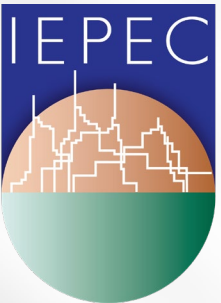**Guidehouse**

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Invisible No Longer: Cost-Effective Methods for Determining Gas End Use Load Shapes

IEPEC | November 1-4, 2022 | San Diego, CA

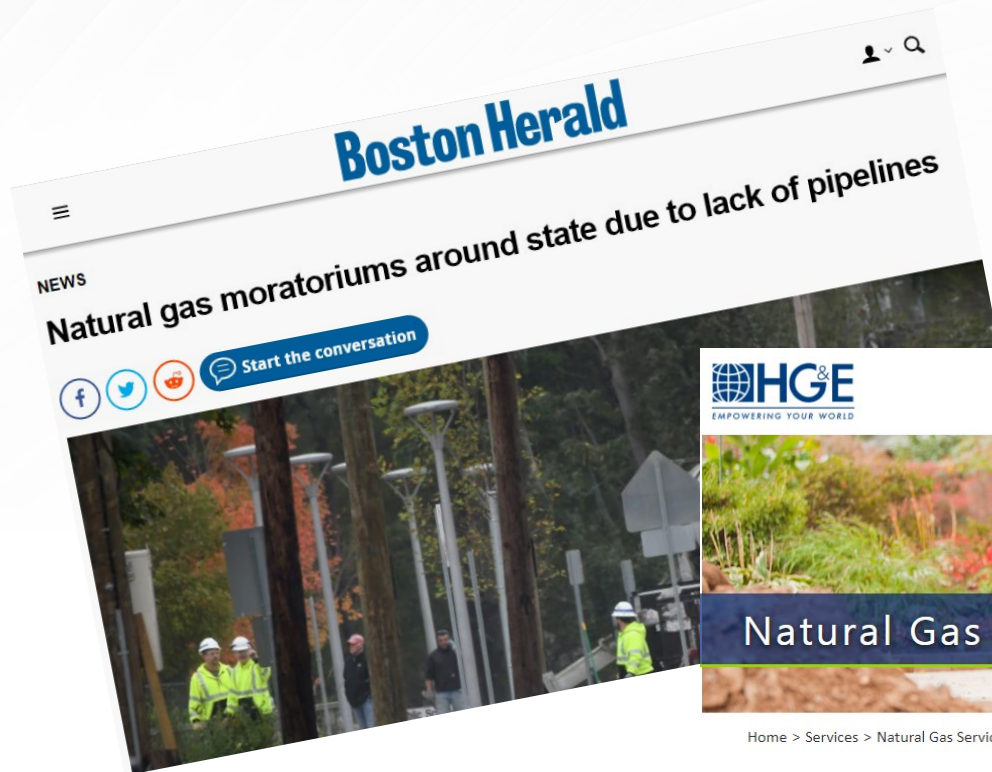**Ryan Powanda, Guidehouse**

IEPEC

Agenda

OVERVIEW OF STUDY

METERING AND ANALYSIS METHODOLOGY

RESULTS AND RECOMMENDATIONS

Why should we care about gas end use load shapes?

