

ANALYTICAL PERSPECTIVES ON AFFORDABILITY



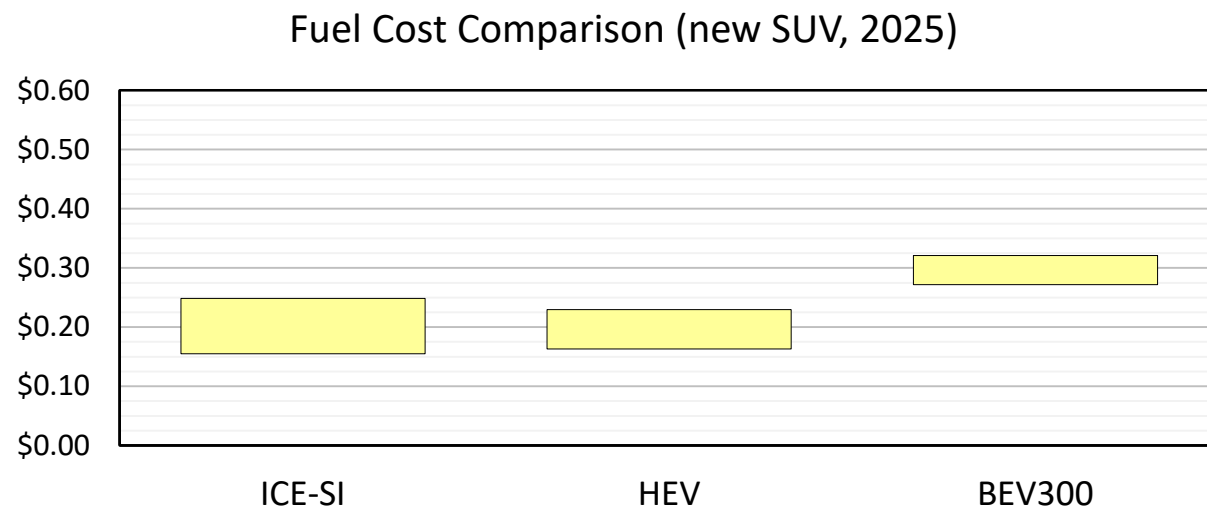
DAVID GOHLKE
Argonne National Laboratory

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Total Cost of Ownership

- Vehicle efficiency and fuel switching can reduce **fuel costs**



Comprehensive Total Cost of Ownership Quantification for Vehicles with Different Size Classes and Powertrains

Energy Systems Division

Andrew Burnham¹, David Gohike¹, Luke Rush¹, Thomas Stephens¹, Yan Zhou¹, Mark A. Delucchi², Alicia Birky³, Chad Hunter³, Zhenhong Lin⁴, Shiqi Ou⁴, Fei Xie⁴, Camron Proctor⁵, Steven Wiriyadinata⁵, Nawei Liu⁶, and Madhur Boloor⁷

¹ Energy Systems Division, Argonne National Laboratory

² Lawrence Berkeley National Laboratory

³ National Renewable Energy Laboratory

⁴ Oak Ridge National Laboratory

⁵ Sandia National Laboratories

⁶ University of Tennessee

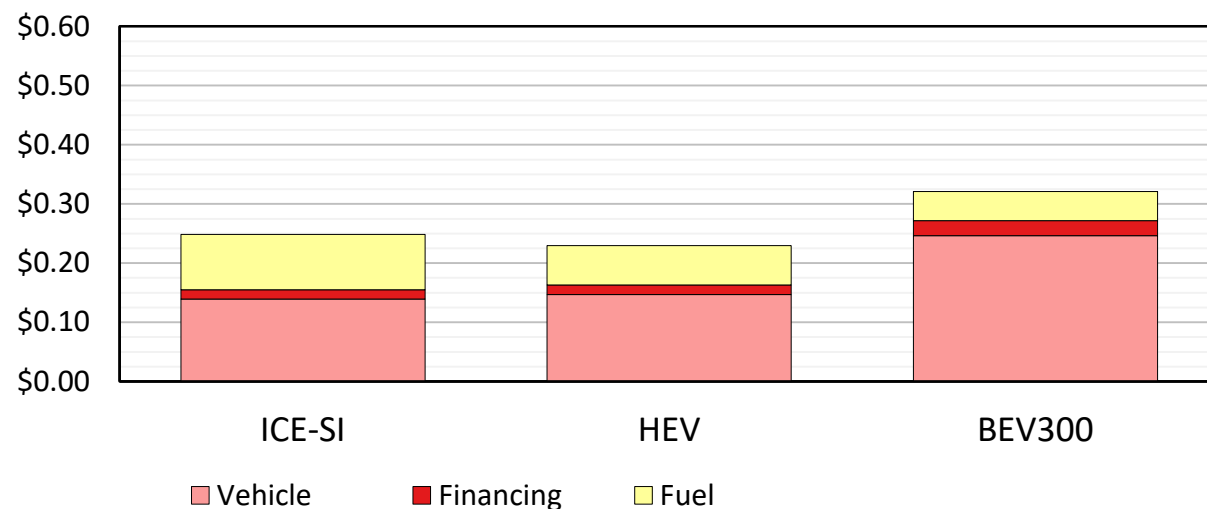
⁷ U.S. Department of Energy, Vehicle Technologies Office

<https://www.osti.gov/biblio/1780970>

Total Cost of Ownership

- Vehicle efficiency and fuel switching can reduce **fuel costs**
- More efficient technologies often have higher **upfront costs**

