



University of Colorado
Boulder



Graduate student researcher: Lisa Wang

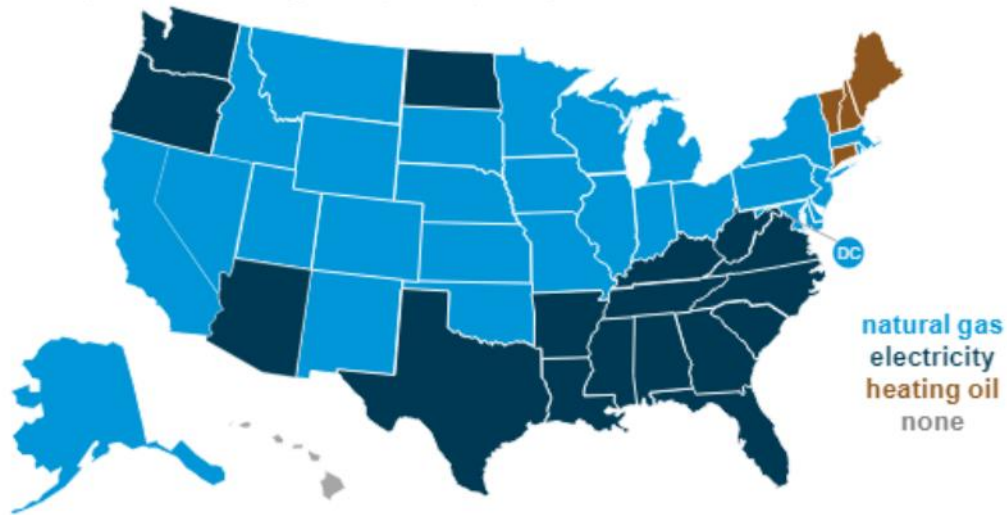
Advisor: Dr Shelly Miller

Department: Mechanical Engineering

Collaborators: City of Boulder, Radiant Labs, CU Boulder

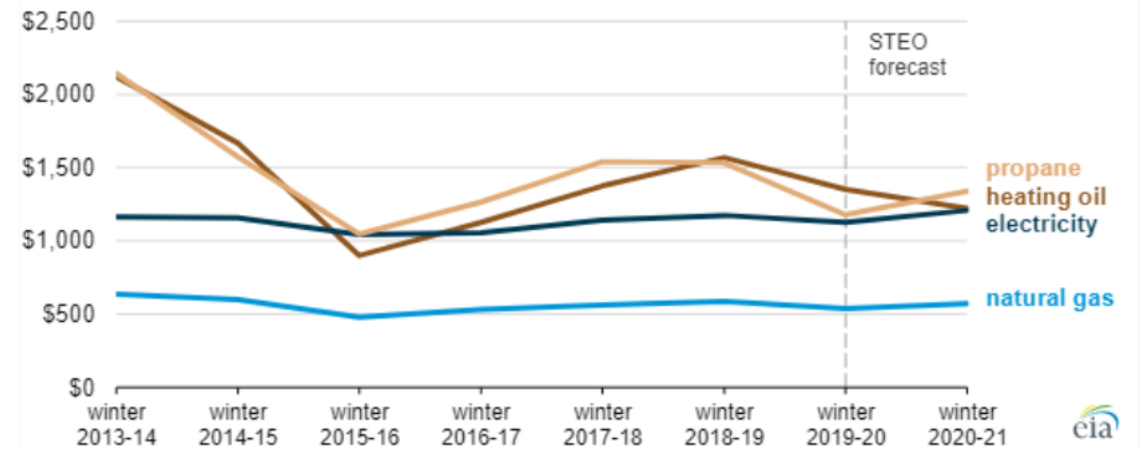
a study on Energy Transition, Health and Indoor air Quality *ETHIQ*

Most prevalent heating fuel by state (2019)