Natural gas moratoriums around state due to lack of pipelines
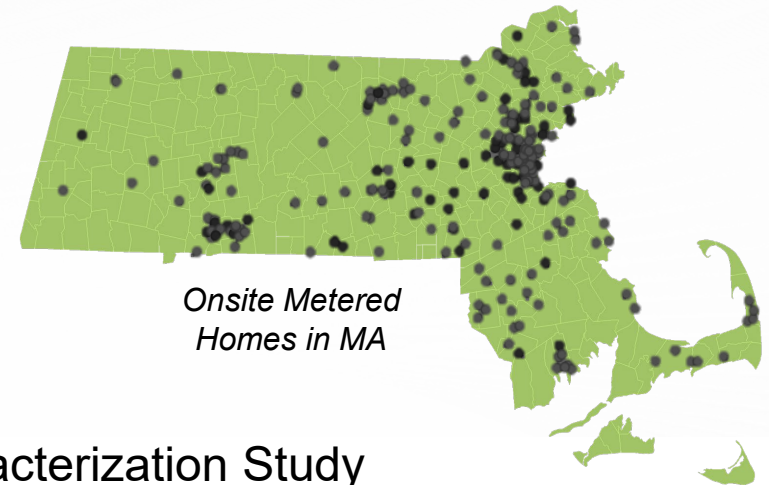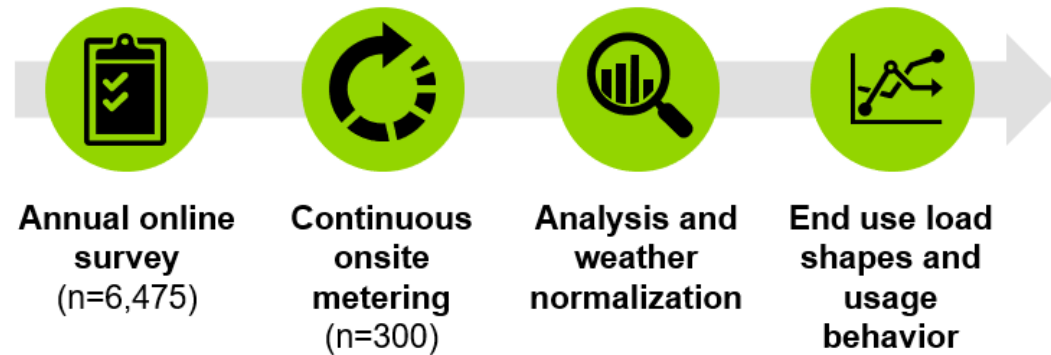
In January 2019, HG&E was forced to impose a natural gas moratorium on all requests for new or increased natural gas service. Regionally, demand for natural gas is outpacing supply, which has led to several local utilities imposing moratoriums.

N.Y.C.'s Gas Ban Takes Fight Against Climate Change to the Kitchen

New York will become the nation's largest city to enact a ban on gas heat and stoves in new buildings. It's a major step away from fossil fuels that is expected to influence wider markets.

MA Residential Building Use and Equipment Characterization Study

Annual online survey (n=6,475) → Continuous onsite metering (n=300) → Analysis and weather normalization → End use load shapes and usage behavior
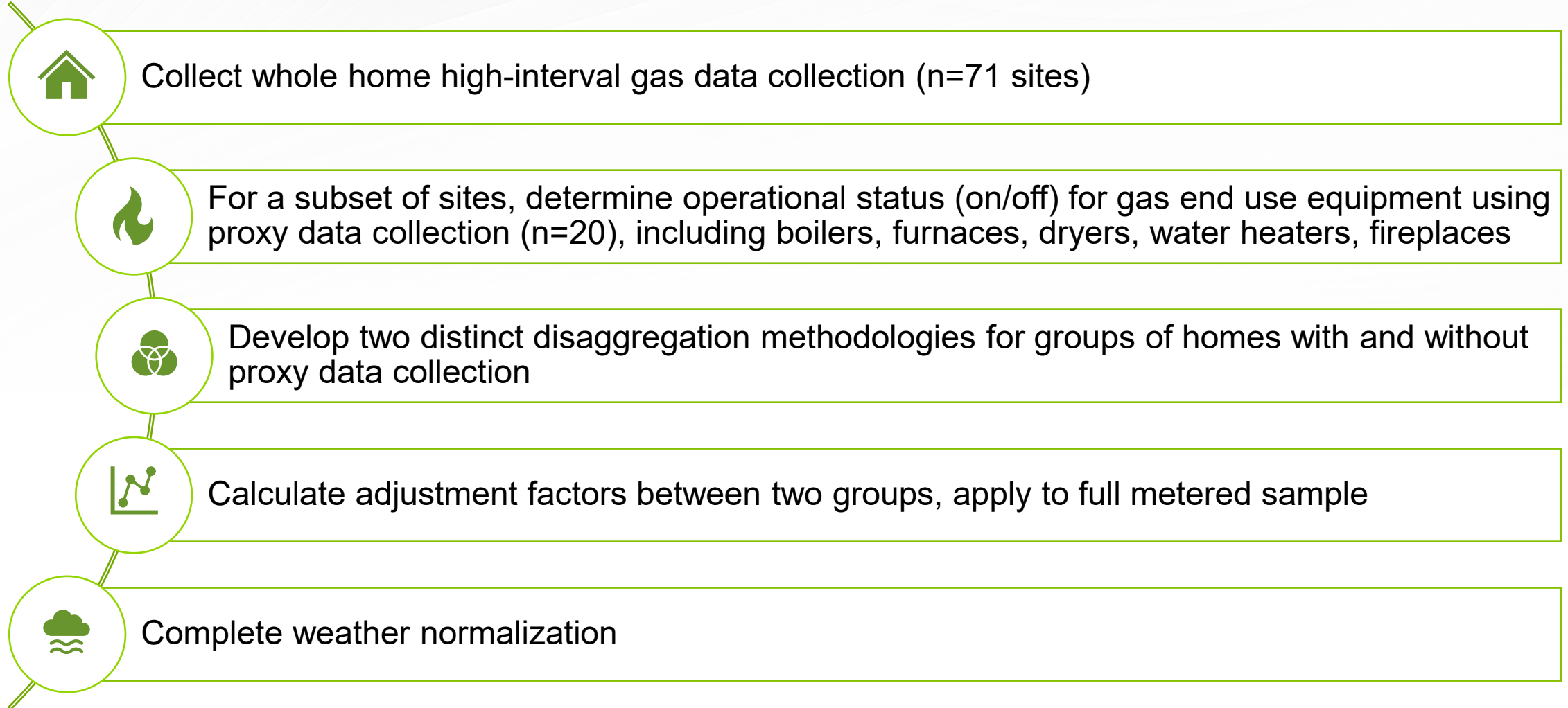
Onsite Metered Homes in MA

