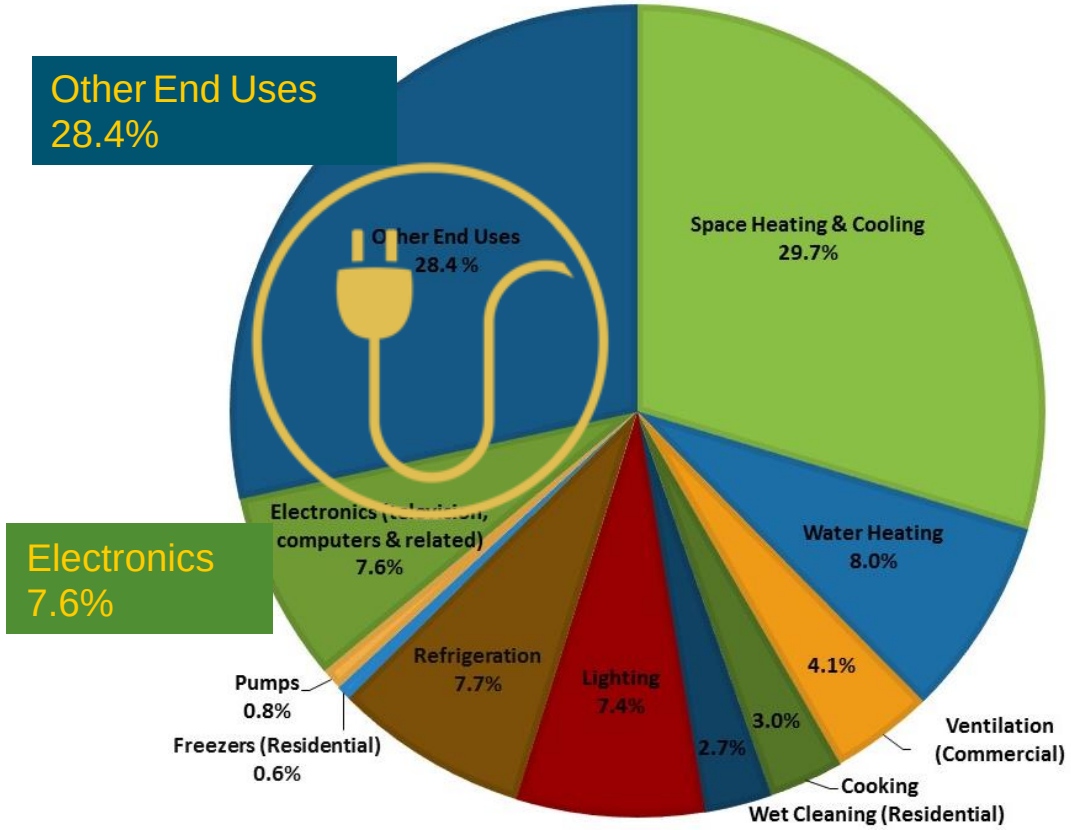
U.S. DEPARTMENT OF ENERGY

Office of ENERGY EFFICIENCY & RENEWABLE ENERGY

Emerging Technologies: Miscellaneous Electric Loads (MELs)



2016 Residential and Commercial Building Primary Energy Use (Quads)

Pacific Northwest National Laboratory (PNNL) and Lawrence Berkeley National Laboratory (LBNL)
Harry Bergmann, Marina Sofos, Josh Butzbaugh, Jared Langevin, Alan Meier, and Robert Hosbach

The Need to Characterize Miscellaneous Loads

- **Miscellaneous electric loads (MELs) are the largest end use category in building energy consumption.**
  - MELs are expected to increase both their share of total building energy consumption and magnitude of energy use over time according to the Annual Energy Outlook (AEO).
  - MELs are a challenging end use category to classify, characterize, and compare consistently.
  - Thus far, a well-accepted and widely-adopted taxonomy for MELs has yet to emerge.
- **EIA does not specifically define MELs in AEO summaries, it includes an "Other" category for both residential and commercial sector key indicators and consumption.**
  - EIA's data collection and research of MELs is limited in the National Energy Modeling System (NEMS).
  - EIA only estimates the number of devices per household and average consumption per household for MELs in NEMS.
  - NEMS does not incorporate data on lifetime, cost, or energy efficiency of MELs into its annual or long-term projections.
- **Few individual MELs are well studied or understood.**
  - Identification and quantification leads to energy savings.