Graphic Source: EIA

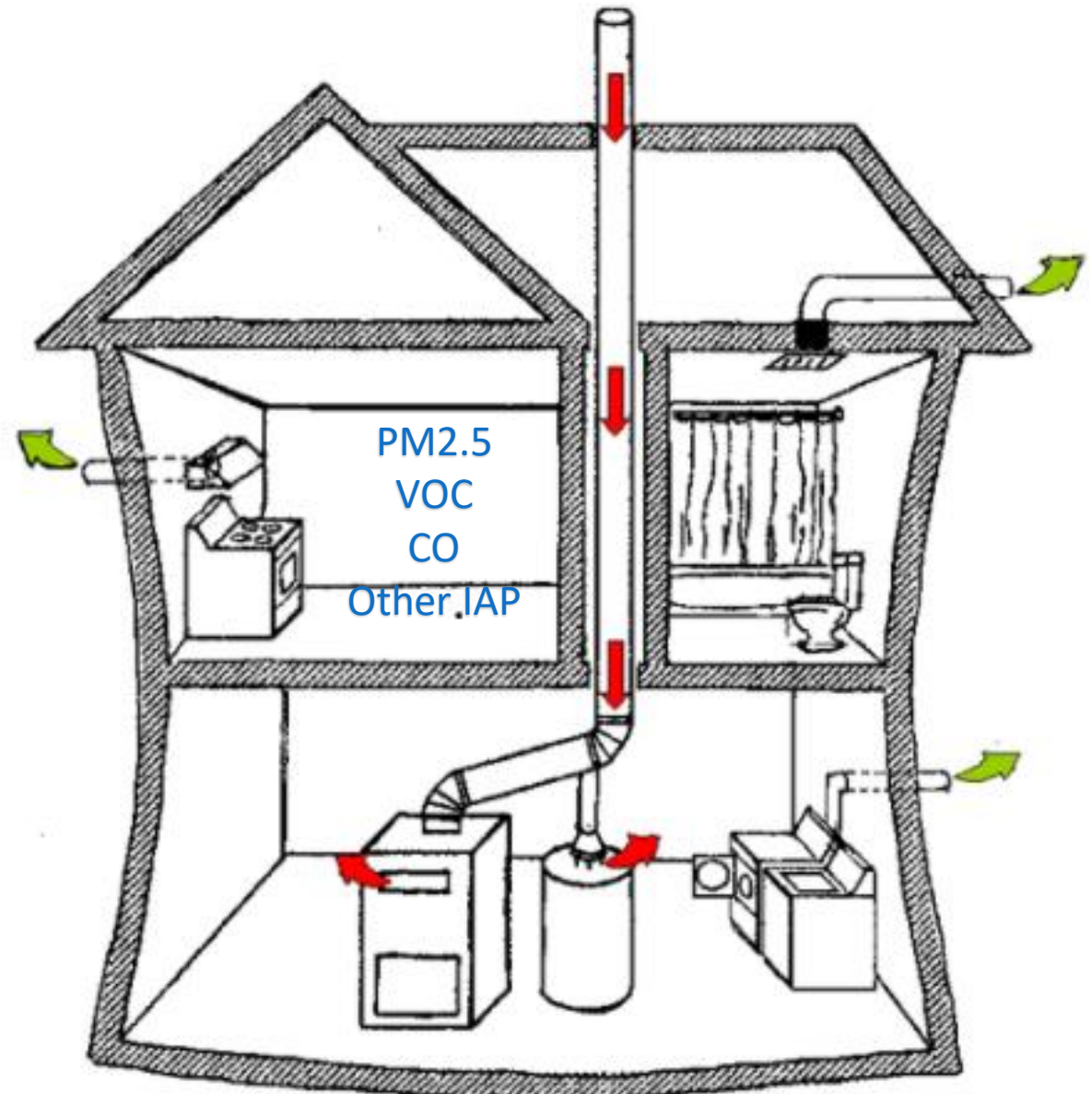
Average winter household expenditures for heating fuels (winter months, 2013–2021)
dollars per household



