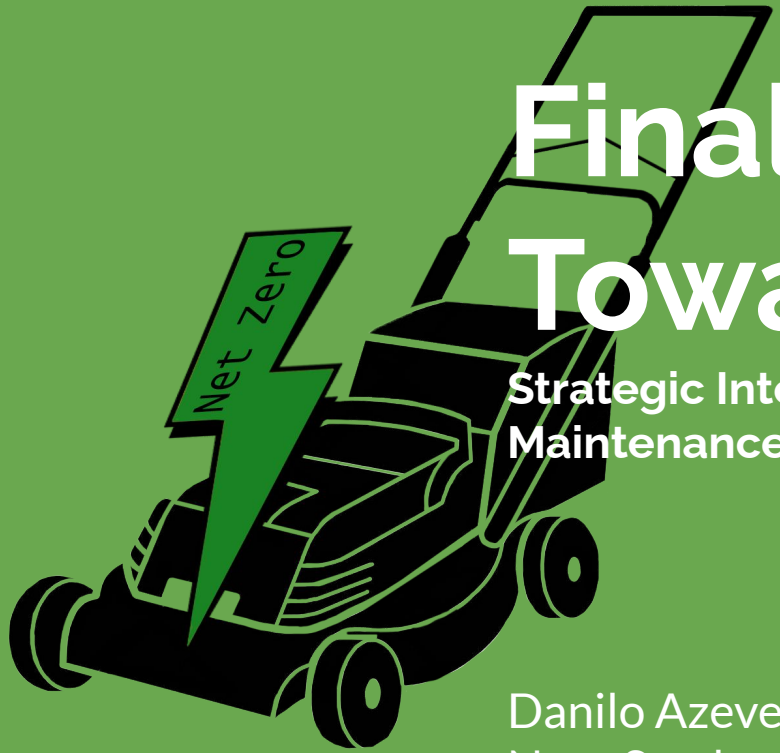
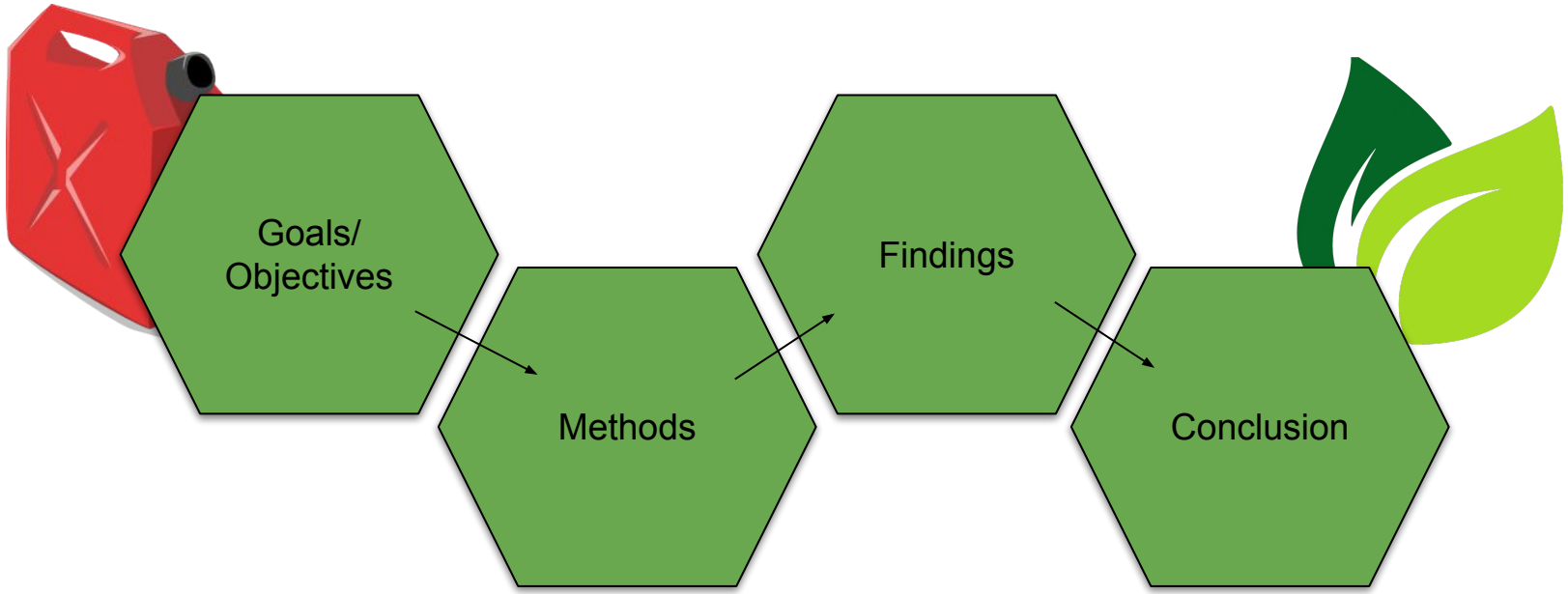


Final Presentation: Toward Net Zero

Strategic Integration of Electric Mowers into Landscape Maintenance Operations

Danilo Azevedo, Tanner Davis, José Diaz, Nirit Rotenberg, Nora Snyder, Donald Vogel, Rosalynd Young

