

# Environmental Landscape Footprint (ELF<sup>®</sup>)

## City of Glendale



March 26, 2023

## I. INTRODUCTION

The City of Glendale, CA is working with the American Green Zone Alliance (AGZA) to transition maintenance of several municipal properties from gas-powered equipment to battery electric equipment, to the extent allowed by advanced battery technology and has met AGZA's criteria for certification as an AGZA Green Zone® City. An AGZA Green Zone is a defined area of land on which all routine maintenance is performed with battery electric equipment and/or manual tools (**Appendix A**). The minimal requirement for an AGZA Certified Green Zone is the elimination of all two-stroke equipment for routine grounds maintenance. AGZA is a recognized certification agency in zero emissions, low noise land care practices.

Gas-powered landscape maintenance equipment account for considerable amounts of noise, emissions, and waste affecting the health of workers, the public, and the environment. Zero emissions, low noise battery electric equipment can substantially reduce many of these impacts. A successful transition would result in a quieter, cleaner, and healthier city.

Quiet Communities, Inc, a national nonprofit organization, works with AGZA to implement the AGZA Green Zone program and quantify the impacts of maintaining land with gas-powered equipment and translating those impacts to their health and environmental consequences using ELF® (Environmental Landscape Footprint) methodology.

This ELF quantifies the beneficial reductions in toxic and carcinogenic emissions, greenhouse gas emissions, noise, and other impacts that will result from the equipment transition that began in late 2020/early 2021 as well as additional impact reductions from equipment transitions anticipated in 2023.

## II. TECHNOLOGY

Advances in battery technology have enabled the development of zero emissions, low noise battery electric equipment. These advances have resulted in equipment with run times, charge times, and performance that make it practical to perform commercial scale work cost-effectively with electric equipment for all but the heaviest maintenance work. Currently, lithium battery technology has proven itself to be a comparable alternative to gas powered equipment for 100% of Routine commercial grounds maintenance and Special Tasks, like shrub and tree pruning. The tasks include:

- Mowing
- String/line trimming
- Edging
- Leaf/debris blowing
- Hedge trimming
- Light to medium tree work

Tasks for which gas-powered equipment is still needed include heavy clean-ups, dethatching, aeration, heavy tree trimming, rototilling compacted areas, heavy seasonal workloads, pressure washing, and contracted enhancement work.

### III. PROPERTY AND MAINTENANCE OVERVIEW

In 2020, Glendale replaced a set of gas equipment used to maintain approximately 4 acres of City properties (see **Appendix B**). The number and type of equipment are shown in **Table 1A**.

**Table 1A**  
**Gas Maintenance Equipment Replaced in 2020**

<u>Non-Handheld Equipment</u>	<u>Handheld Equipment</u>	
2, Walk behind mowers	3, String trimmers	3, Hedge trimmers
	4, Backpack blowers	

In 2023, Glendale hopes to replace a set of gas equipment used to maintain many more City properties (see **Appendix B**). The number and type of equipment are shown in **Table 1B**.

**Table 1B**  
**Gas Maintenance Equipment Replacements Anticipated in 2023**

<u>Non-Handheld Equipment</u>	<u>Handheld Equipment</u>	
12, Walk behind mowers	20, String trimmers	14, Hedge trimmers
18, Wheeled edgers	21, Backpack blowers	3, Chainsaws
	1, Handheld blower	

### IV. METHODOLOGY

In 2020 and 2022 inventories of gas-powered equipment were conducted estimate their impacts and the benefits of replacing them with battery electric and other less polluting equipment. The inventory involved identifying equipment by brand, model number, and other characteristics and documenting their frequency and duration of use on City properties.

Emissions impacts were calculated for all gas equipment used for the designated routes. The impacts were analyzed in the aggregate and by tool category (non-handheld vs handheld) and within each category by tool type. Noise levels were derived from product specifications and trade sources.

Information on each of the quantified impacts is provided below.

## Toxic and Carcinogenic Exhaust

The exhaust emissions below were quantified in pounds-per-year (and tons-per-year, where appropriate) using validated equations from the US Environmental Protection Agency.

