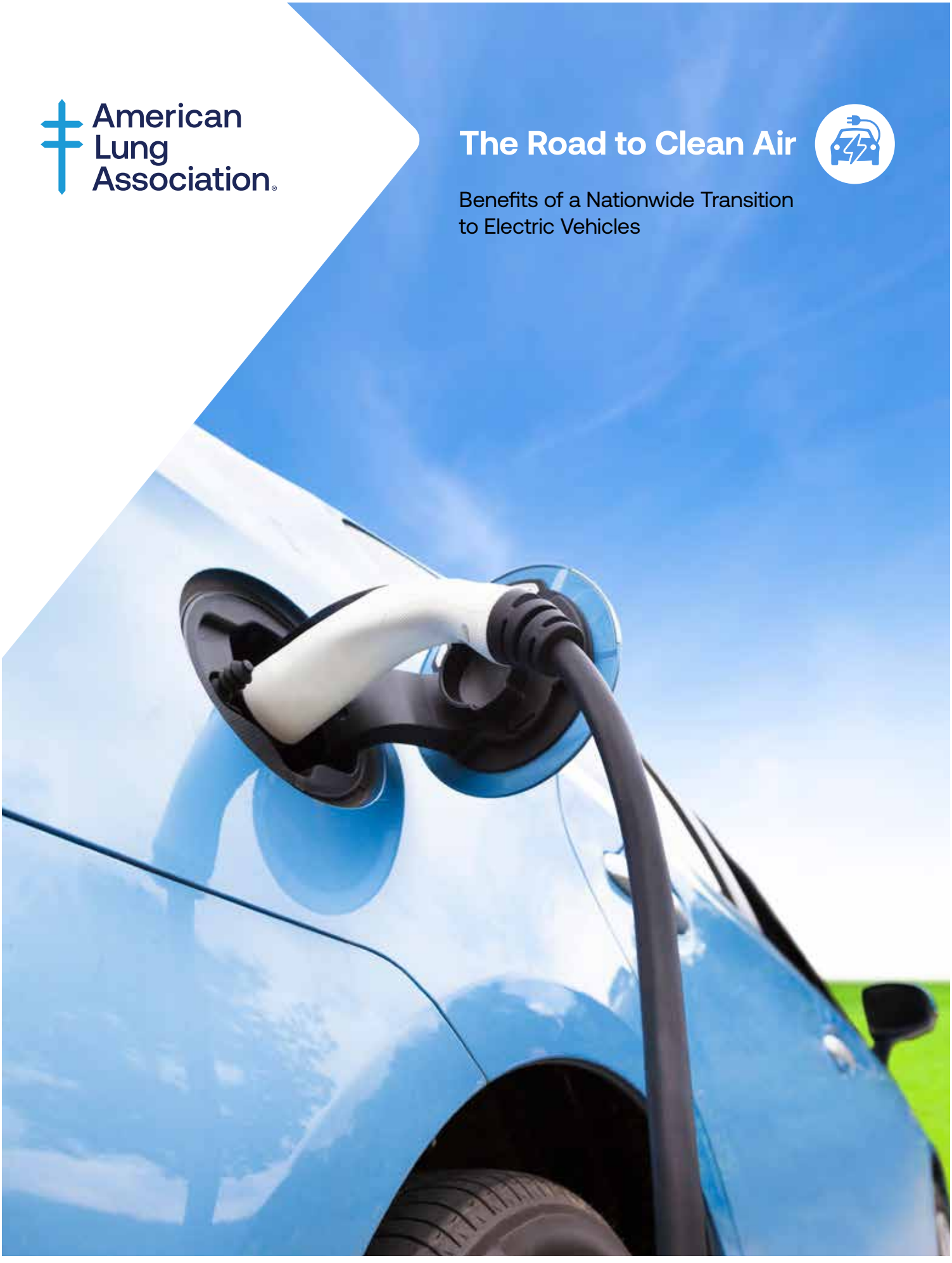
American Lung Association.

The Road to Clean Air

Benefits of a Nationwide Transition to Electric Vehicles



Executive Summary

"The Road to Clean Air" is a national report by the American Lung Association highlighting the potential for major public health benefits of widespread electrification of the transportation sector. Across the United States, the transportation sector is a leading source of harmful air pollution threatening the health of the public. Transportation pollution and poor air quality are associated with an increased risk of a wide range of negative health outcomes including asthma attacks, lost work days and premature deaths. People who live near major roadways, lower-income communities and communities of color often face disproportionate exposures to harmful pollution, along with poor health outcomes, making health and climate equity key to the electric vehicle discussion. Children, seniors and those living with respiratory, cardiovascular and other chronic health conditions are also more vulnerable to poor air quality. The transportation sector is also the leading contributor to climate change, which harms health in a number of ways, including by degrading air quality.

Our air quality and climate crises demand steady, consistent progress toward moving our passenger vehicles, transit and school buses, delivery vans and the broad trucking sector away from combustion and toward non-polluting vehicles powered by more non-combustion renewable energy. The analysis illustrates that transitioning to zero-emission transportation solutions along with increasing levels of renewable energy by mid-century will save thousands of lives, avoid tens of thousands of asthma attacks, hundreds of thousands of other health impacts, and avoid tens of billions of dollars in health costs as a result of significant pollution reductions. In addition, moving to eliminate combustion from the transportation sector will yield significant reductions in greenhouse gases that drive wide-ranging climate change impacts on air quality and public health. The dual air pollution and climate change health crises facing America today must be addressed immediately, with electric vehicles and clean energy playing a leading role in the solution.

