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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

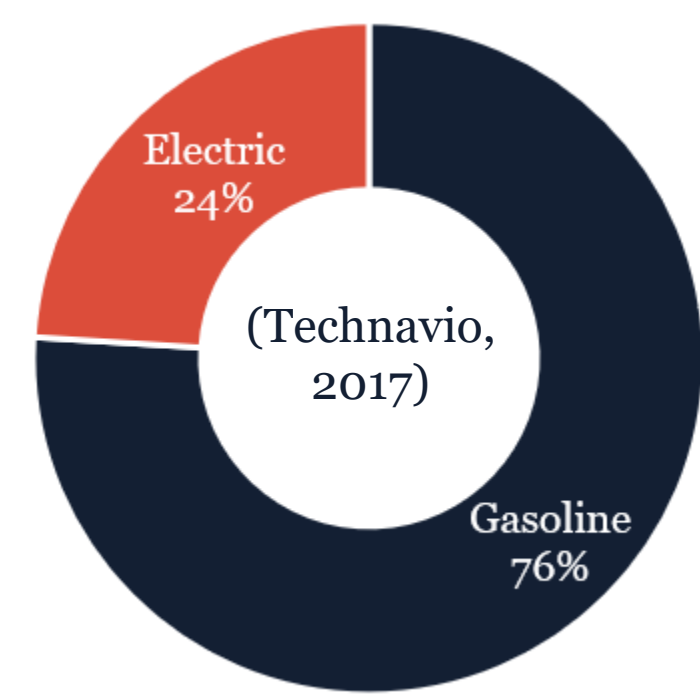
### Energy transition:

- 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 CO<sub>2</sub> 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.

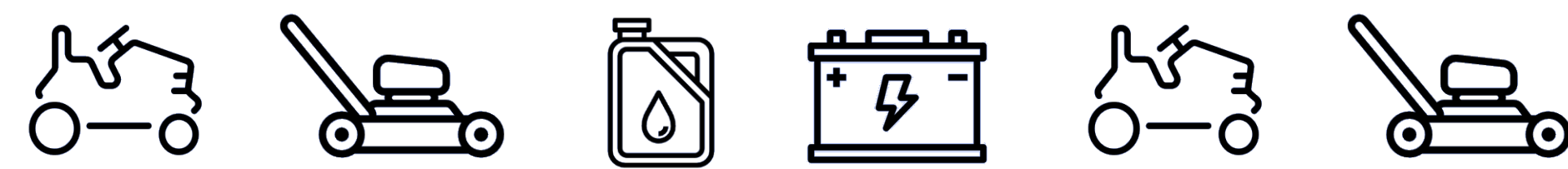
### Lawn mower U.S. industry/market:

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)