Vehicle and Fuel Cost Comparison (new SUV, 2025)



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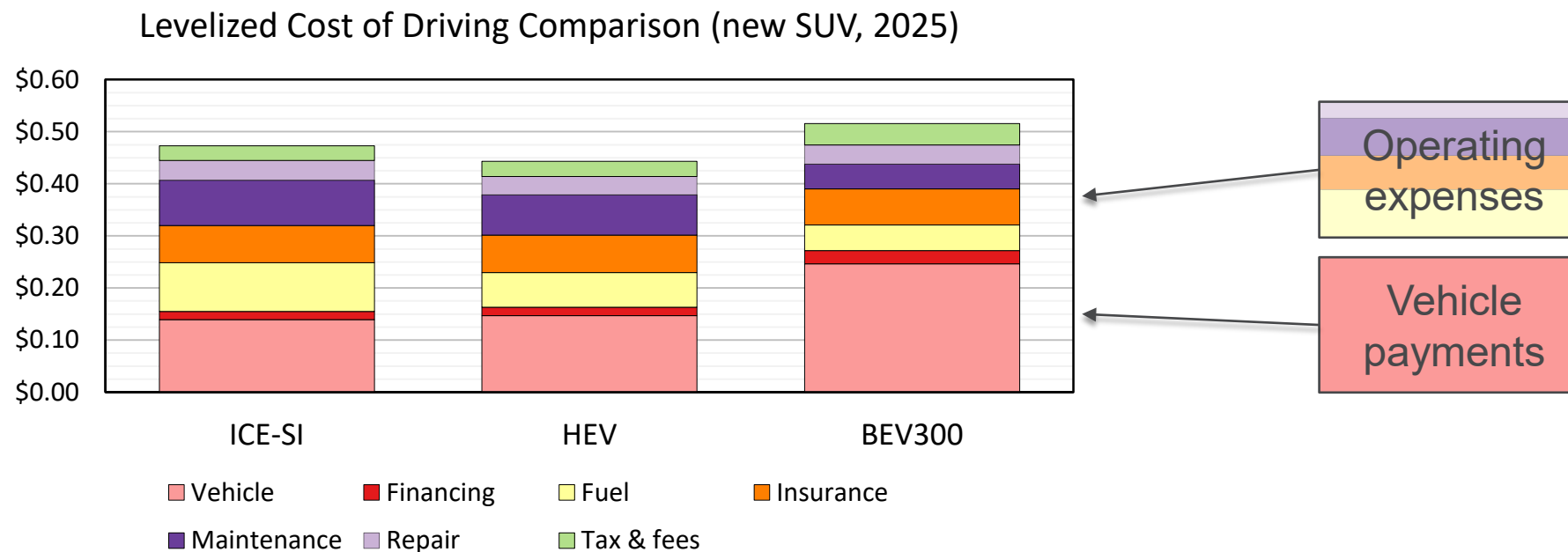
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Total Cost of Ownership

- Vehicle efficiency and fuel switching can reduce **fuel costs**
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- Comprehensive TCO should consider all **operating expenses**

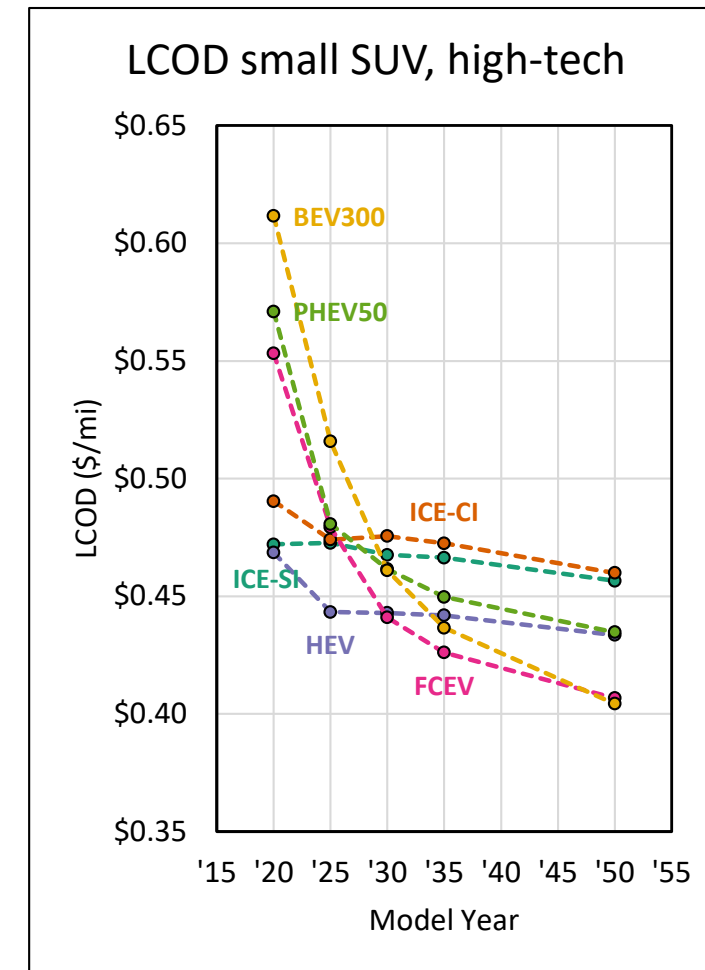
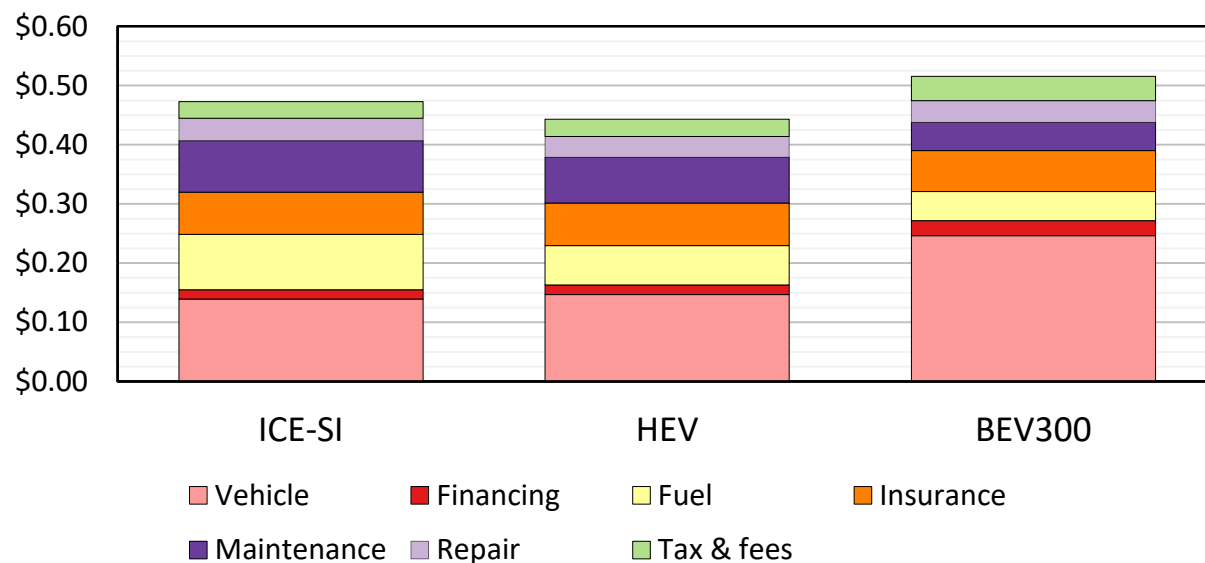


