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Quantification of the environmental and economic benefits of lawn mowers electrification on the U.S. residential market

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MOTIVATIONS

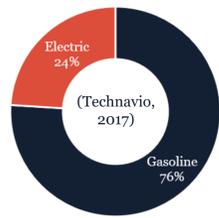
Energy transition:

- A pathway toward transformation of the global energy sector from fossil-based to zero-carbon by the second half of this century. At its heart is the need to reduce energy-related CO₂ emissions to mitigate climate change.
- The benefits of switching diesel-powered machines for fossil-free, electric counterparts are numerous: green house gases (GHG) emissions reduction, lower noise level, energy efficiency, ease of maintenance.

Lawn mower U.S. industry/market:

In the agricultural and gardening sector, compared to the automotive vehicles, there is a lack of in-depth investigation on the potential environmental benefits and economic repercussions of electrifying the mower market.

Around 55 million pushing mowers + 25 millions riding mowers are used each year in the U.S. (Statista, 2018)



Gasoline-powered lawn and garden equipment are important contributors of GHG (30 million tons of pollutants) (EPA, 2015)



METHODOLOGY

Life cycle analysis (LCA)

Most recognized approach to evaluate the environmental impacts of a product, process or activity throughout its life cycle (ISO 14040-44, 2006).

Life cycle costing (LCC)

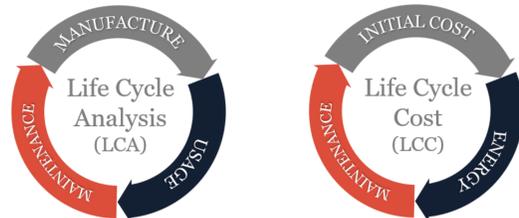
Equivalent of LCA for the economic assessment. Allows trade-off analysis between products: cost of impact reduction.

Life cycle impact assessment methods (LCIA)

Up-to-date values from SimaPro 8.5, ReCiPE method, GREET model, market data (lawn mowers retailers).

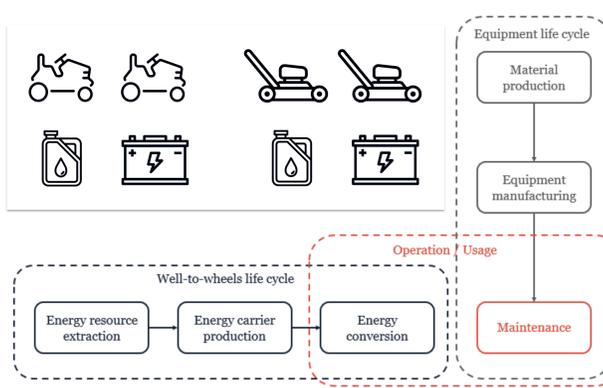
In-scope: Manufacturing, usage and maintenance phases taken into account with a high-level of details, plus a distinction between PbA and Li-ion batteries.

Out of scope: Assembly, transport for maintenance, end-of-life.



RESULTS

Comparative LCA/LCC model



Functional unit (FU for the pushing mowers)

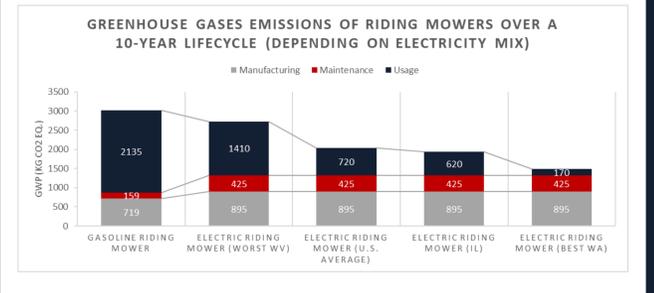
Mowing a 1000m² surface area (estimated average residential grass surface area), 1 hour per week (performance), 26 times per year (mowing season), during 10 years (lifespan) with a generic 2.5 hp pushing lawn mower in the U.S.

Quantitative assessment (see charts below)

- 1.0 (-0.3) metric ton of CO₂ emissions per riding (pushing) mower switch from gasoline to electricity.
- Total life cycle cost is slightly higher for electric mowers (lower operating costs) but their initial extra cost, compared to gasoline mowers is non-negligible, which could be an hindrance to increase their market share.

