BEFORE THE UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

PETITION TO LIST INDUSTRIAL DAIRY AND HOG OPERATIONS AS SOURCE CATEGORIES UNDER SECTION 111(b)(1)(A) OF THE CLEAN AIR ACT

INTRODUCTION

All Americans deserve clean air and water, a stable climate, and to live in healthy and sustainable communities. And President Biden has committed to act on climate, follow the science, and place environmental justice at the center of climate policy. EPA should therefore list and regulate industrial dairy and hog operations under section 111 of the Clean Air Act because these operations cause and contribute significantly to air and climate pollution that endangers public health and welfare. Over the past few decades, these operations have dramatically grown in size and number while simultaneously spewing unabated and increasing air pollution, including methane, a climate super pollutant, while driving smaller, sustainable, pasture-based farmers out of business. The proliferation of this corporate-controlled model has hollowed out and impacted Black, Latino, Indigenous, and other communities of color, as well as white rural communities, from the coastal plain of North Carolina to the San Joaquin Valley of California. And the U.S. Environmental Protection Agency has stood idly by for more than twenty years while communities suffer the consequences. But now the Biden Administration and an EPA that no longer prioritizes polluters over people have an opportunity to stand with these communities, advance environmental justice, follow the science, and Build Back Better a system of agriculture that behaves like a good neighbor and helps restore our land, air, and water. Taking that stand and delivering on recent promises begins with the EPA granting this Petition.

This Petition urges EPA to regulate industrial dairy and hog operations that liquefy manure and confine at least 500 cows or 1,000 hogs without access to pasture. These operations stock far more animals in confinement than would otherwise be sustainably farmed on pasture and thus generate massive amounts of manure and waste. To deal with the massive increase in manure, the corporate-controlled pork and dairy industry concocted a system of liquefying the manure and storing it in football field-sized impoundments before disposing the manure on nearby crop fields. These intentionally created super-emitters release methane from the liquefied manure in those giant lagoons and the animals' digestive systems. The methane from these industrial dairy and hog operations has increased dramatically during recent decades and now accounts for 33 percent of agricultural methane emissions, 13 percent of total U.S. methane emissions, and 1.3 percent of total U.S. greenhouse gas emissions.

This unabated methane pollution has not gone unnoticed. Recently, Big Oil & Gas have smelled opportunity and developed a scheme to continue the use of their products – fossil fuels – and greenwash their business model. Seizing on the false solution of factory farm gas "energy" from liquefied manure in anaerobic digesters, Big Oil & Gas want to burn factory farm gas to make their fossil fuel climate impact seem less severe. But burning factory farm gas and fossil fuels does not reflect the clean energy economy that America, especially rural and communities of color, need to stabilize our climate. Constructing pipelines through rural communities, expanding industrial dairy and hog operations, and increasing air and water pollution leads us further away from the future our communities deserve. The tried and true approach of sustainably raising far fewer dairy cattle and hogs on pasture provides a myriad of benefits far greater than Big Oil & Gas's false and dirty solution. To minimize those benefits and avoid the harms of industrial dairy and hog operations, this petition urges the EPA to reject the false solution of burning factory farm gas and instead rely on proven, pasture-based farming with reduced, sustainable herd sizes that will restore rural communities, help stabilize the climate, and provide environmental justice. And communities deserve healthy and affordable food that does not come at the expense of their health and welfare, so Building Back Better also means equity and justice at the grocery store.

The twenty-five Petitioners here represent over 2.4 million members from coast to coast. Our members and rural communities want respect, dignity, clean air and water, and a livable climate. Our well-being and that of future generations depend on the EPA fulfilling its duty to protect people. Industrial hog and dairy operations have hollowed out rural communities, gutted Main Street, and driven family farmers off their land. Big Oil & Gas clings to their use of fossil fuels despite that massive pollution. Doubling down on their corporate schemes will not Build Back Better; it will not revitalize rural America, family farmers, local grocery and hardware stores, our Main Street economy, or our climate. Rather than wasting millions of dollars on a system that requires harming people and polluting our communities, the EPA can grant this petition and choose what already works. Truly clean and sustainable energy solutions, like wind and solar, combined with food production led by local family farmers, will allow future generations to enjoy a livable climate and clean air and water. EPA should grant this Petition and stand with family farmers and local communities committed to sustainable farming and truly clean, renewable energy.

Environmental justice principles also demand the EPA grant this Petition. The Biden Administration has committed to environmental justice, while preceding administrations have fallen far short. On January 27, 2021, President Biden signed the Executive Order on Tackling the Climate Crisis at Home and Abroad, and section 219 of that Order commits the Administration to placing environmental justice at the center of climate policy. The President stated, "[i]t is therefore the policy of my Administration to secure environmental justice and spur economic opportunity for disadvantaged communities that have been historically marginalized and overburdened by pollution[.]" Racism and exploitation reflect the status quo in communities harmed by industrial dairy and hog operations and Big Oil & Gas. Black communities in North Carolina and Latino communities in California bear a disproportionate impact from air and water pollution, and from climate impacts such as catastrophic wildfires and more intense hurricanes. The EPA can and should provide every person the opportunity to live, work, play, and pray in a healthy and sustainable community. Being good neighbors and treating the soil, air, water, land, and everyone in our communities as connected and valued is the key to EPA doing its part to Build Back Better.

Building Back Better starts with EPA granting this Petition. EPA has the duty and authority to regulate these methane super-emitters under the Clean Air Act as part of the Administration's larger strategy to prevent catastrophic and irreversible climate change. On the first day of his administration, President Biden issued the Executive Order on Protecting Public Health and the Environment and Restoring Science to Tackle the Climate Crisis. Section 1 of the Order declares:

> It is, therefore, the policy of my Administration to listen to the science; to improve public health and protect our environment; to ensure access to clean air and water; to limit exposure to dangerous chemicals and pesticides; to hold polluters accountable, including those who disproportionately harm communities of color and low-income communities; to reduce greenhouse gas emissions; to bolster resilience to the impacts of climate change; to restore and expand our national treasures and monuments; and to prioritize

> both environmental justice and the creation of the well-paying union jobs necessary to deliver on these goals.

As this Executive Order directs, EPA should list industrial dairy and hog operations under Clean Air Act section 111 of the Act as sources that cause or contribute significantly to dangerous pollution. Within one year of listing, EPA must issue regulations to reduce methane from such new and existing operations. And EPA should reject factory farm gas – branded as "biogas" by Big Oil & Gas – as dirty energy and a false solution. Because pasture-based farms mean reduced herd sizes and avoided methane emissions, while providing myriad co-benefits, EPA should base subsequent regulations on the emission reductions achievable with widespread application of sustainable, pasture-based practices. Pasture-based operations not only significantly reduce methane, they also remove carbon dioxide from the atmosphere through healthy soils, reduce nitrous oxide emissions from feed crops and manure disposal, reduce water pollution, and decrease odors and other harmful air pollutants in local communities. The EPA should thus grant this Petition, reject dirty and harmful factory farm gas, truly place environmental justice at the center of climate policy, and Build Back Better.

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The Association of Irritated Residents, Center for Food Safety, Center on Race, Poverty & the Environment, Dakota Rural Action, Environmental Integrity Project, Farm Forward, Food & Water Watch, Friends of Family Farmers, Friends of the Earth, Great Lakes Environmental Law Center, Government Accountability Project, GreenLatinos, Idaho Organization of Resource Councils, Institute for Agriculture and Trade Policy, Iowa Citizens for Community Improvement, Johns Hopkins Center for a Livable Future, Land Stewardship Project, Leadership Counsel for Justice & Accountability, Missouri Rural Crisis Center, North Carolina Environmental Justice Network, Northeast Organic Farming Association, Massachusetts Chapter, Organic Consumers Association, Public Justice Foundation, Sierra Club, and Socially Responsible Agriculture Project petition the U.S. Environmental Protection Agency to fulfill its obligation under section 111 of the Clean Air Act to list industrial dairy and hog operations as source categories of methane that endanger public health and welfare. After EPA has listed these source categories, EPA shall establish (1) national standards to reduce methane emissions from new and modified sources within these source categories; and (2) requirements for state-specific standards to reduce methane emissions from existing sources.

Industrial dairy and hog operations rely on confinement production facilities with liquefied manure management systems to maximize production at the expense of independent farmers, local communities, public health, and the environment. Although industrial dairy and hog operations emit significant amounts of methane and other air pollutants, EPA has failed to regulate any emissions from these operations.[1] By failing to list these source categories, EPA is breaching its clear statutory duty under section 111 to maintain a list of source categories, establish emissions standards for new and modified sources within these source categories, and develop guidelines for states to issue emission standards for existing sources. Further, EPA's inaction is exacerbating climate change risks and endangering public health and welfare.

Accordingly, we file this Petition to urge EPA to list industrial dairy and hog operations as stationary sources of methane pursuant to section 111 of the Act. Specifically, we respectfully petition EPA to initiate rulemaking on the following required actions:

- Find that industrial dairy and hog operations with (1) fully confined production facilities for 500 or more dairy cows or 1,000 or more hogs, and (2) liquefied manure management systems are stationary sources that cause or contribute significantly to air pollution that endangers health and welfare;

- Although not required by statute, and irrespective of other pollutants from these industrial dairy and hog operations, find that methane emissions specifically cause or contribute significantly to air pollution that endangers public health and welfare.

- Consistent with the prior findings, list industrial dairy and hog operations as source categories subject to regulation under section 111(b)(1)(A);

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[1] *See* U.S. EPA, Denial of Petition to List Concentrated Animal Feeding Operations under Clear Air Act, 82 Fed. Reg. 60940 (Dec. 26, 2017) (notice of final action denying petition for rulemaking).

- Within one year of the listing decision, promulgate standards of performance to reduce methane emissions from new and modified sources within the listed industrial dairy and hog source categories, as required under section 111(b)(1)(B); and

- Within one year of the listing decision, promulgate guidelines for states to develop standards of performance to reduce methane emissions from existing sources within these source categories, as required under section 111(d)(1).

II. PETITIONERS

The Petitioners are local, regional, and national environmental justice and public interest organizations committed to stabilizing our climate crisis, reforming harmful industrial animal agricultural practices, and advocating for a more just, humane, and regenerative animal agriculture system.

Association of Irritated Residents is a California nonprofit advocating for environmental justice in the areas of clean air, water quality and global warming as in the San Joaquin Valley. Members live in close proximity to hundreds of industrial dairy operations, which impact their ability to enjoy clean air, a safe water supply, and a zero carbon energy and food system.

Center for Food Safety is a national nonprofit organization that aims to empower people, support farmers, and protect the earth from the harmful impacts of industrial agriculture. Through groundbreaking legal, scientific, and grassroots action, Center for Food Safety protects and promotes everyone's right to safe food and the environment.

Center on Race, Poverty & the Environment (CRPE) is a nonprofit environmental justice organization with the mission to achieve environmental justice and healthy sustainable communities through collective action and the law. CRPE represents predominately Latino communities in the San Joaquin Valley to reduce impacts of climate change and health harming pollution from industrial dairy operations.

Dakota Rural Action is a statewide grassroots organization in South Dakota with a history of working on environmental, agricultural, and justice issues. Dakota Rural Action specifically has worked with citizens and communities to insure people have a say in the siting of concentrated animal feeding operations (CAFOs) in their communities and to ensure the state does not take away rights from people.

Environmental Integrity Project (EIP) is a nonpartisan, nonprofit organization that advocates for more effective enforcement of environmental laws and greater regulation of air and water pollution from CAFOs. EIP aims to reduce air and water pollution from CAFOs and empower affected communities by holding federal agencies, as well as individual corporations, accountable for failing to enforce or comply with environmental laws.

Farm Forward was founded in 2007 as the nation's first nonprofit devoted exclusively to end factory farming and our work improves the lives of 400,000,000 farmed animals annually.

Farm Forward implements innovative strategies to promote conscientious food choices, reduce farmed animal suffering, and advance sustainable agriculture.

Food & Water Watch is a national, nonprofit membership organization that mobilizes regular people to build political power to move bold and uncompromised solutions to the most pressing food, water, and climate problems of our time. Food & Water Watch uses grassroots organizing, media outreach, public education, research, policy analysis, and litigation to protect people's health, communities, and democracy from the growing destructive power of the most powerful economic interests. Food & Water Watch has worked to address pollution from CAFOs since its founding, and advocates for a ban on these facilities due to their harmful impacts on the environment, rural communities and family farmers, public health, workers, and animal welfare.

Friends of Family Farmers is a statewide grassroots nonprofit organization with more than 8,000 supporters across Oregon. Friends of Family Farmers brings together independent small to mid-size farmers, food advocates, and concerned citizens to shape and support socially and ecologically responsible, family-scale agriculture in Oregon that respects the land, treats animals humanely, and sustains local communities.

Friends of the Earth, founded by David Brower in 1969, fights to create a healthy and just world. Our Climate-Friendly Food Program aims to reduce the harmful impacts of industrial animal agriculture and build a more just and resilient food system through policy change and by reducing institutional purchases of industrial meat and dairy while driving increased demand for plant-based foods and organic, high welfare, and pasture-raised animal products.

Government Accountability Project is a national nonprofit whose mission is to promote corporate and government accountability by protecting whistleblowers, advancing occupational free speech, and empowering citizen activists. Founded in 1977, Government Accountability Project is the nation's leading whistleblower protection and advocacy organization. In addition to focusing on whistleblower support in several program areas, including food and agriculture through its Food Integrity Campaign, Government Accountability Project leads campaigns to enact whistleblower protection laws both domestically and internationally.

Great Lakes Environmental Law Center is a Michigan-based environmental law nonprofit that fights for environmental justice, and works with Michigan residents to develop and implement effective legal and policy strategies to address the environmental issues that are impacting their health and quality of life.

GreenLatinos is a national nonprofit organization that convenes a broad coalition of Latino leaders committed to addressing national, regional and local environmental, natural resources and conservation issues that significantly affect the health and welfare of the Latino community in the United States. GreenLatinos develops and advocates for policies and programs to advance this mission. An overwhelming majority of Latinos (78%) say they have personally experienced the effects of climate change. GreenLatinos members are calling for federal climate action that achieves deep carbon cuts, funds resilient infrastructure, and prioritizes benefits for the most impacted communities.

Idaho Organization of Resource Councils is an environmental justice nonprofit that empowers its members to improve the well-being of their communities, sustain family farms and ranches, transform local food systems, promote clean energy, and advocate for responsible stewardship of Idaho's natural resources.

Institute of Agriculture and Trade Policy (IATP) is a nonprofit that works locally and globally at the intersection of policy and practice to ensure fair and sustainable food, farm, and trade systems. IATP's climate change work aims to reduce the harmful impacts of industrialized animal agriculture and promote regenerative systems based on agroecology principles.

Iowa Citizens for Community Improvement (Iowa CCI) is a statewide, grassroots people's action group that uses community organizing to win public policy that puts communities before corporations and people before profits, politics and polluters. Iowa CCI members are everyday Iowans fighting for a better food and farm system, one that works for farmers, workers, eaters, and the environment. Iowa CCI has been fighting to put people first for over 45 years.

Johns Hopkins Center for a Livable Future is based at the Johns Hopkins Bloomberg School of Public Health. We are an academic based education, research and practice Center focusing our work at the intersection of food production, public health, and the environment. We have a particular focus on the public health, environmental and rural community impacts of large scale animal production systems, commonly referred to as concentrated animal feeding operations.

Land Stewardship Project (LSP) is a private, nonprofit organization founded in 1982 to foster an ethic of stewardship for farmland, to promote sustainable agriculture and to develop sustainable communities. LSP is dedicated to creating transformational change in our food and farming system. LSP's work has a broad and deep impact, from new farmer training and local organizing, to federal policy and community based food systems development. At the core of all our work are the values of stewardship, justice and democracy.

Leadership Counsel for Justice & Accountability works alongside impacted communities in the San Joaquin and Eastern Coachella Valleys to eradicate injustice and secure equal access to opportunity regardless of wealth, race, income, or place. Leadership Counsel advocates at the local, regional, and statewide levels on the overlapping issues of land use, transportation, climate change, safe and affordable drinking water, housing, environmental justice, equitable investment, and government accountability.

Missouri Rural Crisis Center is a statewide farm and rural membership organization founded in 1985 with over 5,600 member families. The Missouri Rural Crisis Center's mission is to preserve family farms, promote stewardship of the land, environmental integrity, and strive for economic and social justice by building unity and mutual understanding among diverse groups, both rural and urban.

North Carolina Environmental Justice Network promotes health and environmental equality for all people of North Carolina through community action for clean industry, safe workplaces and fair access to all human and natural resources. NCEJN seeks to accomplish these goals through organizing, advocacy, research, and education based on principles of economic equity and democracy for all people. NCEJN is a network of twenty eight organizations committed to the principles of environmental justice.

Northeast Organic Farming Association, Massachusetts Chapter is a member-based nonprofit that represents over 1,000 sustainable farmers, gardeners, and organic consumers across the state. NOFA/Mass is primarily an educational organization committed to deep organic and agroecological practices, social justice, and healthy communities. Since 1982 NOFA/Mass has been working to expand the production and availability of nutritious food from living soil for the health of individuals, communities and the planet.

Organic Consumers Association is an online and grassroots 501(c)(3) nonprofit public interest organization, and the only organization in the U.S. focused exclusively on promoting the views and interests of the increasingly vocal majority of Americans who prefer organic food and farming – for their health and the health of the planet.

Public Justice Foundation is a national nonprofit legal advocacy organization committed to fighting injustice, protecting Earth's sustainability, and challenging corporate wrongdoing. The Public Justice Food Project specifically aims to dismantle harmful industrial agricultural practices and promote a just, humane, and regenerative animal agriculture system.

Sierra Club is a national nonprofit organization with 65 chapters and over 800,000 members dedicated to exploring, enjoying, and protecting the wild places of the earth; to practicing and promoting the responsible use of the earth's ecosystems and resources; to educating and enlisting humanity to protect and restore the quality of the natural and human environment; and to using all lawful means to carry out these objectives. The Sierra Club is committed to reducing emissions of all harmful pollutants, including industrial greenhouse gases, and has invested significant resources into combatting emissions of methane, a powerful greenhouse gas that is responsible for approximately one-quarter of the warming our planet has experienced since pre-industrial times.

Socially Responsible Agricultural Project (SRAP) informs and educates the general public about the negative effects of concentrated animal feeding operations – also known as factory farms – while working directly with U.S. communities impacted by this destructive form of industrial animal agriculture. Through public education, issue advocacy, and local community organizing, SRAP empowers rural residents to protect their public health, environmental quality, natural resources and local economies from the damaging impacts of factory farms.

III. STATUTORY BACKGROUND

A. <u>EPA has expansive authority to list industrial dairy and hog operations under section 111 of the Clean Air Act.</u>

Congress enacted the Clean Air Act "to protect and enhance the quality of the Nation's air resources so as to promote the public health and welfare."[2] To this end, the Act outlines a

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[2] 42 U.S.C. § 7401(b)(1).

process for identifying stationary sources of dangerous air pollution, and limiting emissions from those sources. The EPA is the federal agency responsible for administering the Act.

Section 111 of the Clean Air Act requires EPA to publish and regularly revise a "list of categories of stationary sources."[3] Specifically, EPA must list any source category that the Administrator finds, in their judgment, "causes, or contributes significantly to, air pollution which may reasonably be anticipated to endanger public health or welfare."[4] EPA commonly refers to this determination as the "endangerment finding."

1. New Source Performance Standards

Within one year of adding a new source category to this list, EPA must then promulgate "standards of performance" to reduce air pollution from new and modified sources in that category.[5] EPA may also "distinguish among classes, types, and sizes within categories of new sources for the purpose of establishing such standards."[6]

These standards must "reflect[] the degree of emission limitation achievable through the application of the best system of emission reduction which (taking into consideration the cost of achieving such reduction and any nonair quality health and environmental impact and energy requirements) the Administrator determines has been adequately demonstrated."[7] EPA cannot, however, "require any new or modified source to install and operate any particular technological system of continuous emission reduction to comply with any new source standard of performance" unless the Administrator finds, in their judgment, "it is not feasible to prescribe or enforce a standard of performance."[8]

EPA has promulgated standards of performance for pollutants from new and modified facilities in dozens of industries,[9] including non-methane organic compound emissions from

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[3] *Id.* § 7411(b)(1)(A).

[4] *Id.*

[5] *Id.* § 7411(b)(1)(B).

[6] *Id.* § 7411(b)(2).

[7] *Id.* § 7411(a)(1).

[8] *Id.* § 7411(b)(5). If the Administrator finds, in their judgment, "it is not feasible to prescribe or enforce a standard of performance," they "may instead promulgate a design, equipment, work practice, or operational standard, or combination thereof, which reflects the best technological system of continuous emission reduction," taking into account the cost, non-air quality health and environmental impact, and energy requirements. *Id.* § 7411(h)(1).

[9] EPA, *New Source Performance Standards*, https://www.epa.gov/stationary-sources-air-pollution/new-source-performance-standards (last updated Jul. 9, 2020); 40 C.F.R. § 60.16 (prioritized major source categories).

municipal solid waste landfills;[10] particulate matter from grain elevators;[11] particulate matter from glass manufacturing plants;[12] particulate matter, nitrogen oxide, and sulfur dioxide from portland cement plants;[13] and volatile organic compounds from rubber tire manufacturing plants, to name a few.[14] In 2015, EPA promulgated standards of performance to limit GHG emissions "manifested as CO_2" from fossil fuel-fired electric utility steam generating units and stationary combustion turbines,[15] which were among the first sources regulated under section 111(b).[16]

2. Emission Guidelines for Existing Sources

Upon or after setting standards for new and modified sources, EPA must establish guidelines for existing sources, and states must follow these guidelines to develop standards of performance for existing sources located in their borders.[17] This requirement does not apply to emissions of air pollutants regulated as either (1) a criteria air pollutant listed under section 7408(a); or (2) a hazardous air pollutant emitted from a source category regulated under section 7412.[18] Thus, section 111(d) is a gap-filling provision designed to regulate pollutants from existing sources that are not covered by the criteria pollutant provisions or the hazardous air pollutant provisions.

Currently, EPA has listed six criteria air pollutants under section 7408(a): carbon monoxide (CO), lead (Pb), nitrogen dioxide (NO_2), sulfur dioxide (SO_2), ozone (O_3), and

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[10] 40 C.F.R. § 60.752; *see also* Standards of Performance for Municipal Solid Waste Landfills, 61 Fed. Reg. 9905 (Mar. 12, 1996) (adding "municipal solid waste landfills" to the priority list of source categories under section 111 and promulgating NSPS for landfill gas emissions); EPA, EPA-453/R-94-021, Background Information Document, 1-2 and 1-3 (Dec. 1995) (explaining that methane and other organic compounds from landfills endanger public health and welfare by contributing to ozone formation, cancer and non-cancer health effects, and odor nuisance).

[11] 40 C.F.R. § 60.302; *see also* Standards of Performance for Grain Elevators, 43 Fed. Reg. 34340 (Aug. 3, 1978) (promulgating NSPS for particulate matter emissions from grain elevators because senate committee "listed grain elevators as a source for which standards of performance should be developed" in September 1970).

[12] 40 C.F.R. § 60.292; *see also* EPA, EPA-450/3-79-005b, Background Information Document, 2-11 (Sep. 1980) (noting that the Administrator found that particulate matter emissions from new glass manufacturing plants contribute significantly to air pollution, "even though the total amount of emissions is a small portion of the Nation's total particulate emissions"); 44 Fed. Reg. 34193 (Jun. 14, 1979) (adding glass manufacturing to list of source categories that endanger public health and welfare under section 111).

[13] 40 C.F.R. § 60.62.

[14] *Id.* § 60.542; *see also* Standards of Performance for Rubber Tire Industry, 54 Fed. Reg. 38634 (Sep. 19, 1989) (promulgating revised NSPS for VOC emissions from rubber tire manufacturing operations in response to petition); 44 Fed. Reg. 49222 (Aug. 21, 1979) (adding synthetic rubber tire industry to priority list under section 111).

[15] 40 C.F.R. Part 60, Subpart TTTT; *see also* Standards of Performance for GHG Emissions from Electric Utility Generating Units (EGUs), 80 Fed. Reg. 64510 (Oct. 23, 2015).

[16] *See* List of Categories of Stationary Sources, 36 Fed. Reg. 5931 (Mar. 31, 1971); Priority List & Additions to the List of Categories of Stationary Source, 44 Fed. Reg. 49222 (Aug. 21, 1979); *see also* Standards of Performance for New Stationary Sources, 36 Fed. Reg. 24876 (Dec. 23, 1971) (promulgating standards for steam generators, portland cement plants, incinerators, nitric acid plants, and sulfuric acid plants).

[17] 42 U.S.C. § 7411(d)(1).

[18] *Id.* § 7411(d)(1).

particulate matter (PM).[19] The "primary criteria pollutants of concern for agriculture" are particulate matter and ozone.[20] Although industrial animal operations do not directly emit ozone, they emit nitrogen oxides (NOx) and volatile organic compounds (VOCs), which are precursors to ozone formation. Industrial animal operations emit particulate matter as dust. These operations also indirectly emit particulate matter precursors including ammonia, NOx, VOCs, and sulfur dioxide.[21] So while some CAFO emissions are criteria pollutants, methane is not one of them. EPA has also failed to list industrial animal operations as a source category of hazardous air pollutants, even though they emit several hazardous air pollutants listed by EPA.[22] Thus, the gap-filling provisions of section 111(d) would apply with respect to methane, which is not regulated as either a criteria pollutant or a hazardous air pollutant from CAFOs.

EPA has promulgated guidelines under section 111(d) to reduce emissions from existing facilities in the following source categories:

- GHG emissions (in the form of CO_2) from fossil fuel-fired electric utility generating units.[23]
- Non-methane organic compound emissions from municipal solid waste landfills.[24]
- Particulate matter, nitrogen oxides, sulfur dioxides, and other air pollutants from solid waste combustors.[25] Please note that section 129 of the Act requires EPA to issue

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[19] 40 C.F.R. Part 50; EPA, *NAAQS Table*, https://www.epa.gov/criteria-air-pollutants/naaqs-table (Dec. 20, 2016); *see also* Review of the Ozone NAAQS, 85 Fed. Reg. 49,830 (Aug. 14, 2020) (proposed rule) (proposing to retain primary and secondary air quality standards for ozone); Review of the Particulate Matter NAAQS, 85 Fed. Reg. 24,094 (Apr. 30, 2020) (proposed rule) (proposing to retain primary and secondary air quality standards for particulate matter, despite new evidence of health and welfare effects).

[20] *See* NRCS, USDA, CRITERIA POLLUTANTS (2011).

