

National Lawn and Garden Equipment Emissions

Jamie Banks, PhD, MS, Quiet Communities, Inc.

Robert McConnell, US EPA, Region 1

2015 International Emissions Inventory Conference, San Diego, CA

April 16, 2015

Study Goal

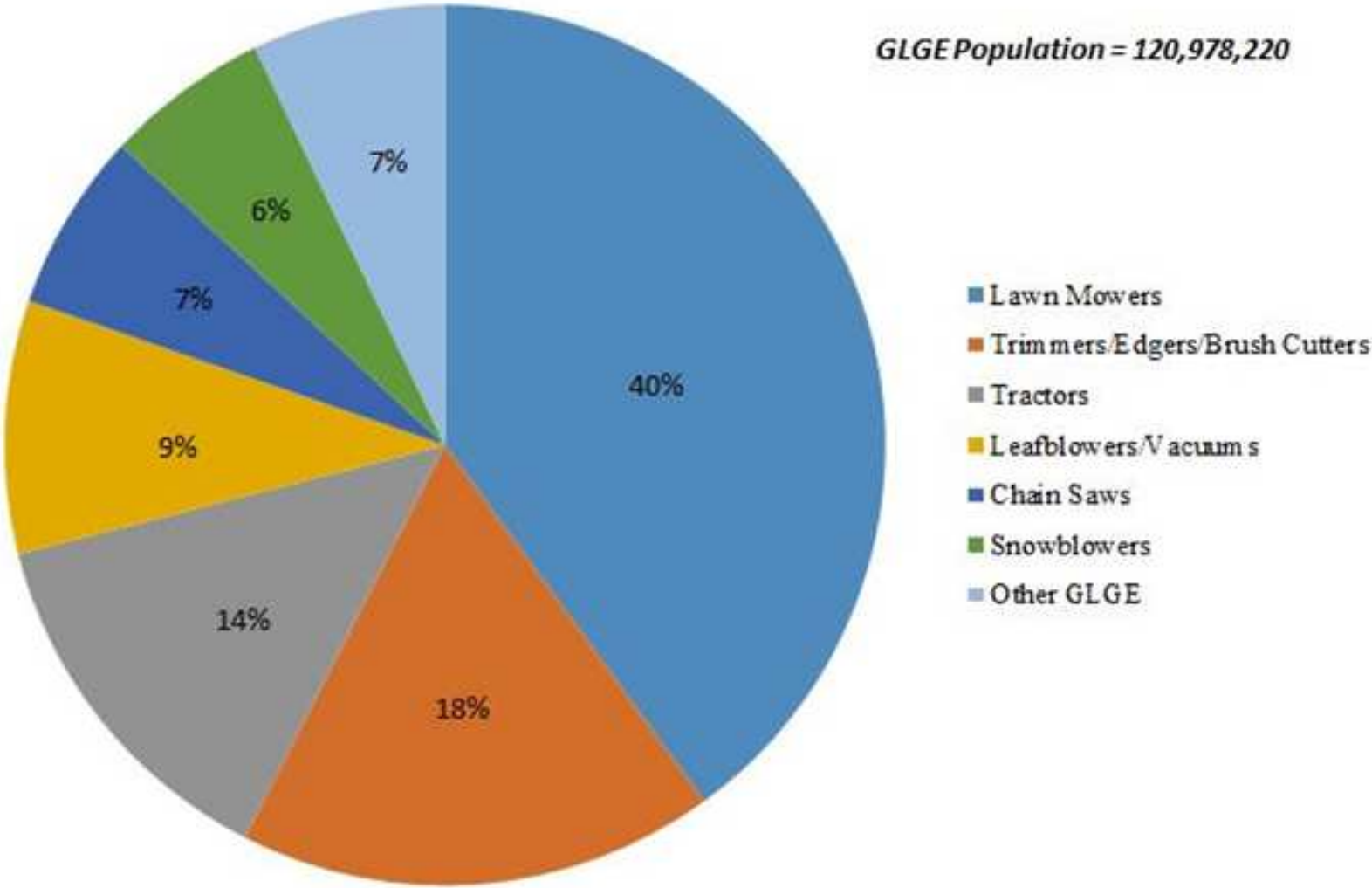
To characterize annual emissions from gasoline-powered lawn and garden equipment (GLGE) at the national level and in selected states and estimate the contribution of landscape maintenance equipment (GLME) to those emissions.