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Total Cost of Ownership

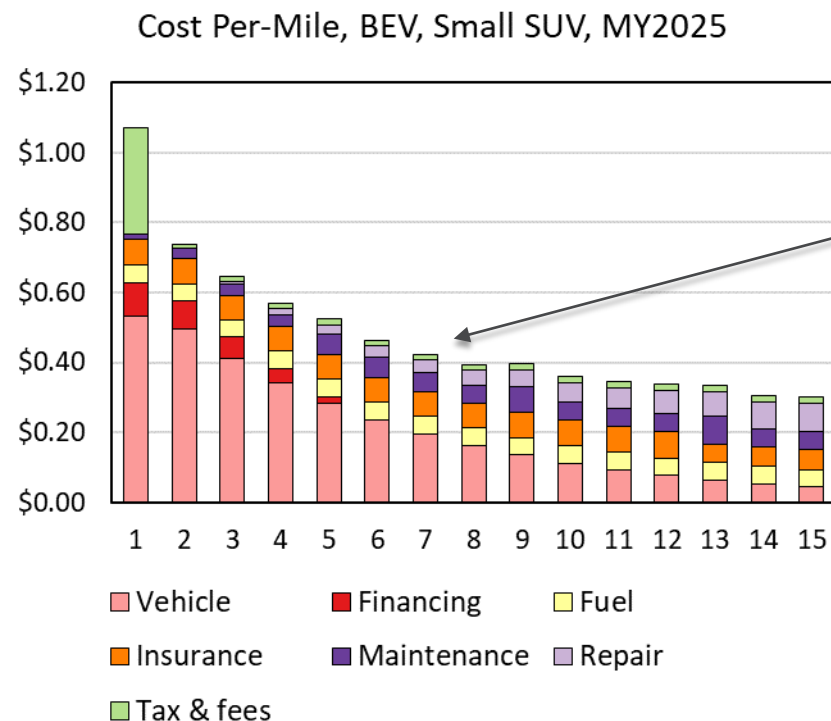
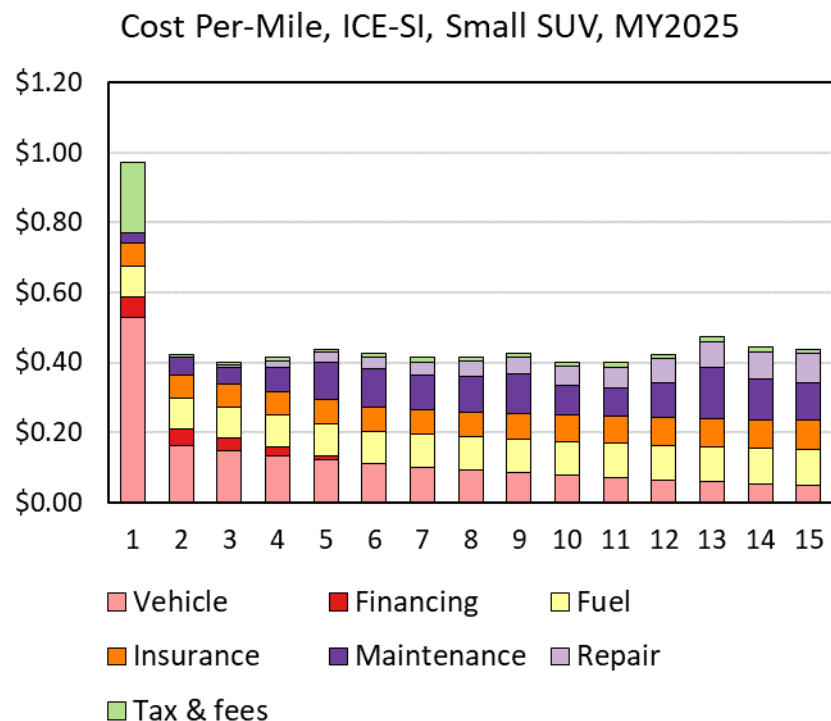
- Vehicle efficiency and fuel switching can reduce **fuel costs**
- More efficient technologies often have higher **upfront costs**
- Comprehensive TCO should consider all **operating expenses**
- As new technologies mature, costs tend to come down