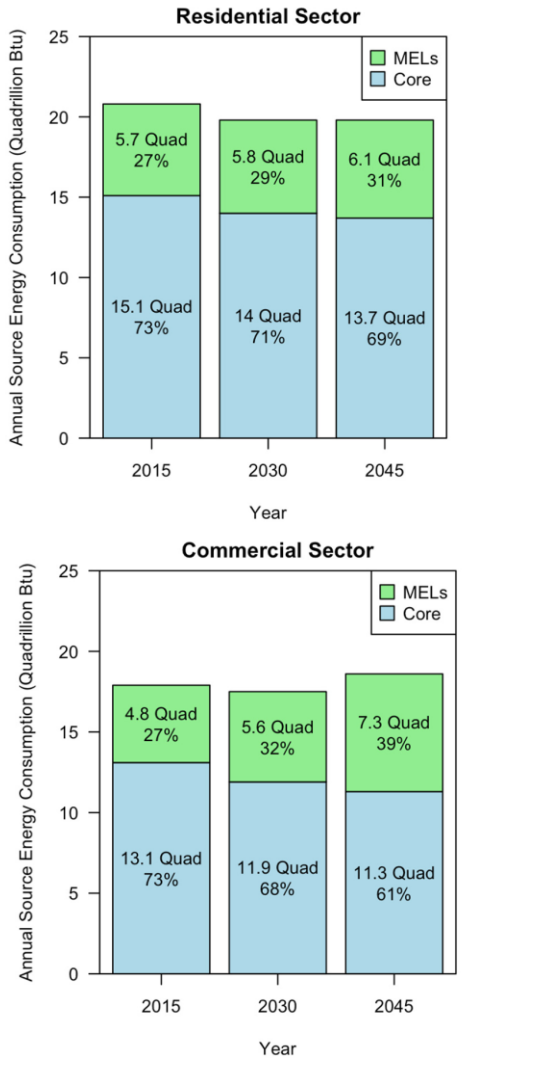


Figure 1. Projected increases in MELs consumption in AEO 2017.

The Need to Characterize Miscellaneous Loads

- **The inability to accurately characterize the typical cost, performance, and lifetime characteristics of MELs can have large effects on the projected impacts of measures that seek to improve the efficiency of MELs technologies**

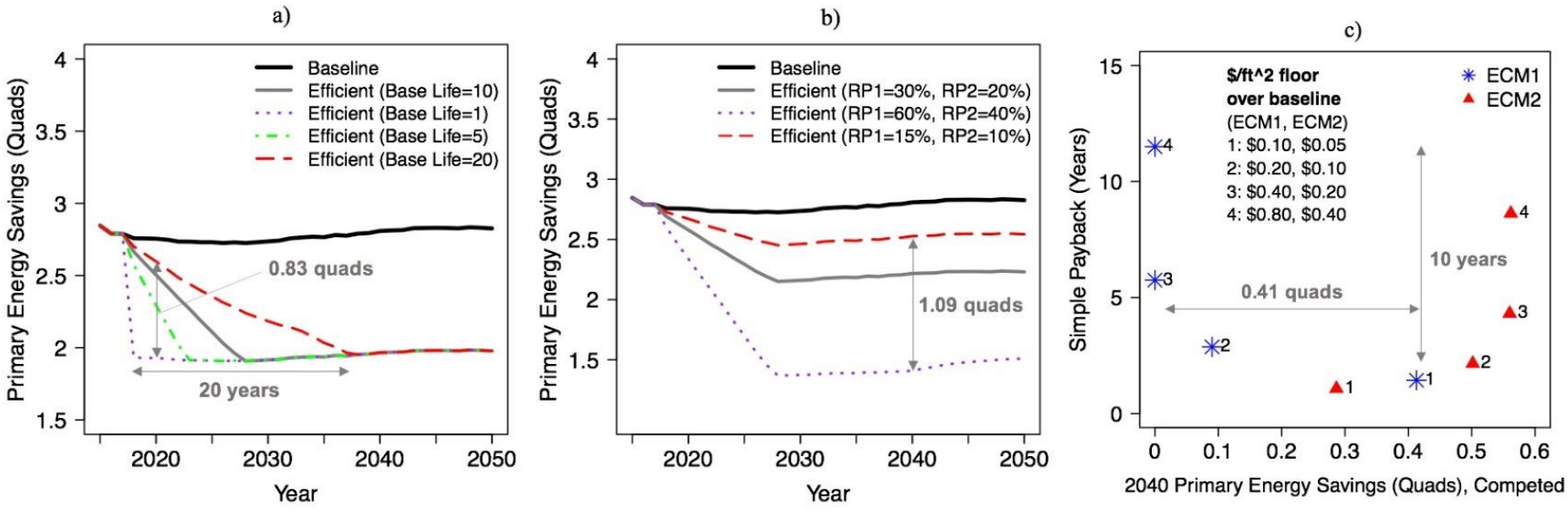


Figure 2. Sensitivity analysis of the effects of baseline MELs technology a) lifetime, b) relative energy performance (RP) level, and c) installed cost on Scout estimates of the primary energy impacts and cost effectiveness of energy conservation measures (ECMs) that are targeted towards improving the energy efficiency of the baseline technology.