Background

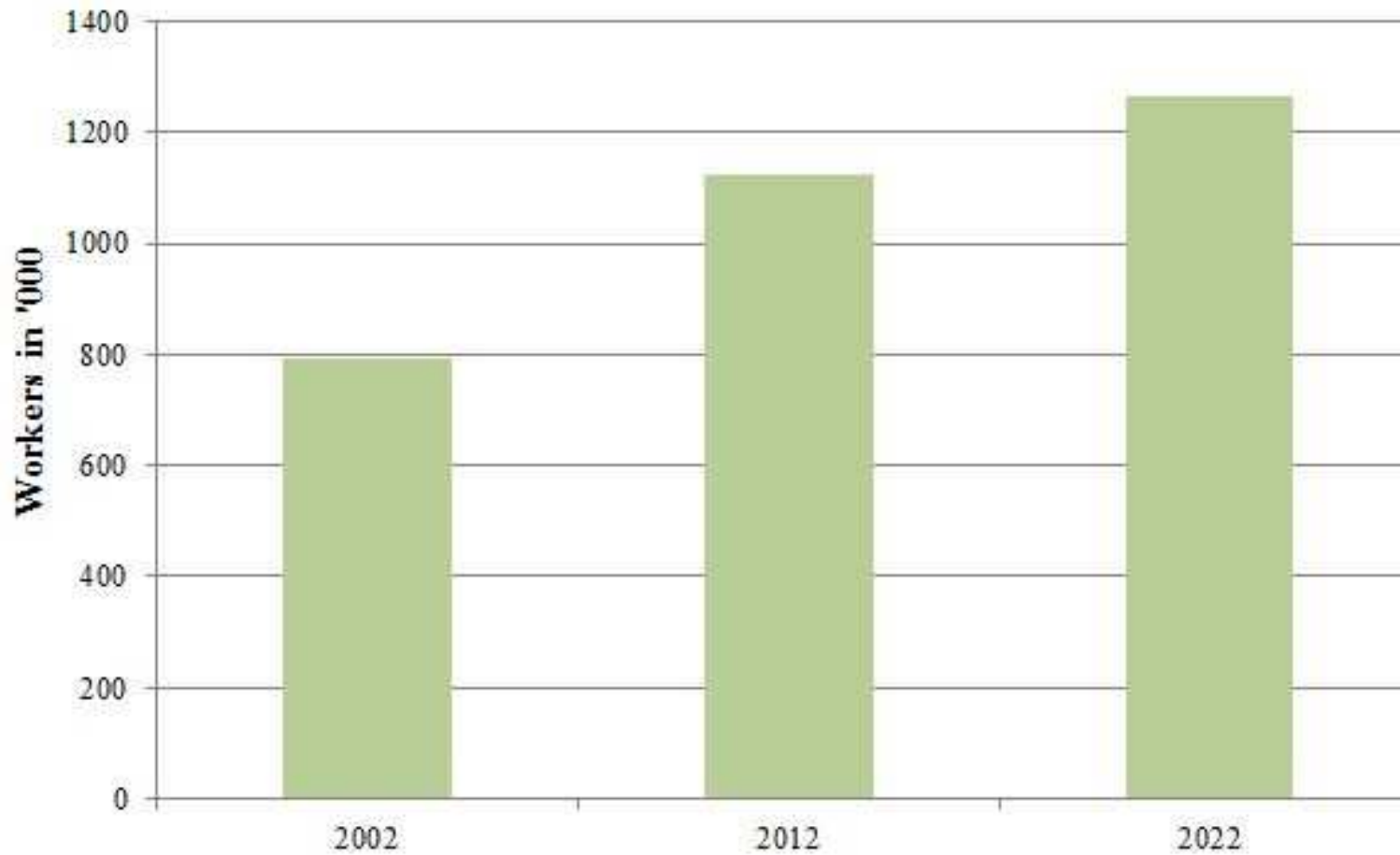
- Gas-powered lawn and garden equipment (GLGE) is known to emit high levels of toxic and carcinogenic pollutants.
- Gasoline-powered landscape maintenance equipment (GLME) is used routinely in neighborhoods, schools, parks, and other public spaces.
 - Workers and others are exposed close to the emitting source.
- These emissions may increase worker and public health risks.
- Understanding the characteristics of GLGE and GLME emissions can help estimate potential health impacts.

GLGE includes GLME (mowers, leaf blowers, vacuums, trimmers, edgers, and cutters) and chain saws, chippers, rotary tillers, stump grinders, shredders, snowblowers, tractors, turf equipment, and other.

