Lawn Care Goes Electric

Why it's time to switch to a new generation of clean, quiet electric lawn equipment

ENVIRONMENT AMERICA RESEARCH & POLICY CENTER

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FRONTIER GROUP

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Executive summary

Lawn and garden equipment – lawn mowers, string trimmers, leaf blowers, chainsaws and other machines – is a significant source of pollution, noise and disruption. The inefficient engines in gasoline-powered lawn equipment can emit as much pollution in an hour as driving hundreds of miles in a typical car, and that pollution is released right in the middle of our neighborhoods, where people live and breathe.

Electric lawn equipment is cleaner, quieter and, over a lifetime of use, often cheaper than fossil fuel-powered options. Recent advances in battery technology allow cordless electric lawn equipment to achieve comparable performance with gasoline-powered equipment for many jobs.

Advances in battery electric technology have made it feasible to transition from gasoline to electric lawn equipment. **In the United States, lawn and garden equipment powered by gasoline and other fossil fuels released more than 30 million tons of carbon dioxide to the atmosphere in 2020 – more than all the greenhouse gas emissions from the city of Los Angeles.[1] That same equipment emitted air pollution linked to serious health problems in amounts comparable to those from tens of millions of cars.**

To accelerate the transition to cleaner lawn equipment, governments must encourage the adoption of electric equipment and consider restrictions on the most polluting fossil fuel equipment.

Gasoline-powered lawn and garden equipment is a surprisingly large source of air pollution.

- The inefficient two-stroke engines often used in smaller, gasoline-powered lawn equipment are notoriously polluting, with the smell of unburned gasoline often combining with that of freshly cut grass on summer days. While manufacturers have increasingly adopted more efficient four-stroke engines (similar to those in automobiles) in some lawn equipment, these engines still lack the advanced emission controls that have reduced pollution from cars and trucks.
- Operating a commercial lawn mower for just one hour produces as much smog-forming pollution as driving 300 miles in a car. Using a commercial leaf blower is even more polluting, emitting as much smog-forming pollution as driving 1,100 miles in a car.[2]

Lawn and garden equipment emitted large amounts of pollution in 2020.

The Environmental Protection Agency's National Emissions Inventory provides county-level estimates of emissions from lawn and garden equipment.[3] In 2020 (the most recent year for which data are available), lawn and garden equipment was responsible for significant emissions of several pollutants.

- **Particulate matter –** Fine particulates ($PM_{2.5}$) are tiny particles far smaller than the width of a human hair. Pollution from fine particulates causes millions of premature deaths each year around the world and health problems ranging from cancer to reproductive ailments to mental health problems.[4] In 2020, lawn and garden equipment in the U.S. emitted more than 21,800 tons of fine particulates – an equivalent amount to the pollution from 234 million typical cars.[5] Florida ranked first among all states for fine particulate emissions from lawn and garden equipment, with Harris County, Texas (home to Houston), ranking first among U.S. counties.

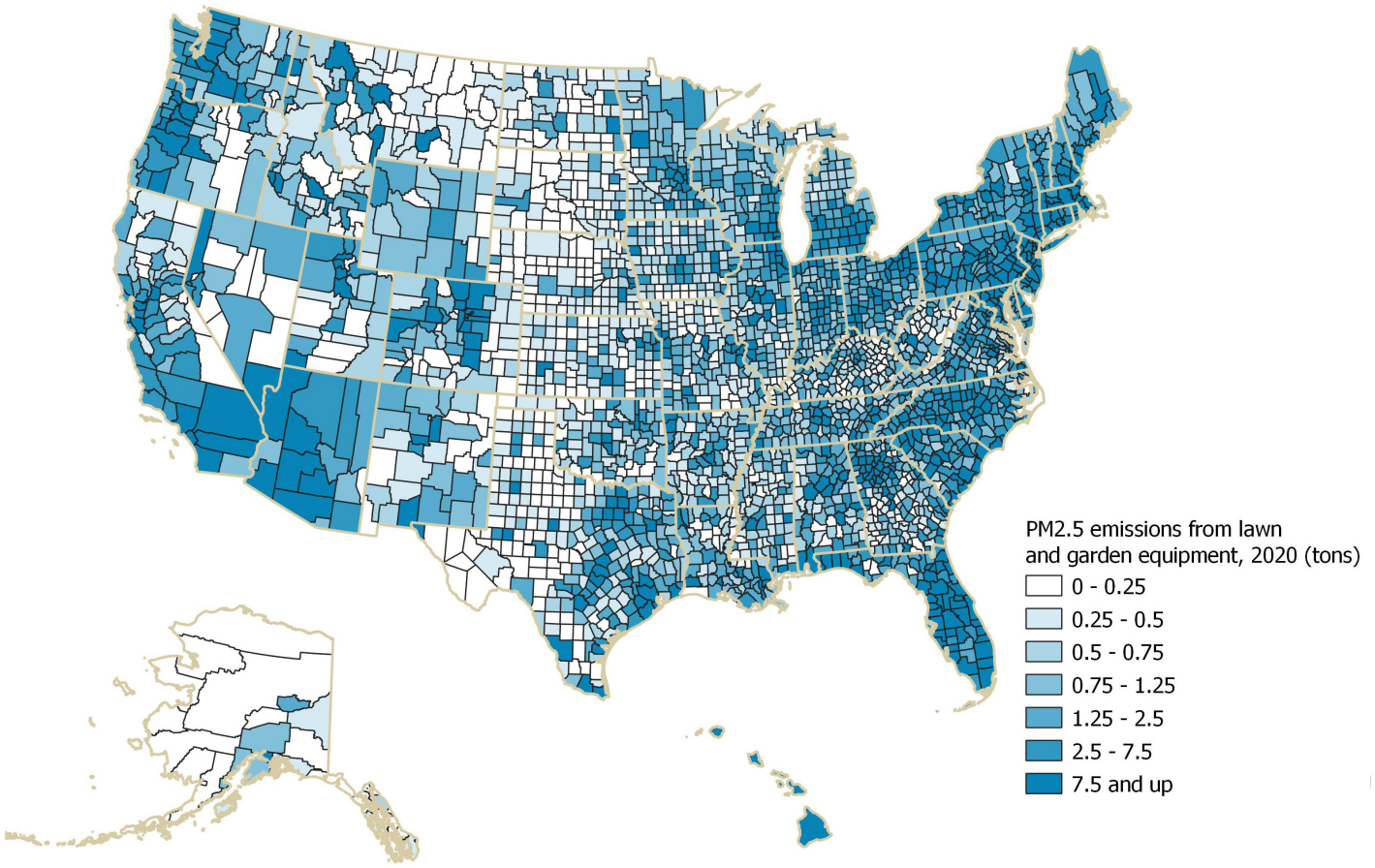

Figure ES-1. $PM_{2.5}$ emissions from lawn and garden equipment by county, 2020

- **Carbon dioxide** – Carbon dioxide is the leading contributor to climate change. In 2020, lawn and garden equipment in the U.S. emitted more than 30 million tons of carbon dioxide – greater than the total greenhouse gas emissions from the city of Los Angeles.[6] California was the leading state for emissions of carbon dioxide from lawn and garden equipment, with Los Angeles County, Calif., leading all U.S. counties for carbon dioxide emissions from lawn and garden equipment.

- **Nitrogen oxides and volatile organic compounds** – Nitrogen oxides (NO_X) and volatile organic compounds (VOCs) are the chemical components of ozone, the main ingredient in smog, which is associated with breathing problems and asthma attacks and can cause premature death with prolonged exposure.[7] In 2020, lawn and garden equipment emitted more than 68,000 tons of NO_X emissions, the equivalent of pollution from 30 million typical cars, as well as more than 350,000 tons of VOC emissions. Florida ranked first among all states for NO_X emissions, while California ranked first for VOC emissions.

- **Air toxics** – Lawn and garden equipment also emits numerous toxic and cancer-causing chemicals. In 2020, emissions of cancer-causing chemicals from lawn and garden equipment in the U.S. included:[8]
  - More than 20 million pounds of benzene,
  - 3.5 million pounds of 1,3-butadiene,
  - 7 million pounds of formaldehyde.

Electric lawn equipment has emerged as an attractive alternative to polluting gasoline-powered equipment, with residential equipment now often competitive on availability, cost and performance.

- Electric lawn equipment is easy to find at major hardware retailers. Retailers offer dozens of options for electric mowers, trimmers, leaf blowers, chainsaws and other types of equipment.
- Electric lawn equipment sometimes has a higher initial price tag but saves money over time due to lower operating costs. In the case of electric mowers, reduced costs for fuel and maintenance lead to the additional investment in electric models being paid back in one to three years.[9]
- Electric lawn equipment is often comparable in quality and performance to gasoline-powered equipment, with typical equipment performing better on some metrics and worse on others in product testing.
- Electric lawn equipment is far quieter than gasoline-powered versions and produces reduced vibration – making it healthier and safer to use.
- Electric equipment is also making inroads in the commercial sector, with an increasing array of available options.

To improve the quality of the air we breathe and protect the climate, states and cities should take concrete steps to encourage a transition from gasoline-powered lawn equipment to cleaner electric options.

- Local and state governments, along with major institutions, should **lead by example** by adopting electric lawn equipment for their own facilities.
- Local and state governments should create **financial incentives** to encourage the purchase of electric lawn equipment. In 2023, for example, Colorado adopted legislation that will provide a 30% discount on electric lawn mowers, leaf blowers, trimmers and snow blowers.[10] In addition to rebates and tax credits, governments should consider loan programs to help commercial landscapers afford the upfront cost of electric equipment.
- To meet the particular needs of **commercial landscapers**, opportunities for education, training and technical support should be provided.
- Local and state governments should consider policies that **phase out** sales of gasoline-powered lawn equipment over time, and/or **restrict the use** of the noisiest and most polluting equipment in certain circumstances. California, for example, will require that most small off-road engines sold, including those in lawn equipment, be zero emission starting in 2024.[11]

Introduction

Americans have a love/hate relationship with lawns.

Lawns can be places to play with kids or dogs, relax or enjoy time with friends.

But while many Americans enjoy having lawns, taking care of them isn't nearly as much fun. In a 2019 survey, weed management and lawn mowing ranked as Americans' two least favorite outdoor chores.[12]

As a result, many of us turn to gasoline-powered lawn equipment – mowers, string trimmers, leaf blowers and more – to try to make the job easier. But much of that equipment comes with its own serious problems.

Gasoline-powered engines are dirty. The seemingly simple task of filling a fuel tank can pollute the very land that is being cared for with spilled fuel. Refueling lawn mowers results in 17 million gallons of spilled gasoline in America each year,[13] producing pollution that can leach into the soil, contaminate groundwater and pose a hazard to wildlife.[14]

Gasoline-powered lawn equipment is smelly, too, overwhelming the aroma of freshly mown grass with exhaust fumes. But this exhaust isn't just unpleasant, it's also a health risk, containing cancer-causing pollutants such as benzene, formaldehyde and 1,3-butadiene.[15]

Gasoline-powered lawn equipment is also notoriously noisy. The Centers for Disease Control and Prevention (CDC) recommends that lawn mower users wear ear protection to prevent hearing loss.[16] Many gasoline-powered lawn tools are more than loud enough to disturb neighbors' sleep or disrupt a peaceful morning.