- **Ozone-forming emissions: Non-methane hydrocarbons (HC)**, also known as volatile organic compounds, include benzene, 1,3 butadiene, formaldehyde, and acetaldehyde, all of which are potent carcinogens ([Loh, 2007](#)). These compounds combine with **Nitrogen Oxides (NOx)** in warm season months to form ground level ozone, a cause of lung disease, heart disease, and premature death.
- **Carbon monoxide (CO)** is a toxic gas which can harm health when people are in close proximity and which can accumulate in enclosed settings (sheds, trailers) and result in death.
- **Fine particulate matter (PM2.5)** is a cause of cancer, lung disease, heart disease, and premature death ([IARC, 2012](#); [US EPA](#)).

## Greenhouse Gases

- **Carbon dioxide (CO2)** emissions were quantified in pounds-per-year and also expressed in terms of equivalent “trees planted.” CO2 is a major greenhouse gas.

## Noise

Transitioning away from gas-powered equipment will result in a very substantial reduction in noise experienced by workers, children, faculty, staff and visitors.

- Studies show that noise can adversely affect children’s cognition, learning, behavior, productivity, and health ([Basner 2017](#); [Stansfeld 2015](#); [Klatte 2013](#)).
- Children and those with autism spectrum disorders, sensory processing disorders, and other conditions may be especially affected ([van Kamp 2013](#)).

The American National Standard Institute (ANSI) and World Health Organization threshold for background noise in classrooms is 35 A-weighted decibels (dBA). Gas-powered landscape maintenance equipment are very loud – 85-115 dBA at ear of the operator and 55-85 dBA at 50 feet. These levels far exceed those known to be safe for worker health ([PLANET, 2012](#)) and public health ([WHO Guidelines, 1999](#); [EPA Levels, 1974](#)).

Loud noise is particularly problematic around classrooms and playgrounds for children trying to learn and play, and teachers trying to teach and manage their classes. Moreover, noise from some types of gas equipment, e.g., lawn mowers, leaf blowers, has a strong low frequency component that allow it to travel over long distances and readily penetrate through windows into classrooms and offices, making it difficult for faculty to teach and for students to concentrate and learn.

Battery electric tools substantially reduce noise relative to gas-powered equipment and largely eliminate the low frequency component responsible for carrying loud noise over long distances (e.g., 400 feet) and through walls and windows ([Pollock, 2019](#); [Walker, 2017](#); [Pasanen, 2004](#)).

## V. RESULTS

### Exhaust Emissions

The following sections present the exhaust emissions that would result once all the gas tools used on the routes indicated in the equipment inventory are replaced with battery electric tools in 2023.

### Toxic and Carcinogenic Exhaust

Approximately 25,412 pounds (12.7 tons) of toxic and carcinogenic exhaust would be avoided each year. Contributions of specific exhaust components are in **Table 2** below.

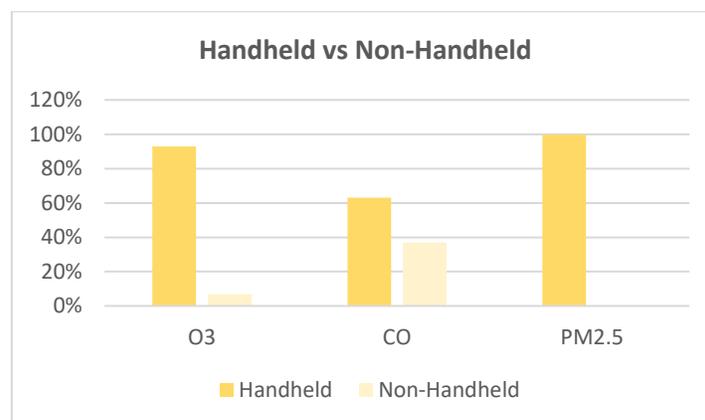
**Table 2. Annual Toxic and Carcinogenic Emissions Avoided**

Category	Volume (Pounds)		
	2020	2023 (E)	Total (E)
Ozone-forming exhaust	712	1,982	2,694
Carbon monoxide	5,024	17,191	22,215
Fine particulate matter	147	356	503