Levelized Cost of Driving Comparison (new SUV, 2025)



<https://www.osti.gov/biblio/1780970>

Levelized Cost of Driving for Aging Vehicles



Starting around year 7 (e.g. second owner), cost of purchasing and operating BEV cheaper than ICEV

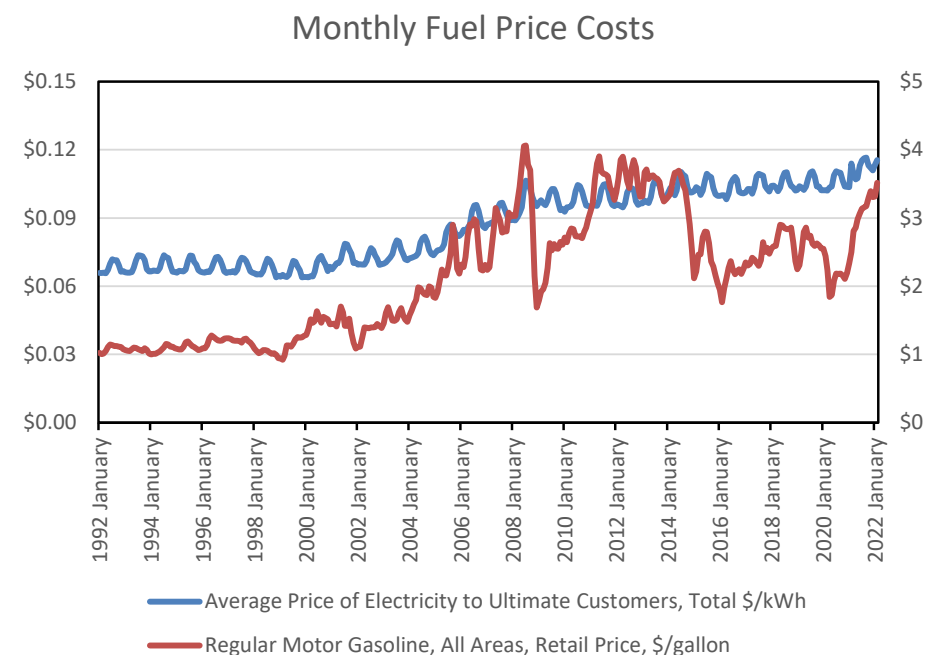
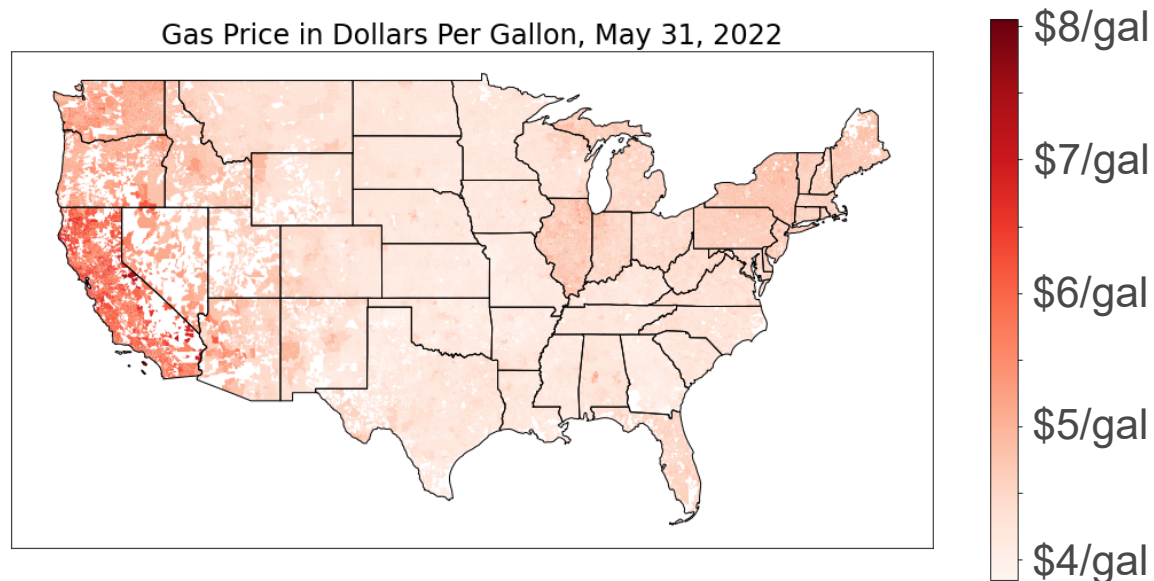
- Large spike in expenditures in first year because of depreciation and sales taxes
- Gradual growth in M&R as vehicle ages counters decreasing depreciation for ICEV
- Potentially lower costs for BEV... if you can get one