About this Report

This new American Lung Association report highlights the public heath, air quality and climate change benefits that could be achieved if steps are taken now to ensure widespread transportation electrification in the coming decades.

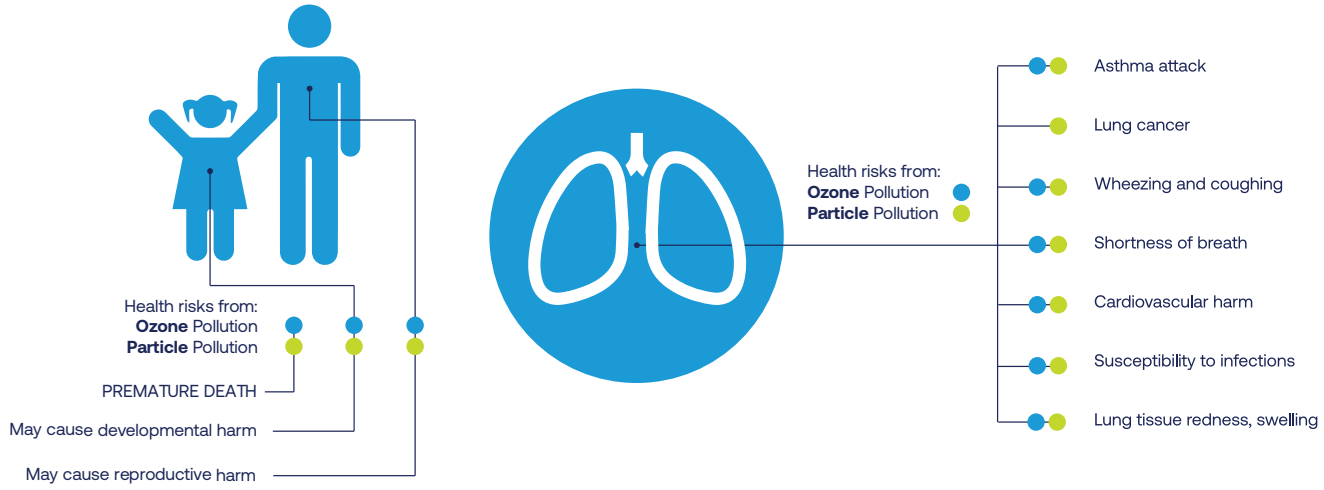
To develop this new research, the American Lung Association worked with ICF to assess a pathway toward an ambitious but achievable transition to electric vehicles powered by increasing levels of renewable energy. This work was conducted using a variety of transportation and energy sector emissions models and United States Environmental Protection Agency public health benefits modeling tools. ICF conducted a comprehensive analysis of the potential health and climate benefits of this transition as a consultant to the American Lung Association, which is solely responsible for the content this report. Additional detail on the structure of the report is found below, and a full methodology and assumptions about future vehicle fleets, changes in the electric power grid and citations are detailed in the technical report document prepared by ICF for the American Lung Association that is available online at **Lung.org/ev**.

Air Pollution and Climate Change Threaten Public Health

Too many Americans are breathing air that can harm their health. The American Lung Association's "State of the Air" 2020 report found that close to five in ten people—150 million Americans—live in counties affected by unhealthy ozone and/or particle pollution, the two most widespread air pollutants in the United States.[1] Our changing climate is contributing to worsening air quality in the form of extreme heat, drought and catastrophic wildfires. Increasing temperatures lead to greater formation of ground-level ozone pollution, and smoke from more frequent and intense wildfires contributes to particle pollution that can travel hundreds of miles.

The health impacts of ozone and particle pollution are well documented based on decades of scientific research. Exposure to ozone and particle pollution contribute to a wide range of negative health effects and are especially dangerous to children, seniors, people living with asthma and other health conditions, lower-income communities and communities of color. Transportation is a leading source of harmful air pollution in the United States, representing over half of the total ozone- and particle-forming oxides of nitrogen (NOx) emissions and represents the largest source of carbon pollution in the United States. Transportation sources also contribute to particle pollution and local diesel exhaust impacts that threaten lung health.[2]

Air pollution remains a major danger to the health of children and adults.



Transportation pollution poses a significant risk to public health. For example, the Health Effects Institute's comprehensive 2010 review of traffic-related health effects noted that up to 45 percent of the urban population in North America may be within close enough proximity to major roadways to increase immediate,

negative health outcomes. The review of over 700 scientific studies concluded that traffic pollution causes asthma attacks in children and may cause a wide range of other effects including the onset of childhood asthma, impaired lung function, premature death and death from cardiovascular diseases and cardiovascular morbidity.[3] Major trucking corridors, warehouse distribution centers and other diesel hot spots close to major population sectors inflict serious harms to human health, and often highlight disparities in the impacts of transportation pollution burdens.

Climate change represents a public health crisis on many fronts and is making it harder to protect public health from poor air quality. Driven by fossil fuel combustion, climate change amplifies current public health challenges and threatens to increase risks into the future. The 4th National Climate Assessment issued by the United States Center on Global Change Research in 2018 noted that the "health and well-being of Americans are already affected by climate change, with the adverse health consequences projected to worsen with additional climate change."[4] Climate change threatens 50 years of clean air progress made under the Clean Air Act by increasing the risk that air pollution, including ozone and particle pollution, will worsen. Because ozone pollution is more likely to form in warmer weather, climate change will make it harder to continue cleaning up this widespread pollutant. Rising temperatures intensify drought, and dust and wildfires add to particle pollution burdens. These risks and exposures are not equally shared across our society, and many communities face greater exposures and are more vulnerable to the impacts of poor air quality and climate change.