Approach

Characterize and classify MELs

- Achieve a common understanding of MELs – a taxonomy
- Identify and prioritize MELs for extensive data collection and analysis
- Characterize the national energy consumption and energy efficiency potential of the identified MELs
- Integrate data collected on identified MELs into Scout for advanced modeling of national energy consumption
- Publicize findings of the research conducted in this study
  - Finalize and publish individual MELs data sheets to OpenEI online data repository or similar vehicle to provide access to data.
  - Complete and submit a journal article summarizing methodology and findings on the energy consumption, cost, energy efficiency, lifetime, and stock/market of key MELs researched in this study.
  - Inspire specific approaches to reducing MELs energy use

Progress

Together, PNNL and LBNL have:

- Defined MELs for the purpose of this study
- Identified 33 key MELs for extensive data collection and research
  - Collected and analyzed data on each MEL to characterize its national energy consumption. Two examples:

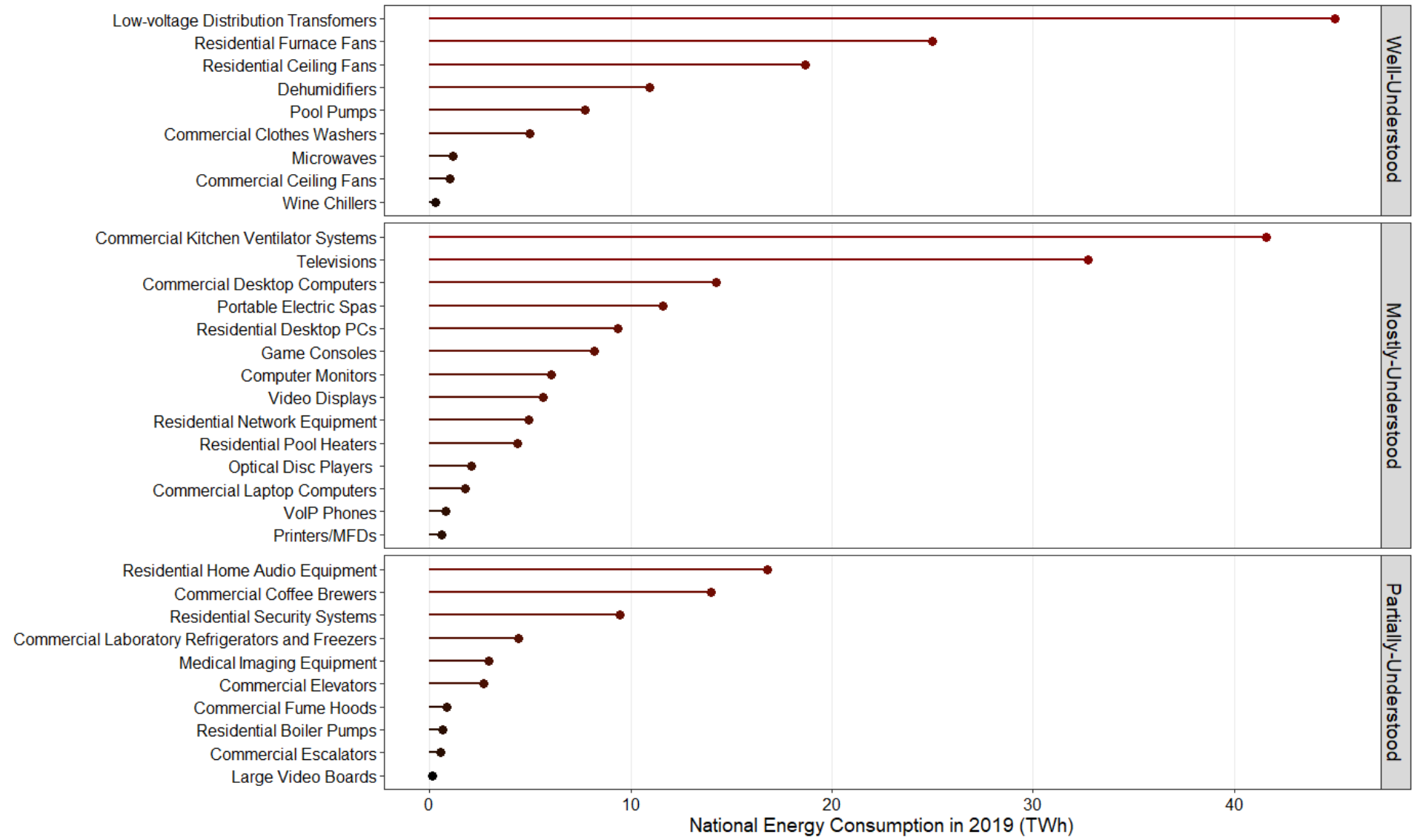
MEL	Sector	Efficiency	First Cost	Annual UEC (kWh)	Fraction of Operating Time in Off/Standby	Average Lifetime (years)	2019 Stock NEC (GWh)
Desktop PCs	Residential	Typical	540 (2018$)	130	59%	5	9,400
		Most Efficient	1,100 (2018$)	40			2,900
	Commercial	Typical	560 (2018$)	230	37%	4.3	14,000
		Most Efficient	810 (2018$)	50			3,100
Optical Disc Video Players	Residential	Typical	51 (2018$)	16	97%	5	2,100
		Most Efficient	48 (2018$)	5			650