Graphic Source: EIA

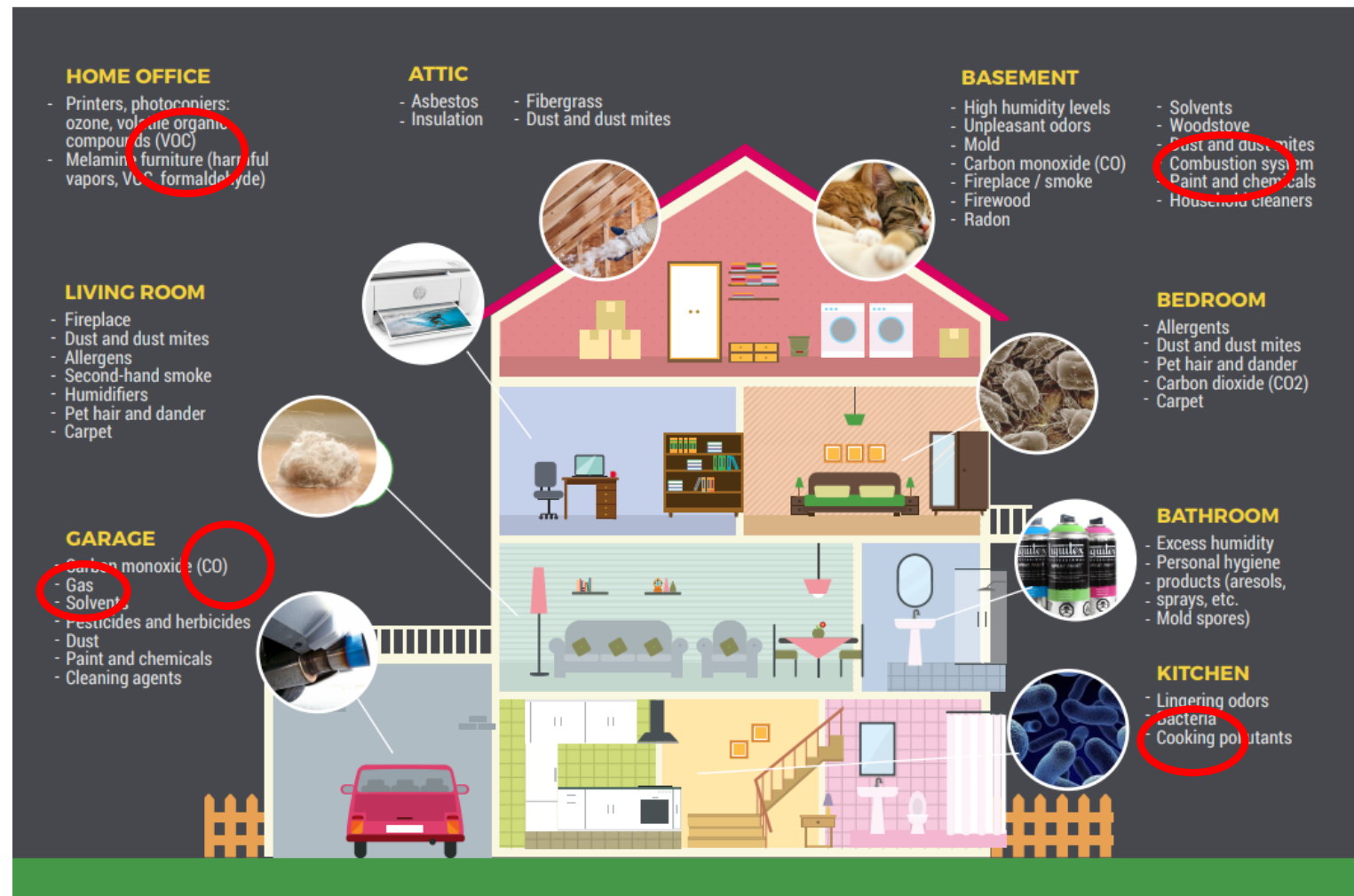
Common forms of residential heating fuels in the US