The good news is that Americans no longer need to rely on gasoline-powered lawn equipment. In addition to trusty, quiet and emissions-free options such as rakes and reel mowers, a new generation of electric-powered lawn equipment is enabling Americans to do their yard work with less pollution, noise and fuss.

In this report, we look at the heavy toll that gasoline-powered lawn equipment inflicts on our health, the climate and our communities, and the environmental, performance and cost benefits of battery-powered lawn equipment.

Electric lawn equipment may not be enough to make Americans love yard work. But it can certainly make it much more tolerable – for ourselves, our neighbors, our air and our climate.

Lawn and garden equipment pollutes our air

Gasoline-powered lawn and garden equipment is noisy and dirty

The air pollution and noise pollution generated by gasoline-powered lawn equipment are hazardous to human health.

What makes gasoline engines so dirty?

Some gasoline-powered lawn equipment relies on inefficient two-stroke engines, which run on a mixture of gasoline and oil and produce significant pollution.[17] The California Air Resources Board (CARB) estimates that using a commercial leaf blower (many of which are powered by two-stroke engines) for one hour produces as much smog-forming pollution as driving 1,100 miles in a car.[18]

Two-stroke engines, which tend to be lighter than four-stroke engines, are particularly common in gasoline-powered leaf blowers, chainsaws and string trimmers. Of the 29 gasoline-powered leaf blowers offered on the Lowe's website on August 15, 2023, 18 were two-stroke and 11 were four-stroke.[19] It's a similar story with string trimmers. Out of 32 gasoline-powered string trimmers offered by Lowe's (on August 15, 2023), 22 had two-stroke engines.[20]

For larger equipment such as lawn mowers, manufacturers have primarily turned to four-stroke engines similar to those used in cars. Four-stroke engines use oil lubrication and better fuel compression to increase combustion efficiency and reduce carbon monoxide emissions, but remain significant sources of pollution.[21] CARB estimates that operating a commercial lawn mower for just one hour produces as much smog-forming pollution as driving 300 miles in a car.[22]

In a 2015 paper that analyzed emissions from gasoline-powered lawn equipment, the Environmental Protection Agency (EPA) listed four-stroke as the only engine type for lawn mowers.[23] As of August 15, 2023, Home Depot did not include any lawn mowers among the two-stroke lawn equipment options on its website.[24]

Pollution from gasoline-powered lawn equipment threatens our health and the climate

Gasoline-powered lawn equipment is a big source of a variety of pollutants that put our health and the climate at risk.

Ozone-forming compounds (VOCs and NO_x)

Nitrogen oxides (NO_x) and volatile organic compounds (VOCs) are the chemical precursors of ground-level ozone (commonly known as smog), which forms when those pollutants react in the presence of sunlight.[25] Exposure to ozone can cause breathing problems and bring on asthma attacks.[26] Exposure to high concentrations of ozone increases the risk of death from respiratory issues.[27] Children are especially susceptible to negative effects from ground-level ozone, in part because they need more air relative to their body weight than adults and their lungs are not fully grown.[28]

Ozone adversely affects our environment as well. The U.S. Department of Agriculture reports that "ground-level ozone causes more damage to plants than all other air pollutants combined."[29] One study estimated that ground-level ozone reduced corn yields by about 10% and soybean yields by about 5% in rain-fed fields in the U.S.

between 1980 and 2011, illustrating the severe impact that pollution can have on agricultural crops and ecosystems.[30]

Some of these ozone-forming compounds are also hazardous pollutants on their own. VOCs include benzene, 1,3-butadiene and formaldehyde, three of the four air pollutants that posed the greatest risk of cancer according to the state of California, as cited in a 2007 study.[31]

Particulate matter

Particulate matter (PM) is another hazardous pollutant from gasoline-powered lawn equipment. Particulate matter refers to soot, smoke, dust and other particles suspended in the air.[32] $PM_{2.5}$ denotes particulates less than 2.5 micrometers wide.[33] PM_{10} is dust, allergens and other particles up to 10 micrometers wide.[34] (For comparison, the width of one human hair is about 70 micrometers).[35] Pollution from fine particulates ($PM_{2.5}$) causes millions of premature deaths each year around the world and health problems ranging from cancer to reproductive ailments to mental health problems.[36]

Climate pollution

Gasoline-powered lawn equipment releases considerable amounts of greenhouse gases. In 2020, fossil fuel-powered lawn equipment accounted for approximately 0.45% of U.S. greenhouse gas emissions – a small but significant share of the overall problem.[37]

Noise and vibration from gasoline-powered lawn equipment are irritating and unhealthy

Lawn equipment is notorious for being loud, ruining many a quiet morning. Noise from lawn equipment is not just an annoyance, however; it negatively affects public health. A pilot study of two gasoline-powered leaf blowers and a hose vacuum (a piece of equipment commercial landscapers use to suck up piles of leaves) conducted by researchers from Quiet Communities and Harvard's T.H. Chan School of Public Health found that the equipment produced levels of noise that exceeded the World Health Organization's "daytime sound standards" of 55 amplitude-weighted decibels (dB(A)) as far as 800 feet – more than two football fields – away from the testing site.[38] The ability of harmful levels of noise from the gas blowers to carry over long distances was attributed to a strong low frequency component. A 2013 study concluded that environmental noise at that level could account for more than 500 hypertension-related heart attacks and almost 800 additional stroke cases annually in the United Kingdom.[39]

The same field study referenced above found even greater levels of noise close to the equipment. Noise levels averaged 82.8 dB(A) 100 feet away from the testing site and 85.5 dB(A) 50 feet away.[40] These are levels of noise at which prolonged exposure may lead to hearing loss.[41]

Staying inside doesn't fully protect people from nearby leaf blowers, either. Low-frequency sounds can readily penetrate walls. A head-to-head study by the engineering firm Arup and nonprofit Quiet Communities found that noise from gas blowers penetrated walls more readily than noise from electric blowers due to presence of a strong low frequency component in the gas blower noise.[42]

The specific effects of exposure to noise generated by lawn equipment have not received extensive study, but several studies have linked sustained exposure to traffic noise to adverse health outcomes, including increased risks of mental illness and ischemic heart disease.[43]

Beyond the effects of noise exposure, the vibration of gas-powered lawn equipment can cause other health issues, including back pain and carpal tunnel syndrome.[44] While the Occupational Safety and Health Administration (OSHA) does not currently regulate vibration exposure in the United States, one study concluded that operating a gas-powered lawn mower for eight hours exceeds the 2.5 m/s^2 "action value" set by the American Conference of Governmental Industrial Hygienists at which ways for workers to reduce exposure should be considered.[45]

Lawn and garden equipment produces as much pollution as tens of millions of cars

Lawn and garden equipment may be small in size, but it can produce an outsized share of a region's air pollution. For some pollutants, the amount of emissions produced by lawn equipment is nearly equivalent to the amount produced by cars.

The EPA's National Emissions Inventory (NEI) provides county-level estimates of emissions of various pollutants by source, derived from EPA modeling (with the exception of estimates for California, which were produced by the state of California).[46] In this analysis, we reviewed emissions classified as produced by "lawn and garden equipment" for 2020, which is the latest year for which estimates are available.[47] The EPA's "lawn and garden equipment" category includes lawn care machines such as mowers, leaf blowers and string trimmers, along with chainsaws and snow blowers. (See methodology.)

Emissions by pollutant

Particulates

In 2020, lawn and garden equipment in the United States emitted nearly 22,000 tons of fine particulates ($PM_{2.5}$). This includes only "primary" particulate emissions, or those that are directly emitted by the equipment. Lawn equipment also emits other pollutants that react in the atmosphere to form "secondary" particulates, which can also damage health. The use of some kinds of lawn equipment – especially leaf blowers – can also create clouds of dust with small particulates capable of harming health, pollution that is also not included in the figures below.[48]

Emissions of fine particulates from lawn equipment in 2020 in the United States were greater than the fine particulate emissions produced by more than 234 million typical American cars over the course of a year.[49]

Florida ranked first among all U.S. states in emissions of fine particulates from lawn equipment, with lawn equipment producing the equivalent of the emissions from 22.7 million cars. (See Table 1.) Among U.S. counties, Harris County, Texas (home to the city of Houston), ranked first for fine particulate emissions from lawn equipment, followed by Cook County, Ill. (Chicago), Clark County, Nev. (Las Vegas), Palm Beach County, Fla., and Dallas County, Texas. (See Figure 1, page 11.)

State	$PM_{2.5}$ emissions, primary (tons)
Florida	2,116
Texas	1,777
New York	1,071
Pennsylvania	965
Illinois	931
Ohio	885
Georgia	864
North Carolina	839
Virginia	814
New Jersey	689

Table 1. Top 10 states for $PM_{2.5}$ emissions from lawn and garden equipment, 2020

Climate pollution

Lawn and garden equipment is also a significant source of carbon dioxide, the leading cause of global warming.[50] In 2020, lawn equipment in the U.S. emitted more than 30 million tons of carbon dioxide – an amount greater than all the carbon dioxide-equivalent greenhouse gas emissions from the city of Los Angeles in 2021.[51] California led all states in carbon dioxide emissions from lawn equipment, emitting as much pollution as 850,000 cars produce over the course of a year. Los Angeles County, Calif., led all U.S. counties for carbon dioxide emissions from lawn equipment, followed by Orange County, Calif., Harris County, Tex., San Diego County, Calif., and Cook County, Ill. (See Figure 2, page 11.)

In 2020, lawn equipment in the U.S. also produced nearly 19,000 tons of methane, which is a global warming pollutant more than 80 times as potent as carbon dioxide over 20 years.[52] (The production of electricity to power electric lawn equipment produces a relatively small amount of "upstream" carbon dioxide pollution at power plants. See 'Upstream' emissions from electric lawn and garden equipment", page 14 for more details.)

