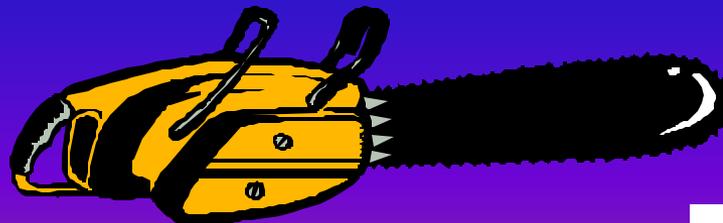
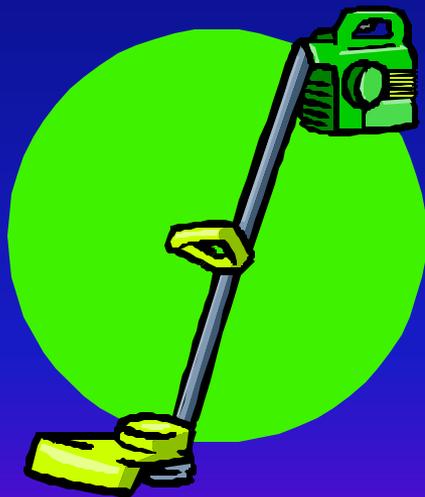


# Potential Electrification Programs for Small Off-Road Engines (SORE)

Mobile Source Control Division  
California Air Resources Board

April 22, 2004  
Board Meeting



California Environmental Protection Agency



Air Resources Board

# Outline

- Background
- Equipment Types
- Electric Alternatives
- Potential Electrification Strategies
- Summary

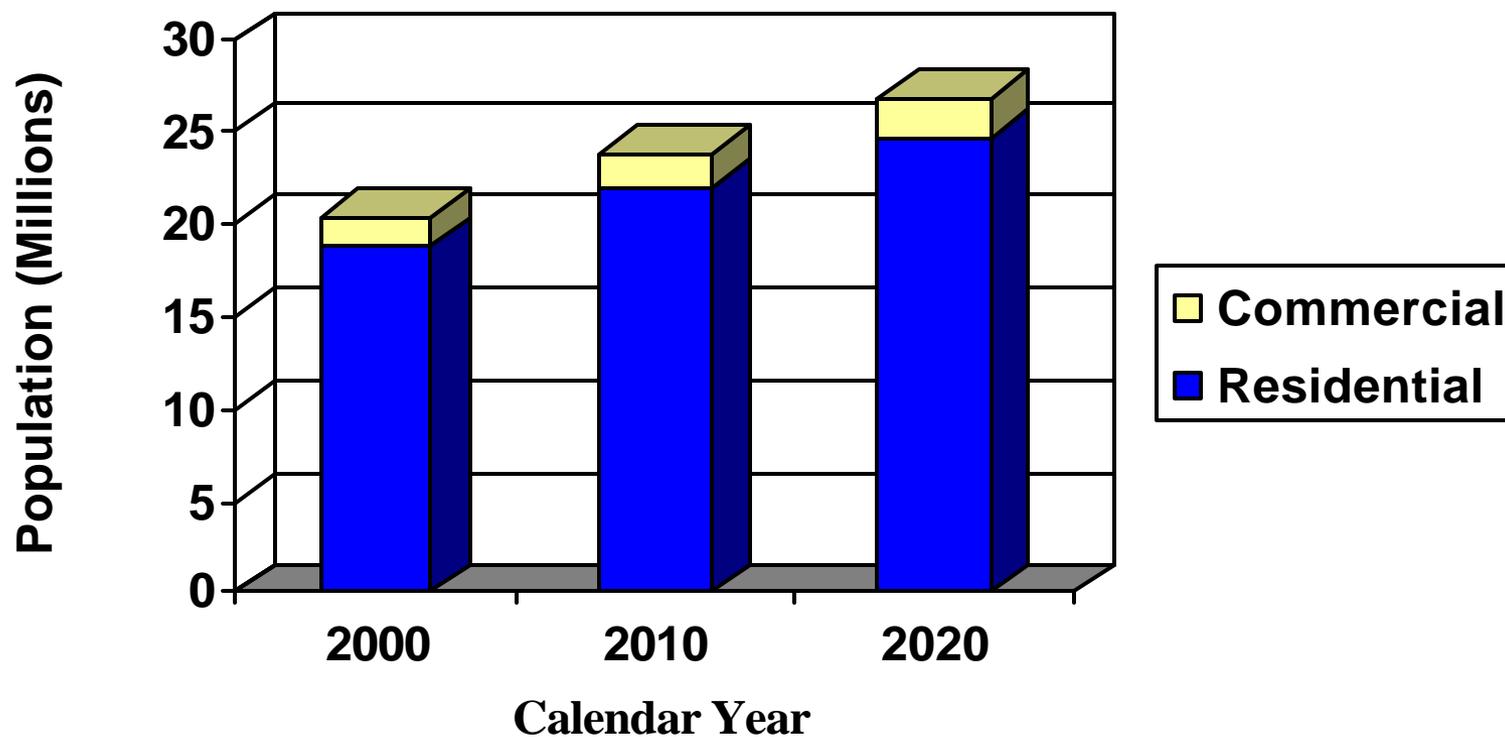
# Small Off-Road Engines and Equipment (SORE)