Combustion gas spillage

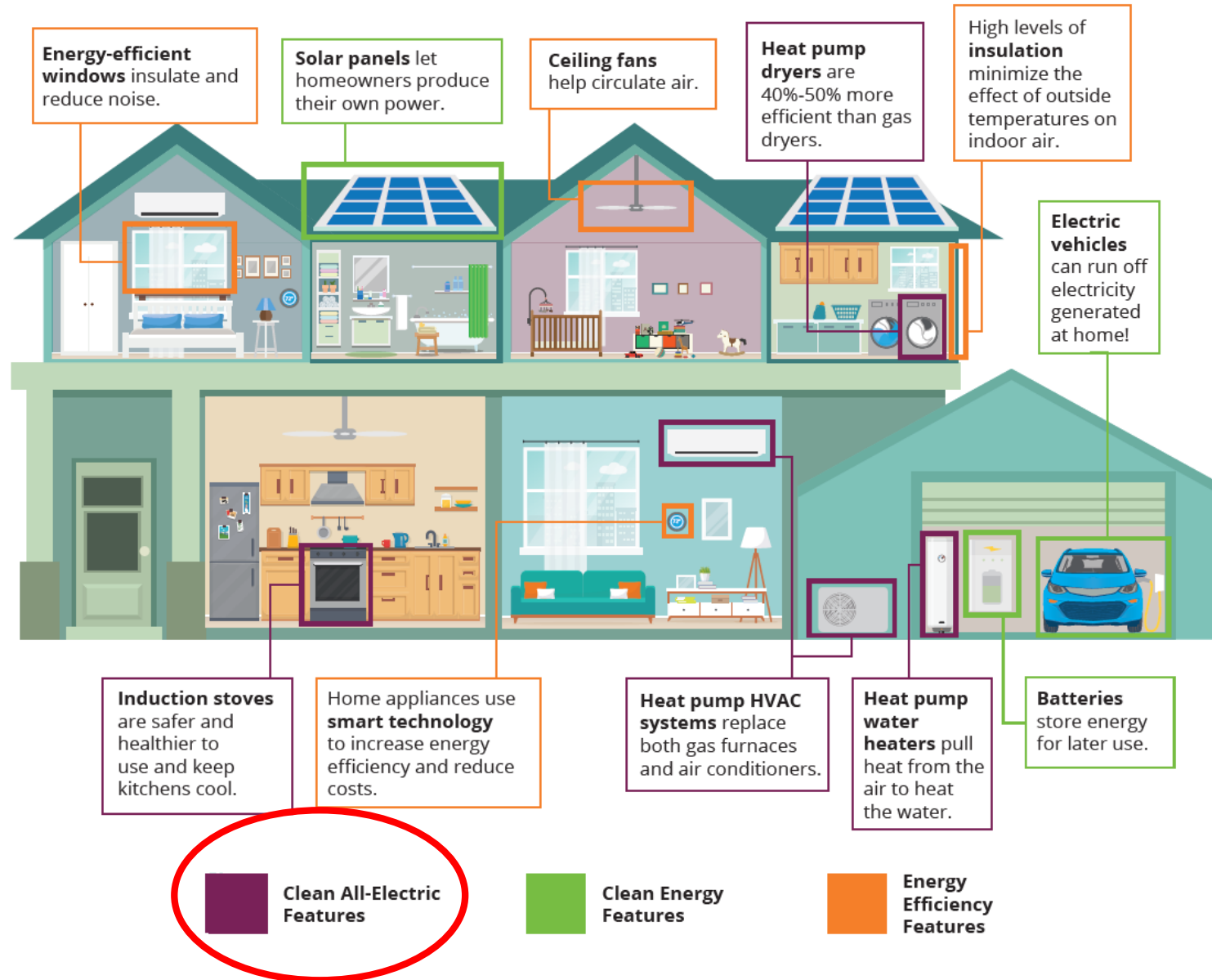


Graphic Source: healthyexposure

Our research question: Can transition to electrified appliances indoors affect health and wellbeing of individuals?

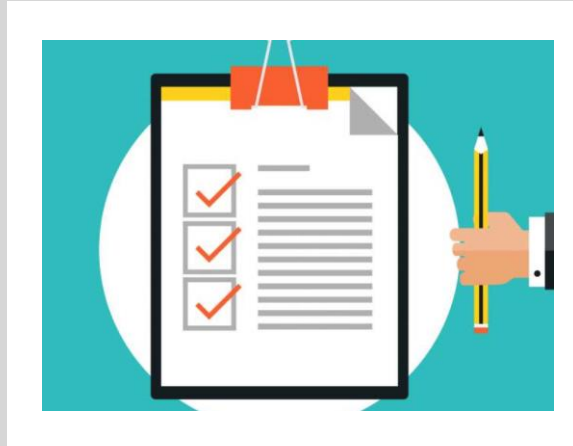
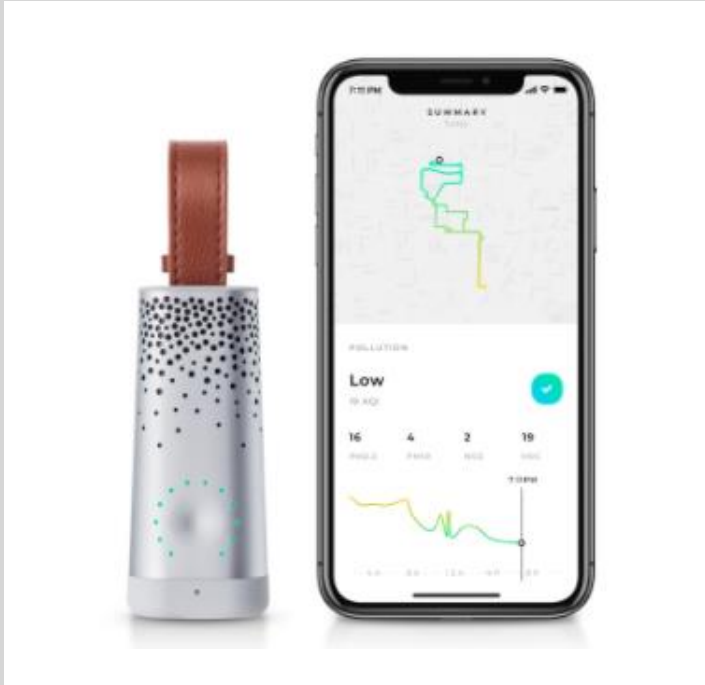


Graphic Source: YellowBlue Eco Tech

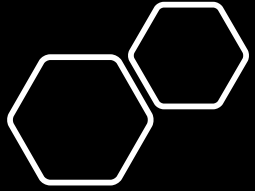


Methods

- Recruited single family homes with either 'fully electrified' ; 'partially electrified' and 'no electrical appliances'
- Deployed low-cost sensors in 12 homes
- Took seasonal health and wellbeing surveys
- Monitor and analyze 1 year of air pollution data