Roadmap

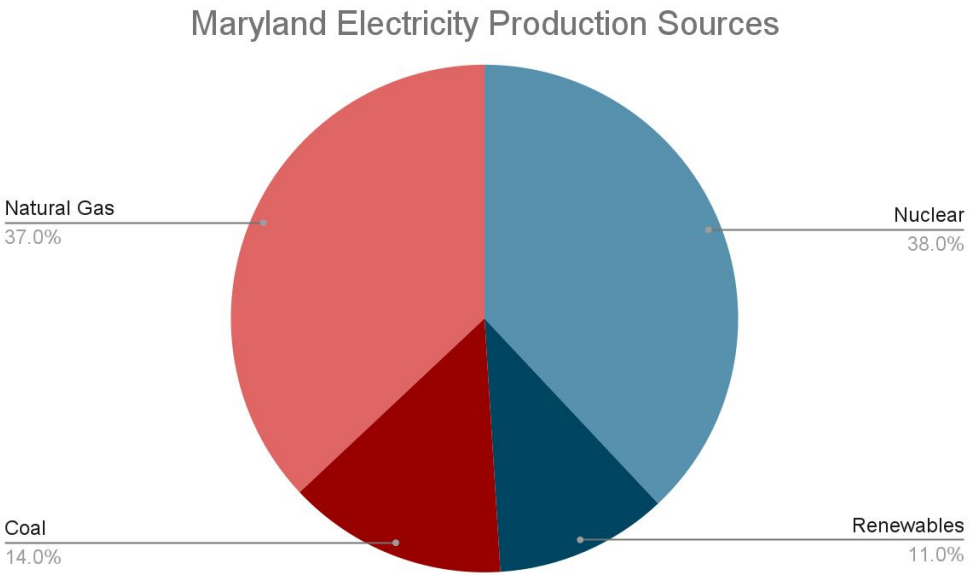


Project Goals

- The Department of Parks and Recreation in Prince George's County will be carbon neutral or net zero emissions by 2040
- Renewable Energy Portfolio
  - May 2019: 50% of the State's energy come from renewable sources by 2030
  - Goal of 100% renewable energy by 2040

Project Goals

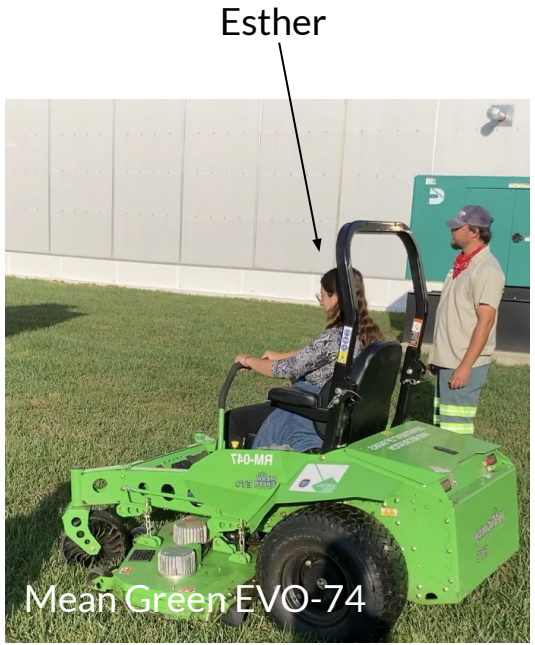
- Energy production in Maryland
  - Nuclear energy makes up 38% (Maryland State Archives)
  - Renewable energy (solar, wind, biomass, and hydropower) makes up 11% (Maryland State Archives)
- With electric equipment
  - No direct emissions
  - Potential for less indirect emissions
  - Energy from biomass is carbon neutral



Objective 1:

Interviewing Workers

- Met with and interviewed workers in the group using the all electric equipment
- Learned about
  - Costs other than the equipment
  - Worker preferences



Objective 1:

Interviewing Workers

- General information about the equipment:
  - Need to use propane mower for thick grass
  - Less maintenance for the electric equipment
  - Charging for riding mowers
    - Every night
    - Could last 2 days without charging
  - Battery life
    - Should last long but would not need to last more than 8 hours
    - Batteries will also get worse overtime

Objective 1:

Small Self-Propelled

	Current Fossil Fuel	Option #1	Option #2
Manufacturer and Model	Toro Timemaster Series 21199	Husqvarna W520i	Snapper 82V Max
Price	$1,099.99	$1,199.99	$699
Pounds of CO2 eq production/ hour operation	8.88	0.41	0.56

Objective 1:

Large Self-Propelled

	Current Fossil Fuel	Option #1	Option #2
Manufacturer and Model	Toro 30288	Meangreen WBX-33HD	
Price	$4721	$10,500	
Pounds of CO2 eq production/ hour operation	33.93	0.71	

Objective 1:

Zero Turn

	Current Fossil Fuel	Option #1	Option #2
Manufacturer and Model	Lazer Z S-Series	Mean Green Evo-74	Pro Turn EV- 997007
Price	$13,599	$38,000	$31,000
Pounds of CO2 eq production/ hour operation	16.26	1.9	1.6

Objective 1:

Gang Reel

	Current Fossil Fuel	Option #1	Option #2
Manufacturer and Model	Toro Reelmaster 3100D	Toro Greensmaster® eTriFlex™ 3370	Jacobsen Eclipse 360 Elite
Price	$53,413.36	$75,652	$59,999
Pounds of CO2 eq production/ hour operation	24.69	1.53	1.53

Objective 2: Life Cycle Analysis

Calculating the CO_2

- Assumptions made:
  - 85% charging efficiency for all the batteries
  - 70% of the battery wattage is used during the runtime
  - Maryland produced 0.841 lb CO_2 eq/kwh in 2018
  - Electricity cost per kwh is $0.1261
  - Total anticipated cost per hour of operation is the runtime times 10