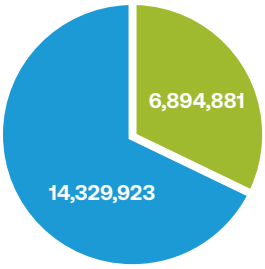
"Far too often, clean air is out of reach for communities living near major pollution sources, including highways, ports and power plants. Communities of color are disproportionately harmed by poor air quality in the United States. The time to act on electric transportation is now."

Harold Wimmer, President and CEO American Lung Association

The American Lung Association's 2020 "State of the Air" report found significant disparities in terms of people of color residing in counties with failing grades for ozone and/or particle pollution. For example, people of color were 1.5 times more likely to live in a county with at least one failing grade, and 3.2 times more likely to live in a county with a failing grade for unhealthy ozone days, particle pollution days and annual particle levels. Disparities in exposure to neighborhood-level transportation pollution specifically was documented in a 2019 assessment by the Union of Concerned Scientists, which highlighted the ethnic and racial disparities in air pollution exposure burdens, with people of color largely facing far greater exposures

than the national average. For example, 74 percent of Black and Latino people in New York State live where particle pollution levels from on-road transportation exceed the state average and are exposed to far greater levels than white residents.[5]

State of the Air 2020
Americans Living in Counties with 3 Failing Grades: Ozone Days, Particle Days, Annual Particle Levels



Shifting to electric vehicle technology and renewable power is vital to achieving clean, healthy air for all communities

The transition to zero-emission transportation will benefit the health of children riding school buses, daily commuters and transit riders, truckers and local delivery drivers and especially those residents nearest major roadways, warehouse distribution centers and other pollution hotspots. People who live downwind of major urban areas will also benefit. Further, the transition away from burning harmful fossil fuels in the power sector to non-combustion renewable energy, including wind and solar, is critical to addressing the impacts on communities most burdened by emissions generated at fossil-fueled power plants. The transportation sector must move comprehensively to zero-emission solutions, including both electric vehicles and their fuels, as rapidly as possible.

Healthy Electric Transportation Scenario Results

The widespread transition to zero-emission transportation technologies could produce emission reductions in 2050 that could add up to $72 billion in avoided health harms, saving approximately 6,300 lives and avoiding more than 93,000 asthma attacks and 416,000 lost work days annually due to significant reductions in transportation-related pollution.[I] [II]

In addition to the health benefits noted above, the benefits to our environment in the form of avoided climate change impacts, as expressed as the Social Cost of Carbon,[III] could surpass $113 billion in 2050 as the transportation systems combust far less fuel and our power system comes to rely on cleaner, non-combustion renewable energy. This value reflects a range of negative consequences to health, agricultural productivity, flood risk and other adverse impacts generated by carbon emissions in the form of global climate change. The transition to electric vehicles powered by increasingly clean power sources like wind and solar yields significant climate benefits in the form of avoided carbon emissions across the transportation sector.

[I] In all cases, the results presented here reflect the benefits of emission reductions estimated for 2050, utilizing the American Lung Association's on-road and upstream emissions scenarios. Health results include the number of avoided adverse health impacts and the economic value of these health risk reductions at a 3% discount rate and reflect higher range estimates associated with the Lepeule et al. (2012) health study. Mortality estimates are grown from EPA 1990 value of a statistical life using standard income growth data while non-fatal costs are presented in 2017$ values. Greenhouse gas emission benefits are presented for 2050 emissions per Obama-era estimates of the global climate impacts of CO2 emissions; climate benefits are also presented in 2017$ values at a 3 percent discount rate.

[II] Note that the analysis and report includes ozone-precursor emissions data. However, ozone-related health effects are not included in this report. US EPA's COBRA model relies on PM2.5 health effects to assess and monetize impacts. Results therefore do not include significant health burdens posed by ozone pollution throughout the United States independent of those related to PM reductions, as described in the health effects section of this report.

[III] The social cost of CO2 emissions (SC-CO2) is a measure, in dollars, of the long-term damage done by a ton of carbon dioxide (CO2) emissions in a given year. This dollar figure also represents the value of damages avoided for a small emission reduction (i.e., the benefit of a CO2 reduction). SC-CO2 is intended to be a comprehensive estimate of climate change damages and includes changes in net agricultural productivity, human health, property damages from increased flood risk, and value of ecosystem services. However, not all important damages are included due to data limitations. The high range estimate of the Social Cost of Carbon presented here reflects a broader suite of global climate impacts and pollutants, as discussed in the full technical document prepared by ICF for the American Lung Association.

These benefits accrue from the reduction in on-road pollution attributed to the shift to electric vehicles. Comparing the emissions from the "Business as Usual" fleet modeling run with the electric vehicle scenario yields major reductions in harmful air and climate pollution. In 2050, the on-road Electric Vehicle scenario would cut:

- ozone- and particle-forming oxides of nitrogen (NOx) by 1 million tons in 2050 (an 82% reduction compared with the "Business As Usual" Scenario)
- directly emitted fine particle pollution (PM2.5) by 30,599 tons in 2050 (a 62% reduction)
- greenhouse gas emissions that cause climate change by over 1.4 billion metric tons in 2050 (a 90% reduction).