[21] *See, e.g.*, $PM_{2.5}$ SIP Requirements Rule, 81 Fed. Reg. 58010 (Aug. 24, 2016) (requiring that states evaluate all $PM_{2.5}$ precursor pollutants (sulfur dioxide, oxides of nitrogen, VOC, and ammonia) in the development of all $PM_{2.5}$ nonattainment area state implementation plans); *see also id.* at 58104 ("The principal precursor gases that contribute to secondary $PM_{2.5}$ formation are . . . ammonia, from sources such as animal feeding operations, wastewater treatment and fertilizer."); P. GREEN & F. MITLOEHNER, EPA, MECHANISMS OF NITROGEN OXIDE FORMATION DURING ENSILING (2014) (long-term feed storage (or silage) at industrial dairy operations emits NOx and VOCs, which are precursors to ozone formation and $PM_{2.5}$).

[22] 40 C.F.R Parts 60-63; *see also id.* § 61.01 (list of hazardous air pollutants); EPA, *National Emission Standards for Hazardous Air Pollutants*, https://www.epa.gov/stationary-sources-air-pollution/national-emission-standards-hazardous-air-pollutants-neshap-9 (Jun. 5, 2020); *Initial List of Hazardous Air Pollutants with Modifications*, https://www.epa.gov/haps/initial-list-hazardous-air-pollutants-modifications (Jun. 18, 2020).

[23] 40 C.F.R. Part 60, Subpart UUUUa; *see also* Emission Guidelines for GHG Emissions from Existing EGUs, 84 Fed. Reg. 32520 (Jul. 8, 2019) (promulgating revised emission guidelines for CO_2 emissions from two subcategories of existing coal-fired EGUs based on measures that can be applied to a designated facility); Carbon Pollution Emission Guidelines for Existing EGUs, 80 Fed. Reg. 64661 (Oct. 23, 2015) (promulgating emission guidelines for CO_2 emissions based on previous best system).

[24] 40 C.F.R. § 60.33c; Emission Guidelines for Existing Municipal Solid Waste Landfills, 81 Fed. Reg. 59276 (Aug. 29, 2016). In 2003, the EPA promulgated national emission standards for hazardous air pollutants from municipal solid waste landfills under section 112. The HAP emitted by landfills include vinyl chloride, ethyl benzene, toluene, and benzene. *See* 40 C.F.R. Part 63, Subpart AAAA; 68 Fed. Reg. 2227 (Jan. 16, 2003).

[25] 40 C.F.R. Part 60, Subpart Cb; Emission Guidelines for Existing Large Municipal Waste Combustors, 71 Fed. Reg. 27323 (May 10, 2006); *see also* 40 C.F.R. Part 60, Subparts BBBB (small municipal waste combustion units), DDDD (industrial solid waste incineration units), EEEE and FFFF (other solid waste incineration units).

emission guidelines for air pollution from existing solid waste incinerators under section 111(d).[26]

- Acid mist from sulfuric acid production plants.[27]
- Fluoride emissions from phosphate fertilizer plants.[28]
- Total reduced sulfur emissions from Kraft pulp plants.[29]
- Fluoride emissions from primary aluminum plants.[30]

B. Although EPA has regulated other sources of GHG emissions under section 111, EPA took final action and declined to determine whether to list concentrated animal feeding operations.

1. EPA's Rulemakings on GHG Emissions

In 2009, EPA determined that six greenhouse gases–carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulfur hexafluoride (SF_6)–endanger the public health and public welfare of current and future generations by causing and contributing to climate change.[31] Subsequently, EPA relied on this finding to establish standards to reduce GHG emissions in the form of CO_2 from new and existing fossil fuel-fired electric utility steam generating units and combustion turbines under section 111 of the Clean Air Act.[32] Further, in addition to establishing VOC standards for new sources within the oil and gas industry under section 111,[33] which have the co-benefit of reducing methane emissions, EPA issued GHG standards in the form of methane emission

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[26] Although section 111(d) generally prohibits EPA from issuing emission guidelines for pollutants regulated as criteria pollutants under section 110 or hazardous air pollutants under section 112, section 129 directs the agency to issue existing source emission guidelines for specified pollutants, including a number of criteria and hazardous air pollutants, from solid waste incinerators. 42 U.S.C. § 7429(b).

[27] 40 C.F.R. Part 60, Subpart Cd; Emission Guideline for Sulfuric Acid Mist, 42 Fed. Reg. 55796 (Oct. 18, 1977).

[28] 42 Fed. Reg. 12022 (Mar. 1, 1977) (notifying public of availability of final guideline document: EPA–450/2–77–005, Guidelines for Control of Fluoride Emissions from Existing Phosphate Fertilizer Plants (Mar. 1977)).

[29] 44 Fed. Reg. 29828 (May 22, 1979) (notifying public of availability of final guideline document: EPA–450/2–78–003b, Guidelines for Control of Emissions from Existing Mills (Mar. 1979)).

[30] 45 Fed. Reg. 26294 (Apr. 17, 1980) (notifying public of availability of final guideline document: EPA– 450/2–78–049b, Guidelines for Control of Fluoride Emissions from Existing Primary Aluminum Plants (Dec. 1979)).

[31] Endangerment & Cause or Contribute Findings from GHGs under Section 202(a) of the Clean Air Act, 74 Fed. Reg. 66496 (Dec. 15, 2009) (final rule) (finding that combined GHG emissions from new motor vehicles and new motor vehicle engines contribute to GHG pollution that endangers both public health and welfare); *see also* Finding that GHG Emissions from Aircraft Cause or Contribute to Air Pollution That May Reasonably Be Anticipated to Endanger Public Health & Welfare, 81 Fed. Reg. 54422 (Aug. 15, 2016) (finding that GHG emissions from aircraft engines satisfy endangerment standard under section 231(a)(2)(A) of the Clean Air Act).

[32] Standards of Performance for GHG Emissions from New EGUs, 80 Fed. Reg. 64510, 64530–31 (Oct. 23, 2015) (final rule) (regulating CO_2 emissions from new EGUs under section 111); Review of Standards of Performance for New EGUs, 83 Fed. Reg. 65424, 65435 (Dec. 20, 2018) (proposed rule) (proposing to promulgate new emission standards for CO_2 emissions from new EGUs under section 111); Emission Guidelines for GHG Emissions from Existing EGUs, 80 Fed. Reg. 32520 (Sep. 6, 2019) (final rule) (promulgating emission guidelines for GHG emissions from existing EGUs based on revised determination of best system of emission reduction).

[33] Review of Standards of Performance for Oil & Gas Sector, 77 Fed. Reg. 49490, 49513 (Aug. 16, 2012) ("[T]he control measures that the EPA is requiring for VOC result in substantial methane reductions as a co-benefit.").

limits.[34] Although EPA has taken action to rescind the GHG standards for oil and gas operations, it has not disputed its earlier finding that GHG emissions—including methane—endanger public health and welfare,[35] and the incoming Biden administration has affirmed its intention to re-institute those standards and to issue existing source guidelines for oil and gas methane emissions.

2. EPA's Final Action Declining to Determine the Petition to Regulate GHG Emissions from CAFOs

In September 2009, several public interest organizations recognized that industrial animal production is a major source of criteria air pollutants and GHG emissions and petitioned EPA to regulate these emissions. Specifically, the petition urged EPA to list concentrated animal feeding operations (CAFOs) as a category of sources that emit GHGs and other air pollutants that cause or contribute significantly to air pollution that endangers public health and welfare under section 111 of the Clean Air Act.[36]

In December 2017, in its final response to the petition, EPA "declined to determine whether to list CAFOs as a source category under . . . section 111."[37] Although information at the time indicated that methane emissions from industrial dairy and hog operations were significant,[38] EPA noted that it needed more time to "gather[] additional information" before "determining which regulatory tool[s] would be most appropriate to regulate CAFO emissions to protect public health and welfare."[39] EPA further claimed that it could not determine whether any regulatory action was needed until the agency finished "[d]eveloping accurate methodologies to estimate air emissions from CAFOs," based on data collected during the National Air Emissions Monitoring Study (NAEMS).[40]

However, as explained further below, these justifications do not explain EPA's failure to list CAFOs as a source category causing or contributing significantly to dangerous air emissions. The NAEMS study focused on a short list of pollutants, which did not include methane, so NAEMS simply has no bearing on methane emissions from CAFOs. Moreover, effective methodologies for estimating methane emissions already exist and are being used by the

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[34] Standards of Performance for Oil & Natural Gas Sector, 81 Fed. Reg. 35824, 35841 (Jun. 3, 2016) (final rule) ("While the controls used to meet the VOC standards in the 2012 NSPS also reduce methane emissions incidentally, in light of the current and projected future GHG emissions from the oil and natural gas industry, reducing GHG emissions from this source category should not be treated simply as an incidental benefit to VOC reduction; rather, it is something that should be directly addressed through GHG standards in the form of limits on methane emissions under CAA section 111(b) . . . ").

[35] Review of Emission Standards for New, Reconstructed, and Modified Sources in Oil & Natural Gas Sector, 85 Fed. Reg. 57018 (Sep. 14, 2020) (final rule).

[36] <u>Petition to List CAFOs & Promulgate Standards of Performance under Section 111 of the Clean Air Act</u> (Sep. 21, 2009).

[37] Letter from E. Scott Pruitt, Administrator, EPA, to Tom Frantz, President, Ass'n of Irritated Residents, at 1–2 (Dec. 15, 2017).

[38] *See* Petition to List CAFOs, *supra* note 36, at 17–19, 28–30.

[39] Letter from E. Scott Pruitt, *supra* note 37, at 1–2.

[40] *Id.* at 4–7.

Agency.[41] EPA has not initiated any rulemaking to reduce these emissions. Accordingly, EPA should list industrial dairy and hog operations as source categories of dangerous methane emissions and subsequently adopt emission reduction standards for methane emissions.

IV. FACTUAL BACKGROUND

A. Climate Change

Over the last several decades, atmospheric concentrations of anthropogenic greenhouse gases (GHGs), such as carbon dioxide, methane, and nitrous oxide, have reached unprecedented levels. Due largely to population growth and industrial processes, this increase in anthropogenic GHG emissions has had widespread climate impacts, from warming temperatures to rising sea levels. However, despite widespread consensus that anthropogenic emissions are the "dominant cause" of climate change, current efforts to reduce emissions from industrial activities have not stabilized current GHG concentrations.[42] Thus, without additional reduction efforts, GHG emissions will continue to rise, resulting in irreversible damage to natural and human systems.[43]

1. Public Health

Climate change is a significant threat to human life and safety. Recent scientific assessments confirm that extreme temperature variation and heat waves are likely to increase deaths and illnesses, especially among society's most vulnerable populations, such as children, pregnant women, elderly people, and people with chronic illness.[44] Climate change is also associated with more intense and frequent extreme weather events (e.g., hurricanes, wildfires, tornadoes), which can have numerous detrimental public health impacts, including increased deaths, injuries, infections, and stress-related disorders. Relatedly, climate change is likely to increase exposure to harmful pathogens and toxins in water and food resources, and accelerate the spread of deadly infectious diseases, such as the West Nile and Zika viruses.[45] Moreover, the health impacts of climate change disproportionately affect low-income communities and communities of color due to their increased exposure and sensitivity to health hazards.[46]

2. Public Welfare

Climate change will also adversely affect public welfare in several ways. For example, rising temperatures will increase extreme weather events, such as droughts, floods, and wildfires. Coastal communities are also particularly vulnerable to property damage and degradation from rising sea levels and more intense hurricanes and storm events. Likewise, the agricultural sector

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[41] *See infra* Part V.B.1.

[42] INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE, FIFTH ASSESSMENT REPORT, SYNTHESIS REPORT 4 (2014) [hereinafter IPCC, AR5 REPORT]; *see also* SPECIAL REPORT ON CLIMATE CHANGE & LAND (2019).

[43] IPCC, AR5 REPORT, *supra* note 42, at 17–20.

[44] *See infra* Part V.A.2.ii.a (discussing public health impacts of climate change).

[45] U.S. GLOBAL CHANGE RESEARCH PROGRAM, FOURTH NAT'L CLIMATE ASSESSMENT, VOL. II: IMPACTS, RISKS, & ADAPTATION 544–46 (2018) [hereinafter USGCRP, NCA4 REPORT].

[46] *Id.* at 546–48.

is uniquely vulnerable to climate change because extreme weather events, such as heavy precipitation and heat waves, threaten crop and livestock production.[47] Further, climate change will disrupt access to critical sectors and infrastructure, including transportation, energy, communication, and medical systems.

B. Expansion of Industrial Dairy and Hog Operations

Over the past few decades, corporate consolidation has forced U.S. hog and dairy production to shift from traditional, independent pasture-based operations to highly concentrated and industrialized operations, which rely on the industrial model of production to maximize the number of animals. Unlike pasture-based operations, where animals can graze and forage on pasture, industrial hog and dairy operations confine animals in large, specialized facilities for every stage of production. Further, industrial operations use liquefied manure management systems, such as lagoons (flush systems) or slurry/liquid tanks (scrape systems), to collect and store massive amounts of manure from production facilities until disposal on nearby agricultural fields.[48] Typically, industrial operations use mechanical spread and injection systems to apply manure to soils, and irrigation systems to apply liquid manure solutions and wastewater to crops and grazing lands.[49] Thus, industrial hog and dairy operations stock more animals per acre than traditional pasture-based operations because they rely on confined production facilities and liquefied manure management systems.

Both confinement facilities and liquefied manure storage systems emit significant amounts of ammonia, hydrogen sulfide, particulate matter, and other odorous and harmful air pollutants, which degrade local and regional air quality. These sources also emit methane, nitrous oxide, and carbon dioxide, which contribute to rising GHG emissions and climate change impacts. In fact, EPA has expressly acknowledged that the expansion of dairy cows and hogs in confinement facilities with liquefied manure management systems has caused methane emissions from this sector to increase significantly in recent decades.[50] In the most recent inventory of U.S. GHG emissions, EPA noted that the "manure management systems with the most substantial methane emissions are those associated with confined animal management operations[,] where

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[47] *See* IPCC, CLIMATE CHANGE & LAND, *supra* note 42, at 5-24 to 5-37.

[48] Manure lagoons "are large earthen containment structures into which manure and wastewater is flushed and maintained in liquid form until removed," and pits or tanks "are often located under hog production facilities where, in the typical system, manure drops into pits through slatted floors and is stored in a slurry form until removed." Both systems of liquefied manure storage "hold the manure until it can be land-applied on the same farm or nearby farms." ECON. RESEARCH SERV. (ERS), USDA, AGRIC. RESOURCES & ENVTL. INDICATORS 75 (2019).

[49] *Id.* ("Technologies for land application include liquid/slurry manure spreaders that may or may not incorporate manure into the soil, and irrigation systems that spray or spread the liquid manure solution on nearby fields."); *see also* WISCONSIN MANURE IRRIGATION WORKGROUP, CONSIDERATIONS FOR THE USE OF MANURE IRRIGATION PRACTICES 13, 16–17 (K. Genskow & R. Larson, eds., 2016) [hereinafter MANURE IRRIGATION REPORT].

[50] EPA, INVENTORY OF U.S. GREENHOUSE GAS EMISSIONS & SINKS: 1990-2018, at 5-12 (2020) (explaining that "the shift toward larger dairy cattle and swine facilities since 1990 has translated into an increasing use of liquid manure management systems, which have higher potential CH_4 emissions than dry systems") [hereinafter U.S. GHG INVENTORY]; *see also id.* at 5-11 (noting that the "majority of [the 66 percent increase in methane emissions from 1990 to 2018] is due to swine and dairy cow manure . . . [and] an increase in animal populations").

manure is handled in liquid-based systems."[51] Consequently, as animal production becomes increasingly more industrialized and concentrated, methane emissions will also increase, leading to adverse climate change impacts.

1. Industrial Dairy

According to the U.S. Department of Agriculture (USDA), "the structure of dairy farming has changed dramatically in the last [three] decades," with production shifting away from small, pasture-based farms to larger and more industrialized operations.[52] In fact, over 60 percent of U.S. dairy production takes place on industrialized operations with more than 500 cows, and "[s]everal farms now have milking herds of well over 10,000 [cows.]"[53] As USDA explained, industrial dairy operations rely on animal confinement, purchased feed, liquefied manure management, and other highly polluting "practices and technologies" to maximize profits.[54]

As the number of U.S. dairy farms has decreased, farmer-owned dairy cooperatives have also decreased. These cooperatives provide a wide-range of beneficial services to member farmers, including price negotiations, milk processing, and marketing. However, as cooperatives consolidate and their membership grows more diverse, it becomes increasingly difficult for cooperatives to adequately represent member farmers with different needs, causing "farmers [to] feel they have lost control of their cooperative's priorities and strategic direction."[55]

The decline in dairy farms and cooperatives has coincided with increased consolidation in ownership on a national scale, including mergers between the nation's largest dairy cooperatives and milk processors.[56] According to recent studies, the expansion of "cooperatives' investments in dairy processing can affect farmers' earnings" and "create power imbalances."[57] Moreover, major grocery retailers, such as Walmart, have started to build their own dairy processing plants to cut costs, forcing dairy farmers to find new buyers and lower their prices.[58]

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[51] *Id.* at 5-11; *see also id.* at 5-12 tbl.5-7 (demonstrating that methane emissions from dairy cattle and swine have increased by 120 percent and 46 percent, respectively, since 1990).

[52] J. MacDonald, et al., USDA, Econ. Res. Rep. 205, Changing Structure, Financial Risks, & Gov't Policy for the U.S. Dairy Industry 7–13, 18 (2016) [hereinafter USDA, U.S. Dairy Report].

[53] *Id.* at 11; USDA, 2017 Census of Agriculture: United States, 23 tbl.17 (2019).

[54] USDA, U.S. Dairy Report, *supra* note 52, at 13–14, 16.

[55] GAO, Dairy Cooperatives: Potential Implications of Consolidation & Investments in Dairy Processing for Farmers 5 (2019).

[56] *See, e.g.*, Press Release: Dean Foods Completes Sale of Assets to Dairy Farmers of America (May 1, 2020) (announcing merger between DFA, largest dairy cooperative in the country, with Dean Foods, largest milk processor in the county).

[57] GAO, Dairy Consolidation, *supra* note 55, at 4.

[58] *See, e.g.*, J. Bunge & J. Kang, *Walmart, Kroger Bottle Their Own Milk & Shake Up American Dairy Industry*, Wall Street J. (Jul. 27, 2020), https://www.wsj.com/articles/walmart-kroger-bottle-their-own-milk-and-shake-up-american-dairy-industry-11595872190.

The increased consolidation of the U.S. dairy industry has put significant financial stress on farmers, most notably independent pasture-based farms. The expansion of industrial dairy operations has increased dairy production,[59] which has caused milk prices and net returns to decline.[60] In doing so, industrial dairies have put "increased financial pressure" on smaller dairies with higher production costs or tighter margins.[61] Across the country, independent farms are struggling to operate with little to no farm income, often wiping out their savings and credit to stay in business.[62] In fact, many independent farms have been forced to close, thereby "continuing the process of structural change" due to increased consolidation and corporate control in the U.S. dairy industry.[63]

Further, industrial dairy operations have several adverse impacts on local communities because they confine large numbers of cows in specialized production facilities, and generate massive amount of manure, odor, dust, and harmful air pollutants in local communities. These emissions degrade local air quality and threaten the health and well-being of local residents.[64] In addition, industrial dairies significantly increase local air pollution and odor because they rely heavily on liquefied manure management systems, most notably lagoons for storing manure. When operations eventually dispose of liquefied manure or wastewater onto nearby agricultural fields, nutrients, pathogens, antibiotic residues, and other harmful pollutants in the manure can

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[59] J. MacDonald, et al., USDA, Econ. Res. Rep. 274, Consolidation in U.S. Dairy Farming 2 fig.1; 6 fig.3 (2020); *see also* USDA, Milk Production 7 (Feb. 20, 2020) (U.S. Milk Production from 2010 to 2019).

[60] *See* USDA, Consolidation in U.S. Dairy, *supra* note 59, at 5 fig.2 (demonstrating declining net returns and fluctuating milk prices in recent years); U.S. Dairy Report, *supra* note 52, at 18 ("Increases in production reduce real (inflation-adjusted) product prices, and ultimately reduce farm milk prices.").

[61] USDA, U.S. Dairy Report, *supra* note 52, at 18; *see also* Consolidation in U.S. Dairy, *supra* note 59, 19-25, 30; *see also* J. MacDonald & D. Newton, *Milk Production Continues to Shifting to Large-Scale Farms*, ERS (Dec. 1, 2014) ("Most of the largest dairy farms generate gross returns that exceed full costs, while most small and mid-size dairy farms do not earn enough to cover full costs."), https://www.ers.usda.gov/amber-waves/2014/december/milk-production-continues-shifting-to-large-scale-farms.

[62] *See, e.g.*, J. Fox, *A Productivity Revolution is Wiping Out (Most) Dairy Farms*, Bloomberg (Jun. 5, 2019), https://www.bloomberg.com/opinion/articles/2019-06-05/dairy-farms-fall-victim-to-the-productivity-revolution; *see, e.g.*, R. Barrett & L. Bergquist, *Industrial Dairy Farming is Taking Over in Wisconsin, Crowding Out Family Operations & Raising Environmental Concerns*, Milwaukee J. Sentinel (updated Feb. 11, 2020), https://www.jsonline.com/in-depth/news/special-reports/dairy-crisis/2019/12/06/industrial-dairy-impacts-wisconsin-environment-family-farms/4318671002.

[63] USDA, U.S. Dairy Report, *supra* note 52, at 18; USDA, Consolidation in U.S. Dairy, *supra* note 59, at 7-14; *see also* Hope Kirwan, *Wisconsin Loses 10 Percent of State's Dairy Herds as Fallout from Low Milk Prices Continues*, Wisconsin Public Radio (Jan. 7, 2020), https://www.wpr.org/wisconsin-loses-10-percent-states-dairy-herds-fallout-low-milk-prices-continues.

[64] *See, e.g.*, S. Rasmussen, et al., *Proximity to Industrial Food Animal Production & Asthma Exacerbations in Pennsylvania*, 14 Int'l J. Envtl. Res. & Public Health 362 (2017); D. Williams, et al., *Cow Allergen (Bos D2) & Endotoxin Concentrations are Higher in the Settled Dust of Homes Proximate to Industrial-Scale Dairy Operations*, 26 J. Exposure Sci. & Envtl. Epidemiology 42 (2016); V. Blanes-Vidal, et al., *Residential Exposure to Outdoor Air Pollution From Livestock Operations & Perceived Annoyance Among Citizens*, 40 Envtl. Int'l 44 (2012) (exposure to animal waste odor is "a significant degradation in [rural residents'] quality of life"); D. Williams, et al., *Airborne Cow Allergen, Ammonia & Particulate Matter at Homes Vary with Distance to Industrial Scale Dairy Operations: An Exposure Assessment*, 10 Envtl. Health. (2011) (industrial dairy operations increase community exposure to particulate matter, ammonia, and cow allergen).

spread to nearby properties and water sources,[65] threatening the health and well-being of local residents and livestock,[66] and contaminating crops.[67]

2. Industrial Hog

Similarly, the expansion of the industrial model of production has significantly changed the structure of the U.S. hog industry.[68] According to USDA, hog farms were traditionally small, independently owned "farrow-to-finish operations that perform[ed] all phases of production," from breeding to slaughtering.[69] Traditional hog farms also "typically fed their hogs crops grown onsite and then sold their hogs at local markets."[70] Over the last three decades, however, corporate interests have forced U.S. hog production to shift away from "farrow-to-finish" operations to larger and more industrialized operations.[71] In fact, 73 percent of U.S. hog production takes place on industrial operations with 5,000 or more hogs.[72]

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[65] *See, e.g.*, EPA, TRANSPORT & FATE OF NUTRIENTS & INDICATOR MICROORGANISMS AT A DAIRY LAGOON WATER APPLICATION SITE: AN ASSESSMENT OF NUTRIENT MANAGEMENT PLANS (2012) (collecting studies demonstrating that land applications of manure and wastewater from industrial dairy lagoons contaminate water sources); EPA, CASE STUDIES ON THE IMPACT OF CAFOS ON GROUND WATER QUALITY 62 (2012) (over-application of dairy lagoon effluent resulted in groundwater contamination by nitrate, as well as antibiotics, estrogens, and other stressors); C. McKinney, et al., *Occurrence & Abundance of Antibiotic Resistance Genes in Agricultural Soil Receiving Dairy Manure*, 94 FEMS MICROBIOLOGY ECOLOGY 1 (2018) (manure applications significantly increase abundance of antibiotic resistant genes in soil); C. Givens, et al., *Detection of Hepatitis E Virus & Other Livestock-Related Pathogens in Iowa Streams*, 556 SCI. TOTAL ENVTL. 1042 (2016) (zoonotic pathogens were present in surface waters near manure application sites).

[66] *See, e.g.*, T. Burch, et al., *Quantitative Microbial Risk Assessment for Spray Irrigation of Dairy Manure Based on an Empirical Fate & Transport Model*, 125 ENVTL. HEALTH PERSPECTIVES 1 (2017) (bioaerosols from spray irrigation of dairy manure increased the risk for acute gastrointestinal illness for nearby residents); M. Jahne, et al., *Emission & Dispersion of Bioaerosols From Dairy Manure Application Sites*, 49 ENVTL. SCI. TECH. 9842 (2015) ("[B]ioaerosols emitted from manure application sites following manure application may present significant public health risks to downwind receptors.); R. Dungan, *Estimation of Infectious Risks in Residential Populations Exposed to Airborne Pathogens During Center Pivot Irrigation of Dairy Wastewaters*, 48 ENVTL. SCI. TECH. 5033 (2014) (bioaerosols from wastewater irrigation pose greatest infection risks to nearby residents); M. BORCHARDT & T. BURCH, AIRBORNE PATHOGENS FROM DAIRY MANURE AERIAL IRRIGATION & THE HUMAN HEALTH RISK (2016).

[67] *See, e.g.*, M. Jahne, et al., *Bioaerosol Deposition to Food Crops Near Manure Application: Quantitative Microbial Risk Assessment*, 45 J. ENVTL. QUAL. 666 (2016) (pathogens from manure application sites can spread by air to nearby leafy greens).

[68] W. MCBRIDE, ET AL., USDA, ECON. RES. REP. 158, U.S. HOG PRODUCTION FROM 1992 TO 2009: TECHNOLOGY, RESTRUCTURING, & PRODUCTIVITY GROWTH 1, 5 (2013) (explaining how "U.S. hog farm numbers dropped by 70 percent over 1991-2009 while hog inventories remained stable") [hereinafter USDA, U.S. HOG REPORT]; *see also see also* USDA, CHANGES IN THE U.S. SWINE INDUSTRY: 1995-2012, at 7–9 (2017); USDA, 2017 CENSUS, *supra* note 53, at 24 tbl. 21.

[69] USDA, U.S. HOG REPORT, *supra* note 68, at 1.

[70] *Id.* at 5.

[71] *Id.* at 1, 5.

[72] USDA, 2017 CENSUS, *supra* note 53, at 24 tbl.21; *see also* USDA, CHANGES IN THE U.S. SWINE INDUSTRY, *supra* note, at 12 tbl.A.2.c.