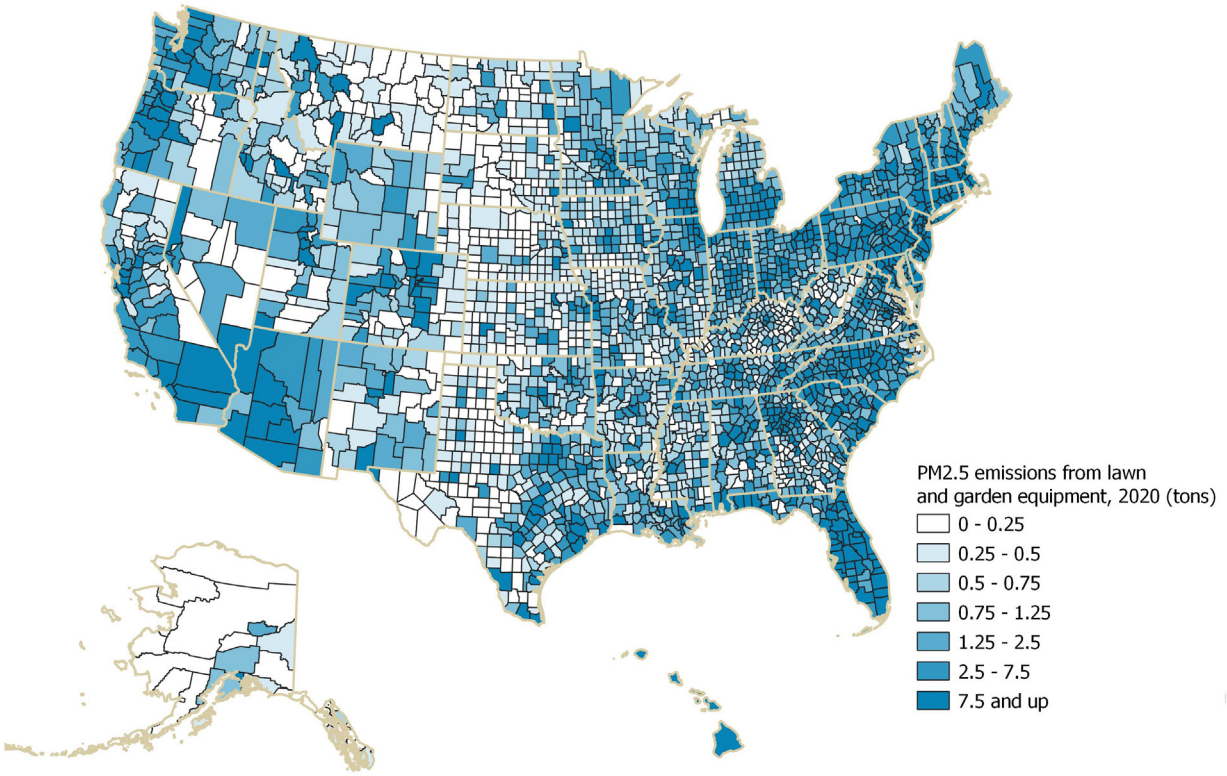

Figure 1. $PM_{2.5}$ emissions from lawn and garden equipment by county, 2020

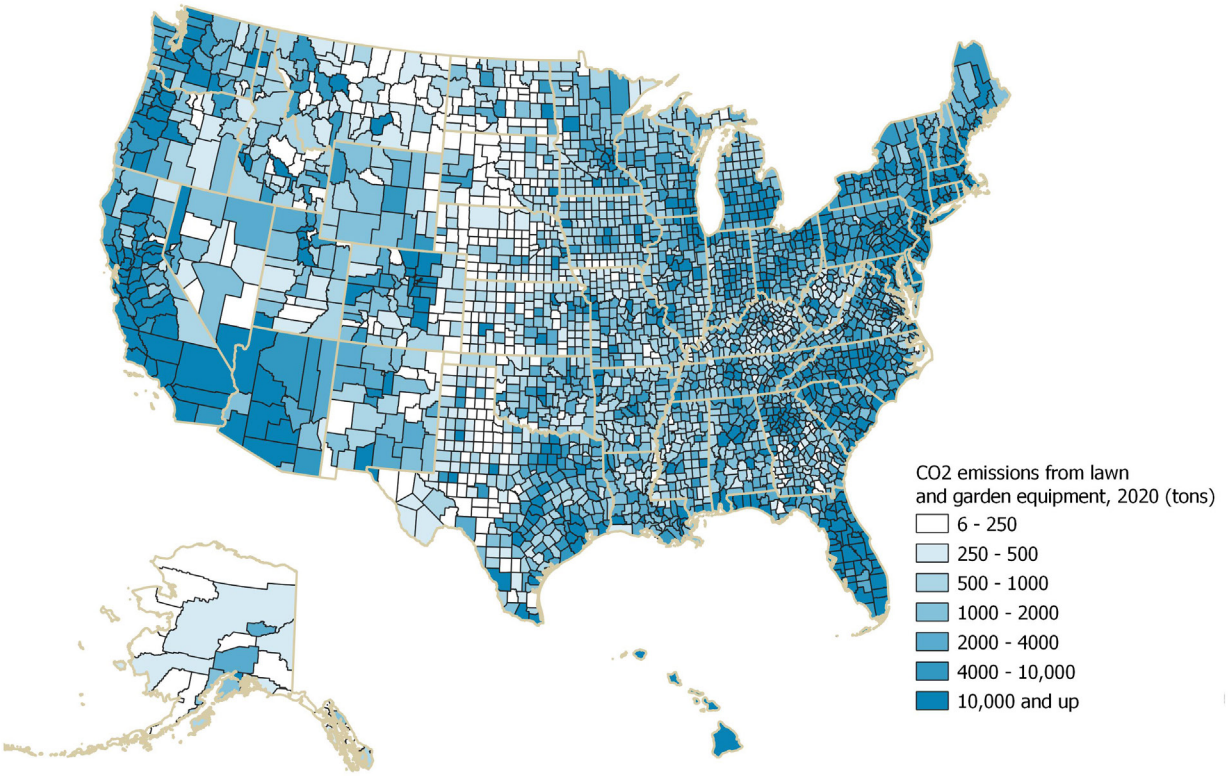

Figure 2. Carbon dioxide emissions from lawn and garden equipment by county, 2020

State	Carbon dioxide emissions
California	3,865,999
Florida	2,575,055
Texas	2,263,494
New York	1,370,870
Illinois	1,197,037
Pennsylvania	1,149,423
Ohio	1,055,582
Georgia	1,043,062
North Carolina	984,230
Virginia	963,374

Table 2. Top 10 states for carbon dioxide emissions from lawn equipment, 2020 (tons)

Ozone-forming pollution

Emissions of volatile organic compounds (VOCs) and nitrogen oxides (NO_X) from lawn and garden equipment contribute to the formation of ground-level ozone, the main ingredient in smog.

In 2020, lawn and garden equipment in the U.S. produced more than 68,000 tons of NO_X emissions, the equivalent of one year's worth of pollution from 30 million typical cars, as well as more than 350,000 tons of VOC emissions. An EPA study estimated that lawn equipment produced nearly 4% of the nation's VOC emissions in 2011.[53]

Florida led all states in NO_X releases from lawn equipment, followed by Texas, California, New York and Illinois. California was the top state for volatile organic compound releases. (See Table 3, page 13.) Los Angeles County was the top county in the U.S. for both nitrogen oxide and volatile organic compound releases from lawn equipment. (See Figures 3 and 4.)

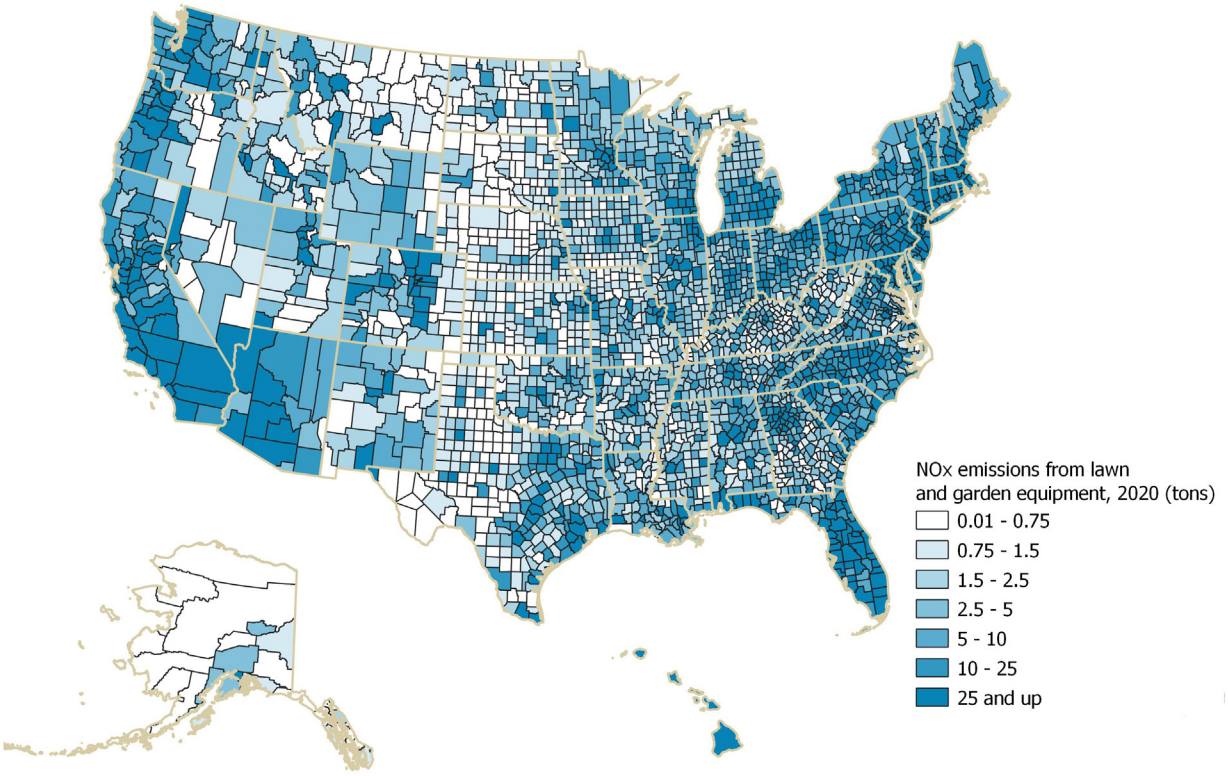

Figure 3. Nitrogen oxide emissions from lawn and garden equipment by county, 2020

State or territory	Nitrogen oxides (tons)	Volatile organic compounds (tons)
Florida	5,913	30,116
Texas	5,126	26,374
California	4,560	33,762
New York	3,271	16,986
Illinois	2,995	14,395
Pennsylvania	2,913	14,553
Ohio	2,672	13,380
Georgia	2,520	12,108
Virginia	2,459	11,564
North Carolina	2,380	11,510

Table 3. Top 10 states for emissions of nitrogen oxides and volatile organic compounds from lawn equipment, 2020 (tons)

Many volatile organic compounds emitted by lawn equipment are also toxic – pollution that is especially concerning because it occurs locally in areas where people live.[54]

In 2020, emissions of cancer-causing chemicals from lawn and garden equipment in the U.S. included:[55]

- More than 20 million pounds of benzene,
- 3.5 million pounds of 1,3-butadiene,
- 7 million pounds of formaldehyde.