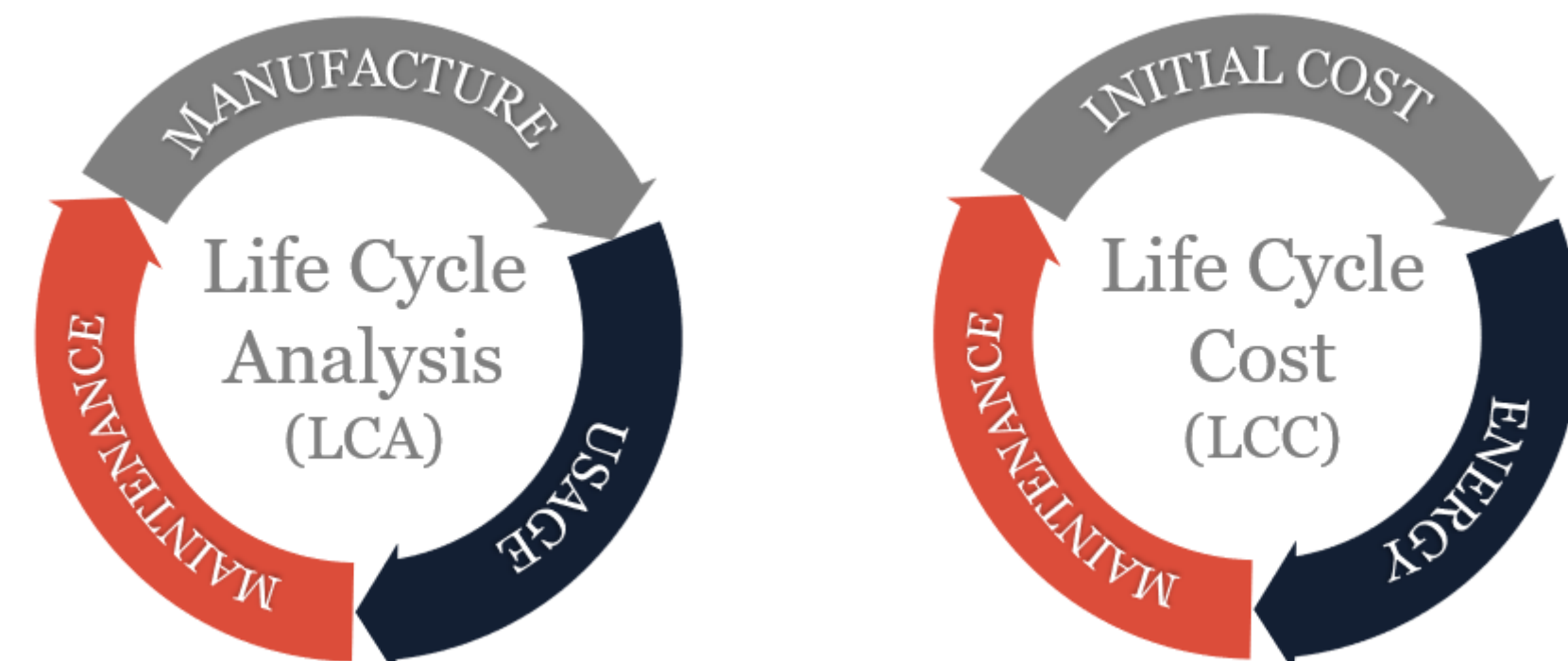
Equivalent of LCA for the economic assessment. Allows trade-off analysis between products: cost of impact reduction.

### Life cycle impact assessment methods (LCIA)

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

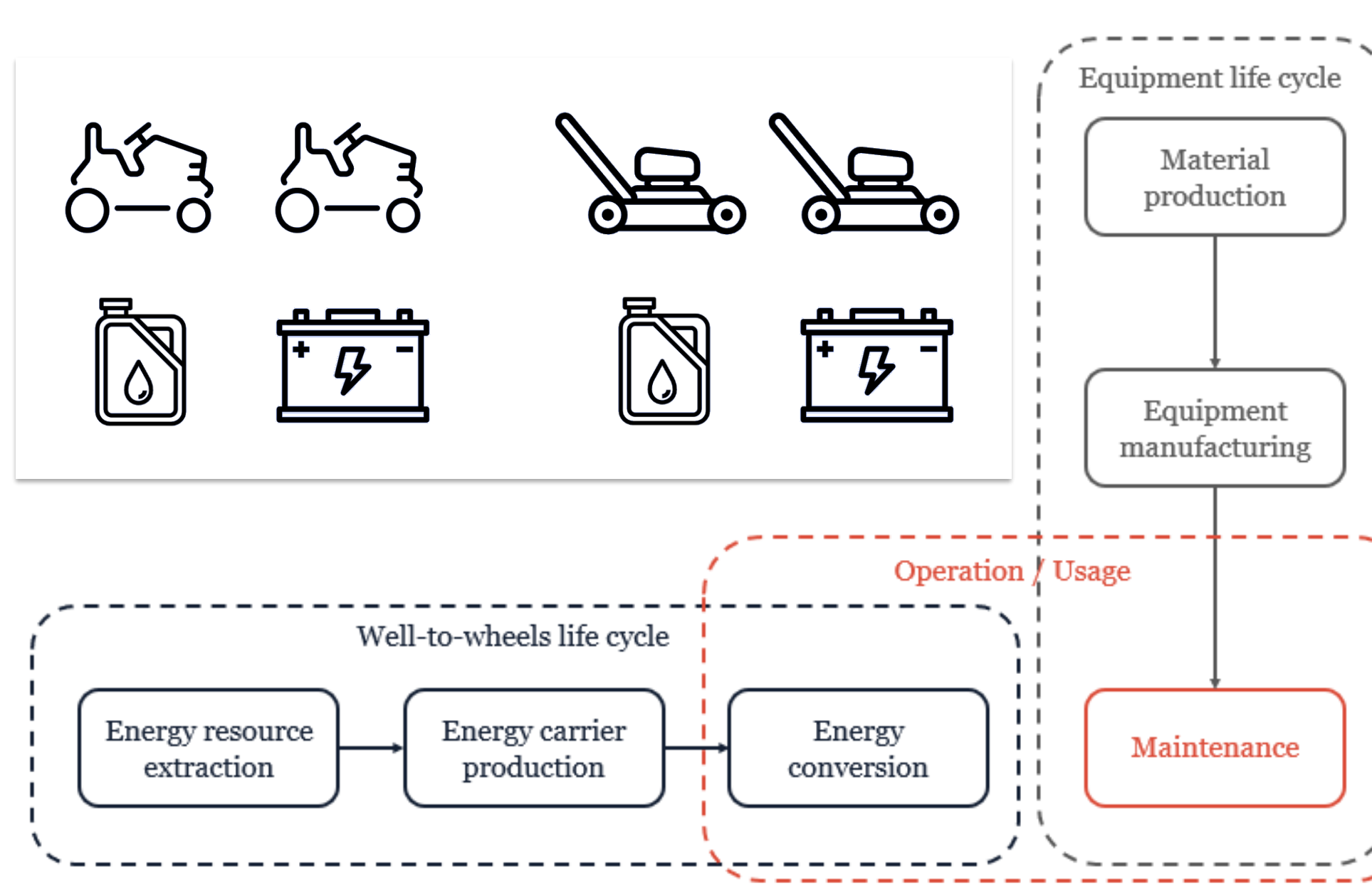
**In-scope:** Manufacturing, usage and maintenance phases taken into account with a high-level of details, plus a distinction between PbA and Li-ion batteries.