Gas-Powered Equipment, US, 2011



Landscape Maintenance Industry



Source: US Bureau of Labor Statistics

GLGE Pollutants

- Volatile organic compounds (VOC)
 - Benzene
 - 1,3 butadiene
 - Acetaldehyde
 - Formaldehyde
 - Toluene
 - Others
- Polycyclic aromatic hydrocarbons
- Nitrogen oxides (NO_x)
- Carbon monoxide
- Particulate matter:
 - PM₁₀, PM_{2.5}, UFP
- Carbon dioxide

Why Be Concerned?

EPA Concludes Ozone Pollution Poses Serious Health Threats

- Causes respiratory harm (e.g. worsened asthma, worsened COPD, inflammation)
- Likely to cause early death (both short-term and long-term exposure)
- Likely to cause cardiovascular harm (e.g. heart attacks, strokes, heart disease, congestive heart failure)
- May cause harm to the central nervous system
- May cause reproductive and developmental harm

—U.S. Environmental Protection Agency, *Integrated Science Assessment for Ozone and Related Photochemical Oxidants*, 2013. EPA/600/R-10/076F.

Outdoor air pollution and fine particulate matter are carcinogenic to humans, causing lung cancer and probably causing bladder cancer.

World Health Organization 2013

Short-term exposure to particle pollution can kill...Deaths can occur on the very day that particle levels are high, or within one to two months afterward.

American Lung Association, State of the Air 2014

EPA Concludes Fine Particle Pollution Poses Serious Health Threats

- Causes early death (both short-term and long-term exposure)
- Causes cardiovascular harm (e.g. heart attacks, strokes, heart disease, congestive heart failure)
- Likely to cause respiratory harm (e.g. worsened asthma, worsened COPD, inflammation)
- May cause cancer
- May cause reproductive and developmental harm

—U.S. Environmental Protection Agency, *Integrated Science Assessment for Particulate Matter*, December 2009. EPA 600/R-08/139F.

And the Evidence Keeps Mounting

- Shah ASV, Lee KK, McAllister DA, et al. Short term exposure to air pollution and stroke: systematic review and meta-analysis. *BMJ* 2015;350:h1295.
 - Conclusion: *Gaseous and particulate air pollutants have a marked and close temporal association with admission to hospital for stroke or mortality from stroke. Public and environmental health policies to reduce air pollution could reduce the burden of stroke.*
- Power MC, Kioumourtzoglou M-A, Hart JE, et al. The relation between past exposure to fine particulate pollution and prevalent anxiety: observational cohort study. *BMJ* 2015;350:h1111.
 - Conclusion: *Exposure to fine particulate matter (PM2.5) was associated with high symptoms of anxiety, with more recent exposures potentially more relevant than more distant exposures.*

Methods

Methods

- Data sources
 - GLGE emissions* data from National Emissions Inventory 2011 and 2018 modeling platform (version 6) and Nonroad model
 - CA ARB Emissions Inventory
- Analysis
 - Projected GLGE emissions through 2018
 - Relative contribution of GLGE to emissions from all, nonroad, and nonroad gasoline sources and contribution of GLME
 - 2-stroke engines as a source of emissions
 - Contributions of the 5 largest (most populated) states
- Metrics
 - Descriptive statistics