Objective 2: Life Cycle Analysis

Calculating the CO2

$$\text{Electric Power Consumption} = \frac{(\text{battery size} * .85)}{(\text{runtime} * .70)}$$

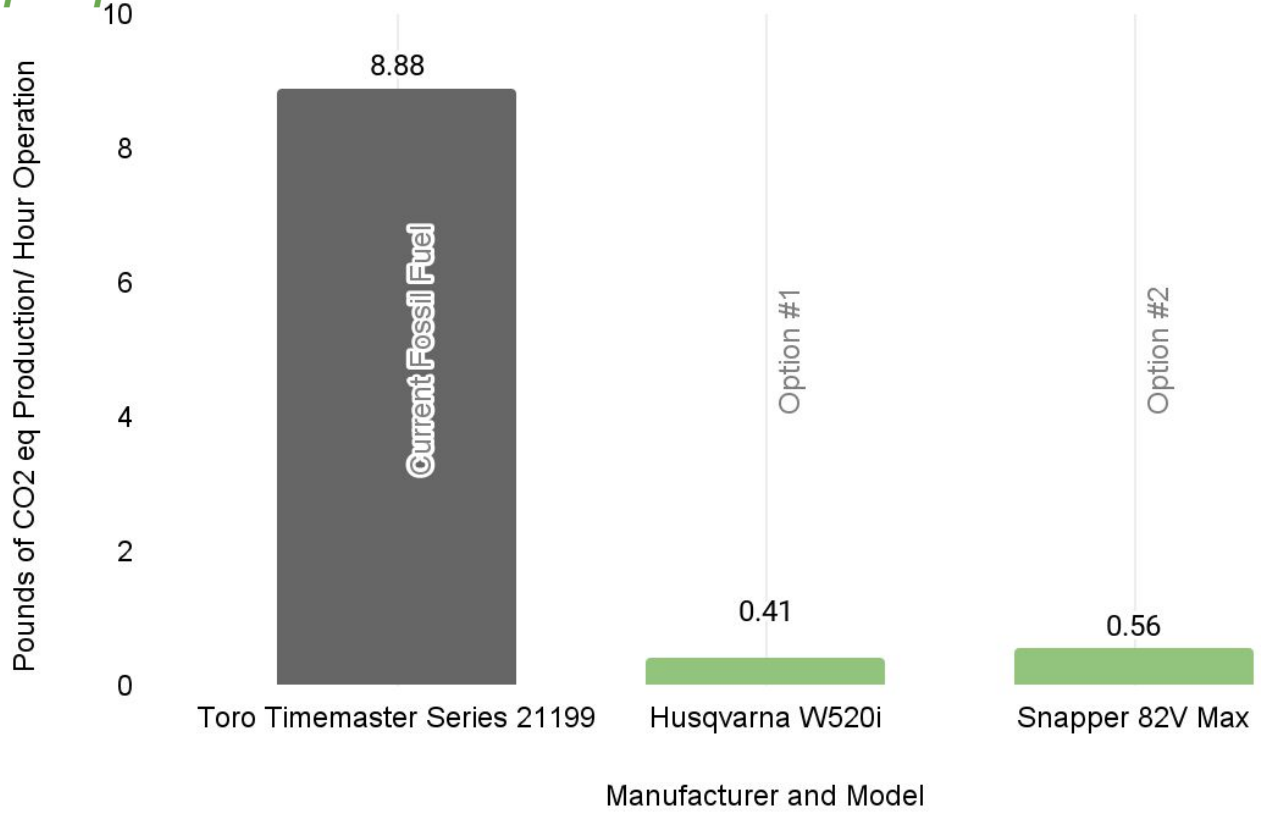
CO_2 eq Production per Hour Operation = (electric power consumption) x (CO_2 per lbs for electricity in MD)

Fuel Cost per Hour Operation = (electric power consumption) x (cost of 1 kwh of electricity in MD)

$$\text{Total Anticipated Cost per Hour of Operation} = \frac{(\text{price of equipment})}{(\text{hours of operation})*(10)} \text{ x fuel cost per hour operation}$$