As the USDA explained, industrial hog producers are often producing hogs under contract for "large conglomerates or corporate organizations" known as integrators,[73] and these integrators put significant financial pressure on producers to externalize the true costs of industrial hog production. Therefore, confinement facilities and the expansion of the corporate-driven model of production have enabled hog integrators to maximize industrial hog production at the expense of local communities, the environment, and public health.

Industrial hog operations significantly degrade local, regional, and global air quality because they densely confine thousands of hogs in large and highly specialized facilities for each stage of production, and generate massive amounts of waste. These confinement facilities are a significant source of harmful air pollutants and odors, such as ammonia, hydrogen sulfide, and particulate matter, which adversely affect local communities.[74] Another significant source of air pollution is liquefied manure storage, which hold millions of gallons of manure and wastewater for long periods until operators can dispose of it onto nearby fields as fertilizer or irrigation water.[75] These systems generate significant amounts of methane, a potent greenhouse gases, and other harmful air pollutants. Unlike traditional farms, which sequester more carbon than they emit,[76] industrial hog operations do not offset GHG emissions because they rely on purchased feed from outside suppliers rather than crops grown on-site.[77]

In addition, industrial hog operations threaten nearby properties and water sources by storing manure in long-term storage systems prone to breakage and spillage.[78] When there is an infrastructure failure or heavy rain storm, manure lagoons can spill decades' worth of accumulated waste onto local properties, causing crop destruction, soil degradation, water

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[73] USDA, U.S. HOG REPORT, *supra* note 68, at 4, 6, 11; *see also* USDA, 2017 CENSUS, *supra* note 53, at 24 tbl.23.

[74] *See, e.g.*, A. Schultz, et al., *Residential Proximity to CAFOs & Allergic & Respiratory Disease*, 130 ENVTL. INT'L 104911 (2019) (living near hog CAFO was associated with reduced lung function, allergies, and asthma); L. Schinasi, et al., *Air Pollution, Lung Function, & Physical Symptoms in Communities Near Concentrated Swine Feeding Operations*, 22 EPIDEMIOLOGY 208 (2011) (air pollutants near hog CAFOs cause acute physical symptoms); B. Pavilonis, et al., *Relative Exposure to Swine Animal Feeding Operations & Childhood Asthma Prevalence in an Agricultural Cohort*, 122 ENVTL. RES. 74 (2013); D. Ferguson, et al., *Detection of Airborne Methicillin-Resistant Staphylococcus aureus Inside & Downwind of a Swine Building*, 21 J. AGROMEDICINE 149 (2016) (methicillin-resistant *S. aureus* (MRSA) was present in air downwind of hog CAFO); K. Kilburn, *Human Impairment From Living Near Hog CAFOs*, J. ENVTL. & PUBLIC HEALTH 1, 4–6 (2012) (residents near hog CAFOs have higher rates of neurobehavioral and pulmonary impairments).

[75] *See* ERS, TRENDS & DEVELOPMENTS IN HOG MANURE MANAGEMENT 11–18 (2011) (explaining industrial hog operations rely on liquefied manure management systems to "concentrat[e] more animals on a limited land base").

[76] *See, e.g.*, W. Teague, et al., *The Role of Ruminants in Reducing Agriculture's Carbon Footprint in North America*, 71 J. SOIL & WATER CONSERVATION 156 (2016) ("[R]uminants consuming only grazed forages under appropriate management result in more C sequestration than emissions.").

[77] USDA, U.S. HOG REPORT, *supra* note 68, at 6, 8 (noting that "hog producers that specialized in individual production phases generally had much less acreage than farrow-to-finish farms").

[78] *See, e.g.*, D. Schaffer-Smith, et al., *Repeated Hurricanes Reveal Risks & Opportunities for Social-Ecological Resilience to Flooding & Water Quality Problems*, 54 ENVTL. SCI. & TECH. 7194, 7199-20 (2020) (finding "91 swine CAFOs with 125 waste lagoons, which produce ~500 million gallons of liquid manure per year, as well as almost 6,700 km2 of agricultural land where manure is likely regularly applied" "within the repeatedly flooded area").

contamination, and other adverse impacts.[79] Manure spills can also spread disease among livestock,[80] and reduce crop yields, quality, and revenue on nearby farms.[81] Moreover, disposing of liquefied manure and wastewater onto nearby agricultural fields can threaten crops, aquatic life, livestock, and human health by increasing manure nutrients and harmful pathogens in the environment.[82] These risks disproportionately affect local farmers and residents.[83] In fact, several rural residents have successfully sued Smithfield, an industry giant, for spraying liquefied

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[79] *See, e.g.*, Press Release: NC Dep't of Envtl. Quality, Division of Water Resources Issues Notice of Violation to B&L Farms (Jul. 16, 2020) (hog lagoon breach caused three million gallons of manure to spread "into farms, wetlands, and . . . tributary"), https://deq.nc.gov/news/press-releases/2020/07/16/division-water-resources-issues-notice-violation-bl-farms; *Eight Manure Lagoons Overflow in Western Iowa Because of Flooding*, SIOUX CITY J. (Mar. 26, 2019), https://siouxcityjournal.com/news/state-and-regional/iowa/eight-manure-lagoons-overflow-in-western-iowa-because-of-flooding/article_792b6561-c617-58ea-b287-70c58d3bb2bc.html; Wynne Davis, *Overflowing Hog Lagoons Raise Environmental Concerns in North Carolina*, NPR (Sep. 22, 2018), https://www.npr.org/2018/09/22/650698240/hurricane-s-aftermath-floods-hog-lagoons-in-north-carolina; Erin Jordan.

[80] *See* S. Haack, et al., *Genes Indicative of Zoonotic & Swine Pathogens are Persistent in Stream Water & Sediment Following a Swine Manure Spill*, 81 APPLIED & ENVTL. MICROBIOLOGY 3430 (2015).

[81] *See, e.g.*, Press Release: NC Dep't of Agric. & Consumer Servs., Flood Crops Cannot Be Used for Human Food (Sep. 21, 2018) ("Farmers whose crops were flooded . . . face not only the prospect of lower yields and loss of quality, but also the reality that those crops cannot be used for human food.").

[82] ERS, TRENDS IN HOG MANURE MANAGEMENT, *supra* note 75, at iii (recognizing that liquid manure storage systems "magnif[y] the risk that manure nutrients (nitrogen, phosphorous, and potassium) and pathogens might flow into ground and surface water due to overapplication of manure on crops or leakage from manure storage facilities"); *see, e.g.*, M. Mallin, et al., *Industrial Swine & Poultry Production Causes Chronic Nutrient & Fecal Microbial Stream Pollution*, 226 WATER, AIR & SOIL POLLUTION 407 (2015); C. Heaney, et al., *Source Tracking Swine Fecal Waste in Surface Water Proximal to Swine CAFOs*, 511 SCI. TOTAL ENVTL. 676 (2015); L. Casanova, et al., *Antibiotic-Resistant Salmonella in Swine Wastes & Farm Surface Waters*, 71 LETTERS IN APPLIED MICROBIOLOGY 117, 120 (2020) (salmonella, including antibiotic-resistant salmonella, was present in environmental waters associated with hog CAFOs); S. Hatcher, et al. *Occurrence of MRSA in Surface Waters Near Industrial Hog Operation Spray Fields*, 565 SCI. TOTAL ENVTL. 1028 (2016) (MRSA and MDRSA were present in surface waters near industrial hog spray fields); L. He, et al., *Discharge of Swine Wastes Risks Water Quality & Food Safety: Antibiotics & Antibiotic Resistance Genes From Swine Sources to the Receiving Environments*, 92 ENVTL. INT'L 210 (2016) (vegetables irrigated with swine wastewater can contain antibiotic resistant genes).

[83] *See* M. Carrel, et al., *Pigs in Space: Determining the Environmental Justice Landscape of Swine CAFOs in Iowa*, 13 INT'L J. ENVTL. RES. PUBLIC HEALTH 1, 13 (2016) (areas with "high densities of swine" are "significant hotspots of hog manure spills" with "uneven exposure to the negative impacts of uncontrolled manure release"); J. Casey, et al., *High-Density Livestock Operations, Crop Field Application of Manure, & Risk of Community-Associated Methicillin-Resistant Staphylococcus aureus Infection in Pennsylvania*, 172 JAMA INTERNAL MEDICINE 1980 (2013) (residents near manure application sites and confinement facilities had increased rates of MRSA and skin and soft tissue infection); *see also* J. Kravchenk, et al., *Mortality & Health Outcomes in North Carolina Communities Located in Close Proximity to Hog Concentrated Animal Feeding Operations*, 79 NC MED. J. 278 (2018) ("[C]ommunities located near hog CAFOs had higher all-cause and infant mortality, mortality due to anemia, kidney disease, tuberculosis, septicemia, and higher hospital admissions . . . ."); V. Guidry, et al., *Connecting Environmental Justice & Community Health: Effects of Hog Production in North Carolina*, 79 NC MED. J. 324 (2018); STEVE WING & JILL JOHNSTON, INDUSTRIAL HOG OPERATIONS IN NORTH CAROLINA DISPROPORTIONATELY IMPACT AFRICAN-AMERICANS, HISPANICS & AMERICAN INDIANS (2014).

manure near their homes.[84] "It is past time to acknowledge the full harms that the unreformed practices of hog farming are inflicting." *McKiver v. Murphy Brown, LLC*, 980 F.3d 937, 977 (4th Cir. 2020) (Wilkinson, J. concurring).

In sum, corporate consolidation has forced U.S. hog and dairy production to shift to a highly concentrated and industrialized model of animal production that generates significant amounts of pollution and waste, and externalizes costs onto local communities and the public.

C. Industrial dairy and hog operations emit significant amounts of methane and other air pollutants.

Industrial dairy and hog operations rely on the corporate-driven model of production to maximize the stocking density of dairy cows and hogs in full confinement conditions, and generate significantly more manure, than traditional, pasture-based farms. Consequently, industrial dairy and hog operations emit significantly more methane (CH_4) than pasture-based farms.[85] As EPA expressly acknowledged in the most recent U.S. GHG Inventory, the expansion of industrial dairy and hog operations, and the facilities in which they confine animals and store their waste, are responsible for causing methane emissions from this sector to increase dramatically in recent decades.[86]

1. Enteric Fermentation

Industrial dairy operations are significant sources of methane emissions from enteric fermentation, which is a by-product of animals' digestive processes, also known as "cow burps."[87] As EPA explained in the most recent U.S. GHG Inventory, methane emissions from enteric fermentation increase as herd size and confinement-based production increases and feed

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[84] *See, e.g.*, Mery P. Dalesio, *Pork Giant Smithfield Foods Loses Another Neighbors' Lawsuit*, US NEWS (Mar.3, 2019), https://www.usnews.com/news/best-states/north-carolina/articles/2019-03-08/pork-giant-smithfield-foods-loses-another-neighbors-lawsuit; *see also* ERS, TRENDS IN HOG MANURE MANAGEMENT, *supra* note 75, at iii ("[I]ncreased concentration of hogs per farm has led to conflicts with nearby residents or communities over odor and air quality . . . .").

[85] For further discussion on the benefits of pasture, including the capacity to sequester carbon dioxide in soil, see Part V.C.1.

[86] *See supra* note 50.

[87] EPA, U.S. GHG INVENTORY, *supra* note 50, at 5-3. Ruminant animals, such as dairy cows, "are the major emitters of CH_4 because of their unique digestive system." *Id.* Although non-ruminant animals, such as hogs, "also produce CH_4 emissions through enteric fermentation," they "emit significantly less CH_4 on a per-animal-mass basis than ruminants because the capacity of the large intestine to produce CH_4 is lower." *Id.*

In 2018, dairy cows emitted 24.5 percent (or 43.6 mmt CO_2 eq.) of all methane emissions from enteric fermentation, and hogs emitted 1.6 percent (or 2.8 mmt CO_2 eq.). *Id.* at 5-4 tbl.5-3.

digestibility decreases.[88] Accordingly, by enabling dairy operators to increase herd size and productivity to unprecedented levels, the expansion of dairy confinement facilities and purchased feed is largely responsible for causing enteric emissions from dairy cows to increase by 10.7 percent (or 4.2 mmt CO_2 eq.) in the last three decades.[89] Likewise, the decrease in feed quality and increase in productivity associated with the expansion of industrial hog facilities have caused enteric emissions from hogs to increase by 40 percent (or 0.8 mmt CO_2 eq.) over this same period.[90] The corporate-driven confinement model thus maximizes enteric methane emissions compared to pasture-based systems, where stocking density is inherently limited by grazeable acres.

2. Manure Management

Industrial dairy and hog operations are the two largest sources of methane emissions from manure management.[91] According to EPA, "the shift toward larger dairy and swine facilities since 1990 has translated into an increasing use of liquid manure management systems, which have higher potential CH_4 emissions than dry systems."[92] Unlike manure deposited on pasture or rangelands, which "decompose[s] aerobically" and produces "little or no CH_4,"[93] manure handled in liquid-based systems (e.g., liquid/slurry tanks or pits) decomposes anaerobically and produces large amounts of methane.[94] Methane emissions also increase when producers use

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[88] *Id.* at 2-20 (noting that increased levels of methane emissions from enteric fermentation "generally follows the increasing trends in cattle populations" and decreasing "digestibility of feed"); 5-3 (explaining that "lower feed quality and/or higher feed intake leads to higher CH_4 emissions," and "[f]eed intake is positively connected to . . . level of activity and production" and thus varies "among different management practices . . . (e.g., animals in feedlots or grazing on pasture"); 5-11 (noting that "the greater the energy content of the feed, the greater the potential for CH_4 emissions"); *see also* USDA, QUANTIFYING GREENHOUSE GAS SOURCES & SINKS IN ANIMAL PROD. SYS., at 5-6 (explaining how animal diet and intake affects enteric fermentation emissions).

[89] EPA, U.S. GHG INVENTORY, *supra* note 50, at 5-4 tbl.5-3; 2-19.

[90] *Id*. at 5-4 tbl.5-3.

[91] In 2018, dairy and hog operations emitted 88.3 percent (or 54.5 mmt CO_2 eq.) of all methane emissions from manure management. *Id.* at 5-12 tbl.5-7. Specifically, dairy operations emitted 52 percent (32.3 mmt CO_2 eq.) of total methane emissions from manure management, and hog operations emitted 36 percent (22.2 mmt CO_2 eq.). *Id.* Note: U.S. GHG Inventory does not provide separate enteric methane data for industrial dairy and hog operations and pasture-based operations.

[92] *Id.* at 5-12; FOOD CLIMATE RESEARCH NETWORK (FCRN), GRAZED & CONFUSED 27 (2017); USDA, QUANTIFYING GHG SOURCES, *supra* note 88, at 5-8 (noting that manure deposited onto confinement flooring, rather than pasture, begins to emit methane almost immediately).

[93] EPA, U.S. GHG INVENTORY, *supra* note 50, at 5-10.

[94] *Id.*; *see also* J. Wightman, et al., *New York Dairy Manure Management Greenhouse Gas Emissions & Mitigation Costs (1992–2022)*, 45 ENVTL. QUALITY 266 (2015) (finding that increased use of liquefied manure management systems was associated with a substantial increase in methane emissions); S. Petersen, *Greenhouse Gas Emissions from Liquid Dairy Manure: Prediction & Mitigation*, 101 J. DAIRY SCI. 6642 (2018).

long-term storage systems, such as lagoons, which can collect and hold liquefied manure for 10 to 15 years.[95]

Consequently, the expansion of industrial dairy and hog operations, and "the resultant effects on manure management system[s]" and farm size, has caused overall methane emissions from manure management to increase by 98.8 percent (or 24.3 mmt CO_2 eq.) in recent decades.[96] Between 1990 and 2018, methane emissions from manure management at industrial dairy and hog operations increased by 80.4 percent. Specifically, industrial dairy and hog operations are responsible for causing methane emissions from manure management to increase by 120 percent at dairy operations, and 43 percent at hog operations, since 1990.[97] Overall, industrial dairy and hog operations have caused methane emissions from manure management to increase by 98.8 percent since 1990. Moreover, several recent studies have found that EPA's U.S. GHG Inventory significantly underestimates methane emissions from liquid manure storage,[98] largely because EPA's emission factors do not reflect recent developments in confinement animal production and liquefied manure management.[99] Under a revised approach, methane emissions from industrial hog and dairy operations would be higher for both enteric fermentation and manure management.

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[95] *See* EPA, U.S. GHG INVENTORY, *supra* note 50, at A-348 tbl.A-190; V. Sokolov, et al., *GHG Emissions from Gradually-filled Liquid Dairy Manure Storages in Different Levels of Inoculant*, 115 NUTRIENT CYCLING IN AGROECOSYSTEMS 455 (2019) ("On average, gradually-filled [liquid manure] tanks had 1.8°C higher manure temperature, which may have contributed to a 12% increase in total CH_4 emissions," and a "28% increase in total NH_3 emissions.").

[96] EPA, U.S. GHG INVENTORY, *supra* note 50, at 5-12 tbl.5-7; 2-20 ("The majority of the increase observed in CH_4 resulted from swine and dairy cattle manure . . . .").

[97] *Id.* at 5-12 tbl.5-7; *see also* J. Wightman, et al., *supra* note, at 269-70 (although total number of cows in New York has deceased since 1992, methane emissions has increased dramatically due to "the shift toward anaerobic manure storage systems").

[98] *See, e.g.*, J. Owen, et al., *Greenhouse Gas Emissions from Dairy Manure Management: A Review of Field-based Studies*, 21 GLOBAL CHANGE BIO. 550 (2015) (suggesting that "current greenhouse gas emission factors generally underestimate emissions from dairy manure"); A. Leytem, et al., *Methane Emissions from Dairy Lagoons in the Western United States*, 100 J. DAIRY SCI. 6803 (2017) ("The [EPA] method underestimated CH4 emissions [from an anaerobic lagoon] by 48%."); H. Baldé, et al., *Measured Versus Modeled Methane Emissions From Separated Liquid Dairy Manure Show Large Model Underestimates*, 230 AGRIC. ECOSYSTEMS & ENVIRONMENT 261 (2016) ("Comparisons between measured and modeled CH_4 emissions showed that both the IPCC methane conversion factor (0.17) for cool climates (10 °C or less), and the USEPA model, underestimated annual emissions by up to 60%."); M. Borhan, et al., *Greenhouse Gas Emissions from Ground Level Area Sources in Dairy & Cattle Feedyard Operations*, 2 ATMOSPHERE 303 (2011) (finding that an industrial dairy's aggregate CH_4 emission rate was significantly higher than EPA's estimated rate).

[99] *See* J. Owen, et al., *supra* note 98 (highlighting 'liquid manure systems as promising target areas for greenhouse gas mitigation"); J. Wolf, et al., *Revised Methane Emissions Factors & Spatially Distributed Annual Carbon Fluxes For Global Livestock*, 12 CARBON BALANCE MGMT. 16 (2017) (finding that IPCC emission factors underestimate methane missions from hog and dairy operations because they fail to account for "reported recent changes in animal body mass, feed quality and quantity, milk productivity, and management of animals and manure"); A. Leytem, *supra* note 98 ("An alternative methodology, using volatile solids degradation factor, provided a more accurate estimate of annual emissions from the lagoon system and may hold promise for applicability across a range of dairy lagoon systems in the United States.").

D. <u>Methane emissions from industrial hog and dairy operations have a substantial impact on climate change.</u>

As discussed above, industrial dairy and hog operations emit large amounts of methane pollution into the ambient air. In 2018, industrial hog and dairy operations in the United States generated approximately 83.6 mmt CO_2 eq. of methane emissions from enteric fermentation (29.14 mmt CO_2 eq.) and manure management (54.5 mmt CO_2 eq.).[100] These emissions constitute 33 percent of total U.S. methane emissions from agriculture (253 mmt CO_2 eq.),[101] and 13 percent of total U.S. methane emissions from all anthropogenic sources (634.5 mmt CO_2 eq.).[102]

Table 1. Total U.S. GHG & Methane Emissions in 2018 (MMT CO_2 Eq.)

Total U.S. GHG Emissions (all sectors & gases)	**6,676.6**
Agriculture Sector	**618.5**
Enteric Fermentation	177.6
Manure Management	81.1
Total U.S. Methane Emissions (all sectors)	**634.5**
Agriculture Sector	253.0
Enteric Fermentation	177.6
Manure Management	61.7

Table 2. Contribution of Industrial Dairy & Hog Operations to Total U.S. Methane Emissions from Enteric Fermentation (MMT CO_2 Eq.)

Total CH_4 Emissions from Enteric Fermentation	**177.6**
Dairy Cows	43.6
Industrial Dairy Operations (500 or more cows)	26.4
Hogs	2.8
Industrial Hog Operations (1,000 or more hogs)	2.7
All Other Livestock	131.2

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[100] According to EPA's methodologies for calculating methane emissions, dairy cows and hogs contributed 43.6 and 2.8 mmt CO2 eq., respectively, to total U.S. methane emissions from enteric fermentation *See* EPA, U.S. GHG INVENTORY, *supra* note 50, at A-319 tbl.A-180. Although EPA's model does not distinguish between animals in confinement facilities or pastures, large operations (500 or more dairy cows or 1,000 or more hogs) account for approximately 61% of all U.S. dairy cow inventory, and 97% of all U.S. hog inventory. *See supra* notes 53 and 73. Thus, using these percentages to calculate industrial operations' relative contribution to total enteric emissions, large dairy and hog operations account for approximately 29.14 mmt CO2 eq. of total U.S. enteric methane emissions (26.42 and 2.72 mmt CO2 eq., respectively).

[101] EPA, U.S. GHG INVENTORY, *supra* note 50, at 2-19 tbl.2-7.

[102] *Id.* at 2-3 tbl.2-1.

Table 3. Contribution of Industrial Dairy & Hog Operations to Total U.S. Methane Emissions from Manure Management (MMT CO_2 Eq.)

Total CH_4 Emissions from Manure Management	**61.7**
Dairy Cows	32.3
Industrial Dairy Operations (500 or more cows)	32.3
Hogs	22.2
Industrial Hog Operations (1,000 or more hogs)	22.2
All Other Livestock	7.2

Table 4. Summary of Contribution of Industrial Dairy & Hog Operations to Total U.S. GHG & Methane Emissions in 2018 (MMT CO_2 Eq.)

Enteric Fermentation	**29.1**	**16%** of total U.S. methane emissions from *all enteric fermentation processes*
Industrial Dairy	26.4	
Industrial Hog	2.7	
Manure Management	**54.5**	**88%** of total U.S. methane emissions from *all manure management processes*
Industrial Dairy	32.3	
Industrial Hog	22.2	
Total CH_4 Emissions from Industrial Dairy & Hog Operations	**83.6**	**Contribution to Total U.S. Methane Emissions** **33%** of total U.S. methane emissions from *agricultural sector* **13%** of total U.S. methane emissions from *all sectors* **Contribution to Total U.S. GHG emissions** **14%** of total U.S. GHG emissions from *agricultural sector* **1.3%** of total U.S. GHG emissions from *all sectors*

Methane is the second most abundant anthropogenic greenhouse gas, after carbon dioxide. As an anthropogenic greenhouse gas, methane contributes to rising global temperatures and in turn, the serious public health and welfare problems associated with climate change, by trapping heat in Earth's atmosphere. EPA recognized the significance of these climate impacts in 2009, when the agency found that methane and five other anthropogenic greenhouse gases "endanger both the public health and the public welfare of current and future generations by causing or contributing to climate change."[103]

Thus, because industrial dairy and hog operations emit large amounts of methane, these operations significantly contribute to overall GHG emissions. Moreover, because methane is a particularly harmful and potent greenhouse gas, industrial dairy and hog operations have a major impact on rising temperatures.

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[103] 2009 GHG Endangerment Finding, *supra* note 31.

1. Contribution to Total GHG Levels

Industrial dairy and hog operations contribute to rising levels of total U.S. GHG emissions. Specifically, methane emissions from these operations account for 14 percent of total U.S. agricultural GHG emissions (or 618.5 mmt CO_2 eq.), and 1.3 percent of total U.S. GHG emissions (or 6,676.6 mmt CO_2 eq.).[104] These figures reflect EPA's most recent U.S. GHG Inventory, which recent studies suggest significantly underestimate emissions from both enteric fermentation and manure management.[105]

As discussed above, methane emissions from industrial dairy and hog operations have increased dramatically in recent decades.[106] However, from 1990 to 2018, total U.S. GHG emissions have only increased by 3.7 percent.[107] Further, although total U.S. methane emissions have *decreased* by 18 percent since 1990, total U.S. methane emissions from agricultural activities have *increased* by 16.3 increase during this same period.[108] Therefore, while total GHG emissions from other sectors are declining due to federal regulatory efforts, total GHG emissions from the agricultural sector are increasing because EPA has failed to implement methane emission standards for industrial hog and dairy operations, which significantly contribute to rising temperatures and domestic GHG levels.

2. Notable Short-Term Climate Change Impacts

While all greenhouse gases contribute to climate change and endanger public health and welfare, methane emissions from industrial dairy and hog operations are particularly potent because methane is far more effective at trapping heat in the atmosphere than other pollutants.[109]

According to the EPA, reducing methane emissions is uniquely important for climate change mitigation because "methane is a potent GHG with a 100-year [global warming potential] that is 28 to 36 times greater than that of carbon dioxide."[110] Consequently, over the next 100 years, methane will trap more heat in the atmosphere than carbon dioxide, resulting in more overall warming. Moreover, when this timescale is shortened to 20 years, methane's climate impacts are even more pronounced. Because methane does not stay in the atmosphere as long as carbon dioxide, methane has a 20-year global warming potential that is 72 to 87 times greater

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[104] EPA, U.S. GHG INVENTORY, *supra* note 50, at 2-3 tbl.2-1.

[105] *See supra* note 98.

[106] EPA, U.S. GHG INVENTORY, *supra* note 50, at 5-1 tbl.5-1. From 1990 to 2018, total GHG emissions from all agriculture sources increased by 11.6% (or 64.1 mmt CO_2 eq.). *Id.* Although CO_2, CH_4, and N_2O agricultural emissions also increased during that period, methane emissions increased the most–CH_4 emissions rose by 16.3%, whereas CO_2 emissions only increased by 1.5% (or 1 mmt CO_2 eq.) and N_2O only increased by 8.4% (or 27.7 mmt CO_2 eq.). *Id.*

[107] *Id.* at 2-3 tbl.2-1.

[108] *Id.*

[109] *Id.*

[110] *See* 2016 Oil & Natural Gas Rulemaking, *supra* note 32, at 35,830 n.15.

than carbon dioxide.[111] This 20-year global warming potential holds significance when the science and policy consensus calls for reductions in the near term, meaning near term methane reductions especially benefit climate stabilization goals.