- Engines  $\leq$  19 kW (25 hp)
- Two and four-stroke engines
- Lawn and garden, small industrial equipment
- Preempt: farm and construction equipment
- September 2003 - Board approved more stringent exhaust standards and new evaporative requirements

# Examples of SORE Equipment

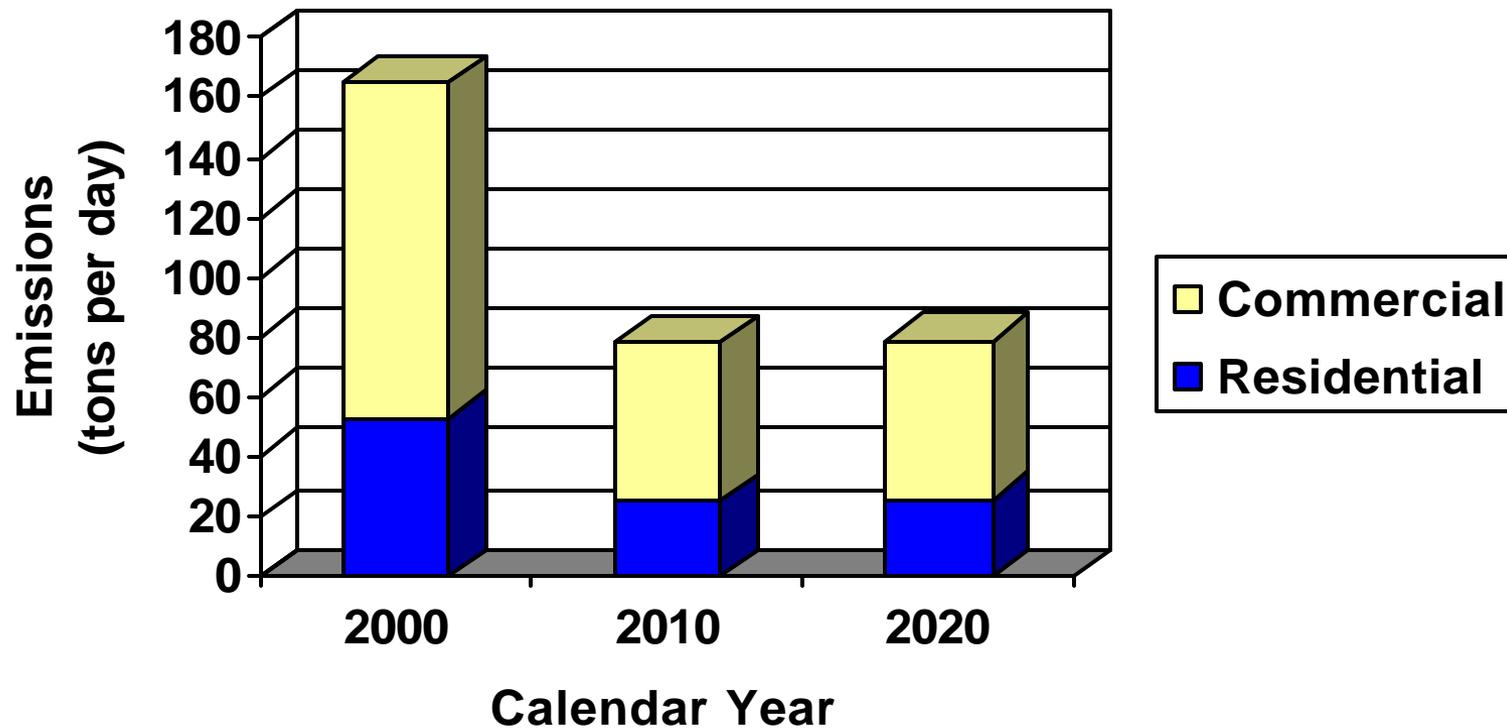


# Majority of the SORE Equipment Population is Residential



\*Including electric equipment

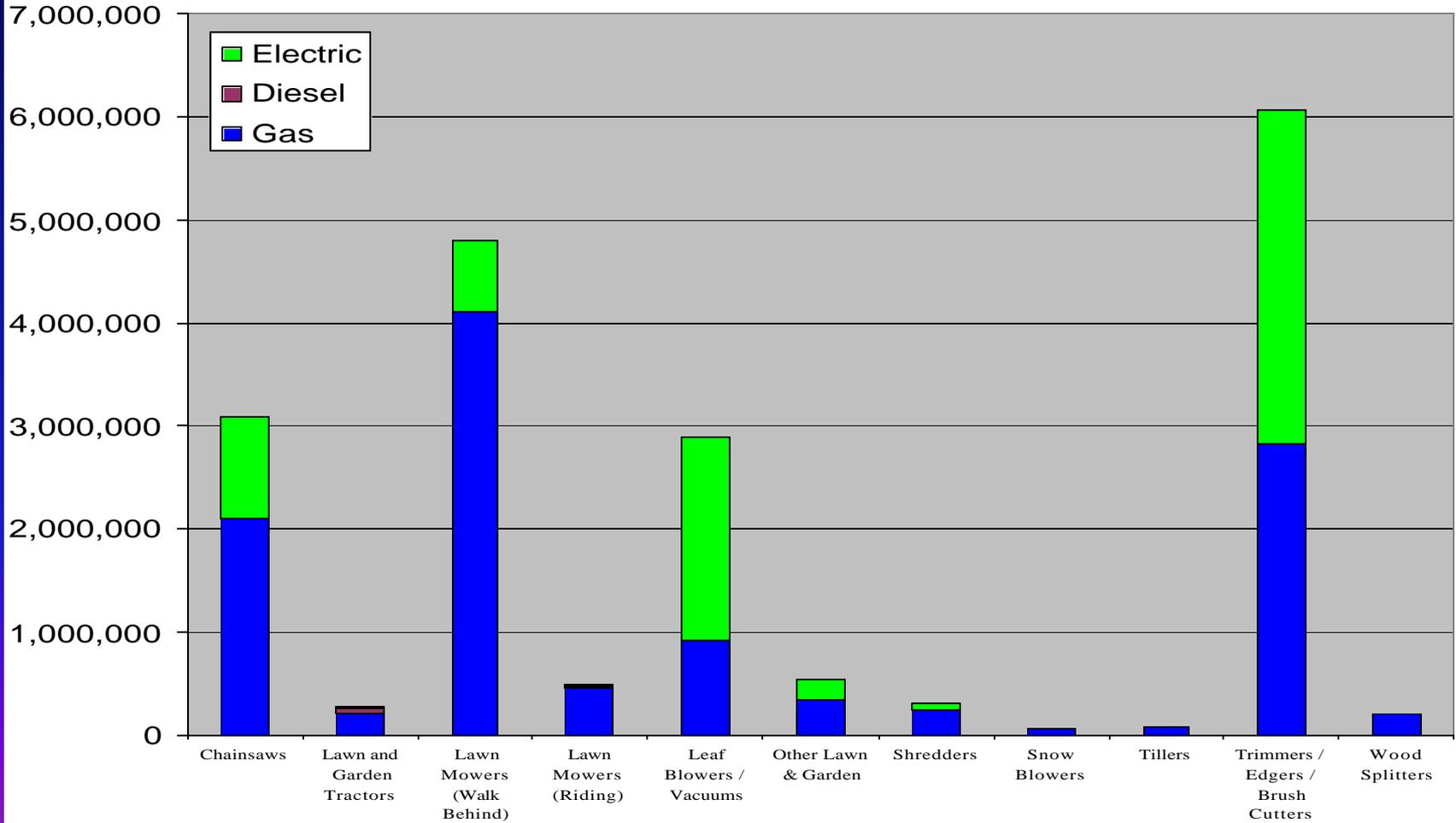
# Majority of the SORE HC+NOx Exhaust Emissions Inventory is Commercial