***Note:** The amount of emission is not indicative of toxicity or carcinogenicity. Rather, the potency or strength of the emission in causing disease must be considered. As a hypothetical example, small amounts of PM2.5 may be more toxic than large amounts of ozone.*

Once the transitions to electric tools are made in 2023, the relative contributions of handheld vs. non-handheld tools to toxic and carcinogenic emission reductions will be as shown below in **Exhibit 1**. Handheld tools will account for the majority of reductions in each emissions category: ozone-forming emissions (93%), carbon monoxide (63%), and PM2.5 (>99%).

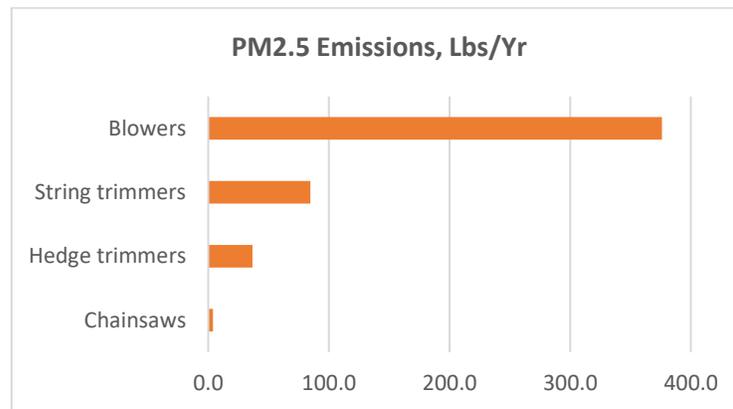
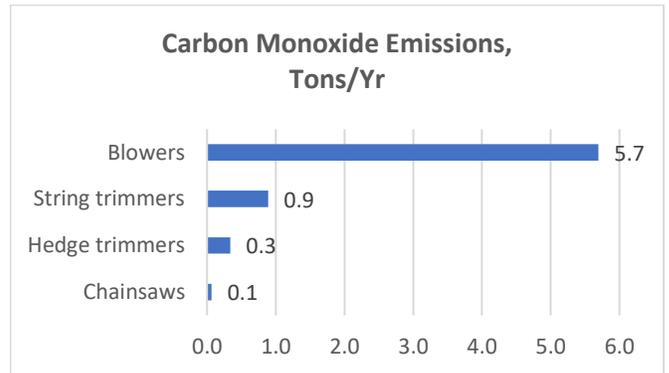
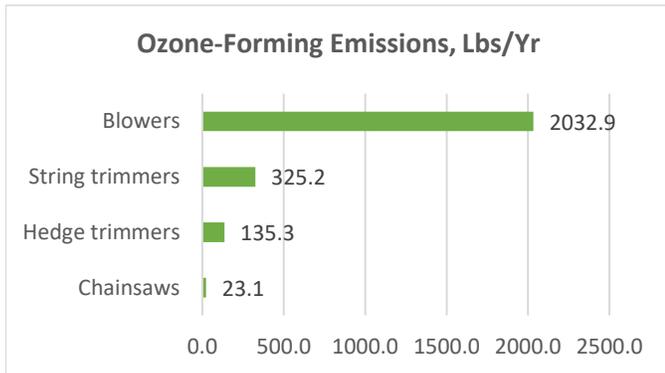
**Exhibit 1. Relative Contribution to Total Toxic Emissions, by Tool Category**