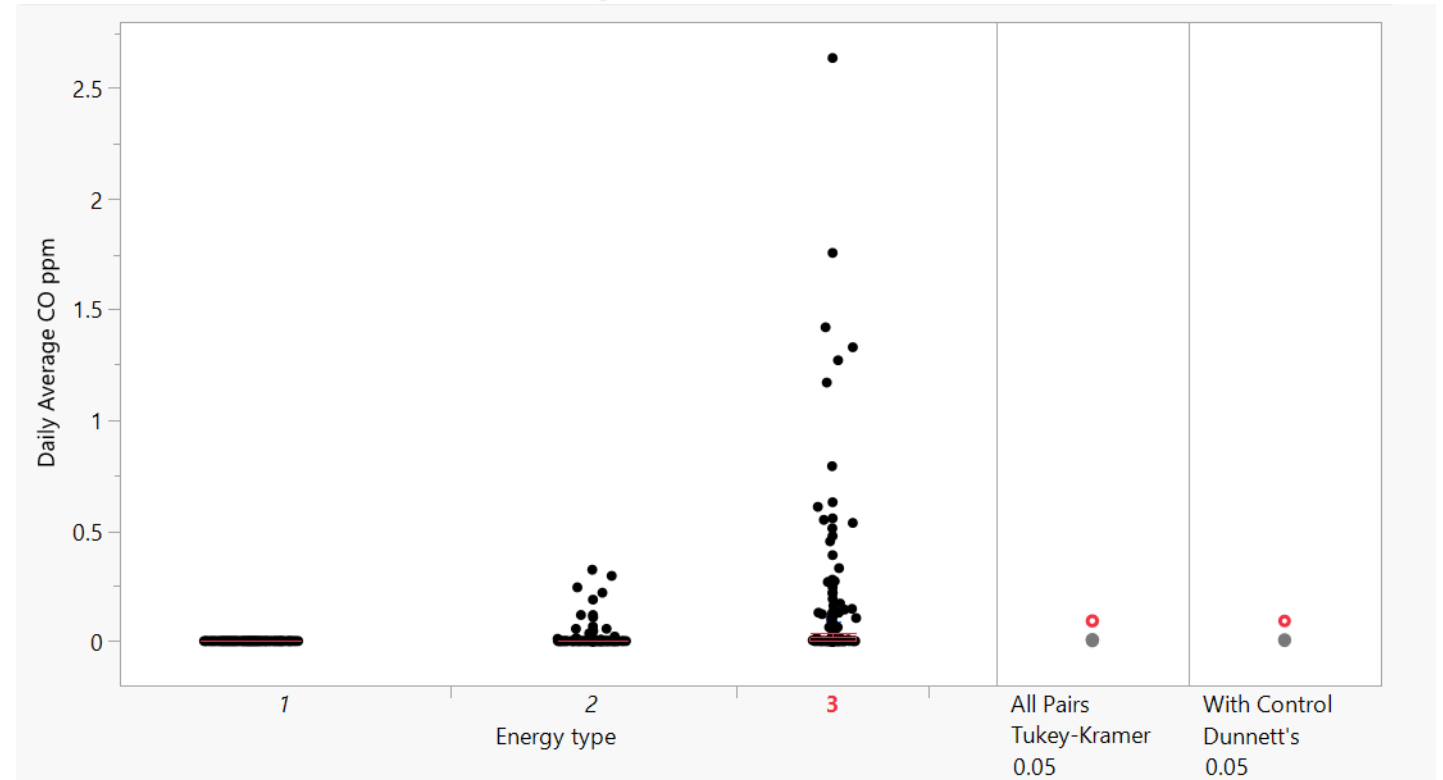
Graphic sources: Plume Labs, Lascar Electronics, Foobot