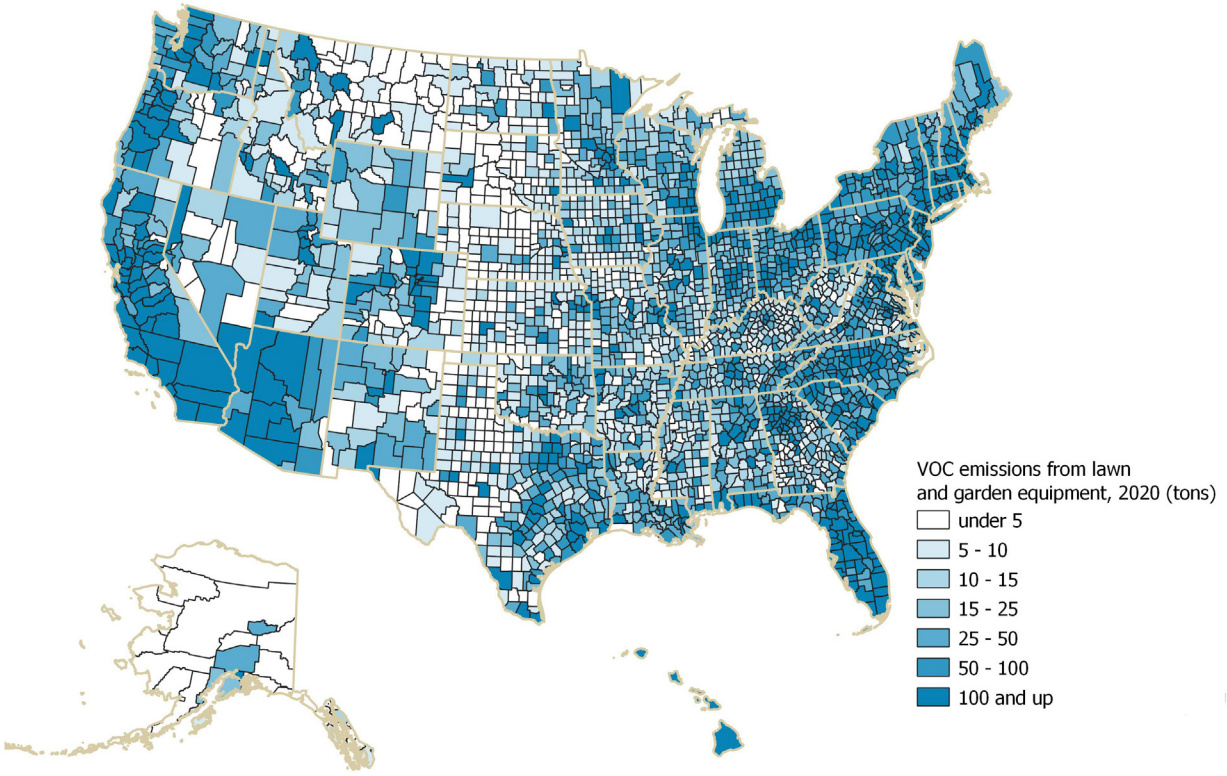

Figure 4. Volatile organic compound emissions from lawn and garden equipment by county, 2020

"Upstream" emissions from electric lawn and garden equipment

Electric lawn and garden equipment is not completely free of emissions, as some amount of pollution is released at the power plants that generate the electricity used to power the equipment. These "upstream" emissions, however, are far less than the emissions produced from burning gasoline or other fossil fuels in lawn equipment.

While the upstream emissions of specific pollutants vary, carbon dioxide provides a good example of the difference between electric and gasoline-powered equipment. According to one study, gasoline-powered riding mowers release 13.8 times as much carbon dioxide per acre as battery-powered lawn mowers when upstream emissions from power plants are taken into account.[56] Electric lawn equipment purchased today will also likely produce less upstream pollution over time as dirty fossil fuel power plants are increasingly phased out in favor of clean, renewable energy.

A 2021 life-cycle analysis confirmed that, even when all the greenhouse gas impacts of the manufacture and use of lawn equipment are taken into account, electric lawn equipment is still the clear winner. The study found that residential electric push mowers produce 49.9% fewer carbon dioxide emissions over their lifetime than gasoline-powered versions, while electric riding mowers reduce carbon dioxide emissions by 32.3% over their lifetime compared with their gasoline-powered counterparts.[57]

Emissions by type of equipment

The EPA's National Emissions Inventory provides a detailed window into the types of lawn and garden equipment that produce the most pollution.

- **Commercial versus residential** – Commercial lawn and garden equipment nationwide is responsible for two to four times the total amount of pollution as residential equipment. In 2020, commercial operations were responsible for 82% of all fine particulate emissions from lawn equipment, along with 77% of NO_X emissions, 73% of carbon dioxide emissions and 67% of VOC emissions. (See Figure 5.)
- **Equipment type** – The EPA includes three broad types of equipment in its "lawn and garden" sector: chainsaws, snow blowers and other commercial and residential lawn and garden care equipment. For most pollutants, lawn equipment produces the vast majority of the emissions in the sector, but there are exceptions: chainsaws, which are largely powered by two-stroke engines, produced about one-third of all fine particulate emissions from the lawn and garden sector, along with more than 20% of VOC emissions.
- **Engine type** – Across all types of equipment, two-stroke engines were responsible for 85% of all fine particulate emissions from gasoline-powered equipment in the lawn and garden sector in 2020, along with 51% of all VOC emissions. By contrast, two-stroke engines were responsible for only 10% of NO_X emissions and 9% of carbon dioxide emissions from gasoline-powered equipment. While EPA data does not indicate how many pieces of two-stroke and four-stroke equipment are in operation, these data suggest that while two-stroke engines may consume only a small fraction of the fuel used in lawn equipment, they produce vastly more of certain types of pollutants than four-stroke engines.[58]

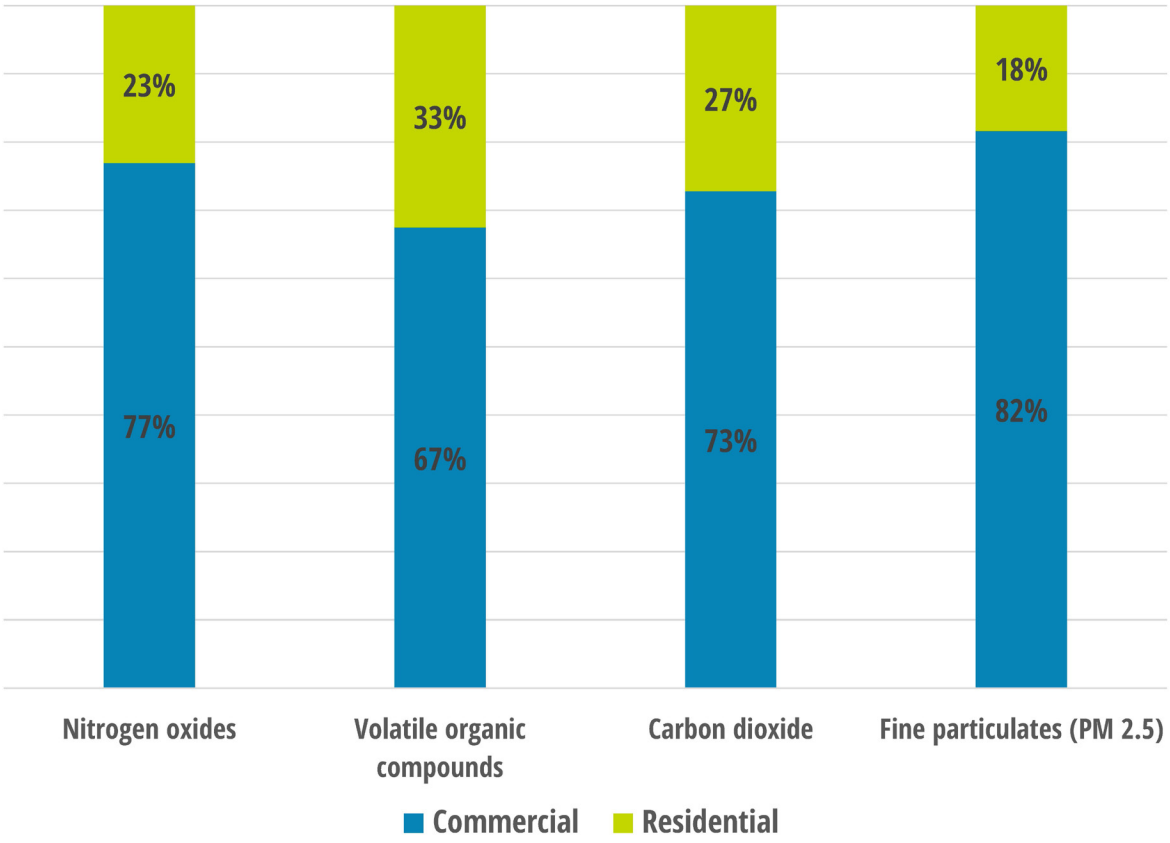

Figure 5. Share of pollution from commercial and residential lawn equipment

Electric lawn equipment is effective and affordable

Lawn equipment has historically been dominated by gasoline-powered engines. The electric models that were available on the market until recently often relied on inconvenient power cords that limited the range of the equipment. Today, as a result of steady advancements in battery technology, rechargeable battery-powered lawn equipment offers residential users comparable performance, value and convenience to gasoline-powered models with minimal environmental impact.

The demands of commercial lawn care are different from, and greater than, those of residential users. But electric equipment is also making inroads in the commercial sector, with an increasing array of available options.

Electric lawn equipment is widely available

Electric lawn equipment is easy to find at major hardware retailers. Ace Hardware, for example, offers 23 battery electric lawn mower models, with one costing as little as $299.99.[59] Electric leaf blowers are available, too: Ace Hardware lists 20 battery-powered models[60] versus 20 gasoline-powered options.[61] A midsummer advertising catalog for Home Depot features several battery-powered leaf blowers, string trimmers and other cordless tools.[62] The number and variety of electric lawn equipment models is expected to continue to grow; Home Depot announced in 2023 that 85% of the lawn equipment it sells will be powered by electricity by 2028.[63]

Electric lawn equipment saves money relative to gas models

Electric lawn equipment sometimes has a higher initial price tag but saves money over time due to lower operating costs. In contrast, while a gasoline-powered model may be cheaper upfront, the user must purchase gasoline regularly and maintain the engine.[64] Beyond those recurring costs, maintaining an engine can be frustrating and time-consuming, while recharging a battery is as simple as it gets.

A Consumer Reports interactive tool shows that extra up-front investment in an average-price electric lawn

	Push/Self-propelled	Lawn mowing time (mins)	Break-even point (years)	Five-year savings
Scenario 1	Push	15	3.1	$65
Scenario 2	Self-Propelled	15	2.5	$85
Scenario 3	Push	30	2.2	$130
Scenario 4	Self-Propelled	30	1.8	$150
Scenario 5	Push	60	1.4	$261
Scenario 6	Self-Propelled	60	1.2	$281

Table 4. Five-year savings from average-price battery-powered lawn mower relative to gasoline-powered model (estimated using Consumer Reports online tool)[67]

mower is almost guaranteed to save money over five years compared to a similarly priced gas model.[65]

Consider the following examples, with gas prices held constant at the national average for August 7, 2023 of approximately $3.80 per gallon.[66] For a relatively small lawn that takes just 15 minutes to mow, an average-price electric push mower pays off the additional cost relative to an average-price gasoline-powered mower in just over three years and saves the owner $65 over five years (See Table 4, Scenario 1). An electric self-propelled mower (as opposed to a push mower without propulsion) under the same conditions pays for the extra upfront cost – achieving the "break-even point" – in 2.5 years and saves the user $85 over five years. (See Table 4, Scenario 2.)

