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Rebutting 33 False Claims About Solar, Wind, and Electric Vehicles

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Columbia Law School | Columbia Climate School
Sabin Center for Climate Change Law

The Sabin Center for Climate Change Law develops legal techniques to fight climate change, trains law students and lawyers in their use, and provides the legal profession and the public with up-to-date resources on key topics in climate law and regulation. It works closely with the scientists at Columbia University's Climate School and with a wide range of governmental, non-governmental and academic organizations.

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INTRODUCTION

Getting the U.S. energy system onto an environmentally sustainable track will require rapid and widespread development of wind, solar, and other renewable energy facilities; corresponding storage, transmission, and distribution infrastructure; and timely industry-specific transitions, such as battery electric vehicles replacing their combustion-engine counterparts. Broad public support exists for transformative climate policies, with a June 2023 Pew Research Center survey finding that 67% of U.S. adults prioritize developing renewable energy sources over increased fossil fuel production.[1] However, "misinformation" and coordinated "disinformation" have at times undermined support for renewable energy projects and electric vehicles.[2] This report addresses some of the more prevalent and persistent distortions about solar energy, wind energy, and electric vehicles, with the aim of promoting a more informed discussion.[3]

While the impact of misinformation and disinformation can be difficult to measure, alarming data has begun to emerge. A Monmouth University poll found, for instance, that support in New Jersey for offshore wind farms had declined from 76% in 2019, to 54% by August 2023.[4] This shift is likely due, in large part, to dubious claims, some of them coming from fossil-fuel funded opposition groups, which have attempted to blame wind farm surveys for recent spikes in whale deaths off the United States' northeastern coast.[5] More generally, both nationwide and in communities on the front lines of our energy transition, anecdotal doubts and coordinated disinformation efforts have dampened public enthusiasm for ambitious renewables infrastructure, particularly among concentrated segments of our polarized population. For example, support for offshore wind among New Jersey Republicans dropped from 69% to 28% from 2019 to August 2023, while support among New Jersey Democrats only dropped from 79% to 76%.[6]

False claims about renewable energy come in many varieties. Some claims rely on sheer bombast, seemingly designed to shock and inflame audiences, rather than contribute to informed debate on pressing policy choices ("Solar farms depend entirely on subsidies from your hard earned money. When the subsidies are gone, the solar farms are abandoned!").[7] Some emphasize theoretical impacts of poorly-designed

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[1] Brian Kennedy, Cary Funk & Alec Tyson, *Majorities of Americans Prioritize Renewable Energy, Back Steps to Address Climate Change*, PEW RESEARCH CENTER, June 28, 2023, https://www.pewresearch.org/science/2023/06/28/majorities-of-americans-prioritize-renewable-energy-back-steps-to-address-climate-change/.

[2] *See Misinformation and disinformation*, AM. PSYCHOLOGICAL ASSOC., https://www.apa.org/topics/journalism-facts/misinformation-disinformation (last visited March 25, 2024) (explaining the distinction between misinformation and disinformation); ANAHI AYALA IACUCCI, USING SOCIAL MEDIA IN COMMUNITY-BASED PROTECTION at 230 (2021), https://www.unhcr.org/innovation/wp-content/uploads/2021/01/Using-Social-Media-in-CBP.pdf (same).

[3] The authors recognize that similar misinformation persists regarding energy transmission infrastructure, the buildout of which is necessary to support the expansion of renewable energy generation and electric vehicle adoption, but transmission is outside the scope of this report. *See* LU NELSEN, FROM THE GROUND UP: ADDRESSING KEY COMMUNITY CONCERNS IN CLEAN ENERGY TRANSMISSION at 10, 12, 15-16 (2013), https://perma.cc/ENA2-S3DW; *See Queued Up . . . But in Need of Transmission,* DEP'T OF ENERGY, Apr. 2022, https://www.energy.gov/sites/default/files/2022-04/Queued%20Up%E2%80%A6But%20in%20Need%20of%20Transmission.pdf.

[4] Monmouth University Poll, *Support for Wind Energy Plunges*, MONMOUTH UNIVERSITY, Aug. 29, 2023, https://www.monmouth.edu/polling-institute/documents/monmouthpoll_nj_082923.pdf/.

[5] Tracey Tully & Winston Choi-Schagrin, *Why 23 Dead Whales Have Washed Up on the East Coast Since December*, N.Y. TIMES, Feb. 28, 2023, https://www.nytimes.com/2023/02/28/nyregion/east-coast-whale-deaths.html.

[6] *See* Monmouth University Poll, *supra* note 4.

[7] *How Solar Affects YOU!*, NO TO SOLAR, https://perma.cc/63GB-ZQ3B (last visited March 25, 2023).

renewable energy projects while ignoring the many well-established methods to minimize or even eliminate those impacts[8] ("[I]ndustrial-scale solar isn't right for rural-agricultural areas . . . [because] [t]he land (forest, farmland, vegetation, soil) is forever destroyed.").[9] Some frame any departure from the status quo, such as the use of farmland for solar production, as categorically inconceivable ("Ask yourself, if several thousand acres of agricultural land is converted to industrial solar facilities, who will grow your food? Bill Gates? Mark Zuckerberg?").[10] Some rely on unsubstantiated theories of causation, such as speculation that whale deaths stem from noise related to wind farm surveys, despite the fact that marine biologists have found that the sounds during offshore wind surveying are similar "to the sound of a fan in a room."[11] Some drill down with single-minded focus on the toxicity or carbon footprint of renewable energy infrastructure or its component parts,[12] while declining to acknowledge that fossil fuel extraction, production, and distribution cause far greater environmental contamination, harm to human health, and climate instability.[13]

This report does not examine the origins of the false claims or the motivations of those who disseminate them. However, it is well documented that much of it comes from deliberately misleading sources, such as astroturf "local" organizations funded by distant policy advocates, themselves funded by fossil-fuel producers.[14] Other researchers, including Brown University's Climate and Development Lab, have extensively mapped out some of these connections in the context of opposition to offshore wind development.[15]

Ultimately, an honest reckoning with what will be required to address the climate crisis requires a fact-based evaluation of the best available pathways to avoid the worst-case scenarios. Renewable energy and its offshoots can significantly reduce climate threats, improve public health, and provide jobs for millions of Americans. The authors designed this report so that, despite the longevity of long-since-debunked misinformation, members of the public, and particularly residents of communities contemplating utility-scale renewable energy projects, can cultivate balanced and informed opinions.

With that context, this report identifies and examines 33 of the most pervasive misconceptions about solar energy, wind energy, and electric vehicles. The false claims about each of these technologies are presented roughly in the following order: misconceptions pertaining to human health, then misconceptions pertaining to environmental impacts, then misconceptions pertaining to economic impacts, and then other

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[8] *See, etc.,* BILL PEDERSON & BROOKS LAMB, AGRIVOLTAICS: PRODUCING SOLAR ENERGY WHILE PROTECTING FARMLAND (2021), https://cbey.yale.edu/sites/default/files/2021-10/CBEY_REPORTS_AGRIVOLTAICS_FINAL_0.pdf; BIODIVERSITY CONSULTANCY, MITIGATING BIODIVERSITY IMPACTS ASSOCIATED WITH SOLAR AND WIND ENERGY DEVELOPMENT (2021), https://portals.iucn.org/library/sites/library/files/documents/2021-004-En.pdf.

[9] *10 Reasons Industrial-Scale Solar Isn't Right for Agricultural-Rural Areas*, CITIZENS FOR RESPONSIBLE SOLAR, https://perma.cc/PYC8-SRPJ (last visited March 25, 2024).

[10] *Welcome to No Solar in Logan County (Ohio)*, NO SOLAR IN LOGAN COUNTY (OHIO), https://perma.cc/P45M-W5NF (last visited March 25, 2024).

[11] Pearl Marvell, *Wind Opponents Spread Myth about Dead Whales*, YALE CLIMATE CONNECTIONS, Sept. 19, 2023, https://yaleclimateconnections.org/2023/09/wind-opponents-spread-myth-about-dead-whales/.

[12] NO TO SOLAR, *supra* note 7.

[13] *See* Hannah Ritchie, *What are the safest and cleanest sources of energy?*, OUR WORLD IN DATA, Feb. 10, 2020, https://ourworldindata.org/safest-sources-of-energy.

[14] David Gelles, *The Texas Group Waging a National Crusade Against Climate Action*, N.Y. TIMES, Dec. 4, 2022, https://www.nytimes.com/2022/12/04/climate/texas-public-policy-foundation-climate-change.html; Marvell, *supra* note 11.

[15] ISAAC SLEVIN ET AL., CLIMATE AND DEVELOPMENT LAB, AGAINST THE WIND: A MAP OF THE ANTI-OFFSHORE WIND NETWORK IN THE EASTERN UNITED STATES (2023), https://drive.google.com/file/d/1a64hVMlqRs4p_a39l2O-g9LSERk7GBb0/view.

misconceptions that do not fit into any of these categories.[16] To identify the most common misconceptions regarding renewables and electric vehicles, the authors first conducted primary research that included reviewing social-media groups and websites created to oppose renewable energy projects or policies, as well as existing press coverage about misinformation.[17] The authors then developed transparent, fact-based responses to these misconceptions, relying to the greatest extent possible on academic literature and government publications. The authors would like to thank Eric Larson, Charles Kutscher, Aniruddh Mohan, and David Gahl for reviewing these responses for technical accuracy. The authors would also like to thank Achyuth Anil and Miguel Severino for their assistance in preparing the report. Any errors that remain are the authors' own. Because each of these responses is designed to stand on its own, there is some repetition in content from one response to the next.

Importantly, this is not the first publication to attempt to debunk or contextualize dubious claims about clean energy. Below is a short, non-comprehensive list of other efforts to clarify misinformation and disinformation pertaining to renewable energy and electric vehicles:

- The United States Environmental Protection Agency's breakdown of "electric vehicle myths."[18]
- RMI's *Reality Check: The IEA Busts 10 Myths about the Energy Transition.*[19]
- USA Today's *Do wind turbines kill birds? Are solar panels toxic? The truth behind green-energy debates*.[20]
- Carbon Brief's factchecks on electric vehicles and renewable energy, including: *Factcheck: How electric vehicles help to tackle climate change*;[21] *Factcheck: 21 misleading myths about electric vehicles*;[22] and *Factcheck: Is solar power a 'threat' to UK farmland?*.[23]
- The Center for American Progress's *The Truth About Offshore Wind: Busting Oil Money Myths and Misinformation*.[24]

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[16] The dividing line among these categories is often blurry: for example, climate change has impacts on human health, the non-human environment, and the economy.

[17] *See, e.g.*, NO TO SOLAR, *supra* note 7*;* NO SOLAR IN LOGAN COUNTY (OHIO), *supra* note 10; DEFIANCE COUNTY CITIZENS FOR RESPONSIBLE SOLAR, https://www.defiancecountycitizensforresponsiblesolar.com/ (last visited March 25, 2024); Windmills Kill, https://windmillskill.com/ (last visited March 25, 2024); *Solar*, ALLIANCE FOR WISE ENERGY DECISIONS, https://wiseenergy.org/solar/ (last visited March 25, 2024); *Letters: America Decides to Make Its Electrical Grid Dysfunctional*, WALL STREET JOURNAL, June 12, 2022, https://www.wsj.com/articles/electric-grid-energy-green-blackout-generator-renewable-solar-wind-11654900508. *See also, e.g.*, Julia Simon, *Misinformation is derailing renewable energy projects across the United States*, NPR, Mar. 28, 2022, https://www.npr.org/2022/03/28/1086790531/renewable-energy-projects-wind-energy-solar-energy-climate-change-misinformation.

[18] *Electric Vehicle Myths*, ENVT'L PROTECTION AGENCY, https://www.epa.gov/greenvehicles/electric-vehicle-myths (last updated Aug. 28, 2023).

[19] Kingsmill Bond & Sam Butler-Sloss, *Reality Check: The IEA Busts 10 Myths about the Energy Transition*, RMI, Sept. 29, 2023, https://rmi.org/reality-check-the-iea-busts-10-myths-about-the-energy-transition/.

[20] Elizabeth Weise, *Do wind turbines kill birds, Are solar panels toxic? The truth behind green-energy debates*, USA TODAY, Feb. 4, 2024 (updated Feb. 6, 2024), https://www.usatoday.com/story/news/investigations/2024/02/04/green-energy-fact-checked/72390472007/.

[21] Zeke Hausfather, *Factcheck: How electric vehicles help to tackle climate change*.[21], CARBONBRIEF, May 13, 2019, https://www.carbonbrief.org/factcheck-how-electric-vehicles-help-to-tackle-climate-change/.

[22] Simon Evans, *Factcheck: 21 misleading myths about electric vehicles*, CARBONBRIEF, Oct. 24, 2023, https://www.carbonbrief.org/factcheck-21-misleading-myths-about-electric-vehicles/.

[23] Josh Gabbatis et al., *Factcheck: Is solar power a 'threat' to UK farmland?*, CARBONBRIEF, Aug. 25, 2022, https://www.carbonbrief.org/factcheck-is-solar-power-a-threat-to-uk-farmland/.

[24] Michael Freeman, *The Truth About Offshore Wind: Busting Oil Money Myths and Misinformation*, CENTER FOR AMERICAN PROGRESS, June 6, 2023, https://www.americanprogress.org/article/the-truth-about-offshore-wind-busting-oil-money-myths-and-misinformation/.

- The Annenberg Public Policy Center's website FactCheck.org, which includes factchecks on climate change related topics,[25] including electric vehicles.[26]
- The Brown Climate and Development Lab's *Discourses of Climate Delay in the Campaign Against Offshore Wind: A Case Study from Rhode Island.*[27]
- Emily Atkin's *A guide to electric car misinformation*.[28]

This publication aims to build on these other reports and should be read in conjunction with them.

[25] *See Issues: climate change*, FACTCHECK.ORG, https://www.factcheck.org/issue/climate-change/ (last visited March 25, 2024).

[26] *See* D'Angelo Gore et al., *Trump's Misleading Claims About Electric Vehicles and the Auto Industry*, FACTCHECK.ORG, Oct. 2, 2023, https://www.factcheck.org/2023/10/trumps-misleading-claims-about-electric-vehicles-and-the-auto-industry/; Catalina Jaramillo, *Electric Vehicles Contribute Fewer Emissions than Gasoline-Powered Cars Over Their Lifetimes*, FACTCHECK.ORG, Feb. 7, 2024, https://www.factcheck.org/2024/02/electric-vehicles-contribute-fewer-emissions-than-gasoline-powered-cars-over-their-lifetimes/.

[27] DISCOURSES OF CLIMATE DELAY IN THE CAMPAIGN AGAINST OFFSHORE WIND: A CASE STUDY FROM RHODE ISLAND, BROWN CLIMATE AND DEVELOPMENT LAB (April 2023), https://ecori.org/wp-content/uploads/2023/04/delay_and_misinformation_tactics_in_anti_osw_campaigns-ri_case_study_4-10-23.pdf.

[28] Emily Atkin, *A guide to electric car misinformation (part 1)*, HEATED, March 27, 2024, https://heated.world/p/a-guide-to-electric-car-misinformation.

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PART A: FALSE CLAIMS ABOUT SOLAR ENERGY (#1–#14)

1. PART A: FALSE CLAIMS ABOUT SOLAR ENERGY (#1-#14)

False Claim #1: Electromagnetic fields from solar farms are harmful to human health.

> *"The EMF (electromagnetic field) from solar farms poses serious health risks especially to those who have electromagnetic hypersensitivity."*[29]

The electromagnetic fields generated at a solar farm are similar in strength and frequency to those of toaster ovens and other household appliances—and harmless to humans. A detailed analysis from North Carolina State University concluded that there is "no conclusive and consistent evidence" of "negative health impact[s] from the EMF [electromagnetic fields] produced in a solar farm."[30]

EMF exposure levels vary according to the EMF source, proximity to the source, and duration of the exposure.[31] On a solar farm, EMFs are highest around electrical equipment such as inverters. However, even when standing next to the very largest inverter at a utility-scale solar farm, one's exposure level (up to 1,050 milligauss, or mG) is less than one's exposure level while operating an electric can opener (up to 1,500 mG), and well within accepted exposure limits (up to 2,000 mG).[32] When standing just nine feet from a residential inverter, or 150 feet from a utility-scale inverter, one's exposure drops to "very low levels of 0.5 mG or less, and in many cases . . . less than background levels (0.2 mG)."[33] For comparison, a typical American's average background exposure level is 1mG, reaching 6 mG when standing three feet from a refrigerator, and 50 mG when standing three feet from a microwave.[34]

The electromagnetic fields present on a solar farm constitute "non-ionizing radiation," which, by definition, generates "enough energy to move atoms in a molecule around (experienced as heat), but not enough energy to remove electrons from an atom or molecule (ionize) or to damage DNA."[35] In addition, EMFs are extremely low in frequency, which means they contain "less energy than other commonly encountered types of non-ionizing radiation like radio waves, infrared radiation, and visible light."[36]

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[29] NO TO SOLAR, *supra* note 7.
[30] Tommy Cleveland, *Health and Safety Impacts of Solar Photovoltaics*, NC STATE UNIVERSITY, 14 (May 2017), https://nccleantech.ncsu.edu/wp-content/uploads/2019/10/Health-and-Safety-Impacts-of-Solar-Photovoltaics-PV.pdf.
[31] *Id.* at 15.
[32] *Id.*; Massachusetts Department of Energy Resources et al., *Questions & Answers: Ground-Mounted Solar Photovoltaic Systems*, 10-11 (Jun. 2015), http://www.mass.gov/eea/docs/doer/renewables/solar/solar-pv-guide.pdf.
[33] Tommy Cleveland, *supra* note 30 at 15.
[34] *Id.*; Massachusetts Clean Energy Center, *Study of Acoustic and EMF Levels from Solar Photovoltaic Projects* (Dec. 2012), http://www.co.champaign.il.us/CountyBoard/ZBA/2018/180329_Meeting/180329_Massachusetts%20Acoustic%20Study%20for%20PV%20Solar%20Projects.pdf.
[35] Tommy Cleveland, *supra* note 30, at 16.
[36] *Id.* at 15.

False Claim #2: Toxic heavy metals, such as lead and cadmium, leach out from solar panels and pose a threat to human health.

> *"Studies have shown the heavy metals in solar panels namely lead and cadmium, can leach out of the cells and get into groundwater, as well as affect plants."*[37]

Roughly 40% of new solar panels in the United States and 5% of new solar panels in the world contain cadmium,[38] but this cadmium is in the form of cadmium telluride, which is non-volatile, non-soluble in water, and has 1/100th the toxicity of free cadmium.[39] Most solar panels, like many electronics, contain small amounts of lead.[40] However, the Massachusetts Department of Energy Resources (DER) has assessed that "because PV panel materials are enclosed, and don't mix with water or vaporize into the air, there is little, if any, risk of chemical releases to the environment during normal use."[41] The Massachusetts DER has further assessed that, even in the unlikely event of panel breakage, releases of chemicals used in solar panels are "not a concern."[42]

All materials in a solar panel are "insoluble and non-volatile at ambient conditions," and "don't mix with water or vaporize into air."[43] Moreover, they are encased in tempered glass that not only withstands high temperatures, but is also strong enough to pass hail tests and is regularly installed in Arctic and Antarctic conditions.[44] It is theoretically possible that, when exposed to extremely high heat exceeding that of a typical residential fire, panels "could emit vapors and particulates from PV panel components to the air." But that risk is limited by the fact that "the silicon and other chemicals that comprise the solar panel would likely bind to the glass that covers the PV cells and be retained there."[45] When a cadmium telluride panel is exposed to fire of an intensity sufficient to melt the glass on the panel, "over 99.9% of the cadmium [is encapsulated in] the molten glass."[46] Furthermore, a 2013 analysis found that, even in the worst-case scenarios of earthquakes, fires, and floods, "it is unlikely that the [cadmium] concentrations in air and sea water will exceed the environmental regulation values."[47]

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[37] Emily Chantiri, *The Dark Side of Renewable Technology: Fossil Fuels Are Used to Produce Solar Panels*, AUSTRALIAN COMPUTER SOCIETY (Feb. 2, 2023), https://ia.acs.org.au/article/2023/the-dark-side-of-renewable-technology.html.
[38] *Polycrystalline Thin-Film Research: Cadmium Telluride*, NAT'L RENEWABLE ENERGY LABORATORY, May 2022, https://www.nrel.gov/docs/fy21osti/76975.pdf; *Taking Cadmium Telluride Technology to the Next Level*, US-MAC, https://www.usa-cdte.org/ (last visited March 25, 2024).
[39] *Health and Safety Impacts of Solar Photovoltaics* at 7*,* NC CLEAN ENERGY TECHNOLOGY CENTER, May 2017, https://content.ces.ncsu.edu/health-and-safety-impacts-of-solar-photovoltaics.
[40] Mark Hutchins, *The weekend read: A lead-free future for solar PV*, PV MAGAZINE, Oct. 26, 2019, https://www.pv-magazine.com/2019/10/26/the-weekend-read-a-lead-free-future-for-solar-pv/.
[41] Massachusetts Department of Energy Resources et al., *supra* note 32 at 5.
[42] *Id.*
[43] *Id.*
[44] *Id.*
[45] *Id.*
[46] NC CLEAN ENERGY TECHNOLOGY CENTER, *supra* note 39 at 7.
[47] Yasunari Matsuno, *Environmental risk assessment of CdTe PV systems to be considered under catastrophic events in Japan*, FIRST SOLAR, Dec. 1, 2013, https://www.firstsolar.com/-/media/First-Solar/Sustainability-Documents/Sustainability-Peer-Reviews/Japan_Peer-Review_Matsuno_CdTe-PV-Tsunami.ashx.

One peer-reviewed study in the *Journal of Natural Resources and Development* found it unlikely for lead or cadmium to leach into the soil from functional solar panels.[48] Measuring heavy metal concentrations in the soil at various distances, researchers found no significant differences in lead or cadmium concentrations directly underneath solar panels, compared to soil 45 or 100 feet away.[49] The study further found that "lead and cadmium were not elevated in soils near PV systems and were far below levels considered to be an imminent or future danger to environmental health."[50]

Although the study did find higher levels of selenium in soil directly underneath solar panels, the study noted that the presence of selenium was possibly a "result of the cement used in construction," rather than leaching from the panels themselves.[51] In addition, the study noted that even the highest selenium concentrations observed were below the EPA's risk threshold for mammals.[52] Finally, the study noted that fly ash, a product of coal combustion "commonly disposed of in landfills and as a soil amendment in agriculture," contains significantly higher concentrations of lead (40x), cadmium (1.1x) and selenium (4x) than the soil samples taken directly underneath the solar panels in the study area.[53]

False Claim #3: Solar panels generate too much waste and will overwhelm our landfills.

"Solar panels pose a huge risk for overfilling the landfills."[54]

The amount of waste that solar panels are expected to generate over the next few decades is trivial compared to the amount of waste that will be generated by fossil fuels. A study published in Nature Physics in October 2023 found that "35 years of cumulative PV module waste (2016-2050) is dwarfed by the waste generated by fossil fuel energy and other common waste streams." Specifically, the study found that "if we do not decarbonize and transition to renewable energy sources, coal ash and oily sludge waste generated by fossil fuel energy would be 300-800 times and 2-5 times larger [in mass], respectively, than PV module waste."[55]

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[48] Seth A. Robinson et al., *Potential for leaching of heavy metals and metalloids from crystalline silicon photovoltaic systems*," 9 J. NAT. RES. AND DEV. 19, 21 (2019), https://doi.org/10.5027/jnrd.v9i0.02.
[49] *Id.* at 21-22.
[50] *Id.*; U.S. Environmental Protection Agency, *Ecological Soil Screening Level* (2018), https://www.epa.gov/chemical-research/ecological-soil-screening-level (last updated May 3, 2023).
[51] Robinson et al., *supra* note 48, at 21-22.
[52] *Id.*
[53] *Id.*
[54] NO TO SOLAR, *supra* note 7.
[55] Heather Mirletz et al., *Unfounded concerns about photovoltaic module toxicity and waste are slowing decarbonization*, NATURE PHYSICS, October 2023, https://www.nature.com/articles/s41567-023-02230-0.