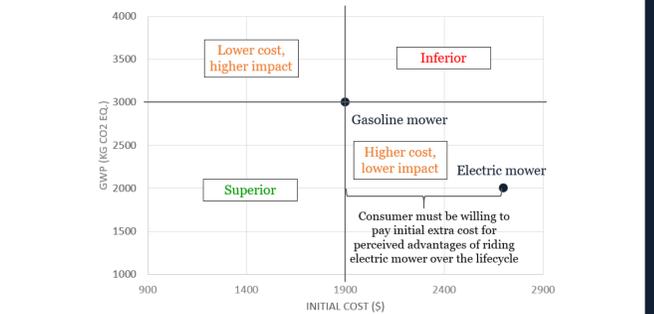
DISCUSSION

- By comparison, a typical passenger U.S. vehicle emits about 4.6 metric tons of CO₂ per year (EPA, 2019).
- Switching from gasoline-powered lawn mowers to electric-powered ones can thus lead to significant environmental impact savings in terms of CO₂ emissions (see results) nationwide or at U.S. State level.
- Environmental savings are more or less important according to the electricity mix used in each State (see chart below).



PERSPECTIVES

A relevant question that will be addressed in future work is then, for example, how to increase the market share of electric lawn mowers by at least 10% by 2022 for the State of Illinois (subsidy, carbon tax, etc.)?



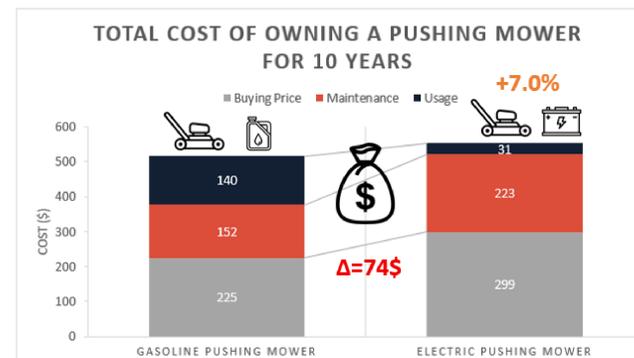
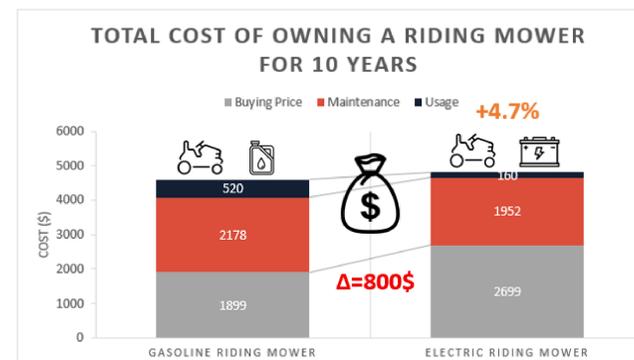
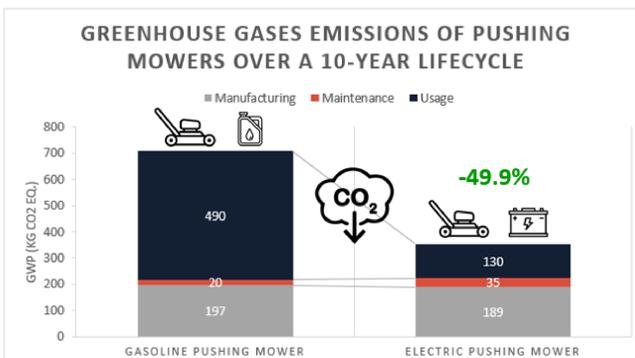
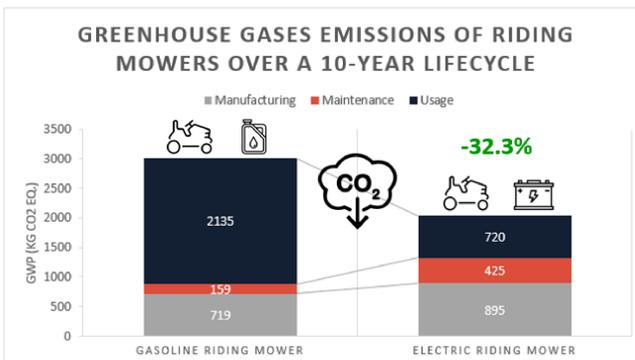
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Three complementary research questions (RQ):

RQ1 (trade-offs): Are electric-powered lawn mowers a better alternative to gasoline-powered ones from economic and environmental perspectives?

RQ2: If so, what are the environmental savings if the electric mowers market share increased by a given percentage?

RQ3: What is/are and how to calculate the appropriate financial incentive(s) to support the green purchase of electric mowers?



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