The Massachusetts Residential Building Use and Equipment Characterization Study collects saturation, characterization, and temporal usage behavior for all major electric (2018-2022) and gas (2020-2022) equipment in MA homes to support program evaluation, design, and potential studies.

Gas pilot study in 2020 sought to test out new metering equipment, disaggregation methodologies, and to develop annual, peak day, and hourly gas load shapes

Also See Poster: COVID-19 Pandemic Impacts to Electric and Gas Consumption Patterns in Massachusetts

Overview of Approach

Collect whole home high-interval gas data collection (n=71 sites)

For a subset of sites, determine operational status (on/off) for gas end use equipment using proxy data collection (n=20), including boilers, furnaces, dryers, water heaters, fireplaces

Develop two distinct disaggregation methodologies for groups of homes with and without proxy data collection

Calculate adjustment factors between two groups, apply to full metered sample

Complete weather normalization

Metering Setup

Whole home gas data collection using Copper Labs loggers

Compatible with Type 12 AMR meters, increment in 0.02 ccf / ~2.1 kBtu – 1.2 min for furnace, 6 min for dryer

Exhaust duct temperature logging using Lascar surface temperature loggers

Gas solenoid valve logging using Onset UX90 on/off motor logger (furnaces/boilers)
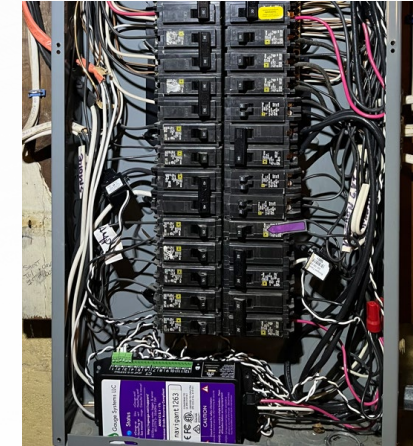
Electric component operation using eGauge in the electric panel (furnace fan, boiler pumps, exhaust/blower fans, dryer use)

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Gas Disaggregation Method 1 – Sites with Proxy Data