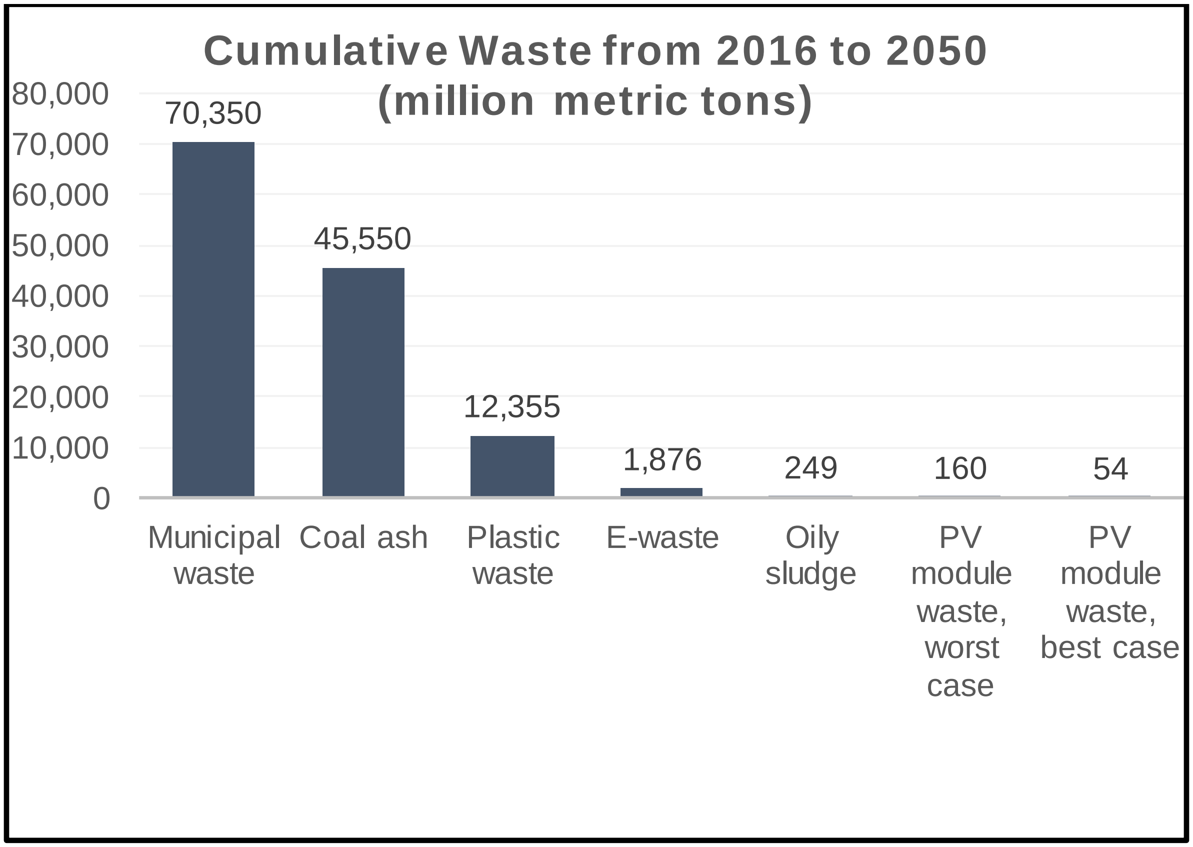

Figure 1: PV module waste from 2016-2050 compared to other sources of waste.
Source: The Sabin Center for Climate Change Law (visualizing data from Heather Mirletz et al.).[56]

In addition, although only about 10% to 15% of solar panels are recycled in the United States,[57] the U.S. Department of Energy has awarded funding under the Infrastructure Investment and Jobs Act for additional research and development for solar technology recycling.[58] A 2024 study on solar PV recycling concluded that "PV recycling will reduce waste, and CO2 emissions, while contributing to a sustainable environment," and that "[i]t is expected that the research for efficient PV recycling strategies will accelerate as the PV industry grows and as many more organizations and government work towards a sustainable future."[59]

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[56] *Id.*
[57] Allyson Chu, *Scientists found a solution to recycle solar panels in your kitchen*, WASH. POST (Jul. 5, 2023), https://www.washingtonpost.com/climate-solutions/2023/07/05/solar-panel-recycling-microwave-technology/#.
[58] *Solar Recycling Research & Development*, OFFICE OF ENERGY EFFICIENCY & RENEWABLE ENERGY, DEP'T OF ENERGY, https://www.energy.gov/eere/solar-recycling-research-development (last visited March 26, 2024).
[59] Zita Ngagoum Ndalloka et al., *Solar photovoltaic recycling strategies*, 270 Solar Energy 112379 (March 2024), at 9-10, https://www.sciencedirect.com/science/article/pii/S0038092X24000732.

Already, some companies have been able to recover 90% of solar panels' mass in their recycling processes.[60] Bulk materials such as glass, steel, and aluminum are recoverable through existing recycling lines,[61] while certain semiconductor materials (tellurium and cadmium) can also be recovered at very high rates of 95% to 97%.[62] Valuable materials in the panels, including silver, copper, and crystalline silicon, are actively sought for the development of other products, including the next generation of solar panels.[63] In addition, new companies are emerging with innovative technologies to recycle solar panels.[64]

False Claim #4: Clearing trees for solar panels negates any climate change benefits.

> *"It isn't 'green' to cut down thousands of acres of trees to build large solar plants. Trees remove carbon from the atmosphere and slow global warming. Deforestation contributes to climate change."*[65]

Forests have immense ecological benefits, recreational benefits, and intrinsic value. However, when looking at the narrow but important issue of carbon accounting, it is usually not true that removing trees to build a solar farm negates any emissions reductions from solar generation. In fact, an acre of solar panels in the United States usually offsets significantly more carbon dioxide emissions than an acre of planted trees can sequester.

In the United States, the emissions intensity of electricity produced by natural gas-fired power plants is roughly 1,071 pounds of carbon dioxide per megawatt-hour (MWh).[66] The emissions intensity of solar PV, meanwhile, is about 95 pounds per MWh, a difference of 976 pounds per MWh compared to natural gas.[67] According to a 2022 *Journal of Photovoltaics* study, utility-scale solar power produces between 394 and 447 MWh per acre per year.[68] When displacing electricity from natural gas, an acre of solar panels, producing zero-emissions electricity would therefore save between 385,000 to 436,000 pounds, or 175 to 198 metric tons, of carbon dioxide per year.

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[60] M.M. Aman, et al., *A review of Safety, Health and Environmental (SHE) issues of solar energy system*, 41 RENEWABLE AND SUSTAINABLE ENERGY REVIEWS 1190 (2015), https://doi.org/10.1016/j.rser.2014.08.086.

[61] Garvin A. Heath, *Research and Development Priorities for Silicon Photovoltaic Module Recycling to Support a Circular Economy*, 5 NATURE ENERGY 502, 503 (2020), https://doi.org/10.1038/s41560-020-0645-2; U.S. DEP'T OF ENERGY, OFFICE OF ENERGY EFFICIENCY & RENEWABLE ENERGY, SOLAR ENERGY TECHNOLOGIES OFFICE, PHOTOVOLTAICS END-OF-LIFE ACTION PLAN 11 (2022), https://www.energy.gov/sites/default/files/2023-10/SETO-PV-End-of-Life-Action-Plan-1.pdf.

[62] Md. Shahariar Chowdhury et al., *An overview of solar photovoltaic panels' end-of-life material recycling*, 27 ENERGY STRAT. REVIEWS 100431, 100437 (2020), https://doi.org/10.1016/j.esr.2019.100431.

[63] Jon Hurdle, *As Millions of Solar Panels Age Out, Recyclers Hope to Cash In*, YALE ENV'T. 360 (Feb. 28, 2023), https://e360.yale.edu/features/solar-energy-panels-recycling.

[64] *Id.*

[65] *5 Things You Need to Know About Solar*, CITIZENS FOR RESPONSIBLE SOLAR, https://perma.cc/VE5H-U33V (last visited March 25, 2024).

[66] Nat'l Renewable Energy Laboratory, *Life Cycle Greenhouse Gas Emissions from Electricity Generation: Update* (Sept. 2021) (Table 1), https://www.nrel.gov/docs/fy21osti/80580.pdf. NREL calculates emissions intensity using grams of carbon dioxide equivalent per kilowatt-hour.

[67] *Id.*

[68] Mark Bolinger and Greta Bolinger, *Land Requirements for Utility-Scale PV: An Empirical Update on Power and Energy Density*, 12 IEEE J. VOLTAICS 589, 593 (2022), https://www.doi.org/10.1109/JPHOTOV.2021.3136805.

By comparison, according to the EPA, an average acre of U.S. forest sequesters 0.857 metric tons of carbon dioxide per year.[69] Thus, an average acre of solar panels in the United States reduced approximately 204–231 times more carbon dioxide per year than an acre of forest.

Furthermore, while removing trees from forests releases stored carbon, such emissions can be offset by solar energy generation and the resulting reduction in fossil fuel-driven emissions. The EPA has estimated the average acre of forests contains 83 metric tons of carbon, and approximately half of that amount is sequestered in soil.[70] Even assuming that all 83 metric tons of carbon (comprising 304 metric tons of carbon dioxide)[71] were released when building a solar farm on an acre of forested land, those emissions could be offset within two years of operation of a typical solar farm.[72] Finally, to put the threat to forests in context, only about 4% of solar projects in the United States are being sited on currently-forested lands.[73]

False Claim #5: Solar energy is worse for the climate than burning fossil fuels.

"It is likely that solar farms are making climate change worse."[74]

There is overwhelming evidence that the lifecycle emissions[75] of solar energy are far lower than those of all fossil fuel sources, including natural gas.[76] On average, it takes only three years after installation for a solar panel to offset emissions from its production and transportation.[77] Modern solar panels have a functional lifecycle of 30–35 years, allowing more than enough time to achieve carbon neutrality and generate new emissions-free energy.[78]

A National Renewable Energy Laboratory (NREL) report released in 2021 examined "approximately 3,000 published life cycle assessment studies on utility-scale electricity generation from wind, solar photovoltaics, concentrating solar power, biopower, geothermal, ocean energy, hydropower, nuclear, natural gas, and coal technologies, as well as lithium-ion

[69] *Greenhouse Gas Equivalencies Calculator – Revision History*, U.S. ENV'T PROT. AGENCY, https://www.epa.gov/energy/greenhouse-gas-equivalencies-calculator-revision-history (last visited March 26, 2024).
[70] *Greenhouse Gas Equivalencies Calculator – Calculations and References*, U.S. ENV'T PROT. AGENCY, https://www.epa.gov/energy/greenhouse-gases-equivalencies-calculator-calculations-and-references (last visited March 26, 2024).
[71] EPA's Greenhouse Gases Equivalencies Calculator explains that, to convert carbon density to carbon dioxide density, metric tons of carbon should be multiplied by the ratio of the molecular weight of carbon dioxide to that of carbon (44/12). *Id.*
[72] This calculation is based on the fact that an acre of solar panels displacing electricity from natural gas would save between 175 to 198 metric tons of carbon dioxide per year, as described earlier in this entry.
[73] L. Kruitwagen et al., *A Global Inventory of Photovoltaic Solar Energy Generating Units*, 598 Nature 604 (October 2021) (Supplemental Data for Supplemental Figure 10), https://doi.org/10.1038/s41586-021-03957-7. Supplemental data for Supplemental Figure 10 establishes that, as of December 2018, solar capacity across all land types in the U.S. was 54.14 GW, while solar capacity across land labelled as "tree covered" was 2.15 GW. *Id.* This represents roughly 4% of the total capacity.
[74] NO TO SOLAR, *supra* note 7.
[75] Lifecycle emissions for energy technologies encompass emissions associated with the operation of an energy facility, such as combustion of fossil fuels. Lifecycle emissions also encompass upstream emissions associated with resource extraction, manufacturing, and construction of a facility, along with downstream emissions associated with decommissioning of a facility. Nat'l Renewable Energy Laboratory, *supra* note 66, at 1.
[76] *See generally id.* at 3; Steffen Schlömer et al., 2014: *Annex III: Technology-specific Cost and Performance Parameters*, CLIMATE CHANGE 2014: MITIGATION OF CLIMATE CHANGE 1329, 1335 (2014), https://www.ipcc.ch/site/assets/uploads/2018/02/ipcc_wg3_ar5_annex-iii.pdf; *Carbon Footprint of Solar Panel Manufacturing*, COOL EFFECT (June 1, 2021), https://www.cooleffect.org/solar-carbon-footprint.
[77] *See* COOL EFFECT, *supra* note 76.
[78] *What Is End-of-Life Management for Photovoltaics?*, U.S. DEP'T OF ENERGY SOLAR ENERGY TECH. OFFICE, https://www.energy.gov/eere/solar/end-life-management-solar-photovoltaics (last visited March 25, 2024).

battery, pumped storage hydropower, and hydrogen storage technologies."[79] The report found widespread agreement that all modes of solar power have total lifecycle emissions significantly below those of all fossil fuels.[80] The report found specifically that the total lifecycle emissions for solar photovoltaic (PV) and concentrating solar power (CSP) panels were 43 and 28 grams of CO_2-eq/KWh (carbon dioxide-equivalents per kilowatt-hour), respectively.[81] Coal, by contrast, generated lifecycle emissions of 1,001 grams of CO_2-eq/KWh, and natural gas generated lifecycle emissions of 486 grams of CO_2-eq/KWh.[82]

Table 1. Median Published Life Cycle Emissions Factors for Electricity Generation Technologies, by Life Cycle Phase

	Generation Technology	One-Time Upstream	Ongoing Combustion	Ongoing Non Combustion	One-Time Downstream	Total Life Cycle	Sources
Renewable	Biomass	NR	—	NR	NR	52	EPRI 2013 Renewable Electricity Futures Study 2012
Renewable	Photovoltaic[a]	~28	—	~10	~5	43	Kim et al. 2012 Hsu et al. 2012 NREL 2012
Renewable	Concentrating Solar Power[b]	20	—	10	0.53	28	Burkhardt et al. 2012
Renewable	Geothermal	15	—	6.9	0.12	37	Eberle et al. 2017
Renewable	Hydropower	6.2	—	1.9	0.004	21	DOE 2016
Renewable	Ocean	NR	—	NR	NR	8	IPCC 2011
Renewable	Wind[c]	12	—	0.74	0.34	13	DOE 2015
Storage	Pumped-storage hydropower	3.0	—	1.8	0.07	7.4	DOE 2016
Storage	Lithium-ion battery	32	—	NR	3.4	33	Nicholson et al. 2021
Storage	Hydrogen fuel cell	27	—	2.5	1.9	38	Khan et al. 2005
Nonrenewable	Nuclear[d]	2.0	—	12	0.7	13	Warner and Heath 2012
Nonrenewable	Natural gas	0.8	389	71	0.02	486	O'Donoughue et al. 2013
Nonrenewable	Oil	NR	NR	NR	NR	840	IPCC 2011
Nonrenewable	Coal	<5	1010	10	<5	1001	Whitaker et al. 2012

Figure 2: Total lifecycle emissions for different energy sources.
Source: NREL.[83]

To be fair, there are some outlier studies. For example, one study examined a worst-case scenario in which the coal-powered manufacture of inefficiently sized solar PV cells may contribute to greater lifecycle emissions than the cleanest and

[79] *See* Nat'l Renewable Energy Laboratory, *supra* note 66, at 1.
[80] *Id.* at 1-3.
[81] *See* Schlömer, *supra* note 76, at 1335.
[82] *Id.*
[83] Nat'l Renewable Energy Laboratory, *supra* note 66, at 3.

most efficient fossil fuel plants.[84] However, the conclusion that solar is worse for the climate than fossil fuels is not backed up by NREL's more extensive survey.

In addition to having smaller greenhouse gas emissions, solar power likewise outperforms fossil fuels in minimizing direct heat emissions. A 2019 Stanford publication notes that, for solar PV and CSP, net heat emissions are in fact negative, because these technologies "reduce sunlight to the surface by converting it to electricity," ultimately cooling "the ground or a building below the PV panels."[85] The study found that rooftop and utility-scale solar PV have heat emissions equivalent to negative 2.2 g-CO2e/kWh-electricity, compared to the positive heat emissions associated with natural gas, nuclear, coal, and biomass.

Technology	Anthropogenic heat emissions
Solar PV-rooftop	-2.2
Solar PV-utility	-2.2
CSP	-2.2
Wind-onshore	-1.7 to -0.7
Wind-offshore	-1.7 to -0.7
Geothermal	0
Hydroelectric	0
Wave	0
Tidal	0
Nuclear	1.6
Biomass	3.4
Natural gas-CCS/U	0.61
Coal-CCS/U	1.5

Figure 3: The 100-year CO_2e emissions impact associated with different energy sources' heat emissions, measured in g-CO2e/kWh-electricity.
Source: M.Z. Jacobson[86]

[84] Jaime Fernández Torres & Fontina Petrakopoulou, *A Closer Look at the Environmental Impact of Solar and Wind Energy*, GLOBAL CHALLENGES, June 22, 2022, https://onlinelibrary.wiley.com/doi/10.1002/gch2.202200016.
[85] Mark Z. Jacobson, *Evaluation of Nuclear Power as a Proposed Solution to Global Warming, Air Pollution, and Energy Security*, Dec. 22, 2019, https://web.stanford.edu/group/efmh/jacobson/Articles/I/NuclearVsWWS.pdf.
[86] *Id*. Reproduced and adapted with permission.

Looking at academic scholarship from outside of the United States, a 2022 University of Western Ontario study tracking the effect of anthropogenic heat emissions on global warming noted that solar technologies emit an "insignificant amount of heat."[87] Likewise, a 2022 analysis from India's Hirwal Education Trust's College of Computer Science and Information Technology describes the global impact of solar panel heat emissions as "relatively small."[88]

False Claim #6: Solar projects harm biodiversity.

> *"Construction of an industrial-scale solar powerplant . . . creat[es] an ecological wasteland."*[89]

When properly developed, including by incorporating pollinator habitat in project design, large-scale solar farms can sustain and even increase natural biodiversity.[90] Microclimates within solar farms can enhance botanical diversity, which, in turn can enhance the diversity of the site's invertebrate and bird populations.[91] In addition, the shade under solar panels can offer critical habitat for a wide range of species, including endangered species.[92] Shady patches likewise prevent soil moisture loss, boosting plant growth and diversity, particularly in areas impacted by climate extremes.[93]

Proactive measures taken before and after a solar farm's construction can further enhance biodiversity. Prior to installation, developers can mitigate adverse impacts by examining native species' feeding, mating and migratory patterns and ensuring that solar projects are not sited in sensitive locations or constructed at sensitive times.[94] For example, developers can schedule construction to coincide with indigenous reptiles' and amphibians' hibernation periods, while avoiding breeding periods.[95]

Additionally, developers can invest in habitat restoration once solar projects have been installed, such as by replanting indigenous flowering species that provide nectar to insects, which also benefits mammals and ground nesting birds.[96] A recent study on the impact of newly-established insect habitat on solar farms in agricultural landscapes found increases in

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[87] Dimitre Karamanev, *The Effect of Anthropogenic Heat Emissions on Global Warming*, EGUSPHERE 2022, https://egusphere.copernicus.org/preprints/2022/egusphere-2022-5/egusphere-2022-5.pdf.
[88] Sudesh Nagu Kadam et. al, *Solar Panel Heat Emission and Its Environmental Impact*, 2 INT'L J. ADVANCED RSCH. SCI. COMMC'N TECH. 3 (Dec. 2022), 113, 116, https://ijarsct.co.in/Paper13924.pdf.
[89] CITIZENS FOR RESPONSIBLE SOLAR, *supra* note 9.
[90] Parikhit Sinha et al., *Best Practices in Responsible Land Use for Improving Biodiversity at a Utility-Scale Solar Facility*, 2 CASE STUDIES IN THE ENV'T, 1, 1-2 (2018), https://doi.org/10.1525/cse.2018.001123.
[91] *Id.*
[92] HANNAH MONTAG ET AL., THE EFFECTS OF SOLAR FARMS ON LOCAL BIODIVERSITY at 34 (Apr. 2016), https://helapco.gr/wp-content/uploads/Solar_Farms_Biodiversity_Study.pdf; Maggie Graham et al., *Partial shading by solar panels delays bloom, increases floral abundance during the late-season for pollinators in a dryland, agrivoltaic ecosystem*, 11 SCI. REP. 7452, 7458, 7463 (2021), https://doi.org/10.1038/s41598-021-86756-4.
[93] Greg Barron-Bafford et al., *Agrivoltaics provide mutual benefits across the food-energy-water nexus in the drylands*, 2 NATURE SUSTAINABILITY 848, 851 (2019), https://doi.org/10.1038/s41893-019-0364-5.
[94] The Biodiversity Consultancy, *Mitigating biodiversity impacts associated with solar and wind energy development*, IUCN (2021), 12, https://portals.iucn.org/library/sites/library/files/documents/2021-004-En.pdf.
[95] *Id.* at 51.
[96] *Id.* at 54, 82.

floral abundance, flowering plant species richness, insect group diversity, native bee abundance, and total insect abundance.[97]

Pollinators play a crucial role in U.S. farming, with more than one third of crop production reliant on pollinators.[98] Bee populations alone contribute an estimated $20 billion annually to U.S. agriculture production and up to $217 billion worldwide.[99] Recognizing these important contributions, the U.S. Department of Energy's Solar Technologies Office is currently funding or tracking numerous studies that seek to maximize solar farms' positive impacts on pollinator-friendly plants.[100]

False Claim #7: Solar projects will reduce agricultural production, hurting farmers and rural communities.

> *"Ask yourself, if several thousand acres of agricultural land is converted to industrial solar facilities, who will grow your food? Bill Gates? Mark Zuckerberg?"*[101]

Ambitious solar deployment would utilize a relatively small percentage of U.S. land when compared to the land currently being used for agriculture. The Department of Energy estimated that total U.S. solar development would take up roughly 10.3 million acres in a scenario in which cumulative solar deployment reaches 1,050–1,570 GW by 2050, the highest land-use scenario that DOE assessed in its 2021 *Solar Futures Study*.[102] If all 10.3 million acres of solar farms were sited on farmland, they would occupy only 1.15% of the 895,300,000 acres of U.S. farmland as of 2021.[103] However, many of these projects will not be located on farmland.[104]

Furthermore, solar arrays can be designed to allow, and even enhance, continued agricultural production on site. This practice, known as agrivoltaics, provides numerous benefits to farmers and rural communities, especially in hot or dry climates.[105] Agrivoltaics allow farmers to grow crops and even to graze livestock such as sheep beneath or between rows

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[97] Leroy J. Walston et al., *If you build it, will they come? Insect community responses to habitat establishment at solar energy facilities in Minnesota, USA*, 19 ENVT'L RESEARCH LETTERS 14053 (2024), at 1, https://iopscience.iop.org/article/10.1088/1748-9326/ad0f72.

[98] *Pollinator Habitat Planting: CP42*, U.S. DEP'T AGRICULTURE, https://www.fsa.usda.gov/Internet/FSA_File/pollinator_fact_sht.pdf (last visited March 25, 2024).

[99] *Id.*

[100] *Buzzing Around Solar: Pollinator Habitat Under Solar Arrays*, U.S. DEP'T ENERGY (Jun. 21, 2022), https://www.energy.gov/eere/solar/articles/buzzing-around-solar-pollinator-habitat-under-solar-arrays.

[101] NO SOLAR IN LOGAN COUNTY (OHIO), *supra* note 10.

[102] U.S. Dep't. Energy Solar Energy Technologies Office, *Solar Futures Study*, U.S. DEP'T. ENERGY OFFICE OF ENERGY EFFICIENCY & RENEWABLE ENERGY, at vi, 179 (Sep. 2021), https://www.energy.gov/sites/default/files/2021-09/Solar%20Futures%20Study.pdf.

[103] U.S. Dep't. of Agriculture, *Farms and Land in Farms: 2021 Summary*, 4 (Feb. 2022), https://www.nass.usda.gov/Publications/Todays_Reports/reports/fnlo0222.pdf.

[104] Eric Larson et al., *Net-Zero American: Potential Pathways, Infrastructure, and Impacts: Final Report*, Princeton University, 247 (Oct. 29, 2021), https://netzeroamerica.princeton.edu/the-report.