American Lung Association Healthy Transportation Scenario Results

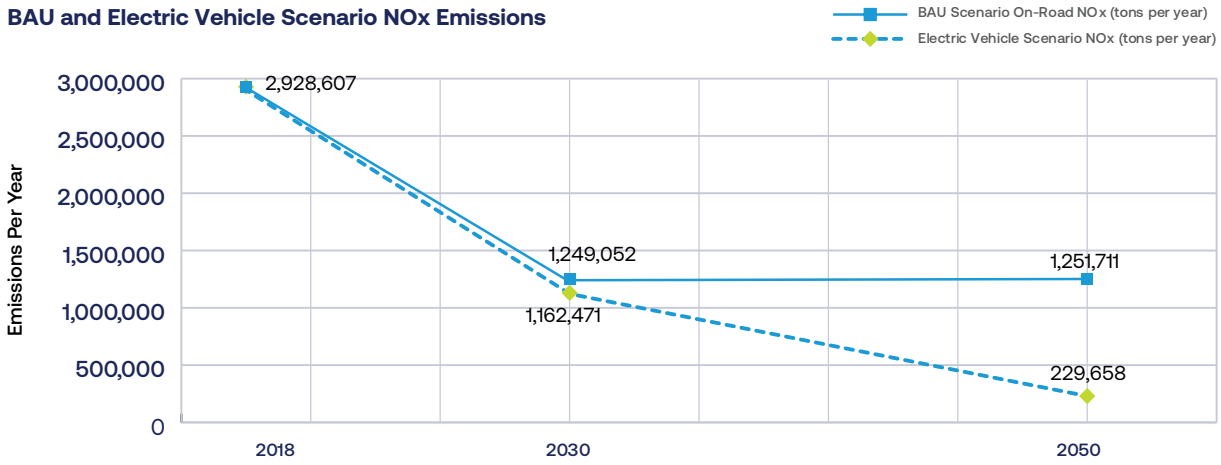
Health Benefits in 2050			Value of Benefits in 2050	
Premature Deaths Avoided	Asthma Attacks Avoided	Lost Work Days Avoided	Health Benefits	Climate Benefits
6,300	93,000	416,000	$72 Billion	$113 Billion

Factoring in the emissions associated with the production and distribution of fuel for the on-road combustion and electric vehicle fleets, the benefits grow further as cleaner energy sources are considered, achieving reductions in excess of total emissions generated by the on-road Business As Usual fleet in 2050. These results are included in the total health and climate impacts noted in the table above.

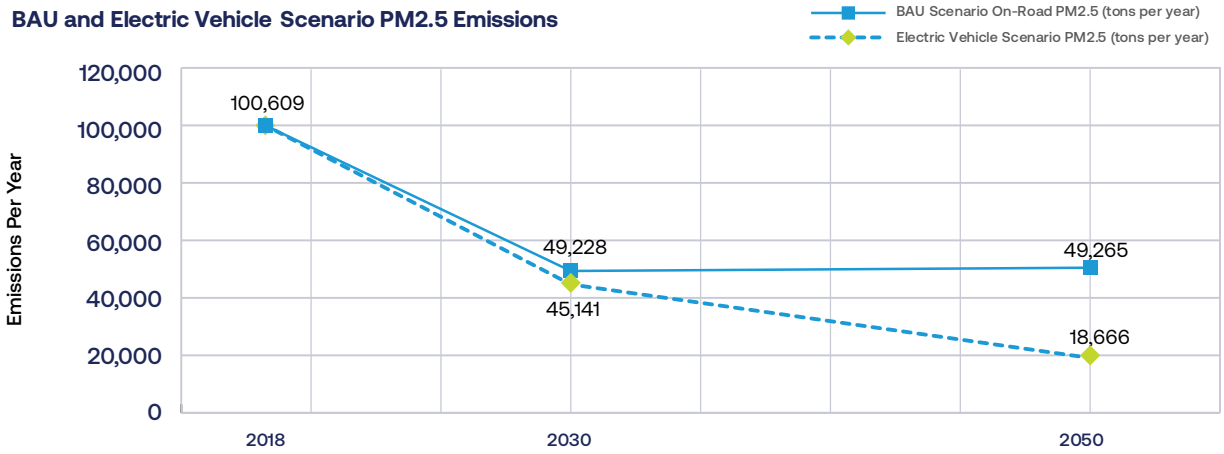
- Ozone- and particle-forming oxides of nitrogen (NOx) are reduced by 1.3 million tons (100% reduction compared with the "Business As Usual" Scenario)
- directly emitted fine particle pollution (PM2.5) is reduced by more than 53,000 tons in 2050 (a 108% reduction below on-road fleet emissions)
* greenhouse gas emissions that cause climate change are reduced by more than 1.5 billion metric tons in 2050 (a 94% reduction) compared with the on-road emissions generated by the baseline fleet.

Comparison of On-Road Emissions Between Baseline and Electric Vehicle Case

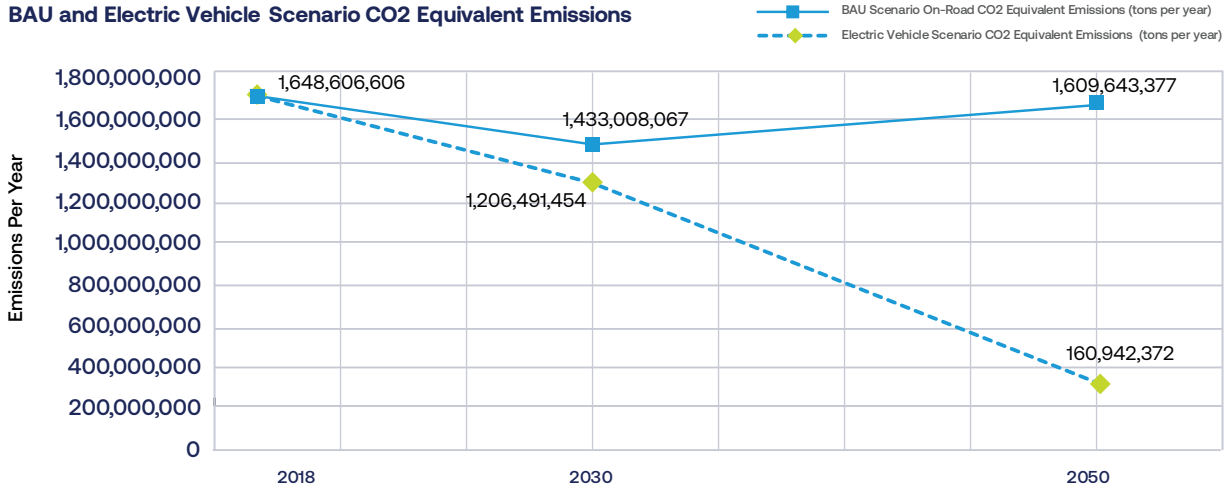
BAU and Electric Vehicle Scenario NOx Emissions