Savings are even greater, and the break-even point is reached faster, for bigger lawns with mowing times of 30 or 60 minutes. (See Table 4, Scenarios 3-6.)

Depending on individual lawn care needs, rotating one battery among multiple machines can increase savings on battery-powered products.[68] In many cases, the battery itself can be a significant proportion of the total cost of a new battery-powered lawn mower. For example, STIHL lists one electric lawn mower at $399.99 with the battery and charger and $249.99 without, so the battery constitutes more than one-third of the total price.[69] STIHL and several competing brands offer proprietary batteries for use in tools across their lawn equipment suites.[70] Consumers who adopt electric equipment from a single manufacturer for all of their lawn and garden needs, therefore, may experience even greater savings than those owning just one piece of electric equipment.

State rebates or tax credits for battery-powered lawn equipment can also boost savings. For example, Massachusetts residents who have Eversource, National Grid, Cape Light Compact or Unitil as their electricity provider are eligible for a rebate of $30 to $75 on four types of lawn equipment in 2023.[71] In Colorado, some types of electric lawn equipment will be 30% cheaper beginning in early 2024 because of a statewide credit for retailers.[72] Consumers in the market for lawn equipment should consult state, local government and utility resources to determine whether similar rebates or tax credits apply to them.

Electric lawn equipment is up to the task

Battery-powered lawn equipment beats out gasoline-powered equipment on lifetime costs, but can it get the job done? In most cases, the answer is "yes."

Lawn mowers

Consumer Reports' extensive independent testing of lawn mowers found a wide range of performance among electric lawn mowers, with a few poor performers but also many options that do the job just as well as gasoline-powered models.[73] Overall, the average scores for electric mowers were slightly below those of gasoline-powered models.[74] However, the testers found a wider range in quality for electric models in certain categories, with a few low outliers dragging down those average scores. Notably, electric models performed better than gas models on "handling" and slightly worse on "cutting evenness."[75] By avoiding the very cheapest options when picking an electric mower, consumers will likely be satisfied with the quality.

Maximum run time has historically been an advantage of gasoline-powered lawn equipment, but electric models are lasting longer and should continue to improve with better battery technology. Consumer Reports found that the battery-powered lawn mowers they tested ran for an average of 30-45 minutes on one charge – enough to cover a quarter-acre lawn.[76] Some users purchase additional batteries to increase the amount of coverage for one mowing session and minimize downtime.

Leaf blowers

Battery-powered leaf blowers are even more competitive in performance for residential users than electric lawn mowers. In Consumer Reports' testing, battery-powered and gasoline-powered leaf blowers each won one performance category handily on average score, and gas edged out electric in "[t]he ability to sweep leaves into a tiny pile."[77] Despite giving gasoline-powered blowers a tiny advantage on average in "sweeping" in its evaluation, Consumer Reports noted that the best electric models earned scores identical to

the best gasoline models.[78] Wirecutter, the New York Times' independent consumer product review platform, recommends five corded and cordless leaf blowers but only one gasoline-powered model.[79] The one gasoline-powered model they recommend is suitable only for "... [i]f your property is more than an acre and has densely wooded areas, and you often need to blast a heap of leaves 100 feet across a field."[80]

String trimmers

Battery-powered string trimmers have become a fixture in the lawn equipment sector. Consumer Reports gave gasoline-powered models a slight advantage in their testing but noted, "... in almost every case, it's easy to find an electric string trimmer that matches or beats the performance of gas models."[81]

Other reviewers rate battery-powered models even more favorably. Popular Mechanics only included two gasoline-powered options on its May 2023 list of 11 recommended string trimmers.[82] In August 2022, Wirecutter cited the "continued success of cordless string trimmers [they]'ve tested" and "the hassle of owning a small engine" among reasons that they stopped recommending gasoline-powered string trimmers entirely.[83]

Commercial equipment

Commercial landscapers have different needs than an average homeowner who mows the lawn once a week. Lawn care equipment must be capable, durable and, above all, available for work whenever needed. Run time and recharging are top concerns about electric equipment according to a 2021 poll of readers of a landscape industry trade publication,[84] but landscapers who have embraced electric equipment are using a variety of strategies to keep their equipment running.

For commercial users in particular, education and training are important for understanding basic differences in battery electric versus gas combustion technology platforms, safety considerations, electrical infrastructure needs, proper charging practices, and operation, handling, storage and maintenance to optimize performance and productivity, and extend product life.

Landscapers may maintain additional backup batteries, or use mobile charging trailers that keep a supply of freshly charged batteries at worksites in order to extend run time.[85] Manufacturers have also introduced rapid chargers to speed the recharge of batteries, ensuring that a bank of fully charged batteries are ready and waiting for the next day's work.[86] The arrival of electric pickup trucks like the Ford F-150 Lightning provides opportunities for recharging some lighter equipment at the worksite from electricity stored in the vehicle's battery.[87] Some operators have even outfitted trucks and trailers with solar panels to provide a remote source of electricity to recharge batteries while at job sites.[88] Continued improvements in battery technology should result in further improvements in run time, charging time and flexibility of charging options in the years ahead.

One clear advantage of electric lawn equipment for commercial operators is ease of maintenance. In the same landscape industry poll mentioned above, maintenance was seen as the second-biggest advantage of electric equipment, trailing only reductions in noise.[89] Electric equipment has far fewer moving parts than gasoline-powered equipment, leading to potentially greater reliability and lower maintenance costs.[90] Battery replacement – typically required after about five years[91] – can be a significant cost, but continual improvement in battery technology could also lead to longer and more reliable operation.

Electric lawn equipment is quieter than gas models

The irritating and unhealthy noise created by gasoline-powered lawn equipment is well documented. The good news is that battery-powered lawn equipment is almost universally quieter than gasoline-powered models. In Consumer Reports' testing, even the noisiest electric lawn mowers and string trimmers were quieter than the quietest gasoline-powered models.[92] Wirecutter, Popular Mechanics and CNN Underscored agree that electric lawn mowers win the noise battle handily, and it's a similar story for leaf blowers and string trimmers.[93] Consumers switching from gas to electric lawn equipment can feel good about contributing much less to noise pollution and rest assured that their ears (and neighbors) will thank them.

Recommendations

To improve the quality of the air we breathe and protect the climate, governments should take concrete steps to encourage a transition from gasoline-powered lawn equipment to cleaner electric options. Specifically:

Local and state governments, along with major institutions, should lead by example by using electric equipment for their landscaping needs.

Leading cities and states have adopted policies requiring a transition to electric equipment wherever feasible. For example, the New York State Department of Conservation is due to release a plan before the end of 2023 to transition its lawn equipment to zero-emission technology.[94] Working with the American Green Zone Alliance (AGZA), the city of South Pasadena, Calif., transitioned its maintenance operations to electric equipment.[95] In 2023, Colorado Gov. Jared Polis issued an executive order to phase out the use of gasoline-powered small landscaping equipment on state property in parts of the state with the worst ozone pollution. The policy takes effect in 2025.[96]

For commercial entities, technical specifications and field-tested equipment certifications can help inform the purchase of high-quality, commercial-grade equipment.

Local and state governments, along with electric utilities, should create financial incentives to encourage the purchase of electric lawn equipment. For example:

- In 2023, Colorado adopted legislation that will provide a 30% discount on electric lawn mowers, leaf blowers, trimmers and snow blowers.[97]
- California provides point-of-sale discounts on the purchase of electric lawn equipment by small-scale commercial landscapers. Additional residential and commercial incentives are available in several of California's air management districts.[98]
- Mass Save, the utility energy efficiency program serving Massachusetts' investor-owned utilities, provides incentives of up to $3,500 for the purchase of electric commercial lawn mowers, and smaller rebates for other types of residential and commercial lawn equipment.[99]
- The city of Yonkers, N.Y., outside New York City, provides rebates toward the purchase of residential and commercial leaf blowers – a policy that supports the city's ban on the use of gasoline-powered leaf blowers during the summer months.[100]
- The city of Louisville, Ky., offers rebates on the purchase of electric lawn equipment, with higher rebates available for individuals or businesses who also trade-in old gasoline-powered equipment for retirement.[101]
- The public utility serving Burlington, Vt., provides incentives for the purchase of electric lawn mowers.[102]
- Clark County Rural Electric Membership Corporation, a utility provider in Indiana, is offering up to $50 towards customer purchases of electric lawn mowers, leaf blowers and string trimmers through the end of 2023.[103]

In addition to these examples of direct financial incentives, state governments should consider creating grant programs to help localities and institutions transition to electric equipment, provide education and training, and offer loan programs to help commercial landscapers finance equipment purchases.

Local and state governments should consider **phasing out gasoline-powered lawn equipment**, and/or **restricting the use** of the noisiest and most polluting equipment in certain circumstances.

- California will require that most off-road equipment with small engines sold in the state starting in 2024 – including lawn and garden equipment – be zero-emission.[104]
- In 2018, Washington, D.C., banned the sale or use of gasoline-powered leaf blowers.[105]
- Several cities and towns, including Brookline, Mass., ban the use of gasoline-powered leaf blowers for part of the year.[106]
- Cities and towns may also adopt rules such as noise ordinances and bans on use during certain hours of the day that reduce the nuisance caused by gasoline-powered equipment and encourage the use of cleaner, quieter alternatives.
- Governments phasing out gasoline-powered lawn equipment should provide support to encourage a smooth transition to clean electric equipment.

Methodology

This analysis uses data from the U.S. Environmental Protection Agency's (EPA) National Emissions Inventory (NEI) for 2020 to estimate air emissions from lawn and garden equipment at the county level across the United States. The EPA estimates were based on the agency's air pollution modeling, with the exception of emissions data for California and three tribal jurisdictions, which were supplied by the state and tribal governments, respectively. The EPA encouraged state, local and tribal governments to submit additional inputs for the agency's modeling; 12 states and one county did so. For the remainder of the country, the estimates are based on inputs developed for the EPA's MOVES3 emissions model.[107]

Data on nonroad emissions from the 2020 NEI was downloaded from the EPA on July 26, 2023.[108] Emissions data was provided in a set of five files, corresponding to EPA regions, which were combined and further analyzed using Python. Emissions related to lawn and garden equipment were identified using EPA Source Classification Codes (SCCs) downloaded from the EPA on July 26, 2023.[109] SCCs associated with the level three category "lawn and garden equipment" were included in our estimates. This category includes lawn equipment such as mowers, trimmers and leaf blowers, along with snow blowers and chainsaws. It also includes emissions from all fossil fuel-powered equipment, including equipment powered with gasoline, diesel fuel and liquefied petroleum gases (propane).

County-level emissions for the SCC codes described above were grouped by county and by state to produce the county- and state-level emissions estimates in this report.