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



## RESULTS

### Comparative LCA/LCC model



### Functional unit (FU for the pushing mowers)

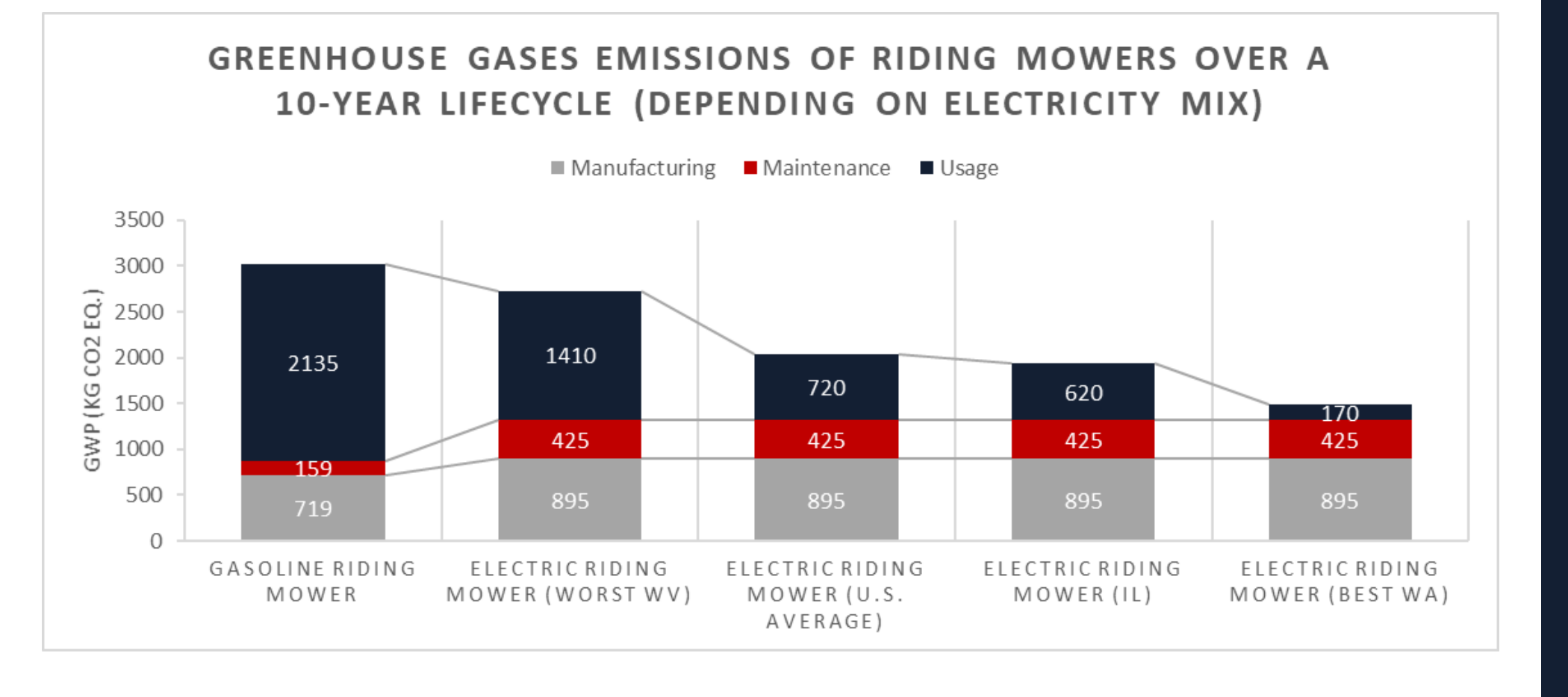
Mowing a 1000m<sup>2</sup> surface area (estimated average residential grass surface area), 1 hour per week (performance), 26 times per year (mowing season), during 10 years (lifespan) with a generic 2.5 hp pushing lawn mower in the U.S.