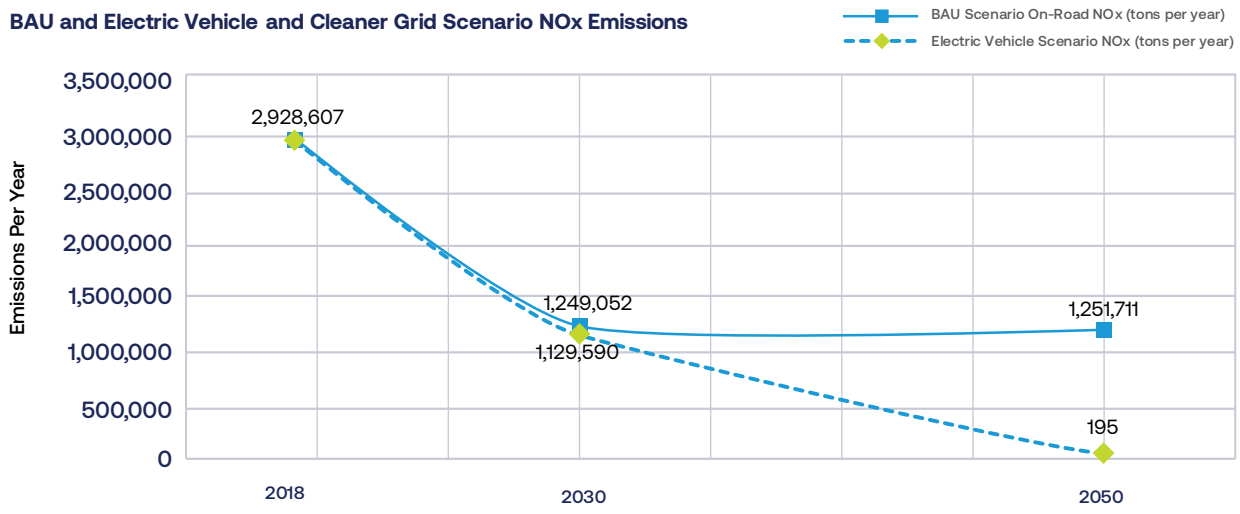
BAU and Electric Vehicle Scenario PM2.5 Emissions