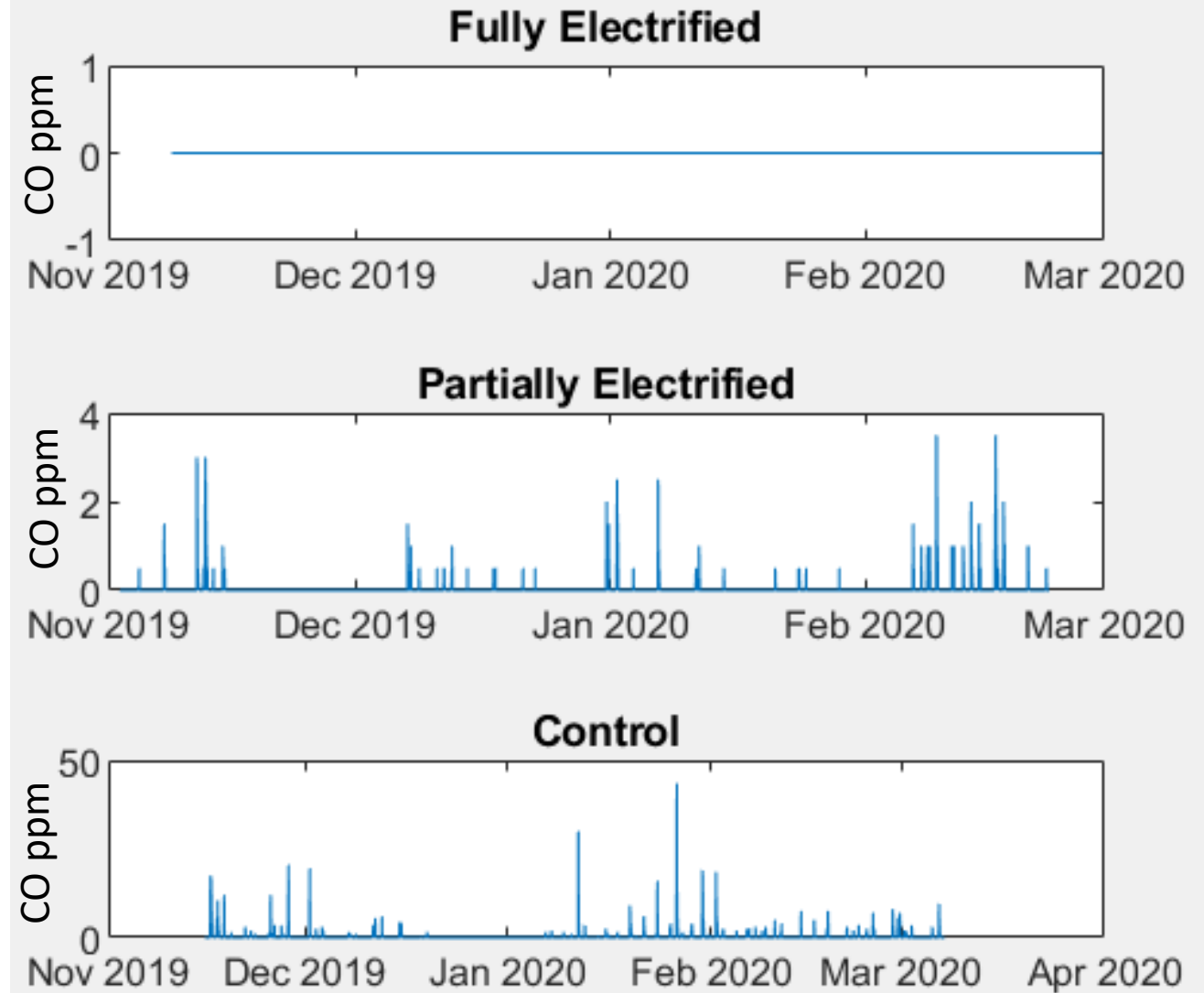
Carbon Monoxide

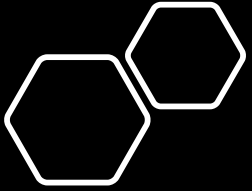
- 1 = Fully electrified homes
- 2 = Partially electrified homes
- 3 = Control group/Natural gas