### Quantitative assessment (see charts below)

- 1.0 (-0.3) metric ton of CO<sub>2</sub> 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.

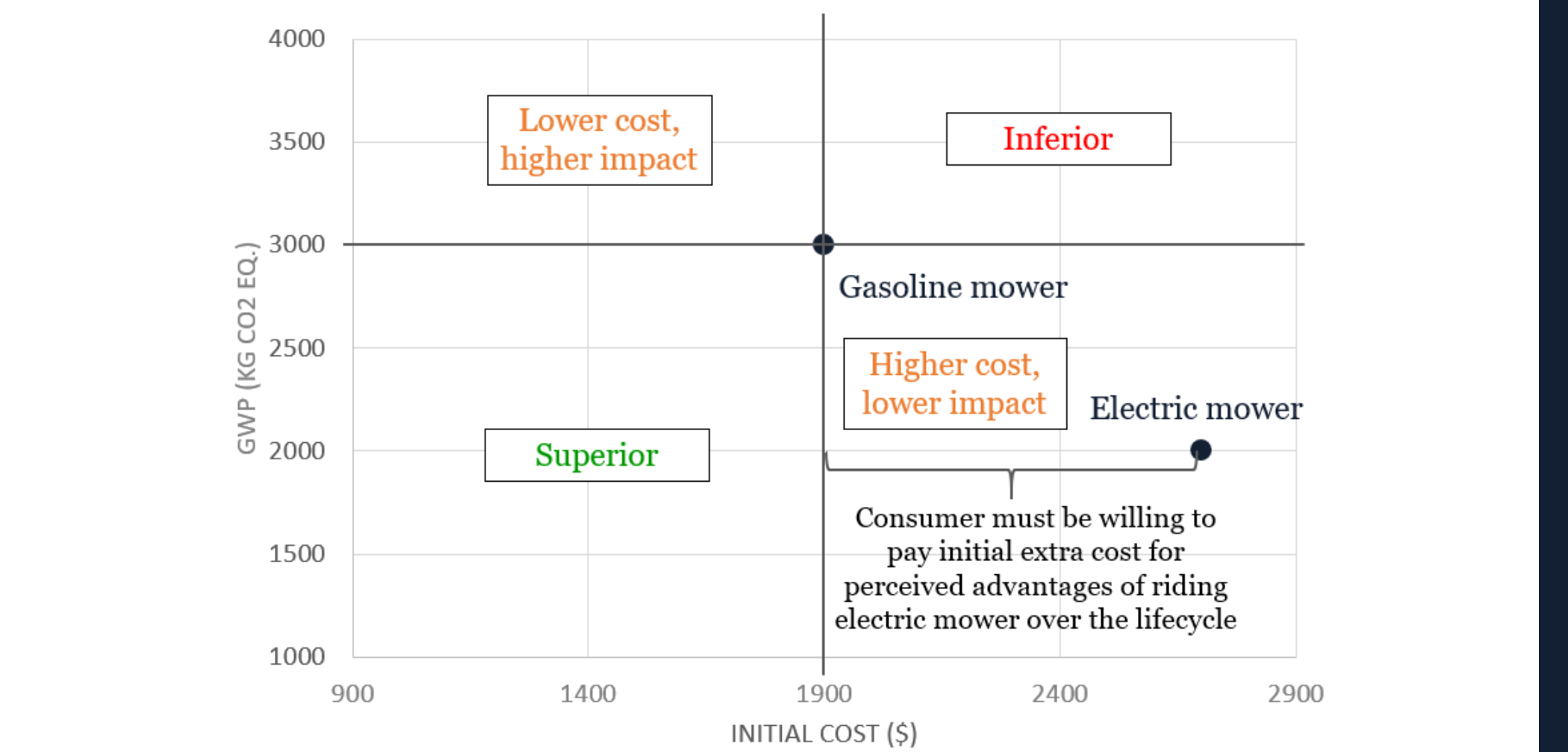
## DISCUSSION

- By comparison, a typical passenger U.S. vehicle emits about 4.6 metric tons of CO<sub>2</sub> 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 CO<sub>2</sub> 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.)?