For nitrogen oxides, fine particulates and carbon dioxide, we estimated the number of miles that would need to be driven in a typical passenger car to produce the same amount of emissions as is produced by lawn equipment. To do so, we compared emissions estimates against the amount of nitrogen oxides and fine particulates ($PM_{2.5}$) produced per mile of driving in a typical gasoline-powered passenger car in 2020, based on data for light-duty vehicles from the Bureau of Transportation Statistics.[110]

For carbon dioxide, we assumed that a typical car would produce one ton of CO_2 emissions for every 2,326 miles driven in a passenger car, based on data from the EPA.[111]

For all pollutants, we then estimated the number of typical passenger cars that would produce the same amount of pollution as lawn and garden equipment, assuming that the average car is driven 10,556 miles per year, based on data for 2021 from the Federal Highway Administration.[112] (Note: 2021 data was used for the comparison because per-capita miles driven in 2020 were abnormally low due to the COVID-19 pandemic.)

Appendix A: Emissions from lawn and garden equipment by state, 2020

Table A-1. Emissions from lawn and garden equipment by state, 2020

State	Nitrogen oxides (tons)	Volatile organic compounds (tons)	Carbon dioxide (tons)	Methane (tons)	$PM_{2.5}$, primary (tons)	1,3-Butadiene (lbs.)	Benzene (lbs.)	Formaldehyde (lbs.)
Alabama	946	4,765	402,797	270	325	43,560	281,920	77,078
Alaska	76	453	36,646	36	26	5,144	37,067	8,859
Arizona	985	5,924	445,908	308	333	49,092	359,830	84,926
Arkansas	553	2,787	238,673	162	188	26,040	165,997	45,103
California	4,560	33,762	3,865,999	N/A	325	449,527	1,939,054	1,676,985
Colorado	1,969	9,811	775,805	584	671	95,924	551,416	168,567
Connecticut	872	4,144	337,890	254	284	41,604	235,033	74,690
Delaware	311	1,327	125,942	83	100	13,332	78,007	24,188
District of Columbia	41	268	20,244	16	11	2,554	16,903	3,813
Florida	5,913	30,116	2,575,055	1,684	2,116	272,675	1,759,153	493,947
Georgia	2,520	12,108	1,043,062	698	864	112,994	709,342	201,667
Hawaii	333	1,542	141,793	93	115	14,988	90,047	27,033
Idaho	432	2,161	165,242	126	147	20,735	121,706	36,566
Illinois	2,995	14,395	1,197,037	897	931	145,737	828,399	254,793
Indiana	1,473	7,483	590,829	444	493	72,578	427,467	126,691
Iowa	609	3,202	247,179	189	207	30,801	182,952	53,102
Kansas	635	3,312	256,484	193	214	31,491	189,188	55,099
Kentucky	668	3,493	279,246	205	221	33,155	205,531	56,536
Louisiana	626	3,381	282,001	191	212	30,499	203,962	52,416
Maine	359	1,767	141,561	109	120	17,752	100,090	30,579
Maryland	1,839	8,739	722,471	531	597	86,845	495,586	155,335
Massachusetts	1,554	7,447	614,932	462	500	75,302	424,381	132,488
Michigan	1,783	8,834	709,938	543	561	88,093	511,328	151,680

Table A-1. Emissions from lawn and garden equipment by state, 2020

State	Nitrogen oxides (tons)	Volatile organic compounds (tons)	Carbon dioxide (tons)	Methane (tons)	$PM_{2.5}$, primary (tons)	1,3-Butadiene (lbs.)	Benzene (lbs.)	Formaldehyde (lbs.)
Minnesota	1,163	5,887	456,933	352	390	57,500	335,073	99,045
Mississippi	362	1,938	159,935	109	118	17,386	117,992	29,804
Missouri	1,438	7,329	586,045	436	485	71,203	418,231	125,153
Montana	213	1,046	83,158	65	67	10,477	60,502	17,787
Nebraska	361	1,931	145,354	112	124	18,268	110,248	31,514
Nevada	933	4,817	380,631	261	338	42,642	277,146	77,390
New Hampshire	414	1,983	161,091	121	137	19,887	111,812	35,065
New Jersey	2,125	10,180	834,100	620	689	101,289	578,741	179,884
New Mexico	385	2,071	157,901	118	123	19,041	121,152	32,957
New York	3,271	16,986	1,370,870	1,042	1,071	169,047	983,371	286,280
North Carolina	2,380	11,510	984,230	669	839	108,595	667,252	193,605
North Dakota	120	615	48,896	38	35	6,134	36,552	10,079
Ohio	2,672	13,380	1,055,582	795	885	130,092	761,137	229,120
Oklahoma	1,072	5,257	451,058	304	379	49,286	306,623	87,382
Oregon	1,128	5,514	441,118	333	374	54,512	311,843	95,644
Pennsylvania	2,913	14,553	1,149,423	871	965	142,417	827,520	249,396
Puerto Rico	1,030	5,353	455,690	298	372	48,239	313,006	87,127
Rhode Island	182	897	72,640	55	58	8,990	51,676	15,553
South Carolina	1,255	6,016	524,581	350	427	56,466	353,712	100,790
South Dakota	132	696	54,075	42	42	6,727	40,778	11,343
Tennessee	1,272	6,261	531,798	365	425	58,773	369,867	103,257
Texas	5,126	26,374	2,263,494	1,503	1,777	241,738	1,565,312	426,503
Utah	599	3,049	237,367	181	201	29,559	173,394	51,185
Vermont	159	788	62,780	48	53	7,886	44,903	13,587
Virgin Islands	30	153	13,596	9	11	1,447	8,973	2,576
Virginia	2,459	11,564	963,374	691	814	112,920	658,480	203,605
Washington	1,736	8,332	670,407	508	557	82,927	475,567	144,690
West Virginia	319	1,709	131,042	100	106	16,311	98,751	27,878
Wisconsin	1,169	5,797	460,196	353	382	57,587	331,489	99,597
Wyoming	110	548	43,567	34	33	5,442	32,017	9,230
U.S. Total	**68,582**	**353,758**	**30,167,664**	**18,858**	**21,840**	**3,513,209**	**20,457,482**	**7,069,165**

Table A-2. Emissions from lawn and garden equipment compared with emissions from automobiles

State	Emissions compared with millions of miles driven in a typical car			Emissions compared with number of typical cars		
	Nitrogen oxides	$PM_{2.5}$	Carbon dioxide	Nitrogen oxides	$PM_{2.5}$	Carbon dioxide
Alabama	4,471	36,803	937	423,136	3,483,168	88,672
Alaska	358	2,955	85	33,911	279,690	8,067
Arizona	4,652	37,808	1,037	440,292	3,578,245	98,162
Arkansas	2,612	21,364	555	247,206	2,021,914	52,542
California	21,543	36,838	8,992	2,038,926	3,486,444	851,061
Colorado	9,304	76,117	1,805	880,554	7,204,002	170,786
Connecticut	4,118	32,240	786	389,770	3,051,268	74,383
Delaware	1,471	11,316	293	139,261	1,070,950	27,725
District of Columbia	192	1,272	47	18,132	120,411	4,456
Florida	27,938	239,953	5,990	2,644,129	22,709,915	566,873
Georgia	11,905	97,965	2,426	1,126,755	9,271,702	229,620
Hawaii	1,573	13,002	330	148,921	1,230,569	31,214
Idaho	2,043	16,633	384	193,309	1,574,189	36,376
Illinois	14,152	105,618	2,784	1,339,410	9,995,996	263,516
Indiana	6,960	55,854	1,374	658,701	5,286,189	130,065
Iowa	2,878	23,497	575	272,343	2,223,834	54,414
Kansas	3,000	24,306	597	283,976	2,300,430	56,462
Kentucky	3,157	25,012	650	298,784	2,367,210	61,473
Louisiana	2,957	24,086	656	279,875	2,279,600	62,080
Maine	1,696	13,659	329	160,491	1,292,690	31,163
Maryland	8,691	67,665	1,680	822,556	6,404,064	159,045
Massachusetts	7,344	56,732	1,430	695,041	5,369,291	135,371
Michigan	8,426	63,602	1,651	797,454	6,019,521	156,286
Minnesota	5,496	44,214	1,063	520,189	4,184,562	100,589
Mississippi	1,712	13,378	372	162,008	1,266,099	35,208
Missouri	6,794	54,977	1,363	642,987	5,203,213	129,012
Montana	1,006	7,550	193	95,184	714,595	18,306

Table A-2. Emissions from lawn and garden equipment compared with emissions from automobiles

State	Emissions compared with millions of miles driven in a typical car			Emissions compared with number of typical cars		
	Nitrogen oxides	$PM_{2.5}$	Carbon dioxide	Nitrogen oxides	$PM_{2.5}$	Carbon dioxide
Nebraska	1,705	14,059	338	161,332	1,330,582	31,998
Nevada	4,410	38,312	885	417,392	3,625,961	83,792
New Hampshire	1,956	15,530	375	185,133	1,469,767	35,463
New Jersey	10,038	78,174	1,940	950,050	7,398,599	183,619
New Mexico	1,819	13,983	367	172,162	1,323,349	34,760
New York	15,453	121,491	3,189	1,462,544	11,498,282	301,783
North Carolina	11,248	95,152	2,289	1,064,514	9,005,487	216,669
North Dakota	568	4,021	114	53,731	380,533	10,764
Ohio	12,626	100,334	2,455	1,195,008	9,495,953	232,376
Oklahoma	5,066	43,010	1,049	479,467	4,070,608	99,296
Oregon	5,328	42,419	1,026	504,268	4,014,714	97,108
Pennsylvania	13,766	109,448	2,674	1,302,837	10,358,520	253,034
Puerto Rico	4,868	42,230	1,060	460,768	3,996,774	100,316
Rhode Island	862	6,589	169	81,578	623,588	15,991
South Carolina	5,931	48,383	1,220	561,311	4,579,103	115,481
South Dakota	625	4,707	126	59,185	445,459	11,904
Tennessee	6,010	48,202	1,237	568,786	4,562,028	117,070
Texas	24,218	201,502	5,265	2,292,112	19,070,831	498,286
Utah	2,829	22,789	552	267,747	2,156,860	52,254
Vermont	753	5,973	146	71,261	565,336	13,820
Virgin Islands	142	1,235	32	13,435	116,871	2,993
Virginia	11,620	92,335	2,241	1,099,795	8,738,873	212,077
Washington	8,202	63,112	1,559	776,245	5,973,091	147,584
West Virginia	1,506	12,006	305	142,576	1,136,322	28,848
Wisconsin	5,523	43,360	1,070	522,678	4,103,748	101,307
Wyoming	522	3,799	101	49,367	359,504	9,591
U.S. Total	**324,044**	**2,476,570**	**70,170**	**30,668,583**	**234,390,507**	**6,641,112**

Appendix B: Top counties for emissions from lawn and garden equipment

Table B-1. Top 100 counties for carbon dioxide emissions from lawn and garden equipment, 2020