Therefore, reducing methane emissions is critical for preventing irreversible climate change. As the IPCC warned, if global temperatures do not decrease significantly in the near future, there is a "very high" risk of "severe and widespread impacts on unique and threatened systems," "large risks to food security and compromised normal activities," and other "abrupt and irreversible" climate change impacts.[112] As such, reducing methane emissions from the animal agriculture sector can help EPA achieve short-term climate goals.[113]

In sum, methane emissions from industrial dairy and hog operations pose unique threats to public health and welfare by contributing to increasing overall GHG levels and imposing a far greater impact on global warming than carbon dioxide. Therefore, reducing methane emissions from industrial dairy and hog operations will have a substantial impact on climate change.[114]

V. DISCUSSION

Section 111 of the Clean Air Act requires EPA to address methane emissions from industrial hog and dairy operations if the Agency finds that these emissions endanger public health or welfare. First, EPA must exercise discretion to list fully confined production facilities and liquefied manure management systems on industrial hog and dairy operations as stationary sources that emit significant amounts of methane into the ambient air.[115] Second, within one year of listing industrial dairy and hog operations, EPA must set standards to reduce methane emissions from new and modified sources within these source categories.[116] Third, within one year of listing, EPA must also promulgate guidelines governing state standards to reduce methane emissions from existing sources within these source categories because EPA is not currently regulating these emissions under the Clean Air Act's national ambient air quality standards or hazardous air pollutant programs.[117]

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[111] EPA, U.S. GHG INVENTORY, *supra* note 50, A-504 tbl.A-252; IPCC, AR5 REPORT, *supra* note 42, at 87 tbl.1 ("The choice of time horizon markedly affects the weighting especially of short-lived climate forcing agents, such as methane."); EPA, *Understanding Global Warming Potential* (last accessed Mar. 31, 2021), https://www.epa.gov/ghgemissions/understanding-global-warming-potentials (noting that because CH_4 "has a short lifetime, the 100-year GWP of 28–36 is much less than the 20-year GWP of 84–87").

[112] IPCC, AR5 REPORT, *supra* note 42, at 63. In a recent, alarm-raising special report, IPCC identified the urgent need to limit global warming to 1.5°C by dramatically reducing emissions. IPCC, GLOBAL WARMING OF 1.5°C, at 4–11 (2019). To achieve this goal, IPCC calls for a 35 percent reduction in methane emissions by 2050 (from 2010 levels). *Id*. at 12.

[113] *See, e.g.,* M. Saunois, et al., *The Growing Role of Methane in Anthropogenic Climate Change*, 11 ENVTL. RES. LETT. 1, 4 (2016).

[114] *See, e.g.*, FCRN, GRAZED & CONFUSED, *supra* note 92, at 72–73.

[115] *See* 42 U.S.C. § 7411(b)(1)(A).

[116] *Id.* § 7411(b)(1)(B).

[117] *Id.* § 7411(d)(1).

A. **Industrial hog and dairy operations are source categories under section 111 of the Clean Air Act.**

Section 111 expressly requires EPA to maintain "a list of categories of stationary sources" that the Administrator finds, in their judgment, "causes, or contributes significantly to, air pollution which may reasonably be anticipated to endanger public health or welfare."[118] Thus, because industrial dairy and hog operations with fully confined production facilities and liquefied manure management systems satisfy this standard, EPA must add these source categories to its list.

1. Industrial hog and dairy operations are "stationary sources" of methane and other air pollutants.

Section 111 defines a "stationary source" as "any building, structure, facility, or installation which emits or may emit any air pollutant."[119] The Clean Air Act broadly defines "air pollutant" as "any air pollution agent or combination of such agents, including any physical, chemical, biological . . . substance or matter which is emitted into or otherwise enters the ambient air."[120] Industrial hog and dairy operations are "stationary sources" because fully confined production facilities and liquefied manure management systems emit large volumes of methane, a potent greenhouse gas and "air pollutant" under the Clean Air Act.[121]

i. *Industrial hog and dairy operations use "buildings, structures, facilities, and installations" for animal confinement and liquefied manure management.*

Industrial dairy and hog operations rely heavily on restrictive housing, confined production facilities, liquid/slurry tanks, liquefied manure lagoons, and other "building[s], structure[s], facilit[ies], and installation[s]" to confine animals for each stage of production and manage their waste.

Fully Confined Production Systems

Both industrial dairy and hog operations rely on confinement facilities to concentrate large numbers of dairy cows and hogs in a small amount of space. Unlike pasture-based dairies, which enable animals to graze and forage in open fields, industrial dairy operations confine dairy cows in restrictive housing systems, such as free stall barns, for the duration of their lives.[122] In fact, most large operations (i.e., 500 or more cows) confine dairy cows in freestalls with concrete

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[118] *Id.* § 7411(b)(1)(A).

[119] *Id.* § 7411(a)(3).

[120] *Id.* § 7602(g); *see also Massachusetts v. EPA*, 549 U.S. at 528-29 ("The Clean Air Act's sweeping definition of 'air pollutant' . . . embraces all airborne compounds of whatever stripe . . . .").

[121] *Massachusetts v. EPA*, 549 U.S. at 529 (finding that "[c]arbon dioxide, methane, [and] nitrous oxide" are "air pollutants" under the Clean Air Act's "unambiguous" definition).

[122] "Tie stall" barns restrain cows "to a particular stall by a neck collar attached to the stall by a chain," and "free stall" barns restrain cows to "cubicles or 'beds' in which dairy cows are free to enter and leave at will." APHIS, DAIRY CATTLE MGMT. PRACTICES IN THE UNITED STATES, 2014, at 4 (2016).

flooring and no outside access,[123] and "[p]asture access for [dairy] cows decrease[s] as herd size increase[s]."[124] Likewise, larger and more industrialized dairies typically rely on restrictive feeding systems, which often confine dairy cows with head locks or fence-line stanchion feed lines.[125] Industrial hog operations also rely on confinement systems to produce hogs in highly specialized and very large, climate-controlled buildings, with no outdoor access.[126] Further, because industrial dairy and hog operations confine and feed animals indoors, they must also store raw materials, such as imported feed and bedding materials, on-site in built installations and structures.[127]

Liquefied Manure Management Systems

Transfer & Storage

Both industrial dairy and hog operations rely on complex systems for managing animal manure and waste. In particular, industrial dairy and hog operations need either a scrape system or flush system to collect manure deposited on housing floors.[128] After collection, industrial hog and dairy operations transport the manure to long-term storage. Because industrial dairy and hog operations generate more manure than they can dispose at once, these operations must store large amounts of liquefied manure for extended periods in physical installations, such as anaerobic lagoons or liquid/slurry tanks.[129]

Disposal

In addition, industrial dairy and hog operations require systems for disposing of stored manure and wastewater. For the majority of industrial hog and dairy operations that rely on anaerobic lagoons, they remove manure from anaerobic lagoons "every 5 to 15 years,"[130] and

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[123] *Id.* at 163, 174.

[124] *Id.* at 166, 167 (noting that the vast majority of small and very small dairies (99 or fewer cows) provided pasture access to cows during summer, whereas only 3.9% of large dairies provided such access).

[125] *Id.* at 190.

[126] APHIS, BASELINE REFERENCE OF SWINE HEALTH & MGMT. IN THE UNITED STATES 27, 36, 59, 75 (2015) (noting that larger hog operations are more likely to rely total confinement facilities for every stage of hog production than smaller operations).

[127] *See* APHIS, DAIRY MGMT. PRACTICES, *supra* note 122, at 185 (demonstrating that larger dairies are more likely to rely on feed from outside sources).

[128] Scrape systems and flush systems are "means of removing manure and other wastes from swine [and dairy] buildings for storage or treatment outside the building." D. Vanderholm, et al., *Scraper Systems for Removing Manure from Swine Facilities* (Aug. 28, 2019), https://swine.extension.org/scraper-systems-for-removing-manure-from-swine-facilities; EPA, U.S. GHG INVENTORY, *supra* note 50, at A-330 ("Based on EPA site visits and the expert opinion of state contacts, manure from dairy cows at medium (200 through 700 head) and large (greater than 700 head) operations are managed using either flush systems or scrape/slurry systems."); D. MEYER, ET AL., UNIV. OF CALIFORNIA, DAVIS, CHARACTERIZE PHYSICAL & CHEMICAL PROPERTIES OF MANURE IN CALIFORNIA DAIRY SYSTEMS TO IMPROVE GREENHOUSE GAS EMISSION ESTIMATES (2019).

[129] EPA, U.S. GHG INVENTORY, *supra* note 50, at 5-11 to -12; A-348 tbl.A-190.

[130] *Id.* at tbl.A-190.

dispose the accumulated sludge by spreading it onto nearby agricultural fields.[131] Operators remove liquid from the lagoons more frequently, and dispose of the accumulated wastewater by spraying it on crops.[132] In addition to manure application and disposal systems, industrial hog and dairy operations rely on other built systems, such as evaporation ponds, to control runoff from their animal confinement and manure storage structures.[133]

EPA already recognizes liquefied manure management systems on industrial hog and dairy operations as a "source category" of methane emissions subject to mandatory GHG emission reporting requirements.[134] Under EPA regulations, a "manure management system" is "a system that stabilizes and/or stores livestock manure, litter, or manure wastewater in one or more of the following system components: Uncovered anaerobic lagoons, liquid/slurry systems with and without crust covers (including but not limited to ponds and tanks), storage pits, digesters, solid manure storage, dry lots (including feedlots), . . . deep bedding systems for cattle and swine, manure composting, and aerobic treatment." 40 C.F.R. § 98.360(b). EPA also expressly excludes from this source category "system components at a livestock facility that are unrelated to the stabilization and/or storage of manure such as daily spread or pasture/range/paddock systems or land application activities."[135] Accordingly, EPA can rely on the same definition for purposes of listing hog and dairy manure management systems under section 111.

In sum, industrial hog and dairy operations rely on several highly specialized "building[s], structure[s], facilit[ies], [and] installation[s]" for animal confinement, liquid manure storage, and manure disposal, satisfying the first half of the definition of a stationary source under section 111.[136]

ii. *Industrial hog and dairy operations emit large amounts of "air pollutants" during animal confinement and liquefied manure management.*

The various "building[s], structure[s], facilit[ies], [and] installation[s]" on which industrial hog and dairy operations rely for animal confinement and liquefied manure management emit significant amounts of methane, which is a potent greenhouse gas and "air

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[131] *Id.*; *see also* C. Gilbertson, et al., *Pumping Liquid Manure from Swine Lagoons & Holding Ponds* (Aug. 24, 2019) (describing different methods of distributing liquid manure onto croplands), https://swine.extension.org/pumping-liquid-manure-from-swine-lagoons-and-holding-ponds.

[132] *See supra* note EPA, U.S. GHG INVENTORY, *supra* note 50, at A-348 tbl.A-190; H. Aguirre-Villegas, et al., *Evaluating Greenhouse Gas Emissions From Dairy Manure Management Practices Using Survey & Lifecycle Tools*, 143 J. CLEANER PROD. 169, 173-34 (2017).

[133] EPA, U.S. GHG INVENTORY, *supra* note 50, at tbl.A-190.

[134] 40 C.F.R. § 98.360; *see also* EPA-430-F-09-026R, Final Rule: Mandatory Reporting of GHGs (Nov. 2009).

[135] 40 C.F.R. § 98.360(c).

[136] 42 U.S.C. § 7411(a)(3).

pollutant" under the Clean Air Act.[137] These stationary sources are also significant sources of other harmful "air pollutants," including ammonia, hydrogen sulfide, volatile organic compounds, and particulate matter.

Fully Confined Production Systems

Both fully confined dairy and hog production facilities generate large amounts of methane and other pollutants. As the EPA recognized, confined production "[b]uildings" "concentrate the emissions of air pollution from a smaller area and/or through vents," which "can increase localized levels of air emissions," and "offer[] opportunities to target emissions of pollutants to reduce the amount that is released to the atmosphere."[138] In particular, dairy production facilities are major sources of enteric methane emissions because they confine large numbers of cows with high input diets that includes non-forage feed like corn silage.[139] Fully confined dairy and hog housing and feeding systems, such as free stall barns, also generate methane by allowing manure to accumulate on floors or in short-term manure holding systems. Since the amount of methane emitted from manure increases when the air temperature in the facility rises,[140] these emissions will likely increase due to climate change. In addition to methane, confined dairy and hog facilities contribute to rising GHG levels by emitting carbon dioxide and nitrous oxide.[141] These facilities also emit other harmful and odorous pollutants,

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[137] *See Massachusetts v. EPA*, 549 U.S. at 529 ("Carbon dioxide, methane, nitrous oxide and hydrofluorocarbons are without a doubt 'physical [and] chemical . . . substance [s] which [are] emitted into . . . the ambient air.'") (citing 42 U.S.C. § 7602(g) (definition of "air pollutant")).

[138] USDA & EPA, AGRICULTURAL AIR QUALITY CONSERVATION MEASURES: REFERENCE GUIDE FOR POULTRY & LIVESTOCK PRODUCTION SYSTEMS 18 (2017).

[139] C. Rotz, *Modeling Greenhouse Gas Emissions From Dairy Farms*, 101 J. DAIRY SCIENCE 6675 (2018) ("Emissions per cow were about 15% less for the grazing operations, which used smaller cattle with lower feed intake and milk production [than confinement operations]."); C. Arndt, et al., *Short-Term Methane Emissions From 2 Dairy Farms in California Estimated by Different Measurement Techniques & U.S. EPA Inventory Methodology*, 101 J. DAIRY SCI. 11461, 11473 (2018) (finding that enteric emissions from industrial dairy housing are strongly correlated with herd size and dry matter intake).

[140] *See, e.g.*, A. Leytem, *Greenhouse Gas & Ammonia Emissions from an Open-Freestall Dairy in Southern Idaho*, 42 J. ENVTL. QUALITY 10, 18 (2013); M. Borhan, et al., *Determining Seasonal Greenhouse Gas Emissions from Ground-Level Area Sources in a Dairy Operation in Central Texas*, 61 J. AIR & WASTE MGMT. ASS'N 786 (2011).

[141] *See, e.g.*, F. Philippe, et al., *Review on Greenhouse Gas Emissions From Pig Houses: Production of Carbon Dioxide, Methane & Nitrous Oxide by Animals & Manure*, 199 AGRIC. ECOSYSTEMS & ENVIRONMENT 10 (2015) (emissions of CO_2, CH_4 and N_2O contribute to 81, 17 and 2% of total emissions from pig buildings, representing 3.87, 0.83 and 0.11 kg CO_2 equiv. per kg carcass, respectively); M. Borhan, et al., *supra* note 140; H. Joo, et al., *Greenhouse Gas Emissions From Naturally Ventilated Freestall Dairy Barns*, 102 ATMOSPHERIC ENVIRONMENT 384 (2015) (mean concentrations of methane in dairy freestall barns ranged from 26 to 180% above background concentrations).

such as ammonia, hydrogen sulfide, volatile organic compounds, and particulate matter.[142] Ammonia emissions are not only highly irritating to local residents, but they are also a significant threat to the environment.[143] Ammonia can also transform into fine particulate matter, which is harmful to human health.[144] Further, confinement facilities are also a major source of ozone-forming volatile organic compounds due to manure deposited on facility floors,[145] feed storage and handling systems,[146] and other sources.

Liquefied Manure Management Systems

Liquefied hog and dairy manure management systems, such as settling basins for manure deposited on facility floors and anaerobic lagoons for long-term manure storage, are significant

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[142] *See, e.g.*, X. Yang, et al., *Analysis of Particle-Borne Odorants Emitted From CAFOs*, 490 SCI. TOTAL ENVIRONMENT 322 (2014) (collecting total suspended particulates and PM_{10} at the air exhaust of different types of hog CAFOs, including farrowing, gestation, weaning, and finishing buildings); G. Kafle, et al., *Emissions of Odor, Ammonia, Hydrogen Sulfide, & Volatile Organic Compounds from Shall-Pit Pig Nursery Rooms*, 39 BIOSYSTEMS ENGINEERING 76 (2014) (hog confinement facilities emit several harmful gases, including ammonia, hydrogen sulfide, carbon dioxide, and volatile organic compounds, and these emissions are directly correlated with the number of hogs in the facility); H. Joo, et al., *supra* note 141 (mean concentrations in dairy freestall barns ranged from 6 to 20% (CO2) and 0 to 4% (N2O) above background concentrations); G. Schauberger, et al., *Empirical Model of Odor Emission From Deep-Pit Swine Finishing Barns to Derive a Standardized Odor Emission Factor*, 66 ATMOSPHERIC ENVIRONMENT 84 (2013) (odor from hog confinement facilities are a public nuisance and health hazard for surrounding communities, and these emissions are directly correlated with the number of hogs in the facility); I. Rumsey, et al., *Characterizing Reduced Sulfur Compounds Emissions From A Swine CAFO*, 94 ATMOSPHERIC ENVIRONMENT 458 (2014) (hydrogen sulfide emissions from hog confinement facilities contributed approximately 98% of total North Carolina H_2S swine CAFO emissions).

[143] Ammonia plays a major role in ecosystem acidification and eutrophication of soil and water, which significantly impairs aquatic and terrestrial ecosystems. *See* EPA, *Health & Environmental Effects of Particulate Matter* (Jun. 20, 2018), https://www.epa.gov/pm-pollution/health-and-environmental-effects-particulate-matter-pm; *see, e.g.*, OECD, AMMONIA EMISSIONS: ACIDIFICATION & EUTROPHICATION 133–34 (2013); Forest Service, USDA, *Acidification Impacts* (last accessed Apr. 13, 2020), https://webcam.srs.fs.fed.us/pollutants/acidification.

[144] *See* EPA, *How Does Particulate Matter Affect Human Health* (Oct. 11, 2019), https://www3.epa.gov/region1/airquality/pm-human-health.html; *see, e.g.*, E. Sanchis, et al., *A Meta-Analysis of Environmental Factor Effects on Ammonia Emissions From Dairy Cattle Houses*, 178 BIOSYSTEMS ENGINEERING 176 (2019) (ammonia emissions from dairy facilities were strongly correlated with air temperature and ventilation rate); K. James, et al., *Characterizing Ammonia Emissions From A Commercial Mechanically Ventilated Swine Finishing Facility & An Anaerobic Waste Lagoon In North Carolina*, 3.3 ATMOSPHERIC POLLUTION RESEARCH 279, 283-84 (2012) (emissions of atmospheric ammonia–nitrogen from hog confinement facility were greatest in the summer and spring, due to high number and average weight of hogs, and low ventilation rate).

[145] *See, e.g.*, H. Sun, et al., *Alcohol, Volatile Fatty Acid, Phenol, & Methane Emissions From Dairy Cows & Fresh Manure*, 37 J. ENVTL. QUALITY 615 (2008) (methanol and ethanol emissions “increased over time, coinciding with increasing accumulation of manure on the chamber floor”)

[146] *See, e.g.*, X. Yang, et al., *Quantification of Odorants in Animal Feeds at Commercial Swine & Poultry Operations*, 61 TRANSACTIONS OF THE ASABE 693 (2018) (animal feed from hog CAFOs emit odorants, including alcohols and nitrogen-containing compounds); B. Yuan, et al., *Emissions of Volatile Organic Compounds from CAFOs: Chemical Compositions & Separation of Sources*, 17 ATMOSPHERIC CHEMISTRY & PHYSICS 4945 (2017) (feed storage and handling emits VOCs, such as carboxylic acids, alcohols and carbonyls); L. Malkina, et al., *Identification & Quantitation of Volatile Organic Compounds Emitted From Dairy Silages & Other Feedstuffs*, 40 J. ENVTL. QUAL. 28 (2011) (silage and other feed storages on dairies emit volatile organic compounds); J. Ni, et al., *Volatile Organic Compounds at Swine Facilities: A Critical Review*, 89 CHEMOSPHERE 769 (2012).

sources of methane emissions.[147] In fact, multiple studies have successfully measured emissions from these sources,[148] and found that manure lagoons and basins have higher aggregate methane emissions than any other source on industrial hog and dairy operations.[149] Most notably, industrial hog and dairy operations generate methane by storing liquefied manure in anaerobic lagoons for long periods.[150] Because lagoons can store manure for several years, the amount of volatile solids in the system increases each month, resulting in an exponential increase in methane emissions over time.[151] Further, because manure management emissions are strongly influenced by rising temperatures, temperature variation, rainfall, and other short-term disruptions,[152] such emissions will increase substantially due to climate change.

In addition to releasing methane, liquefied manure management systems emit ammonia, carbon dioxide, hydrogen sulfide, volatile organic compounds, and other harmful air pollutants

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[147] *See* J. Owen & W. Silver, *Greenhouse Gas Emissions from Dairy Manure Management: A Review of Field-based Studies*, 21 GLOBAL CHANGE BIO. 550, 555 (2015) (finding that "anaerobic lagoons were the largest source of methane [on dairies], more than three times that from enteric fermentation").

[148] *See, e.g.*, W. Todd, et al., *Methane Emissions from Southern High Plains Dairy Wastewater Lagoons in the Summe*r, 166 ANIMAL FEED SCI. & TECH. 575 (2011) ("Uncovered anaerobic lagoons were a source of CH_4 emitted from [industrial dairy operation], and lagoons could be a control point for emission reductions.").

[149] *See, e.g.*, Borhan, *supra* note 98 (settling basin and anaerobic lagoons contributed 98% of aggregate methane emissions on industrial dairy operation); A. VanderZaag, et al., *Measuring Methane Emissions From Two Dairy Farms: Seasonal & Manure-Management Effects*, 194 AGRIC. & FOREST METEOROLOGY 259 (2014) (methane emissions from liquefied manure storage contributed up to 60% of the whole farm emissions); Arndt, *supra* note 139, at 11475 (methane emissions from liquefied manure storage contributed up to 79% of whole farm emissions); H. Aguirre-Villegas, et al., *Evaluating Greenhouse Gas Emissions From Dairy Manure Management Practices Using Survey Data And Lifecycle Tools*, 143 J. CLEANER PROD. 169, 177 (2017) (methane from long-term storage contributed 70% of total GHG emissions from large dairy).

[150] *See* EPA, U.S. GHG INVENTORY, *supra* note 50, at tbl.A-190 and 5-10 to -11 (noting that "manure storage" and "residency time" affects CH_4 production).

[151] *Id.*; *see, e.g.*, A. Leytem, et al., *Methane Emissions from Dairy Lagoons in the Western United States*, 100 J. DAIRY SCIENCE 6803 (2017) (methane emissions from manure lagoons were strongly correlated with the amount of manure solids entering the lagoon (volatile solids), amount of manure in lagoon (total solids), and chemical oxygen demand); Arndt, *supra* note 139, at 11473-74 (methane emissions from manure lagoons were strongly correlated with amount of manure solids in liquefied manure storage); H. Aguirre-Villegas, et al., *supra* note 149, at 177 (large dairy can reduce 47% of GHG emissions by "minimizing VS accumulation in storage to mitigate CH_4 emissions); *see also* T. Flesch, et al., *Methane Emissions From A Swine Manure Tank in Western Canada*, 93 CAN. J. ANIM. SCI. 159 (2013) (methane emissions from concrete manure storage tank "were likely enhanced by an unusually long duration of manure storage [of 15 months]").

[152] *See* EPA, U.S. GHG INVENTORY, *supra* note 50, at 5-10 to -11 (noting that "[a]mbient temperature" and "moisture" affects methane production); *see, e.g.*, Baldé, *supra* note 98 (methane emissions from manure storage tank were highest "when high manure temperature and high volume coincided" due to "high biodegradability of liquid manure faction"); R. Grant, et al., *Methane & Carbon Dioxide Emissions From Manure Storage Facilities At Two Free-Stall Dairies*, 213 AGRIC. & FOREST METEOROLOGY 102 (2015) (warmer weather increases the mass ratio of CH_4 to CO2 emissions of industrial dairy manure storage facilities); A. Leytem, et al., *Methane Emissions From Dairy Lagoons In The Western United States*, *supra* note 151, (finding that methane emissions from manure lagoon increased during events that agitated the lagoon surface, such as rainfalls and high winds); VanderZaag, *supra* note 149 (finding that methane emissions from manure storage increased 40 percent in the fall, when cows produced more manure, but emissions were highest during "agitation").

and odors.[153] These emissions are not only annoying to human senses, but they are also harmful to human health.[154] Liquefied manure storage systems also emit nitrogen into the atmosphere as ammonia (NH_3), which can transform into nitrous oxide (N_2O), another potent GHG and air pollutant.[155] Further, ammonia emissions are a precursor to fine particulate matter in the atmosphere, which poses a significant threat to human health.[156] In addition, disposing of manure and wastewater onto nearby agricultural fields also emits volatile organic compounds and other harmful pollutants.[157]

Accordingly, industrial dairy and hog operations are "stationary sources" under section 111 of the Clean Air Act because they rely on several highly specialized "building[s], structure[s], facilit[ies], [and] installation[s]" for animal confinement and manure management, and they emit significant amounts of the super pollutant methane–a potent "air pollutant" and greenhouse gas–directly into the ambient air.

2. Industrial hog and dairy operations satisfy the requisite standard for listing a source category under section 111.

EPA has authority to list fully confined dairy and hog production facilities and liquefied dairy and hog manure management facilities as source categories under section 111 because they

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[153] A. Leytem, et al., *Greenhouse Gas & Ammonia Emissions from an Open-Freestall Dairy in Southern Idah*o, 42 J. ENVTL. QUAL. 10 (2013) (wastewater ponds on industrial dairy operation with anaerobic lagoons emitted ammonia, methane, and nitrous oxide); R. Grant, et al., *Manure Ammonia & Hydrogen Sulfide Emissions From A Western Dairy Storage Basin*, 44 J. ENVTL. QUALITY 127 (2015) (manure storage basins on industrial hog operation emitted hydrogen sulfide and ammonia).

[154] E, Nie, et al., *Characterization of Odorous Pollution & Health Risk Assessment of Volatile Organic Compound Emissions in Swine Facilities*, 223 ATMOSPHERIC ENVIRONMENT 117233 (2020) (manure storage had most odor activity on industrial hog operation, with emissions including methanethiol, dimethyl sulfide, and hydrogen sulfide, and exceeded cumulative carcinogenic risk threshold during the summer.); S. Trabue, et al., *Odorous Compounds Sources & Transport from a Swine Deep-Pit Finishing Operation: A Case Study*, 233 J. ENVTL. MGMT. 12 (2019) (finding that manure storage on industrial hog operation was the "main source of odorous compounds," particularly hydrogen sulfide during agitation and pumping of the deep pits); F. Andriamanohiarisoamanana, et al., *Effects of Handling Parameters on Hydrogen Sulfide Emission From Stored Dairy Manure*, 154 J. ENVTL. MGMT. 110 (2015) ("H_2S concentration increased with [total solids] concentration").