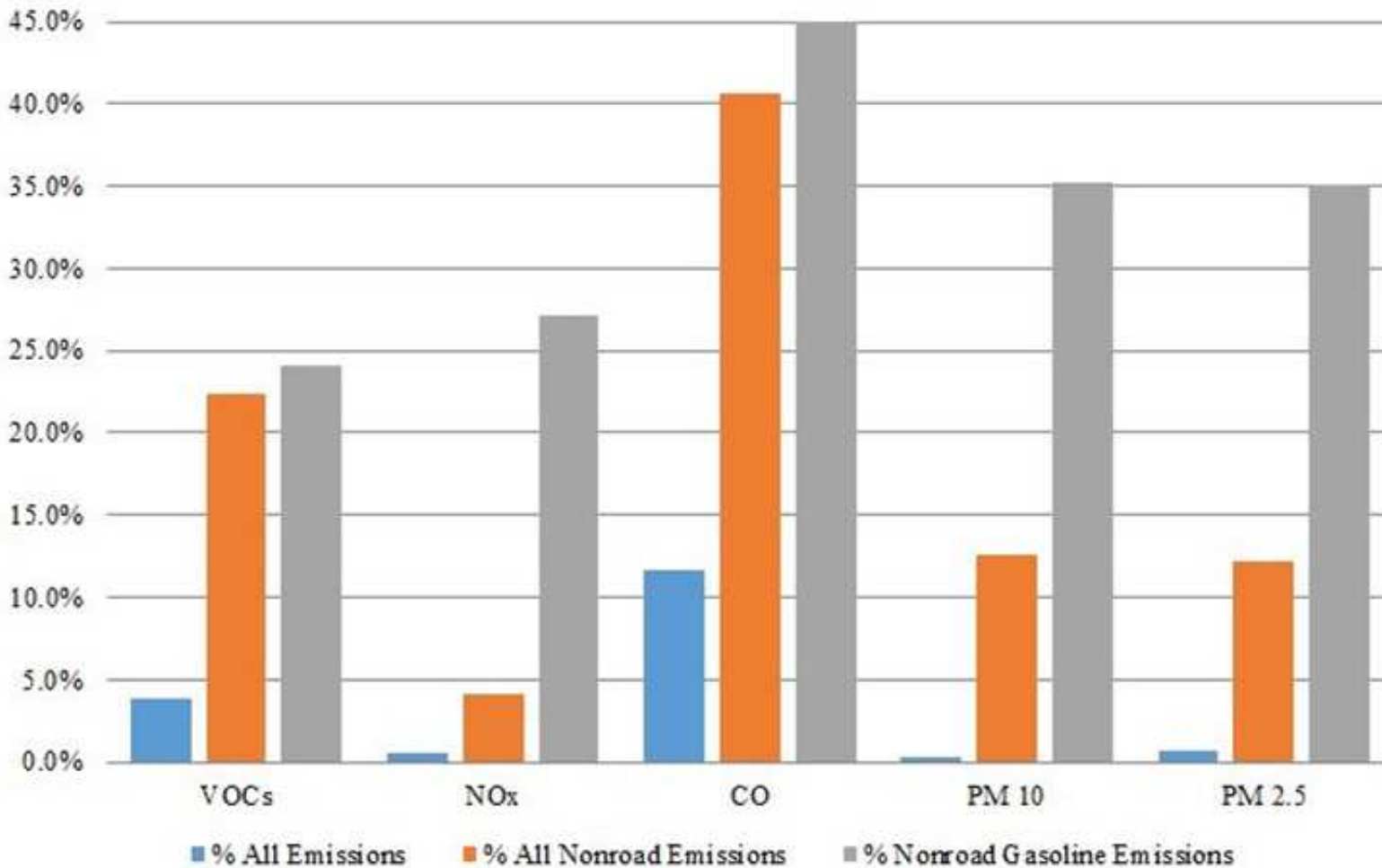
*Pollutants analyzed: Volatile organic compounds (VOC), individual VOCs (benzene, 1,3 butadiene, formaldehyde, acetaldehyde); Criteria pollutants: CO, NO_x, PM₁₀, PM_{2.5}; Carbon dioxide (CO₂)