S0566 - Furnace 100 kBtu/h 84 AFUE, Fireplace 40 kBtu/h, Oven or Range 15 kBtu/h, DHW 38 kBtu/h, Clothes Dryer 22 kBtu/h
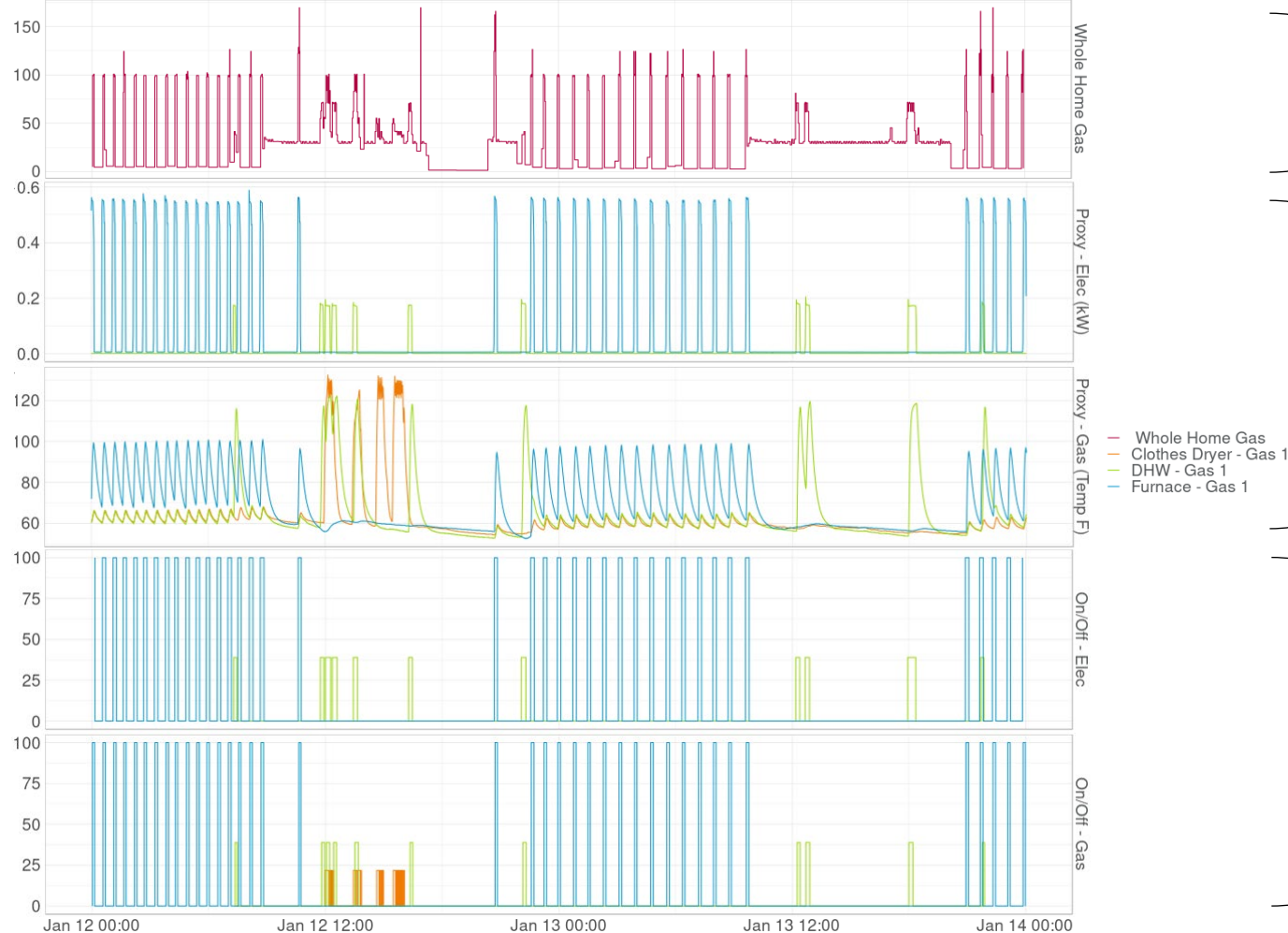
Whole home gas usage (2 days)

Electric and surface temp proxy data
- Used to identify on/off

On/off for proxy metered equip
- When multiple gas end uses run during given time period, consumption split using run time and gas heat rates of individual equip

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Gas Disaggregation Method 1:
Sites with Proxy Data

For sites with non-metered gas fireplaces, we were often able to identify the heat rate and usage signature (40 kBtu/hr in previous slide)
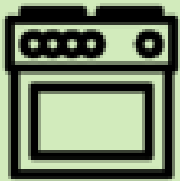
We leveraged the electric cooking load shapes from the broader MA Residential Building Use and Equipment Characterization Study, converting to gas using ratio of average efficiencies

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Gas Disaggregation Method 2:
No Proxy Data

Gas cooking and clothes dryer loadshapes sourced from analogous electric loadshapes