Rank	County	State	Carbon dioxide (tons)	Carbon dioxide (number of cars equivalent)
1	Los Angeles County	California	675,790	148,768
2	Orange County	California	613,584	135,074
3	Harris County	Texas	443,353	97,600
4	San Diego County	California	442,915	97,503
5	Cook County	Illinois	366,806	80,749
6	Palm Beach County	Florida	309,980	68,239
7	Riverside County	California	308,450	67,902
8	Clark County	Nevada	303,190	66,744
9	Dallas County	Texas	302,146	66,515
10	King County	Washington	259,950	57,225
11	Broward County	Florida	248,193	54,637
12	Suffolk County	New York	239,199	52,657
13	Maricopa County	Arizona	233,413	51,384
14	St. Louis County	Missouri	229,028	50,418
15	Bexar County	Texas	220,804	48,608
16	Santa Clara County	California	218,133	48,020
17	Alameda County	California	200,917	44,230
18	Miami-Dade County	Florida	199,024	43,813
19	Orange County	Florida	196,158	43,182
20	Tulsa County	Oklahoma	191,705	42,202
21	Fairfax County	Virginia	186,782	41,118
22	DuPage County	Illinois	173,150	38,117
23	Montgomery County	Maryland	172,840	38,049
24	Cuyahoga County	Ohio	166,478	36,648
25	Sacramento County	California	156,767	34,511
26	Mecklenburg County	North Carolina	154,694	34,054
27	Travis County	Texas	154,390	33,988
28	Middlesex County	Massachusetts	153,480	33,787

Table B-1. Top 100 counties for carbon dioxide emissions from lawn and garden equipment, 2020

Rank	County	State	Carbon dioxide (tons)	Carbon dioxide (number of cars equivalent)
29	Tarrant County	Texas	153,142	33,713
30	Lake County	Illinois	152,215	33,509
31	Hillsborough County	Florida	149,015	32,804
32	Montgomery County	Pennsylvania	148,271	32,640
33	Duval County	Florida	145,650	32,063
34	Westchester County	New York	143,203	31,525
35	Gwinnett County	Georgia	140,396	30,907
36	San Bernardino County	California	139,107	30,623
37	Fairfield County	Connecticut	136,200	29,983
38	Arapahoe County	Colorado	132,379	29,142
39	Nassau County	New York	127,801	28,134
40	Wake County	North Carolina	125,853	27,705
41	Hennepin County	Minnesota	123,712	27,234
42	Oakland County	Michigan	122,181	26,897
43	Collin County	Texas	115,867	25,507
44	Pima County	Arizona	115,724	25,476
45	Contra Costa County	California	114,750	25,261
46	Oklahoma County	Oklahoma	113,031	24,883
47	Shelby County	Tennessee	112,807	24,833
48	Salt Lake County	Utah	112,243	24,709
49	Cobb County	Georgia	111,786	24,609
50	Washington County	Oregon	108,727	23,935
51	Collier County	Florida	108,330	23,848
52	Franklin County	Ohio	106,824	23,516
53	Bergen County	New Jersey	106,597	23,466
54	Ventura County	California	103,903	22,873
55	Allegheny County	Pennsylvania	103,845	22,861
56	Polk County	Florida	103,258	22,731
57	Jefferson County	Colorado	102,337	22,529
58	Wayne County	Michigan	102,289	22,518
59	Pinellas County	Florida	102,240	22,507
60	Monroe County	New York	102,202	22,499
61	Ashland County	Ohio	98,918	21,776
62	San Mateo County	California	95,818	21,093
63	Bucks County	Pennsylvania	94,520	20,808
64	Prince George's County	Maryland	94,007	20,695
65	Baltimore County	Maryland	93,931	20,678
66	Lee County	Florida	92,959	20,464

Table B-1. Top 100 counties for carbon dioxide emissions from lawn and garden equipment, 2020

Rank	County	State	Carbon dioxide (tons)	Carbon dioxide (number of cars equivalent)
67	Pierce County	Washington	90,646	19,955
68	Loudoun County	Virginia	90,286	19,876
69	Honolulu County	Hawaii	90,029	19,819
70	Davidson County	Tennessee	89,981	19,808
71	Kane County	Illinois	89,517	19,706
72	Clackamas County	Oregon	87,135	19,182
73	Pulaski County	Arkansas	87,014	19,155
74	Bernalillo County	New Mexico	86,387	19,017
75	Chester County	Pennsylvania	86,154	18,966
76	Snohomish County	Washington	85,909	18,912
77	Marion County	Indiana	85,301	18,778
78	Middlesex County	New Jersey	81,580	17,959
79	Johnson County	Kansas	80,032	17,618
80	New Castle County	Delaware	79,461	17,493
81	Jackson County	Missouri	78,677	17,320
82	Hartford County	Connecticut	77,753	17,117
83	Shelby County	Alabama	77,504	17,062
84	Morris County	New Jersey	77,495	17,060
85	El Paso County	Colorado	76,614	16,866
86	Fresno County	California	76,429	16,825
87	Milwaukee County	Wisconsin	74,150	16,323
88	Kings County	New York	73,722	16,229
89	Monmouth County	New Jersey	73,363	16,150
90	Anne Arundel County	Maryland	73,183	16,111
91	Queens County	New York	72,492	15,958
92	Fulton County	Georgia	72,346	15,926
93	Essex County	Massachusetts	70,771	15,580
94	DeKalb County	Georgia	70,579	15,537
95	Adams County	Colorado	69,862	15,380
96	Frederick County	Virginia	69,511	15,302
97	Will County	Illinois	69,500	15,300
98	Hamilton County	Ohio	68,284	15,032
99	Erie County	New York	68,282	15,032
100	Seminole County	Florida	68,193	15,012

Table B-2. Top 100 counties for nitrogen oxide emissions from lawn and garden equipment, 2020

Rank	County	State	Nitrogen oxides (tons)	Nitrogen oxides (number of cars equivalent)
1	Los Angeles County	California	1,135	507,571
2	Harris County	Texas	1,009	451,099
3	Cook County	Illinois	894	399,996
4	Clark County	Nevada	735	328,888
5	Palm Beach County	Florida	726	324,555
6	Dallas County	Texas	703	314,378
7	King County	Washington	687	307,067
8	Suffolk County	New York	602	269,077
9	St. Louis County	Missouri	584	261,092
10	Broward County	Florida	563	251,614
11	Bexar County	Texas	513	229,319
12	Maricopa County	Arizona	498	222,549
13	Fairfax County	Virginia	489	218,668
14	Tulsa County	Oklahoma	471	210,713
15	Orange County	Florida	462	206,503
16	Orange County	California	456	203,992
17	Montgomery County	Maryland	449	200,959
18	DuPage County	Illinois	447	200,004
19	Miami-Dade County	Florida	435	194,645
20	Cuyahoga County	Ohio	428	191,421
21	San Diego County	California	415	185,752
22	Lake County	Illinois	399	178,553
23	Middlesex County	Massachusetts	390	174,373
24	Montgomery County	Pennsylvania	388	173,616
25	Mecklenburg County	North Carolina	383	171,416
26	Travis County	Texas	361	161,529
27	Fairfield County	Connecticut	360	161,055
28	Westchester County	New York	358	160,249
29	Gwinnett County	Georgia	351	156,971
30	Tarrant County	Texas	349	155,986
31	Duval County	Florida	344	153,811
32	Hillsborough County	Florida	342	152,850
33	Arapahoe County	Colorado	336	150,400
34	Hennepin County	Minnesota	317	141,841
35	Oakland County	Michigan	315	140,799
36	Wake County	North Carolina	311	139,255
36	Nassau County	New York	311	139,179
38	Salt Lake County	Utah	286	127,745

Table B-2. Top 100 counties for nitrogen oxide emissions from lawn and garden equipment, 2020

Rank	County	State	Nitrogen oxides (tons)	Nitrogen oxides (number of cars equivalent)
39	Washington County	Oregon	285	127,400
40	Collin County	Texas	278	124,498
41	Cobb County	Georgia	277	123,867
42	Bergen County	New Jersey	276	123,345
43	Shelby County	Tennessee	274	122,394
44	Oklahoma County	Oklahoma	272	121,722
45	Pima County	Arizona	271	121,013
46	Franklin County	Ohio	270	120,812
47	Riverside County	California	268	119,865
48	Ashland County	Ohio	267	119,271
49	Jefferson County	Colorado	263	117,440
50	Allegheny County	Pennsylvania	260	116,062
51	Monroe County	New York	259	115,719
52	Collier County	Florida	256	114,698
53	Bucks County	Pennsylvania	246	110,162
53	Wayne County	Michigan	246	110,146
55	Loudoun County	Virginia	244	108,955
56	Polk County	Florida	241	107,983
57	Baltimore County	Maryland	238	106,597
57	Pierce County	Washington	238	106,567
59	Prince George's County	Maryland	237	105,882
60	Kane County	Illinois	234	104,789
61	Clackamas County	Oregon	231	103,386
62	Snohomish County	Washington	229	102,307
63	Chester County	Pennsylvania	226	101,018
64	Pinellas County	Florida	224	100,099
65	San Bernardino County	California	223	99,706
66	Davidson County	Tennessee	222	99,287
67	Bernalillo County	New Mexico	220	98,334
68	Santa Clara County	California	217	96,879
69	Lee County	Florida	213	95,150
70	Pulaski County	Arkansas	212	94,996
71	Marion County	Indiana	211	94,452
72	Middlesex County	New Jersey	210	93,818
73	Honolulu County	Hawaii	209	93,254
74	Johnson County	Kansas	205	91,864
74	Morris County	New Jersey	205	91,766
76	Hartford County	Connecticut	199	89,122

Table B-2. Top 100 counties for nitrogen oxide emissions from lawn and garden equipment, 2020

Rank	County	State	Nitrogen oxides (tons)	Nitrogen oxides (number of cars equivalent)
77	Alameda County	California	198	88,731
77	New Castle County	Delaware	198	88,575
79	Shelby County	Alabama	197	88,179
80	Jackson County	Missouri	196	87,477
81	El Paso County	Colorado	192	85,870
82	Frederick County	Virginia	190	84,989
83	Monmouth County	New Jersey	189	84,467
84	Anne Arundel County	Maryland	187	83,611
84	Milwaukee County	Wisconsin	187	83,436
86	Somerset County	New Jersey	180	80,591
86	Essex County	Massachusetts	180	80,393
88	Will County	Illinois	178	79,530
89	Adams County	Colorado	176	78,556
90	Sacramento County	California	175	78,285
91	Barnstable County	Massachusetts	174	77,649
92	Fulton County	Georgia	173	77,422
93	Douglas County	Colorado	172	77,097
94	DeKalb County	Georgia	171	76,667
94	Allen County	Indiana	171	76,483
96	Hamilton County	Ohio	168	75,259
97	Knox County	Tennessee	166	74,155
98	Waukesha County	Wisconsin	165	73,790
98	Erie County	New York	165	73,635
100	Stark County	Ohio	164	73,238

Table B-3. Top 100 counties for fine particulate ($PM_{2.5}$) emissions from lawn and garden equipment, 2020