[105] National Renewable Energy Laboratory, *Agrivoltaics*, https://www.nrel.gov/solar/market-research-analysis/agrivoltaics.html (last visited March 25, 2024).

of solar panels.[106] When mounted above crops and vegetation, solar panels can provide beneficial shade during the day.[107] Multiple studies have shown that these conditions can enhance a farm's productivity and efficiency.[108] One study found, for example, that "lettuces can maintain relatively high yields under PV" because of their capacity to calibrate "leaf area to light availability."[109] Extra shading from solar panels also reduces evaporation, thereby reducing water usage for crops by around 14-29%, depending on the level of shade.[110] Reduced evaporation from solar installations can likewise mitigate soil erosion.[111] Solar farms can also create refuge habitats for endangered pollinator species, further boosting crop yields while supporting native wild species.[112] Overall, agrivoltaics can increase the economic value of the average farm by over 30%, while increasing annual income by about 8%.[113] Farmers in other countries have begun implementing agrivoltaic systems.[114] As of March 2019, Japan had 1,992 agrivoltaic farms, growing over 120 different crops while simultaneously generating 500,000 to 600,000 MWh of energy.[115]

Furthermore, the argument that solar development will imperil the food supply is belied by the fact that tens of millions of acres of farmland are currently being used to grow crops for other purposes, such as the production of corn ethanol. Currently, roughly 90 million acres of agricultural land in the United States is dedicated to corn, with nearly 45% of that corn being used for ethanol production.[116] Solar energy could provide a significantly more efficient use of the same land. Corn-derived ethanol used to power internal combustion engines has been calculated to require between 63 and 197 times more land than solar PV powering electric vehicles to achieve the same number of transportation miles.[117] If converted to electricity to power electric vehicles, ethanol would still need roughly 32 times more land than solar PV to achieve the same number of transportation miles.[118] And even when accounting for other energy by-products of ethanol production, solar PV produces between 14 and 17 times more gross energy per acre than corn.[119] The figure below contrasts the land use

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106 Michael Nuckols, *Considerations when leasing agricultural lands to solar developers*, CORNELL SMALL FARMS (Apr. 6, 2020), https://smallfarms.cornell.edu/2020/04/considerations-when-leasing-agricultural-lands-to-solar-developers/; Elnaz Adeh et al., *Solar PV power potential is greatest over croplands*, 9 SCI. REP. 4 (2019), https://doi.org/10.1038/s41598-019-47803-3.
107 Henry J. Williams et. al., *The potential for agrivoltaics to enhance solar farm cooling*, APPLIED ENERGY 332 (2023), https://doi.org/10.1016/j.apenergy.2022.120478.
108 Raúl Aroca-Delgado et al., *Compatibility between Crops and Solar Panels: An Overview from Shading Systems,* 10 SUSTAINABILITY 743, 745 (2018), https://doi.org/10.3390/su10030743.
109 Hélène Marrou et. al, *Productivity and Radiation use Efficiency of Lettuces Grown in the Partial Shade of Photovoltaic Panels*, 44 EUR. J. AGRONOMY 54, 60, 63 (2013), https://doi.org/10.1016/j.eja.2012.08.003.
110 Harashavardhan Dinesh & Joshua M. Pearce, *The potential of agrivoltaic systems,* 54 RENEWABLE AND SUSTAINABLE ENERGY REVIEWS 299, 302 (2016), https://doi.org/10.1016/j.rser.2015.10.024.
111 *Id*.
112 *Empowering Biodiversity on Solar Farms*, UNIVERSITY OF GEORGIA COLLEGE OF AGRICULTURAL AND ENVIRONMENTAL SCIENCES, 2020, https://www.caes.uga.edu/research/impact/impact-statement/9839/empowering-biodiversity-on-solar-farms.html.
113 Dinesh & Pearce, *supra* note 110, at 305.
114 *See, e.g.*, Makoto Tajima and Tetsunari Iida, *Evolution of Agrivoltaic Farms in Japan*, 2361 AIP CONF. PROC. 030002 (2021), https://doi.org/10.1063/5.0054674.
115 *Id.* at 2. This is enough energy to power roughly 50,000 American households. U.S. Energy Information Admin., *Use of energy explained: Energy use in homes*, https://www.eia.gov/energyexplained/use-of-energy/electricity-use-in-homes.php (last visited March 25, 2024).
116 *Feed Grains Sector at a Glance*, U.S. DEP'T OF AGRICULTURE (last updated Dec. 21, 2023), https://www.ers.usda.gov/topics/crops/corn-and-other-feed-grains/feed-grains-sector-at-a-glance/.
117 PAUL MATHEWSON & NICHOLAS BOSCH, CORN ETHANOL VS. SOLAR: LAND USE COMPARISON at 1 (Clean Wisconsin 2023), https://www.cleanwisconsin.org/wp-content/uploads/2023/01/Corn-Ethanol-Vs.-Solar-Analysis-V3-9-compressed.pdf.
118 *Id.*
119 *Id.*

requirements of solar PV with dedicated biomass and other energy sources. Whereas dedicated biomass consumes an average of 160,000 hectares of land per terawatt-hour per year, ground-mounted solar PV consumes an average of 2,100.[120]

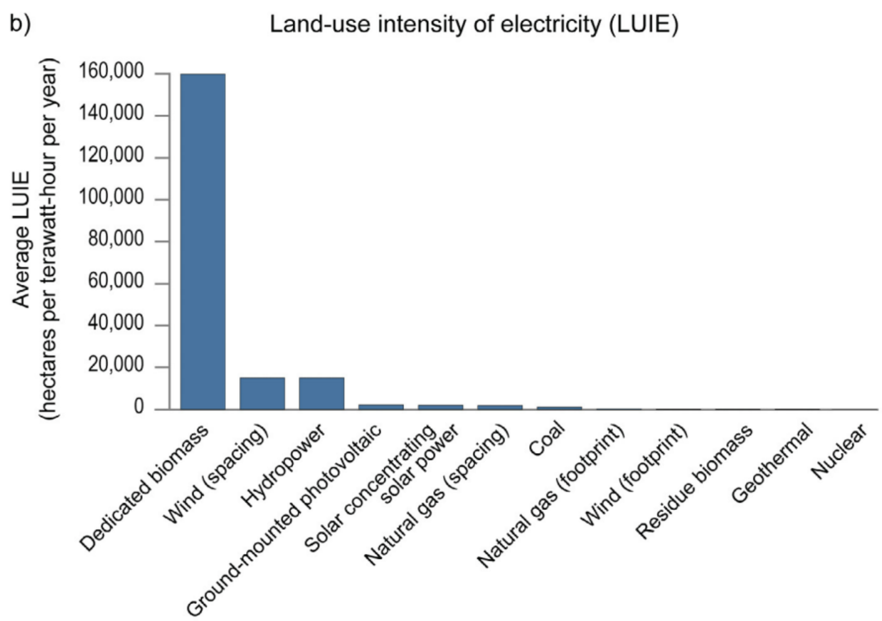

Figure 4: Average land-use intensity of electricity, measured in hectares per terawatt-hour per year.
Source: U.S. Global Change Research Program (visualizing data from Jessica Lovering et al.).[121]

Finally, while solar installations, like any infrastructure projects, will inevitably have some adverse impacts, the failure to build the infrastructure necessary to avoid climate change poses a far more severe threat to agricultural production. Climate change already harms food production across the country and globe through extreme weather events, weather instability, and water scarcity.[122] The most recent Intergovernmental Panel on Climate Change (IPCC) report forecasts that climate change will cause up to 80 million additional people to be at risk of hunger by 2050.[123] A 2019 IPCC report forecasted up

[120] Jessica Lovering et al., *Land-use intensity of electricity production and tomorrow's energy landscape*, PLOS ONE, July 2022, at 8, https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0270155#pone-0270155-t001.
[121] U.S. GLOBAL CHANGE RESEARCH PROGRAM, FIFTH NATIONAL CLIMATE ASSESSMENT at 32-29 (2023), https://nca2023.globalchange.gov/downloads/NCA5_Ch32_Mitigation.pdf (visualizing data from Jessica Lovering et al., *supra* note 120 at 8).
[122] Alisher Mirzabaev et al., *Severe climate change risks to food security and nutrition*, 39 Climate Risk Management 100473, 3 (2023), https://www.sciencedirect.com/science/article/pii/S2212096322000808 ("Adverse consequences are already occurring, and the chances of their exacerbation under climate change are high"); FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS, CLIMATE CHANGE AND FOOD SECURITY: RISKS AND RESPONSES at ox-xii (2015), https://www.fao.org/3/i5188e/I5188E.pdf; *Agriculture and Climate*, U.S. ENV'T. PROT. AGENCY, https://www.epa.gov/agriculture/agriculture-and-climate (last visited March 25, 2024); Laura Reiley & Kadir van Lohuizen, *Climate change is pushing American farmers to confront what's next*, WASH. POST, Nov. 10, 2023, https://www.washingtonpost.com/business/interactive/2023/american-agriculture-farming-climate-change/.
[123] IPCC, Climate Change 2022: Impacts, Adaptation, and Vulnerability (2022), 717, https://report.ipcc.ch/ar6/wg2/IPCC_AR6_WGII_FullReport.pdf.

to 29% price increases for cereal grains by 2050 due to climate change.[124] These price increases would strain consumers globally, while also producing uneven regional effects.[125] Moreover, while higher carbon dioxide levels may initially increase yield for certain crops at lower temperature increases, these crops will likely provide lower nutritional quality.[126] For example, wheat grown at 546–586 parts per million (ppm) CO_2 has a 5.9–12.7% lower concentration of protein, 3.7–6.5% lower concentration of zinc, and 5.2–7.5% lower concentration of iron.[127] Distributions of pests and diseases will also change, harming agricultural production in many regions.[128] Such impacts will only intensify for as long as we continue to burn fossil fuels.[129]

False Claim #8: Solar development will destroy U.S. jobs.

> *"Requirements for renewable energy mean that Americans' oil and gas jobs are being sacrificed to Chinese making wind turbines and solar panels."*[130]

Solar development creates significantly more jobs per unit of energy generated than other types of energy production, including natural gas.[131] Moreover, the number of jobs created by the renewable energy industry, including solar, is expected to far exceed the number lost due to a shift away from fossil fuels. The United States' Fifth National Climate Assessment predicts that there will be nearly 3,000,000 new solar, wind, and transmission-related jobs by 2050 in a high electrification scenario and 6,000,000 new jobs in a 100% renewable scenario, with less than 1,000,000 fossil fuel-related jobs lost.[132]

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124 Chiekh Mbow et al., Food Security, *in Climate Change and Land: an IPCC special report on climate change, desertification, land degradation, sustainable land management, food security, and greenhouse gases fluxes in terrestrial ecosystems*, Exec. Summary, Intergovernmental Panel on Climate Change, https://www.ipcc.ch/srccl/chapter/chapter-5/ (2019).

125 *Id.*; *see also* Climate Change 2022: Impacts, Adaptation, and Vulnerability, *supra* note 123, at 796.

126 Climate Change 2022: Impacts, Adaptation, and Vulnerability, *supra* note 123, at 717.

127 Mbow et al., *supra* note 124.

128 *Id.*; Climate Change 2022: Impacts, Adaptation, and Vulnerability, *supra* note 123, at 718.

129 *Causes and Effects of Climate Change*, United Nations, https://www.un.org/en/climatechange/science/causes-effects-climate-chang (last visited March 25, 2024).

130 Diana Furchtgott-Roth, *The Hypocrisy of the Left on Energy Policy,* Heritage Foundation (May 9, 2023), https://www.heritage.org/energy-economics/commentary/the-hypocrisy-the-left-energy-policy.

131 National Association of State Energy Officials et al., *Wages, Benefits and Change*, https://www.usenergyjobs.org/s/Wage-Report.pdf (last visited March 25, 2024).

132 U.S. Global Change Research Program, Fifth National Climate Assessment, *supra* note 121, at 32-31.

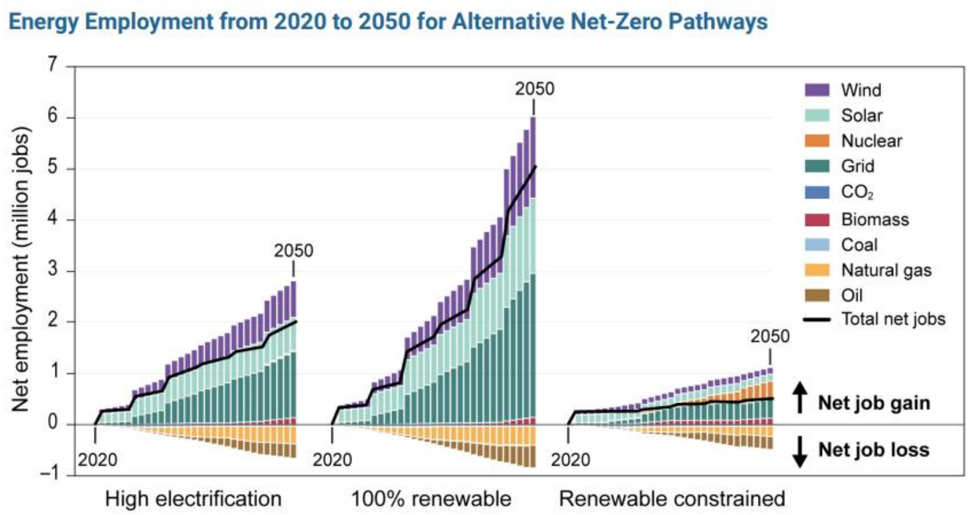

Figure 5: Energy employment from 2020 to 2050 under various U.S. net-zero GHG emissions scenarios.
Source: U.S. Global Change Research Program.[133]

As of 2022, the solar industry supported approximately 346,143 U.S. jobs, including 175,302 construction jobs and 44,875 manufacturing jobs, with numbers generally increasing each year.[134] In addition, most of these jobs cannot be outsourced. Roughly 65% of today's U.S. solar energy jobs are in project development and 6% are in operations or maintenance, most of which cannot be exported.[135] The number of jobs in solar energy also exceeds those in the fossil fuel generation industries. In Kentucky, for example, there are now eight times as many jobs in clean energy, including solar, as coal mining.[136] Throughout the United States, there are roughly 5.4 times as many jobs in solar alone than in coal, and there are roughly 1.78 times as many jobs in solar than in coal, gas, and oil generation combined.[137]

Domestic job growth in solar production and related industries has been further accelerated by recent federal legislation, including the 2021 Infrastructure Investment and Jobs Act, and the 2022 Inflation Reduction Act, which collectively provide more than $60 billion to support clean energy manufacturing, primarily with domestic supply chains.[138] In response, manufacturers have announced plans to build multibillion dollar solar panel manufacturing facilities and related battery

[133] *Id.*
[134] *United States Energy & Employment Report 2023*, U.S. DEP'T OF ENERGY (June 2023), https://www.energy.gov/sites/default/files/2023-06/2023%20USEER%20REPORT-v2.pdf.
[135] *National Solar Jobs Census 2022*, INTERSTATE RENEWABLE ENERGY COUNCIL, https://irecusa.org/programs/solar-jobs-census/ (last visited March 25, 2024).
[136] Ryan Van Velzer, *Kentucky has the second fastest growing clean energy sector in the U.S.*, LOUISVILLE PUBLIC MEDIA, Sept. 27, 2023, https://www.lpm.org/news/2023-09-27/kentucky-has-the-second-fastest-growing-clean-energy-sector-in-the-u-s.
[137] *United States Energy & Employment Report 2023*, *supra* note 134 at 4.
[138] *DOE Optimizes Structure to Implement $62 Billion in Clean Energy Investments From Bipartisan Infrastructure Law*, U.S. Dep't. Energy (Feb. 9, 2022), https://www.energy.gov/articles/doe-optimizes-structure-implement-62-billion-clean-energy-investments-bipartisan.

manufacturing facilities in the United States that will employ thousands of workers.[139] At a smaller scale, the emerging solar recycling industry has also begun to create jobs.[140]

False Claim #9: Reliance on solar will make the United States dependent on China and other countries.

> *"One of the biggest mistakes the West has done on green policies to cut CO_2 emissions and trying to reduce dependence on oil and gas producing nations is that the transition to renewable energy puts the West at the mercy of China."*[141]

Although the United States still imports a majority of the solar panels it installs, domestic solar manufacturing is on the rise, especially following passage of the 2021 Infrastructure Investment and Jobs Act (IIJA), and the 2022 Inflation Reduction Act (IRA).[142] In 2022, the United States manufactured approximately 10% more solar panels than in 2021.[143] This share is likely to grow as manufacturers take advantage of IIJA and IRA incentives to open factories in the United States.[144] In addition, as previously noted, roughly 65% of today's U.S. solar production jobs are in project development and 6% are in operations or maintenance, most of which cannot be outsourced.[145]

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[139] *See, e.g.*, Syris Valentine, *The IRA has injected $240 billion into clean energy. The US still needs more*, GRIST, Mar. 12, 2024, https://grist.org/economics/the-ira-has-injected-250-billion-into-clean-energy-it-might-not-be-enough/; Zack Budryk, *White House touts biggest single investment in US solar by Korean company,* The Hill (Jan. 11, 2023), https://thehill.com/policy/energy-environment/3807489-white-house-touts-biggest-single-investment-in-u-s-solar-energy-by-korean-company/; *Gov. Kemp: Battery Manufacturer to Invest $2.57B, Create Over 700 Jobs in Coweta County,* Governor Brian P. Kemp Office of the Governor (Nov. 11, 2022), https://gov.georgia.gov/press-releases/2022-11-11/gov-kemp-battery-manufacturer-invest-257b-create-over-700-jobs-coweta.

[140] Jon Hurdle, *As Millions of Solar Panels Age Out, Recyclers Hope to Cash In*, YALE ENVIRONMENT 360 (February 28, 2023), https://e360.yale.edu/features/solar-energy-panels-recycling; *SOLARCYCLE Raises $30M to Scale Advanced Recycling for the Solar Industry*, SolarCycle News (March 15, 2023), https://www.solarcycle.us/press-releases/solarcycle-raises-30m-equity-financing-to-scale-advanced-recycling-for-the-solar-industry.

[141] Kenneth Rapoza, *How China's Solar Industry Is Set Up to Be the New Green OPEC*, FORBES (Mar. 14, 2021), https://www.forbes.com/sites/kenrapoza/2021/03/14/how-chinas-solar-industry-is-set-up-to-be-the-new-green-opec/?sh=f3f6e851446d.

[142] *U.S. solar photovoltaic module shipments up 33% in 2020,* U.S. ENERGY INFORMATION ADMINISTRATION (Sep. 2, 2021), https://www.eia.gov/todayinenergy/detail.php?id=49396; U.S. Dep't. of Energy Solar Energy Tech. Office, *Solar manufacturing*, U.S. DEP'T. OF ENERGY OFFICE OF ENERGY EFFICIENCY AND RENEWABLE ENERGY, https://www.energy.gov/eere/solar/solar-manufacturing (last visited March 25, 2024).

[143] David Feldman et al., *Spring 2023 Solar Industry Update*, NAT'L RENEWABLE ENERGY LABORATORY, 68 (Apr. 27, 2023), https://www.nrel.gov/docs/fy23osti/86215.pdf.

[144] U.S. Dep't. of Energy, *DOE Fact Sheet: The Bipartisan Infrastructure Deal Will Deliver For American Workers, Families and Usher in the Clean Energy Future*, U.S. DEPARTMENT OF ENERGY (Nov. 9, 2021), https://www.energy.gov/articles/doe-fact-sheet-bipartisan-infrastructure-deal-will-deliver-american-workers-families-and-0; Bella Isaacs-Thomas, *What the Inflation Reduction Act does for green energy,* PBS NEWS HOUR (Aug. 17, 2022), https://www.pbs.org/newshour/science/what-the-inflation-reduction-act-does-for-green-energy; U.S. Dep't of Energy, Inflation Reduction Act of 2022, https://www.energy.gov/lpo/inflation-reduction-act-2022; Kavya Balaraman, *Inflation Reduction Act could spur American Manufacturing Renaissance, Advocates Say*, UTILITYDIVE (Aug. 18, 2022), https://www.utilitydive.com/news/inflation-reduction-act-solar-manufacturing-seia/630061/.

[145] INTERSTATE RENEWABLE ENERGY COUNCIL, *supra* note 135.

Finally, to the extent that there are concerns that solar energy will increase the United States' dependence on China specifically, it bears noting that China is no longer a major source of solar panel imports—at least not directly.[146] Tariffs imposed by the U.S. government in 2012 on Chinese-sourced solar panels have considerably diminished China's status as a principal U.S. supplier. In 2022, approximately 77% of U.S. solar panel imports came from four countries: Vietnam (37%), Thailand (17%), Malaysia (16%) and Cambodia (7%).[147] While the U.S. Department of Commerce found that companies in these four countries have been incorporating Chinese-sourced materials without paying corresponding tariffs, the U.S. Government has taken measures to crack down on noncompliance.[148] In particular, the U.S. Government now requires, as of June 2024, that solar manufacturers exporting from these countries to the U.S. certify their compliance with all relevant trade rules, subject to potential audit.[149]

False Claim #10: Utility-scale solar farms destroy the value of nearby homes.

> *"Solar power plants decrease property values. Over time, industrial-scale solar counties' property values will decline and the county become less desirable, while other location's [sic] values will increase."*[150]

Data across multiple studies show that utility-scale solar projects do not have major impacts on the values of surrounding properties.[151] Rather, the installation of a solar farm typically has only a minor impact on the value of homes closest to it. The most comprehensive study to date, which examined over 1.8 million home transactions near 1,500 large-scale photovoltaic projects across six states, found relatively minor impacts on property values.[152] Homes located within 0.5 miles of solar farms were found to experience price reductions of 1.5%, compared to properties 2–4 miles away.[153] Homes located more than 1 mile from a solar farm were found to experience no statistically significant effect on its price.[154] Similarly, a 2020 study examining 400,000 transactions around 208 utility-scale solar installations in Massachusetts and Rhode Island found a 1.7% decrease in property value for homes located within 1 mile of a project.[155] These declines were concentrated

[146] David Feldman et al., *supra* note 143, at 68, 80; Ian Tiseo, *Distribution of solar photovoltaic modules imported in the united States in 2022, by country of origin*, STATISTA, Jan. 25, 2024, https://www.statista.com/statistics/232941/us-imports-of-solar-equipment-by-source-contry/.
[147] David Feldman et al., *supra* note 143, at 68, 80.
[148] Eric McDaniel, *The U.S. Imports Most of Its Solar Panels. A New Ruling Might Make That More Expensive*, NATIONAL PUBLIC RADIO (Aug. 18, 2023), https://www.npr.org/2023/08/18/1194303196/solar-panel-imports-china%20and%20.
[149] U.S. Department of Commerce, *Department of Commerce Issues Preliminary Determination of Circumvention Inquiries of Solar Cells and Modules Produced in China*, Dec. 2, 2022, https://www.commerce.gov/news/press-releases/2022/12/department-commerce-issues-preliminary-determination-circumvention.
[150] *Property Values*, CITIZENS FOR RESPONSIBLE SOLAR, https://www.citizensforresponsiblesolar.org/property-values (last visited March 25, 2024).
[151] Richard Kirkland, *Grand Solar Impact Study*, KIRKLAND APPRAISALS, (Feb. 25, 2016), https://www.southripleysolar.com/wp-content/uploads/2020/09/Kirkland-Grandy-Solar-Impact-Study.pdf; *Solar and Property Value,* SOLAR ENERGY INDUSTRIES ASSOCIATION (Jul. 2019), https://www.seia.org/sites/default/files/2019-09/Solar%20Property%20Value%20FactSheet%202019-PRINT_1.pdf.
[152] Salma Elmallah et al., *Shedding Light on Large-Scale Solar Impacts: An Analysis of Property Values and Proximity to Photovoltaics Across Six U.S. States,* 175 Energy Policy 113425 (2023), https://doi.org/10.1016/j.enpol.2023.113425.
[153] *Id.* at 113425.
[154] *Id.*
[155] Vasundhara Gaur et al., *Property Value Impacts of Commercial-Scale Solar Energy In Massachusetts And Rhode Island*, DEP'T. ENV'T. AND NAT. RES. ECON. U. R.I., 4 (2020), https://www.uri.edu/news/wp-content/uploads/news/sites/16/2020/09/PropertyValueImpactsOfSolar.pdf.

in suburban areas, where there is more competition for space.[156] In rural communities there was no impact on property values.[157] Other studies have also found that utility-scale solar farms have a greater impact on property values in areas with higher residential population density.[158]

Yet other studies have found that solar panels can have a neutral or even a positive impact on home values. A 2018 study of solar farms in Indiana and Illinois found "no consistent negative impact" to the value of adjacent properties "that could be attributed to proximity to the adjacent solar farm."[159] Instead, the researchers discovered that properties within 1,320 feet of solar farms sold by an average of 1.92% more than comparable properties that were not located near any solar farms.[160] Another 2018 study examined 956 U.S. solar projects installed before 2016 and found a majority of these projects had a neutral impact on property values.[161]

By contrast, a separate study found that the presence of a fossil fuel fired power plant within 2 miles of one's home decreased its value by 4–7%, with the largest decreases within 1 mile and for high-capacity plants.[162] In that study, 92% of the power plants surveyed were fueled by natural gas.[163]

False Claim #11: Solar energy is more expensive than fossil fuels and completely dependent on subsidies.

> *"Solar farms depend entirely on subsidies from your hard earned money. When the subsidies are gone, the solar farms are abandoned!"*[164]

Unsubsidized solar energy is now generally cheaper than fossil fuels. According to the International Energy Agency's 2020 *World Energy Outlook*, photovoltaic solar power is "the cheapest source of new electricity generation in most parts of the world," and "[f]or projects with low cost financing that tap high quality resources, solar PV is now the cheapest source of electricity in history." [165]

Solar energy compares favorably to fossil fuels in terms of levelized cost (*i.e.*, lifetime costs divided by lifetime energy output). According to Lazard's April 2023 *Levelized Cost of Energy Analysis*, the mean unsubsidized levelized cost of utility-

[156] *Id.* at 35.
[157] *Id.* at 35.
[158] Leila Al-Hamoodah et al., *An Exploration of Property-Value Impacts Near Utility-Scale Solar Installations*, LAWRENCE BERKELEY NATIONAL LABORATORY (May 2018), https://static1.squarespace.com/static/58d03116725e2542873aa638/t/6058df6f1107f91adc9cc20d/1616437113682/Link+in+No.+13C+-+An+Exploration+of+Property+Value+Impacts+Near+Utility+Scale+Solar+Installations.pdf.
[159] PATRICIA MCGARR & ANDREW LINES, PROPERTY VALUE IMPACT STUDY: PROPOSED SOLAR FARM, MCLEAN COUNTY, IL, at 17, (Aug. 7, 2018), https://www.mcleancountyil.gov/DocumentCenter/View/13192/Patricia-L-McGarr—Property-Value-Impact-Study.
[160] *Id.*
[161] Leila Al-Hamoodah et al., *supra* note 158.
[162] Lucas Davis, *The Effect of Power Plants on Local Housing Value and Rents*, 93 REV. ECON. STAT. 1391 (2011), https://doi.org/10.1162/rest_a_00119.
[163] *Id.* at 1400.
[164] 164 NO TO SOLAR, *supra* note 7.
[165] *World Energy Outlook 2020*, INT'L. ENERGY AGENCY, 202, 214 (2020), https://iea.blob.core.windows.net/assets/a72d8abf-de08-4385-8711-b8a062d6124a/WEO2020.pdf.

scale solar PV is $60/MWh.[166] By comparison, the mean unsubsidized levelized cost of gas combined cycle is $70/MWh, the mean unsubsidized levelized cost of coal is $117/MWh, and the mean unsubsidized levelized cost of gas peaking is $168/MWh.[167] The figure below from Lazard shows historical mean unsubsidized LCOE values for different types of utility-scale energy generation.