Household Transportation Energy Affordability

- We quantified **transportation energy cost burden** for each community in the United States, based on local fuel costs and driving behavior

<https://www.osti.gov/biblio/1760477>

$$\text{Cost Burden} = \frac{\text{Cost}}{\text{Income}} = \frac{\frac{\$}{\text{gallon}} \times \frac{\text{gallon}}{\text{mile}} \times \frac{\text{mile}}{\text{household}}}{\$/\text{year} \cdot \text{household}}$$



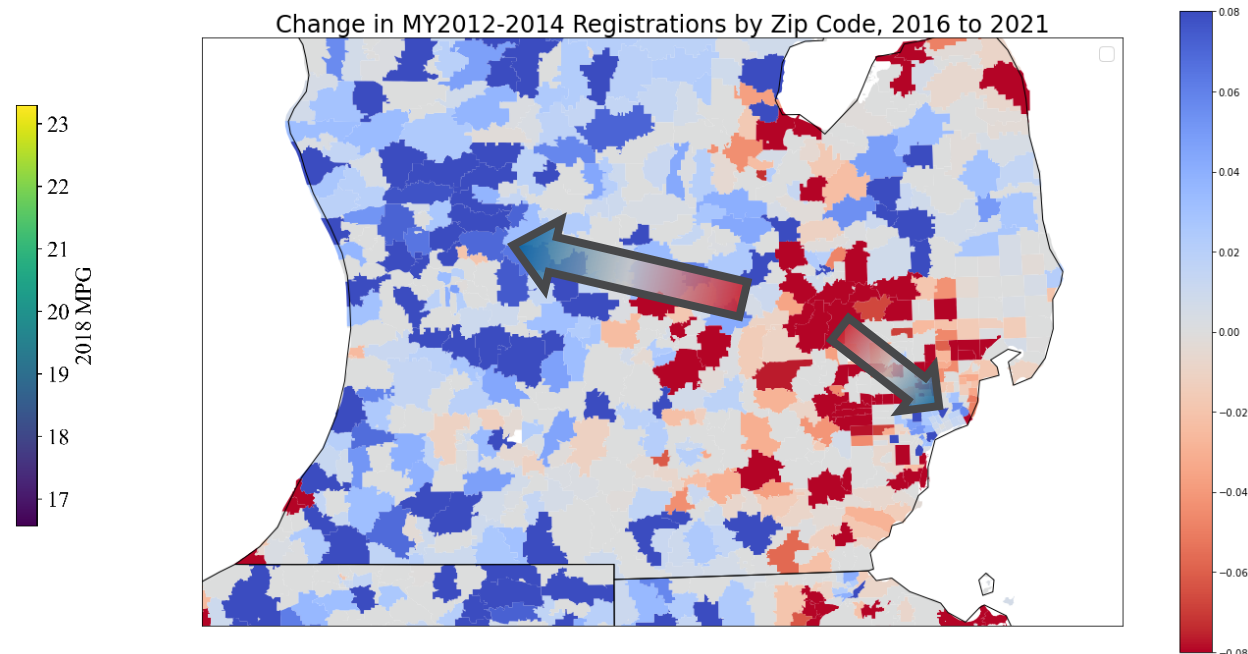
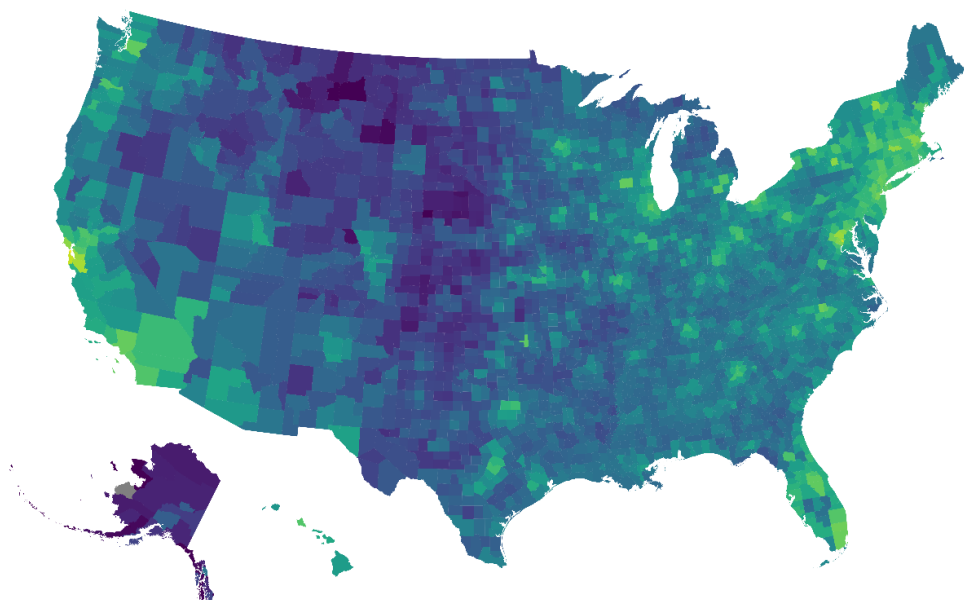
Consider **spatial variation** of cost burden and distributions **across communities**