[155] A. Leytem, et al., *Ammonia Emissions From Dairy Lagoons In The Western U.S.*, 61 TRANSACTIONS OF THE ASABE 1001, 1006 (2018) (finding that ammonia emissions from anaerobic lagoons on industrial dairies were correlated with the amount of N in the lagoon, temperature, and wind speed, and lagoon receiving water from freestall flush dairy had highest emissions due to "greater concentrations of manure N"); K. James, *supra* note 144, at 284-86 (finding that emissions of atmospheric ammonia–nitrogen from anaerobic lagoon on industrial hog operation were greatest in the summer); A. Leytem, et al., *Greenhouse Gas & Ammonia Emissions*, *supra* note 153 (finding wastewater ponds contributed 67% of total farm ammonia emissions in the spring and summer); FAO, TACKLING CLIMATE CHANGE THROUGH LIVESTOCK, *supra* note 273, at 17, 20.

[156] *See, e.g.*, EPA, *How Does Particulate Matter Affect Human Health* (Oct. 11, 2019), https://www3.epa.gov/region1/airquality/pm-human-health.html; *Health & Environmental Effects of Particulate Matter* (Jun. 20, 2018), https://www.epa.gov/pm-pollution/health-and-environmental-effects-particulate-matter-pm.

[157] B. Woodbury, et al., *Emission of Volatile Organic Compounds After Land Application of Cattle Manure*, 43 J. ENVTL. QUALITY 1207 (2014) ("[A]n increase in emissions of volatile sulfur compounds resulted from increased manure application.").

"cause[]" and "contribute[] significantly to, air pollution which may reasonably be anticipated to endanger public health or welfare."[158]

i. *Significant Contribution Finding*

Contribution to Total U.S. Methane Emissions

Methane emissions from confined hog and dairy production and liquefied manure management system significantly contribute to elevated concentrations of GHGs in the atmosphere. According to EPA's most recent GHG inventory, which is based on EPA's methodologies for calculating non-carbon GHG emissions on a 100-year time horizon, methane emissions from these source categories account for 33 percent of total U.S. methane emissions from agricultural activities, and 13 percent of total U.S. methane emissions.[159] Moreover, on a CO2-equivalent basis, methane emissions from industrial hog and dairy operations increase by 196 to 236 percent when the time horizon for methane's global warming potential is adjusted to 20 years.[160]

Contribution to Total U.S. GHG Emissions

In 2009, EPA found that GHG emissions from sources covered under section 202(a) of the Clean Air Act (e.g., passenger cars, light-duty trucks, motorcycles, buses, and heavy- and medium-duty trucks) contribute to air pollution that endangers public health and welfare by accounting for 23 percent of total U.S. GHG emissions.[161] In 2016, EPA found that GHG emissions from aircraft engines satisfy the endangerment standard because they contributed to 10 percent of total U.S. transportation GHG emissions, and 2.8 percent of total U.S. GHG emissions.[162] In comparison, according to EPA's methodologies for estimating methane emissions based on a 100-year global warming potential, industrial dairy and hog operations account for 13 percent of total U.S. agricultural GHG emissions, and 1.3 percent of total U.S. GHG emissions.[163] Because methane is one of the few greenhouse gases with a greater short-term global warming potential, the relative contribution of these source categories to overall GHG emissions increases if the time horizon is adjusted to 20 years. Thus, although methane emissions from industrial hog and dairy operations contribute to rising GHG concentrations and have a significantly greater impact on total U.S. agricultural GHG emissions than regulated sources in the other industries, EPA has thus far refused to find that GHG emissions from industrial hog and dairy operations satisfy the endangerment standard.

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[158] 42 U.S.C. § 7411(b)(1)(A).

[159] *See supra* Part IV.D.

[160] *See* EPA, U.S. GHG INVENTORY, *supra* note 50, at A-503 ("While [EPA's GHG] Inventory uses agreed-upon GWP values according to the specific reporting requirements of the UNFCCC, . . . users of the Inventory can apply different metrics and different time horizons to compare the impacts of different greenhouse gases.").

[161] 2009 GHG Endangerment Finding, *supra* note 31, at 66,499 & 66,540.

[162] 2016 GHG Endangerment Finding, *supra* note 31, at 54,461; 54,465-66; 54,472 (also noting that GHG emissions from covered aircraft engines comprises 89 percent of total U.S. aircraft GHG emissions).

[163] See *supra* Part IV.D.

Unless EPA promulgates standards to reduce these emissions, methane emissions will continue to pose significant near-term climate threats.[164] As corporate interests continue to pressure dairy and hog operations to increase herd sizes and adopt larger and more industrialized facilities for animal confinement and liquefied manure management, methane emissions from these source categories will continue to increase. Likewise, as small dairy and hog farms in the United States continue to go out of business, methane emissions from industrial dairy and hog operations will become an increasingly significant proportion of overall agricultural emissions.

Contribution to Total Social Costs of Methane

Furthermore, while we recognize that a source category's percentage contribution to an industry's (or the whole economy's) GHG emissions may in some cases provide useful information about that source's significance to dangerous air pollution, it is not necessarily the only relevant data point. Another useful metric is the Interagency Working Group's (IWG) social cost of methane, which was recently reinstated by the Biden Administration and updated to reflect 2020 dollars. According to that metric, in 2020, the social cost of one metric ton of methane ranges from $670 to $3,900 in terms of climate damages. *See* Interagency Working Group on Social Cost of Greenhouse Gases, Technical Support Document: Social Cost of Carbon, Methane, and Nitrous Oxide, Interim Estimates under Executive Order 13990 (Feb. 2021), Table ES-2. In 2030, this figure rises to $940 to $5,200 per metric ton. *Id*. Given the estimates in Table 4, *supra*, industrial dairy and hog operations contributed 3.344 million metric tons in CH_4 emissions in the most recently recorded year using the 100-year global warming potential of 25. Those emissions would impose social costs of $2.24 to $13.04 billion. In 2030, these costs increase to a range between $3.14 and $17.39 billion. From any conceivable viewpoint, this reflects a significant contribution to climate change. The actual costs are likely higher, since, as noted above, the inventory likely underestimates these sources' methane emissions by a large margin. Furthermore, the IWG's metrics, which are currently being updated, represent merely a floor as to the true costs that greenhouse gases impose on society, which are almost surely significantly higher than the values that the IWG has produced thus far. For this reason as well, these figures likely underreport the true harm that industrial dairy and hog operations impose on society.

According to EPA, methane is a particularly harmful and potent greenhouse gas because it has a greater global warming potential than CO_2.[165] Methane also has a greater short-term impact on climate change than longer-lived GHGs, such as CO_2. Therefore, methane emissions from industrial dairy and hog operations significantly contribute to climate change by (1) constituting a large fraction of total U.S. methane emissions; (2) imposing huge absolute social costs through climate damages, even regardless of their percentage of total emissions; (3) increasing overall GHG emissions, and (4) trapping heat more effectively than other GHGs, especially in the near-term 20-year period. As such, even if EPA interpreted section 111 to require the agency "to make a pollutant-specific [significant contribution finding] for GHG

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[164] *See supra* note Part IV.D.2.

[165] Although industrial dairy and hog operations emit other greenhouse gases and air pollutants, such as carbon dioxide (CO_2), EPA can make a pollutant-specific endangerment finding, as well as a significant contribution finding, with respect to methane emissions from these operations.

emissions from [each] source category as a prerequisite to regulat[e] those emissions,"[166] methane emissions from confined hog and dairy production and liquefied manure management facilities still easily satisfy the significant contribution standard.[167]

ii. *Endangerment Finding*

Under section 111, the Administrator has discretion to make the initial endangerment determination. However, as the U.S. Supreme Court explained in *Massachusetts v. EPA*, the word "judgment" does not give the Administrator "a roving license to ignore the statutory text," but rather "a direction to exercise discretion within defined statutory limits." 549 U.S. 497, 533 (2007).

Methane emissions from confined hog and dairy production and liquefied manure management facilities endanger public health and welfare by significantly contributing to elevated greenhouse gas concentrations and rising temperatures. EPA has repeatedly found that greenhouse gases, including methane, "endanger both the public health and the public welfare of current and future generations by causing or contributing to climate change,"[168] and recent scientific assessments confirm that climate change continues to threaten public health and welfare. Thus, methane emissions from confined hog and dairy production and liquefied manure management facilities also satisfy the requisite endangerment standard.

Further, these facts and scientific assessments support a pollutant-specific endangerment finding. Because EPA has recognized that methane is a particularly potent GHG with a high 20-year global warming potential, and considerable short-term impacts on climate change, methane emissions from fully confined hog and dairy production and liquefied manure management facilities pose significant and immediate threats to public health and welfare.

a. *"Public Health" Impacts*

The Clean Air Act requires EPA to consider the "public health" impacts of methane pollution.[169] Although the Act does not expressly define the term "public health," the legislative history demonstrates that Congress intended EPA to interpret this term broadly.[170] Congress also intended EPA to consider the adverse health impacts on "average healthy individuals," as well as "sensitive citizens," such as "children" and "people with . . . conditions rendering them

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[166] 2019 Proposed Oil & Natural Gas Rulemaking, *supra* note 32, at 50261 (soliciting comments on pollutant-specific significant contribution finding for methane emission standards from new sources in the oil and gas sector). We dispute this interpretation and expect the Biden Administration to disavow it.

[167] EPA's recent rulemaking to exempt certain source categories from listing under section 111 has been vacated. *See* Pollutant-Specific Significant Contribution Finding for Greenhouse Gas Emissions From New, Modified, and Reconstructed EGUs, and Process for Determining Significance of Other New Source Performance Standards Source Categories, 86 Fed. Reg. 2542 (Jan. 13, 2021); *California v. EPA*, Order Granting Motion for Voluntary Vacatur and Remand, No. 21-1035 (April 5, 2021).

[168] 2009 GHG Endangerment Finding, *supra* note 31.

[169] 42 U.S.C. § 7411(b)(1)(A).

[170] *See American Lung Ass'n v. EPA*, 134 F.3d 388, 388-89 (D.C. Cir. 1998) (finding that "Congress defined public health broadly").

particularly vulnerable to air pollution."[171] Therefore, EPA must evaluate a range of potential health impacts, including the threats to vulnerable groups.

Because methane is a potent and abundant greenhouse gas, methane emissions from confined dairies and hog production and liquefied manure management source categories "contribute[] significantly" to the serious health problems associated with rising global temperatures and sea levels. In prior rulemakings under section 111, EPA has found that "[c]limate change caused by manmade emissions of GHGs threatens the health of Americans in multiple ways."[172] For example, "climate change increases the likelihood of heat waves, which are associated with increased deaths and illnesses," and it exacerbates health problems in vulnerable populations, such as "[c]hildren, the elderly, and the poor."[173]

Recent assessments demonstrate that climate change continues to endanger public health by threatening to increase mortality, injury, and illness, and worsen existing health problems. For example, climate change is associated with increased heat waves, which cause a range of serious health complications, including kidney failure, blood poisoning, and death.[174] Other human health threats include increased spread of deadly infectious diseases, such as the West Nile and Zika viruses; heightened exposure to foodborne, airborne, and waterborne diseases; and the emergence of new diseases.[175] In addition, climate change is very likely to increase physical injuries and death from wildfires and other extreme weather events.[176]

Moreover, climate change will also exacerbate existing health vulnerabilities among at-risk populations, including children, elderly people, pregnant women, and people with chronic illnesses.[177] Relatedly, the health impacts of climate change will disproportionately affect low-income communities and communities of color due to their increased exposure and sensitivity to health hazards.[178] Undernutrition and other health problems will also increase in rural and underserved areas.[179] By increasing heat waves and other extreme and dangerous weather

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[171] *Id.*

[172] 2016 Oil & Natural Gas Rulemaking, *supra* note 32, at 35,833 (summarizing adverse public health effects identified in 2009 GHG Endangerment Finding, *supra* note 31).

[173] *Id.*

[174] C. Mora, et al., *Twenty-Seven Ways a Heat Wave Can Kill You: Deadly Heat in the Era of Climate Change*, 10 CIRCULATION: CARDIOVASCULAR QUALITY & OUTCOMES (Nov. 2017).

[175] USGCRP, NCA4 REPORT, *supra* note 45, at 544–46, 1217; IPCC, AR5 REPORT, *supra* note 42, at 69.

[176] USGCRP, NCA4 REPORT, *supra* note 45, at 1217; IPCC, AR5 REPORT, *supra* note 42, at 69.

[177] *See, e.g.*, IPCC, AR5 REPORT, *supra* note 42, at 15, 69 (noting that climate change will lead to more illness, "especially in developing countries with low income"); *see also* HARVARD HEALTH PUBLISHING, HEAT STROKE (Jan. 2019) (explaining that nonexertional heat strokes are more likely "to occur in people who have diminished ability to regulate body temperatures, such as older people, very young children or people with chronic illnesses"), https://www.health.harvard.edu/a_to_z/heat-stroke-hyperthermia-a-to-z.

[178] USGCRP, NCA4 REPORT, *supra* note 45, at 546–48.

[179] IPCC, AR5 REPORT, *supra* note 42, at 69.

conditions, climate change will also adversely affect the health of farm workers and other agricultural workers who work outside.[180]

Thus, because recent assessments confirm that climate change continues to pose serious acute and chronic health threats, EPA must find that methane emissions from industrial dairy and hog operations significantly endanger public health.

b. *"Welfare" Impacts*

EPA must also find that methane pollution affects public "welfare," which the Act defines exceptionally broadly:

> All language referring to effects on welfare includes, but is not limited to, [1] effects on soils, water, crops, vegetation, man-made materials, animals, wildlife, weather, visibility, and climate, damage to and deterioration of property, and hazards to transportation, as well as [2] effects on economic values and on personal comfort and well-being, whether caused by transformation, conversion, or combination with other air pollutants.

42 U.S.C. § 7602(h). Accordingly, this sweeping definition gives EPA expansive power to regulate sources of air pollution that harm public welfare and contribute to global warming. Specifically, the Act expressly requires EPA to consider a wide range of environmental and ecological factors, as well as qualitative factors, such as "economic values," and "personal comfort and well-being."[181] Further, because the Act requires EPA to consider any potential effects "caused by transformation, conversion, or combination with other air pollutants," EPA must evaluate the effects associated with climate change–the combined effect of methane and other well-mixed greenhouse gases.

Disproportionate Impacts

Climate change disproportionately affects Black, Indigenous and other communities of color, low-income communities, and other vulnerable populations. Because these communities are more likely to be located in isolated rural areas, floodplains, coastlines, and other at-risk locations, they have increased risk of exposure to adverse climate change impacts.[182] Moreover, these communities have disproportionately high rates of pollution and other socioeconomic stressors, which increases their risk of exposure, as well as their vulnerability to climate change impacts.[183] For example, Black and Latino communities have higher rates of underlying health conditions and poverty, which increases their sensitivity to heat waves, foodborne illnesses,

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[180] *Id.* at 15 (explaining how climate change will "compromise common human activities, including growing food and working outdoors").

[181] 42 U.S.C. § 7602(h).

[182] USGCRP, IMPACTS OF CLIMATE CHANGE ON HUMAN HEALTH IN THE UNITED STATES 249 (2016); CALIFORNIA'S FOURTH CLIMATE CHANGE ASSESSMENT, CLIMATE JUSTICE SUMMARY REPORT 36-48 (2018).

[183] USGRP, IMPACTS OF CLIMATE CHANGE, *supra* note 182, at 252.

infectious diseases, air pollution, and other climate change impacts.[184] Further, for immigrant and low-income populations in rural farming communities, drought and other climate-related impacts threaten to worsen existing vulnerabilities, such as water scarcity, unemployment, and food insecurity.[185]

In addition to heightening exposure and vulnerability to climate-related impacts, these communities face social, political, and economic barriers, which impede their ability to respond and adapt to climate change. For example, communities with limited social capital or poorly maintained infrastructure have greater difficulty preparing and responding to natural disasters, disease outbreaks, and other climate change impacts.[186] These communities also face economic barriers to adaptive capacity, such as lack of financial capital for mitigation strategies or technologies.[187] Further, linguistically and geographically isolated populations or people with undocumented residency status are particularly vulnerable because they are less likely to receive the information and resources they need to respond to extreme weather events, public health impacts, and persistent climate change impacts, such as displacement.[188]

Environmental & Ecological Impacts

Climate change has already had several environmental and ecological impacts, including "effects on soils, water, crops, vegetation, man-made materials, animals, wildlife, weather, visibility."[189] For example, well-documented ecological impacts include increasing atmospheric and oceanic temperatures, melting glaciers, rising sea levels, and ocean acidification.[190]

These changes have also had widespread impacts on natural systems. Changing precipitation patterns and melting snow has adversely affected hydrological systems, resulting in coastal erosion, damage to water and sanitation systems, and decreased water availability.[191] In recent decades, global warming has already caused "widespread shrinking of the cryosphere,"

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[184] *See* S. CARRATALA & C. MAXWELL, CTR. FOR AMERICAN PROGRESS, HEALTH DISPARITIES BY RACE & ETHNICITY (2020); *see, e.g.*, K. Shaw, et al., *Presence of Animal Feeding Operations & Community Socioeconomic Factors Impact Salmonellosis Incidence Rates: An Ecological Analysis Using Data From The Foodborne Diseases Active Surveillance Network, 2004–2010*, 150 ENVTL. RES. 166 (2016) (increased rates of *Salmonella* illness were linked to communities with CAFOs, higher percentages of African American populations, and higher poverty rates).

[185] *See, e.g.*, C. Greene, *Broadening Understandings of Drought: The Climate Vulnerability of Farmworkers & Rural Communities in California*, 89 ENVTL. SCI. & POLICY 283 (2018).

[186] USGRP, IMPACTS OF CLIMATE CHANGE, *supra* note 182, at 252; *see, e.g.*, A. Chriest, et al., *The Role of Community Social Capital for Food Security Following an Extreme Weather Event*, 64 J. RURAL STUDIES 80 (2018) (rural communities with high social capital have greater capacity to respond to food insecurity after extreme weather events).

[187] *See, e.g.*, M. Hayden, et al., *Adaptive Capacity to Extreme Heat: Results From a Household Survey in Houston, Texas*, 9 WEATHER, CLIMATE, & SOCIETY 787 (2017) (finding that most people suffering heat-related symptoms at home during heat wave could not afford to use air conditioning because of the high cost of electricity).

[188] *See, e.g.*, E. Fussell, et al., *Implications of Social & Legal Status on Immigrants' Health in Disaster Zones*, 108 AMERICAN J. PUBLIC HEALTH 1617 (2018).

[189] *Id.*

[190] USGCRP, NCA4 REPORT, *supra* note 45, at 37, 39.

[191] IPCC, AR5 REPORT, *supra* note 42, at 6.

with thinning ice sheets and glaciers, declining snow cover, and increasing permafrost temperatures.[192] Likewise, climate change has caused many terrestrial and aquatic species to change their migratory, feeding, and reproductive behaviors.[193] A significant portion of plant and animal species are also at a greater risk of extinction due to climate change.[194]

Weather-related impacts have also been considerable. In recent years, there has been a well-documented increase in extreme temperature and precipitation variation and heat waves.[195] In addition, weather-related changes have already had widespread effects on natural systems, including droughts, floods, wildfires, tornadoes, and severe storms.[196] As anthropogenic GHG emissions continue to rise, extreme weather-related events, such as heat waves and heavy precipitation events, are "virtually certain" to become more frequent and intense.[197] Climate change is also likely to cause larger and more destructive wildfires in the United States,[198] as well as "chronic, long-duration hydrological drought."[199]

Further, climate change will decrease productivity of irrigated agriculture and livestock. Declining winter snowmelt runoff will reduce water availability for crop irrigation,[200] and the release of mercury and other contaminants stored in glaciers and permafrost will reduce water quality.[201] Relatedly, declining snow cover will directly affect soil moisture, resulting in drier soil and lower agricultural yields.[202] Climate change will also reduce agricultural yields by changing growing seasons, increasing extreme precipitation events (e.g., dry spells, heavy rainfalls), and increasing animal diseases and pest infestations.[203] Thus, as food demand increases, food and water availability will become an increasingly important issue.[204]

Property Impacts

EPA should also consider the various ways in which climate change will "damage . . . and deteriorat[e] . . . property."[205] Extreme weather events, such as wildfires,

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[192] IPCC, SPECIAL REPORT ON THE OCEAN & CRYOSPHERE IN A CHANGING CLIMATE 1–6 (2019) [hereinafter OCEAN REPORT].

[193] IPCC, AR5 REPORT, *supra* note 42, at 6.

[194] *Id.* at 13.

[195] *Id.* at 7–8.

[196] *Id.*

[197] *Id.* at 10.

[198] USGCRP, NCA4 REPORT, *supra* note 45, at 240–41.

[199] *Id.* at 159.

[200] IPCC, OCEAN REPORT, *supra* note 192, at 154–55, 163.

[201] *Id.* at 153; *see also id.* at 511–13 (explaining how climate change threatens human health by increasing the amount of mercury and other contaminants in marine organisms).

[202] *Id.* at 154, 165.

[203] IPCC, AR5 REPORT, *supra* note 42, at 6, 13; USGCRP, NCA4 REPORT, *supra* note 45, at 401.

[204] IPCC, AR5 REPORT, *supra* note 42, at 13.

[205] 42 U.S.C. § 7602(h).

floods, and hurricanes, will cause significant property damage, and repairing or replacing this damage will cost hundreds of millions of dollars each year.[206] Likewise, sea level rise poses serious threats to coastal property and public infrastructure, such as international airports and interstate highways.[207] Climate change is also likely to have significant impacts on energy systems and infrastructure, resulting in disrupted access to communication, transportation, electricity, medical care, and other critical resources.[208]

With respect to agricultural infrastructure, extreme temperature variation or seasonal change will make liquefied manure storage systems more prone to erosion, breakage, and wall collapse.[209] Similarly, extreme precipitation events (e.g., heavy rains or hurricanes) cause liquefied manure storage and runoff systems to overflow and spill large amounts of waste onto nearby agricultural lands, waterways, and residential properties,[210] which can lead to serious environmental and public health consequences, such as groundwater contamination, soil degradation, and crop destruction.[211]

Transportation Impacts

Likewise, climate change poses several "hazards to transportation."[212] Weather-related impacts, such as heat waves, power outages, flooding, and heavy precipitation, adversely affect the efficiency, reliability, and safety of interconnected transportation systems.[213] These impacts also delay completion of modernization and expansion projects, which further undermines the system's overall performance.[214] Further, extreme weather events will put a significant strain on transportation infrastructure and assets.[215] Thus, as these events become more frequent and destructive, maintenance and replacement costs will also increase.[216]

Moreover, the transportation impacts of climate change will disproportionately affect low-income people, elderly people, people with limited English proficiency, and other vulnerable populations.[217] Disrupted access to transportation systems will also disproportionately harm rural communities with limited infrastructure, resources, and political influence.[218] For example,

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[206] USGCRP, NCA4 REPORT, *supra* note 45, at 1220; *see also id.* at 240–41 (discussing "the high cost of protecting property [from wildfires] in the wildland-urban interface").

[207] *Id.* at 1118–19.

[208] *Id.* at 652–53.

[209] *See supra* note 78.

[210] *See supra* note 79.

[211] For further discussion on the impacts of manure overapplication, see Part V.B.2.i.

[212] 42 U.S.C. § 7602(h).

[213] USGCRP, NCA4 REPORT, *supra* note 45, at 486–90.

[214] *Id.* at 484.

[215] *Id.* at 486–90.

[216] *Id.*

[217] *Id.* at 490–91.

[218] *Id.* at 409.

disrupted transportation channels can prevent people in these communities from obtaining food, water, or medical supplies; evacuating a dangerous area; or obtaining emergency assistance. Consequently, climate change will not only make it more difficult for these communities to prepare for extreme weather events, but it will also make it more difficult for them to recover from them.

Economic Impacts

Climate change is a major threat to "economic values" on an individual level, as well as a community, state, regional, and national level.[219] For example, climate change will likely increase food and energy costs and alter purchasing behaviors.[220] Rising temperatures will also slow economic growth and prolong poverty traps, especially in "urban areas and emerging hotspots of hunger."[221] Rural communities are particularly vulnerable, as climate change will make it difficult for linguistically and spatially isolated areas to access jobs, food, water, and other essential resources and sectors.[222] Similarly, climate change will have significant impacts on development in coastal communities and other areas prone to extreme weather events.[223]

Likewise, recent assessments confirm that climate change will adversely affect the entire U.S. agricultural sector,[224] as well as the rural communities that depend on the agricultural sector for jobs and tax revenue.[225] Most notably, increased precipitation and temperature extremes will have widespread impacts on food production, including reduced crop yield, decreased water availability and supply, increased pest pressure, and decreased soil quality.[226] In addition, climate change will adversely affect agricultural productivity by increasing health risks for workers, and "compromis[ing] common human activities, including growing food and working outdoors."[227]

Extreme weather events will also negatively affect livestock health and animal agricultural productivity.[228] Rising global temperatures will reduce industrial dairy and hog production because heat stress has the greatest effect on animals held in confinement facilities.[229]

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[219] 42 U.S.C. § 7602(h).

[220] USGCRP, NCA4 REPORT, *supra* note 45, at 447, 452.

[221] IPCC, AR5 REPORT, *supra* note 42, at 15.

[222] *Id.*; *see also* USGCRP, NCA4 REPORT, *supra* note 45, at 392.

[223] USGCRP, NCA4 REPORT, *supra* note 45, at 1118–19; *see also* IPCC, OCEAN REPORT, *supra* note 192, at 75 (noting that people in polar, mountain, and coast environments regions "face the greatest exposure to ocean and cryosphere change, and poor and marginalized people here are particularly vulnerable to climate-related hazards and risks").

[224] IPCC, CLIMATE CHANGE & LAND, *supra* note 42, at 5-121 (explaining how climate change negatively affects food production, distribution, and utilization).

[225] *Id.* at 4-53 to -56 (discussing links between poverty, land degradation, and climate change).

[226] USGCRP, NCA4 REPORT, *supra* note 45, at 406–08, IPCC, AR5 REPORT, *supra* note 42, at 69.

[227] IPCC, AR5 REPORT, *supra* note, at 42.

[228] USGCRP, NCA4 REPORT, *supra* note 45, at 406–08.

[229] J. Derner, et al., *Vulnerability of Grazing & Confined Livestock in the Northern Great Plains to Projected Mid-& Late-Twenty-First Century Climate*, 146 CLIMATIC CHANGE 19 (2018).

According to a recent study, heat stress from climate change alone already decreases U.S. dairy production by 1.9 percent each year, resulting in $670 million in annual production losses, and likely reaching $2.2 billion by the end of the century.[230] Further, climate-related impacts will increase feed costs, disease, and other threats to U.S. animal production.[231] For example, three years of drought in Texas and California caused more than $10 billion in direct agricultural losses, including increased feed costs.[232]

Climate change will directly affect food utilization.[233] Specifically, rising temperatures will increase the spread of waterborne and foodborne diseases, and decrease effectiveness of transportation and distribution infrastructure,[234] making it more difficult for safe and uncontaminated food products to reach consumers before spoiling. Consequently, climate change will not only intensify competition for soil and water resources, but it will decrease food availability and overall agricultural incomes.[235]

On a national scale, climate change is also "virtually certain" to have widespread effects on the U.S. economy and trade, from supply chains to transportation and access to global markets.[236] Relatedly, climate change will negatively affect the "income and purchasing" power of low-income consumers.[237]

Personal Comfort & Well-Being Impacts

In addition, climate change poses several threats to "personal comfort and well-being" and overall quality of life. 42 U.S.C. § 7602(h). For example, climate threats include loss of cultural and traditional lifestyles and traditions, and "the accompanying mental health or social disruption effects" of such loss.[238] As recent studies demonstrate, climate change will have serious mental health impacts, such as increased rates of anxiety, stress-related disorders,

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[230] G. Mauger, et al., *Impacts of Climate Change on Milk Production in the United States*, 67 PROFESSIONAL GEOGRAPHER 121 (2015). This study only estimated direct losses from heat stress.