Rank	County	State	$PM_{2.5}$, primary (tons)	$PM_{2.5}$, primary (number of cars equivalent)
1	Harris County	Texas	358	3,838,708
2	Cook County	Illinois	274	2,942,956
3	Clark County	Nevada	273	2,925,594
4	Palm Beach County	Florida	265	2,843,023
5	Dallas County	Texas	245	2,630,084
6	King County	Washington	222	2,386,132
7	Suffolk County	New York	209	2,243,944
8	St. Louis County	Missouri	203	2,180,081
8	Broward County	Florida	203	2,179,786
10	Bexar County	Texas	182	1,955,358
11	Tulsa County	Oklahoma	172	1,848,796
12	Maricopa County	Arizona	167	1,795,236
12	Orange County	Florida	167	1,793,145
14	Fairfax County	Virginia	164	1,761,687
15	Miami-Dade County	Florida	155	1,662,658
16	Montgomery County	Maryland	147	1,580,988
17	Cuyahoga County	Ohio	143	1,536,464
18	DuPage County	Illinois	142	1,523,550
19	Mecklenburg County	North Carolina	139	1,491,783
20	Montgomery County	Pennsylvania	134	1,437,933
21	Travis County	Texas	128	1,372,318
22	Middlesex County	Massachusetts	127	1,359,347
23	Lake County	Illinois	126	1,353,456
24	Westchester County	New York	124	1,333,517
25	Duval County	Florida	122	1,313,005
25	Hillsborough County	Florida	122	1,311,570
25	Gwinnett County	Georgia	122	1,304,644
28	Fairfield County	Connecticut	120	1,288,039
28	Tarrant County	Texas	120	1,284,163
30	Arapahoe County	Colorado	118	1,269,581
31	Wake County	North Carolina	112	1,207,264
32	Hennepin County	Minnesota	109	1,165,396
33	Nassau County	New York	107	1,148,162
34	Oakland County	Michigan	102	1,092,898
35	Collin County	Texas	98	1,047,945
36	Oklahoma County	Oklahoma	97	1,044,934
36	Washington County	Oregon	97	1,044,836
36	Salt Lake County	Utah	97	1,043,291

Table B-3. Top 100 counties for fine particulate ($PM_{2.5}$) emissions from lawn and garden equipment, 2020

Rank	County	State	$PM_{2.5}$, primary (tons)	$PM_{2.5}$, primary (number of cars equivalent)
39	Cobb County	Georgia	96	1,027,084
40	Pima County	Arizona	95	1,018,362
41	Shelby County	Tennessee	94	1,013,243
41	Collier County	Florida	94	1,006,554
43	Ashland County	Ohio	92	991,517
44	Bergen County	New Jersey	90	968,111
44	Jefferson County	Colorado	90	962,700
44	Franklin County	Ohio	90	961,929
47	Monroe County	New York	87	935,425
47	Polk County	Florida	87	933,040
49	Allegheny County	Pennsylvania	85	907,682
50	Bucks County	Pennsylvania	84	906,712
51	Loudoun County	Virginia	82	881,650
52	Los Angeles County	California	81	873,203
53	Pinellas County	Florida	79	842,700
54	Clackamas County	Oregon	78	839,956
54	Chester County	Pennsylvania	78	837,139
56	Prince George's County	Maryland	77	828,154
56	Pierce County	Washington	77	825,252
56	Baltimore County	Maryland	77	824,818
56	Lee County	Florida	77	822,788
60	Davidson County	Tennessee	76	819,899
60	Wayne County	Michigan	76	819,778
60	Pulaski County	Arkansas	76	817,413
63	Kane County	Illinois	74	793,572
63	Snohomish County	Washington	74	789,743
65	Bernalillo County	New Mexico	72	776,488
65	Honolulu County	Hawaii	72	775,421
67	Johnson County	Kansas	71	764,841
67	Shelby County	Alabama	71	762,423
67	Marion County	Indiana	71	757,948
70	Middlesex County	New Jersey	69	737,181
71	Morris County	New Jersey	67	721,803
72	Jackson County	Missouri	66	709,937
73	El Paso County	Colorado	65	702,575
73	Hartford County	Connecticut	65	693,379
75	Frederick County	Virginia	64	688,081
76	New Castle County	Delaware	63	681,068

Table B-3. Top 100 counties for fine particulate ($PM_{2.5}$) emissions from lawn and garden equipment, 2020

Rank	County	State	$PM_{2.5}$, primary (tons)	$PM_{2.5}$, primary (number of cars equivalent)
77	Monmouth County	New Jersey	62	663,598
78	Adams County	Colorado	61	659,937
78	Anne Arundel County	Maryland	61	657,288
78	Milwaukee County	Wisconsin	61	656,729
81	Douglas County	Colorado	60	642,102
81	Somerset County	New Jersey	60	641,835
83	DeKalb County	Georgia	59	629,176
84	Fulton County	Georgia	58	627,797
84	Allen County	Indiana	58	627,684
84	Essex County	Massachusetts	58	621,494
87	Seminole County	Florida	57	616,028
87	Barnstable County	Massachusetts	57	612,554
87	Knox County	Tennessee	57	608,917
87	Waukesha County	Wisconsin	57	606,892
91	Will County	Illinois	56	600,558
91	Hamilton County	Ohio	56	598,724
93	Stark County	Ohio	55	595,247
94	Guilford County	North Carolina	54	584,282
94	Randolph County	Indiana	54	579,084
94	Ada County	Idaho	54	578,874
94	Beaufort County	South Carolina	54	575,757
98	Denver County	Colorado	53	566,539
98	Charleston County	South Carolina	53	565,164
100	Erie County	New York	52	563,313

Table B-4. Top 100 counties for volatile organic compound emissions from lawn and garden equipment, 2020

Rank	County	State	Volatile organic compounds (tons)
1	Los Angeles County	California	8,603
2	Harris County	Texas	5,013
3	Cook County	Illinois	4,405
4	Clark County	Nevada	3,817
5	Palm Beach County	Florida	3,534
6	Dallas County	Texas	3,390
7	King County	Washington	3,212
8	Orange County	California	3,100
9	San Diego County	California	3,086
10	Maricopa County	Arizona	3,031
11	Suffolk County	New York	2,908
12	Broward County	Florida	2,880
13	St. Louis County	Missouri	2,826
14	Bexar County	Texas	2,527
15	Miami-Dade County	Florida	2,349
16	Fairfax County	Virginia	2,302
17	Orange County	Florida	2,265
18	Tulsa County	Oklahoma	2,167
19	Montgomery County	Maryland	2,092
20	Cuyahoga County	Ohio	2,084
21	DuPage County	Illinois	2,040
22	Riverside County	California	1,962
23	Middlesex County	Massachusetts	1,862
24	Montgomery County	Pennsylvania	1,841
25	Lake County	Illinois	1,784
26	Hillsborough County	Florida	1,775
27	Mecklenburg County	North Carolina	1,771
28	Westchester County	New York	1,756
29	Tarrant County	Texas	1,754
30	Travis County	Texas	1,749
31	Duval County	Florida	1,674
32	Arapahoe County	Colorado	1,670
33	Fairfield County	Connecticut	1,662
34	San Bernardino County	California	1,655
35	Santa Clara County	California	1,619
36	Hennepin County	Minnesota	1,596
37	Gwinnett County	Georgia	1,588
38	Nassau County	New York	1,570

Table B-4. Top 100 counties for volatile organic compound emissions from lawn and garden equipment, 2020

Rank	County	State	Volatile organic compounds (tons)
39	Pima County	Arizona	1,506
40	Oakland County	Michigan	1,497
41	Alameda County	California	1,468
42	Wake County	North Carolina	1,442
43	Salt Lake County	Utah	1,424
44	Franklin County	Ohio	1,357
45	Washington County	Oregon	1,344
46	Sacramento County	California	1,341
47	Allegheny County	Pennsylvania	1,333
48	Oklahoma County	Oklahoma	1,303
49	Bergen County	New Jersey	1,302
50	Shelby County	Tennessee	1,297
51	Jefferson County	Colorado	1,276
52	Wayne County	Michigan	1,273
53	Collin County	Texas	1,272
53	Cobb County	Georgia	1,272
55	Monroe County	New York	1,255
56	Collier County	Florida	1,219
57	Pinellas County	Florida	1,214
58	Polk County	Florida	1,213
59	Bucks County	Pennsylvania	1,175
60	Prince George's County	Maryland	1,152
61	Baltimore County	Maryland	1,144
62	Pierce County	Washington	1,123
63	Bernalillo County	New Mexico	1,109
64	Loudoun County	Virginia	1,102
65	Marion County	Indiana	1,096
66	Ashland County	Ohio	1,088
67	Lee County	Florida	1,083
68	Clackamas County	Oregon	1,073
69	Chester County	Pennsylvania	1,069
70	Snohomish County	Washington	1,058
71	Kane County	Illinois	1,051
72	Davidson County	Tennessee	1,020
73	Johnson County	Kansas	1,001
74	Middlesex County	New Jersey	1,000
75	Honolulu County	Hawaii	987
76	Jackson County	Missouri	982

Table B-4. Top 100 counties for volatile organic compound emissions from lawn and garden equipment, 2020

Rank	County	State	Volatile organic compounds (tons)
76	El Paso County	Colorado	982
78	Pulaski County	Arkansas	980
79	Contra Costa County	California	958
80	Hartford County	Connecticut	956
81	Morris County	New Jersey	940
82	Kings County	New York	933
83	Milwaukee County	Wisconsin	919
84	Queens County	New York	912
85	Monmouth County	New Jersey	894
86	Anne Arundel County	Maryland	888
86	Adams County	Colorado	888
88	Hamilton County	Ohio	880
89	Shelby County	Alabama	865
90	Essex County	Massachusetts	854
90	New York County	New York	854
92	Frederick County	Virginia	853
93	San Francisco County	California	847
94	Erie County	New York	846
95	Fulton County	Georgia	841
96	Denver County	Colorado	837
97	New Castle County	Delaware	835
98	Allen County	Indiana	824
99	Will County	Illinois	823
99	Somerset County	New Jersey	823

Notes

1 The emissions estimates in this report reflect those in the EPA's "Lawn and Garden Equipment" category, which includes equipment such as lawn mowers, leaf blowers and string trimmers, along with snow blowers and chainsaws. Emissions of 30.2 million short tons of carbon dioxide from lawn equipment converted to 27.3 million metric tons using conversion of 0.907 metric tons per short ton. Los Angeles city emissions in 2021 were 26.9 million metric tons. See Los Angeles Department of Public Works, City of Los Angeles, *2021 Community Greenhouse Gas Inventory*, March 2023, archived at https://web.archive.org/web/20231005184246/https://www.lacitysan.org/cs/groups/public/documents/document/y250/mdg4/~edisp/cnt088358.pdf.

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3 The emissions estimates in this report reflect those in the EPA's "Lawn and Garden Equipment" category, which includes equipment such as lawn mowers, leaf blowers and string trimmers, along with snow blowers and chainsaws. See methodology for more details.

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