  - Categorized each MEL as Well Understood, Mostly Understood, and Partially Understood based on the veracity of the collected data
  - Aggregated data analysis into an overall summary of national energy use
- Published an overview of the work in the 2018 ACEEE Summer Study Proceedings (Fares et al, “Improving Characterization of Miscellaneous Energy Loads in Energy Demand Models,” 2018.) https://aceee.org/files/proceedings/2018/#/paper/event-data/p074

Impact

- Identification
  - Striving for a common understanding of MELs across DOE offices
- Quantification
  - The 33 MELs researched in this study comprise:
    - 1.5 billion products installed in the residential and commercial sectors
    - One quad of annual national electricity consumption, representing 11% of delivered electricity to the residential and commercial sectors combined
- Energy Savings Potential
  - A subset of 23 MELs consume nearly 250 TWh nationally per year (Well Understood and Mostly Understood categories)
  - The potential exists to reduce the energy consumption of these 23 MELs by 57% (or 0.48 quads), thereby decreasing their aggregate national annual energy consumption to 107 TWh

Impact


Low-voltage Distribution Transfomers
Residential Furnace Fans
Residential Ceiling Fans
Dehumidifiers
Pool Pumps
Commercial Clothes Washers
Microwaves
Commercial Ceiling Fans
Wine Chillers
Well-Understood
Commercial Kitchen Ventilator Systems
Televisions
Commercial Desktop Computers
Portable Electric Spas
Residential Desktop PCs
Game Consoles
Computer Monitors
Video Displays
Residential Network Equipment
Residential Pool Heaters
Optical Disc Players
Commercial Laptop Computers
VoIP Phones
Printers/MFDs
Mostly-Understood
Residential Home Audio Equipment
Commercial Coffee Brewers
Residential Security Systems
Commercial Laboratory Refrigerators and Freezers
Medical Imaging Equipment
Commercial Elevators
Commercial Fume Hoods
Residential Boiler Pumps
Commercial Escalators
Large Video Boards
Partially-Understood
0
10
20
30
40
National Energy Consumption in 2019 (TWh)

Next Steps

- Publish individual MELs spreadsheets on OpenEI or equivalent
- Update Scout with the collected data
  - Generate projections of MELs energy use across various scenarios of technological integration and adoption
  - Help inform DOE strategic decision-making and policies
- Continue collaboration with EIA on the development of a taxonomy
  - Investigate information-centric tagging framework
- Stimulate greater research and activity on MELs
  - Investigate cross-cutting, energy-efficient technologies
  - Test methods
  - Voluntary specifications
  - Procurement strategies

Discussion

- MELs are always evolving as products come and go…
  - Alan Meier & Leo Rainier's 1992 MELs paper featured energy efficiency characterization of water beds…installed base has changed!
  - Need for long lasting policies
    - EU Lot 26 Horizontal Standby and Networked Standby Standards
    - Others?
- R&D and Technology Integration
  - California Energy Commission's battery charger standards – Ni-Cad chargers
  - Deep sleep modes
  - Motor efficiency
  - Others?

Thank You

DOE, PNNL, LBNL

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