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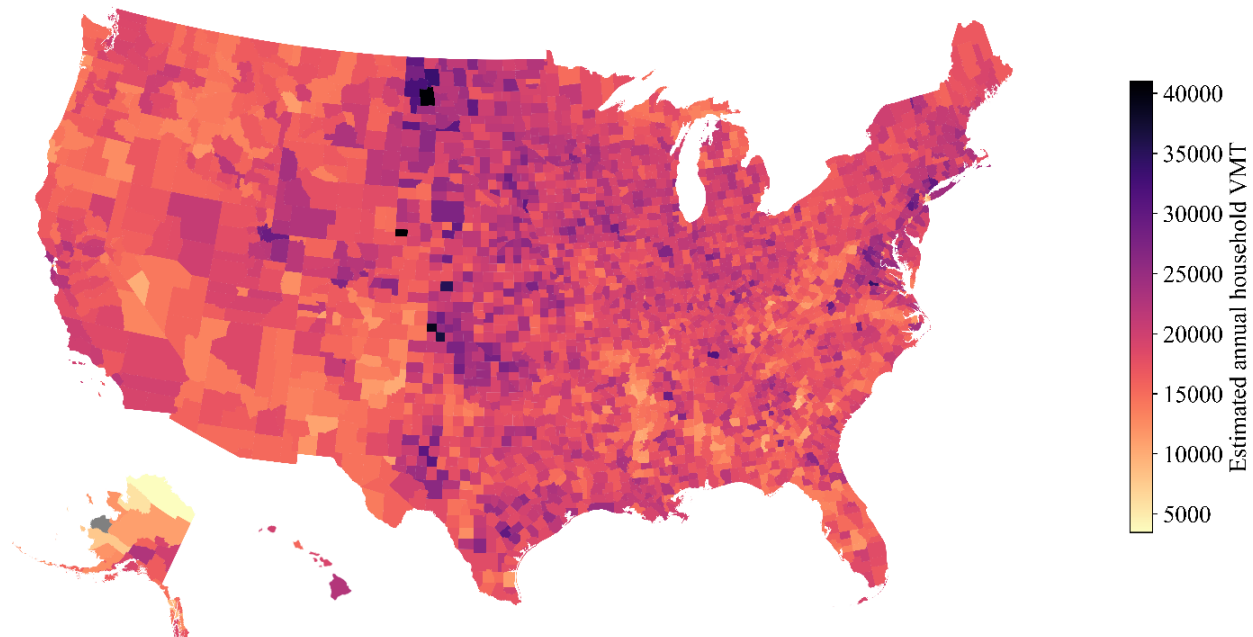
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| Number of Workers | Number of Vehicles | Annual Household Income (thousand \$) | | | | | | | | | | | | | | | | | | | |
|-------------------|--------------------|---------------------------------------|--------|--------|--------|--------|--------|--------|--------|--------|---------|--------|---|---|---|---|---|---|---|---|---|
| | | 0-5 | 5-10 | 10-15 | 15-20 | 20-25 | 25-35 | 35-50 | 50-75 | 75-100 | 100-150 | 150+ | | | | | | | | | |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 1 | 2,972 | 2,972 | 3,234 | 4,013 | 4,013 | 5,620 | 7,574 | 8,192 | 9,390 | 8,799 | 9,016 | | | | | | | | | |
| 0 | 2 | 5,986 | 5,986 | 4,796 | 5,511 | 5,511 | 7,586 | 10,213 | 11,325 | 13,359 | 14,228 | 15,853 | | | | | | | | | |
| 0 | 3 | 6,177 | 6,177 | 5,103 | 5,648 | 5,648 | 7,615 | 9,594 | 10,576 | 12,144 | 12,469 | 14,915 | | | | | | | | | |
| 0 | 4 | 3,215 | 3,215 | 2,951 | 5,393 | 5,393 | 8,761 | 11,384 | 12,718 | 15,565 | 15,949 | 18,541 | | | | | | | | | |
| 0 | 5+ | 4,200 | 4,200 | 3,805 | 6,476 | 6,476 | 10,360 | 12,977 | 13,443 | 15,948 | 17,075 | 20,237 | | | | | | | | | |
| 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | | | | | | | | |
| 1 | 1 | 6,614 | 6,614 | 7,097 | 7,419 | 7,419 | 8,267 | 9,695 | 10,168 | 11,978 | 12,824 | 13,733 | | | | | | | | | |
| 1 | 2 | 11,305 | 11,305 | 8,830 | 9,361 | 9,361 | 10,836 | 12,628 | 13,491 | 16,107 | 18,703 | 20,642 | | | | | | | | | |
| 1 | 3 | 10,348 | 10,348 | 8,356 | 8,802 | 8,802 | 10,200 | 12,174 | 13,181 | 15,976 | 19,249 | 22,099 | | | | | | | | | |
| 1 | 4 | 4,959 | 4,959 | 3,548 | 7,065 | 7,065 | 9,586 | 11,342 | 12,282 | 15,801 | 19,258 | 22,345 | | | | | | | | | |
| 1 | 5+ | 5,581 | 5,581 | 3,962 | 7,321 | 7,321 | 9,786 | 10,949 | 10,465 | 13,714 | 19,535 | 24,310 | | | | | | | | | |
| 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | | | | | | | | |
| 2 | 1 | 10,860 | 10,860 | 9,919 | 9,529 | 9,529 | 9,960 | 10,965 | 11,296 | 13,262 | 14,619 | 15,529 | | | | | | | | | |
| 2 | 2 | 19,010 | 19,010 | 12,725 | 12,750 | 12,750 | 13,054 | 15,673 | 16,373 | 18,504 | 20,635 | 22,114 | | | | | | | | | |
| 2 | 3 | 16,457 | 16,457 | 12,048 | 12,370 | 12,370 | 12,120 | 15,185 | 16,091 | 18,428 | 21,443 | 23,810 | | | | | | | | | |
| 2 | 4 | 20,120 | 20,120 | 14,553 | 12,807 | 12,807 | 12,640 | 14,148 | 14,815 | 17,565 | 21,090 | 24,069 | | | | | | | | | |
| 2 | 5+ | 21,518 | 21,518 | 16,081 | 14,681 | 14,681 | 14,888 | 15,802 | 13,880 | 16,961 | 23,737 | 28,890 | | | | | | | | | |
| 3+ | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | | | | | | | | |
| 3+ | 1 | 7,572 | 7,572 | 10,028 | 12,251 | 12,251 | 13,084 | 13,639 | 13,045 | 14,291 | 14,830 | 15,389 | | | | | | | | | |
| 3+ | 2 | 9,865 | 9,865 | 12,774 | 17,342 | 17,342 | 18,844 | 21,310 | 20,409 | 21,223 | 22,175 | 23,094 | | | | | | | | | |
| 3+ | 3 | 8,371 | 8,371 | 12,390 | 17,287 | 17,287 | 18,629 | 21,356 | 20,548 | 21,514 | 22,973 | 24,948 | | | | | | | | | |
| 3+ | 4 | 16,254 | 16,254 | 21,747 | 19,520 | 19,520 | 19,145 | 19,487 | 18,431 | 19,802 | 22,637 | 26,815 | | | | | | | | | |
| 3+ | 5+ | 16,724 | 16,724 | 21,805 | 20,115 | 20,115 | 20,028 | 19,368 | 14,851 | 15,372 | 24,346 | 31,428 | | | | | | | | | |