CO: carbon monoxide; O3: ozone; PM2.5 fine particulate matter

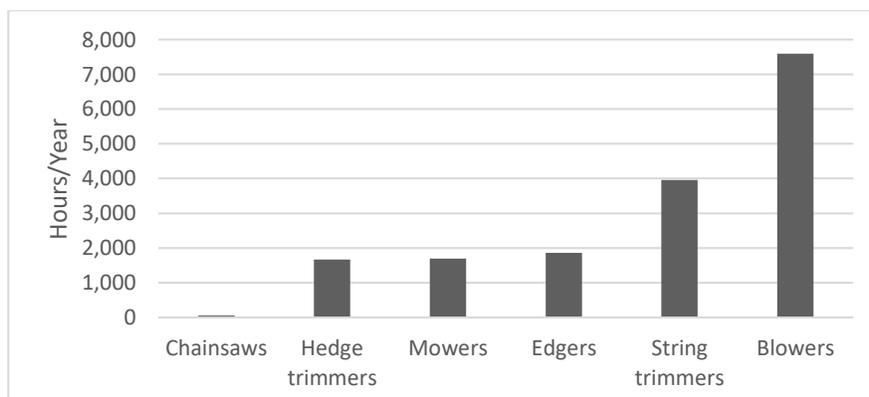
Among the handheld tools (leaf blowers, string trimmers, hedge trimmers, and saws), leaf blowers are estimated to account for the majority of all toxic and carcinogenic emissions (**Exhibit 2**). This is due in large part due to the much greater amount of annual runtime amongst this category of tools (**Exhibit 3**).

**Exhibit 2. Amounts of Toxic and Carcinogenic Exhaust by Handheld Tool Type**



Amongst all tools – Handheld and Non-Handheld – differences in emission levels are based mainly on three factors: 1) annual runtimes - **Exhibit 3** below; 2) engine type (4-stroke for Non-Handheld tools vs 2-stroke for Handheld tools) and 3) engine power.

**Exhibit 3. Annual Runtime by Tool**



## Greenhouse Gases

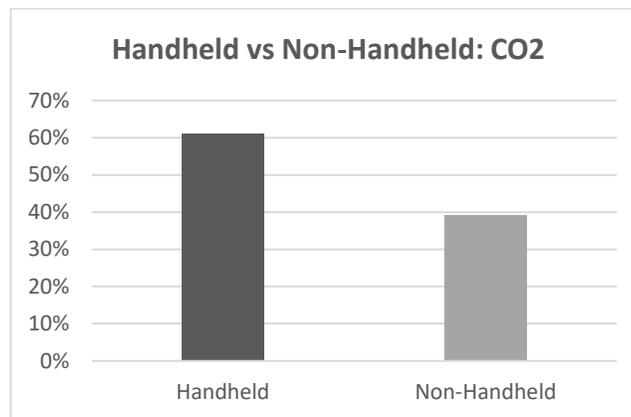
Replacement of the gas equipment with battery electric equipment purchased through 2023 will eliminate close to 50 tons of CO<sub>2</sub> per year (**Table 3**).

**Table 3. Carbon Dioxide Emissions Avoided, Lbs/Tons**

<u>2020</u>	<u>2023 (E)</u>	<u>Total (E)</u>
24,532/12.3	73,866/36.9	98,398/49.2

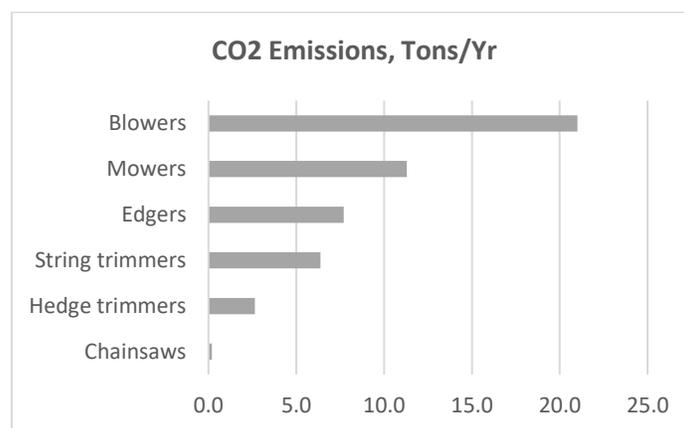
The contribution of tool category and tool type to those potential reductions is shown in **Exhibits 4 - 5** below.

**Exhibit 4. Amount of Greenhouse Gases Avoided by Tool Category**



**Exhibit 5** shows that blowers and non-handheld equipment will account for the majority of CO<sub>2</sub> emissions, accounting for 81% of the total.