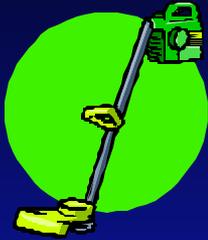
\*Exhaust emissions only

# Nearly 40% of Residential Lawn & Garden Equipment is Electric in 2000

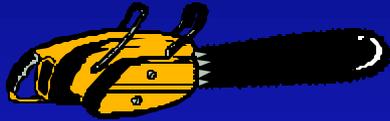
Population



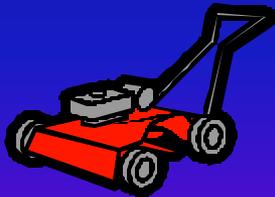
# Electric Alternatives



- String Trimmer
- Hedge Trimmer
- Non-backpack Blower



- Chain Saw



- Walk-behind Mower
- Battery-powered Tillers and Riding Mowers/Tractors

# Electric vs. Gasoline String Trimmers / Brush Cutters

<u>Equipment</u>	<u>Cost Range</u>	<u>Performance Cutting Path</u>
Electric corded	\$20-\$65	7"-17"
Electric Cordless	\$80-\$145	7"-17"
Gasoline-powered	\$55-\$700	15"-24"

# Electric vs. Gasoline Hedge Trimmers

<u>Equipment</u>	<u>Cost Range</u>	<u>Performance Blade Length</u>
Electric corded	\$25-\$180	6"-22"
Electric Cordless	\$55-\$90	6"-22"
Gasoline- powered	\$140-\$500	17"-40"

# Electric vs. Gasoline Typical Lawn Mower

<u>Equipment</u>	<u>Average Cost</u>	<u>Performance Cutting Path</u>
Electric corded	\$179	Up to 19"
Electric Cordless	\$440	Up to 19"
Gasoline-powered	\$250	21"-48"

# Electric Lawn Mower Pros & Cons

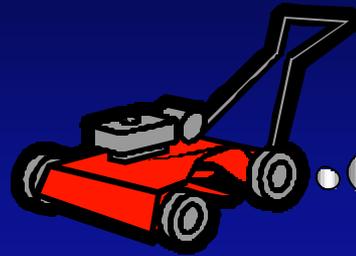
compared to gasoline mowers

ADVANTAGES	DISADVANTAGES
Zero Emissions	Limited Range corded, cordless
Quiet Operation	Reduced Power corded, cordless
No Refueling	Charging Time cordless only
Low Maintenance	Increased Weight cordless only
Good Durability	Expensive cordless only

# Electric Vs. Gasoline Powered Mower

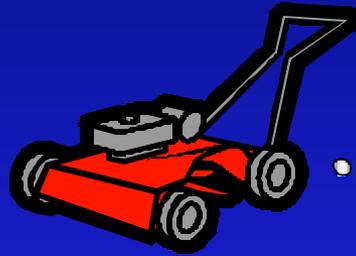
Lifetime Exhaust and Evaporative Emissions  
HC+NOx

Pre-2007



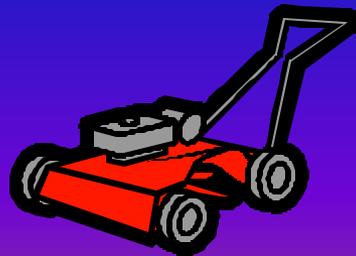
38 lbs

2007+



11 lbs

Electric



Zero emissions

# Potential Electrification Strategies

## Residential Lawn Mowers

- Lower Fleet Average Standard
- Zero Emission Mandate
- Residential Electric Requirement
- Manufacturer Scrap Program
- Residential Weekend Usage Restriction
- Consumer Awareness and Information
- Incentives, Rebates, and Trade-in Programs

# Lower Fleet Average Standard Engine Manufacturers

- Strategy
  - Lower emission standard applicable to each engine manufacturer
  - Compliance by producing some zero emission engines or much cleaner combustion engines

# Lower Fleet Average Standard Engine Manufacturers

- Pro:
  - Ensures lower emissions, and possibly an increase in electric mowers
- Con:
  - Equity: Most manufacturers do not currently make electric motors
  - Some manufacturers may exit CA market
- Emissions benefit: Low (<1 tpd)
- Cost effectiveness: Moderate