Results

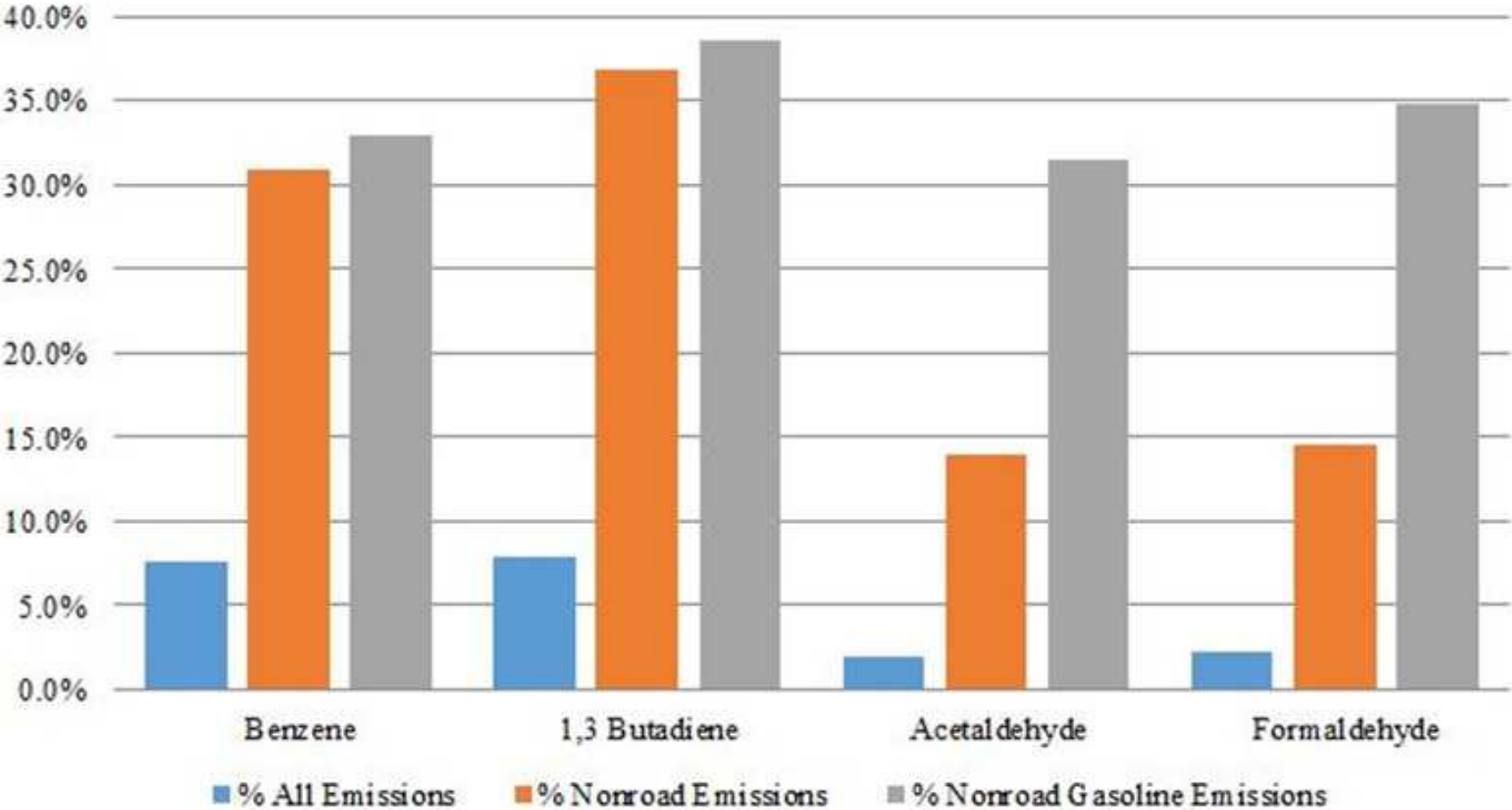
Projected GLGE Emission Estimates, US, 2011–2018 (Tons per year)

Pollutant	2011	2018	% Change
VOCs	461,798	365,326	-20.9%
NOx	68,517	47,239	-31.1%
CO	5,793,164	5,510,185	-4.9%
CO2	20,382,401	22,887,041	12.3%
PM 10	20,688	22,389	8.2%
PM 2.5	19,002	20,598	8.4%