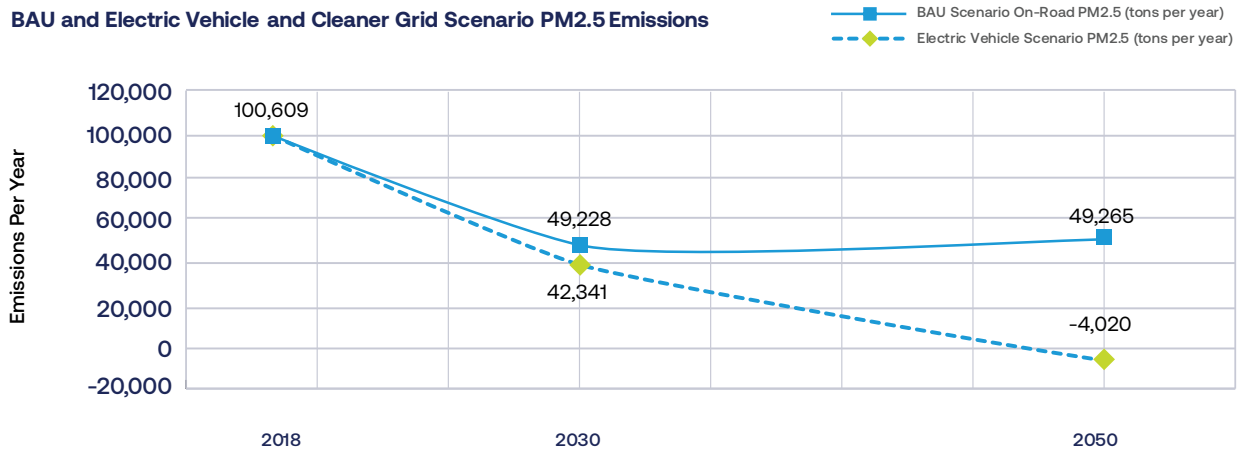


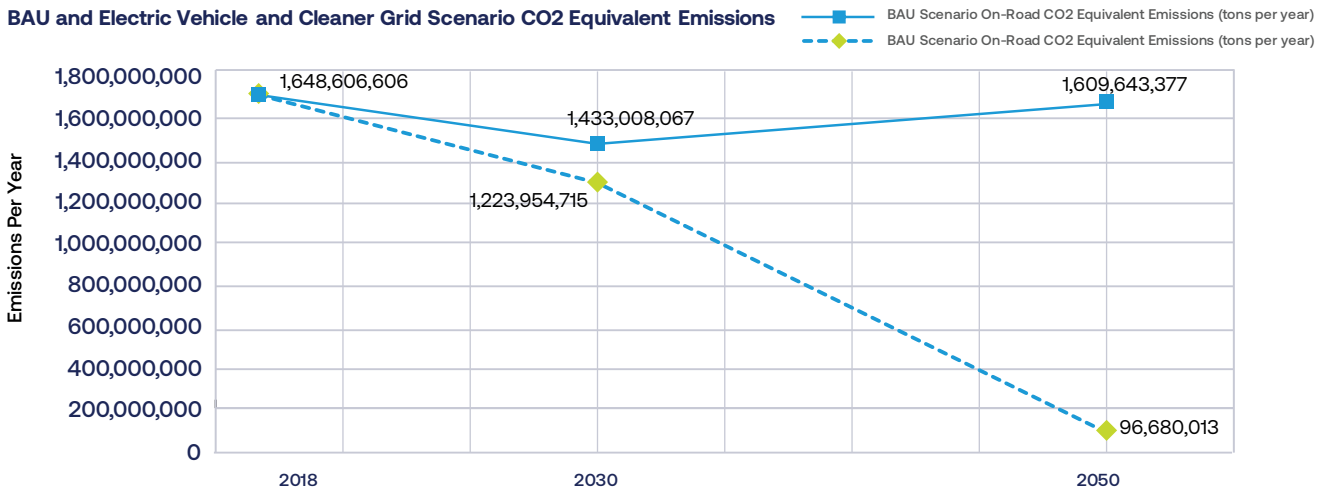
BAU and Electric Vehicle Scenario CO2 Equivalent Emissions



Comparison of Emissions including Changes in Upstream Emissions With Electric Vehicles and Cleaner Energy Scenario







Benefits Across the United States

Transportation sources pose a risk to residents in every region of the United States, and residents in every region stand to benefit from the elimination of on-road traffic pollution and clean, renewable electric generation. Across the United States, the annual health benefits of reduced exposures to transportation range from the tens of millions per year into the billions. Eighteen states show annual benefits reaching $1 billion or more in 2050 while even the smallest states see benefits in the tens to hundreds of millions. Under the American Lung Association's zero-emission transportation scenario, all states will experience health benefits as the result of reduced pollution from on-road vehicles and the transition to cleaner power grids.

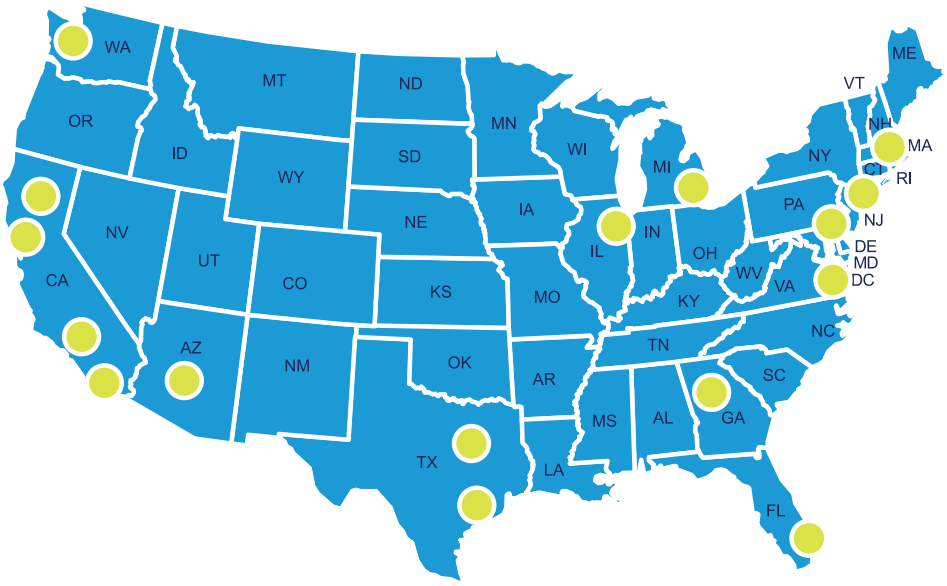
The following pages illustrate the estimated State—and major Metropolitan Area—level benefits possible through the emission reductions estimated under the 2050 Healthy Electric Transportation Scenario.

State	Avoided Health Impact Cost in 2050	Premature Deaths Avoided in 2050	Asthma Attacks Avoided in 2050	Work Loss Days Avoided in 2050
California	$22,026,904,800	1,924	26,292	122,047
Texas	$6,690,000,982	582	11,554	46,914
New York	$4,027,731,052	351	5,153	24,974
Florida	$3,698,618,418	323	3,564	17,612
Illinois	$3,155,062,850	274	4,106	18,735
Ohio	$2,369,377,792	207	2,860	12,208
Pennsylvania	$2,359,678,447	206	2,399	10,814
New Jersey	$1,938,971,167	169	2,306	10,725
Georgia	$1,686,021,026	147	2,665	12,045
Michigan	$1,662,382,013	145	1,837	8,253
North Carolina	$1,617,991,214	141	2,384	10,527
Arizona	$1,446,667,053	126	1,956	8,475
Washington	$1,424,476,544	124	1,970	8,938
Maryland	$1,349,126,363	118	1,649	7,497
Virginia	$1,324,456,174	115	1,783	8,189
Tennessee	$1,236,196,031	107	1,684	7,309
Missouri	$1,102,005,533	96	1,519	6,437
Indiana	$1,053,581,012	92	1,533	6,296
Massachusetts	$947,969,253	83	1,059	5,293
Wisconsin	$834,519,169	73	1,156	4,930