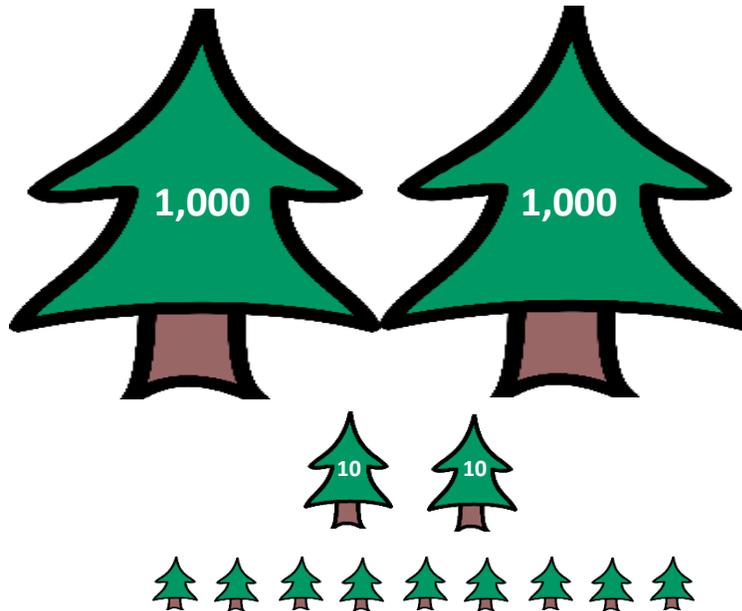
**Exhibit 5. Amount of Greenhouse Gases Avoided by Tool Type**



## Tree Equivalents

The 49 tons of carbon dioxide that would be avoided annually by the continued replacement of gas equipment with battery electric equipment through 2023 will be equivalent to the amount that would be absorbed by 2,029 trees ([European Environment Agency](#)) as illustrated in **Exhibit 6** below.

**Exhibit 6. Tree Equivalents**



**49.2 tons of CO2 avoided = amount of CO2 absorbed by 2,029 trees each year.**

## Car Equivalents

The 49 tons of carbon dioxide that would be avoided annually by the continued replacement of gas equipment with battery electric equipment through 2023 will be roughly equivalent to taking ten cars off the road each year ([EPA, 2018](#)) as illustrated in **Exhibit 7** below.

**Exhibit 7. Car Equivalents**



**49.2 tons of CO2 avoided yearly is roughly equivalent to removing 10 cars from the road every year.**

## Noise

The loudness of battery electric equipment is generally 10–20 dBA lower than that of their gas counterparts. In some cases, the difference is even greater. As a rule of thumb, each 10-decibel decrease in noise level translates to a halving of loudness as perceived by the human ear.

- Mowers: At the source, sound from battery electric mowers is 10 decibels or more below the average of 94 decibels for large gas-powered mowers. For workers, that means the loudness of the mowers is cut in half. Because of the absence of a strong low frequency component, the difference in sound between battery electric mowers and gas mowers becomes even greater over distance. For students, teachers, and staff, the sound at a distance from the electric mowers may be hardly detectable.
- Leaf blowers: For large blowers, the difference in sound level between a powerful commercial gas backpack blower like the Echo PB-770 and a powerful commercial battery electric blower is estimated around 10 decibels or higher with blowers like the Husqvarna 550iBTX (rated at [73 decibels](#) at the source) ([Pollock, 2019](#); [opereviews.com, 2019](#)). For the operator, a 10-decibel difference means the electric blower will be half as loud and a 20 to 30 decibel difference would mean a quarter to an eighth as loud. For the public in the immediate vicinity, the difference in sound may range from 13-24 decibels or more at 50 feet, translating to a 2x to 4x reduction (or greater) in loudness. As for the electric mowers, the reduction in low frequency sound when using the electric vs gas blower substantially lessens the ability of noise to penetrate through walls and windows ([Pollock, 2019](#)).
- String trimmers, hedge trimmers: At the source, sound levels of commercial string trimmers and hedge trimmers, like the and Echo SRM2620, are 100 decibels or higher compared with [76 decibels](#) for a battery/electric trimmer (like the Husqvarna 520IL). That 24-decibel difference alone would translate to a 4-fold reduction in loudness for workers and a substantial reduction in loudness for people outdoors and indoors.