# Zero Emission Mandate Equipment Manufacturers

- Strategy
  - Require a specified percent of an equipment manufacturer's production of residential lawn mowers be electric

## Zero Emission Mandate Equipment Manufacturers

- Pro:
  - Assures more zero emission mowers are produced
- Con:
  - Majority of equipment manufacturers don't currently make electric mowers
  - Homeowners could purchase commercial mowers, making compliance by equipment manufacturers difficult
- Emissions benefit: Low (<1 tpd)
- Cost effectiveness: Moderate

# Residential Electric Purchase Requirement

- Strategy
  - SCAQMD suggested 30% of new residential lawn and garden equipment (not just lawn mowers) sold be electric
  - Retailers would be required to sell only electric equipment to homeowners and non-commercial users

# Residential Electric Purchase Requirement

- Pro:
  - Assures electric equipment is sold
- Con:
  - Difficult for retailer to enforce
- Emissions benefit: None. Residential electric lawn and garden equipment use already greater than 30%

# Scrap Program Engine Manufacturer

- Strategy
  - Require engine manufacturer to acquire and scrap used mowers (specified percentage of new sales)
  - To increase electric sales, incentive to acquire old mowers could be voucher good toward purchase of an electric mower
  - Suggested by SCAQMD

# Scrap Program Engine Manufacturer

- Pro:
  - Accelerates turnover to low emission equipment
- Con:
  - Doesn't guarantee electric equipment is purchased unless use of zero emission voucher is mandated
- Emissions benefit: Low (~ 1 tpd)
- Cost effectiveness: Moderate

# Residential Weekend Usage Restriction

- Strategy
  - Restrict use of residential lawn mowers on weekend days (or weekend days with predicted high ozone)
    - Weekend days typically have highest smog levels
    - 96% of residential mowing is on weekend days
  - Benefit from:
    - Encouraging purchase of electric mowers for weekend use
    - Shifting mower use to lower ozone weekdays

# Residential Weekend Usage Restriction

- Pro:
  - Effective in Bay Area on voluntary basis (8% reduction in lawn and garden equipment use)
- Con:
  - Difficult to enforce if mandatory
- Emission benefit: Potentially significant (3 tpd for every 10% that use electric instead of current mowers)
- Cost effectiveness: Moderate to poor (depends on type of electric mower purchased)

# Consumer Awareness and Information

- Strategy
  - Statewide “Spare the Air” program similar to Bay Area
  - District notifies public of smoggy day; asks for reduced use of pollution activities
  - Voluntary

# Consumer Awareness and Information

- Pro:
  - Demonstrated effective in Bay Area (8% reduction in lawn and garden equipment use)
  - May result in other polluting activities reduced
- Con:
  - Significant resources required to publicize
- Emissions benefit: Moderate (<2 tpd)
- Cost effectiveness: Moderate

# Incentives, Rebates, Trade-ins

- Strategy
  - Offer incentives to trade in old mower for a voucher to buy an electric mower

# Incentives, Rebates, Trade-ins

- Pro:
  - Popular; demand greater than available vouchers
  - High visibility; may promote other low polluting activities
- Con:
  - Requires new source of funding
- Emissions benefit: Low (~1 tpd)
- Cost effectiveness: Moderate

# Feasibility of Potential Control Measures

<u>Potential Control Measure</u>	<u>2010 HC+NOx TPD Benefit</u>	<u>Cost-Effectiveness \$ per lb. HC+NOx</u>
<u>Low Feasibility</u>		
Residential Electric Requirement	0	\$0
Residential Usage Restriction	3.2-10.1	\$14 - \$39
<u>Medium Feasibility</u>		
Lower Fleet Average Std	0.2	\$4 - \$16
Zero Emission Mandate	0.2	\$4 - \$16
Manufacturer Scrap Program	1.1	\$9
<u>High Feasibility</u>		
Consumer Awareness	1.7	\$10 - \$18
Incentive Programs	1.1	\$9 - \$18

# Summary

- Electric equipment limited to residential use, which accounts for less than half of the small engine emissions
- Mowers are main residential category with little electrification
- Strategies to increase electric mower use generally offer small emission benefit and are fairly costly compared to other strategies
- Increased consumer awareness and incentive programs appear to be the most feasible
  - Would require significant new resources