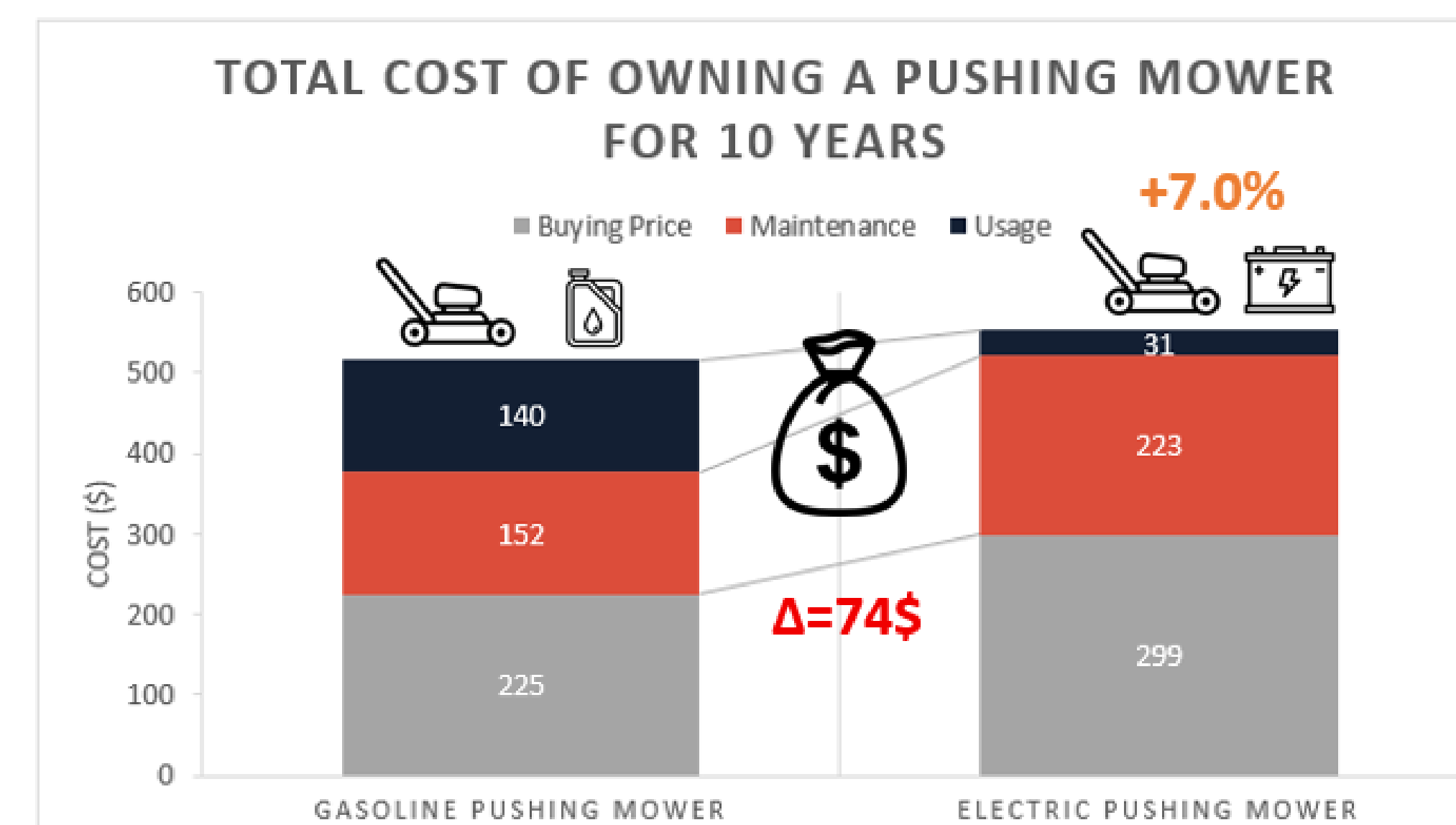
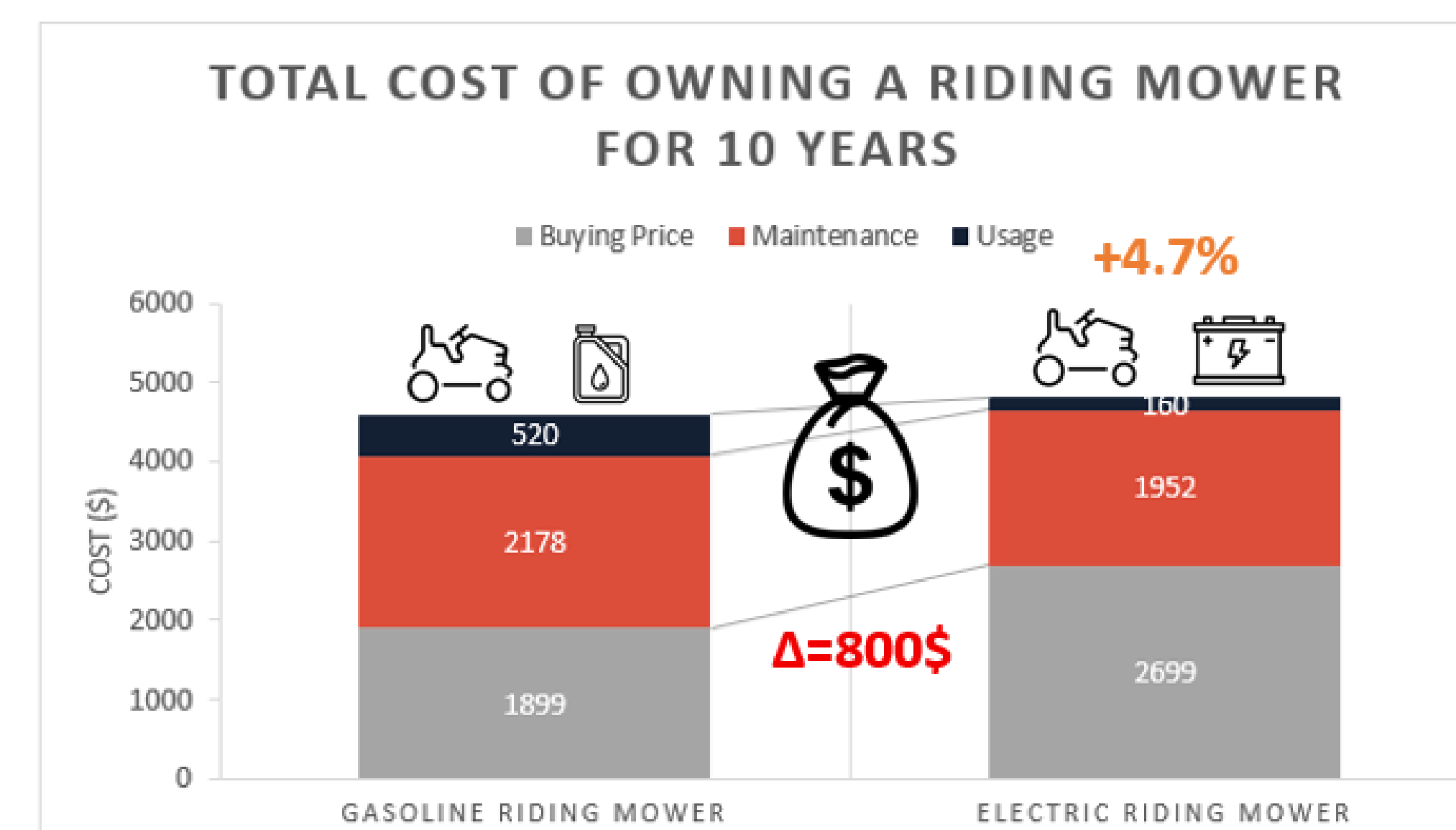
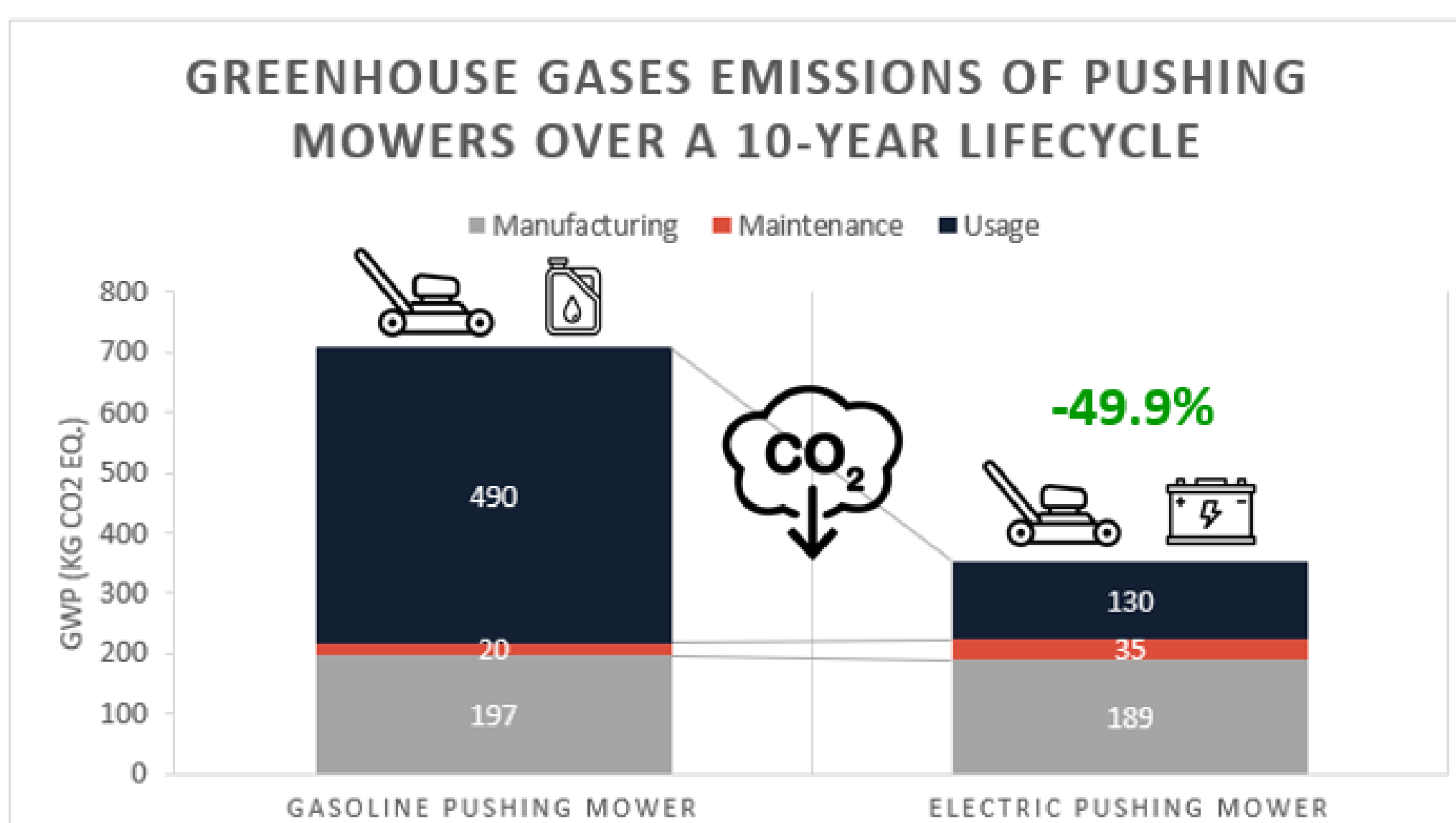
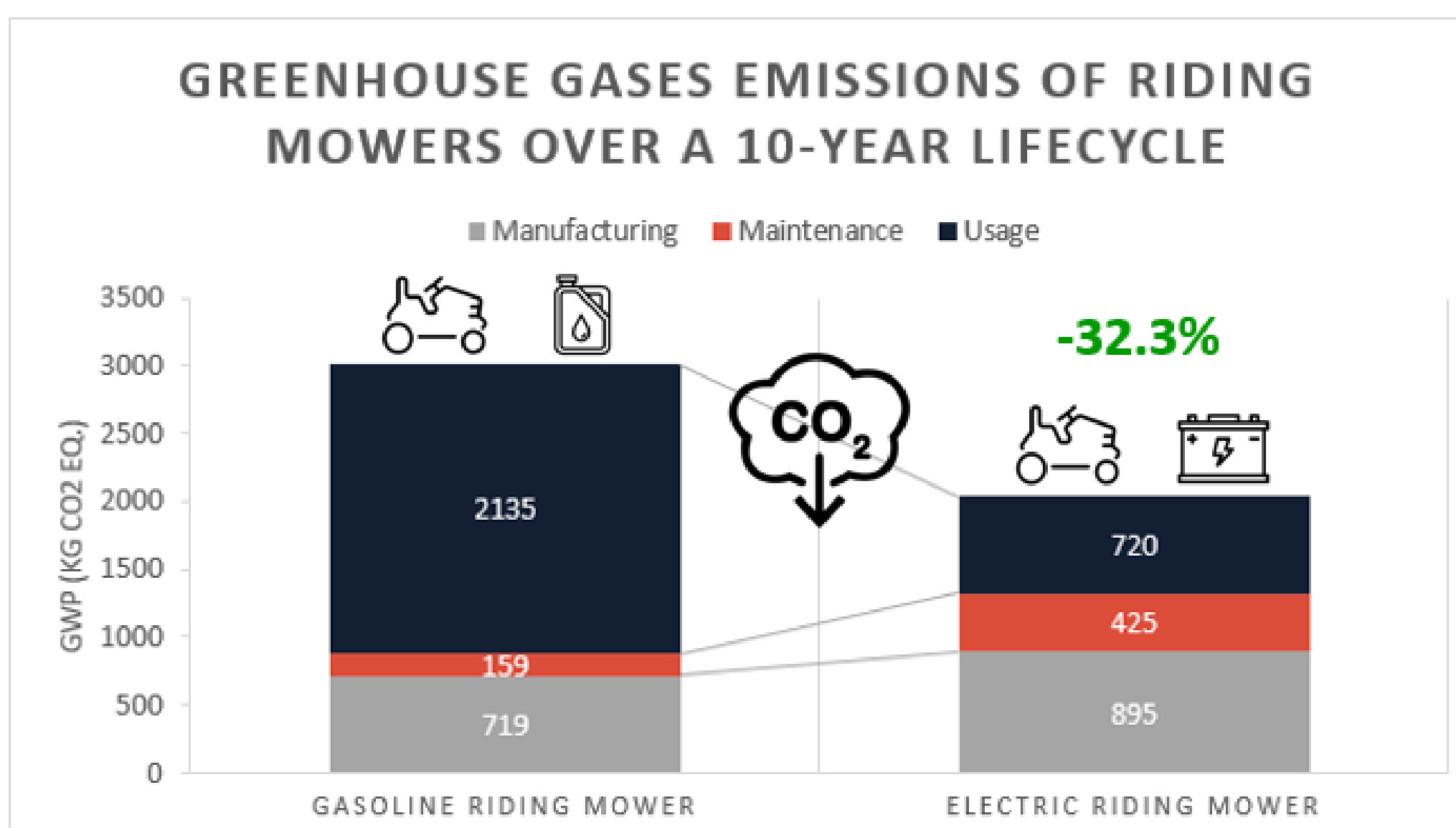
## AIM

### 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?



## REFERENCES

- EPA-Environmental Protection Agency. 2015. US National Emissions from Lawn and Garden Equipment. International Emissions Inventory Conference, April 2015, San Diego, USA.
- ISO-International Organization for Standardization. 2006. ISO 14040: 2006 Environmental management - Life cycle assessment - Principles and framework. In: ISO 14000 International Standards Compendium. Genève, Switzerland.
- Saidani, M., Kim, H. 2021. Quantification of the environmental and economic benefits of the electrification of lawn mowers on the US residential market. Int J Life Cycle Assess, 26(6), 1267-1284. <https://doi.org/10.1007/s11367-021-01917-x>.
- Technavio. 2017. Electric Lawn Mowers Market to Register the Highest Growth Through 2021. Report.