One-way ANOVA of CO



Upon a
closer glance
at CO

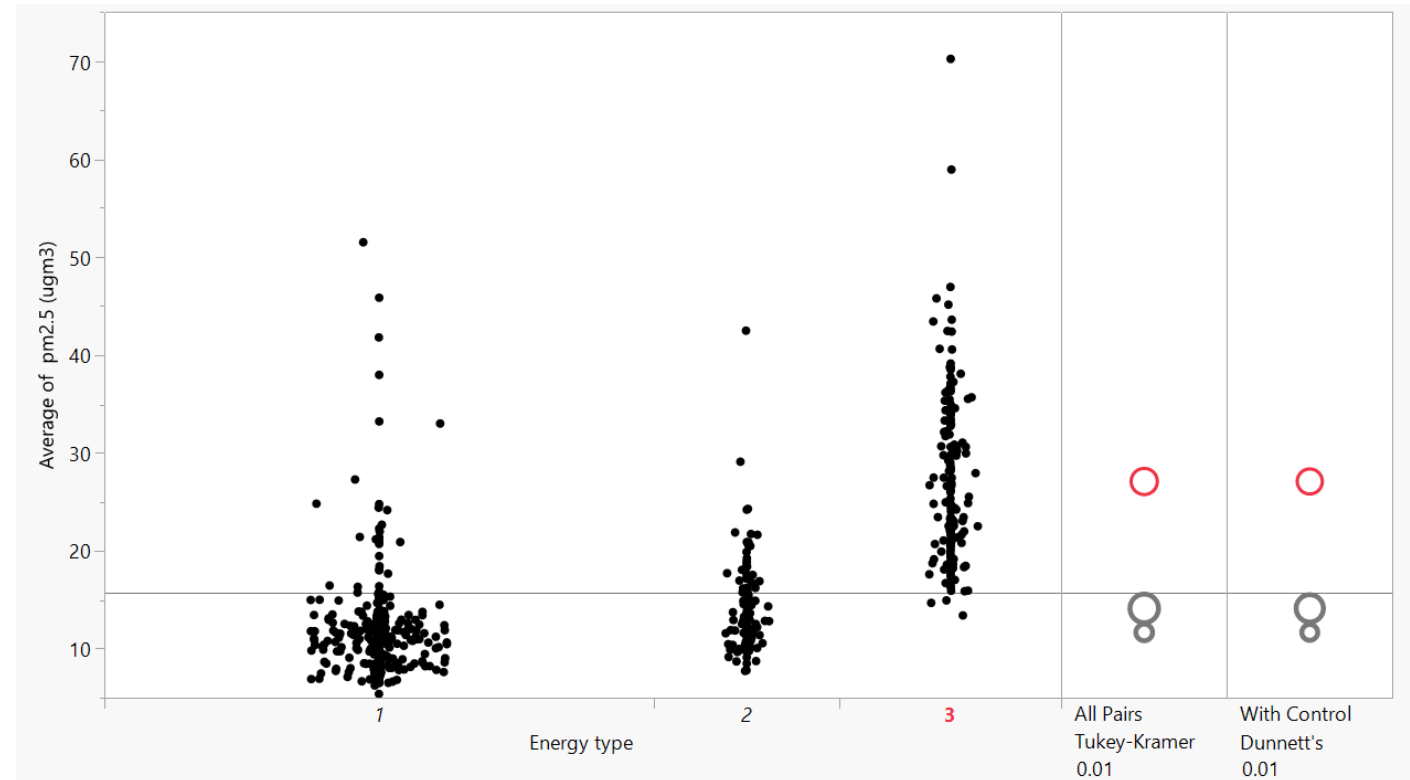


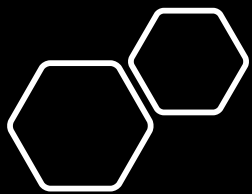


PM2.5

- 1 = Fully electrified homes
- 2 = Partially electrified homes
- 3 = Control group/Natural gas

One-way ANOVA of PM2.5

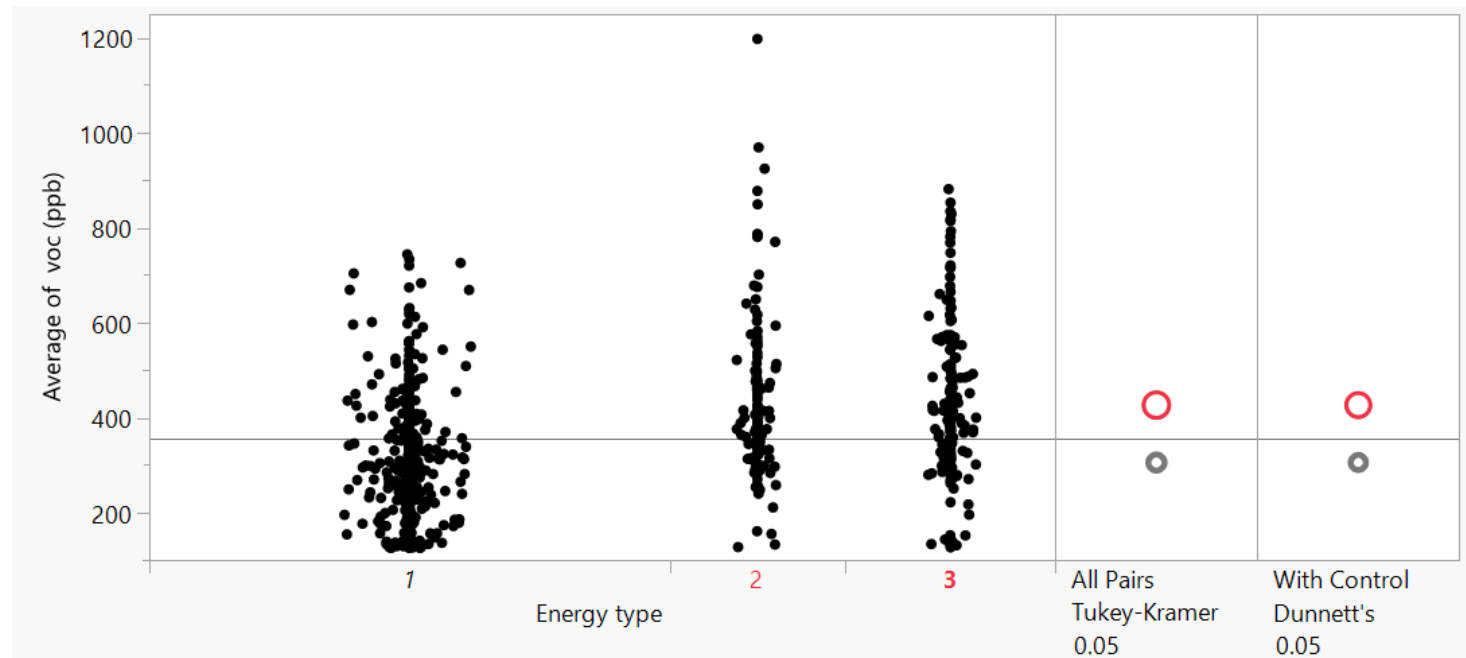




Volatile Organic Compounds

- 1 = Fully electrified homes
- 2 = Partially electrified homes
- 3 = Control group/Natural gas