[231] *See* A. Leister, et al., *Dynamic Effects of Drought on U.S. Crop & Livestock Sectors*, 47 J. AGRIC. & APPLIED ECONOMICS 261 (2015); A. Anyamba, et al., *Recent Weather Extremes & Impacts on Agricultural Production & Vector-Borne Disease Outbreak Patterns*, 9 PLoS ONE e92538 (2014).

[232] *See* D. Anderson, et al., *Agricultural Impacts of Texas's Driest Year on Record*, 27 CHOICES 1 (2012) (noting that in 2011, drought caused $7.62 billion in direct financial losses to agriculture, including $3.23 billion in livestock losses (e.g., increased cost of feed)); J. Lund, et al., *Lessons From California's 2012–2016 Drought*, 144 J. WATER RES. PLANNING & MGMT. 04018067 (2018) (noting that in 2014-2016, drought caused approximately $3.8 billion in total direct statewide economic losses to agriculture, including lost revenue from dairy and livestock production).

[233] IPCC, CLIMATE CHANGE & LAND, *supra* note 42, at 5-39 to -40, 5-121 (describing how climate change will increase mycotoxins in food and livestock feed).

[234] IPCC, AR5 REPORT, *supra* note 42, at 69.

[235] *Id*.

[236] USGCRP, NCA4 REPORT, *supra* note 45, at 620–21.

[237] IPCC. CLIMATE CHANGE & LAND, *supra* note 42, at 5-121.

[238] USGCRP, NCA4 REPORT, *supra* note 45, at 1217.

depression, and suicide.[239] These impacts will likely disproportionately affect residents of rural communities due to lack of access mental health services.[240]

Climate change will also have serious socioeconomic and political impacts on a regional, national, and global scale. For example, climate change will perpetuate existing social and economic injustices by making it more difficult for members of low-income communities to escape poverty.[241] Climate change will also reduce quality of life in urban areas by disrupting access to social networks and systems, economic opportunities, education, nature, recreation, and culture.[242] Moreover, extreme weather events and land degradation will increase displacement of people, which will likely lead to heightened risk of racial and social tension, as well as violent conflict.[243] Further, experts predict that climate change will increase conflict and competition for resources in agricultural communities, as water resources and productive land become scarcer.[244]

In sum, climate change continues to pose serious threats to public health and welfare. Accordingly, because methane emissions from industrial dairy and hog operations significantly contribute to climate change, EPA must list these source categories under section 111.

B. EPA must reconsider its final action that decided not to determine whether to list industrial hog and dairy operations as source categories of methane under section 111.

"Under the clear terms of the Clean Air Act, EPA can avoid taking further action only if it determines that greenhouse gases do not contribute to climate change or *if it provides some reasonable explanation as to why it cannot or will not exercise its discretion to determine whether they do.*" *Massachusetts v. EPA*, 549 U.S. at 533 (emphasis added). Accordingly, EPA must "adequately explain[] the facts and policy concerns it relied on and . . . those facts [must] have some basis in the record." *WildEarth Guardians v. EPA*, 751 F.3d 649, 653 (D.C. Cir. 2014) (citations omitted). Courts will overturn EPA's decision not to initiate a rulemaking if there is a "fundamental change in the factual premises previously considered by the agency" or other "compelling cause." *Id.* Thus, because EPA can effectively determine that methane emissions from industrial hog and dairy operations contribute to rising GHG emissions and climate change impacts, and promulgate standards to reduce these emissions based on currently

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[239] *See* M. Burke, et al., *Higher Temperatures Increase Suicide Rates in the United States & Mexico*, 8 NATURE CLIMATE CHANGE 723 (2018).

[240] *See, e.g.*, Claire Hettinger & Pam Dempsey, *Seeking a Cure: Mental Health Access Scarce in Rural, Farming Communities*, MIDWEST CTR. FOR INVESTIGATIVE REPORTING (Feb. 14, 2020), https://investigatemidwest.org/2020/02/14/seeking-a-cure-mental-health-access-scarce-in-rural-farming-communities.

[241] IPCC, AR5 REPORT, *supra* note 42, at 15.

[242] USGCRP, NCA4 REPORT, *supra* note 45, at 447.

[243] IPCC, AR5 REPORT, *supra* note 42, at 16; CLIMATE CHANGE & LAND, *supra* note 42, at 4-57 to -58 (explaining how displacement due to land degradation and lost livelihoods will lead to conflict and violence); OCEAN REPORT, *supra* note 126, at 172–73 (explaining how reduced water supply will undermine agricultural and pastoral livelihoods, and lead to more labor migration and displacement).

[244] IPCC, CLIMATE CHANGE & LAND, *supra* note 42, at 5-120 (discussing how climate change will increase "resource competition" and conflict in "agriculture-dependent communities").

available data and methodologies, EPA has no reasonable explanation for refusing to make an endangerment finding, as sought in this petition.

1. EPA is not currently developing emission estimation methodologies for methane.

In December 2017, EPA took final action and declined to determine whether to list CAFOs as a source category under section 111 because the agency claimed to need more time to "develop[] accurate methodologies to estimate air emissions from CAFOs."[245] EPA claimed that it "has been undertaking [the National Air Emissions Monitoring Study (NAEMS)]" "[t]o better understand and evaluate emissions from CAFOs,"[246] and the agency is "unable to provide emission-estimating methodologies for use with [farm emission reports] until [NAEMS] is complete."[247] However, NAEMS was a two-year monitoring study that collected data on "emissions of particulate matter, ammonia, hydrogen sulfide, and volatile organic compounds" from hog, dairy, and poultry confinement structures and manure storage units.[248] It did not collect data on methane emissions. Moreover, in EPA's denial letter, the agency expressly admitted that it was only "develop[ing] methodologies to estimate emissions of ammonia, hydrogen sulfide, PM and VOC"–not methane.[249] Thus, EPA is not addressing emission estimation methodologies for methane through NAEMS,[250] and EPA has no plans to develop such methodologies (because, as described below, they already exist).[251] Accordingly, EPA's prior excuse does not apply to the present petition, and EPA should thus grant this petition.

EPA cannot refuse to carry out the objectives of section 111 with respect to one pollutant (methane) while it develops methodologies for other pollutants (particulate matter, ammonia, hydrogen sulfide, and volatile organic compounds).[252] In *Massachusetts*, the Supreme Court overturned EPA's denial of a petition to regulate carbon dioxide emissions from new vehicles because the agency's reasons "ha[d] nothing to do with whether greenhouse gas emissions

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[245] Letter from E. Scott Pruitt, *supra* note 37, at 5.

[246] *Id.* at 10.

[247] *Id.* at 7–8.

[248] EPA, *National Air Emissions Monitoring Study* (last accessed Nov. 15, 2019), https://www.epa.gov/afos-air/national-air-emissions-monitoring-study; *see also* OFF. OF INSPECTOR GENERAL, REP. NO. 17-P-0396, ELEVEN YEARS AFTER AGREEMENT, EPA HAS NOT DEVELOPED RELIABLE EMISSION ESTIMATION METHODS TO DETERMINE WHETHER ANIMAL FEEDING OPERATIONS COMPLY WITH CLEAN AIR ACT & OTHER STATUTES 7 (Sep. 19, 2017) [hereinafter 2017 NAEMS REVIEW]; Animal Feeding Operations Consent Agreement & Final Order, 70 Fed. Reg. 4958, 4971–72 (Jan. 31, 2005) (enumerating the targeted emissions and measurement methodologies).

[249] Letter from E. Scott Pruitt, *supra* note 37, at 8.

[250] *Id.* at 7.

[251] In May 2019, Petitioner Environmental Integrity Project (EIP) submitted a FOIA request for agency records relating to EPA's efforts to complete NAEMS and comply with the 2017 NAEMS REVIEW, *supra* note 248. *See* Letter from Abel Russ, Senior Attorney, EIP, to EPA (May 21, 2019). As EPA's released records reveal, EPA has not yet finalized any methodologies and continues to unduly delay development of emission estimation methodologies.

[252] EPA has not finalized emission models for any of the pollutants or emission sources monitored as part of the NAEMS. As of August 2020, the agency has only released draft emission models for ammonia, hydrogen sulfide, and particulate matter from industrial hog operations. *See* EPA, DEVELOPMENT OF EMISSIONS ESTIMATING METHODOLOGIES FOR SWINE BARNS & LAGOONS (2020).

contribute to climate change." 549 U.S. at 533. There, EPA claimed that other federal programs were providing "an effective response to the threat of global warming," and reducing emissions from new vehicles would result in "an inefficient, piecemeal approach" to climate change. *Id.* The Supreme Court held that EPA's "policy judgments" do not amount to "a reasoned justification for declining to form a scientific judgment." *Id.* at 533–34.

> Nor can EPA avoid its statutory obligation by noting the uncertainty surrounding various features of climate change and concluding that it would therefore be better not to regulate at this time. If the scientific uncertainty is so profound that it precludes EPA from making a reasoned judgment as to whether greenhouse gases contribute to global warming, EPA must say so. That EPA would prefer not to regulate greenhouse gases because of some residual uncertainty. . . is irrelevant. The statutory question is whether sufficient information exists to make an endangerment finding.

Id. at 534. Thus, if EPA refuses to make an endangerment determination, the agency must provide a "reasoned explanation for its refusal to decide whether greenhouse gases cause or contribute to climate change." *Id.* at 534.

EPA is not taking any regulatory action to reduce GHG emissions from industrial hog and dairy operations. In *WildEarth Guardians v. EPA*, the D.C. Circuit upheld EPA's denial of a petition to list coal mines as a stationary source category under section 111 because the agency was "focusing first on promulgating standards for transportation and electricity systems," which accounted for more than 60 percent of total U.S. GHG emissions at the time, and coal mines only accounted for 1 percent of total emissions. 751 F.3d 649, 653, 655 (D.C. Cir. 2014). The D.C. Circuit held that EPA's reasons for denying the petition for rulemaking are entirely consistent with the agency's duties under [section 111]" because "the statute affords agency officials discretion to prioritize sources that are the most significant threats to public health." *Id.* Unlike *WildEarth Guardians*, however, EPA is not currently "prioritiz[ing] sectors that emit more air pollutants" or otherwise "prioritiz[ing] regulatory actions in a way that best achieves the objectives of § 7411." *Id.* Rather, the Biden Administration has committed to taking action on climate with an emphasis on environmental justice and public health, factors this Petition demonstrates. Thus, if EPA refuses to take action to reduce GHG emissions from industrial hog and dairy operations, EPA's discretionary decision would lack a foundation in the statutory scheme, spin untethered from congressional objectives, and warrant no deference during judicial review.[253]

2. Existing methane emission estimation methods are reliable.

EPA does not need to develop new methodologies for estimating methane emissions from industrial dairy and hog source categories because reliable methods already exist. As explained in the most recent U.S. GHG Inventory, EPA currently estimates methane emissions from enteric fermentation based on recommendations in the 2006 IPCC Guidelines for National Greenhouse

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[253] *See Utility Air Regulatory Group v. EPA*, 573 U.S. 302 (2014) (holding that "EPA lacked authority to 'tailor' the [Clean Air] Act's unambiguous numerical thresholds . . . to accommodate its greenhouse-gas-inclusive interpretation of the permitting triggers").

Gas Inventories.[254] Specifically, EPA uses the IPCC Tier 2 methodology to estimate enteric emissions from the most significant source–dairy cows and other cattle–and the IPCC Tier 1 methodology for hogs and other livestock.[255]

EPA also has an effective method for estimating methane emissions from manure management systems. The agency first uses existing data to determine key characteristics of existing animal agriculture operations, such as herd size and type of manure management system.[256] It does not need to collect its own data. EPA then uses IPCC defaults to calculate methane emission factors for dry systems, such as pasture-based operations, and its own methodology for liquefied manure management systems, such as lagoons, to capture seasonal temperature changes and long-term retention time.[257]

Moreover, EPA has already established methods for calculating methane emissions from industrial hog and dairy manure management systems and industrial wastewater systems in its mandatory GHG reporting requirements.[258] Under these requirements, owners or operators of facilities that contain a liquefied manure management system that emits at least 25,000 metric tons of GHGs (methane and nitrous oxide) per year must collect emissions data, calculate methane emissions from manure management source categories, and report emissions to EPA.[259]

EPA can use these existing methods to predict how changing key characteristics of dairy and hog operations will affect methane and other air pollutant emissions. Under this approach, EPA would find that the most effective way to reduce methane emissions from industrial dairy and hog operations is to apply pasture-based practices that will reduce reliance on confinement production and liquefied manure management systems. Accordingly, there is no need to develop new or different emissions estimating methodologies, and EPA can and should make a finding that methane from industrial dairy and hog operations endangers public health and welfare.

C. **EPA can significantly reduce methane emissions from industrial hog and dairy operations by setting standards based on pasture-based systems.**

Because the Administrator should find that methane emissions from industrial hog and dairy operations satisfy the endangerment standard, EPA has a statutory duty under section 111(b) within one year to establish standards of performance for new and modified industrial hog and dairy sources based on application of pasture-based practices, the best system of emission reduction achievable, within one year of the endangerment finding. EPA also has a duty under section 111(d) to develop guidelines requiring states to follow the same approach for existing

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[254] EPA, U.S. GHG INVENTORY, *supra* note 50, at A-298.

[255] *Id.* at A-312 to -319.

[256] *Id.* at A-326 to -332.

[257] *Id.* at A-332.

[258] 40 C.F.R. § 98.323; *see also* Technical Support Document (Nov. 2009); see also Industrial Wastewater Treatment Sources (2018); Technical Support Document, 6-1 (2010).

[259] 40 C.F.R. Part 98, Subpart JJ; *see also* EPA-430-F-09-026R, Final Rule: Mandatory Reporting of GHGs (Nov. 2009).

sources within their state. Petitioners provide this information to educate EPA and do not conflate the endangerment finding and subsequent regulatory analyses.

Once EPA makes an endangerment finding and lists a source category under section 111, EPA must establish "standards of performance" for newly constructed or modified sources in the listed category."[260] This duty is nondiscretionary.[261] EPA may also "distinguish among classes, types, and sizes within categories of new sources for the purpose of establishing such standards."[262]

In setting a "standard of performance" for new sources,[263] EPA must determine the emission reduction achievable based on the Best System of Emission Reduction (BSER) that has been "adequately demonstrated," considering the (1) "cost of achieving such reduction"; (2) "nonair quality health and environmental impact[s]"; and (3) "energy requirements."[264] Under EPA's most recent interpretation in the Affordable Clean Energy Rule, section 111 "unambiguously limits the BSER to those systems that can be put into operation at a building, structure, facility, or installation, such as "add-on controls (e.g., scrubbers) and inherently lower-emitting processes/practices/designs."[265] Recently, the D.C. Circuit held that Congress did not limit BSER to only those measures at the stationary source itself, vacated this interpretation and rule, and remanded the issue to EPA to interpret section 111 anew. *American Lung Ass'n v. EPA*, 985 F.3d 914 (D.C. Cir. 2021). Under the previous interpretation in the Clean Power Plan, EPA more broadly interpreted BSER to "measures that can be implemented . . . by the sources themselves," i.e., "by actions taken by the owners or operators of the sources."[266] After evaluating each of these factors and determining the best system, EPA must then apply the best system to the sources to determine the "degree of emission limitation achievable." EPA's prior interpretation and the D.C. Circuit's rejection of the ACE Rule both support pasture-based systems for BSER.

Moreover, EPA does not need to collect emissions data to apply the best system "adequately demonstrated" to new sources. In *Lignite Energy Council v. EPA*, the D.C. Circuit

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[260] 42 U.S.C. § 7411(b)(1)(B); *see also id.* §§ 7411(a)(2) (defining "new source" as "any stationary source, the construction or modification of which is commenced after the publication of regulations (or, if earlier, proposed regulations) prescribing a standard of performance . . . which will be applicable to such source"); § (4) (defining "modification" as "any physical change in, or change in the method of operation of, a stationary source which increases the amount of any air pollutant emitted by such source or which results in the emission of any air pollutant not previously emitted").

[261] *See Zook v. EPA*, 611 Fed. Appx. 725 (D.C. Cir. 2015) ("[T]he Administrator's duty to regulate [an air pollutant under section 111] is triggered by an endangerment finding that the Act entrusts to the Administrator's sole judgment.")

[262] 42 U.S.C. § 7411(b)(2), (d).

[263] EPA can authorize states to implement and enforce new source performance standards within their borders. 42 U.S.C. § 7411(c)(1) (allowing EPA to delegate implementation and enforcement authority to any state that develops and submits an adequate implementation plan to EPA for approval). However, even if EPA delegates limited authority to a state, EPA can still enforce applicable standards in the state. *Id.* § (c)(2).

[264] *Id.* § 7411(a)(1).

[265] Repeal of the Clean Power Plan, 84 Fed. Reg. 32520, 32524 (Jul. 8, 2019).

[266] Carbon Pollution Emission Guidelines for Existing EGUs, 60 Fed. Reg. 64661, 64720 (Dec. 22, 2015).

upheld EPA's new source performance standard, even though the agency was unable to collect data for the application of the best system, because the "absence of data is not surprising for a new technology," and "section 111 'looks toward what may fairly be projected for the regulated future, rather than the state of the art at present.'" 198 F.3d 930, 933-34 (D.C. Cir. 1999) (citations omitted). "Of course, where data are unavailable, EPA may not base its determination that a technology is adequately demonstrated or that a standard is achievable on mere speculation or conjecture, but EPA may compensate for a shortage of data through the use of other qualitative methods." *Id.* at 934 (internal citations omitted).

In addition to developing nationally applicable standards for new and modified sources, EPA must establish guidelines for states to develop their own standards of performance for existing sources located within their respective borders.[267] Under section 111(d), EPA has broad authority and flexibility to set emission guidelines for unregulated air pollutants,[268] and states must follow these guidelines when developing standards for existing sources located in their jurisdiction.[269] However, section 111(d) grants states the authority to consider a source's remaining useful life and other factors when applying a standard of performance to the source.[270]

1. Pasture-based production is the best system of emission reduction.

Pasture-based dairy and hog production is the "best system of emissions reduction . . . [that] has been adequately demonstrated," based on a variety of factors, including implementation costs, operation and maintenance costs, "nonair quality" health impacts, "nonair quality" environmental impacts, and energy requirements.[271] Thus, EPA should establish national standards for new and modified sources within industrial dairy and hog source categories based on the level of methane and GHG emission reductions achievable by applying pasture-based practices.

Methane Emissions Reductions

As several recent studies demonstrate, industrial hog and dairy operations can dramatically reduce methane emissions by adopting pasture-based production systems.

Enteric Emissions

Industrial dairy operations generate significant amounts of enteric methane emissions because they feed animals in a manner other than grazing with liquefied manure management systems to confine thousands of animals in specialized confinement facilities. In contrast, well-managed pasture-based dairy operations have lower enteric emissions because they stock fewer

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[267] 42 U.S.C. § 7411(d).

[268] *Id.* For example, EPA has previously established regulations for existing sources in the form of emission guidelines that describe the BSER, the degree of emission reductions achievable, costs and environmental impacts of application, the time required to implement, and a goal for reductions based on BSER analysis. *See supra* note 32.

[269] If any state's plan does not comply with EPA regulations, EPA can reject the state's plan, or develop a plan for the state.

[270] *See* 42 U.S.C. § 7411(d).

[271] *Id.* § 7411(a)(1).

cows than industrial operations. Hog and dairy producers can thus reduce enteric emissions by (1) reducing the amount of time hogs and dairy cows spend in confinement, and (2) increasing the amount of time animals spend in well-maintained pastures or paddocks grazing and foraging.

Further, hog and dairy producers can reduce enteric emissions by maintaining pastures, paddocks, and grazing lands properly to ensure that animals have access to high-quality forage and feed. According to recent assessments, industrial dairy operations can reduce enteric methane emissions by adding high-quality forage to animal diets.[272] Studies also confirm that "better quality pasture and better pasture management can lead to improvements in forage digestibility and nutrient quality," which "results in faster animal growth rates," "increase[d] cow fertility rates, and reduce[d] mortality rates," "thus improving animal and herd performance."[273] Likewise, "better grazing management," which includes increased mobility and balancing of grazing and rest periods, can promote "forage production and soil carbon sequestration."[274] Thus, by adopting a well-managed pasture-based system, hog and dairy producers can "maintain high quality forage and reduce per-animal enteric methane emissions."[275]

Manure Management Emissions

In addition to enteric emissions, fully confined dairy and hog production facilities generate methane from fresh manure on facility flooring. By reducing the number of cows and hogs per farm and the overall amount of manure deposited in confinement facilities, methane emissions from manure decomposing on facility flooring and in liquid manure management systems will decrease significantly. Likewise, by increasing reliance on forage feed, rather than purchased feed grown off-site, pasture-based systems significantly reduce methane emissions from spoilage and loss during transport, long-term feed storage, and handling.[276]

Moreover, fully confined dairy and hog production facilities emit significant amounts of methane from liquefied manure management systems, and these emissions increase over time.[277]

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[272] IPCC, CLIMATE CHANGE & LAND, *supra* note 42, at 2-79; NAT'L SUSTAINABLE AGRIC. COALITION (NSAC), AGRIC. & CLIMATE CHANGE: POLICY IMPERATIVES & OPPORTUNITIES TO HELP PRODUCERS MEET THE CHALLENGE 26 (Nov. 2019) (explaining how changing the grain to forage ratio in dairy cows' diets can significantly reduce enteric methane emissions); A. Dall-Orsoletta, et al., *Ryegrass Pasture Combined With Partial Total Mixed Ration Reduces Enteric Methane Emissions & Maintains The Performance of Dairy Cows During Mid To Late Lactation*, 99 J. DAIRY SCIENCE 4374 (2016) (finding that "inclusion of annual ryegrass pasture to the diet of [confined] dairy cows maintained animal performance and reduced enteric methane emissions"); M. Dutreuil, et al., *Feeding Strategies & Manure Management for Cost-Effective Mitigation of Greenhouse Gas Emissions From Dairy Farms in Wisconsin*, 97 J. DAIRY SCI. 5904, 5912 (2014) (finding that GHG emissions from confinement housing facilities decreased when cows on industrial diary operations were given access to pastures); *see also* B. O'Neill, al., *Effects of a Perennial Ryegrass Diet or Total Mixed Ration Diet Offered to Spring-Calving Holstein-Friesian Dairy Cows on Methane Emissions, Dry Matter Intake, & Milk Production*, 94 J. DAIRY SCI. 1941 (2011).

[273] P. GERBER, ET AL., FOOD & AGRIC. ORGANIZATION (FAO), TACKLING CLIMATE CHANGE THROUGH LIVESTOCK: A GLOBAL ASSESSMENT OF EMISSIONS & MITIGATION OPPORTUNITIES 69, 70 (2013).

[274] *Id.* at 73.

[275] NSAC, AGRIC. & CLIMATE CHANGE, *supra* note 272, at 25–26.

[276] *Id.* at 26.

[277] *See, e.g.*, M. Dutreuil, *supra* note 272, at 5912 (finding that GHG emissions from manure storage decreased when cows from industrial dairy operations were given access to pastures for part of the year).

Conversely, pasture-based systems emit significantly less methane from manure management because animals on pastures deposit manure directly on the land, and manure management is only required when animals deposit manure in temporary or partial confinement areas, such as milking stations and walkways. Thus, even if industrial hog and dairy operations can only rely on pasture-based systems during the spring or summer, when conditions allow, they can substantially reduce methane emissions from liquefied manure management.[278]

In sum, emission standards based on widespread application of well-managed pasture-based systems will significantly reduce methane emissions from fully confined dairy and hog confinement and liquefied manure management sources.

Additional GHG Emission Reductions

Nitrous Oxide & Carbon Dioxide Emissions

In addition to releasing methane, manure decomposing in liquefied storage systems can release nitrogen into the atmosphere as ammonia (NH_3), which can transform into nitrous oxide (N_2O), another potent GHG and air pollutant.[279] Thus, pasture-based systems decrease direct methane emissions from manure management, as well as indirect nitrous oxide emissions, by decreasing the amount of manure managed with liquefied manure systems through herd size decreases and manure decomposition on pasture.[280]

Further, pasture-based systems reduce direct and indirect nitrous oxide emissions from stored manure and wastewater applied to land. When manure is stored in liquefied manure management systems, producers must eventually dispose of the waste through land applications. When producers dispose of the waste by applying the manure to feed crops as fertilizer, significant amounts of nitrous oxide is emitted from the soil.[281] Manure applied to soil that is frozen or covered in snow also generates nitrous oxide as it decomposes on the surface.[282] Moreover, manure applications can result in indirect nitrous oxide emissions (from leached or volatilized N), which contributes to rising GHG emissions and climate change.[283] Thus, pasture-based systems can reduce nitrous oxide emissions from manure land applications.

Allowing animals to graze on pastures will decrease the need for imported feed, which will in turn reduce CO_2 and N_2O created in growing, processing, transporting, and storing grain

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[278] *See, e.g.*, Baldé, *supra* note 98 (finding that methane emissions from long-term liquid manure storage are highest "when high manure temperature and high volume coincide[]").

[279] FAO, TACKLING CLIMATE CHANGE THROUGH LIVESTOCK, *supra* note 273, at 17, 20.

[280] *See, e.g.*, J. Owen, et al., *supra* note 98, at 555.

[281] EPA, U.S. GHG INVENTORY, *supra* note 50, at 5-11; *see also* I. Shcherbak, et al., *Global Meta-Analysis of the Nonlinear Response of Soil Nitrous Oxide (N_2O) Emissions to Fertilizer Nitrogen*, 111 PNAS 9199 (2014) (finding that N_2O contributes to global climate change and ozone depletion, and N_2O emissions rise rapidly as applied N rates exceed crop needs).

[282] NSAC, AGRIC. & CLIMATE CHANGE, *supra* note 272, at 26.