Gas water heater loadshape determined from summer whole home gas usage, minus gas cooking and clothes dryers
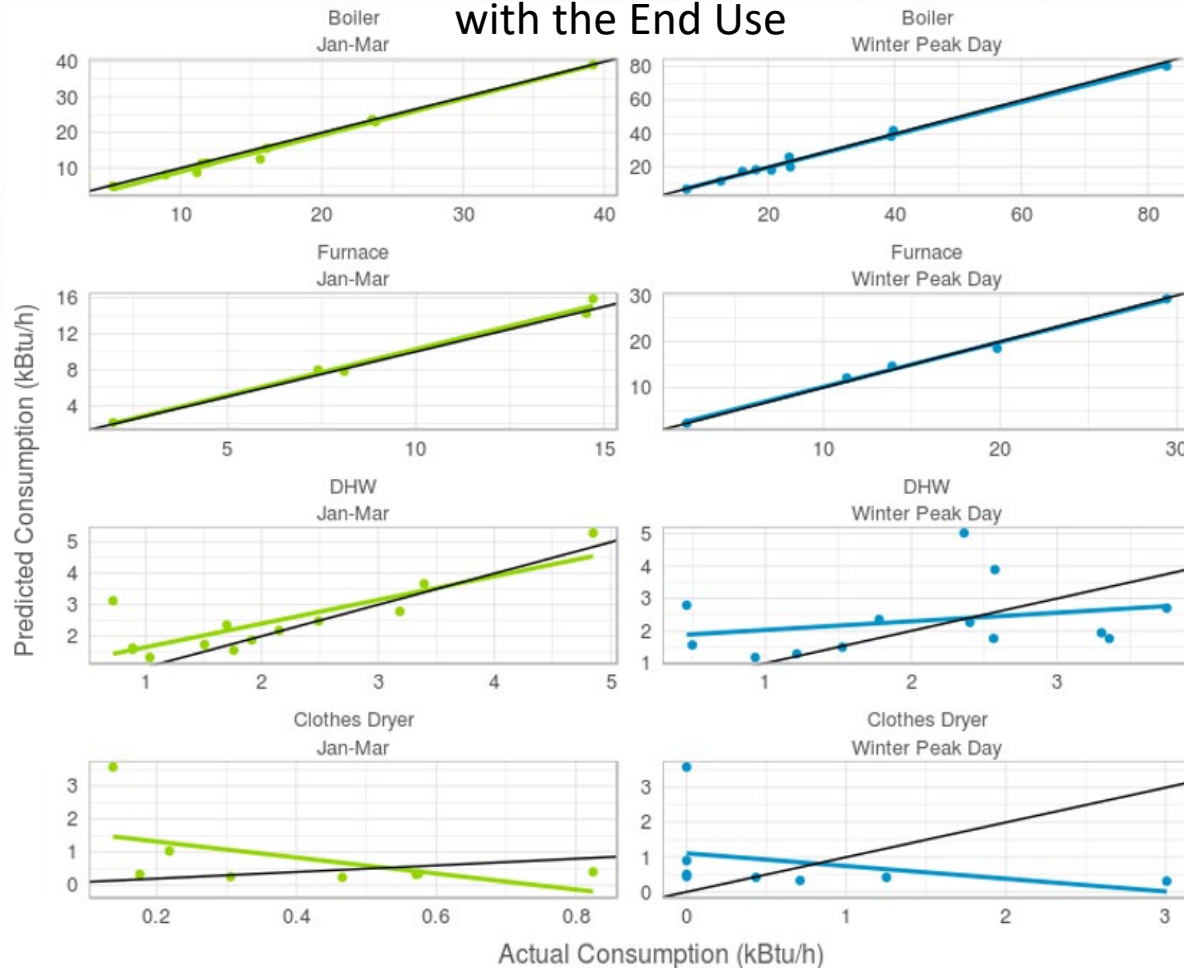
- Usage then scaled by month based on average water mains temperature

Space heating loadshapes determined from winter whole home gas usage, minus all other end uses

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Adjustment Factors

Average Disaggregation Adjustment Factors for Sites with the End Use

- The team used the proxy disaggregation group (n=20) to calculate adjustment factors, ratio of usage using results from both disaggregation methods applied to the same 20 sites

- These adjustment factors were used to "true up" the disaggregation for homes without proxy data (n=51)

- The Method 2 disaggregation (no proxy data) worked well for boilers and furnaces, and relatively well for hot water (usage, not demand)