One-way ANOVA of VOC



Health and Wellbeing

Acute, chronic exposure could induce



Symptoms of Carbon monoxide poisoning

- Dizziness
- Headache
- Disorientation
- Impairment of the cerebral function
- Coma

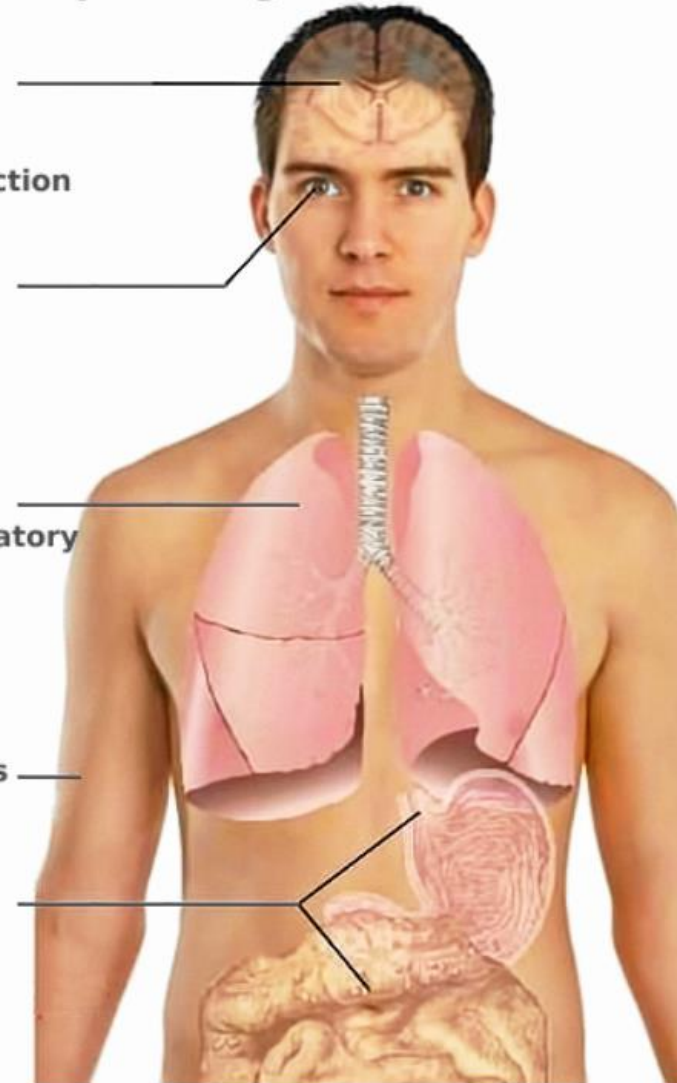
- Visual disturbances

- Disease of the heart and respiratory

- Muscle weakness
- Muscle cramps
- Seizures

- Nausea

- Aggravation of preexisting diseases





The takeaways

- We see a decrease in CO, PM2.5 and VOC in homes which are electrified. This could impact individual health in the long run.
- This pilot study showed that low-cost sensors (with health surveys included) communicated impacts of electrification that can be useful for a greater study.



Questions?

Sources:

- I. Fugler, D. *Residential combustion spillage monitoring*. Canada.
- II. Chung-Ping Lo, Shao-Yuan Chen, Kwo-Whei Lee, Wei-Liang Chen, Cheng-Yu Chen, Chun-Jen Hsueh, Guo-Shu Huang, May 13, 2007. DOI:10.2214/AJR.07.2425, AJR 2007; 189:W205–W211 0361–803X/07/1894–W205
- III. Tuula H, Tarkiainen, Kirsi L Timonen, Esko J Vanninen, Sari Alm, Juha E.K. Hartikainen, Juha Pekkanen, Effect of acute carbon monoxide exposure on heart rate variability in patients with coronary artery disease, 17 March 2003, [Clinical Physiology and Functional Imaging Volume 23, Issue 2](https://doi.org/10.1046/j.1475-097X.2003.00478.x) <https://doi.org/10.1046/j.1475-097X.2003.00478.x>
- IV. US Energy Information Association (EIA) ,Winter energy bills in the United States likely to be similar to last winter's, October 7 2020, <https://www.eia.gov/todayinenergy/detail.php?id=45416>
- V. Yellowblue, Sources of indoor Air pollution, July 24 2017, <https://yellowbluetech.com/2017/07/24/sources-indoor-air-pollution/>
- VI. Yang, S., Pernot, J. G., Jörin, C. H., Niculita-Hirzel, H., Perret, V., & Licina, D. (2020). Energy, indoor air quality, occupant behavior, self-reported symptoms and satisfaction in energy-efficient dwellings in Switzerland. *Building and Environment*, 171, 106618. <https://doi.org/10.1016/j.buildenv.2019.106618>