with ME Indivisible Group
Christian Council of Delmarva
Christians For The Mountains
Church Women United in New York State
Citizen Power, Inc.
Citizens Awareness Network
Citizens' Resistance at Fermi Two (CRAFT)
Ciudadanos Del Karso
Clean Air Council
Clean, Healthy, Educated, Safe & Sustainable Community, Inc.
Climable, Inc.
Climate Action Alliance of the Valley
Climate Defense Project

Climate First: Replacing Oil & Gas (CFROG)
Climate Health Now
Climate Reality Project Los Angeles Chapter
Climate Reality Project of Coastal Georgia
Coalition Against Pilgrim Pipeline - NJ
Colorado Businesses for a Livable Climate
Columbus Community Bill of Rights
Columbus Community Rights Coalition
Common Ground Community Trust
Communities for a Better Environment
Concerned Health Professionals of New York
Concerned Ohio River Residents
Conejo Climate Coalition
Congregation of Our Lady of Charity of the Good Shepherd, U.S. Provinces
Conservation Congress
Conservation Law Foundation
Cook Inletkeeper
Cool Effect
Cooperative Energy Futures
Coosa River Basin Initiative/Upper Coosa Riverkeeper
CORALations
Courage California
DeSmog Denver
Detroit Hamtramck Coalition for Advancing Healthy Environments
Dogwood Alliance
Don't Gas the Meadowlands Coalition
Don't Waste Arizona
Dryden Resource Awareness Coalition
Earth Action, Inc.
Earthworks
East Valley Indivisibles
Eco-Eating
Eco-Poetry.org
EcoAction Committee of the Green Party of the United State
Ecological Rights Foundation
Education, Economics, Environmental, Climate and Health Organization (EEECHO)
Efficiency for All
Environment and Human Health, Inc. (EHHI)
Environmental Integrity Project
Environmental Protection Information Center
Fairbanks Climate Action Coalition
Families Advocating for Chemical and Toxics Safety (FACTS)
Feminists in Action Los Angeles
Feminists of Speech (Indivisible Suffragists)
Florida Springs Council
Food & Water Watch

For Love of Water (FLOW)
FracTracker Alliance
Franciscan Action Network
FreshWater Accountability Project
Friends of Nelson
Friends of the Bitterroot
Friends of the Earth
Fuerza Mundial Global
Genesis Farm
George Mason University Center for Climate Change Communication
Global Network Against Weapons & Nuclear Power in Space
Good Neighbor Steering Committee
Grandmothers 4 a Green New Deal
Grassroots Environmental Education
Great Egg Harbor Watershed Association
Great Old Broads for Wilderness
Green Amendments For The Generations
Green America
Green Compass, LLC
Green Party of Florida
Green Party of Pennsylvania
Green River Action Network
GreenFaith
GreenLatinos
GRID Alternatives-Greater Los Angeles
Groundwork Denver
Hampton Roads Green Party
Hands Across the Sand
Harambee House, Inc
Harford County Climate Action
Hazon
Healthy Environment Alliance of Utah
Healthy Gulf
HealthyPlanet, Inc.
Heartwood
Hitec Aztec Communications
Honeydew Advisors
Howling For Wolves
Hudson River Sloop Clearwater, Inc.
Idaho Conservation League
In the Public Interest
In the Shadow of the Wolf
Indian Point Safe Energy Coalition
Indivisible Bainbridge Island
Indivisible CA33
Indivisible Ga 04

Indivisible Tacoma
Indivisible Ventura
Inland Ocean Coalition
inNative
Interfaith Earthkeepers
International Marine Mammal Project of Earth Island Institute
Jammin' Salmons' Phys & Nutr. Therapies
Judson Memorial Church
Justice Commission
Kentucky Environmental Foundation
Kentucky Heartwood
Kettle Range Conservation Group
Kissimmee Waterkeeper
Klamath Forest Alliance
KyotoUSA
Labor Network for Sustainability
Lone Tree Council
Lonely Whale
Long Beach Alliance for Clean Energy
Long Beach Gray Panthers
Los Padres ForestWatch
Loudoun Climate Project
Louisiana Bucket Brigade
Malach Consulting
ManaSota-88, Inc.
Maryland Legislative Coalition
Maryland Ornithological Society
Mazaska Talks
Medical Advocates for Healthy Air
Michigan Clinicians for Climate Action
Mid-Missouri Peaceworks
Midwest Environmental Justice Organization
Milwaukee Riverkeeper
MLC Climate Justice Wing
MLK Coalition of Greater Los Angeles
Mothers Out Front
Movement for a People's Party
Movement Rights
Multicultural Alliance for a Safe Environment
Nassau Hiking & Outdoor Club
National Advocacy Center of the Sisters of the Good Shepherd
National Network for Immigrant & Refugee Rights
NC WARN
New Energy Economy
New Mexico Interfaith Power and Light
New York Lawyers for the Public Interest