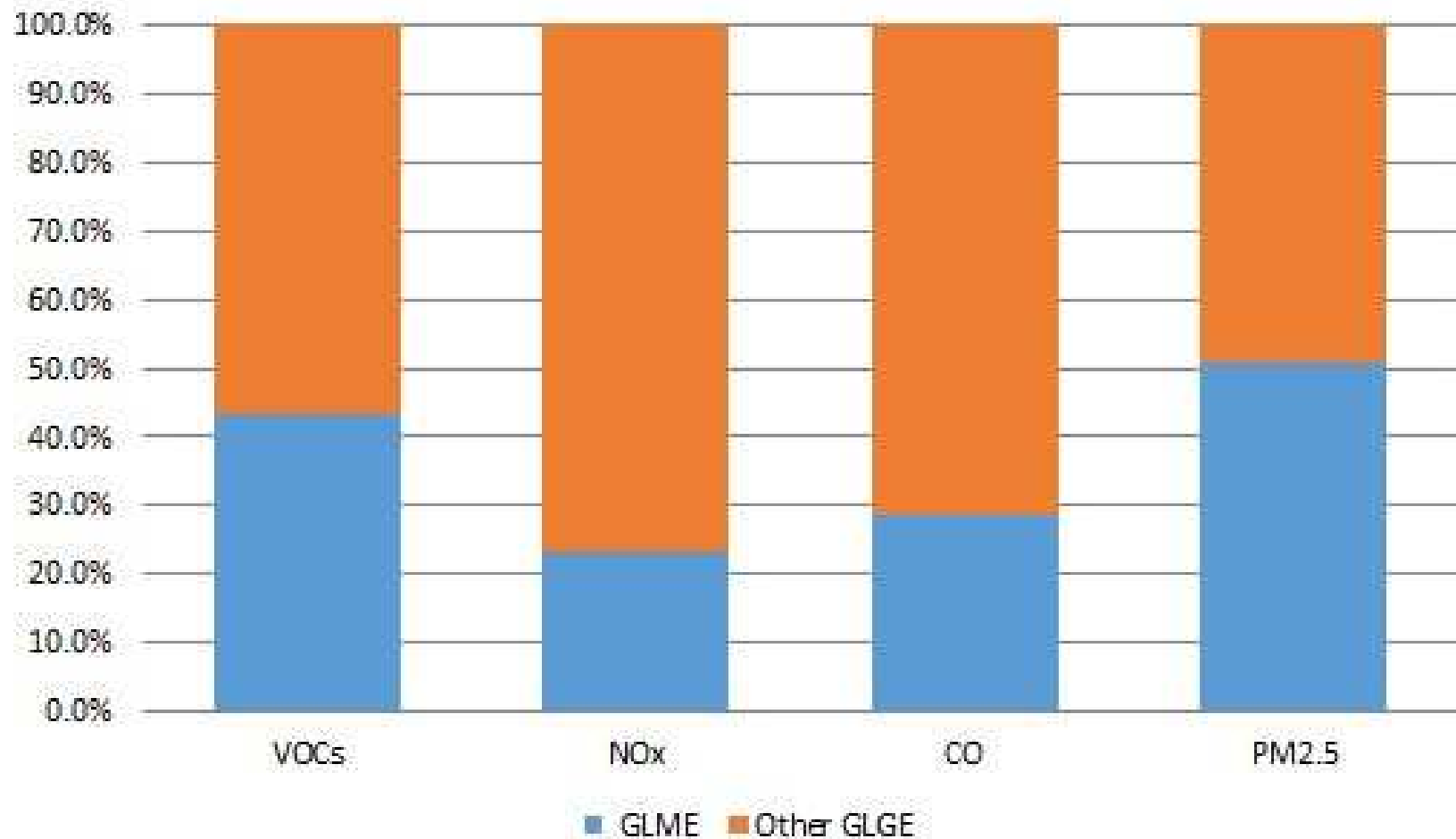
GLGE Emissions, US, 2011



GLGE VOC Emissions, US, 2011

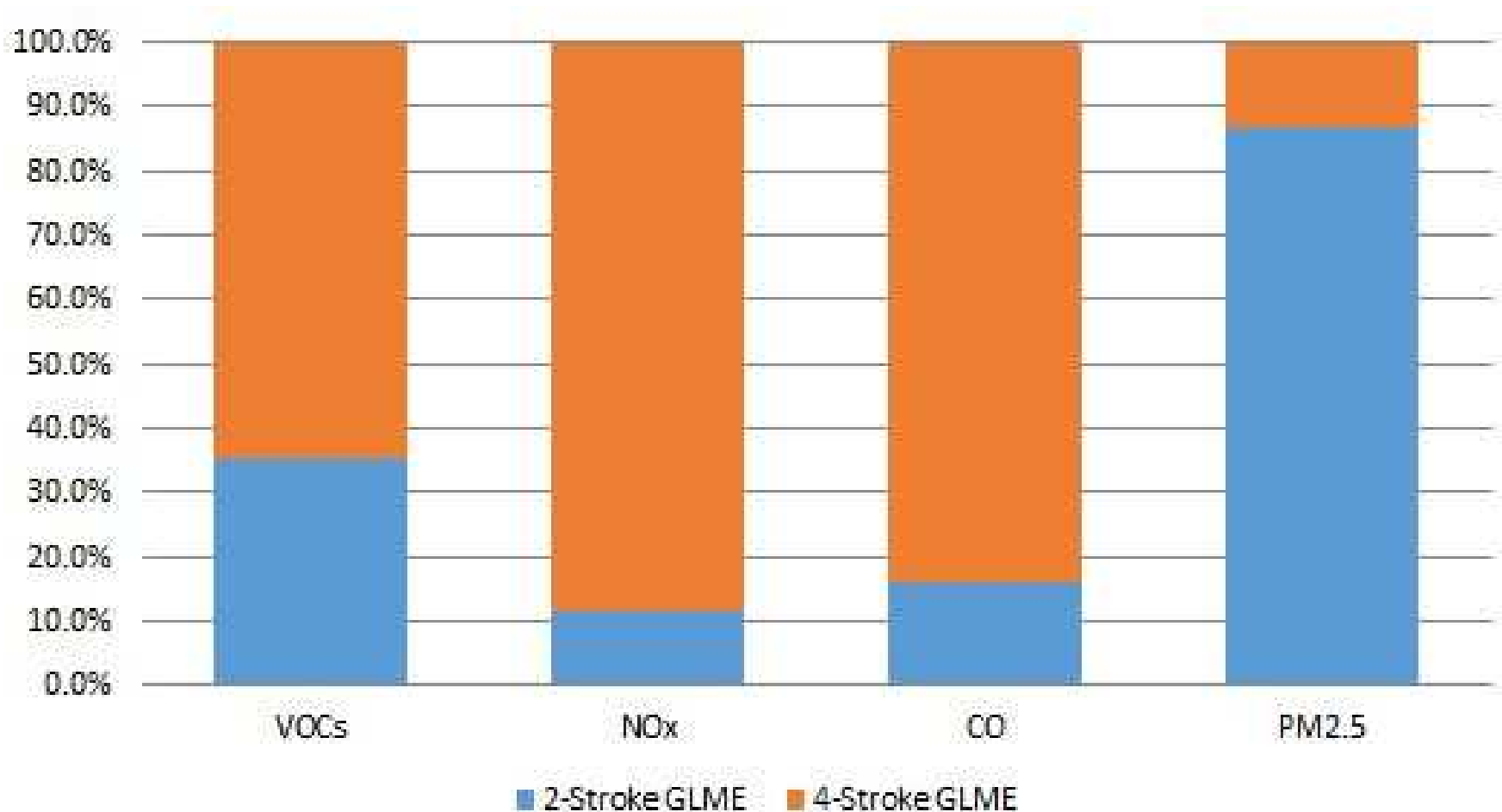


Contribution of GLME* to GLGE Emissions, US, 2011



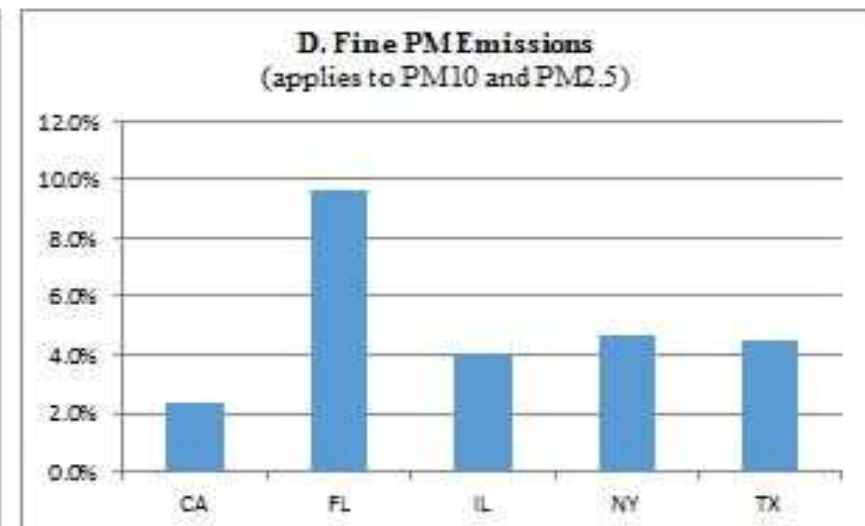
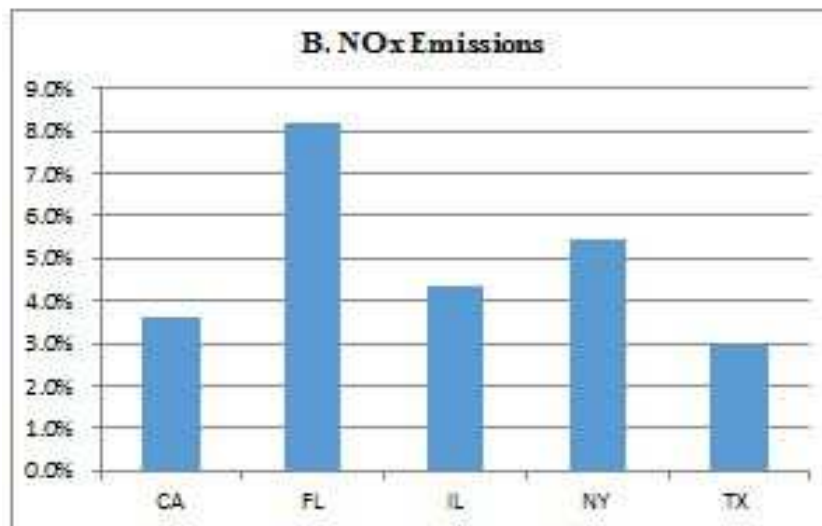
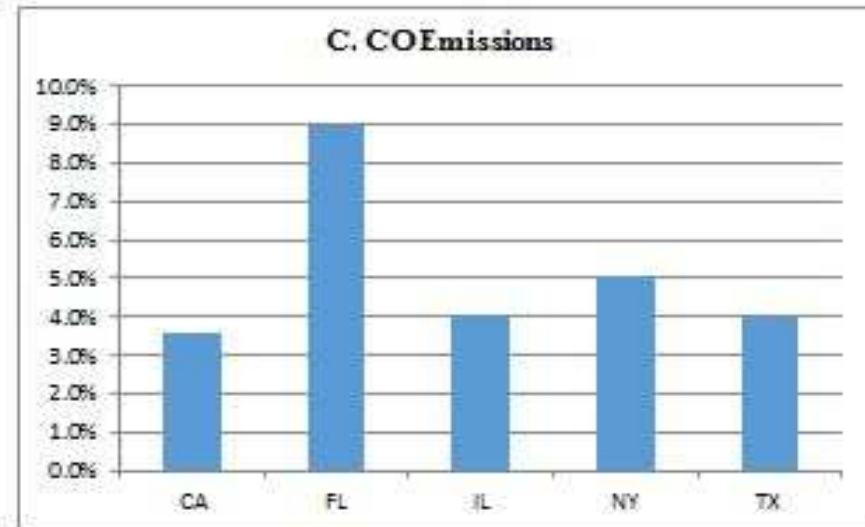
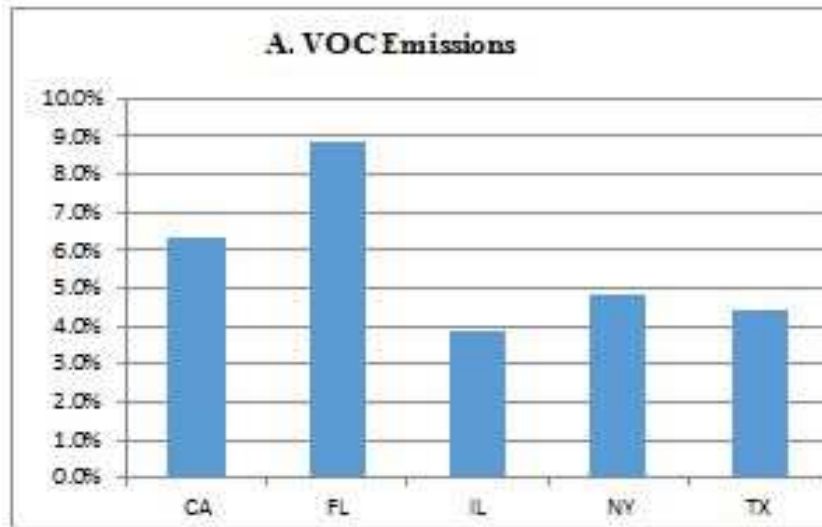
*GLME: Leaf blowers and vacuums, trimmers, edgers, brush cutters, mowers.
Results for PM10 and PM2.5 were equal.

Contribution of 2-Stroke Engines to GLME Emissions, US, 2011



*GLME: Leaf blowers and vacuums, trimmers, edgers, brush cutters, mowers. Results for PM10 and PM2.5 were approximately equal.

GLGE Emissions from 5 Largest States, US, 2011*



*California data are from 2012.

Summary

- GLGE is an important source of toxic and carcinogenic exhaust and **fine particulate matter**.
- GLGE ozone precursors are expected to decrease through 2018, but **fine particulate pollution is expected to increase**.
- 2-stroke engines of leaf blowers, vacuums, trimmers, edgers, brush cutters account for the vast majority of fine particulate pollution in landscape maintenance activities.
- Workers and other vulnerable populations are exposed close to the emitting sources.
- Short term as well as long term exposure to GLGE pollutants **close to the emitting source** are public health concerns.

Conclusions

- Medical and scientific organizations should increase public awareness of GLGE and GLME as local sources of dangerous air pollutants.
- Communities, environmental and public health officials should create policies and programs to protect the public from GLGE air pollutants and promote non-polluting alternatives.