State	Avoided Health Impact Cost in 2050	Premature Deaths Avoided in 2050	Asthma Attacks Avoided in 2050	Work Loss Days Avoided in 2050
Louisiana	$781,955,933	68	961	3,937
Nevada	$746,431,012	65	767	3,724
Minnesota	$744,387,115	65	1,159	5,093
Colorado	$690,027,423	60	1,296	5,691
Oklahoma	$674,830,366	59	1,026	3,961
South Carolina	$672,435,708	59	743	3,167
Connecticut	$637,321,723	55	726	3,479
Kentucky	$561,522,369	49	737	3,122
Alabama	$431,124,811	38	527	2,271
Arkansas	$420,138,060	37	554	2,275
Utah	$410,642,433	36	1,007	3,330
Kansas	$385,190,452	34	654	2,517
Oregon	$355,292,368	31	434	1,983
West Virginia	$326,495,859	28	304	1,362
Iowa	$304,671,140	27	452	1,788
New Mexico	$263,532,370	23	334	1,305
Mississippi	$230,611,840	20	285	1,134
Idaho	$194,297,781	17	321	1,188
New Hampshire	$191,446,788	17	178	898
Maine	$181,518,670	16	151	724
Rhode Island	$178,274,742	16	170	835
Nebraska	$176,049,712	15	325	1,231
Delaware	$163,712,559	14	207	934
Washington, DC	$117,397,617	10	142	829
Montana	$100,943,248	9	118	476
North Dakota	$78,339,494	7	95	368
Vermont	$73,383,492	6	63	320
South Dakota	$64,069,035	6	106	384
Wyoming	$46,588,545	4	67	252
Total	$72,154,369,558	6,293	93,337	416,793

Note: Data for Alaska and Hawaii are not presented in this report because COBRA Model provides health outputs for the continental United States.

Selected Metropolitan Area Results



Metropolitan Area	2050 Health Benefits	Deaths Avoided	Asthma Attacks Avoided
Los Angeles, CA	$14,185,163,117	1,239	16,297
New York, NY	$5,191,191,434	452	6,766
San Francisco, CA	$3,638,114,607	318	4,489
Chicago, IL	$2,875,776,986	250	3,754
Dallas, TX	$2,094,390,070	182	3,676
Washington, DC	$2,007,786,421	175	2,739
San Diego, CA	$1,934,303,928	169	2,100
Houston, TX	$1,704,274,597	148	3,333
Miami, FL	$1,442,342,868	126	1,389
Philadelphia, PA	$1,441,391,523	126	1,660
Atlanta, GA	$1,358,920,809	118	2,256
Boston, MA	$1,185,120,806	103	1,286
Detroit, MI	$1,145,075,305	100	1,220
Seattle, WA	$1,018,047,240	89	1,416
Phoenix, AZ	$959,667,714	84	1,463
Sacramento, CA	$893,473,382	78	1,164

The counties assigned to a metropolitan area follow the groupings determined by the White House Office of Management and Budget (OMB) and used by the U.S. Census Bureau. The Metropolitan Statistical Areas and Combined Statistical Areas are used as the basis for considering populations at risk in these urban areas because they reflect the “high degree of social and economic interaction as measured by commuting ties,” as OMB describes them.

Achieving Significant Health Benefits through Transportation Electrification

The benefits are clear and should spur action at all levels of government to speed and scale the electric vehicle transition and ensure these potential benefits become a reality for all Americans, especially those communities most impacted and vulnerable to pollution burdens.

Actions taken today to transition away from combustion technologies set a crucial course to healthier air in communities across the United States. Below is a sampling of actions that can be taken at the household, local government, state government and federal levels in partnership with industry, utilities and other stakeholders to spur the transition to zero-emission technologies throughout the transportation sector, and support clean air for all communities.

Key Points

- At all levels, governments must align toward zero-emission transportation through policy change, investment, public education and partnership with public agencies, private entities and the public working together to reduce air pollution and climate change.
- Investments in zero-emission transportation infrastructure and incentive programs must be designed to address equity issues and correct disparities in pollution burdens caused by the transportation sector, including the heavy-duty sector.
- State authority under the Clean Air Act to enact zero-emission vehicle standards must be protected and implemented.
- Consumers must have full access to electric vehicle options that meet their needs and the benefits of zero-emission vehicles must be available to all communities.

Federal Actions

- Establish stronger vehicle standards for passenger vehicles and medium- and heavy-duty trucks, and and support state authority to adopt stronger standards.
- Prioritize zero-emission transportation and energy sources as central to federal climate change policy to maximize health benefits in the most heavily polluted US communities and support attainment of Clean Air Act health-based air quality standards.
- Establish health-protective clean air standards based on the current state of science and ensure an adequate level of safety for protection of vulnerable communities as required by the Clean Air Act.
- Designate zero-emission infrastructure a national priority program for economic recovery from the COVID-19 pandemic.
- Increase grant funding support for zero-emission truck and bus purchases and manufacturing and maintain existing consumer and business tax credits for zero-emission vehicle purchases.
- Increase incentives to ensure widespread deployment of zero-emission transportation infrastructure and technologies.

State Actions

- Use Clean Air Act authority to adopt the California zero-emission standards for passenger vehicles and medium- and heavy-duty trucks.
- Pursue fully electric public fleets and support zero-emission infrastructure including in all public buildings and garages.
- Support accelerated fleet turnover through incentive programs targeting older vehicles, consumer purchase decisions via point-of-purchase rebates and non-financial incentives.
- Ensure vehicle registration fees are structured to support electric vehicle deployment and complement —rather than counteract—consumer incentives.
- Invest in publicly available charging infrastructure along major highways and roads to ensure both personal and commercial charging opportunities exist.

