Economy-Wide Rebound Effect

ENGR 333 B, Professor Matthew K Heun. Calvin University, Grand Rapids, Michigan

Calvin UNIVERSITY 1876

Objectives

The Engineering 333 class at Calvin University has been conducting research with the goal of determining the economy wide rebound effect of adopting new energy efficient technologies.

Each class broke into teams, with each team investigating the rebound effect of two different devices. To do this, each team needed to determine:

- Device level rebound
- Embodied energy rebound
- Respending rebound

These values combine to find economy wide rebound values for each device. Device rebound effects could then be compared on a ternary graph

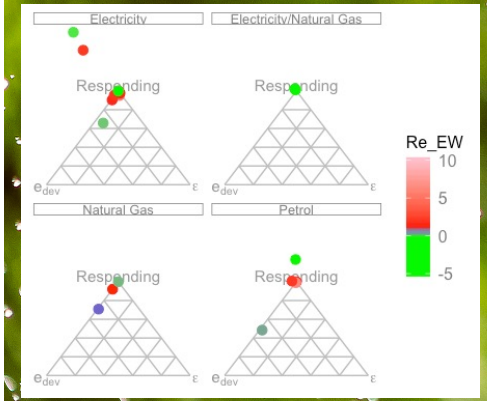

Figure 3: *Respending, Device level rebound, and Embodied energy as a percent of Economy Wide (EW) rebound compared over fuel type.*

Acknowledgements

We would like to thank Professor Heun of Calvin University and the Thermal Systems Design class as well as Professor Brockway of Leeds University.

Methods

The data produced from this study was found in a variety of ways. Each team involved in the project found studies pertaining to their devices that contained data such as direct energy consumption, device level rebound, and lifetime costs, each used to find economy wide rebound. When studies did not provide pertinate numbers, equations and other estimating tools were used to find these values. Once all the data was collected, it was entered into the following equation:

$$Re_{EW} = Re_{dev} + \varepsilon + (1 - Re_{dev} - \gamma)kIp_e$$

Where:

- k is a constant based on the marginal propensity to consume, or the percentage a society will spend if given "free" money.
- I is the energy intensity of the economy which relates GDP to energy.
- p_e is the price of energy for the given device
- γ is the cost to implement
- ε is embodied energy
- Re_{dev} is device level rebound

The equation contains each of the three parameters found by each team:

1. Device level rebound (Re_{dev})
2. Embodied energy (ε)
3. Respending ($(1 - Re_{dev} - \gamma)kIp_e$)

Dividing each of these terms by the economy wide rebound gives the percent each term contributes to the economy wide rebound, as shown in Figure 1.

Results

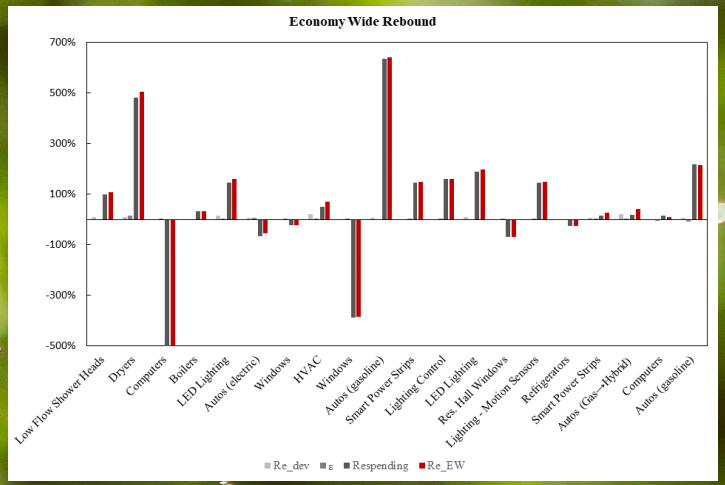

Figure 2: *Economy wide rebound by device. Note that the Economy Wide Rebound for Computers reaches -3000%*

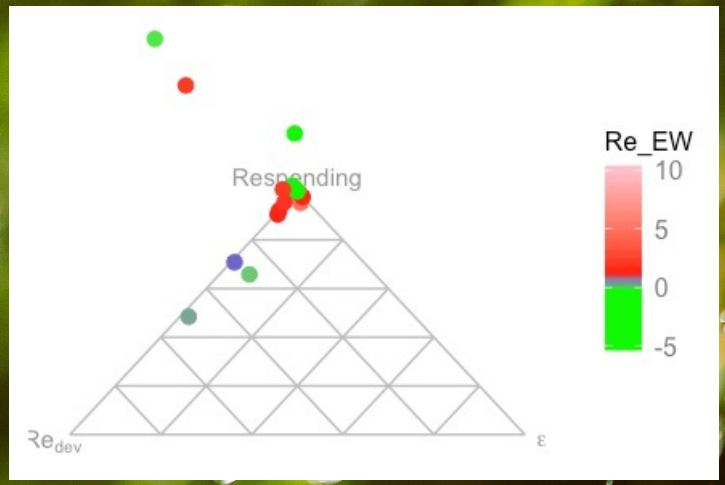

Figure 1: *Respending, Device level rebound, and Embodied energy as a percent of Economy Wide (EW) rebound. Note that the color indicates the magnitude of EW rebound*