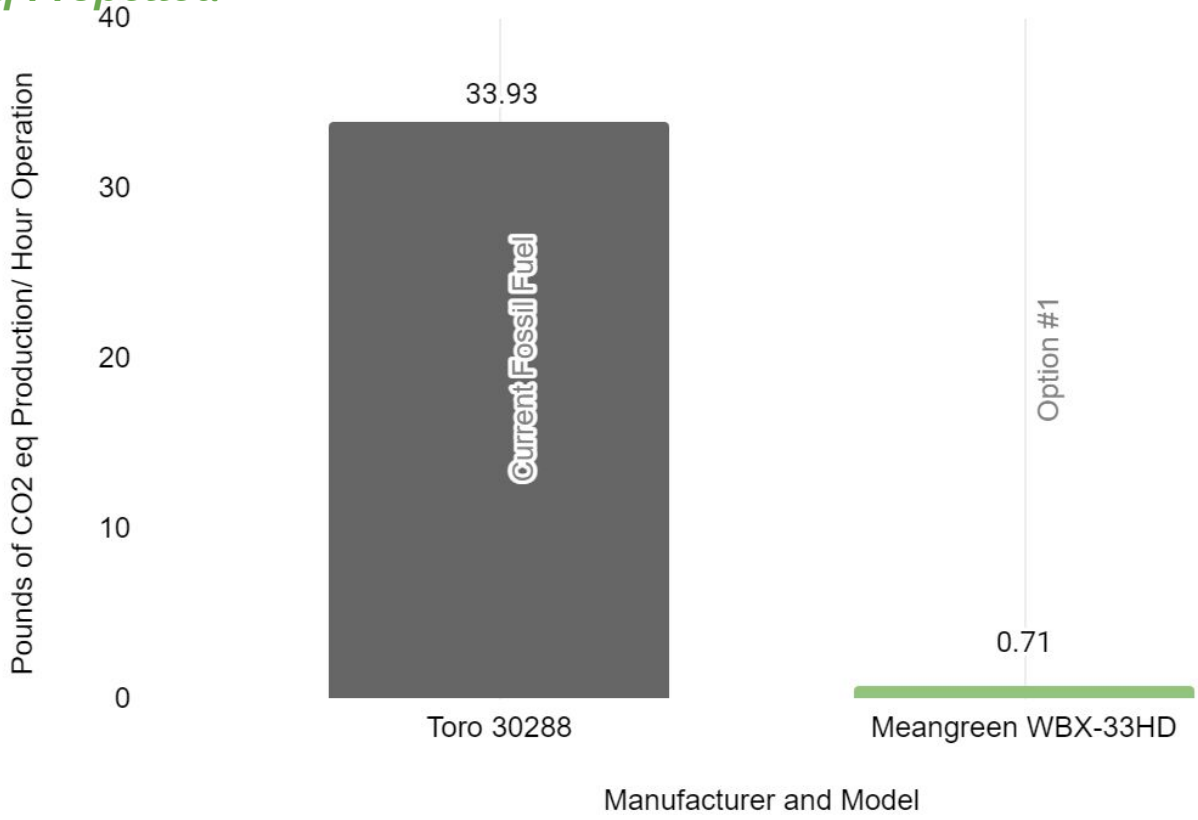
Objective 2: CO_2 Results

Small Self Propelled



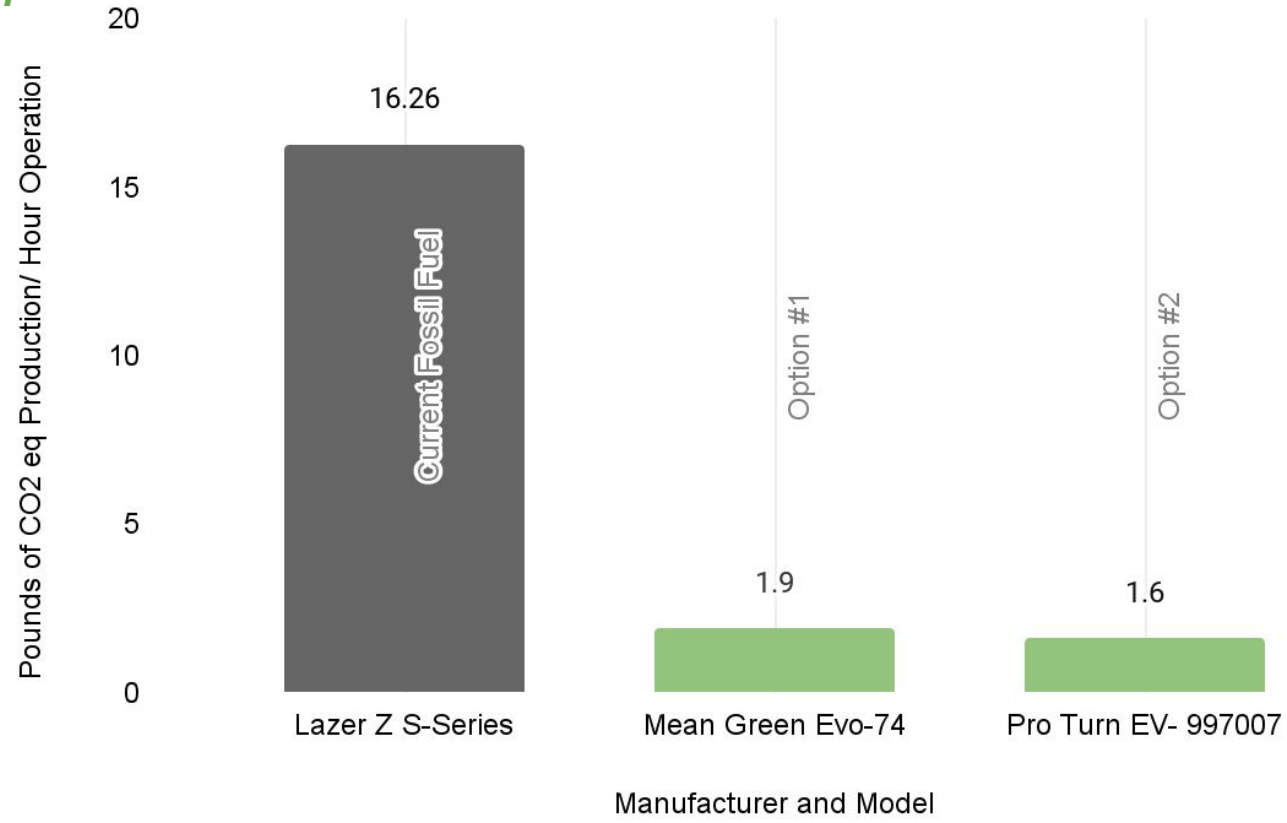
Objective 2: CO_2 Results

Large Self Propelled



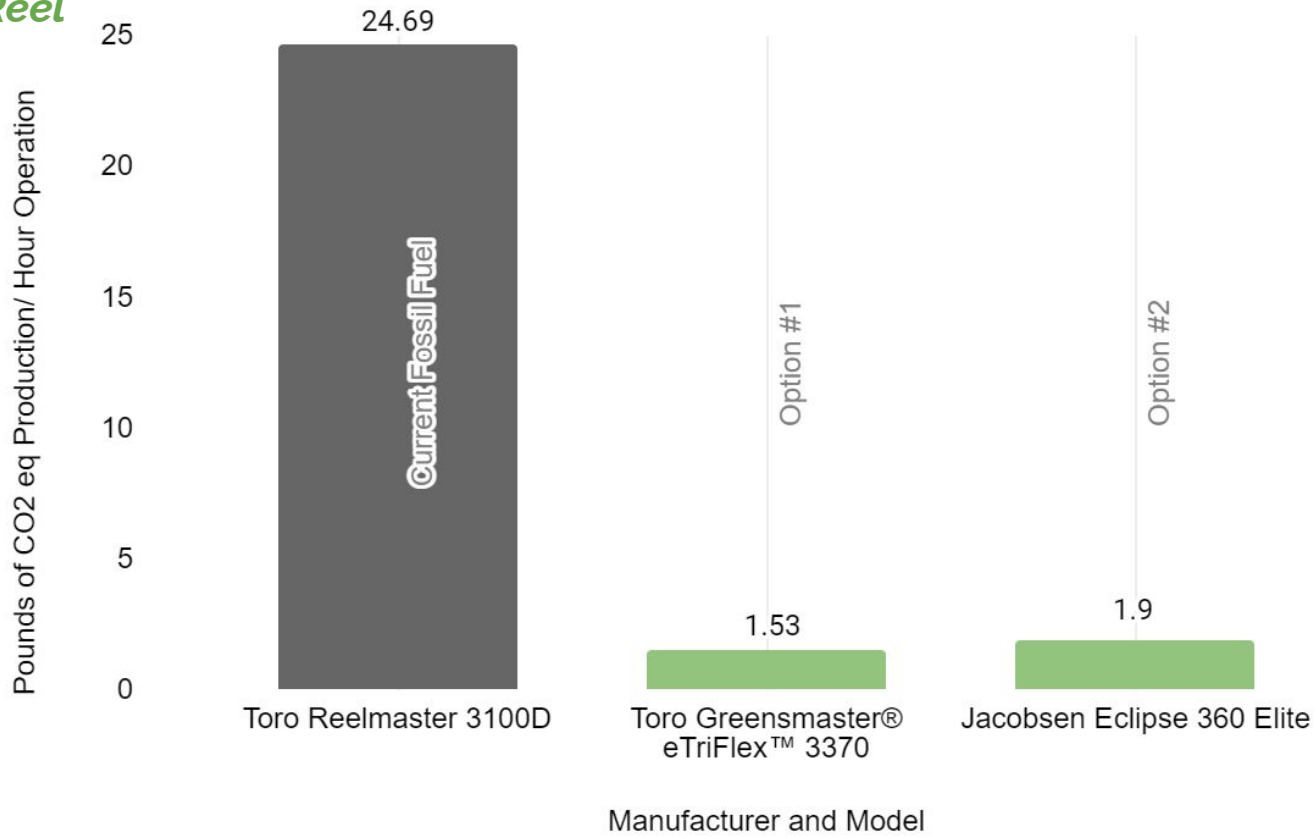
Objective 2: CO_2 Results