NJ State Industrial Union Council
NJ Student Sustainability Coalition
No Coal in Oakland
No Fracked Gas in Mass
No Sharon Gas Pipeline | Clean Energy Now
North American Climate, Conservation and Environment (NACCE)
North American Water Office
North Carolina Council of Churches
North Carolina Interfaith Power & Light
North Country 350 Alliance
North Kitsap Indivisible
Northcoast Environmental Center
Northern Jaguar Project
Northern Michigan Environmental Action Council
NY4WHALES
NYC H2O
NYPAN of the Southern Finger Lakes
Occidental Arts and Ecology Center
Ocean Conservation Research
Ohio Clinicians for Climate Action
Ohio River Waterkeeper
Oil Change International
On Behalf Of Planet Earth
OneUpAction
Our Santa Fe River
Panhandle Watershed Alliance
Paradise: Las Vegas Indivisible
Pasco Activists
Peace and Freedom Party
Pelican Media
PennFuture
People Over Petro Coalition
Peoples Climate Movement - NY
Physicians for Social Responsibility
Physicians for Social Responsibility - New York
Physicians for Social Responsibility Colorado
Physicians for Social Responsibility Maine Chapter
Physicians for Social Responsibility Pennsylvania
Physicians for Social Responsibility, Arizona
Physicians for Social Responsibility/ Florida
PLAN: The Post Landfill Action Network
Plastic Pollution Coalition
Plymouth Friends for Clean Water
Portland Raging Grannies
Poweshiek-Jasper Green Party
Progressive Democrats of America

Progressive Democrats of America, Tucson, AZ Chapter
Project CoffeeHouse
PSARA (Puget Sound Advocates for Retirement Action)
Public Lands Project
Rachel Carson Council
Rainforest Action Network
Rapid Shift Network
Raptors Are The Solution
RE Sources
Redeemer Community Partnership
Resilient Denver
Resist the Pipeline
Resource Renewal Institute
Responsible Drilling Alliance (RDA)
RESTORE: The North Woods
Revolution LA
Rio Grande International Study Center (RGISC)
RISE St. James
River Guardian Foundation
Riverdale Jewish Earth Alliance
RocACTION
Rogue Climate
Safe Alternatives for our Forest Environment
Safina Center
San Antonio Bay Estuarine Waterkeeper
San Bernardino Valley Audubon Society
San Francisco Bay Physicians for Social Responsibility
San Francisco Baykeeper
SanDiego350
Santa Barbara County Action Network
Santa Barbara Standing Rock Coalition
Santa Cruz Climate Action Network
Save Our Shores
SAVE THE FROGS!
SEE-LA (Social Eco Education-LA)
Seneca Lake Guardian
Sequoia ForestKeeper®
Signal Fire
Sisters of Charity Federation
Sisters of Mercy of the Americas
Sisters of St. Dominic of Blauvelt, New York
Sisters of St. Francis of Philadelphia
SoCal 350 Climate Action
Social Justice Commission (Episcopal Diocese of Western Massachusetts)
Social Justice Ministry of Live Oak Unitarian Universalist Congregation, Goleta
SocioEnergetics Foundation

Solar Wind Works
Solarize Albany
South Asian Fund For Education, Scholarship and Training Inc. (SAFEST)
South Central Michigan Greens
Spottswoode Winery, Inc.
St Andrews Earth Care Team
St. Johns Riverkeeper
Stand.earth
Stella Sustainability
Stockbridge Democratic Town Committee
Stop NY Fracked Gas Pipeline
Stop the Algonquin Pipeline Expansion (SAPE)
Straits Area Concerned Citizens for Peace, Justice and Environment
Sullivan Alliance for Sustainable Development
Sunflower Alliance
Sunrise Dallas
Sunrise Fairview
Sunrise Grinnell
Sunrise Huntsville
Sunrise Stony Brook University
Sunrise Worcester
Surfrider Foundation
Surfrider Foundation Los Angeles Chapter
Sustainable Arizona
Sustainable Medina County
Sylvia Earle Alliance / Mission Blue
Syracuse Cultural Workers
Takoma Park Mobilization Environment Committee
Tennessee Riverkeeper
Texas Campaign for the Environment
The Center for Rural Enterprise and Environmental Justice, Inc.
The Climate Center
The Enviro Show
The Greater Prince William Climate Action Network
The Lands Council
The Last Plastic Straw
The Lilies Project
The Ohio Valley Environmental Coalition
The People's Justice Council
The Rewilding Institute
The River Project
The Shame Free Zone
The Story of Stuff Project
The Wei LLC
Tikkun Magazine's Network of Spiritual Progressives
Topanga Peace Alliance

Toxic Free NC
Toxics Information Project (TIP)
Transition Sebastopol
Turtle Island Restoration Network
Unite North Metro Denver
United For Clean Energy
United Native Americans
Upper West Side Recycling
Utah Physicians for a Healthy Environment
UU Congregation of Binghamton, Green Sanctuary
Valley Watch, Inc.
Venice Resistance
Ventura Coastkeeper
Vermont Yankee Decommissioning Alliance
Vote Climate
Wall of Women
Wasatch Clean Air Coalition
WATCH
Wellstone Democratic Renewal Club
WESPAC Foundation, Inc.
West 80s Neighborhood Association
Western Nebraska Resources Council
WILDCOAST
WildEarth Guardians
Winyah Rivers Alliance
Wisconsin Green Party
Wisconsin Health Professionals for Climate Action
Wishtoyo Foundation
Women's Earth and Climate Action Network (WECAN)
Women's March Santa Barbara
www.SafeEnergyAnalyst.org
Young Ecosocialists of the Green Party of the United States
YUCCA Action
Zero Hour
Zero Waste Capital District
Zero Waste Humboldt
Zero Waste Washington

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