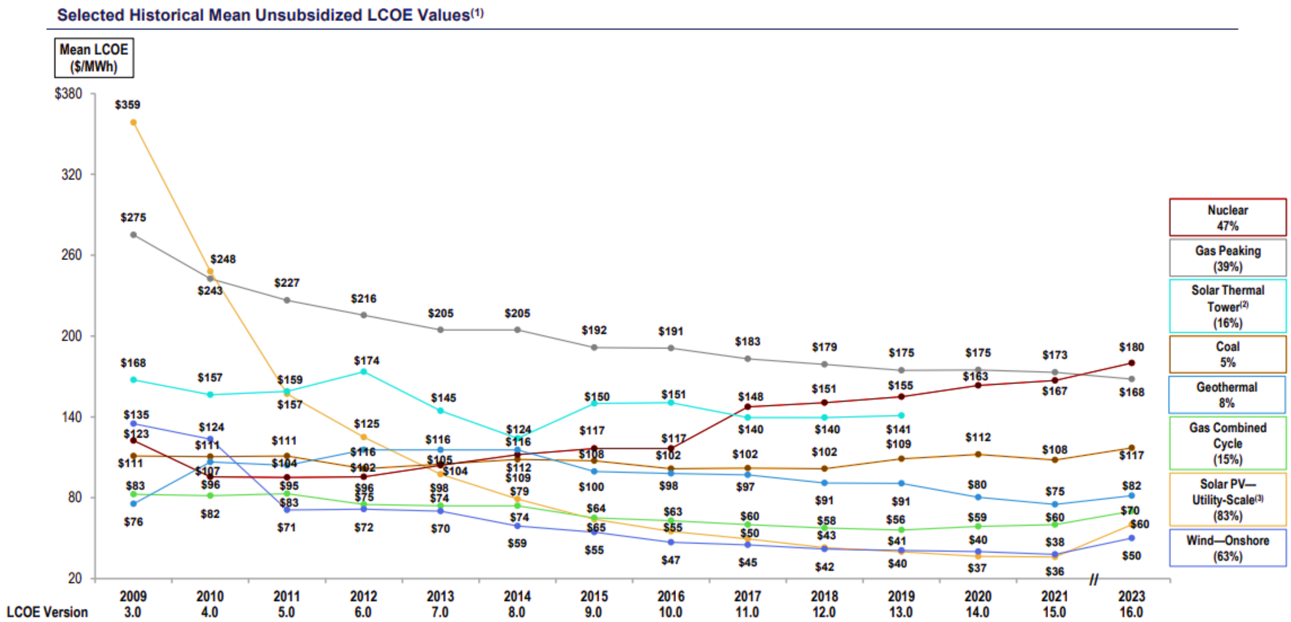

Figure 6: Selected historical mean unsubsidized LCOE values. This graph reflects the average of the high and low LCOE for each technology in each year. The percentages on the right of the figure represent the decrease in average LCOE since 2009.
Source: Lazard.[168]

Lazard attributes the significant historical cost declines for utility-scale renewable energy generation to decreasing capital costs, improving technologies, and increased competition, among other factors.[169] For solar energy, as with onshore wind energy and electric vehicle batteries, historical decreases in costs have correlated with increases in cumulative capacity and sales.[170] As one example of decreasing costs of solar generation, the figure below from Inside Climate News shows a roughly 90% decline in solar module prices from 2011 to 2023.[171]

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[166] *Levelized Cost of Energy Analysis: Version 16.0*, Lazard, 9 (Apr. 2023), https://www.lazard.com/media/2ozoovyg/lazards-lcoeplus-april-2023.pdf.
[167] *Id.*
[168] *Id.* Reproduced with permission.
[169] *Id.*
[170] *See* U.S. Global Change Research Program, *supra* note 121 at 32-15.
[171] Dan Gearino, *Inexpensive Solar Panels Are Essential for the Energy Transition. Here's What's Happening With Prices Right Now*, Inside Climate News (Jun. 15, 2023), https://insideclimatenews.org/news/15062023/inside-clean-energy-solar-panel-prices-drop/.

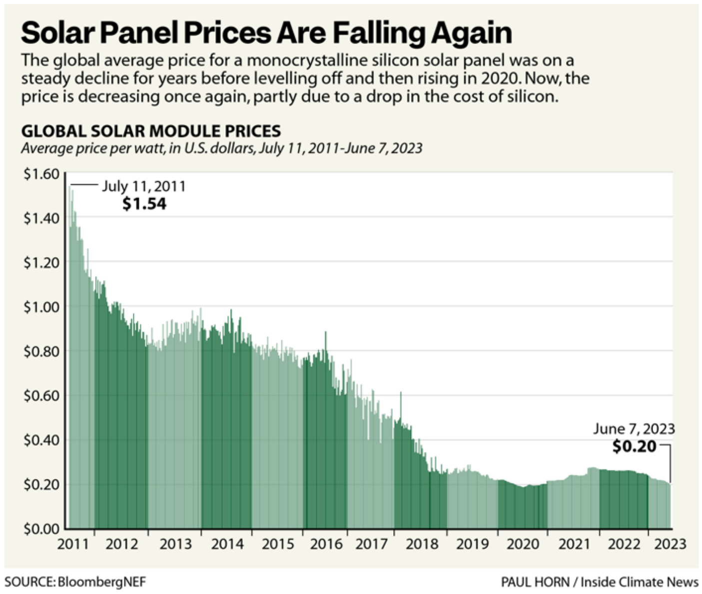

Figure 7: Solar price from 2011 to 2023.
Source: BloombergNEF/Paul Horn/Inside Climate News.[172]

In addition to the many factors reducing solar's unsubsidized LCOE, there are substantial subsidies that will further reduce cost on a subsidized basis. In particular, the Inflation Reduction Act is predicted to reduce the subsidized LCOE for solar by 20%–35% by 2030.[173] The figure below from ICF shows the anticipated impact of the IRA on the subsidized LCOE for solar.

[172] *Id.* Reproduced with permission.
[173] Ian Bowen et al., *How clean energy economics can benefit from the biggest climate law in US history*, ICF (Sept. 16, 2022), https://www.icf.com/insights/energy/clean-energy-economic-benefits-us-climate-law; *see also* Lazard, *supra* note 166, at 3.

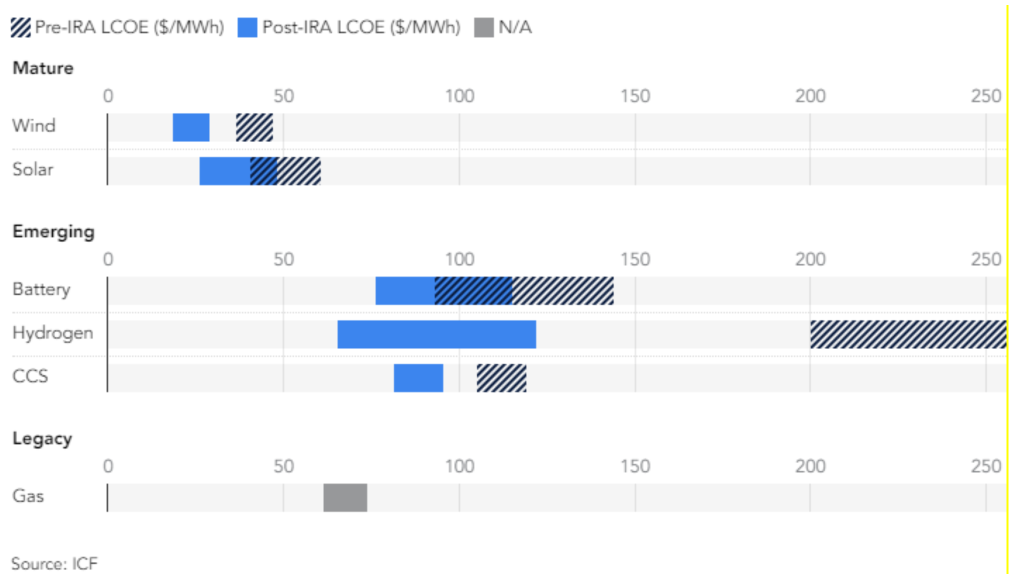

Figure 8: Impact of the IRA on anticipated LCOE in 2030.
Source: ICF.[174]

Fossil fuels also receive subsidies, albeit smaller subsidies than renewable energy currently received.[175] In fiscal year 2022, the federal government's tax expenditures for natural gas and petroleum subsidies were $2.1 billion.[176]

One shortcoming of relying on levelized cost as a metric for comparing solar with natural gas and other types of legacy power plants is that levelized cost does not take into account that additional energy generation is needed to compensate for any intermittency. But even when factoring in these so-called firming costs, the subsidized and unsubsidized LCOE of stand-alone solar is lower than the levelized cost of gas peaking and cost-competitive with gas combined cycle across most of the United States.[177] Solar-plus-storage systems are more expensive. However, when factoring in firming costs, both the subsidized and unsubsidized LCOE of solar plus storage is generally within or below the range of LCOE for gas peaking, depending on location within the United States.[178]

[174] *Id.* Reproduced with permission.
[175] Federal Financial Interventions and Subsidies in Energy in Fiscal Years 2016-2022, U.S. Energy Information Admin., at 3 (Aug. 2023), https://www.eia.gov/analysis/requests/subsidy/pdf/subsidy.pdf.
[176] *Id.* at 3-4.
[177] LAZARD, *supra* note 166, at 8. California is the exception, where the subsidized and unsubsidized LCOE of solar exceeds that of gas combined cycle when factoring in firming costs. *Id.*
[178] *Id.*

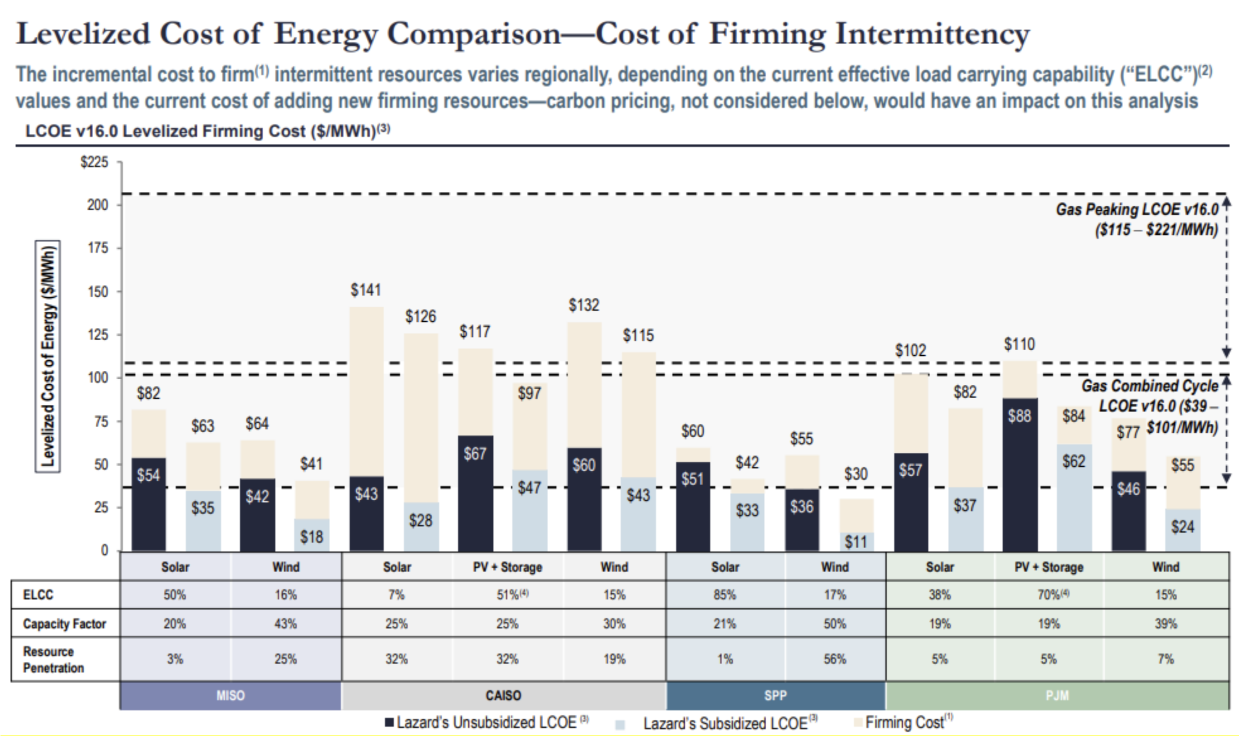

Figure 9: LCOE for wind, solar, and solar plus storage, adjusted for the cost of firming intermittency.
Source: Lazard.[179]

False Claim #12: Solar panels don't work in cold or cloudy climates.

"A cloud goes over and solar plummets"[180]

Solar panels generate energy even in cold or cloudy conditions.[181] Although cloudy weather may reduce power generation by as much as 45%, substantial energy can still be generated during those conditions.[182] Cold temperatures, however, do not reduce output at all and actually increase solar panel efficiency by increasing voltage.[183]

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[179] *Id.* Reproduced with permission.
[180] Brian Gitt, *Solar's Dirty Secrets: How Solar Power Hurts People and the Planet*, ATOMIC INSIGHTS (Feb. 24, 2022), https://atomicinsights.com/solars-dirty-secrets-how-solar-power-hurts-people-and-the-planet/. [See comment from Chris Morris, March 17, 2022 at 2:23 AM].
[181] *What happens to solar panels when it's cloudy or raining?*, SOLAR ENERGY INDUSTRIES ASSOCIATION, https://www.seia.org/initiatives/what-happens-solar-panels-when-its-cloudy-or-raining (last visited March 25, 2024); Makbul A.M. Ramli et al., *On the investigation of photovoltaic output power reduction due to dust accumulation and weather conditions*, 99 RENEWABLE ENERGY 836, 843 (2016), https://doi.org/10.1016/j.renene.2016.07.063.
[182] Ramli et al., *supra* note 181, at 843.
[183] Pranjal Sarmah et al., *Comprehensive Analysis of Solar Panel Performance and Correlations with Meteorological Parameters*, 8 ACS OMEGA 47897, 47900 (2023), https://doi.org/10.1021/acsomega.3c06442.

False Claim #13: Solar energy is unreliable and requires 100% fossil fuel backup.

> *"[S]olar plants require 100% back up all the time by fossil fuels."*[184]

Complete reliance on solar generation, without battery storage, wind power, or long-distance transmission, would pose intermittency challenges. However, an increasing number of planned solar projects are set to include an energy storage component,[185] and solar, wind and storage together can provide the majority of the country's electricity without compromising reliability.[186]

When a local service area does face diminished solar capacity, for instance during a cloudy day, wind and other renewable sources, as well as battery storage and long-distance transmission that carries power from sunnier regions can supplement energy supply, ensuring a resilient grid.[187] As a result, increased reliance on solar energy need not require the construction of new natural gas plants for backup.[188] The Department of Energy's 2021 "Solar Futures Study," for example, outlines three distinct decarbonization scenarios, each of which assumes both a massive increase in renewable energy generation and decrease in natural gas.[189] Under the "business as usual" reference scenario, natural gas, oil, and steam together decrease from roughly 39% of U.S. annual electricity generation in 2020 to roughly 31% by 2035/2036 and 30% by 2049/2050; under the same scenario, solar PV increases from roughly 3.4% in 2020 to 17.6% by 2035/2036 and 27.3 % by 2049/2050.[190] Under the two non-reference decarbonization scenarios assessed in the studies, natural gas, oil, and steam shrink to roughly 4.7%-5.2% of annual electricity generation by 2035/2036 and 0% by 2049/2050; solar PV, meanwhile, increases to between 36.9% and 42.2% by 2035/36 and to between 40.1% and 44.8% by 2049/2050.[191] Princeton University's Net-Zero America study, which assesses pathways to achieving net-zero GHG emissions by 2050, likewise foresees significant reductions in fossil fuel consumption and generation, even when maintaining 500-1,000 GW of firm generating capacity to ensure reliability.[192] Across the suite of assessed net-zero scenarios, the study assumes that all thermal coal production and consumption will cease by 2030, oil production will decline between 25% to 85% by 2050, and natural gas production will decline between 20% and 90% by 2050.[193]

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[184] *Solar Energy Is Unreliable*, CITIZENS FOR RESPONSIBLE SOLAR, https://www.citizensforresponsiblesolar.org/solar-unreliable (last visited March 25, 2024).

[185] JOSEPH RAND ET AL., QUEUED UP: CHARACTERISTICS OF POWER PLANTS SEEKING TRANSMISSION INTERCONNECTION AS OF THE END OF 2021 at 13 (Berkely Lab 2022), https://eta-publications.lbl.gov/sites/default/files/queued_up_2021_04-13-2022.pdf.

[186] *See* Eric Larson et al., *supra* note 104, at 88 (noting that, "[t]o ensure reliability, all cases maintain 500-1,000 GW of firm generating capacity through all years," compared to 7,400-9,900 GW for wind and solar in net-zero scenarios for 2050).

[187] Robert Fares, *Renewable Energy Intermittency Explained: Challenges, Solutions, and Opportunities,* Scientific America (Mar. 11, 2015), https://blogs.scientificamerican.com/plugged-in/renewable-energy-intermittency-explained-challenges-solutions-and-opportunities/; Mark Jacobson, *Renewable Energy's Intermittency is Not a Showstopper*, AM. PHYSICAL SOC'Y. (Apr. 20, 2022), https://physics.aps.org/articles/v15/54.

[188] *The 2035 Report: Plummeting Solar, Wind, and Battery Costs Can Accelerate our Clean Electricity Future,* U. CAL. BERKELEY GOLDMAN SCH. PUB. POL'Y, 4 (2020), https://cta-redirect.hubspot.com/cta/redirect/6000718/8a85e9ea-4ed3-4ec0-b4c6-906934306ddb.

[189] U.S. Dep't. Energy Solar Energy Technologies Office, *Solar Futures Study*, *supra* note 102, at 215.

[190] *Id.*

[191] *Id.*

[192] Eric Larson et al., *supra* note 104, at 88, 261.

[193] *Id.* at 261.

California has already increased solar energy generation while decreasing natural gas utilization. In 2012, solar PV and solar thermal together accounted for only 0.9% of California's in-state electricity generation, while natural gas accounted for roughly 70%.[194] By 2022, solar had increased to 19.9% of California's in-state electricity generation, while natural gas had decreased to 47.5%.[195] Significantly, even with this increase in solar reliance, California's grid reliability remains near, or above, the national average.[196] Elsewhere in the United States, energy experts have asserted that Texas's widespread adoption of solar generation helped prevent outages when electricity usage spiked during a recent summer heatwave.[197] And although the reliability of solar and wind energy was questioned following Texas' widespread power outages in the winter of 2021, Texas' grid failure was primarily caused by freezing natural gas infrastructure, rather than failures at solar and wind farms, though nuclear, coal, and wind also experienced disruptions at a smaller scale.[198]

Energy storage also will play an important role in achieving decarbonization, while improving energy reliability. The DOE's "Solar Futures Study" forecasts that an additional 60 GW per year of storage will be needed to achieve decarbonization.[199] Fortunately, research on storage technologies has experienced significant breakthroughs in recent years. For example, sodium-ion batteries have emerged as a possible alternative to lithium-ion batteries, with sodium a much more abundant and less expensive material.[200] Researchers are likewise developing more efficient utility-scale methods for storing solar energy.[201]

Finally, while solar energy is intermittent, multiple studies have shown that the panels themselves are highly reliable—with appreciably low degradation and failure rates, thus rarely requiring repair or replacement.[202] A National Renewable Energy Laboratory (NREL) study found that the median failure rate for panels installed between 2000 to 2015 was five out of

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194 California Energy Comm'n., *Electric Generation Capacity and Energy*, https://www.energy.ca.gov/data-reports/energy-almanac/california-electricity-data/electric-generation-capacity-and-energy (last visited March 25, 2024).

195 California Energy Comm'n, *2022 Total System Electric Generation*, https://www.energy.ca.gov/data-reports/energy-almanac/california-electricity-data/2022-total-system-electric-generation (last visited March 25, 2024).

196 California Public Utilities Comm'n, *Electric System Reliability Annual Reports*, https://www.cpuc.ca.gov/industries-and-topics/electrical-energy/infrastructure/electric-reliability/electric-system-reliability-annual-reports (last visited March 25, 2024). In 2020, five of California's six investor-owned utilities had frequency of sustained outages below national average when including major event days; four of six had frequency of sustained outages below national average when excluding major event days; four of six had duration of outages below national average when including major event days; and four of six had duration of outages below national average when excluding major event days. "Major event days" consist of the worst 0.63% of outage events. *Id*.

197 *See* E&E News & Benjamin Storrow, *Solar Power Bails Out Texas Grid During Major Heat Wave*, SCIENTIFIC AMERICAN, June 26, 2023, https://www.scientificamerican.com/article/solar-power-bails-out-texas-grid-during-major-heat-wave/.

198 Joshua W. Busby et al., *Cascading risks: Understanding the 2021 winter blackout in Texas*, 77 ENERGY RESEARCH AND SOCIAL SCIENCE 102106, 1-4 (2021), https://www.sciencedirect.com/science/article/pii/S2214629621001997; Adriana Usero & Salvador Rizzo, *'Frozen windmills' aren't to blame for Texas's power failure*, WASH. POST, Feb. 18, 2021, https://www.washingtonpost.com/politics/2021/02/18/frozen-windmills-arent-blame-texass-power-failure-neither-is-green-new-deal/; Dionne Searcey, *No, Wind Farms Aren't the Main Cause of the Texas Blackouts*, N.Y. TIMES, Feb. 17, 2021 (updated May 3, 2021), https://www.nytimes.com/2021/02/17/climate/texas-blackouts-disinformation.html.

199 U.S. Dep't. Energy Solar Energy Technologies Office, *Solar Futures Study*, *supra* note 102 at 33.

200 Karyn Hede, *Longer Lasting Sodium-Ion Batteries on the Horizon,* Pac. Nw. Nat'l. Lab'y. (Jul. 13, 2022), https://www.pnnl.gov/news-media/longer-lasting-sodium-ion-batteries-horizon.

201 Robert Armstrong et al., *The Future of Energy Storage: An Interdisciplinary MIT Study,* MASS. INST. TECH. (Jun. 3, 2022), https://energy.mit.edu/wp-content/uploads/2022/05/The-Future-of-Energy-Storage.pdf.

202 Dirk C. Jordan et al., *Photovoltaic failure and degradation modes*, 25 PHOTOVOLTAICS RES. AND APPLICATIONS 318, 324 (2017), https://doi.org/10.1002/pip.2866; Dirk C. Jordan et al., *PV field reliability status—Analysis of 100 000 solar systems*, 28 PHOTOVOLTAICS RESEARCH AND APPLICATIONS 739, 747 (2020), https://doi.org/10.1002/pip.3262.

10,000 annually, a rate of 0.05%.[203] Researchers have described the failure rate of residential PV inverters as "acceptable, even good," with an inverter typically needing to be replaced only once in the lifetime of a PV system.[204]

False Claim #14: We do not have sufficient mineral resources for large-scale solar development.

> *"[T]here simply aren't enough minerals and energy on earth to make a transition to 'renewables.'"*[205]

A 2023 study that examined 75 emissions-reduction scenarios concluded that global reserves of critical materials are likely adequate to meet future demand for electricity generation infrastructure.[206] Production rates for many critical materials will need to grow substantially, but "[g]lobal mineral reserves should adequately meet needs posed by power sector material demand."[207] The United States Department of the Interior has likewise concluded that "[o]ther than perhaps short term interruptions resulting from market forces or geopolitical events, it is not anticipated that there will be any long term material constraints that would prevent the development of a significant amount of energy from photoelectric cells."[208]

In addition, as noted previously, new commercial ventures have formed to recycle solar panels,[209] potentially reducing future requirements for individual raw materials.[210] Valuable materials in solar panels, including silver, copper, and crystalline silicon, are actively sought for the development of other products, including the next generation of solar panels.[211] Furthermore, the 2021 Infrastructure Investment and Jobs Act, and the 2022 Inflation Reduction Act, include provisions to identify and develop domestic sources of rare earth materials and other critical minerals required for our energy transition.[212] In tandem with the rollout of these incentives, a Department of the Interior interagency working group has likewise issued more than 60 concrete recommendations for responsibly overhauling an administrative framework still largely shaped by the Mining Law of 1872.[213] These recommendations include substantial research investments, permitting reform, and

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[203] Jordan et al., *Photovoltaic failure and degradation modes*, *supra* note 202, at 324 (2017).

[204] Emiliano Bellini, *Survey shows 34.3% failure rate for residential inverters over 15 years*, PV MAGAZINE, Feb. 8, 2023, https://www.pv-magazine.com/2023/02/08/survey-shows-34-3-failure-rate-for-residential-inverters-over-15-years/ (discussing Christof Bucher et al., *Life Expectancy of PV Inverters and Optimizers in Residential PV Systems*, BERN UNIVERSITY OF APPLIES SCIENCES, 2022, https://www.bfh.ch/dam/jcr:5bfd5c32-f70f-4bf6-8d60-fdab6094e164/2022_09_WCPEC-8_3DV.1.46_-_Life_Expectancy_of_PV_inverters.pdf).

[205] *Not Enough Rare Metals to Scale Up Solar Power*, ENERGYSKEPTIC.COM (Feb. 21, 2021), https://energyskeptic.com/2021/solar-pv-cells-using-rare-elements-unlikely-to-scale-up-enough-to-replace-fossil-fuels/.

[206] Seaver Wang et al., *Future demand for electricity generation materials under different climate mitigation scenarios*, 7 JOULE 309, 315 (Feb. 2023), https://www.cell.com/joule/pdfExtended/S2542-4351(23)00001-6.

[207] *Id.* at 320.

[208] *Byproduct Mineral Commodities Used for the Production of Photovoltaic Cells*, US GEOLOGIC SURVEY (2010), 2, https://pubs.usgs.gov/circ/1365/Circ1365.pdf.

[209] *See* Drew Mays, *Future of Solar Panel Recycling*, INNOVATE ENERGY GROUP, July 6, 2023, https://www.ieg.solutions/post/the-future-of-solar-panel-recycling.

[210] Wang et al., *Future demand for electricity generation materials under different climate mitigation scenarios*, *supra* note 206, at 320.

[211] Jon Hurdle, *As Millions of Solar Panels Age Out, Recyclers Hope to Cash In*, YALE ENV'T 360 (Feb. 28, 2023), https://e360.yale.edu/features/solar-energy-panels-recycling.