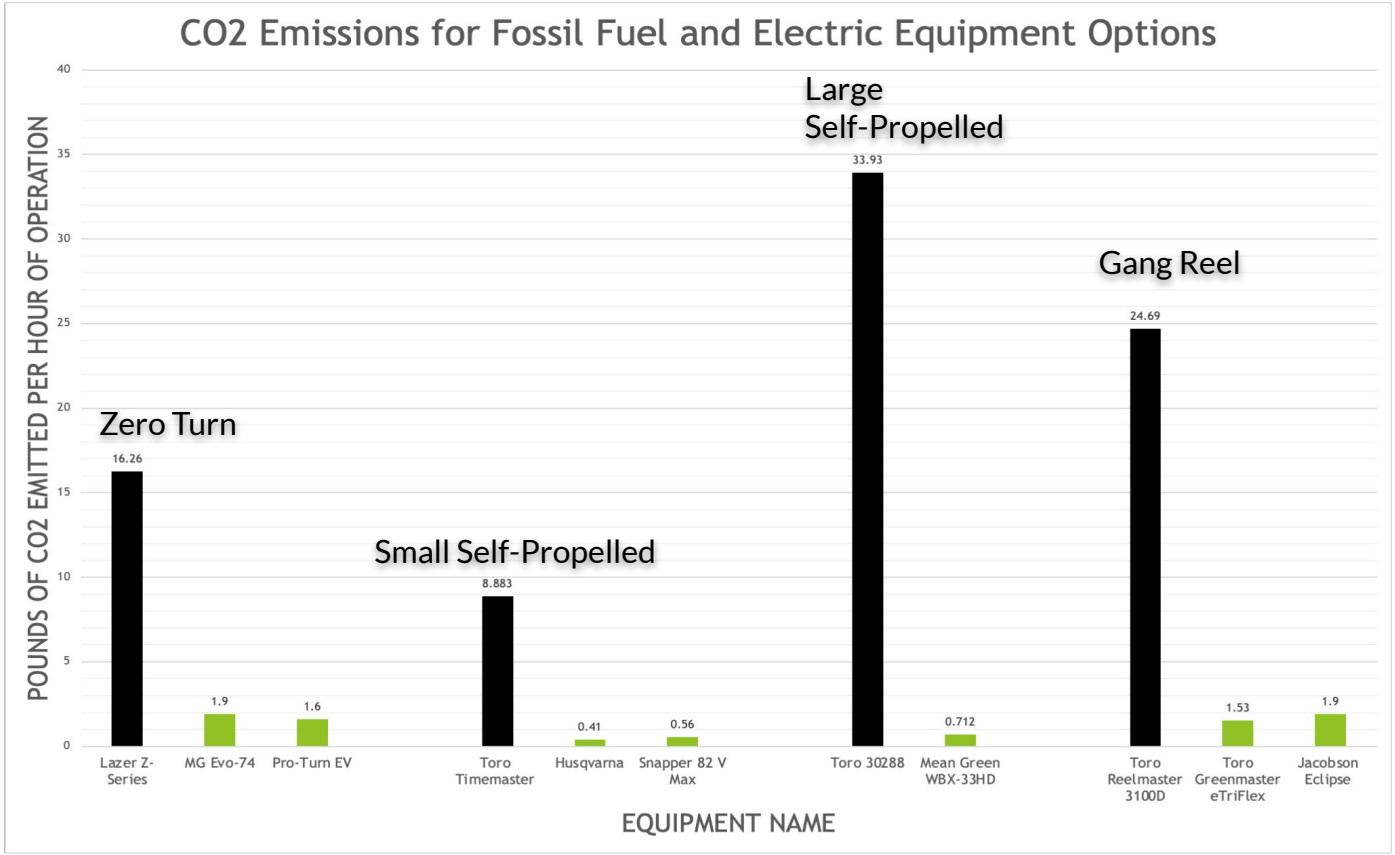
Zero Turn



Objective 2: CO2 Results

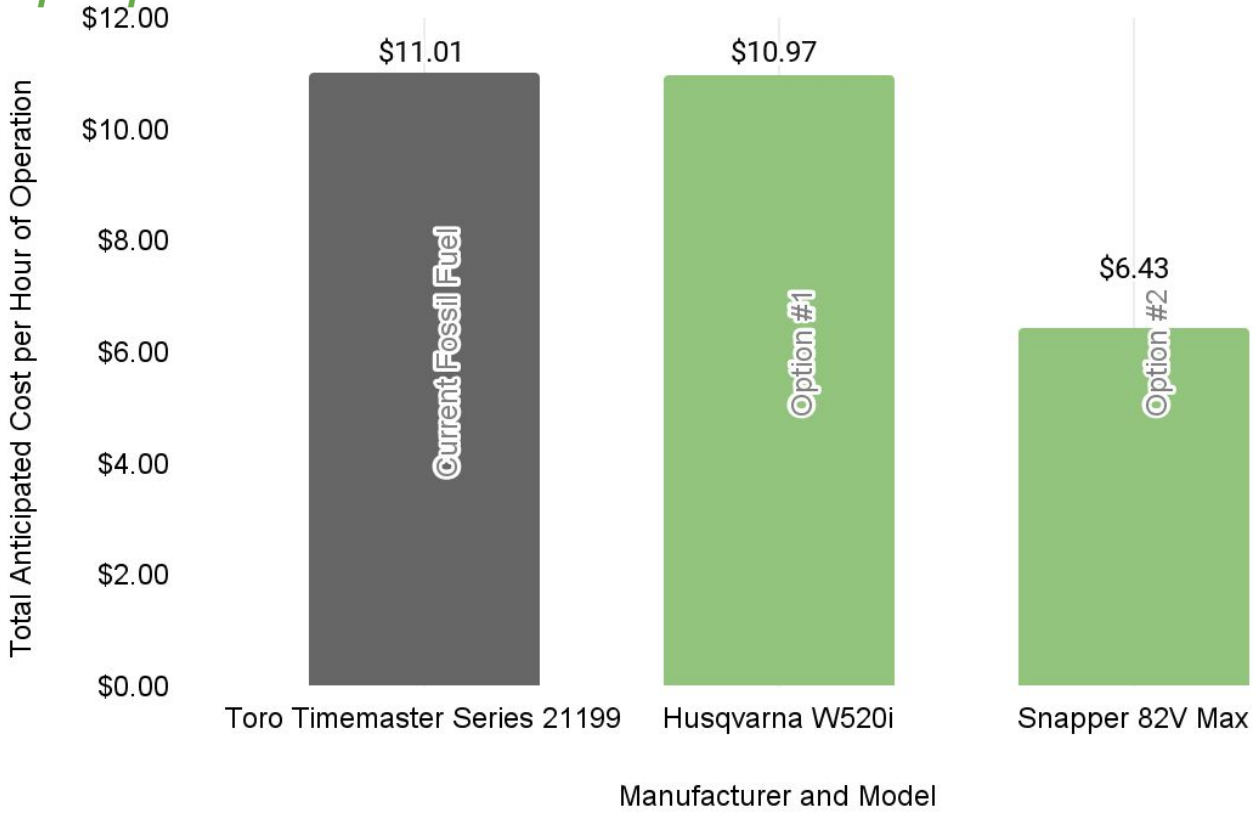
Gang Reel




CO2 Emissions for Fossil Fuel and Electric Equipment Options
POUNDS OF CO2 EMITTED PER HOUR OF OPERATION
EQUIPMENT NAME
Zero Turn
Small Self-Propelled
Large Self-Propelled
Gang Reel
16.26
1.9
1.6
8.883
0.41
0.56
33.93
0.712
24.69
1.53
1.9
Lazer Z-Series
MG Evo-74
Pro-Turn EV
Toro Timemaster
Husqvarna
Snapper 82 V Max
Toro 30288
Mean Green WBX-33HD
Toro Reelmaster 3100D
Toro Greenmaster eTriFlex
Jacobson Eclipse