[283] *See* EPA, U.S. GHG INVENTORY, *supra* note 50, at 5-11.

feed for hog and dairy cows in confinement systems.[284] Pasture-based production systems can also reduce overall GHG emissions by lowering CO_2 emissions from energy consumption.[285] Industrial hog and dairy operations consume significant amounts of energy during animal production because they rely on highly specialized and industrialized facilities to confine large numbers of dairy cows and hogs.[286] These operations also consume energy during manure management because they rely on highly industrialized facilities, technologies, and equipment to collect, manage, store, and monitor liquefied manure for long periods. Likewise, these operations also directly emit CO_2 during manure land application because they rely on specialized equipment for spray irrigation, soil injection, crop fertilization, and runoff monitoring. Pasture-based systems reduce indirect CO_2 emissions generated during the construction, modification, and expansion of industrialized confinement and manure management facilities.[287]

Carbon Sequestration

Pasture-based systems can reduce carbon dioxide in the atmosphere by increasing the amount of C stored in soil through improved land management practices and land restoration.[288] For example, by replacing annual crops with deep-rooted perennial forage plants, pasture-based systems minimize soil disturbance and erosion, and maximize biomass production, resulting in

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[284] *See* G. Malcolm, et al., *Energy & Greenhouse Gas Analysis of Northeast US Dairy Cropping Systems*, 199 AGRIC. ECOSYSTEMS & ENVIRONMENT 407 (2015) (dairy cropping systems lowered total fossil energy inputs per Mg of milk produced by 18-15%, “largely by importing [77-71%] less feed crops that would have been grown elsewhere”); A. Fredeen, et al., *Implications of Dairy Systems on Enteric Methane & Postulated Effects on Total Greenhouse Gas Emission*, 7 ANIMAL 1875 (2013).

[285] M. Pagani, et al., *An Assessment of the Energy Footprint of Dairy Farms in Missouri & Emilia-Romagna*, 145 AGRIC. SYS. 116 (2016) (dairy operations can reduce energy inputs by switching to forage-based farming and reducing reliance on fertilizer, feed, and fuel).

[286] J. Tallaksen, et al., *Reducing Life Cycle Fossil Energy & Greenhouse Gas Emissions For Midwest Swine Production Systems*, 246 J. CLEANER PRODUCTION (2020) (hog production facilities use significant amounts of fossil energy for heating, cooling, and ventilation); P. Lammers, et al., *Energy Use In Pig Production: An Examination of Current Iowa Systems*, 90 J. ANIMAL SCI. 1056 (2012) (hog production facilities account for 25% of energy use on industrial hog operations); L. Murgia, et al., *A Partial Life Cycle Assessment Approach to Evaluate the Energy Intensity & Related Greenhouse Gas Emission in Dairy Farms*, 44 J. AGRIC. ENGINEERING 186, 190 (2013) (feed preparation and distribution operations require the largest amount of total fuel consumption (52%)).

[287] *See* M. Koesling, et al., *Embodied & Operational Energy in Buildings on 20 Norwegian Dairy Farms: Introducing the Building Construction Approach to Agriculture*, 108 ENERGY & BUILDINGS 330 (2015).(“Choosing a design that requires less material or materials with a low amount of embodied energy, can significantly reduce the amount of embodied energy in [dairy] buildings.”).

[288] NSAC, AGRIC. & CLIMATE CHANGE, *supra* note 272, at 9; *see, e.g.*, P. Stanley, et al., *Impacts of Soil Carbon Sequestration on Life Cycle GHG Emissions in Midwestern USA Beef Finishing Systems*,162 AGRIC. SYS. 249 (2018) (“[Adaptive multi-paddock] grazing can contribute to climate change mitigation through [soil organic carbon] sequestration”); A. Franzluebbers, et al., *Crop & Cattle Production Responses to Tillage & Cover Crop Management in an Integrated Crop-Livestock System in the Southeastern USA*, 57 EUROPEAN J. AGRONOMY 62 (2014).

increased soil carbon sequestration.[289] Likewise, pasture-based systems increase soil carbon by increasing soil health and biodiversity in degraded or eroded lands.[290] Thus, well-managed, regenerative pasture-based systems can lead to significant, long-term soil sequestration of carbon, and EPA's emission standards for industrial hog and dairy operations should reflect the amount of carbon dioxide emission reductions achievable under pasture-based systems.

Additional Emission Reductions

In addition, reducing GHG emissions from industrial hog and dairy operations will also reduce dust, odor, zoonotic pathogens, and other harmful pollutants emitted from confinement facilities and liquefied manure management systems.[291] These emissions degrade local air quality, increase odor, decrease property values, and threaten health and well-being of local residents.[292] Thus, allowing animals to graze on pasture-based systems will dramatically reduce odor and air pollution in rural communities. Pathogen exposure and illness in rural, agricultural communities will also decrease because fewer contaminants will enter the air during manure land disposal.[293]

Additional Environmental & Public Health Benefits

In addition to reducing GHG emissions, well-managed pasture-based systems provide several additional public health and welfare benefits to rural communities and farmers.[294]

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[289] NSAC, AGRIC. & CLIMATE CHANGE, *supra* note 272, at 17–21; *see, e.g.*, R. Ghimire, et al., *Long-term Management Effects & Temperature Sensitivity of Soil Organic Carbon in Grassland and Agricultural Soils*, 9 SCI. REPORTS 12151 (2019) ("Reducing tillage" and "growing perennial grasses could minimize [soil organic carbon] loss and have the potential to improve soil health and agroecosystem resilience under projected climate warming."); W. Teague, et al., *supra* note 76 ("Incorporating forages and ruminants into regeneratively managed agroecosystems can elevate soil organic C, improve soil ecological function by minimizing the damage of tillage and inorganic fertilizers and biocides, and enhance biodiversity and wildlife habitat."); M. Machmuller, et al., *Emerging Land Use Practices Rapidly Increase Soil Organic Matter*, 6 NATURE COMM. 6995 (2015) (pasture-based intensively grazed dairy systems can restore soil quality and mitigate climate change by increasing soil C).

[290] *See supra* note 289.

[291] *See supra* notes 65 and 80.

[292] *See supra* notes 66 and 83; *see also McKiver v. Murphy Brown, LLC*, 980 F.3d 937 (4th Cir. 2020).

[293] *See, e.g.*, R. Dungan, *supra* note 66 (finding that the risk of infection after inhaling pathogens aerosolized during irrigation of diluted dairy wastewaters were greatest in individuals closest to the operation due to "higher pathogen dose"); T. Burch, et al., *supra* note 66, at 1, 10-11 ("Reducing pathogen prevalence and concentration in source manure would most effectively mitigate [human health risks from spray irrigation of livestock manure].").

[294] *See, e.g.*, IPCC, CLIMATE CHANGE & LAND, *supra* note 42, at 4-61 ("There is strong scientific consensus that a combination of forestry with agricultural crops and/or livestock, agroforestry systems can provide additional ecosystem services when compared with monoculture crop systems."); J. Guyader, et al., *Forage Use to Improve Environmental Sustainability of Ruminant Production*, 94 J. ANIMAL SCI. 3147 (2016) ("The potential environmental benefits of forage-based systems may be expanded even further [than GHG emission reductions] by considering their other ecological benefits, such as conserving biodiversity, improving soil health, enhancing water quality, and providing wildlife habitat.").

Water Quality

When industrial hog and dairy operations apply too much manure to a small area, or when they apply manure at high rates for long periods, contaminants in the manure, such as nitrogen and phosphorus, fecal bacteria, pathogens, and antibiotic residents, accumulate in the soil and enter waterways through soil erosion and runoff.[295] Likewise, when producers apply more manure to croplands than crops can use, the excess nitrogen can mineralize into nitrate, which is an extremely soluble form of nitrogen that can move through soil with water, potentially leaching into groundwater or surface waters.[296] Further, nutrients, pesticides, heavy metals, and other harmful contaminants can also enter water sources from feed crops (e.g., soybean and corn). A recent analysis of groundwater impacts from industrial dairy operations in California revealed that "94 percent of groundwater nitrogen loading on dairies . . . occurs on croplands," with "'unaccounted-for' manure nitrogen on many dairies."[297]

Because liquefied manure storage systems allow manure to accumulate for long periods, these systems increase the amount of manure applied to land at one time, which increases the risk of oversaturation and runoff.[298] In addition to improper manure disposal, including applications to saturated or frozen ground, liquefied manure management systems increase the risk of manure entering local water sources during heavy rain events, spills, and storage lagoon and equipment failures.[299] Further, because industrial hog and dairy operations need to transport and store massive amounts of imported feed to produce animals in confinement facilities, these operations increase runoff from feed production, transportation, and storage.

As several studies demonstrate, manure runoff and discharges to surface waters have several adverse impacts on public health and ecological systems.[300] For example, manure from

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[295] EPA, *Nutrient Pollution, The Issue* (last access Mar. 23, 2020), https://www.epa.gov/nutrientpollution/issue; EPA, LITERATURE REVIEW OF CONTAMINANTS IN LIVESTOCK & POULTRY MANURE & IMPLICATIONS FOR WATER QUALITY 1 (2013) ("The geographic concentration of livestock . . . can lead to concentrations of manure that may exceed the needs of the plants and the farmland where it was produced.") [hereinafter CONTAMINANTS IN LIVESTOCK MANURE]; *see also* APHIS, DAIRY MGMT. PRACTICES, *supra* note 122, at 38 tbl.A.4.a (demonstrating that most large farms use spray irrigation or surface application systems, and large farms are far more likely to use subsurface injection and spray irrigation than small farms).

[296] *See, e.g.*, EPA, CONTAMINANTS IN LIVESTOCK MANURE, *supra* note 295, at 2 tbl.1-1 (summarizing the impacts of key pollutants from livestock operations and animal manure); FAO, SOIL POLLUTION: A HIDDEN REALITY 20–21 (2018).

[297] CENT. VALLEY DAIRY REPRESENTATIVE MONITORING PROGRAM, SUMMARY REPRESENTATIVE MONITORING REPORT 10, 26 (Apr. 19, 2019).

[298] *See supra* EPA, U.S. GHG INVENTORY, *supra* note 50, at A-348 tbl.A-190; S. COX, ET AL., U.S. GEOLOGICAL SURVEY, CONCENTRATIONS OF NUTRIENTS AT THE WATER TABLE BENEATH FORAGE FIELDS RECEIVING SEASONAL APPLICATIONS OF MANURE, WHATCOM COUNTY, WASHINGTON, AUTUMN 2011–SPRING 2015 (2018).

[299] EPA, CONTAMINANTS IN LIVESTOCK MANURE, *supra* note 295, 22, 35, 72.

[300] *See* CASE STUDIES ON CAFO GROUNDWATER IMPACT, *supra* note 65 (over-application of dairy lagoon effluent resulted in groundwater contamination by nitrate, as well as antibiotics, estrogens, and other stressors); S. Stackpoole, et al., *Variable Impacts of Contemporary Versus Legacy Agricultural Phosphorus On US River Water Quality*, 116 PNAS 20562 (2019); C. Long, et al., *Use of Manure Nutrients From Concentrated Animal Feeding Operations*, 44 J. GREAT LAKES RESEARCH 245 (2018) (CAFOs applied excess manure nutrients to cropland by over-estimating crop yields in calculating plant nutrient requirements in 67% of cases) .

industrial hog and dairy operations can spread harmful contaminants, such as fecal bacteria and zoonotic pathogens, to local water sources, resulting in waterborne and foodborne disease outbreaks, antibiotic-resistant infections, and other adverse community impacts.[301] Moreover, runoff from manure applications can increase concentrations of heavy metals (from supplemented animal feed), which can harm beneficial soil organisms, impair plant metabolism, and decrease crop productivity.[302] Because heavy metals can persist and accumulate in living organisms, these metals also threaten the health and well-being of local residents and animals.[303] Further, manure applications can increase concentrations of other highly persistent pollutants, such as veterinary antibiotic residues, which can lead to antimicrobial-resistant bacteria in soils.[304]

In addition, both manure disposal and feed production degrade local water quality by increasing the amount of oxygen-depleting nutrients in the environment.[305] Nutrient loading contributes to oxygen depletion and excessive algae blooms in surface waters, which leads to degraded water quality, fish mortality, and other harmful ecological impacts.[306] Moreover, algae blooms in recreational and drinking water sources can produce dangerous toxins.[307] For example, cyanobacteria (commonly referred to as blue-green algae) multiplies or "blooms" when water is rich in nutrients from manure runoff or storage overflows, and a cyanobacterial algal bloom can produce cyanotoxins, which are harmful to people, aquatic life, and the environment.[308]

Industrial dairy and hog operations often generate more waste than the surrounding land can utilize for crop production because they confine animals in fully confined production facilities, which are concentrated in certain regions.[309] In contrast, well-managed pasture-based systems evenly distribute manure on the land, and limit herd sizes to the amount of agricultural

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[301] *See supra notes* 65 and 80; *see also* O. Alegbeleye, et al., *Manure-Borne Pathogens as an Important Source of Water Contamination*, 227 INT'L J. HYGIENE & ENVTL. HEALTH 113524 (2020).

[302] FAO, SOIL POLLUTION, *supra* note 296, at 16, 20.

[303] *Id.*

[304] *Id.* at 16, 34.

[305] *See* S. Porter, et al., *Using a Spatially Explicit Approach to Assess the Contribution of Livestock Manure to Minnesota's Agricultural Nitrogen Budget*, 10 AGRONOMY 480 (2020) (total amount of N from both commercial fertilizer and manure exceeded the N crop need in all rate scenarios).

[306] EPA, CONTAMINANTS IN LIVESTOCK MANURE, *supra* note 295, at 47–48, 63.

[307] *Id.* at 48 tbl.6-1 (summarizing types of harmful or nuisance inland algae, toxin production, and potential adverse impacts).

[308] *See id.*; CDC, Facts about Cyanobacterial Harmful Algal Blooms for Poison Center Professionals (2018).

[309] *See, e.g.*, C. Heaney, et al., *supra* note 82; *see also* J. Powell, et al., *Measures of Nitrogen Use Efficiency & Nitrogen Loss from Dairy Production Systems*, 44 J. ENVTL. QUAL. 336 (2015) ("Dairy farms that import all grain and protein supplements have more than double the amount of manure N to manage per hectare (363 vs. 172 kg N ha^{-1} of corn) and therefore incur much higher loses of NH_3 ha^{-1} compared with farms that [do not import grain]."); K. Zirkle, et al., *Assessing the Relationship Between Groundwater Nitrate & Animal Feeding Operations in Iowa*, 566 SCI. TOTAL ENVIRONMENT 1062 (2016) (finding a significant relationship between the total number of animal feeding operations within 2 km of a well and groundwater nitrate concentration).

land available for optimum grazing and foraging.[310] By setting appropriate stocking rates and recovery periods, these systems avoid nutrient overloading and decrease the spread of harmful pollutants.[311] Other benefits of pasture-based systems include improved soil conditions and nutrient cycling; improved drinking water quality and public health; and reduced or eliminated need for synthetic nitrogen or other agrichemical input.[312]

Community Benefits

Reducing GHG emissions from industrial hog and dairy operations will also reduce disproportionate concentrations of air and water pollution in rural communities. For instance, industrial dairy operations rely on corn silage cropping systems to both feed cows and absorb land-applied nitrogen, but such silage emits volatile organic compounds and generates more ozone than passenger vehicles in the San Joaquin Valley, one of the most ozone polluted air basins in the U.S.[313] Allowing cows to graze on pasture, instead of distributing corn silage to cows in confinement feeding systems, reduces these ozone-forming emissions.

As discussed above, pasture-based production also reduces harmful airborne gas and odor emissions from industrial hog and dairy confinement facilities and manure storage. Further, pasture-based systems reduce the overall amount and concentration of liquefied manure in polluted regions because pasture-based dairy and hog producers do not need to dispose excessive amounts of liquefied manure and wastewater onto nearby fields. As a result, pasture-based systems reduce the risk of runoff, soil degradation, and drinking water contamination. Additional

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[310] *See, e.g.*, C. Zegler, et al., *Management Effects on Forage Productivity, Nutritive Value, & Legume Persistence in Rotationally Grazed Pastures*, 58 CROP SCIENCE 2657 (2018); E. Coffey, et al., *Effect of Stocking Rate & Animal Genotype on Dry Matter Intake, Milk Production, Body Weight, & Body Condition Score in Spring-Calving, Grass-Fed Dairy Cows*, 100 J. DAIRY SCI. 7556 (2017); *see also* J. Powell, et al., *Potential Use of Milk Urea Nitrogen to Abate Atmospheric Nitrogen Emissions from Wisconsin Dairy Farms*, 43 J. ENVTL. QUAL. 1169 (2014) (pasture-based dairy farms had the lowest N emissions due to direct deposition of urine in pasture, and farms that used tie-stall barns with daily hauling of manure had highest N emissions due to greater surface exposure of urine and continuous mixing of feces and urine by animals and scrapers during manure removal).

[311] *See, e.g.*, C. Rotz, et al., *An Environmental Assessment of Grass-Based Dairy Production*, 184 AGRIC. SYS. 102887 (2020) ("With less [nutrient] loss per unit of land [than confinement systems]," "grass-based dairy systems provide a benefit by reducing nitrogen and phosphorous losses from farms and potentially reducing pollution to downstream surface waters.").

[312] *See* NSAC, AGRIC. & CLIMATE CHANGE, *supra* note 272, at 27; *see, e.g.*, J. Doltra, et al., *Forage Management to Improve On-Farm Feed Production, Nitrogen Fluxes & Greenhouse Gas Emissions From Dairy Systems in a Wet Temperate Region*, 160 AGRIC. SYS. 70 (2018); S. Dahal, et al., *Strategic Grazing in Beef-Pastures for Improved Soil Health & Reduced Runoff-Nitrate*, 12 SUSTAINABILITY 558 (2020) (finding that strategic grazing systems have several positive ecosystem impacts, "including an increase in active carbon, consistent respiration rate, and cleaner runoff water a reduction in nitrate in runoff water").

[313] C. Howard, et al., *Reactive Organic Gas Emissions from Livestock Feed Contribute Significantly to Ozone Production in Central California*, 44 ENVTL. SCI. TECH. 2309, 2309–14 (2010); J. Hu, et al., *Mobile Source & Livestock Feed Contributions to Regional Ozone Formation in Central California*, 46 ENVTL. SCI. & TECH. 2781 (2012); *see also* D. Gentner, et al., *Emissions of Organic Carbon & Methane From Petroleum & Dairy Operations in California's San Joaquin Valley*, 14 ATMOS. CHEM. PHYS. 4955–78 (2014) (finding that dairy operations and petroleum operations were each responsible for 22% of anthropogenic non-methane organic carbon emissions. and 13% of potential anthropogenic ozone formation)

community health benefits include reduced exposure to airborne pathogens from manure disposal on nearby fields.

Agricultural Benefits

Reducing GHG emissions from industrial hog and dairy operations will increase climate resiliency and adaptive capacity in the U.S. hog and dairy sector. As discussed above, the expansion of highly concentrated and industrialized operations makes U.S. hog and dairy production more vulnerable to extreme weather events, power outages, and other climate change impacts.[314] Pasture-based systems are not only more resilient to climate change impacts, but they also mitigate the direct climate change risks to U.S. dairy and hog production, from heat waves to water shortages to new disease and insect threats.[315] Well-managed pasture-based systems can reduce the overall stress on hogs and dairy cows brought on through climate change.[316] Further, animals "engag[ing] in natural behaviors outside as opposed to being crowded together indoors tend to be healthier and need fewer antibiotics, which reduces production costs and the rate of antibiotic resistance in food-borne bacteria."[317] In addition to reducing the GHG footprint of hog and dairy operations, pasture-based systems protect soil, air, and water quality, and increase resiliency in rural areas with the highest exposure and risk to climate change impacts.[318] All these benefits work together to make hog and dairy production systems more resilient to climate change impacts.

Thus, to achieve climate goals and co-benefits, EPA should calculate emission reduction standards based on the amount of reductions achievable through adoption of pasture-based systems. In doing so, EPA will significantly reduce fossil fuel consumption,[319] and overall GHG

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[314] *See supra* notes 229 to 232; *see, e.g.*, K. Martin, et al., *The Unknown Risks to Environmental Quality Posed by the Spatial Distribution & Abundance of Concentrated Animal Feeding Operations*, 642 SCI. TOTAL ENVIRONMENT 887 (2018) (increased storm intensity and longer dry periods due to climate change could exacerbate the environmental impacts CAFOs in Coastal Plain, a low-lying region vulnerable to flooding).

[315] *See* IPCC, CLIMATE CHANGE & LAND, *supra* note 42, at 5-48 and 5-100 (discussing the benefits of diversified production systems and agro-ecological approaches); J. Steiner, et al., *Vulnerability of Southern Plains Agriculture to Climate Change*, 146 CLIMATE CHANGE 201 (2018) (explaining how farms can improve adaptive capacity through enterprise adaptations emphasizing "adjustment of livestock herd size and composition to match forage supply with demand," including integrated crop-livestock systems).

[316] NSAC, AGRIC. & CLIMATE CHANGE, *supra* note 272, at 27.

[317] *Id.*; *see also* G. Arnott, et al., *Review: Welfare of Dairy Cows in Continuously Housed & Pasture-Based Production Systems*, 11 ANIMAL 261, 261–73 (2017) ("cows on pasture-based systems had lower levels of lameness, hoof pathologies, hock lesions, mastitis, uterine disease and mortality compared with cows on continuously housed systems"); F. Grandl, et al., *Impact of Longevity on Greenhouse Gas Emissions & Profitability of Individual Dairy Cows Analysed with Different System Boundaries*, 13 ANIMAL 198 (2019) ("increasing the length of productive life of dairy cows is a viable way to reduce the climate impact [and] to improve profitability of dairy production").

[318] NSAC, AGRIC. & CLIMATE CHANGE, *supra* note 272, at 26; *see also* D. O'Brien, et al., *A Life Cycle Assessment of Seasonal Grass-based & Confinement Dairy Farms*, 107 AGRIC. SYS. 33 (2012) (confinement systems had a greater impact on global warming, eutrophication, acidification, land use, and non-renewable energy use than grass-based system per unit of milk and per on-farm area).

[319] *See, e.g.*, E. Llanos, et al., *Energy & Economic Efficiency in Grazing Dairy Systems under Alternative Intensification Strategies*, 91 EUROPEAN J. AGRONOMY 133, 133–40 (2018) ("dairy farms with a higher proportion of pasture consumption . . . used less fossil energy per liter of milk").

emissions from agricultural activities.[320] EPA will also help make the U.S. agricultural sector more resilient to climate change impacts.[321]

Implementation Costs

Pasture-based systems are economically viable and beneficial. Because pasture does not require costly infrastructure or equipment, farmers do not need to obtain large amounts of funding to build or maintain infrastructure (e.g., buildings or liquefied manure management systems, pipelines).[322] Nor do farmers need to enter into complicated funding and purchasing arrangements with government entities or private investors to remain profitable or economically viable.[323]

Adopting sustainable land management practices and technologies requires an average of $500 per hectare (or approximately $202.34 per acre) in upfront investments, and "[m]any sustainable land management technologies and practices are profitable within three to ten years."[324] Moreover, sustainable land management practices "can improve crop yields and the economic value of pasture"; "improve livelihood systems"; and "provide both short-term positive economic returns and longer-term benefits in terms of climate change adaptation and mitigation, biodiversity, and enhanced ecosystem functions and services."[325] In addition, "[n]ear-term change to balanced diets . . . can reduce the pressure on land and provide significant health co-benefits through improving nutrition."[326]

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[320] *See, e.g.*, Dutreuil, et al., *supra* note 272, at 5904–17 ("incorporation of grazing practices for lactating cows in the conventional farm led to a 27.6% decrease in total GHG emissions [-0.16 kg of CO2 eq./kg of energy corrected milk]").

[321] *See, e.g.*, C. Rotz, et al., *Environmental Assessment of Grass-Based Dairy*, *supra* note 311, at 6 ("fossil energy use was much less for the all-grass production system than for the [confinement] system using grain supplementation, primarily due to the energy required to produce and transport grain"); B. Horan, et al., *Defining Resilience in Pasture-Based Dairy-Farm Systems in Temperate Regions*, 60 ANIMAL PROD. SCI. 55, 55–66 (2019) (explaining how resilient grazing systems minimize the need "for machinery and housing, and exposure to feed prices").

[322] *See, e.g.*, J. Hanson, et al., *Competitiveness of Management-Intensive Grazing Dairies in the mid-Atlantic Region from 1995 to 2009*, 96 J. DAIRY SCI. 1894, 1901 (2013) ("Management-intensive grazing operations require less equipment for crop production and smaller freestall areas in barns (because cows spend more of their time grazing in pasture) [than confinement systems."); *see also id.* at 1900 ("Because confinement operators had more crop equipment than [pasture-based] operators, their depreciation and maintenance costs were higher.").

[323] *Id.* at 1901 ("Lower upfront investment costs make [well-managed pasture-based systems] easier to finance and thus more accessible to new entrants lacking capital [than confinement systems].").

[324] IPCC, CLIMATE CHANGE & LAND, *supra* note 42, at 40.

[325] *Id.*

[326] *Id.*

Further, pasture-based systems have several economic and environmental benefits for farmers and agricultural communities.[327] For example, integrating perennial forage plants into corn and soybean fields is not only an effective method of improving biodiversity and reducing soil and groundwater contamination from manure land applications, but also one of the least expensive conservation practices available to farmers, with an average annual cost of $60 to $85 per treated hectare.[328] In addition, by diversifying corn and soybean fields with perennial forage plants, farmers can reduce reliance on mineral fertilizer, pesticides, and fossil fuel energy; and improve crop yields, profitability, environmental quality, and weed and pest suppression.[329]

Pasture-based systems are more profitable and efficient than industrial, confinement-based systems "on a per hundredweight, per cow, and per acre basis, and no less profitable on a whole-farm basis."[330] Pasture-based systems also have lower operational expenses due to reduced hired labor and capital costs, as well as reduced veterinary, breeding, and medicine costs per cow.[331] In addition, pasture-based systems are less vulnerable to price declines and market instability than industrial operations because profits are more stable on pasture-based operations.[332] Further, because climate change will likely increase the cost of imported feed,[333] pasture-based systems will be less vulnerable to climate-related impacts on feed production.

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[327] M. Liebman, e t al., *Enhancing Agroecosystem Performance & Resilience Through Increased Diversification of Landscapes & Cropping Systems*, 3 ELEMENTA SCI. 41 (2015); A. Franzluebbers, et al., *Building Agricultural Resilience With Conservation Pasture-Crop Rotations* in AGROECOSYSTEM DIVERSITY, 109–121 (2019) (arguing that "integrating pastures and crops with other ecologically based practices leads to dramatic improvement in soil organic C and N contents and associated soil quality properties"); M. Sanderson, et al., *Diversification & Ecosystem Services For Conservation Agriculture: Outcomes From Pastures & Integrated Crop-Livestock Systems*, 28 RENEWABLE AGRIC. & FOOD SYS. 129 (2013); H. Asbjornsen, et al., *Targeting Perennial Vegetation in Agricultural Landscapes For Enhancing Ecosystem Services,* 29 RENEWABLE AGRIC. & FOOD SYS. 101 (2014).

[328] J. Tyndall, et al., *Field-Level Financial Assessment of Contour Prairie Strips for Enhancement of Environmental Quality*, 52 ENVTL. MGMT. 736 (2013).