[212] Oscar Serpell, *Impacts of the Inflation Reduction Act on Rare Earth Elements*, KLEINMAN CENTER FOR ENERGY POLICY (Sep. 24, 2022), https://kleinmanenergy.upenn.edu/news-insights/impacts-of-the-inflation-reduction-act-on-rare-earth-elements/.

[213] *Biden-Harris Administration Fundamental Principles for Domestic Mining Reform*, U.S. DEP'T OF THE INTERIOR (Feb. 22, 2022), https://www.doi.gov/sites/doi.gov/files/biden-harris-administration-fundamental-principles-for-domestic-mining-reform.pdf.

proactive public and Tribal engagement.[214] The Department of Energy, in turn, recently announced a $150 million initiative "to advance cost effective and environmentally responsible processes" for producing critical minerals and materials in the United States.[215]

[214] *See Recommendations to Improve Mining on Public Lands*, U.S. DEP'T OF THE INTERIOR (Sept. 2023), https://www.doi.gov/media/document/mriwg-report-final-508-pdf.

[215] *Biden-Harris Administration Announces $150 Million to Strengthen Domestic Critical Material Supply Chains*, U.S. DEP'T OF ENERGY (Sept. 6, 2023), https://www.energy.gov/articles/biden-harris-administration-announces-150-million-strengthen-domestic-critical-material.

PART B: FALSE CLAIMS ABOUT WIND ENERGY (#15–#29)

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False Claim #15: Electromagnetic radiation from wind turbines poses a threat to human health.

> *"Recently, concerns about exposure to EMF from wind turbines, and associated electrical transmissions, have been raised at public meetings and legal proceedings."*[216]

Multiple studies have found that the electromagnetic fields (EMFs) generated by wind turbines are lower than those generated by most common household appliances and that they easily meet rigorous international safety standards.[217] For context, the average home that is not located near power lines has a background level EMF of roughly 0.2 μT.[218] However, this value varies greatly depending on proximity to certain household appliances.[219] For example, from a distance of 4 feet, an electric can opener's EMF is 0.2 μT, but this value increases to 60 μT from a distance of 6 inches.[220] A 2020 academic study found that the EMF generated by turbines are approximately 0.44 μT at a distance of 1 meter but less than 0.1 μT at a distance of 4 meters, as shown below.[221]

216 OHIO DEPARTMENT OF HEALTH, WIND TURBINES AND WIND FARMS: SUMMARY AND ASSESSMENTS at 8 (Apr. 12, 2022), https://odh.ohio.gov/wps/wcm/connect/gov/816f89dc-767f-4f08-8172-71c953b8ee02/ODH+Wind+Turbines+and+Farms+Summary+Assessment_2022.04.pdf?MOD=AJPERES.

217 Lindsay C. McCallum et al., *Measuring Electromagnetic Fields (EMF) Around Wind Turbines in Canada: Is there a Human Health Concern?*, 13 ENV'T. HEALTH 1, 9 (2014), https://doi.org/10.1186/1476-069x-13-9; Aris Alexias et al., *Extremely Low Frequency Electromagnetic Field Exposure Measurement in the Vicinity of Wind Turbines*, 189 RADIATION PROTECTION DOSIMETRY 395, 397 (2020), https://doi.org/10.1093/rpd/ncaa053; Nektarios Karanikas et al., *Occupational health hazards and risks in the wind industry*, 7 ENERGY REP. 3750, 3752 (2021), https://doi.org/10.1016/j.egyr.2021.06.066.

218 *Radiation: Electromagnetic fields*, WORLD HEALTH ORGANIZATION (August 4, 2016), https://www.who.int/news-room/questions-and-answers/item/radiation-electromagnetic-fields.

219 *Id.*

220 *Electromagnetic Fields (EMF)*, WIS. DEP'T. OF HEALTH SERV. (Sept. 14, 2022), https://www.dhs.wisconsin.gov/air/emf.htm.

221 Alexias et al., *supra* note 217, at 397.

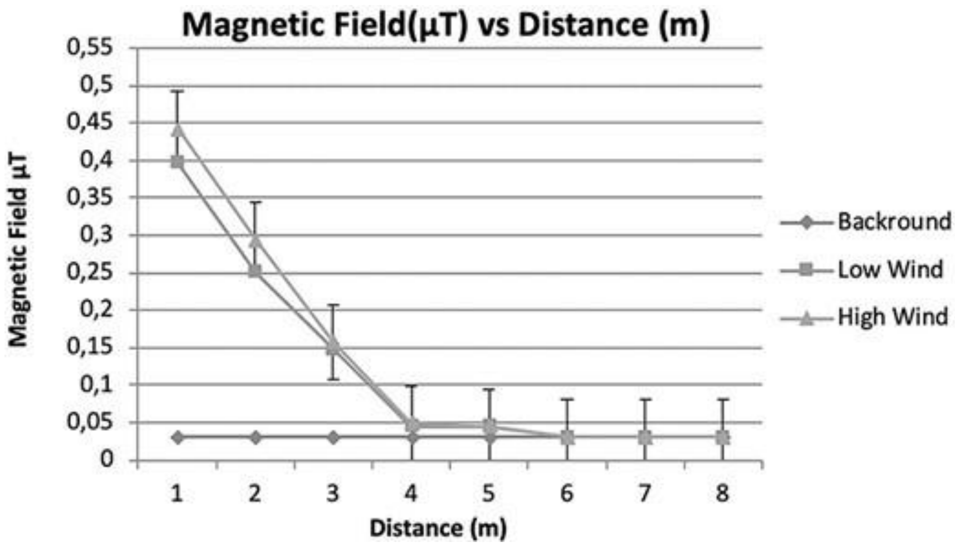

Figure 10: The EMF level, measured in microtesla (µT), is shown to drop dramatically with increase in distance from source.
Source: Alexias et al.[222]

These EMF levels are not dependent on wind speeds.[223]

False Claim #16: Wind turbines frequently fall over, and blades or other components easily break off, threatening human health and safety.

> *"There are many health hazards associated with living near turbines as a result of . . . broken flying blades."*[224]

Turbine collapse or breakage are extremely rare, and utility-scale wind turbines are fitted with safety mechanisms to survive extreme weather conditions, such as hurricanes.[225] Turbine blade breakage does not pose a significant threat to humans.[226] The Department of Energy has noted that, although the risk of turbine blades becoming detached during operation "was a concern in the early years of the wind industry," such failures "are virtually non-existent on today's turbines due to better engineering and the use of sensors."[227] Turning to all turbine blade failures, rather than just turbine blade detachment, a

[222] *Id.*
[223] *Id.* at 398.
[224] *No Wind Turbines! Get the Facts!*, SAVE PIATT COUNTY, http://www.savepiattcounty.org/ (last visited March 25, 2024).
[225] *How do wind turbines survive severe storms?*, OFFICE OF ENERGY EFFICIENCY AND RENEWABLE ENERGY, U.S. DEPARTMENT OF ENERGY, (June 20, 2017), https://www.energy.gov/eere/articles/how-do-wind-turbines-survive-severe-storms.
[226] M. McGugan et al., *Damage Tolerance and Structural Monitoring for Wind Turbine Blades.* 373 PHIL. TRANSACTIONS ROYAL SOC'Y A, 4 (2015), https://doi.org/10.1098/rsta.2014.0077.
[227] *Wind Energy Projects and Safety*, Dep't of Energy, https://windexchange.energy.gov/projects/safety (last visited March 25, 2024).

2015 study found that wind turbine blades fail at a rate of approximately 0.54% per year globally.[228] The Department of Energy has further reported that "catastrophic wind turbine failures . . . are considered rare events with fewer than 40 incidents identified in the modern turbine fleet of more than 40,000 turbines installed in the United States as of 2014."[229]

When looking at deaths per terawatt-hour of energy produced, the mortality rate from wind energy pales in comparison to the risks associated with fossil fuels. Brown coal causes 32.72 human deaths per terawatt-hour, while black coal causes 24.6 human deaths, oil causes 18.4 human deaths, natural gas causes 2.8 human deaths, and wind energy causes only 0.04 human deaths.[230]

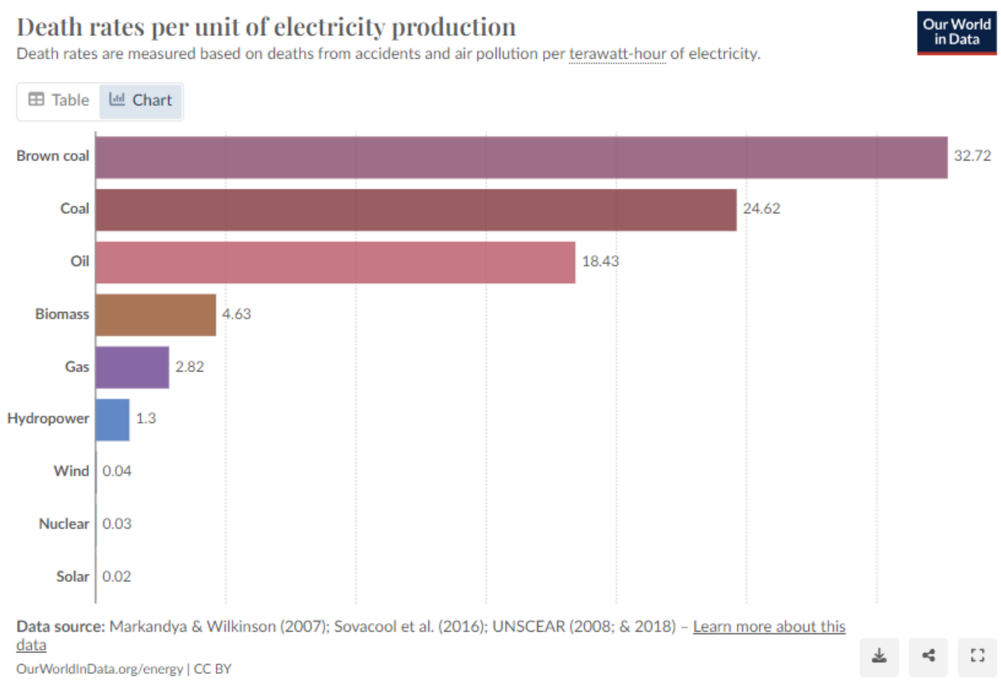

Figure 11: Death rates per unit of electricity production.
Source: Hannah Ritchie, Our World in Data.[231]

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[228] GCube Insurance Services, Inc. *GCube report: breaking blades: global trends in wind turbine downtime events* (2015), summarized in Xiao Chen, *A Critical Review of Damage and Failure of Composite Wind Turbines Blade Structures*, IOP CONFERENCE SERIES: MATERIALS SCI. AND ENGINEERING (2020), at 4, https://iopscience.iop.org/article/10.1088/1757-899X/942/1/012001/pdf.
[229] *Wind Vision: A New Era for Wind Power in the United States*, U.S. DEPARTMENT OF ENERGY, 105 (2015), https://www.energy.gov/sites/prod/files/WindVision_Report_final.pdf
[230] Hannah Ritchie, *supra* note 13.
[231] *Id.*

False Claim #17: Low-frequency noise from wind turbines harms human health and causes "wind turbine syndrome."

> *"As wind turbines spring up like mushrooms around people's homes, Wind Turbine Syndrome has become an industrial plague."*[232]

Multiple studies have concluded that there is no direct causal correlation between noise from wind turbines and human health.[233] Rather, studies have found that individual cases of headache or malaise in proximity to new wind turbines are most likely the result of personal attitudes toward and annoyance regarding the turbines.[234]

Accounts of "wind turbine syndrome" have received significant criticism from the scientific community, and public-health experts argue that any symptoms experienced are likely psychosomatic.[235] One historical study looked at complaints filed in relation to 51 Australian wind farms from 1993 to 2012.[236] Prior to 2009, complaints related to health and noise were rare, despite the fact that many small and large wind farms were already in operation.[237] However, following the coining of the phrase "wind turbine syndrome" in a self-published book that year, there was a dramatic spike in complaints.[238]

False Claim #18: Shadow flicker from wind turbines can trigger seizures in people with epilepsy.

> *"Wind farms are more than just an eyesore. They can cause epileptic fits."*[239]

Even at its peak, shadow flicker from wind turbines typically remains far weaker than what is known to trigger seizures in people with epilepsy.[240]

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[232] Calvin Luther Martin, *Your Guide to Wind Turbine Syndrome…A Roadmap to this Complicated Subject*, NATIONAL WIND WATCH (July 2010), https://docs.wind-watch.org/WTSguide.pdf.
[233] Jenni Radun et al., *Health Effects of Wind Turbine Noise and Road Traffic Noise on People Living Near Wind Turbines*, 157 RENEWABLE & SUSTAINABLE ENERGY REV., 10 (2022), https://doi.org/10.1016/j.rser.2021.112040; Irene van Kamp et al., *Health Effects Related to Wind Turbine Sound: An Update*, 18 INT'L J. ENV'T RSCH & PUB. HEALTH, (2021), https://doi.org/10.3390%2Fijerph18179133; Wind Energy Technologies Office, *Frequently Asked Questions about Wind Energy*, OFFICE OF ENERGY EFFICIENCY AND RENEWABLE ENERGY, U.S. DEPARTMENT OF ENERGY, https://www.energy.gov/eere/wind/frequently-asked-questions-about-wind-energy#WindTurbineHealth (last visited March 25, 2024); Jesper Schmidt et al., *Health Effects Related to Wind Turbine Noise Exposure: A Systematic Review*, 9 PLOS ONE, (2014), https://doi.org/10.1371/journal.pone.0114183; *NHMRC Statement: Evidence on Wind Farms and Human Health*, NATIONAL HEALTH AND MEDICAL RESEARCH COUNCIL (NHMRC), AUSTRALIAN GOVERNMENT, 1 (2015), https://www.nhmrc.gov.au/file/19045/download?token=0IAl7MHu.
[234] Irene van Kamp et al., *supra* note 233.
[235] Nathaniel Marshall et al., *The Health Effects of 72 Hours of Simulated Wind Turbine Infrasound: A Double-Blind Randomized Crossover Study in Noise-Sensitive, Healthy Adults*, 131 ENV'T HEALTH PROSPECTIVE, 1 (2023), https://doi.org/10.1289/EHP10757.
[236] Fiona Crichton et al., *The Link between Health Complaints and Wind Turbines: Support for the Nocebo Expectations Hypothesis*, 2 FRONTIERS PUBL. HEALTH, 2-3 (2014), https://doi.org/10.3389/fpubh.2014.00220.
[237] *Id.*
[238] *Id.*
[239] *Wind Turbines Can Trigger Epileptic Fits and Seizures, Say Scientists,* DAILY MAIL (Apr. 9, 2008), https://www.dailymail.co.uk/news/article-562841/Wind-turbines-trigger-epileptic-fits-seizures-say-scientists.html.
[240] Wind Energy Technologies Office, *Frequently Asked Questions about Wind Energy*, *supra* note 233.

A 2021 academic study found that wind turbines operate between 0.5 to 1 Hz, much lower than the threshold frequency of 3 Hz typically required to cause a seizure.[241] Similarly, a 2012 report prepared for the Massachusetts Department of Environmental Protection found that shadow flicker frequencies from wind turbines are "usually in the range of 0.3–1.0 Hz, which is outside of the range of seizure thresholds according to the National Resource Council and the Epilepsy Foundation."[242] If shadow flicker were to reach 3 Hz, the probability of causing a seizure in a member of the photosensitive population would be approximately 1.7/100,000.[243]

Additional public-health studies have likewise found that wind turbines do not cause seizures.[244] Wind turbines with three blades, for example, would need to rotate at a speed of 60 rpm to cause a seizure.[245] However, modern turbines typically operate at maximum speeds between 15 and 17 rpm, depending on model, well below the 60 rpm threshold.[246]

False Claim #19: Wind turbines are a major threat to birds, bats, and other wildlife.

> *"The evidence is clear . . . that wind turbines present yet another threat to the lives of birds and bats."*[247]

According to the National Audubon Society, two-thirds of all North American bird species are at heightened risk of extinction due to climate change.[248] Wildfires will destroy the nesting grounds of many species,[249] while extreme heatwaves will render their typical habitats uninhabitable.[250] For example, the American Goldfinch is projected to lose 65% of its range under a scenario of 3 degrees Celsius global warming, while the Allen's Hummingbird is projected to lose 64% of its range.[251]

By contrast, wind power is a relatively minor source of mortality for birds. The U.S. Fish and Wildlife Service has estimated that, throughout the United States, cats kill an average of 2.4 billion birds per year, and collisions with building glass kill an average of 599 million birds, while wind turbines kill an average of 234,000 birds per year.[252] These mortality figures for wind impacts rely on studies dating back to 2013 or 2014 and may be outdated due to the fact that there were fewer wind

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[241] Nektarios Karanikas et al., *Occupational Health Hazards and Risks in the Wind Industry*, 7 ENERGY REP. 3750, 3752-3753 (2021), https://doi.org/10.1016/j.egyr.2021.06.066.
[242] *Wind Turbine Health Impact Study: Report of Independent Expert Panel,* MASSACHUSETTS DEPARTMENT OF ENVIRONMENTAL PROTECTION, 36 (2012), https://www.mass.gov/doc/wind-turbine-health-impact-study-report-of-independent-expert-panel/download.
[243] *Id.*
[244] Oleksandr Zaporozhets et al., *Environment Impact Assessment for New Wind Farm Developments in Ukraine*, *in* 2022 IEEE 8TH INTERNATIONAL CONFERENCE ON ENERGY SMART SYSTEMS 386, 387 (Institute of Electrical and Electronics Engineers, 2022), https://doi.org/10.1109/ESS57819.2022.9969323; Loren Knopper et al., *Wind Turbines and Human Health*, 2 FRONTIERS PUBL. HEALTH, 14 (2014), https://doi.org/10.3389/fpubh.2014.00063.
[245] Knopper et al., *supra* note 244 at 14.
[246] *Id.*
[247] *FAQ: Impact on Wildlife*, NATIONAL WIND WATCH, https://www.wind-watch.org/faq-wildlife.php (last visited March 25, 2024).
[248] Audubon Society, *Survival by Degrees: 389 Bird Species on the Brink*, NAT'L. AUDUBON SOC'Y., https://www.audubon.org/climate/survivalbydegrees (last visited March 25, 2024).
[249] Audubon Society, *How Wildfires Affect Birds*, NAT'L. AUDUBON SOC'Y., https://www.audubon.org/news/how-wildfires-affect-birds (last visited March 25, 2024).
[250] Audubon Society, *Survival by Degrees: 389 Bird Species on the Brink*, *supra* note 248.
[251] *Id.*
[252] *Threats to Birds*, U.S. FISH & WILDLIFE SERVICE, https://www.fws.gov/library/collections/threats-birds (last visited March 25, 2024).

turbines 10 years ago than there are today.[253] However, research has found that wind power causes far fewer bird deaths than fossil fuels per unit of energy output, a metric that is not sensitive to the total number of wind turbines installed. While fossil fuels cause 5.2 avian fatalities per GWh, wind turbines cause only 0.3–0.4 avian fatalities per GWh.[254]

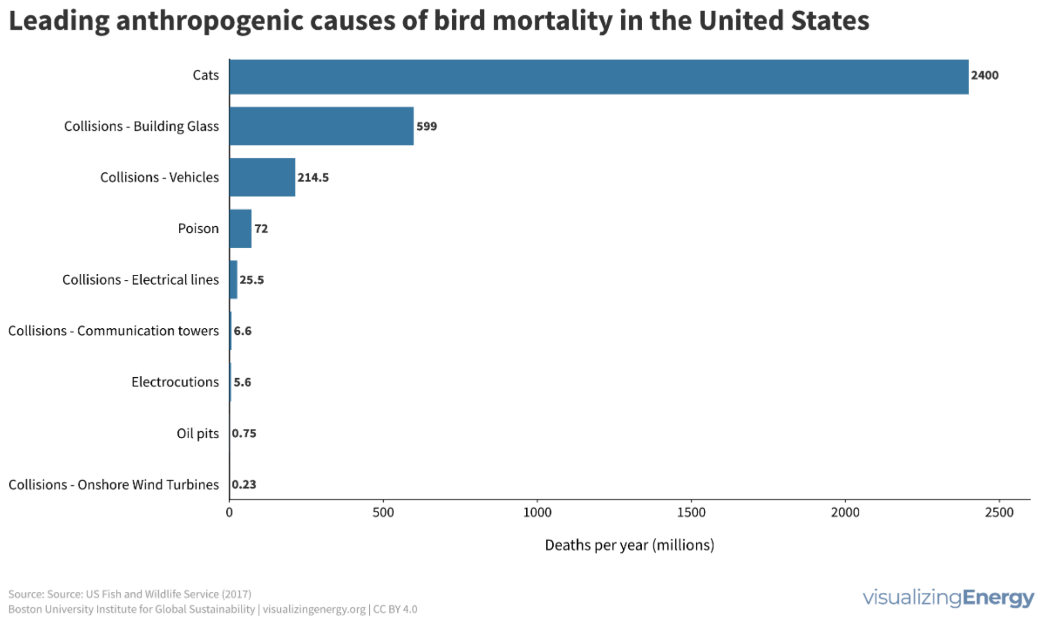

Figure 12: Leading anthropogenic causes of deaths to birds in the United States.
Source: Boston University Institute for Global Sustainability.[255]

In addition, actionable steps can be taken to reduce bird and bat fatalities from wind turbines. To provide one example, most bird deaths occur when turbines are sited near nesting places. Proper siting of turbines that takes into account where birds nest, feed and mate, as well as where they stop when migrating, has proved successful at reducing fatalities.[256]

To provide a second example, the wind turbine components that pose the greatest risk to birds are the blades and tower.[257] The relatively simple action of painting the tower black has been shown to reduce deaths by roughly 48%, while painting one of the blades black has reduced deaths by 70%. Other successful methods promoting the safe passage of birds and

[253] *Do wind turbines kill birds?* MIT CLIMATE PORTAL (Aug. 17, 2023), https://climate.mit.edu/ask-mit/do-wind-turbines-kill-birds (noting that the cited studies were published in 2013 and 2014, and the numbers are likely to be higher today because more wind farms have been built since then).
[254] Benjamin K. Sovacool, *The avian benefits of wind energy: A 2009 update*, 49 RENEWABLE ENERGY 19, 19 (2013), https://doi.org/10.1016/j.renene.2012.01.074. The Sovacool study explains that fossil fuels cause avian fatalities upstream during coal mining, through collision and electrocution with operating plant equipment, and indirectly through acid rain, mercury pollution, and climate change. *Id.* at 21. The study is based on operating performance in the United States and Europe. *Id.* at 19.
[255] Cutler Cleveland et al., *Is Wind Energy a Major Threat to Birds?*, VISUALIZING ENERGY, Oct. 9, 2023, https://visualizingenergy.org/is-wind-energy-a-major-threat-to-birds/.
[256] Sovacool, *supra* note 254 at 19-20.
[257] *Id.* at 23.

bats include slowing or stopping turbine motors when vulnerable species are present, in order to reduce the likelihood of collisions.[258] Deployment of this method in Wyoming has contributed to an 80% decline in eagle fatalities.[259]

New strategies under development include the use of artificial intelligence and surveillance to monitor nearby bird and bat activity, which can help inform when to slow or stop turbine motors. One preventative strategy involves producing visual and auditory outputs that deter vulnerable bird and bat species from flying near the turbines altogether.[260] Overall, though it remains difficult to eliminate the risk of collisions entirely, wind power can ultimately help to protect bird and bat populations by displacing fossil fuels and mitigating climate change impacts.[261]

False Claim #20: Offshore wind development is harmful to whales and other marine life.[262]

> *"Record numbers of endangered whales [are] being killed by windfarms off America's East Coast"*[263]

When properly sited, offshore wind farms need not pose a serious risk of harm to whales or other marine life. During installation, the impact from construction noise can be mitigated by implementing seasonal restrictions on certain activities that coincide with whale migration. Once operational, wind turbines generate far less low-frequency sound than ships do, and there is no evidence that noise from turbines causes negative impacts to marine species populations.[264]

There has been considerable attention to how offshore wind development, including noise from pile-driving during construction, affects the critically endangered North Atlantic right whale, which has a total population of roughly 360.[265] But the main causes of mortality for right whales are vessel strikes (75% of anthropogenic deaths) and entanglements in

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[258] U.S. Dep't. of Energy Wind Energy Technologies Office, *Environmental Impacts and Siting of Wind Projects,* U.S. DEP'T. ENERGY: OFFICE OF ENERGY EFFICIENCY AND RENEWABLE ENERGY, https://www.energy.gov/eere/wind/environmental-impacts-and-siting-wind-projects (last visited March 25, 2024).
[259] Christopher J.W. McClure et al., *Eagle fatalities are reduced by automated curtailment of wind turbines*, 58 BRITISH ECOLOGICAL SOC'Y. 446, 450-451 (2021), https://doi.org/10.1111/1365-2664.13831.
[260] *Chapter 4: Minimizing Collision Risk to Wildlife During Operations: Minimization: Deterrence*, RENEWABLE ENERGY WILDLIFE INST. (Dec. 27, 2022), https://rewi.org/guide/chapters/04-minimizing-collision-risk-to-wildlife-during-operations/minimization-deterrence/.
[261] Audubon Society, *Wind Power and Birds*, NAT'L. AUDUBON SOC'Y. (Jul. 21, 2020), https://www.audubon.org/news/wind-power-and-birds.
[262] While outside the scope of this report, it bears noting that journalists have uncovered financial connections between fossil fuel interest groups and certain groups alleging that offshore wind development leads to considerable negative impacts on whales. *See* Marvell, *supra* note 11.
[263] Mike Parker, *Record Numbers of Endangered Whales Being Killed by Windfarms Off America's East Coast*, EXPRESS, (Sept 2, 2023) https://www.express.co.uk/news/us/1808681/endangered-whales-killed-east-coast-windfarms (capitalization edited to sentence case).
[264] Jakob Tougaard et al., *How Loud is the Underwater Noise from Operating Offshore Wind Turbines?* 148 J. ACOUSTICAL SOC. OF AMER. 2885, 2888 (2020), https://doi.org/10.1121/10.0002453.
[265] North Atlantic Right Whale, NOAA FISHERIES, https://www.fisheries.noaa.gov/species/north-atlantic-right-whale (last visited March 25, 2024).

fishing gear—not anything related to offshore wind development.[266] Critically, the National Oceanic and Atmospheric Administration (NOAA) has also found no link between offshore wind surveys or development on whale deaths.[267]

Moreover, any impacts to the North Atlantic right whale can be avoided or greatly minimized through proper planning. For example, in 2019, the developer of the 800-MW Vineyard Wind project entered into an agreement with three environmental organizations, which established seasonal restrictions on pile-driving during construction (to avoid excessive noise when right whales are present), as well as strict limits on vessel speeds during the operational phase (to avoid vessel strikes), among other measures.[268] In the final environmental impact statement for the project, the U.S. Bureau of Ocean Energy Management (BOEM) found that, "[g]iven the implementation of Project-specific measures, BOEM anticipates that vessel strikes as a result of [the project] alone are highly unlikely and that impacts on marine mammal individuals . . . would be expected to be minor; as such, no population-level impacts would be expected."[269] BOEM also found that project installation would be unlikely to cause noise-related impacts to right whales, due to the time of year during which construction activities would take place.[270]

Offshore wind development can have benefits for other marine species. For example, the base of an offshore wind turbine may function as an artificial reef, creating new habitats for native fish species.[271]

By contrast, offshore oil and gas drilling routinely harms marine life, while posing a persistent risk of catastrophic outcomes.[272] Sonar used for offshore oil and gas exploration emits much stronger pulses of sound than sonar used for wind farm surveying.[273] The 2010 Deepwater Horizon oil spill killed millions of marine animals, including as many as 800,000 birds.[274] More broadly, carbon dioxide emissions from fossil fuel use are making the ocean increasingly acidic, which inhibits shellfish and corals from developing and maintaining calcium carbonate shells and exoskeletons.[275] Finally, climate change is expected to have "long-term, high-consequence impacts" on whales and other marine mammals, including "increased energetic costs associated with altered migration routes, reduction of suitable breeding and/or foraging habitat, and reduced individual fitness, particularly juveniles."[276]

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266 *Id.*; VINEYARD WIND 1 OFFSHORE WIND PROJECT FINAL ENVIRONMENTAL IMPACT STATEMENT Vol. I, March 2023, at 3-95, https://www.boem.gov/sites/default/files/documents/renewable-energy/state-activities/Vineyard-Wind-1-FEIS-Volume-1.pdf.