## VI. OTHER IMPACTS AND BENEFITS

The results of this ELF indicate that continuing transition to battery electric equipment will result in substantial reductions in toxic emissions, greenhouse gases, and noise exposure to the benefit of worker health, public health and environment.

- AFTC (AGZA Field Tested Certified) battery electric equipment can reduce sound levels 45% – 70%, relative to gas equipment.
- Battery electric equipment and manual tools produce no toxic and carcinogenic exhaust emissions at point of operation.
- Battery electric equipment and manual tools produce no carbon dioxide at point of operation.

In addition:

- Idling of gas engines is eliminated.
- Push button starts for battery electric equipment can be less tedious than pull cord starts for gas equipment.
- Battery electric equipment eliminates the need for carrying and mixing the gas and oil used in many gas-powered handheld tools.

- Fuel spillage is eliminated, and the amount of solid and toxic waste associated with maintenance of gas equipment are reduced.
- Equipment vibration may be reduced.

For the City of Glendale, a transition may lead to other important benefits:

- A heightened awareness in the region of how the City is creating a healthier environment for workers, residents, and visitors, and one that enhances quality of life.
- Recognition of the City as a leader in low impact, low noise maintenance and a model for area businesses, institutions, and municipalities.

## VII. CLOSING STATEMENT

The transition to low impact land care practices by the City of Glendale promises substantial benefits for health and environment. Further, the City stands to realize long-term savings accruing from eliminated fuel consumption and reduced maintenance required by battery electric equipment. In addition, work crews benefit from healthier working conditions and from recognition and pride in the work they do. AGZA and QC congratulate the City of Glendale on its leadership!

# Appendix A: AGZA Certified Green Zone® Levels



the leader in low-impact  
landscape maintenance strategies

## AGZA GREEN ZONE® CERTIFICATION Features and Benefits



AGZA Green Zone® Certification establishes municipalities, academic institutions, school districts, and private industry as models of low-impact land care for their communities. Certification also strengthens environmental leadership and sets examples for clean, quiet, and sustainable landscape maintenance practices in their regions and beyond. AGZA collaborates with the nonprofit organization, Quiet Communities, to implement the Green Zone® program.



### Why Low-Impact?

Low-impact lawn and garden operations improve a community's quality of life and benefits worker and community health by reducing localized noise and air pollution.

### Benefits of Certification

- Independently verified and certified transition
- Long term commitment to low impact operations
- Operations orientation, training, equipment recommendations, charging infrastructure, certification
- ELF\* (Environmental Landscape Footprint) reports documenting beneficial reductions in health- and environment-related impacts
- Economic analyses
- Lead-by-example opportunity
- Communicating and celebrating success
- Battery re-purposing and recycling guidance

### Certification Levels

#### LEVEL 1

Phase out all two-stroke operations for routine maintenance

#### LEVEL 2

Phase out all gas operations for routine maintenance

#### LEVEL 3

Phase out all gas operations for routine maintenance, heavy tree work, seasonal workloads, and incorporation of best practices

#### LEVEL 4

Phase out all gas operations for routine maintenance, heavy tree work, seasonal workloads, and incorporation of best practices, organics for pest, weed control, and fertilizing

\* Note: Gas allowances for levels 1 & 2 for heavy tree work, and seasonal workloads



## Appendix B: Route Inventory

### Routes Transitioned in 2020

Casa Adobe Route

City Hall

Harvard Route

Project Crew

Verdugo Adobe

### Routes Expected to Transition in 2023

Arc

Lower Scholl

BRAND Office

Maple

BRAND Right Cage

Mayors

BRAND Tea House

Montrose

Carr Park

New York

Cerritos

Nibley

Duekmejain

Pac Ed

Dunsmore

Palmer Park

Emerald isle

Pelanconi

Fremont

Scholl Ballfields

Glenoaks

Verdugo Park

Glorietta

Verdugo South

Griffith Manor