[329] A. Davis, et al., *Increasing Cropping System Diversity Balances Productivity, Profitability & Environmental Health*, 7 PLoS ONE e47149 (2012).

[330] J. Hanson, et al., *supra note* 322, at 1894; *see also* J. Gillespie, et al., *Pasture-Based versus Conventional Milk Production: Where Is the Profit?*, 46 AGRIC. & APPLIED ECON. 543, 554 (2014) (net return over total cost was approximately $36,000 higher on pasture-based operations than matched conventional operations due to "higher gross value of milk production and lower operating expenses on pasture-based operations").

[331] J. Hanson, et al., *supra* note 322, at 1894, 1898; J. Gillespie & R. Nehring, *supra* note 330, at 552 ("total feed cost was lower on pasture-based operations [than confinement operations] on both per-cow and total expense bases"); *see also* J. Hanson, et al., *supra* note 322, at, 1899 (pasture-based operators "had higher cattle sales per cow than confinement operators" because "cows that are grazed have a longer productive life and [a lower] annual culling percentage for the herd"); CTR. FOR INTEGRATED AGRIC. SYS., PASTURED HEIFERS GROW WELL & HAVE PRODUCTIVE FIRST LACTATION (2013) ("heifers on managed pastures match the weights and age at first calving of their confined counterparts," and "outperformed the confinement heifers in terms of average daily gain during the pasture season and milk production in their first lactation").

[332] J. Hanson, et al., *supra* note 322, at 1900, 1901 ("Management-intensive grazing systems may also enhance the sustainability of small dairy operations by allowing entry of greater numbers of young farmers.").

[333] A. CRANE-DROESCH , ET AL., ERS, USDA, CLIMATE CHANGE & AGRICULTURAL RISK MANAGEMENT INTO THE 21ST CENTURY (2019) ("All climate scenarios considered suggest that climate change would lower domestic production of corn, soybeans, and wheat," suggesting that "prices would be higher than they would otherwise.").

Given these factors and benefits, pasture-based systems are the best system of emission reduction. Therefore, EPA should establish new source performance standards based on the methane reductions achievable with pasture-based dairy and hog production. EPA should also require states to do the same for existing sources within their borders by promulgating emission guidelines that identify pasture-based systems as the best system for reducing methane emissions from existing industrial dairy and hog sources.

2. Factory Farm Gas is a false solution.

The factory farm gas scheme – so-called biogas energy – recovers methane from anaerobic digestion of manure, produces dirty energy, and does not meet the best system of emission reduction. Industrial hog and dairy operations cannot achieve the maximum emission reduction with anaerobic digesters to produce biogas from decomposing liquefied manure.[334] Biogas recovery would not reduce enteric emissions, provide for carbon sequestration in soil, and would not reduce nitrous oxide emissions from manure land application, among other forgone GHG emissions reductions. Industrial hog and dairy operations' continued use of liquefied manure management systems will have adverse and long-lasting environmental, economic, and public health impacts.

i. *Factory Farm Gas has no place in a clean energy economy.*

Corporate conglomerates with an ownership interest in the oil and gas industry, and their allied industrial hog and dairy operations, tout so-called biogas as a cleaner and more environmentally friendly source of energy than fossil fuel gas, and the solution to reducing emissions, achieving full electrification, and fighting climate change.[335] These claims are not only false, but they are deliberately intended to safeguard the role of fossil gas in the transition from dirty fossil fuels (e.g., oil, coal, and natural gas) to clean zero-emission sources of energy (e.g., solar and wind). Some of the most vocal proponents of biogas are front groups for investor-owned utilities with an institutional interest in continuing the investment and use of fossil gas.[336] As stated by a dairy executive on record with the Guardian, however, biogas is not a realistic replacement for fossil gas because it is "'way too expensive' to use in homes or businesses" and "doesn't make all that much sense from an environmental standpoint."[337]

So-called biogas as BSER will increase reliance on dirty energy, delay the transition to clean renewable energy, and hinder ongoing efforts to meet emission reduction targets. A standard based on smaller herd sizes and pasture-based management systems will not only

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[334] This section focuses exclusively on biogas produced from the anaerobic decomposition of waste on industrial hog and dairy operations. For convenience, the section refers to manure-to-biogas systems as "biogas."

[335] *See, e.g.*, SOUTHERN CAL. GAS CO., *Biogas & Renewable Energy* (last accessed Mar. 11, 2020), https://www.socalgas.com/smart-energy/renewable-gas/biogas-and-renewable-natural-gas; DUKE ENERGY CORP., *Biogas: An Alternative Energy Source with a Bright Future* (last accessed Mar. 11, 2020), https://www.duke-energy.com/our-company/environment/renewable-energy/biopower.

[336] *See, e.g.*, S. Cagle, *U.S. Gas Utility Funds 'Front' Consumer Group To Fight Natural Gas Bans*, THE GUARDIAN (Jul. 26, 2019), https://www.theguardian.com/us-news/2019/jul/26/us-natural-gas-ban-socalgas-berkeley.

[337] *Id.*

achieve more methane emission reductions, but it will also recognize additional GHG reductions and environmental benefits.

Factory Farm Gas increases dependence on dirty fossil fuels.

So-called biogas is not a clean alternative to fossil fuels because biogas supplies cannot meet energy demand for buildings and vehicles. For example, the amount of biomethane potentially available in California from all sources would only meet 3 percent of the state's demand for natural gas.[338] Moreover, "[a]ssuming California could access up to its population-weighted share of the U.S. supply of sustainable waste-product biomass," biomethane "would not displace the necessary amount of building and industry fossil natural gas consumption to meet the state's long-term climate goals."[339] Likewise, switching to biofuel would not meet long-term targets for heavy duty truck emissions.[340]

Thus, because biogas can only supply a small fraction of total fuel needs, biogas increases reliance on dirty fossil fuels and undermines long-term climate goals. As one recent study in California concluded, one of the most effective and cost-efficient strategies for reducing GHG emissions by 80 percent by 2050 is "building electrification, which reduces the use of gas in buildings," *not* biomethane.[341] In addition, "electrification across all sectors, including in buildings, leads to significant improvements in outdoor air quality and public health."[342]

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[338] CAL. ENERGY COMMISSION (CEC), INTEGRATED ENERGY POLICY REPORT UPDATE, VOL. II, at 42 (Aug. 1, 2018) (concluding that biogas "is limited and at best could meet only 0.6 percent to 4.1 percent of California's total gas consumption"); CEC, BUILDING A HEALTHIER & MORE ROBUST FUTURE: 2050 LOW-CARBON ENERGY SCENARIOS FOR CALIFORNIA 59 (2019) (finding that transitioning to biofuels will not sufficiently reduce emissions to meet 2050 targets); UNION OF CONCERNED SCIENTISTS, THE PROMISES & LIMITS OF BIOMETHANE AS A TRANSPORTATION FUEL 2–3 (2017) (noting that "[i]ncreasing the number of [biofuel] vehicles in California could ultimately increase the state's consumption of natural gas").

Several states have made similar findings. *See, e.g.,* WASH. STATE UNIV., PROMOTING RENEWABLE NATURAL GAS IN WASH. STATE 34 (2018) (finding that biomethane or biofuel could potentially meet 3 to 5 percent of current natural gas consumption in Washington); OREGON DEP'T OF ENERGY, 2017 BIOGAS & RENEWABLE NATURAL GAS INVENTORY (2018) (finding that biomethane or biofuel could potentially meet 10 to 20 percent of natural gas consumption in Oregon).

[339] CEC, DEEP DECARBONIZATION IN A HIGH RENEWABLES FUTURE 33 (2018).

[340] CEC, BUILDING A HEALTHIER & MORE ROBUST FUTURE, *supra* note 338, at 59.

[341] CEC, NATURAL GAS DISTRIBUTION IN CALIFORNIA'S LOW-CARBON FUTURE: TECH. OPTIONS, CUSTOMER COSTS & PUB. HEALTH BENEFITS iii (2019).

[342] *Id.*; *see also* B. Zhao, et al., *Air Quality & Health Cobenefits of Different Deep Decarbonization Pathways in California*, 53 ENVTL. SCI. TECH. 7163 (2019) (finding that "a technology pathway focusing on electrification and clean renewable energy results in four times more health cobenefits than a pathway featuring combustible renewable fuel application").

Moreover, several states and cities across the United States have already started to phase out fossil fuel-based natural gas.[343]

Factory Farm Gas requires substantial investment in stranded assets.

So-called biogas is not economically viable. Farm owners and operators need a tremendous amount of capital to develop, operate, and maintain anaerobic digesters. Typically, farms need approximately $2 to $6 million to build an anaerobic digester, depending on the volume of manure the digester will process and other factors (e.g., location).[344] Because it is nearly impossible for most farms to generate enough revenue to cover upfront capital costs, farms must rely heavily on grants and public funds.[345] These investment costs do not include the upfront cost of constructing or connecting to a pipeline, which requires additional public funding or financing from utility rate-payers.

This infrastructure is not only expensive to construct, but also expensive to maintain and operate.[346] The profitability of the biogas system also depends on the ability to negotiate a contract or power purchase agreement with a utility company interested in purchasing the electricity output at a reasonable rate.[347] Moreover, the revenue potential is limited because the expected lifetime of a digester system is only 10 years, excluding the individual components, which often require more frequent maintenance and replacement (e.g., engines).[348]

In the climate and energy scenarios to meet IPCC reduction goals, these capital investments will become stranded assets when the economy shifts to non-combustion building and transportation solutions. The California Public Utilities Commission (CPUC) has, as a result, recently opened a proceeding to manage the transition from gas as an energy source.[349]

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[343] *See, e.g.*, CEC, INTEGRATED ENERGY REPORT, *supra* note 338, at 38–42 (describing California's efforts to transition from natural gas); Lauren Sommer, *San Francisco Proposes Natural Gas Ban, Following Other Bay Area Cities*, KQED (Sep. 24, 2019), https://www.kqed.org/science/1945656/trade-in-your-gas-stove-to-save-the-planet-berkeley-bans-natural-gas; Rick Sobey, *Brookline Bans Natural Gas, Heating Oil Pipes for New Buildings*, BOSTON HERALD (Nov. 21, 2019), https://www.bostonherald.com/2019/11/21/brookline-bans-natural-gas-heating-oil-pipes-for-new-buildings-gas-is-the-past.

[344] In 2019, the average cost for a publicly funded dairy digester project in California was $5.4 million. CAL. DEP'T OF FOOD & AGRIC. (CDFA), 2019 DAIRY DIGESTER RES. & DEV. PROGRAM: APPLICATIONS; *see also*

[345] *See id.* California offers dairies up to $3 million per project, so long as the applicant contributes at least 50 percent of total project cost in matching funds, which can come from private investors or another government funding program. CDFA, 2019 DAIRY DIGESTER RES. & DEV. PROGRAM: REQUEST FOR APPLICATIONS 6 (Dec. 8, 2018).

[346] *See* H. Lee & D. Sumner, *Dependence on Policy Revenue Poses Risks for Investments in Dairy Digesters*, 72 CAL. AGRIC. 226 (2018).

[347] *See* EPA, AGSTAR, *Project Financing* (last accessed Mar. 11, 2020), https://www.epa.gov/agstar/project-financing ("A utility contract or power purchase agreement has a major influence on the profitability of a project.").

[348] *See, e.g.*, PENN STATE UNIV. EXTENSION, *Agric. Anaerobic Digesters: Design & Operation* (Dec. 2016), https://extension.psu.edu/agricultural-anaerobic-digesters-design-and-operation.

[349] CPUC, Order Instituting Rulemaking to Establish Policies, Processes, & Rules to Ensure Safe & Reliable Gas Systems in California and Perform Long-Term Gas System Planning (Jan. 27, 2020).

EPA should not base its performance standard on farms paying out-of-pocket or obtaining public funding for false solutions that perpetuate resource-intensive industrial animal agriculture systems, increase climate change risks, and require substantial infrastructure investments with significant risk.

Factory Farm Gas increases emissions from industrial hog and dairy operations.

Proponents of so-called biogas claim that biogas is a "clean" energy because it captures methane emissions from liquefied manure decomposition for electricity or transportation fuel. However, liquefied manure decomposition is not a necessary part of hog or dairy production, and industrial hog and dairy operations can avoid these emissions by adopting a pasture-based model of production.[350] In other words, the industrial model is a production choice made by the operator and methane from liquefied manure does not reflect an inevitable waste product.

Instead of encouraging operators to eliminate or reduce emissions from liquefied manure management systems, biogas *increases* emissions from methane enteric emissions by incentivizing industrial hog and dairy operations to increase herd size to maximize methane production and cover the substantial cost of building and maintaining biogas infrastructure:

> [R]ather than avoiding methane generation altogether, [digesters] can actually create incentives to generate methane from manure. The more methane that is produced then converted to electricity or biogas, the higher the revenue for the digester operator . . . Especially in light of the [significant] financial strains that digester investment can bring about, this is a potential perverse incentive . . . ."[351]

As this Petition documents above, the industrial model of dairy and hog production evolved from the pasture-based model and represents a management decision to liquefy manure while maximizing herd size. This makes the methane from liquefied manure at industrial dairy and hog operations intentionally produced and that which would not otherwise occur as waste methane. In such a situation, corresponding methane leaks from biogas systems are additional, negate the climate benefits of methane capture and destruction, and must be factored into EPA's analysis.[352]

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[350] In pasture-based operations, manure management is only required when animals deposit manure in temporary or partial confinement areas, such as milking stations and walkways.

[351] CAL. CLIMATE & AGRIC. NETWORK, DIVERSIFIED STRATEGIES FOR REDUCING METHANE EMISSIONS FROM DAIRY OPERATIONS 3 (2015); *see also* M. Lauer et al., *Making Money from Waste: The Economic Viability of Producing Biogas & Biomethane in the Idaho Dairy Industry*, 222 APPLIED ENERGY 621 (2018) ("At least, 3000 cows per farm are needed for an economically feasible use of dairy manure for the production of biogas."); Z. Debruyn, et al., *Increased Dairy Farm Methane Concentrations Linked to Anaerobic Digester in a Five-Year Study*, 49 J. ENVTL. QUAL. 509 (2020) (methane emissions from biogas facility increased over time due "an increased use of food waste feedstocks").

[352] E. Grubert, *At Scale, Renewable Natural Gas Systems Could Be Climate Intensive: The Influence of Methane Feedstock & Leakage Rates*, 15 ENVTL. RES. LETTERS 084041 (2020).

Thus, biogas is not an effective emission reductions strategy because it encourages industrial operations to produce more manure as a biogas feedstock, which results in more GHGs and air pollutants in the atmosphere.

Factory Farm Gas increases emissions from electricity generation.

So-called biogas is dirty energy because generating electricity and heat from biogas increases emissions. To generate on-farm electricity, operators typically burn biogas with internal combustion engines, which emit significant criteria pollutants, including particulate matter, carbon monoxide, and sulfur dioxide.[353] Biogas combustion also emits ozone-forming criteria pollutants (i.e., nitrogen oxides (NOx)).[354] In fact, twenty biogas systems using internal combustion engines would emit as much ozone-forming (smog) NOx pollution as a modern natural gas-fired power plant, but generate only 4 percent of the electricity.[355]

Moreover, because some biogas producers are located in areas with existing air pollution problems, these emissions exacerbate pollution disparities and make local communities more vulnerable to climate change.[356] Thus, using biogas for electricity generation contributes to rising GHGs and climate change risks by increasing carbon dioxide and other localized criteria pollutants in the atmosphere.

Factory Farm Gas facilitates emissions from natural gas.

The limited amount of so-called biogas inherently means that fossil gas use will continue to hinder the transition to zero carbon energy. When operators upgrade biogas to biomethane, they can inject it into natural gas pipelines because it has the same composition as fossil natural gas.[357] As a result, there are no additional benefits to combusting biomethane mixed with natural gas. When the mixed gas is combusted as fuel, it enters the atmosphere as carbon dioxide, another greenhouse gas. Thus, the use of biomethane will perpetuate GHG emissions from fossil

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[353] CAL. STATE UNIV., FULLERTON, AIR QUALITY ISSUES RELATED TO USING BIOGAS FROM ANAEROBIC DIGESTION OF FOOD WASTE 1, 8–9 (2015).

[354] M. KOSUSKO, ET AL., AIR QUALITY, CLIMATE & ECON. IMPACTS OF BIOGAS MGMT. TECHNOLOGIES 1 (2016).

[355] Cal. Assembly Budget Subcomm. No. 3, Resources & Transportation, *Hearing Agenda*, at 17 (Apr. 19, 2017).

[356] *Id.*; M. KOSUSKO, ET AL., *supra* note 354, at 1, 2 fig.2; CAL. AIR RES. BD. (CARB), ASSESSMENT OF THE EMISSIONS & ENERGY IMPACTS OF BIOMASS & BIOGAS USE IN CALIFORNIA 1, 81 (Feb. 2015) ("[B]iopower production could increase NOx emissions by 10% in 2020, which would cause increases in ozone and PM concentrations in . . . areas . . . where ozone and PM concentrations exceed air quality standards constantly throughout the year"), 48–49, 100 (noting that "[i]ncreases in ozone . . . could seriously hinder the effort of air pollution control districts to attain ozone standards in areas like the Central Valley").

[357] N. WENTWORTH, A DISCUSSION ON THE FUTURE OF NATURAL GAS IN CALIFORNIA 3 (2018) ("For the case of [renewable natural gas or biomethane], methane is captured from sources that would typically emit the methane to the atmosphere and processes the methane into pipeline-quality natural gas to transport to the customer. Emissions from end-use combustion remain the same as do fugitive emissions from the in-state distribution of the gas.").

natural gas combustion.[358] Emissions reductions, not fuel substitution, must occur to meet GHG emissions reduction targets.

Further, when natural gas leaks before it reaches the end user, it enters the atmosphere as methane, a greenhouse gas far more potent than carbon dioxide. Therefore, methane leakage from production, transportation, storage, and distribution infrastructure will offset any emissions diverted by replacing oil and coal with natural gas derived from liquefied manure.[359] Likewise, the construction and maintenance of biogas infrastructure can also produce significant GHG emissions, which further offsets any purported benefits to fuel-switching.

In sum, biogas conflicts with climate goals because it requires continued use of fossil fuels, delays the transition to zero-carbon electricity, and contributes to rising GHGs and localized air pollution. Therefore, any standard that promotes biogas will waste significant time and resources, and stymie ongoing efforts to achieve emission reduction targets and other environmental benefits with electrification and clean renewable energy.[360] Unlike biogas, pasture-based systems do not prop up the continued combustion of fossil fuels. Thus, the best system of emissions reductions for methane emissions from industrial hog and dairy operations is pasture-based production systems.

ii. *Factory Farm Gas entrenches the industrial model of animal agriculture.*

In addition to conflicting with state and international goals to significantly reduce GHG emissions,[361] so-called biogas increases air and water pollution in communities with a disproportionately high pollution burden.

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[358] *Id.*; *see also* CEC, NATURAL GAS DISTRIBUTION IN CALIFORNIA, *supra* note 341 (noting that "the CO2 emissions from burning . . . renewable gasoline and biomethane . . . would have occurred anyway as the biomass decayed").

[359] *See* R. Alvarez, et al., *Greater Focus Needed on Methane Leakage from Natural Gas Infrastructure*, 109 PNAS 6435, 6436–37 (2012) (switching gasoline with compressed natural gas or biofuel would not reduce climate impacts unless the leakage rate of natural gas infrastructure was under 1.6%); E. Grubert, *supra* note 352, at 1 ("methane leakage from biogas production and upgrading facilities . . . is [anticipated to be] in the 2%–4% range"); T. Flesch, et al., *Fugitive Methane Emissions From An Agricultural Biodigester*, 35 BIOMASS & BIOENERGY 3927 (2011) ("average fugitive emission rate [of manure digester] corresponded to 3.1% of the CH_4 gas production rate"); *see also* CEC, NATURAL GAS DISTRIBUTION IN CALIFORNIA, *supra* note 341, at 8 ("non-combustion greenhouse gas emissions must be reduced, including [emissions from] methane leakage," to achieve reduction targets), 51 ("Remaining non-combustion GHG emissions include CO2 released during the production of cement" and "nitrous oxide resulting from the application of fertilizer . . . .").

[360] *See supra* note 343.

[361] *See* IPCC, GLOBAL WARMING OF 1.5°C, *supra* note 112; *see also* California's Executive Order S-3-05 (setting a target for 80% reduction in California's GHG emissions by 2050); New York's Climate Leadership & Community Protection Act, Art. 75, Sec. 75-0107 (requiring 85% reduction in New York's GHG emissions by 2050); Colorado's Climate Action Plan (requiring 90% reduction in GHG emissions by 2050); New Mexico's Energy Transition Act (requiring 100% reduction in GHG emissions by 2050); Press Release: Governor Whitmer Announces Bold Action to Protect Public Health & Create Clean Energy Jobs by Making Michigan Carbon-Neutral by 2050 (Sep. 23, 2020); Sierra Club, Map of U.S. Cities Committed to 100% Clean Energy.

Environmental & Public Health Impacts

So-called biogas increases methane emissions from enteric fermentation by incentivizing producers to increase the number of animals in confinement with low-quality diets.[362] Likewise, biogas dramatically increases ammonia emissions from liquefied manure management systems,[363] which leads to increased odor, fine particulate matter, and other negative impacts (e.g., ecosystem change).[364] Further, according to recent studies, biogas digestate storage emits significant amounts of volatile organic compounds, odorous pollutants, and hazardous air pollutants.[365]

By incentivizing increased manure generation and reliance on liquefied manure management systems, biogas also increases methane and nitrous oxide emissions from the subsequent disposal and land application of liquefied manure and wastewater on agricultural lands. In addition, biogas production increases the harmful soil and water impacts of nutrient loading and runoff by increasing the concentration of industrial dairy and hog operations in rural communities, and the amount of liquefied manure applied to nearby fields.[366]

Community Impacts

By incentivizing industrial dairy and hog operations to increase herd size and manure production, biogas threatens to exacerbate existing social and environmental inequities in communities with a high concentration of industrial hog and dairy operations.[367] Biogas significantly increases the pollution burden in the communities surrounding industrial hog and dairy operations, which already suffer from disproportionately high environmental, and public

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[362] According to several recent assessments, one of the most effective ways to reduce enteric methane emissions from hogs and dairy cows is to improve animal diets through high-quality forage feed, which is more nutritious and digestible than grain feed. *See* NSAC, AGRIC. & CLIMATE CHANGE, *supra* note 272, at 26 (explaining how changing the grain to forage ratio in dairy cows' diets can significantly reduce enteric methane emissions).

[363] *See* M. Holly, et al., *Greenhouse Gas & Ammonia Emissions from Digested & Separated Dairy Manure During Storage & After Land Disposal*, 239 AGRIC., ECOSYSTEMS & ENVIRONMENT 410, 417 (2017) (manure processed in anaerobic digesters had 81% more ammonia emissions than other manure management systems, "meaning that if [anaerobic digestion] is implemented at all dairies in the U.S., this could result in an increase of 143 Gg [ammonia] emissions per year").

[364] *See supra* notes 143 to 146.

[365] Y. Zhang, et al., *Characterization of Volatile Organic Compound Emissions from Swine Manure Biogas Digestate Storage*, 10 ATMOSPHERE 411 (2019) (biogas digestate storage emitted 49 compounds of VOCs, including 22 hazardous air pollutants listed by EPA and other odorous compounds)

[366] *See, e.g.*, M. Lauer, et al., *supra* note 351 ("[A]naerobic digestion cannot prevent the negative impact of nitrogen contamination imposed by concentrated livestock farming on water systems . . . ."); CARB, EVALUATION OF DAIRY MANURE MANAGEMENT PRACTICES FOR GHG EMISSIONS MITIGATION IN CALIFORNIA 70-71 (2016); *see also* C. Liu, et al., *Temporal Effects of Repeated Application of Biogas Slurry on Soil Antibiotic Resistance Genes & Their Potential Bacterial Hosts*, 258 ENVTL. POLLUTION 113652 (2020).

[367] *See supra* notes 64 (disproportionate impacts of industrial dairy operations), 83 (industrial hog operations), and 184 (climate change); *see also* J. Lenhardt, et al., *Environmental Injustice in the Spatial Distribution of CAFOs in Ohio*, 6 ENVLT. JUSTICE 133 (2013) ("[B]lack and Hispanic populations, as well as households with relatively low incomes, are disproportionately exposed to CAFOs [in Ohio.]").

health risks and socioeconomic vulnerabilities, because biogas combustion emits large amounts of localized air pollutants.[368] In addition, by enabling industrial hog and dairy operations to continue to rely on confinement production and liquefied manure management systems, such operations will continue to pose the greatest threat to local residents, wildlife, and natural resources.[369] Surrounding communities will also continue to suffer disproportionate economic and physical harm due to odors, pathogens, and other intolerable nuisance conditions caused by liquefied manure management and land application.[370] Thus, biogas production entrenches a highly polluting model of dairy and hog production with disparate impacts on frontline and vulnerable communities. And biogas production increasingly relies on the revenue from "offsets" or pollution trading scheme credits sold to entities that continue to emit GHGs and co-pollutants (e.g. an oil refinery, power plant, cement plant), which results in continued or increased pollution in often majority Black, Latino, or other communities. When pollution trading provides revenues for biogas operators, then communities on both sides of the transaction can suffer.

In sum, any standard that purports to reduce methane with biogas technology will not only increase emissions and endanger public health and welfare, but also entrench the use of manure lagoons and other industrialized animal production systems. Moreover, this technology does not address other problems associated with industrialized animal agriculture, including water pollution and the public health impacts of air pollution from these industrial operations on surrounding communities.

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[368] *See supra* notes 353 and 356; *see also* CARB, BIOGAS IMPACT REPORT, *supra* note 356, at 1 (describing how "biopower production" will increase air pollution "in large areas of the Central Valley where ozone and PM concentrations exceed air quality standards constantly throughout the year"); 100 ("Increases in ozone are localized around the biopower facilities and downwind areas," and "could seriously hinder the effort of air pollution control districts to attain ozone standards in areas like the Central Valley . . . .").

[369] *See supra* Part IV.B.

[370] *See supra* note 367; *see also* S. Wing, et al., *Odors from Sewage Sludge & Livestock: Associations with Self-Reported Health*, 129 PUBLIC HEALTH REPORTS 505 (2014) (residents near manure application sites have reduced quality of life due to excessive pests and odors).

CONCLUSION

EPA must add industrial dairy and hog operations to its list of categories of stationary sources under section 111 of the Clean Air Act because these source categories satisfy the requisite standard. Accordingly, within one year of listing industrial dairy and hog operations, EPA must initiate a rulemaking to implement standards of performance and emission guidelines to reduce methane emissions from new and existing sources within these sources categories. Further, EPA will be able to fulfill its statutory responsibility to promulgate such standards based on pasture-based dairy and hog farms as the Best System of Emissions Reduction.

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