267 Frequent Questions – Offshore Wind and Whales, NOAA, https://www.fisheries.noaa.gov/new-england-mid-atlantic/marine-life-distress/frequent-questions-offshore-wind-and-whales (last visited March 25, 2024).

268 Vineyard Wind – NGO Agreement, Jan. 22, 2019, https://www.nrdc.org/sites/default/files/vineyard-wind-whales-agreement-20190122.pdf.

269 Vineyard Wind Final EIS, *supra* note 266, at 3-95.

270 *Id.* at 3-91.

271 Steven Degraer et al., *Offshore Wind Farm Artificial Reefs Affect Ecosystem Structure and Functioning: A Synthesis,* 33 OCEANOGRAPHY 48, 49 (2020), https://doi.org/10.5670/oceanog.2020.405; *Offshore Renewable Energy Improves Habitat, Increases Fish*, RHODE ISLAND SEA GRANT (July 26, 2020), https://seagrant.gso.uri.edu/offshore-renewable-energy-improves-habitat-increases-fish/.

272 Marvell, *supra* note 11.

273 *Id.*

274 Martha Harbison, *More Than One Million Birds Died During the Deepwater Horizon Disaster.* Audubon, NATIONAL AUDUBON SOCIETY (May 6, 2014), https://www.audubon.org/news/more-one-million-birds-died-during-deepwater-horizon-disaster.

275 National Ocean Service, *What is Ocean Acidification?*, NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION, https://oceanservice.noaa.gov/facts/acidification.html (last visited March 25, 2024).

276 Vineyard Wind Final EIS, *supra* note 266, at 3-85.

False Claim #21: Producing and transporting wind turbine components releases more carbon dioxide than burning fossil fuels.

> *"[W]indmills are perhaps the worst boondoggle . . . because they require much more high quality energy to manufacture, install, maintain, and back up than [they] will ever produce."*[277]

On a lifecycle basis, wind power emits far less carbon dioxide than fossil fuels per kilowatt-hour of energy generated.[278] According to the National Renewable Energy Laboratory (NREL), the average lifecycle emissions of offshore and onshore wind turbines is 13 g CO_2-eq/KWh.[279] Lifecycle emissions for fossil fuels are much higher, with natural gas and coal releasing 486 g CO_2-eq/KWh and 1001 g CO_2-eq/KWh emissions, respectively.[280] In other words, the average lifecycle emissions of wind energy is roughly 1/77th that of coal.[281]

Manufacturing accounts for only a small percentage (2.41%) of the lifecycle emissions for wind power turbines.[282] Most turbine emissions come from transportation, which accounts for over 90% of emissions for both offshore and onshore operations.[283] Once operational, wind turbines create clean, emissions-free energy that offsets the carbon dioxide emissions associated with production and transportation.[284]

False Claim #22: Wind turbines will generate an unsustainable amount of waste.

> *"This clean, green energy is not so clean and not so green . . . [i]t's just more waste going in our landfills."*[285]

Roughly 80%-85% of modern wind turbine materials, including the steel turbine tower, can be recycled.[286] Turbine blades,

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277 *Developer Claims: Wind Energy Efficiency*, INTERSTATE INFORMED CITIZENS COALITION, https://iiccusa.org/developer-claims/developer-claims-wind-energy-inefficiency/ (last visited March 25, 2024).
278 Stacey L. Dolan & Garvin A. Heath, *Life Cycle Greenhouse Gas Emissions of Utility-Scale Wind Power,* 16 J. INDUS. ECOLOGY, S136-S154 (2012), https://doi.org/10.1111/j.1530-9290.2012.00464.x; Shifang Wang et al., *Life-Cycle Green-House Gas Emissions of Onshore and Offshore Wind Turbines*, 210 J. CLEANER PROD. 804, 807-808 (2019), https://doi.org/10.1016/j.jclepro.2018.11.031; Nat'l Renewable Energy Laboratory, *supra* note 66, at 3.
279 Nat'l Renewable Energy Laboratory, *supra* note 66, at 3.
280 *Id.*
281 *Id.*
282 Wang et al., *Life-Cycle Green-House Gas Emissions of Onshore and Offshore Wind Turbines*, *supra* note 278, at 807.
283 *Id.* at 804.
284 Sara Peach, *What's the Carbon Footprint of a Wind Turbine?,* YALE CLIMATE CONNECTIONS (June 30, 2021), https://yaleclimateconnections.org/2021/06/whats-the-carbon-footprint-of-a-wind-turbine/.
285 Donnelle Eller, *Iowa's betting big on wind energy, but it's creating a problem: What happens to the blades once they're no longer useful?*, DES MOINES REGISTER (Nov. 6, 2019), https://www.desmoinesregister.com/story/money/agriculture/2019/11/06/few-recycling-options-wind-turbine-blades-head-iowa-landfills/3942480002/.
286 Muhammad Khalid et al., *Recycling of Wind Turbine Blades Through Modern Recycling Technologies: A Road to Zero Waste*, 44 RENEWABLE ENERGY FOCUS 373, 375 (2023), https://doi.org/10.1016/j.ref.2023.02.001; Alejandro de la Garza, Time, Sept. 25, 2023, https://time.com/6316828/recycling-old-wind-turbine-blades/.

which contain fiberglass composite materials are more difficult to recycle, but new techniques are being explored.[287] A recent breakthrough supported by the Department of Energy, for example, enabled all turbine components to be recycled.[288] Private companies have begun developing turbine blade recycling plants to ensure that wind turbine production is entirely circular.[289]

One company's analysis found that total cumulative waste from decommissioned turbines blades could exceed 14 million tons by the early 2040s.[290] This is not insignificant. However, Nature Physics has projected that fossil fuel-based power generation is expected to produce roughly 45,550 million metric tons of coal ash alone by 2050, along with 249 million metric tons of oily sludge.[291] These figures far exceed the anticipated waste from wind turbine blades, and both coal ash and oily sludge are known to be toxic.[292] For context, roughly 600 million tons of construction and demolition debris were generated in the United States in 2018 across all sectors.[293]

False Claim #23: Wind turbines take up too much land.

> *"The wind's low power density means massive materials and land/sea area requirements."*[294]

Princeton University's 2021 report, *Net-Zero America*, concluded that the wind turbines needed for the United States to reach net-zero emissions by 2050 will have a direct footprint (i.e. the area covered by turbine bases and access roads) of between 603,678 and 2,479,208 acres.[295] This is notably less than the 4.4 million acres currently used for natural gas extraction and the 3.5 million acres for oil extraction.[296]

Moreover, depending on the location and the technology used, wind turbines can also require less land per kilowatt-hour generated than fossil fuels.[297] A report by the United Nations Economic Commission for Europe (UNECE) found that total land occupation (agriculture and urban) for wind power ranged from 0.3–1 m^2/KWh for 2022.[298] The exact value depends

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287 Jonas Jensen et al., *Wind Turbine Blade Recycling: Experiences, Challenges and Possibilities in a Circular Economy*, 97 RENEWABLE & SUSTAINABLE ENERGY REV. 165, 171 (2018), https://doi.org/10.1016/j.rser.2018.08.041.

288 Wind Energy Technologies Office, *Carbon Rivers Makes Wind Turbine Blade Recycling and Upcycling a Reality with Support From DOE*, OFFICE OF ENERGY EFFICIENCY AND RENEWABLE ENERGY, U.S. DEPARTMENT OF ENERGY (October 17, 2022) https://www.energy.gov/eere/wind/articles/carbon-rivers-makes-wind-turbine-blade-recycling-and-upcycling-reality-support.

289 Dave Downey, *Here's How One Iowa Company is Taking Wind Turbine Blades Out of the Landfill*, WE ARE IOWA (January 24, 2023), https://www.weareiowa.com/article/tech/science/environment/recycling-wind-turbine-blades-regen-fiber-travero-alliant-energy-fiberglass-iowa/524-88fe0610-cede-4a56-a9a3-01a36319927c.

290 Madeline Ruid, *Recycling: An Imperative for the Renewable Energy Landscape*, GLOBAL X, Nov. 14, 2023, https://www.globalxetfs.com/recycling-an-imperative-for-the-renewable-energy-landscape/.

291 Mirletz et al., *supra* note 55, at 1376.

292 *Id.*

293 *Construction and Demolition Debris: Material-Specific Data*, United States Envt'l Protection Agency, https://www.epa.gov/facts-and-figures-about-materials-waste-and-recycling/construction-and-demolition-debris-material (last visited Apr. 1, 2024).

294 *Home*, NAT'L WIND WATCH, https://www.wind-watch.org/ (last visited March 25, 2024).

295 Eric Larson et al., *supra* note 104, at 245. The report predicts that the "total wind farm area" will be significantly larger, but these numbers include the entire visual footprint of wind farms.

296 Dave Merrill, *The U.S. Will Need a Lot More Land for a Zero-Carbon Economy,* BLOOMBERG (June 3, 2021), https://www.bloomberg.com/graphics/2021-energy-land-use-economy/.

297 *Carbon Neutrality in the UNECE Region: Integrated Life-cycle Assessment of Electricity Sources*, UNITED NATIONS ECONOMIC COMMISSION FOR EUROPE (UNECE), United Nations, 70 (2022), https://unece.org/sites/default/files/2022-08/LCA_0708_correction.pdf.

298 *Id.*

on the type of wind tower, onshore or offshore siting, and the particular location of the turbine.[299] By comparison, natural gas values ranged from 0.6–3.3 m^2/KWh, and coal values from 7.2–23.8 m^2/KWh.[300] The UNECE report notes that these calculations do not include carbon capture and storage (CCS), which, if implemented, would decrease emissions but increase land use.[301]

Wind energy also uses far less land than biomass. Dedicated biomass consumes an average of 160,000 hectares of land per terawatt-hour per year.[302] By contrast, the land-use intensity of wind energy is only 170 hectares per terawatt-hour per year when looking at the direct footprint of wind or 15,000 hectares per terawatt-hour per year when including space between turbines.[303]

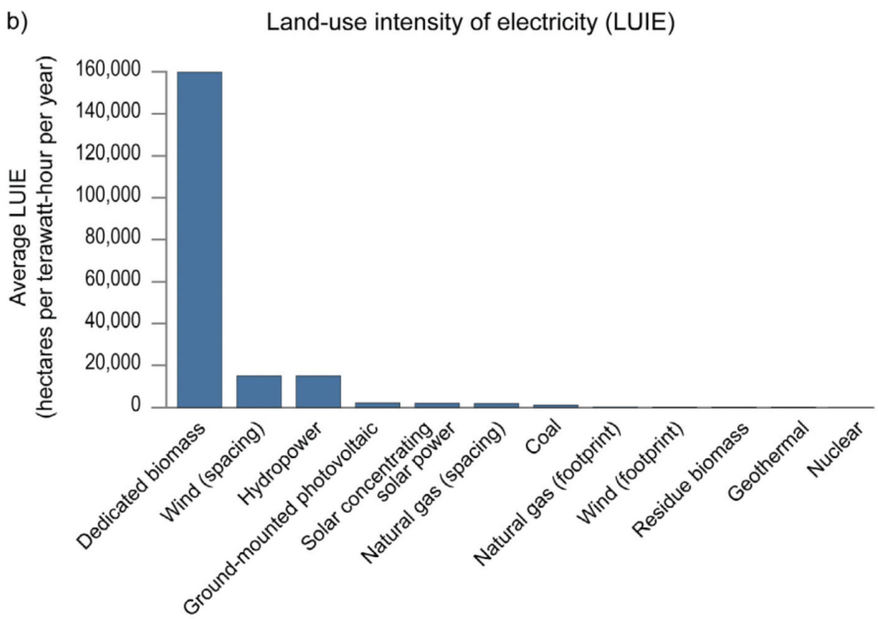

Figure 13: Average land-use intensity of electricity, measured in hectares per terawatt-hour per year.
Source: U.S. Global Change Research Program (visualizing data from Jessica Lovering et al.).[304]

Fossil fuel generation also has more harmful and enduring impacts on the land that it uses. Spills frequently occur as a result of the extraction, transportation, and distribution of oil and natural gas, causing soil and water damage. A 2017 study found that between 2% and 16% of unconventional oil and gas wells reported a spill each year, with more spills in some

[299] *Id.*
[300] *Id.*
[301] *Id.*
[302] Jessica Lovering et al., *supra* note 120, at 8.
[303] *Id.*
[304] U.S. GLOBAL CHANGE RESEARCH PROGRAM, *supra* note 121 at 32-29 (visualizing data from Jessica Lovering et al., *supra* note 120 at 8).

states than others.[305] Reclamation is difficult in areas surrounding extraction sites because of frequent leakage.[306] The land involved often suffers long-term damage and can only be used for limited purposes.[307] Moreover, abandoned coal mines and orphaned oil and gas wells can continue to threaten public health by contaminating groundwater, emitting methane and other noxious gases, and, in the case of abandoned coal strip mines, even result in continuing risk from falling boulders.[308] There are currently over 130,000 documented orphaned oil and gas wells in the United States,[309] and nearly 40% of Kentucky's active coal mines are "functionally abandoned."[310]

By contrast, utility-scale wind farms can be incorporated into America's pasture and cropland with significantly less disturbance. Wind farms directly occupy relatively small amounts of land. According to the Department of Energy, powering 35% of our national electric grid through wind turbines would require 3,200 km^2 (790,000 acres) of land, a small fraction of the United States' 2.3 billion acres of land.[311] Furthermore, there is ample space for additional land uses within wind farms: the National Renewable Energy Laboratory estimates that about 98% of the area in a wind farm is available for agriculture or other uses.[312] Moreover, plant and animal species can safely grow and roam directly up to a turbine's base. This can help native species to flourish, as well as allowing farmers to continue cultivating crops and grazing animals after wind projects are installed.[313] And reclamation of wind (and solar) energy sites can begin as soon as plants begin operation, because wind and solar require only small amount of soil disturbance compared to other energy sources.[314]

Finally, climate change produced by burning fossil fuels directly harms forests, oceans, crops, and wildlife, including by causing wildfires, algal blooms, droughts, and extreme weather events that mar the visual landscape.[315] Wind energy, in contrast, further protects local landscapes by mitigating climate impacts.

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305 Lauren A. Patterson, *Unconventional Oil and Gas Spills: Risks, Mitigation Priorities, and State Reporting Requirements*, 51 ENVT'L SCIENCE & TECHNOLOGY 2563, 2563 (2017), https://pubs.acs.org/doi/full/10.1021/acs.est.6b05749.

306 Brady Allred et al., *Ecosystem Services Lost to Oil and Gas in North America,* 348 SCI 401, (2015), https://www.science.org/doi/full/10.1126/science.aaa4785.

307 *Id*.

308 *See Orphaned Wells*, U.S. DEP'T OF INTERIOR, https://www.doi.gov/orphanedwells (last visited Apr. 1, 2024); James Bruggers, *Congressional Office Agrees to Investigate 'Zombie' Coal Mines*, INSIDE CLIMATE NEWS, Jan. 12, 2024, https://insideclimatenews.org/news/12012024/kentucky-zombie-coal-mines/.

309 *Federal Orphaned Well Program*, U.S. BUREAU OF LAND MANAGEMENT, https://www.blm.gov/programs/energy-and-minerals/oil-and-gas/federal-orphaned-well-program (last visited Apr. 1, 2024).

310 Bruggers, *supra* note 308.

311 *Wind Vision: A New Era for Wind Power in the United States*, *supra* note 229, at 139; *Land and Natural Resources*, ECONOMIC RESEARCH SERVICE, U.S. DEP'T OF AGRICULTURE, https://www.ers.usda.gov/data-products/ag-and-food-statistics-charting-the-essentials/land-and-natural-resources/?topicId=a7a658d4-f209-4641-9172-066ca0896abe (last visited March 25, 2024).

312 Paul Denholm et al., *Examining Supply-Side Options to Achieve 100% Clean Electricity by 2035* at 51, NAT'L RENEWABLE ENERGY LABORATORY, 2022, https://www.nrel.gov/docs/fy22osti/81644.pdf.

313 Molly Bergen, *How Wind Turbines are Providing a Safety Net for Rural Farmers,* World Resources Institute (October 13, 2020), https://www.wri.org/insights/how-wind-turbines-are-providing-safety-net-rural-farmers.

314 Amalesh Dhar, *Perspectives on environmental impacts and a land reclamation strategy for solar and wind energy systems*, 718 Science of the Total Environment 134602, 11 (2020), https://www.sciencedirect.com/science/article/pii/S0048969719345930.

315 Savannah Bertrand, *Fact Sheet: Climate, Environmental, and Health Impacts of Fossil Fuels,* Environmental and Energy Study Institute (December 17, 2021), https://www.eesi.org/papers/view/fact-sheet-climate-environmental-and-health-impacts-of-fossil-fuels-2021.

False Claim #24: Wind power, particularly offshore wind power, is too expensive.

> *"[W]ind farms . . . cannot produce electricity competitively and require massive government subsidies for both installation and subsequent operation. Rate payers are hit [with] a double whammy, higher electric rates and higher taxes to pay the subsidies."*[316]

In the United States, onshore wind has the lowest unsubsidized levelized cost of energy (LCOE) of all utility-scale energy sources. Onshore wind's mean unsubsidized LCOE is $50/MWh, substantially lower than the mean unsubsidized LCOE of gas combined cycle ($70/MWh), coal ($117/MWh), and gas peaking ($168/MWh).[317] And, as the figure below from Lazard shows, although offshore wind power is more expensive than gas combined cycle when subsidies are not taken into account, the unsubsidized mean LCOE for offshore wind ($106) is still lower than that of gas peaking and coal.[318]

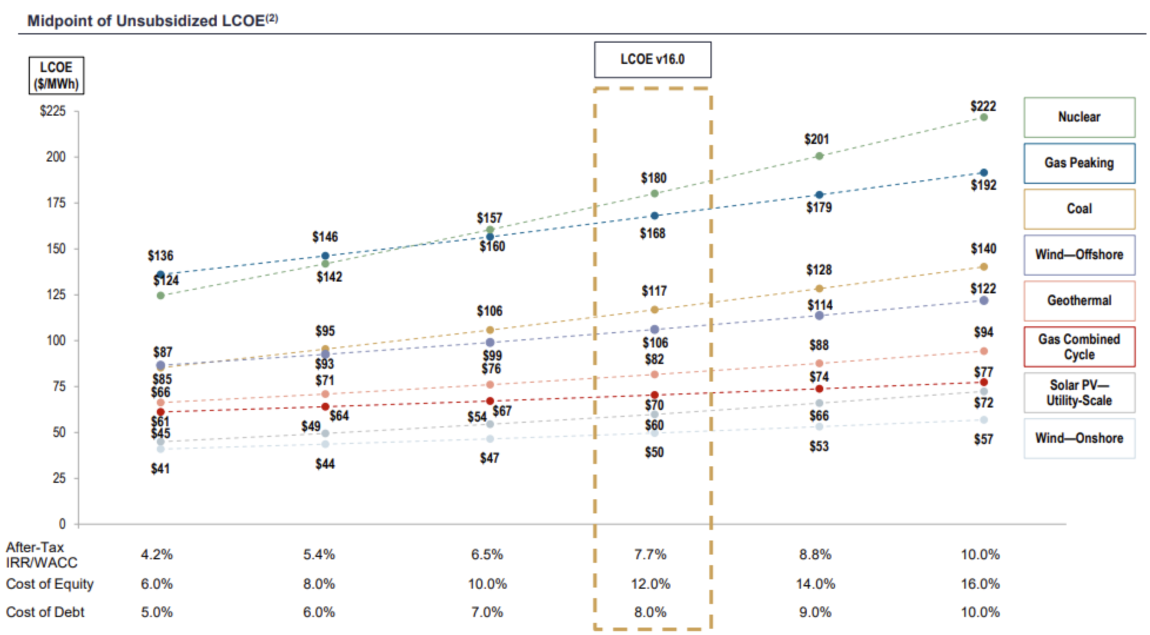

Figure 14: The range of unsubsidized LCOE for utility-scale energy sources across various cost of capital scenarios, highlighting the mean unsubsidized LCOE as of April 2023. "IRR" stands for "internal rate of return" and "WACC" stands for "weighted average cost of capital."
Source: Lazard.[319]

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[316] *Problems with Offshore Wind Farms Not Worth It*, NATIONAL WIND WATCH, https://www.wind-watch.org/news/2011/04/21/problems-with-offshore-wind-farms-not-worth-it/ (last visited March 25, 2024).
[317] LAZARD, *supra* note 166, at 2, 6, 9.
[318] *Id.*
[319] *Id.* Reproduced with permission.

In addition, the LCOE for offshore wind power has declined substantially over the past decade.[320] The Department of Energy's most recent offshore wind market report estimates that the LCOE for a fixed-bottom offshore wind project beginning operations in 2022 would have been roughly 50% lower than one beginning operations in 2014, despite a 6% increase in costs compared to a 2021 cost estimate.[321] Researchers further project that the average LCOE for offshore wind energy will fall to $63/MWh by 2030.[322]

Due in large part to this dramatic price decline, deployment of offshore wind has surged in recent years, both domestically and globally. By the end of 2022, global capacity had reached 59,009 MW, up roughly 18% from 2021.[323] As of the end of May 2023, the pipeline of U.S. offshore wind projects in development and operation was estimated to represent 52,687 MW of wind energy capacity, a 15% growth compared to May 2022.[324] It bears noting, however, that several offshore wind projects have been removed from the U.S. offshore wind pipeline since May 2023 as a result of project cancellation.[325] This includes Ocean Wind I and II, canceled in October 2023, which were anticipated to deliver over 2,200 MW of wind energy capacity.[326]

Once operational, offshore wind turbines generate more energy and greater revenues than onshore wind farms, due to higher and steadier wind speeds; they also have the advantage of generating energy closer to many U.S. coastal population centers, thus reducing the need for long-distance transmission.[327] According to the European Wind Energy Association, while the average onshore wind turbine generates enough energy to power 1,500 homes, the average offshore turbine can power more than 3,300 homes.[328] Moreover, when factoring in costs associated with climate change and human health impacts, offshore wind becomes even less expensive compared to many fossil fuel energy sources.[329]

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[320] *See* Walter Musial et al., *Offshore Wind Market Report: 2023 Edition*, OFFICE OF ENERGY EFFICIENCY & RENEWABLE ENERGY, U.S. DEPARTMENT OF ENERGY, at xiii, 81-83 (2023), https://www.energy.gov/sites/default/files/2023-09/doe-offshore-wind-market-report-2023-edition.pdf; *see also* Ryan Wiser et al., *Expert Elicitation Survey Predicts 37% to 49% Declines in Wind Energy Costs by 2050*, 6 NATURE ENERGY, 555, 557 (2021), https://doi.org/10.1038/s41560-021-00810-z.

[321] Musial et al., *supra* note 320, at xiii, 81-83.