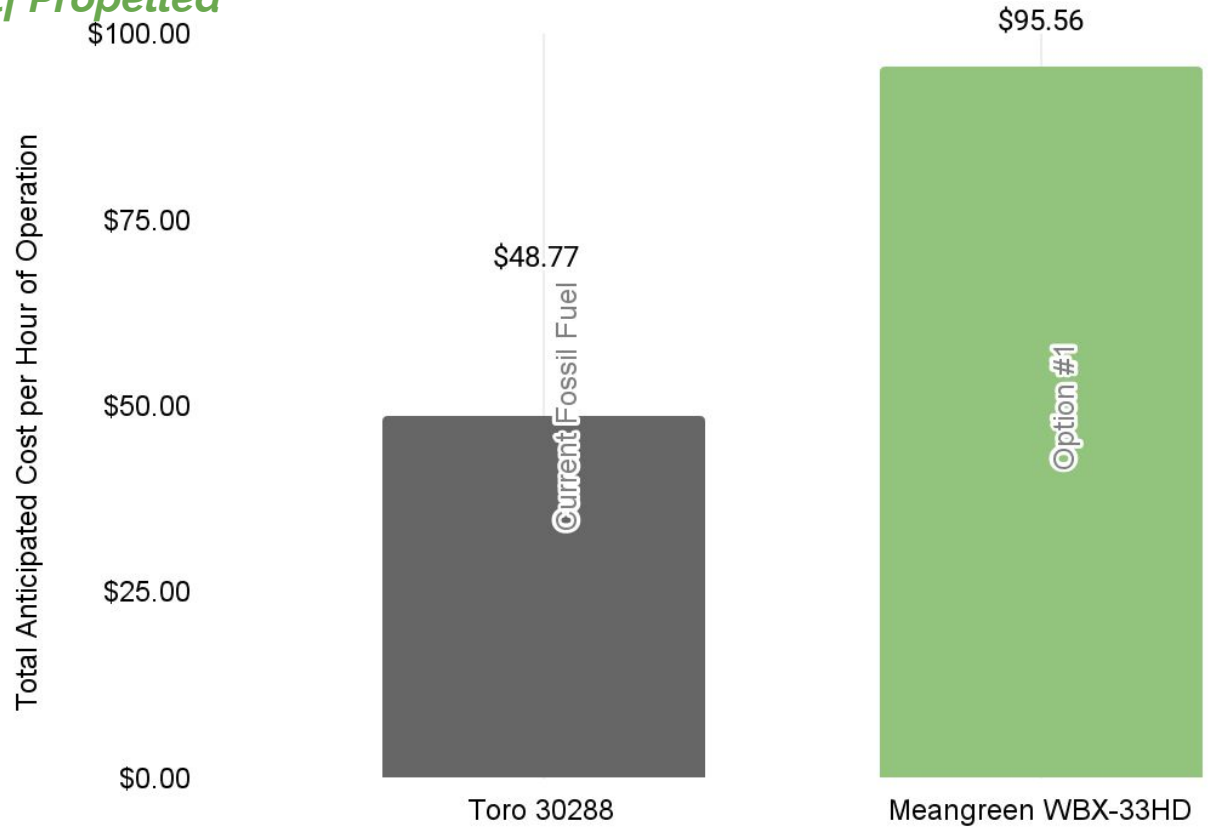
Objective 3: Cost Results

Small Self Propelled



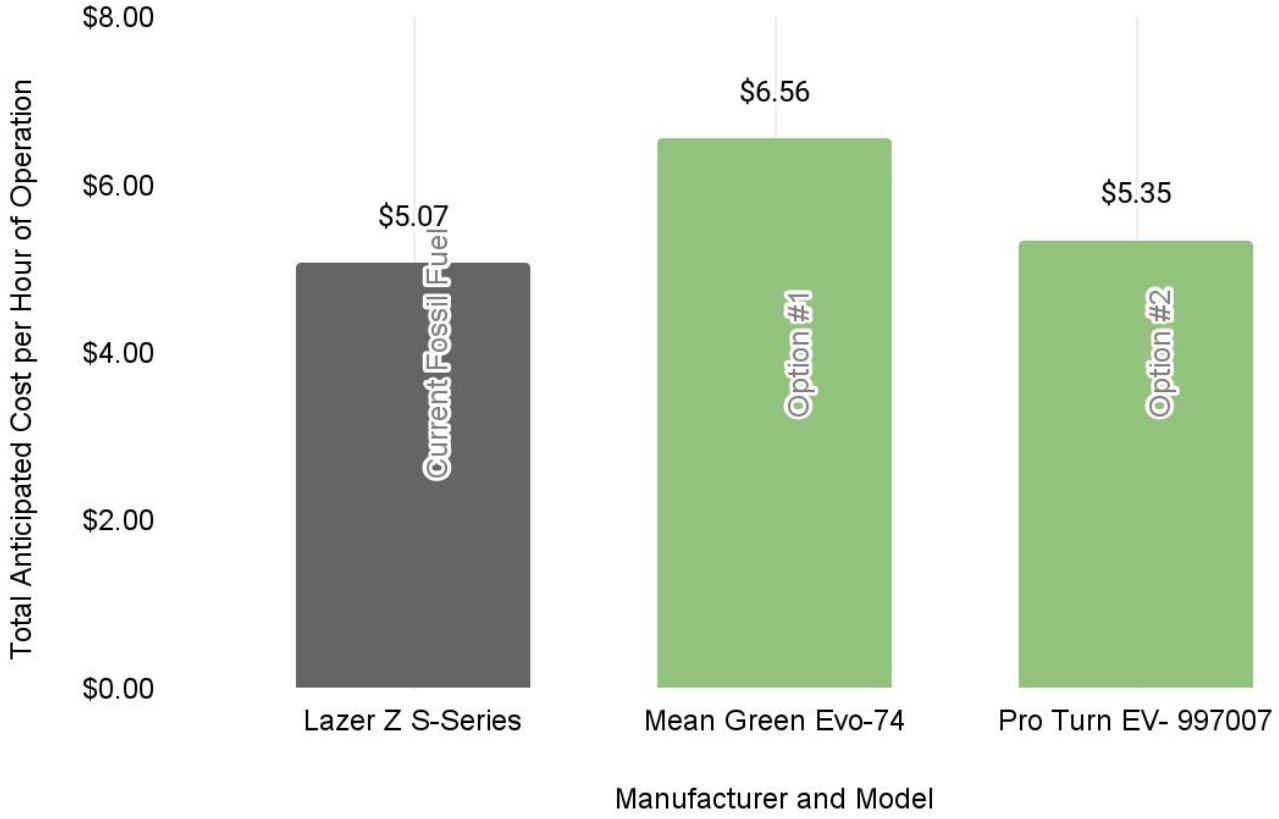
Objective 3: Cost Results

Large Self Propelled



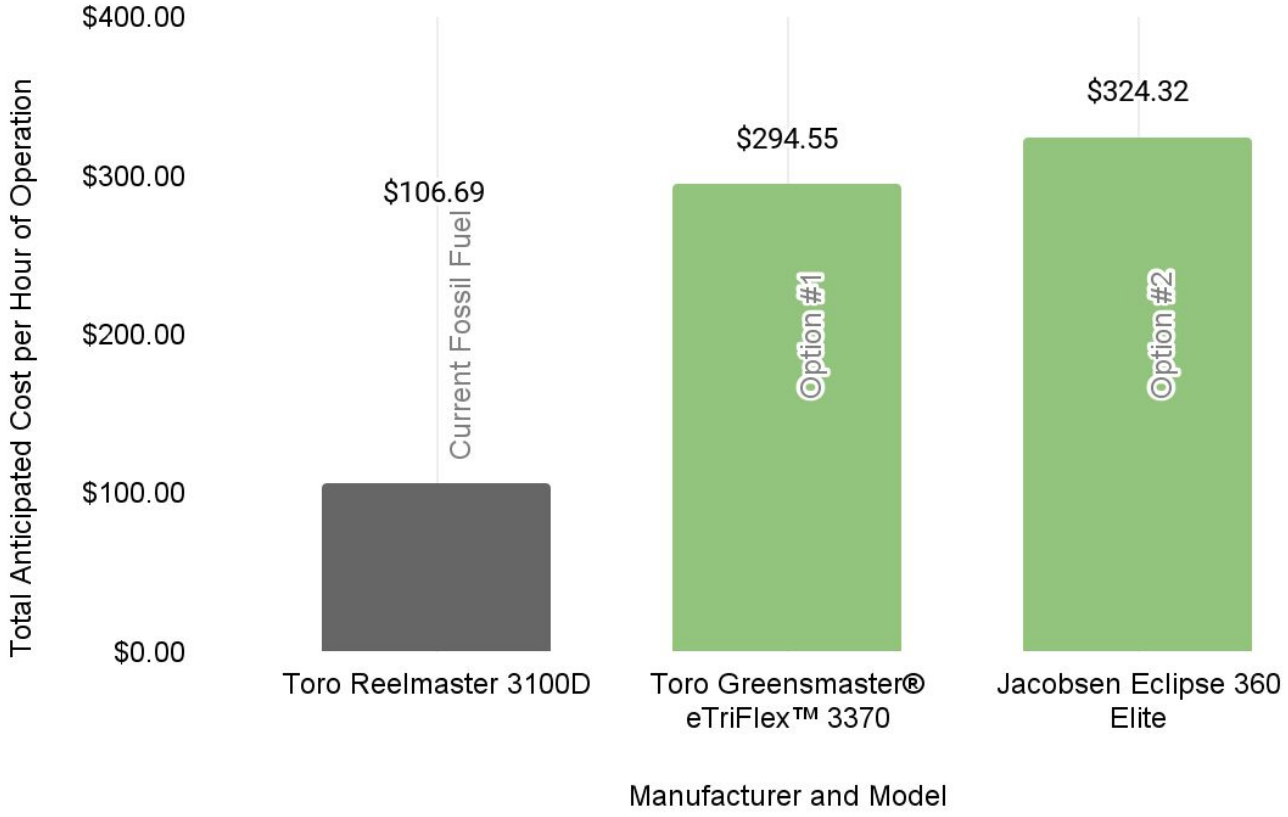
Objective 3: Cost Results

Zero Turn



Objective 3: Cost Results

Gang Reel



Objective 3: Cost Results

Return on Investment

- Assumptions made:
  - Buy the equipment at the price given
  - Electricity and fossil fuel price stays the same
  - These are the only variables that are impacting the breaking even point
- Results:
  - Small Self Propelled: 105.04 hours
  - Large Self Propelled: 1,206.47 hours
  - Zero Turn: 9,606.70 hours
  - Gang Reel: 5,883.33 hours

Objective 4: Purchasing Plan

Recommendations

Husqvarna W520

Meangreen WBX-33HD

Objective 4: Purchasing Plan

Recommendations

Mean Green Evo-74

Toro Greensmaster®
eTriFlex™ 3370

Questions?

Sources

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