Local Actions

- Support affordable zero-emission infrastructure readiness and deployment through electric vehicle-ready building codes, access to utility infrastructure for charging connections, streamlined permitting processes and parking policies that support accessible charging infrastructure for all communities, including for multi-unit housing.
- Commit to local zero-emission fleet purchases for garbage collection, transit, school buses and other fleets, with priority for fleets operating in heavily-polluted communities.
- Seek partnerships with utilities and clean air agencies to provide local incentives to complement state and federal tax credits or rebates; promote higher zero-emission rebates for lower-income consumers in the used car market.
- Adopt local climate action plans and integrate zero-emission vehicle infrastructure within healthier community planning that includes support for walking, biking, transit and other clean air choices.
- Enact local incentive and pilot projects related to zero-emission transit, carsharing and other mobility options, preferred parking and free—or reduced—cost charging in public garages.

Individual Actions

- Test drive a zero-emission vehicle at your local vehicle dealership - if they don't yet offer zero emission vehicles, engage with local ride-and-drive events to get a first-hand experience with knowledgeable vehicle enthusiasts.
- If you need a new personal vehicle, consider a zero-emission vehicle. Each year brings new models of zero-emission vehicles including motorcycles, pickups and SUVs.
- Consider local utility clean energy programs (i.e. opting into a 100 percent wind power plan if available) or going solar at home to increase non-combustion electric power.
- Advocate for clean air in your community, your state and nationally at Lung.org/policy-advocacy/take-action
- Visit Lung.org/ev to sign our petition calling on your Governor to make electric vehicles and infrastructure a priority.

Conclusion

Air pollution and climate change are harming the health of Americans today. The transition to zero-emission transportation solutions will yield major health and climate benefits across the United States, according to new research published by the American Lung Association. Thousands of lives will be saved, along with tens of thousands of asthma attacks and hundreds of thousands of other negative health outcomes avoided due to cleaner air throughout the United States as the majority of on-road transportation shifts to zero-emission technologies and increasing levels of non-combustion, renewable energy sources. These annual benefits could yield over $72 billion in avoided health costs in the United States and over $113 billion in avoided global climate change impacts. There is no time to delay - the nation must get on the pathway to zero-emission transportation, and actions taken at all levels of government can support healthier air.

Report Description, Technical Documentation and Methodology

This report relies on a series of modeling exercises comparing a business-as-usual on-road vehicle scenario reliant on combustion technologies versus an ambitious transition to increasing levels of sales of zero-emission vehicles, buses and trucks over the next three decades. The American Lung Association hired ICF as a technical consultant to run the models described below related to fleet characteristics, emissions and health benefits. The electrification scenario was developed by the American Lung Association to illustrate the benefits possible if local, state and federal actions were to meaningfully prioritize the transition away from the combustion of fuels. This ALA electrification scenario is scoped to achieve full transition to zero-emission passenger vehicle sales by 2040. It also includes penetrations of a range of electrified heavy-duty vehicles on pathways to fully zero-emission technologies over the coming decades. The vehicle electrification scenario considered here would have significant national and international benefits resulting from the cleaner air the scenario would create, including dramatic reductions in pollution from on-road sources. The climate benefits from reductions of greenhouse gas are expected to reach into the hundreds of billions of dollars globally, while the domestic health benefits would range in the tens of billions of dollars, including thousands of avoided deaths due to reduced air pollution.

The report illustrates only the incremental benefit for powering zero-emission transportation with increasing levels of non-combustion renewables; the full suite of public health and climate benefits from a cleaner grid powering non-transportation end uses (e.g. industrial operations, commercial and residential buildings, etc.), is beyond the scope of this evaluation. Our power sector approach may be considered conservative in that all analyses reflect national-scale simulations and rely on an average power approach. We do not assume that electric vehicle demand causes low carbon energy growth, nor do we implement an incremental approach to future electricity generation that pairs the increased demand with cleaner electricity only.

These scenarios were compared based on the tailpipe and other vehicle related emissions (utilizing the U.S. Environmental Protection Agency's MOVES model), emissions upstream of the vehicle such as the extraction, refining and transportation of fossil fuels or the power generation needs associated with growing zero-emission vehicle fleets (utilizing the Argonne National Lab GREET model), and finally the change in pollution burdens possible under the zero-emission fleet scenario utilizing the US EPA COBRA model for health benefit analysis. It is important to note that these modeling tools provide outputs for the continental United States; Alaska and Hawaii are not included. Using county-level results, the American Lung Association presents results for the continental United States, individual states and a sampling of the largest metropolitan areas in the nation to highlight the potential benefits of widespread zero-emission transportation in the coming decades.

For more information about this report, including the comprehensive report findings and methodology prepared by ICF for the American Lung Association, please visit **Lung.org/ev**

American Lung Association Resources

- **State of the Air**
  - Health Effects of Ozone and Particle Pollution
    http://www.stateoftheair.org/health-risks/
  - Living Near Highways and Air Pollution
    https://www.lung.org/clean-air/outdoors/who-is-at-risk/highways

- **Stand Up for Clean Air**
  https://www.lung.org/clean-air/stand-up-for-clean-air

- **Health Professionals for Clean Air and Climate Action**
  https://www.lung.org/policy-advocacy/healthy-air-campaign/health-pros-clean-air-climate

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[1]American Lung Association. State of the Air 2020. April 2020. www.lung.org/sota
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