[322] *Id.*

[323] *Id.* at xii; Walter Musial et al., *Offshore Wind Market Report: 2022 Edition*, OFFICE OF ENERGY EFFICIENCY & RENEWABLE ENERGY, U.S. DEPARTMENT OF ENERGY, ix (2022), https://www.energy.gov/sites/default/files/2022-09/offshore-wind-market-report-2022-v2.pdf.

[324] Musial et al, *supra* note 323, at viii.

[325] *See* Associated Press, *In a setback for the wind industry, 2 large offshore projects are canceled in N.J.*, NPR, Nov. 1, 2023, https://www.npr.org/2023/11/01/1209986572/offshore-wind-energy-new-jersey-orsted; Heather Richards, *Offshore wind faces more financial turbulence in 2024*, ENERGYWIRE, Jan. 8, 2024, https://www.eenews.net/articles/offshore-wind-faces-more-financial-turbulence-in-2024/.

[326] Ocean Wind 2, https://oceanwindtwo.com/ (last visited March 25, 2024).

[327] *What are the Advantages and Disadvantages of Offshore Wind Farms?*, AMERICAN GEOSCIENCE INSTITUTE, https://www.americangeosciences.org/critical-issues/faq/what-are-advantages-and-disadvantages-offshore-wind-farms (last visited March 25, 2024); Adrijana Buljan, *Offshore Wind Costs in 2050 Could be Lower than Previously Expected,* OFFSHOREWIND.BIZ (Apr. 19, 2021), https://www.offshorewind.biz/2021/04/19/offshore-wind-costs-in-2050-could-be-lower-than-previously-expected/; Laura Small et al., *Fact Sheet | Offshore Wind: Can the United States Catch Up With Europe?*, ENVIRONMENTAL & ENERGY STUDY INSTITUTE, 3 (January 4, 2016), https://www.eesi.org/papers/view/factsheet-offshore-wind-2016; *Wind Turbines: the Bigger, the Better*, UNITED STATES DEP'T OF ENERGY, Aug. 24, 2023, https://www.energy.gov/eere/articles/wind-turbines-bigger-better.

[328] Laura Small et al., *supra* note 327, at 3.

[329] *Id.* at 2; Paul R. Epstein et al., *Full Cost Accounting for the Life Cycle of Coal*, 1219 ECOLOGICAL ECON. REV., ANNALS OF THE N.Y. ACADEMY OF SCIENCES, Apr. 2011, 73-98 (Robert Costanza, Karin Limburg & Ida Kubiszewski eds., 2011), https://pubmed.ncbi.nlm.nih.gov/21332493/.

False Claim #25: Wind turbines are bad for farmers and rural communities.

> *"The construction of industrial wind turbines affects aquifers, water flow, tile lines, soil erosion, soil compaction, air pressure and current. In essence, it is destruction of the best soil in the world, the farmland that the generations before us were proud of and left for us to feed the world with."*[330]

Wind power offers farmers the opportunity to earn additional income from leasing out their land, while also growing crops or grazing livestock.[331] As a result, many farmers view wind turbines as beneficial for their farmland and the local community.[332] And wind farms leave ample space for continued agricultural use: the National Renewable Energy Laboratory estimates that about 98% of the area in a typical wind farm is available for agriculture or other uses.[333] The New York Farm Bureau has stated that "[w]ind turbines are geared towards continued farming activities, because wind turbines are typically spaced one acre apart."[334] Moreover, "[l]ivestock are unaffected by the presence of wind turbines and will graze right up to the base of wind turbines."[335]

The additional income from lease payments can help farmers keep their land in production.[336] One 2017 University of Michigan study found that farmers with turbines tend to invest twice as much in their farms as farmers without wind turbines.[337] In addition, property tax payments from utility-scale wind projects provide revenue to rural communities for investing in schools, roads, and bridges.[338]

Farmers with turbines also appear more confident that they will continue to own their farms at the time of death. In the University of Michigan study, survey results showed 80% of those with turbines had a plan of succession for their farm, while only 62% of those without a turbine had a succession plan.[339] The researchers concluded that this difference was likely due to added income the wind turbine provided.[340]

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330 SAVE PIATT COUNTY, *supra* note 224.
331 *See Wind Energy's Economic Impacts to Communities Energy,* OFFICE OF ENERGY EFFICIENCY AND RENEWABLE ENERGY, U.S. DEPARTMENT OF ENERGY, https://windexchange.energy.gov/projects/economic-impacts (last visited March 26, 2024); Elizabeth Weise, *Wind energy gives American farmers a new crop to sell in tough times*, USA TODAY, Feb. 16, 2020 (updated Feb. 20, 2020), https://www.usatoday.com/story/news/nation/2020/02/16/wind-energy-can-help-american-farmers-earn-money-avoid-bankruptcy/4695670002/.
332 Kirsty Holstead et al., *Discourses of On-Farm Wind Energy Generation in the UK Farming Press*, 19 J. ENV'T. POL'Y & PLAN. 391, 399 (2017), https://doi.org/10.1080/1523908X.2016.1224157; Sarah Mills, *Wind Energy and Rural Community Sustainability*, *in* HANDBOOK SUSTAINABILITY & SOC. SCI. RSCH. 215, 219-221 (Walter Leal Filho, Robert W. Marans & John Callewaert eds., 2018), https://doi.org/10.1007/978-3-319-67122-2_12.
333 Paul Denholm et al., *supra* note 312 at 51.
334 NEW YORK FARM BUREAU, LEASING YOUR FARMLAND FOR WIND & SOLAR ENERGY DEVELOPMENT: A BEGINNER'S GUIDE FOR FARMERS at 3 (2014), https://www.nyfb.org/application/files/2014/9780/6349/file_y349d211hx.pdf; *see also id.* ("Wind turbine installations are compatible with livestock grazing and growing crops.").
335 *Id.*; *see also id.* ("Wind turbines are sturdy enough to withstand cattle using them as rubbing posts or for shade.").
336 *Wind Energy's Economic Impacts to Communities*, *supra* note 331; Kirsty Holstead et al., *Discourses of On-Farm Wind Energy Generation in the UK Farming Press*, 19 J. ENV'T. POL'Y & PLAN. 391, 399 (2017), https://doi.org/10.1080/1523908X.2016.1224157; Mills, *supra* note 324, at 219-221.
337 Mills, *supra* note 332, at 219-221.
338 *Wind energy's economic impacts to communities*, *supra* note 331.
339 Mills, *supra* note 332, at 215, 219.
340 *Id.* at 215, 219-220.

Wind farms can likewise contribute to agricultural productivity. A 2019 study of Gobi Desert wind farms, from China's Zhejiang University, found that turbine proximity made local vegetation "more metabolically efficient, with higher community coverage, density, and AGB [aboveground biomass]."[341] Recent research from Iowa State's Agronomy department posits that related benefits to agricultural yields might stem from increased photosynthesis capacity as turbines draw additional carbon dioxide out of the soil.[342] Further studies suggest that wind turbines may even increase crop yields on neighboring farms, by minimizing harmful temperature extremes in the surrounding area.[343] Moreover, while recognizing that wind farm installation can contribute to short-term soil degradation, a 2020 analysis from Brazil's Universidade Federal do Ceará concluded that these installations produce impacts less intense than those "caused by agricultural use and rainfall in the same period" and that local farmers found it possible "to reconcile agriculture and wind power generation without major repercussions on rural lots."[344]

False Claim #26: Wind energy is bad for U.S. jobs.

"Subsidised wind and solar destroy far more jobs than they ever 'create'"[345]

Wind power is a fast-growing industry, creating many U.S. jobs. In 2021, wind energy production employed roughly 120,000 U.S. workers, creating roughly 5,400 new jobs (up 4.7%) since 2019.[346] The Department of Energy suggests that this sector could employ as many as 600,000 U.S. workers by 2050.[347] As noted previously, the United States' Fifth National Climate Assessment predicts that there will be nearly 3,000,000 new solar, wind, and transmission-related jobs by 2050 in a high electrification scenario and 6,000,000 new jobs in a 100% renewable scenario, with less than 1,000,000 fossil fuel-related jobs lost.[348]

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341 Kang Xu et al., *Positive Ecological Effects of Wind Farms on Vegetation in China's Gobi Desert*, SCI. REPORTS 9, 6341 (2019) https://www.nature.com/articles/s41598-019-42569-0.

342 Ed Adcock, *Iowa State University Research Finds Wind Farms Positively Impact Crops*, IOWA STATE UNIVERSITY EXTENSION AND OUTREACH, Mar. 5, 2018, https://www.extension.iastate.edu/news/iowa-state-university-research-finds-wind-farms-positively-impact-crops.

343 Daniel T. Kaffine, *Microclimate effects of wind farms on local crop yields*, 96 J. ENV'T. ECON. MGMT. 159, 159-160 (2019), https://doi.org/10.1016/j.jeem.2019.06.001.

344 Manoel Fortunato Sobrinho Júnior et al., *Soil Use and Occupation of Wind Farm Agricultural Areas*, 19 MERCATOR - REVISTA DE GEOGRAFIA DA UFC, 1, 3, (2020), https://www.redalyc.org/journal/2736/273664287012/273664287012.pdf.

345 *Renewable Energy Job Myth: Subsidised Wind and Solar Destroy Far More Jobs Than They Ever "Create,"* STOP THESE THINGS, May 11, 2020, https://stopthesethings.com/2020/05/11/renewable-energy-job-myth-subsidised-wind-and-solar-destroy-far-more-jobs-than-they-ever-create/ (capitalization edited to sentence case).

346 *United States Energy & Employment Report 2022*, OFFICE OF POLICY, OFFICE OF ENERGY JOBS, U.S. DEPARTMENT OF ENERGY, 24 (June 2022), https://www.energy.gov/sites/default/files/2022-06/USEER%202022%20National%20Report_1.pdf.

347 *Wind Vision: A New Era for Wind Power in the United States*, *supra* note 229, at 139.

348 U.S. GLOBAL CHANGE RESEARCH PROGRAM, *supra* note 121, at 32-31.

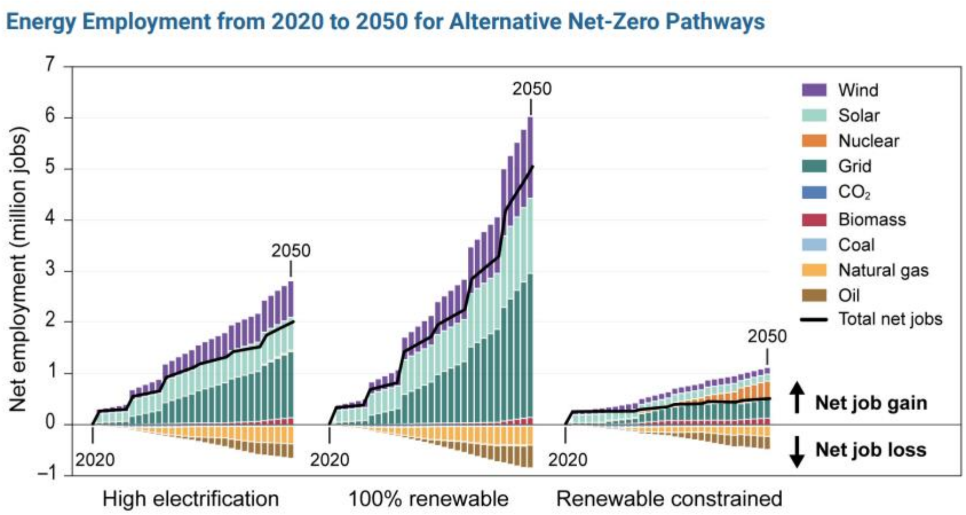

Figure 15: Energy employment from 2020 to 2050 under various U.S. net-zero GHG emissions scenarios.

Source: U.S. Global Change Research Program.[349]

Most of the current domestic jobs are in manufacturing.[350] Over 500 U.S. manufacturing facilities now specialize in producing components for wind power generation.[351] For turbines installed in the United States, approximately 70% of tower manufacturing and 80% of nacelle assembly also occurs domestically.[352] Furthermore, the U.S. Bureau of Labor Statistics identified wind turbine service technicians as the fastest growing occupation between 2022 and 2023, growing roughly 45% in size during that time.[353]

False Claim #27: Wind turbines destroy nearby property values.

> *"[T]he presence of a wind power facility is likely to drive down the value of surrounding properties."*[354]

Multiple academic studies have assessed the impact of wind turbines on property values. Most recently, a March 2024 study found that having a wind turbine in a home's viewshed reduces the sales price by 1.12% on average.[355] The study found that the negative impact of turbines on property values was primarily observed for urban, rather than rural, properties, and

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[349] *Id.*

[350] James Hamilton et al., *Careers in Wind Energy*, U.S. BUREAU OF LABOR STATISTICS (Sept. 2010), https://www.bls.gov/green/wind_energy/wind_energy.pdf

[351] Wind Energy Technologies Office, *Wind Manufacturing and Supply Chain*, OFFICE OF ENERGY EFFICIENCY AND RENEWABLE ENERGY, U.S. DEPARTMENT OF ENERGY, https://www.energy.gov/eere/wind/wind-manufacturing-and-supply-chain (last visited March 25, 2024).

[352] *Id.* The nacelle is the housing that holds the gearbox, generator, drivetrain, and brake assembly.

[353] *Fastest Growing Occupations*, U.S. BUREAU OF LABOR STATISTICS (Sept. 2023), https://www.bls.gov/ooh/fastest-growing.htm.

[354] *FAQ: Economics*, NATIONAL WIND WATCH, https://www.wind-watch.org/faq-economics.php (last visited March 25, 2024).

[355] Wei Guo et al., *The visual effect of wind turbines on property values is small and diminishing in space and time*, PNAS, March 2024, at 2, https://www.pnas.org/doi/epdf/10.1073/pnas.2309372121.

that any negative impact on property values disappeared within ten years after turbine installation.[356] The study also found that turbine installations have become less disruptive to home values over time: the researchers found no statistically-significant impact on home values for turbines installed after 2017 and stated that the 1.12% average impact "is larger than the effect one would expect for recent and future installations."[357]

For comparison, a December 2023 study found evidence that, when a wind development is announced within one mile of a home, prices decline by up to 11% compared to homes three to five miles away.[358] However, home prices return to within 2% of inflation-adjusted pre-announcement levels roughly five years after the project enters operation.[359] The study found that the population of the county mattered: the decrease was roughly 15% in counties with over 250,000 people but statistically insignificant in counties with fewer than 250,000 people.[360] The study also found no statistically-significant adverse impacts on home sale prices outside of 1.25 miles from the nearest turbine.[361]

An earlier study from 2021 testing how turbine size affects property values at varying distances found that, on average, nearby turbine installation decreases home value by 1.8%.[362] The study also found that the farther a turbine was placed from a home, the less impact it had on property value.[363] The greatest impact, a price drop of 8.3%, occurred when a large turbine (>150 meters) was placed within 750 meters of a home.[364] The greatest impact from a medium sized turbine (50–150 meters) was 3.4%.[365] Beyond 2,250 meters, moreover, the 2021 study found no discernible price impact from turbines.[366] A separate study found no impact beyond 3 km.[367] The figure below shows how, for the 2021 study, size and distance of a turbine impacted property value.[368]

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[356] *Id.* at 3.
[357] *Id.* at 3-4.
[358] Eric J. Brunner et al., *Commercial wind turbines and residential home values: New evidence from the universe of land-based wind projects in the United States*, 185 ENERGY POLICY 113837, at 1 (2023), https://www.sciencedirect.com/science/article/pii/S0301421523004226?via%3Dihub.
[359] *Id.* at 1.
[360] *Id.* at 9-10.
[361] *Id.* at 7, 10.
[362] Martijn Dröes et al., *Wind Turbines, Solar Farms, and House Prices*, 155 ENERGY POL'Y, 2 (2021), https://doi.org/10.1016/j.enpol.2021.112327.
[363] *Id.* at 8.
[364] *Id.*
[365] *Id.*
[366] *Id.*
[367] Cathrine Jensen et al., *The Impact of On-Shore and Off-Shore Wind Turbine Farms on Property Prices*, 116 ENERGY POL'Y 54, 50-59 (2018), https://doi.org/10.1016/j.enpol.2018.01.046.
[368] Martijn Dröes et al., *supra* note 362, at 8.

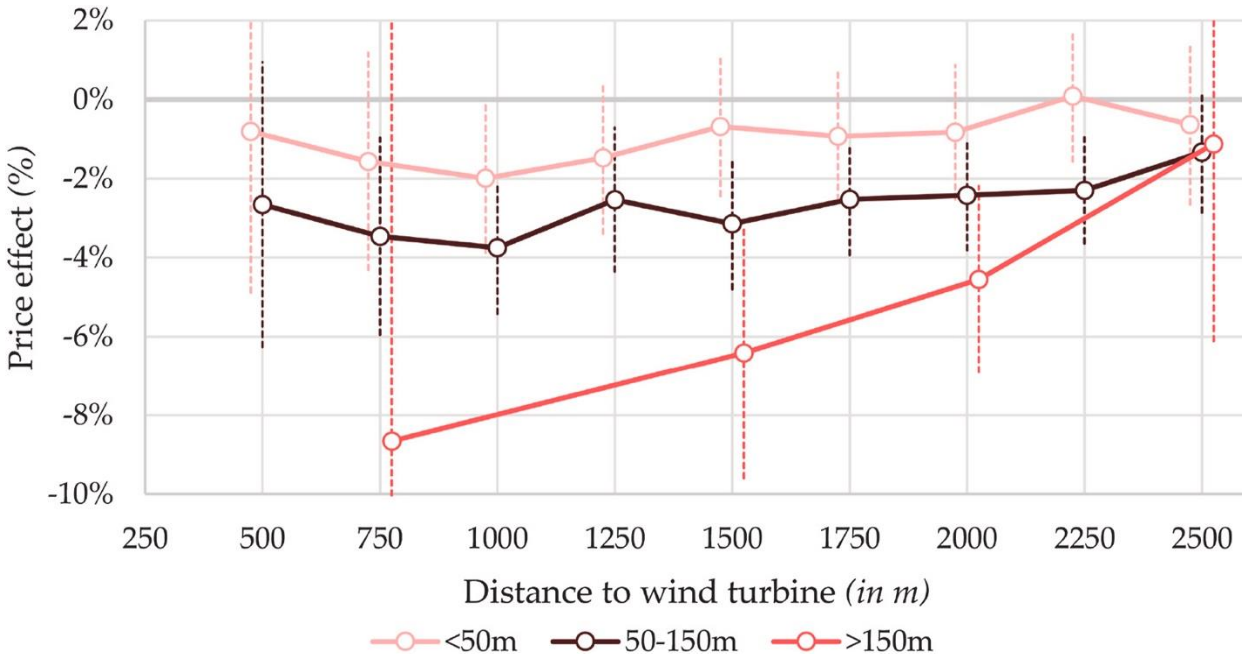

Figure 16: Graph shows how different size of wind turbines, and distance from property, affects home value. Turbine height is calculated as axis height plus half of the rotor blade diameter.
Source: Martijn Dröes et al.[369]

Another academic study of roughly 50,000 Rhode Island single-family home transactions located within 5 miles of a turbine site found no statistically significant price impact. [370] While yet another academic study of roughly 50,000 home transactions (spread across nine states) within 10 miles of a turbine site likewise found no statistically significant evidence of a price change. [371] By contrast, a 2011 paper found that the presence of a fossil fuel fired power plant within 2 miles of one's home decreased its value by 4–7%.[372] Among the fossil fuel power plants in the study sample, 92% were natural gas plants.[373]

Finally, these impacts can be mitigated. For example, multiple studies recommend clustering turbines within wind farms.[374] One of these studies found that adding a turbine within two kilometers of an existing turbine had a statistically insignificant

369 *Id.*
370 Corey Lang et al., *The Windy City: Property Value Impacts of Wind Turbines in an Urban Setting,* 44 ENERGY ECON. 413, 420-421 (2014), https://doi.org/10.1016/j.eneco.2014.05.010.
371 Lucas Nelsen, *Are Property Values Affected by Wind Farms?*, CENTER FOR RURAL AFFAIRS (July 19, 2018), https://www.cfra.org/blog/are-property-values-affected-wind-farms.
372 Lucas Davis, *The Effect of Power Plants on Local Housing Value and Rents*, 93 REV. ECON. STAT. 1391 (2011), https://doi.org/10.1162/rest_a_00119.
373 *Id.* at 1400.
374 Cathrine Jensen et al., *supra* note 367, at 51; Martijn Dröes et al., *supra* note 362, at 7.

impact on house prices.[375] It bears noting, however, that turbines must be spaced in such a way as to minimize wake interference, the phenomenon where an upstream wind turbine interferes with the production of a downstream turbine.[376]

False Claim 28: Wind energy is unreliable.

> *"[B]ecause of the wind's intermittency and high variability, they do next to nothing to reduce the need for other fuels."*[377]

As with solar energy, complete reliance on wind energy would pose intermittency challenges. However, wind, solar, and storage together can provide the majority of the country's electricity without compromising reliability.[378] Hydropower has also been found to support wind and solar by compensating for intermittency in those sources.[379] Moreover, building more long-distance transmission infrastructure can enable greater reliance on wind and solar generation,[380] and linking offshore wind projects through offshore transmission networks is also expected to enhance grid reliability.[381] A National Renewable Energy Laboratory report concluded that "wind power can support power system reliability" by providing "active power controls,"[382] which are mechanisms for balancing the power generated by wind farms with the power consumed on the electricity grid.[383] And although the reliability of wind and solar energy was questioned following Texas' widespread power outages in the winter of 2021, Texas' grid failure was primarily caused by freezing natural gas infrastructure, rather than failures at wind and solar farms, though nuclear, coal, and wind also experienced disruptions at a smaller scale.[384]

Wind energy has already been successfully incorporated into the United States' electric grid at significant scale.[385] Domestic energy production from wind more than tripled between 2011 and 2022, from 120 billion kilowatt-hours (2.9% of total

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375 Martijn Dröes et al., *supra* note 362, at 7.
376 *See* Daniel R. Houck, *Review of wake management techniques for wind turbines*, 25 Wind Energy 195, 195-96 (2022), https://onlinelibrary.wiley.com/doi/epdf/10.1002/we.2668.
377 *Id.*
378 *See* Eric Larson et al., *supra* note 104, at 88 (noting that, "[t]o ensure reliability, all cases maintain 500-1,000 GW of firm generating capacity through all years," compared to 7,400-9,900 GW for wind and solar in net-zero scenarios for 2050).
379 Rui Shan et al., *Complementary relationship between small-hydropower and increasing penetration of solar photovoltaics: Evidence from CAISO*, 155 Renewable Energy 1139, 1140 (2020).
380 *See id.* at 97 (noting that "[l]imiting inter-regional transmission capacity to a maximum of 2x current capacity . . . leads to slightly more gas w/ [carbon capture] and less wind").
381 Office of Energy Efficiency & Renewable Energy, U.S. Dep't of Energy, Atlantic Offshore Wind Transmission Study, at vii (March 2024), https://www.nrel.gov/docs/fy24osti/88003.pdf.
382 Erik Ela et al., *Active Power Controls from Wind Power: Bridging the Gaps* at xi, Nat'l Renewable Energy Laboratory, Jan. 2014, https://www.nrel.gov/docs/fy14osti/60574.pdf; *see also NREL Report Redefines Wind as a Grid Stabilizer, Not a Liability*, Nat'l Renewable Energy Laboratory, Jan. 2014, https://www.nrel.gov/docs/fy14osti/60993.pdf; Weihang Yan et al., *Synchronous Wind: Evaluating the Grid Impact of Inverterless Grid-Forming Wind Power Plants*, Nat'l Renewable Energy Laboratory, 2023 (preprint), https://www.nrel.gov/docs/fy23osti/84609.pdf.
383 Jan-Willem van Windergarden et al., *Active Power Control of Waked Wind Farms*, 50 IFAC 4484, 4484, (July 2017), https://www.sciencedirect.com/science/article/pii/S240589631730722X.
384 Joshua W. Busby et al., *Cascading risks: Understanding the 2021 winter blackout in Texas*, 77 Energy Research and Social Science 102106 (2021), 1-4, https://www.sciencedirect.com/science/article/pii/S2214629621001997; Adriana Usero & Salvador Rizzo, *'Frozen windmills' aren't to blame for Texas's power failure*, Wash. Post, Feb. 18, 2021, https://www.washingtonpost.com/politics/2021/02/18/frozen-windmills-arent-blame-texass-power-failure-neither-is-green-new-deal/; Dionne Searcey, *No, Wind Farms Aren't the Main Cause of the Texas Blackouts*, N.Y. Times, Feb. 17, 2021 (updated May 3, 2021), https://www.nytimes.com/2021/02/17/climate/texas-blackouts-disinformation.html.
385 *Wind Explained: Electricity Generation from Wind*, U.S. Energy Information Administration, https://www.eia.gov/energyexplained/wind/electricity-generation-from-wind.php (last visited March 25, 2024).

energy production) to 435 billion kilowatt-hours (10.3% of total energy production).[386] Some states have seen even more rapid growth. In 2021, wind energy accounted for 58% of electricity production in Iowa, and 43% of electricity production in Kansas.[387]

Wind power has enabled Iowa not only to reduce energy costs, but to generate additional revenue by selling excess power to neighboring states during shortages.[388] Today, Iowa is considered one of the states with the most reliable energy systems.[389] In California, electricity generated from wind power increased from roughly 3% in 2009, to roughly 7% in 2022. Electricity generated from natural gas declined from roughly 56% in 2009, to roughly 47% in 2022.[390] Yet even with this increased reliance on wind power, California's grid reliability has remained consistent, and largely above national averages.[391] California has even been able to briefly meet 103% of its energy demands exclusively from renewable sources, demonstrating that a large economy can by powered by renewable energy.[392] The UK has also made substantial progress utilizing wind power, which was responsible for 26.8% of overall energy production in 2022, and which helped stave off the worse impacts from the energy crisis following Russia's invasion of Ukraine.[393]

False Claim 29: Wind turbines are very noisy.