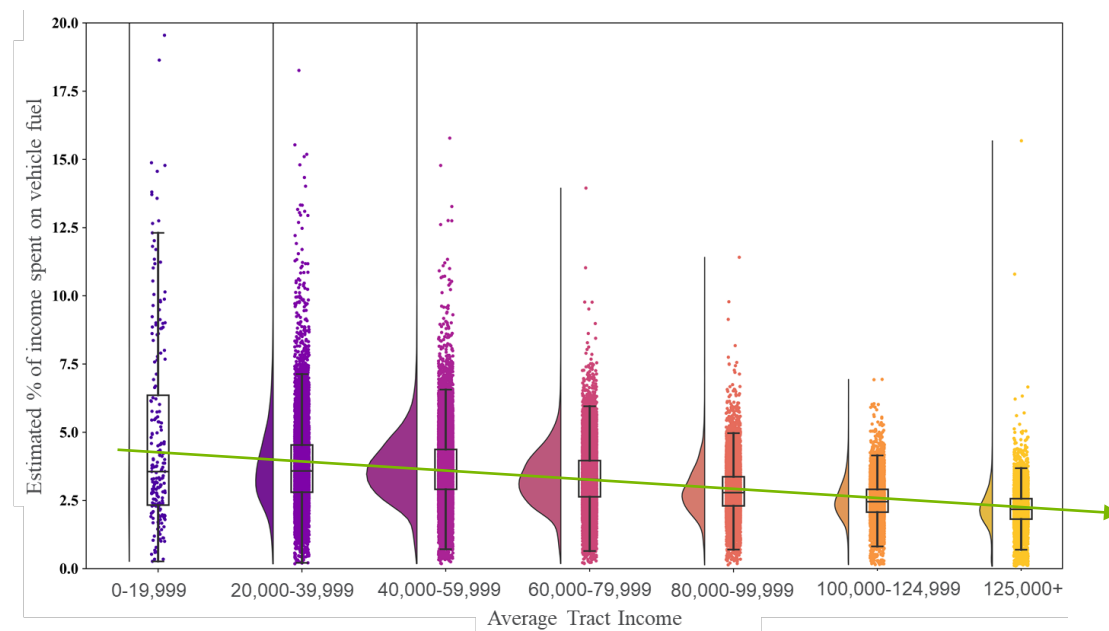
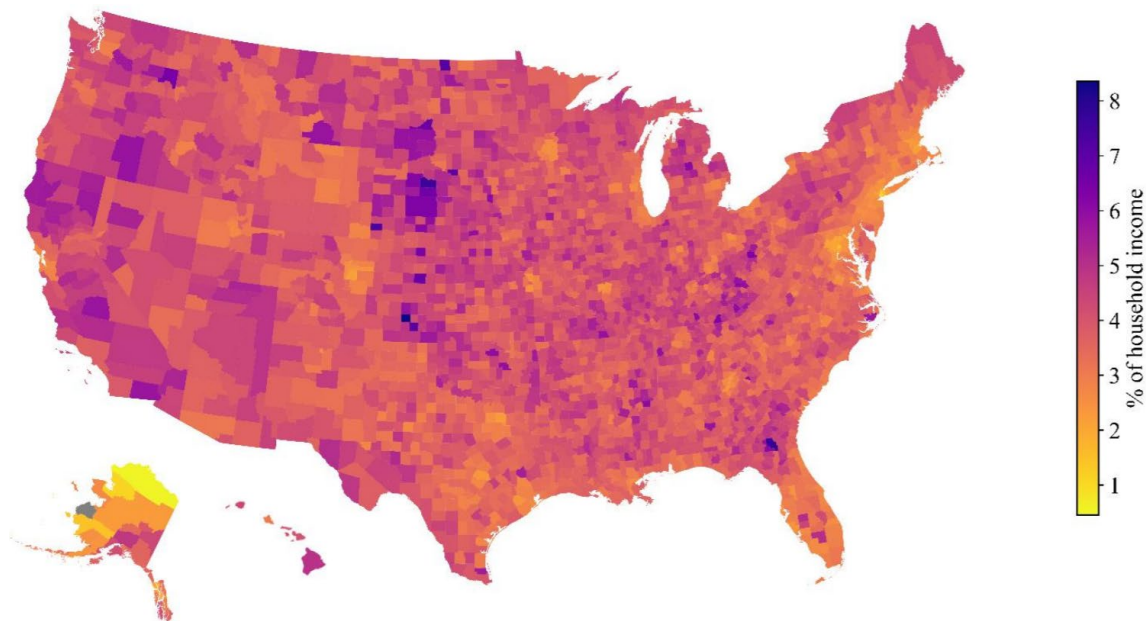
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– *Expanding analysis to total cost of ownership, including depreciation, insurance, maintenance & repair*