  - It did not work well for clothes dryers

Results

Typical Gas End Use Consumption for Homes with the End Use
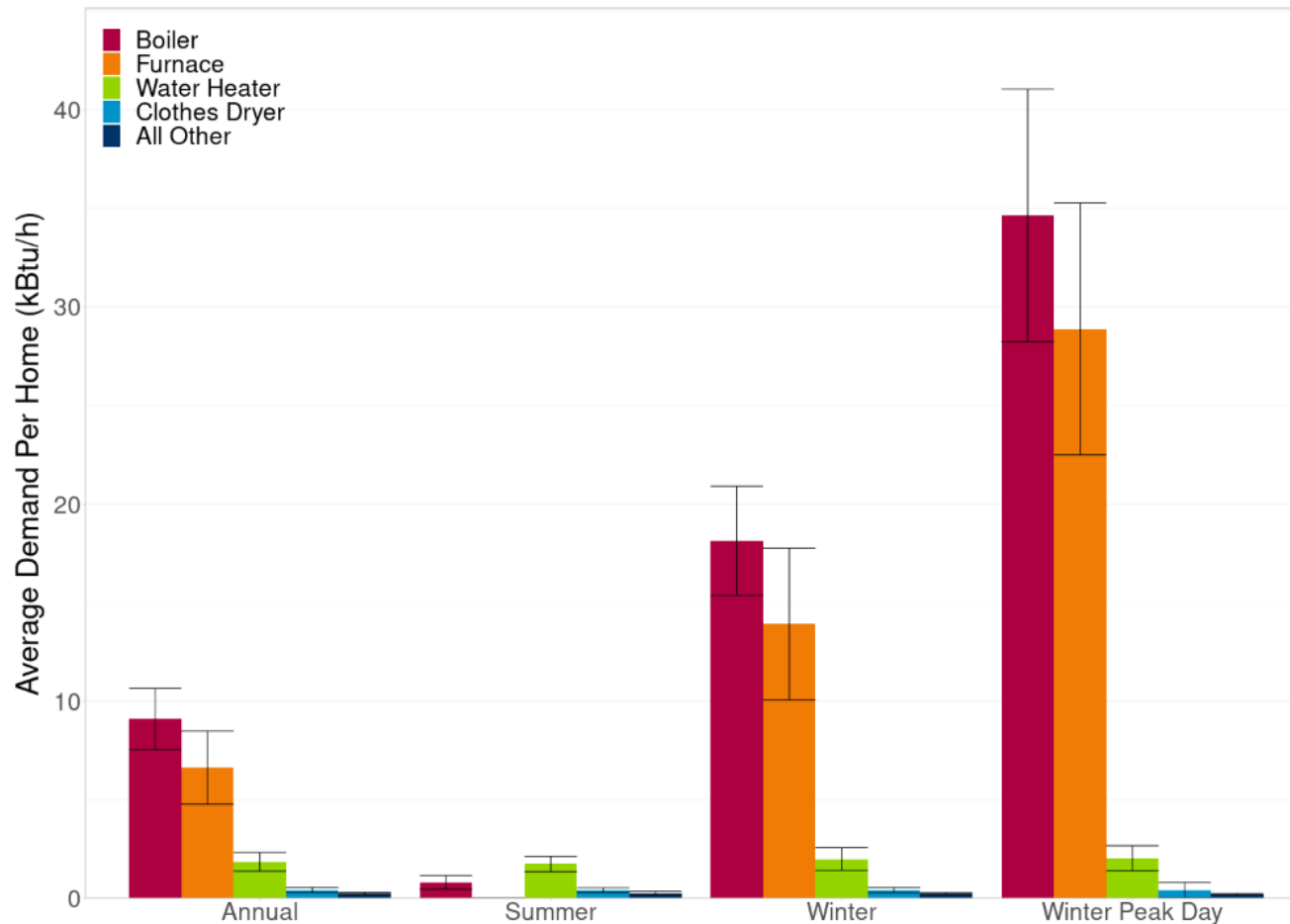
- Space heating consumption accounts for the bulk of gas use (~76% annually, 92% of winter peak)

- Hot water consumption accounts for ~19% annually, 7% of winter peak

- Clothes dryer and other end use consumption (such as cooking) consumes ~5% annually, 1% of winter peak)

- Relative precision was ~30% and below for annual, seasonal, and winter peak day consumption for all end uses, except clothes dryers (winter peak day), due to higher variability of usage