> *"Noise created by commercial-scale wind turbines has become a major concern around the world as wind power development continues to proliferate."*[394]

In a 2021 environmental impact statement for the 120-turbine, 500-MW Rail Tie Wind Project in Wyoming, which is anticipated to serve the energy needs of 180,000 households, the Department of Energy found that noise generated by site operations likely would not exceed 55 A-weighted decibels (dBAs),[395] except in a worst-case scenario in which noise "might reach slightly above 55 dBA."[396] The DOE provides as a point of comparison that sounds at 60 dBA resemble those of a

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[386] *Id.*

[387] Niccolo Conte, *Which US State Generates the Most Wind Power? There's a Clear Winner*, World Economic Forum (April 26, 2022), https://www.weforum.org/agenda/2022/04/us-wind-electricity-generation-renewable-energy/.

[388] Chazz Allen, *Iowa Leads in Homegrown, Reliable, Renewable Energy*, Gazette (November 12, 2022) https://www.thegazette.com/guest-columnists/iowa-leads-in-homegrown-reliable-renewable-energy/.

[389] *Energy Rankings: Measuring States' Energy Infrastructure,* U.S. News and World Report, https://www.usnews.com/news/best-states/rankings/infrastructure/energy (last visited March 25, 2024).

[390] California Energy Comm'n, *Total System Electric Generation 2009-2022 with totals*, California Energy Commission, (2022), https://www.energy.ca.gov/media/7311.

[391] California Energy Comm'n, *Electric System Reliability Annual Reports*, California Energy Commission, (2022), https://www.cpuc.ca.gov/industries-and-topics/electrical-energy/infrastructure/electric-reliability/electric-system-reliability-annual-reports.

[392] Lauren Sommer, *California Just Ran on 100% Renewable Energy, but Fossil Fuels Aren't Fading Away Yet*, NPR (May 13, 2022), https://www.npr.org/2022/05/07/1097376890/for-a-brief-moment-calif-fully-powered-itself-with-renewable-energy.

[393] Georgina Rannard, *Wind Generated a Record Amount of Electricity in 2022*, BBC News, (January 6, 2023), https://www.bbc.com/news/science-environment-64179918.

[394] *Noise Complaints on Rise with New Industrial Wind Power Projects*, National Wind Watch, https://www.wind-watch.org/faq-noise.php (last visited March 25, 2024).

[395] A-weighted decibel measurements factor into their assessment how the human ear actually perceives sound. *See Fundamentals of Noise and Sound,* Federal Aviation Administration, https://www.faa.gov/regulations_policies/policy_guidance/noise/basics (last visited March 25, 2024).

[396] Rail Tie Wind Project Final Environmental Impact Statement, Nov. 2021, at ES-vi, https://www.energy.gov/sites/default/files/2021-11/final-eis-0543-rail-tie-wind-wyoming-2021-11.pdf.

residential air conditioner 20 feet away, whereas sounds at 50 dBA resemble those of a residential air conditioner 50 feet away.[397]

When measured from inside a building located 124–330 meters from a wind turbine, noise produced by the turbine's motion has ranged from 30.7–43.4 decibels.[398] When measured from outside at the same distance, noise level has ranged from 38.2-50.0 decibels in summer, and 38.9–44.6 decibels in winter.[399] For context, a soft whisper is 30 decibels, a refrigerator hum is 40 decibels, and a typical conversation takes place at 60 decibels.[400] The CDC has set 70 decibels as the cutoff at which prolonged exposure can cause annoyance and hearing damage.[401] Also, noise has substantially decreased with turbine innovation: while earlier turbines created a steady noise from gears turning, modern turbines have been designed to insulate these sounds.[402]

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397 *Id.* at 3-104.
398 Chun-Hsiang Chiu et al., *Effects of Low-Frequency Noise from Wind Turbines on Heart Rate Variability in Healthy Individuals*, 11 SCI. REP. 17817, 17822 (2021), https://doi.org/10.1038/s41598-021-97107-8.
399 *Id.*
400 *What Noises Cause Hearing Loss?*, CENTERS FOR DISEASE CONTROL AND PREVENTION (CDC), https://www.cdc.gov/nceh/hearing_loss/what_noises_cause_hearing_loss.html (last visited March 25, 2024)
401 *Id.*
402 *Wind Turbines*, ENVIRONMENTAL PROTECTION AGENCY, MINISTRY OF ENVIRONMENT OF DENMARK, https://eng.mst.dk/air-noise-waste/noise/wind-turbines/noise-from-wind-turbines/ (last visited March 25, 2024).

PART C: FALSE CLAIMS ABOUT ELECTRIC VEHICLES (#30-#33)

PART C: FALSE CLAIMS ABOUT ELECTRIC VEHICLES (#30–#33)

False Claim #30: Electric vehicles have a net harmful effect on climate change.

"Contrary to vociferous assertions, EVs are no friends of the environment."[403]

EVs are essential to reducing greenhouse gas (GHG) emissions and the use of fossil fuels that cause those emissions.[404] The Environmental Protection Agency has found that EVs typically have lower lifecycle emissions than traditional gasoline-powered cars, even when taking into account the emissions released when manufacturing EVs and generating power to charge them.[405] The Intergovernmental Panel on Climate Change has further explained that "[t]he extent to which EV deployment can decrease emissions by replacing internal combustion engine-based vehicles depends on the generation mix of the electric grid although, even with current grids, EVs reduce emissions in almost all cases."[406] The key reason why EVs reduce emissions in almost all cases is that they are inherently more efficient than conventional gasoline-powered vehicles: EVs convert over 77% of electrical energy to power at the wheels, whereas conventional vehicles only convert roughly 12%–30% of the energy in gasoline to power at the wheels.[407]

Assuming average U.S. grid emissions, the average lifecycle GHGs associated with a gasoline-powered car that gets 30.7 miles per gallon are more than twice as high as those of an EV with a 300-mile range.[408] The figure below from the EPA shows that the lifecycle GHGs for the gasoline-powered car under this scenario are between 350 and 400 grams/mile, whereas the lifecycle GHGs for the EV are only slightly above 150 grams/mile.[409]

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403 Steve Forbes, *The Expensive and Harmful Truth About Electric Vehicles*, FORBES, Jan. 6, 2023, https://www.forbes.com/sites/steveforbes/2023/01/06/the-expensive-and-harmful-truth-about-electric-vehicles/.

404 *See* Divya Singh et al., *Does electric vehicle adoption (EVA) contribute to clean energy? Bibliometric insights and future research agency*, 8 Cleaner & Responsible Consumption 100099, 1 (2023), https://www.sciencedirect.com/science/article/pii/S2666784322000535#bib4; *Electric Vehicle Benefits and Considerations*, ALTERNATIVE FUELS DATA CENTRE, OFFICE OF ENERGY EFFICIENCY AND RENEWABLE ENERGY, US DEPARTMENT OF ENERGY, https://afdc.energy.gov/fuels/electricity_benefits.html (last visited Apr. 1, 2024).

405 *Electric Vehicle Myths, supra* note 18.

406 IPCC, Climate Change 2022: Mitigation of Climate Change (2022), 271, https://www.ipcc.ch/report/ar6/wg3/downloads/report/IPCC_AR6_WGIII_FullReport.pdf.

407 *All-Electric Vehicles*, U.S. DEPT. OF ENERGY, https://www.fueleconomy.gov/feg/evtech.shtml (last visited March 25, 2024); *see also* Eric Larson et al., *supra* note 104, at 40.

408 *Electric Vehicle Myths, supra* note 18.

409 *Id.*

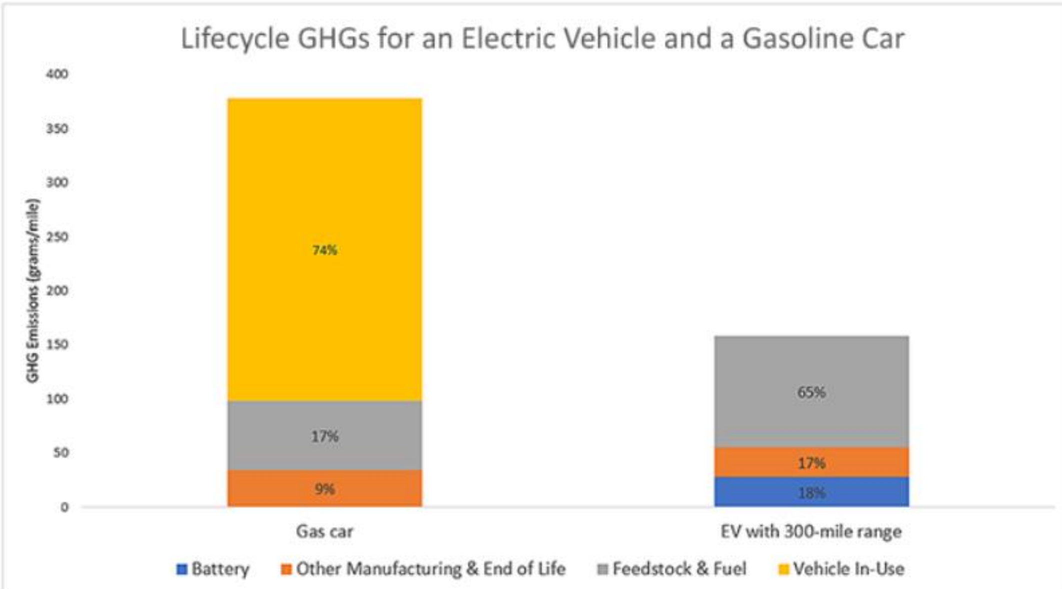

Figure 17: Break down of lifecycle emissions for electric and gasoline cars. This figure is based on the following assumptions: a vehicle lifetime of 173,151 miles for both the EV and gas car; a 30.7 MPG gas car; and U.S. average grid emissions.
Source: EPA.[410]

Most importantly, EVs' lack of tailpipe emissions and heightened efficiency more than offset the emissions required to manufacture EV batteries: these emissions are offset within 1.4-1.5 years for electric sedans, and within 1.6-1.9 years for electric SUVs.[411] These reduced tailpipe emissions not only help to stabilize our climate, but also improve air quality, bringing multiple health benefits including reduced rates of childhood asthma, particularly in urban areas.

The emissions offset by transitioning to EVs vary based on the carbon intensity of the energy grid. A study from Munich's Universität der Bundeswehr found EVs to have reduced emissions by 72% when powered by Germany's electric grid, which drew 23% of its electricity from renewable energy in 2021.[412] But the researchers projected that a 100% renewable energy grid would have allowed EVs to reduce emissions by as much as 97%.[413] And the U.S. grid is getting cleaner over time, with a 44% reduction in power sector emissions from 2005 to 2023, meaning that EVs are having an increasingly positive impact on U.S. emissions.[414] For those drivers in the United States who would like to ensure that they are charging their

[410] *Id.*
[411] Maxwell Woody *et al.*, *The Role of Pickup Truck Electrification in the Decarbonization of Light-Duty Vehicles*, 17 *ENVIRON. RES. (Mar. 1, 2022),* https://iopscience.iop.org/article/10.1088/1748-9326/ac5142. These figures assume "a business-as-usual scenario which includes policies in place as of June 2020 with no projected policy changes, resulting in a grid that is 50% less carbon intensive in 2035 compared to 2005."
[412] Johannes Buberger et al., *Total CO2-Equivalent Life-Cycle Emissions from Commercially Available Passenger Cars*, 159 RENEWABLE & SUSTAINABLE ENERGY REV, 10 (2022), https://doi.org/10.1016/j.rser.2022.112158.
[413] *Id.*; *see also* Paul Wolfram et al., *Pricing Indirect Emissions Accelerates Low—Carbon Transition of US Light Vehicle Sector*, 12 NATURE COMMC'NS, (2021), https://doi.org/10.1038/s41467-021-27247-y.
[414] *Power Sector Carbon Index*, SCOTT INSTITUTE FOR ENERGY INNOVATION, https://emissionsindex.org/ (last visited March 25, 2024).

EVs with the cleanest possible energy, the Environmental Protection Agency's Energy Star program helps drivers determine which chargers rely on renewable energy sources.[415]

False Claim #31: Electric vehicles will cost the United States many automobile industry jobs.

> "By most estimates under Biden's electric vehicle mandate, 40 percent of all U.S. auto jobs will disappear—think of this—in one or two years."[416]

EV manufacturing need not result in fewer jobs in the U.S. automobile industry.[417] A 2022 study found that manufacturing battery EV [BEV] powertrain components is more labor intensive than manufacturing powertrain components for internal combustion engine vehicles [ICEVs], which suggests that vehicle electrification may lead to powertrain manufacturing job growth.[418] In addition, an Economic Policy Institute report concluded that "if the shift to BEVs is accompanied by strategic investments in manufacturing and job quality in the U.S. auto sector, then the number and quality of jobs can rise together with BEV production."[419]

Electric vehicle production already has created thousands of new jobs in the United States. From 2015 to 2023, there were over 179,000 announced U.S. jobs related to EVs and EV batteries.[420] In 2021, the domestic EV industry employed roughly 106,000 workers, more than a 90% increase from 2016 (roughly 55,000 jobs).[421] In 2021 alone, the number of domestic jobs in the EV industry grew by over 26%.[422]

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[415] *Charge Your Electric Vehicle Sustainably With Green Power*, ENERGY STAR, U.S. ENVIRONMENTAL PROTECTION AGENCY, 2, https://www.energystar.gov/sites/default/files/asset/document/Charging%20EVs%20with%20Green%20Power.pdf (last visited March 25, 2024).

[416] Angelo Fichera, *Trump Autoworkers Speech Fact Check: What of Electric Vehicles?*, N.Y. TIMES (Sept. 28, 2023, last updated Oct. 9, 2023), https://www.nytimes.com/2023/09/28/us/politics/trump-fact-check-electric-vehicles.html (quoting Donald Trump).

[417] *See* Emily Pontecorvo, *There's Surprisingly Little Evidence That EVs Will Require Fewer Workers*, HEATMAP (Oct. 6, 2023), https://heatmap.news/electric-vehicles/evs-trump-uaw-jobs-evidence.

[418] Turner Cotterman et al., *The transition to electrified vehicles: Evaluating the labor demand of manufacturing conventional versus battery electric vehicle powertrains* at 1 (June 4, 2022), https://ssrn.com/abstract=4128130.

[419] Jim Barrett & Josh Bivens, *The Stake for Workers in How Policymakers Manage the Coming Shift to All-Electric Vehicles*, ECONOMIC POLICY INSTITUTE (Sept. 22, 2021), https://www.epi.org/publication/ev-policy-workers/ .The study authors focused on vehicle powertrains, "the automotive system responsible for generating the kinetic power to move the vehicle forward," because the powertrain is the least similar aspect between EVs and ICEVs. *Id.* At 3.

[420] ENVT'L DEFENSE FUND, U.S. ELECTRIC VEHICLE MANUFACTURING INVESTMENTS AND JOBS: CHARACTERIZING THE IMPACTS OF THE INFLATION REDUCTION ACT AFTER 1 YEAR at 2 (2023), https://www.edf.org/sites/default/files/2023-08/EDF%20WSP%20EV%20report%208-16-23%20FINAL%20FINAL.pdf.

[421] BW Research Partnership, *Energy Employment by State – 2020*, 147 (2020), https://www.usenergyjobs.org/s/USEER-Energy-Employment-by-State-2020.pdf; David Keyser et al., *United States Energy and Employment Report 2022*, OFFICE OF POLICY, OFFICE OF ENERGY JOBS, U.S. DEPARTMENT OF ENERGY, 141-143 (2022), https://www.energy.gov/sites/default/files/2022-06/USEER%202022%20National%20Report_1.pdf.

[422] *DOE Report Finds Energy Jobs Grew Faster Than Overall U.S. Employment in 2021*, U.S. DEPARTMENT OF ENERGY (June 28, 2022), https://www.energy.gov/articles/doe-report-finds-energy-jobs-grew-faster-overall-us-employment-2021.

Moreover, economic incentives from the 2022 Inflation Reduction Act have increased domestic production and strengthened domestic supply chains.[423] The Inflation Reduction Act provides a customer rebate of up to $7,500 for EVs produced in the United States. The IRA includes additional provisions that mobilize domestic mining and mineral processing, as well as battery manufacturing, to further concentrate EV supply chains within the United States.[424] This has spurred broadly distributed job growth, with rough 84,800 new EV-related jobs and $92.3 billion in EV-related investments announced since the passage of the IRA.[425] And in addition to benefitting U.S. jobs, EVs are anticipated to benefit U.S. consumers: a recent Gartner analysis suggests that, on average, next-generation EVs will be cheaper to produce than comparable internal-combustion engine vehicles by 2027.[426]

False Claim #32: Electric vehicles are impractical due to range restrictions.

"Here's the problem with an electric car: they don't go far. Very simple."[427]

The majority of EVs can travel roughly 200 miles on a single charge and some models can travel over 400 miles on a single charge.[428] Although the median range of a gasoline vehicle (403 miles) is roughly twice that of an EV (234 miles),[429] the range of a standard EV is more than enough to meet the daily needs of median U.S. households.[430] A 2016 study found that the travel requirements of 87% of vehicle-days could be met by existing, affordable electric vehicles.[431] The average range of electric vehicles has only increased since then, from roughly 145 miles in 2016 to roughly 217 miles in 2021.[432] Because most EV drivers charge their vehicles overnight at their home, most of these drivers can go about their daily driving with no need to stop to recharge.[433]

EV range is also benefiting from the build-out of charging infrastructure. The United States is rapidly building electric charging stations, roughly tripling those in operation, from approximately 53,000 in 2017 to approximately 144,000 in

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[423] *See* ENVT'L DEFENSE FUND, *supra* note 420, at 4-5; Leo Banks, *How Inflation Reduction Act Electric Vehicles Incentives Are Driving a U.S. Manufacturing Renaissance*, Center for American Progress, Nov. 22, 2023, https://www.americanprogress.org/article/how-inflation-reduction-act-electric-vehicle-incentives-are-driving-a-u-s-manufacturing-renaissance/.

[424] Owen Minott et al., *IRA EV Tax Credits: Requirement for Domestic Manufacturing,* BIPARTISAN POLICY CENTER (Feb. 24, 2023), https://bipartisanpolicy.org/blog/ira-ev-tax-credits/.

[425] ENVT'L DEFENSE FUND, *supra* note 420, at 4-5.

[426] *Gartner Outlines a New Phase for Electric Vehicles*, GARTNER, March 7, 2024, https://www.gartner.com/en/newsroom/press-releases/2024-03-07-gartner-outlines-a-new-phase-for-electric-vehicles.

[427] *Former President Donald Trump, Campaign Speech in Ankeny, Iowa*, CSPAN (Dec. 2, 2023), https://www.c-span.org/video/?532073-1/president-trump-delivers-remarks-ankeny-iowa.

[428] *Electric Vehicle Myths*, supra note 18; *Model Year 2021 All-Electric Vehicles Had a Median Driving Range about 60% That of Gasoline Powered Vehicles*, DEP'T OF ENERGY, Jan. 17, 2022, https://www.energy.gov/eere/vehicles/articles/fotw-1221-january-17-2022-model-year-2021-all-electric-vehicles-had-median; *Evolution of average range of electric vehicles by powertrain, 2010-2021*, IEA (last updated May 19, 2022), https://www.iea.org/data-and-statistics/charts/evolution-of-average-range-of-electric-vehicles-by-powertrain-2010-2021.

[429] DEP'T OF ENERGY, *supra* note 428.

[430] *Electric Vehicle Myths*, supra note 18.

[431] Zachary A. Needell et al., *Potential for Widespread Electrification of Personal Vehicle Travel in the United States*, NATURE ENERGY 1, 16112 (2016). https://doi.org/10.1038/nenergy.2016.112.

[432] *Evolution of average range of electric vehicles by powertrain, 2010-2021*, *supra* note 428.

[433] *Charging Electric Vehicles at Home*, U.S. Dep't of Energy, https://afdc.energy.gov/fuels/electricity_charging_home.html (last visited March 25, 2024).

2022.[434] Using funds from the 2021 Infrastructure Investment and Jobs Act and the 2022 Inflation Reduction Act, the United States has pledged to build 500,000 charging stations by 2030.[435] This is more than three times the current number of gas stations.[436] In addition, the United States installed 6,300 fast chargers in 2022, bringing the national total to 28,000 fast chargers.[437] On a global scale, by 2022 there were 2.7 million EV chargers in operation worldwide, with more than 900,000 installed in 2022 alone, a 55% increase from 2021.[438]

False Claim #33: Electric vehicles cannot function in hot or cold weather.

"Temperature affects EVs in bad ways."[439]

Extreme temperatures can decrease EV range, particularly extreme cold, but this issue is not unique to EVs. According to a 2019 American Automobile Association report, when compared to conditions of 75°F with the HVAC set to Off, a typical EV's range decreased by 12% at 20°F, and by 4% at 95°F. [440] When comparing conditions with the HVAC set to Auto, a temperature drop from 72°F to 20°F decreased a typical EV's range by 41%, and a temperature rise from 72°F to 95°F decreased range by 17%.[441] However, EV models are increasingly adopting heat pump technology in place of traditional electric resistance heating, which can minimize the electricity consumption associated with heating an electric vehicle in extreme cold.[442]

Traditional gasoline-powered cars are likewise susceptible to extreme weather conditions. Fuel economy tests have also shown a decrease in mileage per gallon for conventional gasoline cars due to temperature drops, with mileage roughly 15% lower at 20°F than at 72°F.[443] As with EVs, decreased fuel efficiency for conventional gasoline cars in extreme weather is

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[434] *Electric Vehicle Charging Infrastructure Trends*, OFFICE OF ENERGY EFFICIENCY AND RENEWABLE ENERGY, U.S. DEPARTMENT OF ENERGY, https://afdc.energy.gov/fuels/electricity_infrastructure_trends.html (last visited March 26, 2024).
[435] *FACT SHEET: Biden-Harris Administration Announces New Standards and Major Progress for a Made-in-America National Network of Electric Vehicle Chargers*, WHITE HOUSE (February 15, 2023), https://www.whitehouse.gov/briefing-room/statements-releases/2023/02/15/fact-sheet-biden-harris-administration-announces-new-standards-and-major-progress-for-a-made-in-america-national-network-of-electric-vehicle-chargers/.
[436] *Service Station FAQs*, AMERICAN PETROLEUM INSTITUTE, https://www.api.org/oil-and-natural-gas/consumer-information/consumer-resources/service-station-faqs (last visited March 25, 2024).
[437] INTERNATIONAL ENERGY AGENCY, GLOBAL EV OUTLOOK 2023, 45 (2023), https://iea.blob.core.windows.net/assets/dacf14d2-eabc-498a-8263-9f97fd5dc327/GEVO2023.pdf.
[438] *Id*.
[439] Federico Alcala, *15 Disadvantages of Electric Cars*, TOPSPEED (Jul. 6, 2023), https://www.topspeed.com/disadvantages-of-electric-cars/#charging-times-are-still-not-on-par-with-filling-up-gas.
[440] *AAA Electric Vehicle Range Testing*, AMERICAN AUTOMOBILE ASSOCIATION, 32, 51 (2019), https://www.aaa.com/AAA/common/AAR/files/AAA-Electric-Vehicle-Range-Testing-Report.pdf.
[441] *Id.*
[442] Carolyn Fortuna, *Why Heat Pumps Are Essential for EVs When the Weather Is Cold*, CLEANTECHNICA, Jan. 22, 2024, https://cleantechnica.com/2024/01/22/why-heat-pumps-are-essential-for-evs-when-the-weather-is-cold; Shannon Osaka, *Why you might want a heat pump in your electric car*, WASHINGTON POST, Jan. 7, 2023, https://www.washingtonpost.com/climate-solutions/2023/01/07/electric-vehicles-cold-winter-range/.
[443] *Fuel Economy in Cold Weather*, U.S. DEP'T. ENERGY, https://www.energy.gov/energysaver/fuel-economy-cold-weather (last visited March 25, 2024).

partially attributable to increased reliance on HVAC systems.[444] Both EVs and gasoline-powered cars are likewise susceptible to cold temperatures lowering tire pressure.[445]

Data from a roadside assistance company in Norway suggests that, by certain metrics, electric vehicles may actually be more reliable than gasoline-powered cars in the cold: 23% of vehicles in Norway are EVs, but the company reported that only 13% of the cases of vehicles failing to turn on in the cold were EVs.[446]

[444] *Id.*; *Fuel Economy in Hot Weather*, U.S. DEP'T ENERGY, https://www.energy.gov/energysaver/fuel-economy-hot-weather (last visited March 25, 2024).
[445] *See* Sydnie Gjerald, *Winter Range: ICE vs EV*, UTILMARC, Jan. 4, 2022, https://www.utilimarc.com/blog/winter-range-ice-vs-ev/; *Fuel Economy in Cold Weather*, *supra* note 443.
[446] Fred Lambert, *Electric vehicles fail at a lower rate than gas cars in extreme cold*, ELECTREK, Jan. 17, 2024, https://electrek.co/2024/01/17/electric-vehicles-fail-lower-rate-than-gas-cars-extreme-cold/. The relatively strong performance of EVs in cold weather in Norway may be influenced by the more frequent use of home charging, more extensive charging port distribut ion, and drivers that are more accustomed to managing EVs in the cold. *See* Emily Schmall & Jenny Gross, *Electric Car Owners Confront a Harsh Foe: Cold Weather*, N.Y. TIMES, Jan. 17, 2024 (updated Jan. 18, 2024), https://www.nytimes.com/2024/01/17/business/tesla-charging-chicago-cold-weather.html.