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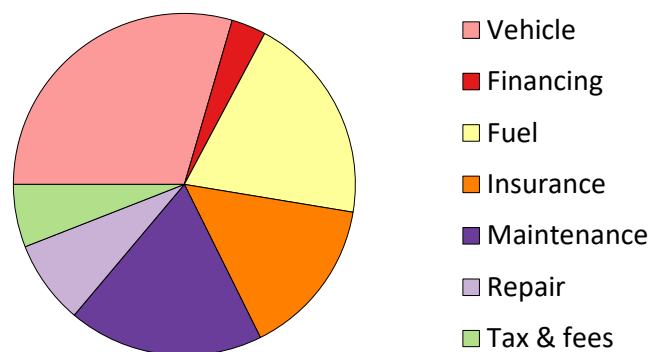


gohlke@anl.gov -- <https://www.anl.gov/es/transportation-energy-equity-analysis-and-resources>

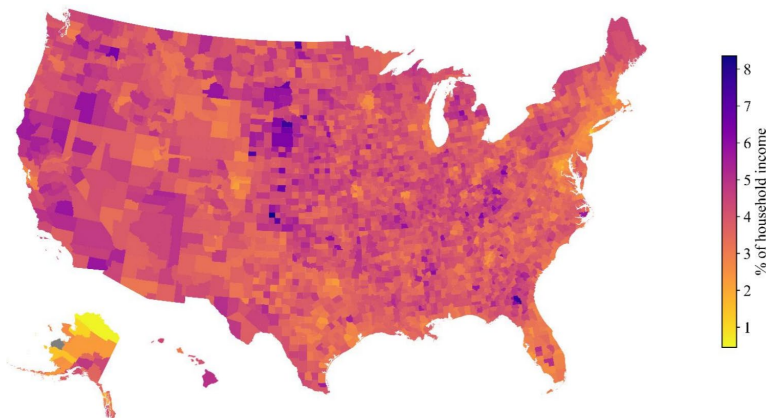
Key Research Results

1. Andrew Burnham, David Gohlke, et al., April 2021. *Comprehensive Total Cost of Ownership Quantification for Vehicles with Different Size Classes and Powertrains.*
2. Yan Zhou, Spencer Aeschliman, and David Gohlke, December 2020. *Affordability of Household Transportation Fuel Costs by Region and Socioeconomic Factors.*
3. Luke Rush, Yan Zhou, and David Gohlke, May 2022. *Vehicle Residual Value Analysis by Powertrain Type and Impacts on Total Cost of Ownership.*

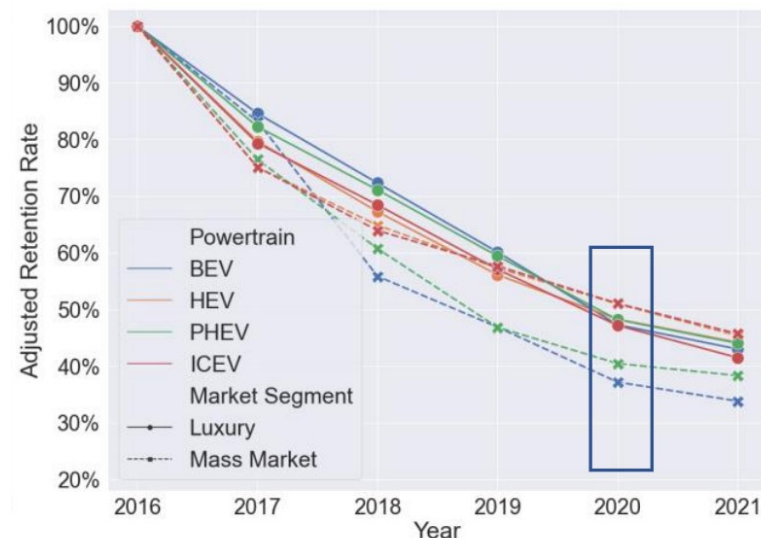
Per-Mile Cost of Ownership, Gasoline ICE,
Small SUV, MY2025



1: <https://www.osti.gov/biblio/1780970>



2: <https://www.osti.gov/biblio/1760477>



3: <https://www.osti.gov/biblio/1876197>

<https://www.anl.gov/es/transportation-energy-equity-analysis-and-resources>