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Results

Average Winter Day and Winter Peak Day Hourly Gas End Use Consumption for Homes with the End Use
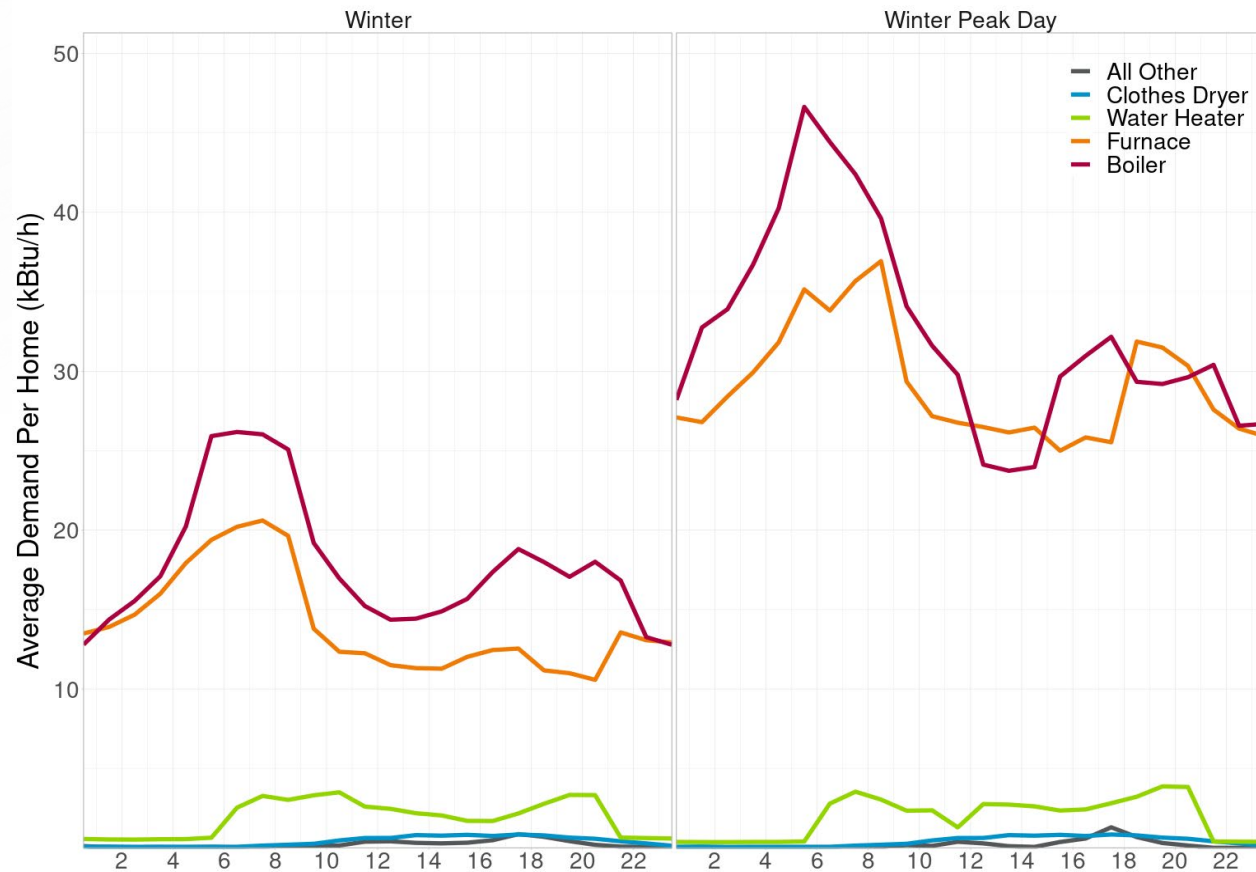
- Space heating peaks from 5-9AM, with secondary peak from 5-9 PM

- Water heating peaks from 7-9AM and again at 7-9PM

- The peak gas consumption on the winter peak day is approximately 60% higher than peak consumption on the average winter day

Key Takeaways

Important for utilities to understand gas end use consumption and peak demand (EE program design)

Study design option 1: Whole home only data collection is possible if all you care about is annual energy consumption for space heating and water heating, plus peak demand for space heating. Copper Labs loggers can be mailed to sites and installed by customers, further reducing field costs.

Study design option 2: If you need to nail peak demand for water heating, and care about dryer annual consumption and peak demand, additional proxy data collection is necessary on a sample of homes. Stats from this study can inform required sample sizes (see paper).

Next steps:
- Increased metered sample to 30 in 2021, analysis forthcoming
- Similar study conducted in New York using methods tested in this study

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