PROJECT UPDATE
MARCH 2025

H2k to HPXML
Systems

volta RESEARCH

March 26, 2025

Volta Research
A Brief History

- Founded as a not-for-profit corporation in 2018 with its mission to reduce energy use and emissions in Canada
- We do research, development, analysis, and technical consulting on energy and emissions reduction processes, practices, and tools
- We focus on demographic, economic, and wider societal relationships with energy usage and emissions in Canada
- We are a small team that looks to hire and support recent graduates or new entrepreneurs to help us with our work
- Stakeholder driven and want to build everyone's capacity to talk about and reduce energy use and emissions

Project Objectives

- Develop and test a methodology to convert HOT2000 files (.h2k) into HPXML files (.xml) which can be used as inputs in an OpenStudio (OS) workflow to run EnergyPlus simulations
- Current Project: Translate all “Systems” and compare fuel usage between HOT2000 and U.S. DOE’s EnergyPlus simulation tools.
- Showcase and analyze alignment of results, identify potential gaps in translation methodology
- Produce and investigate hourly (or subhourly) simulation results from translated files

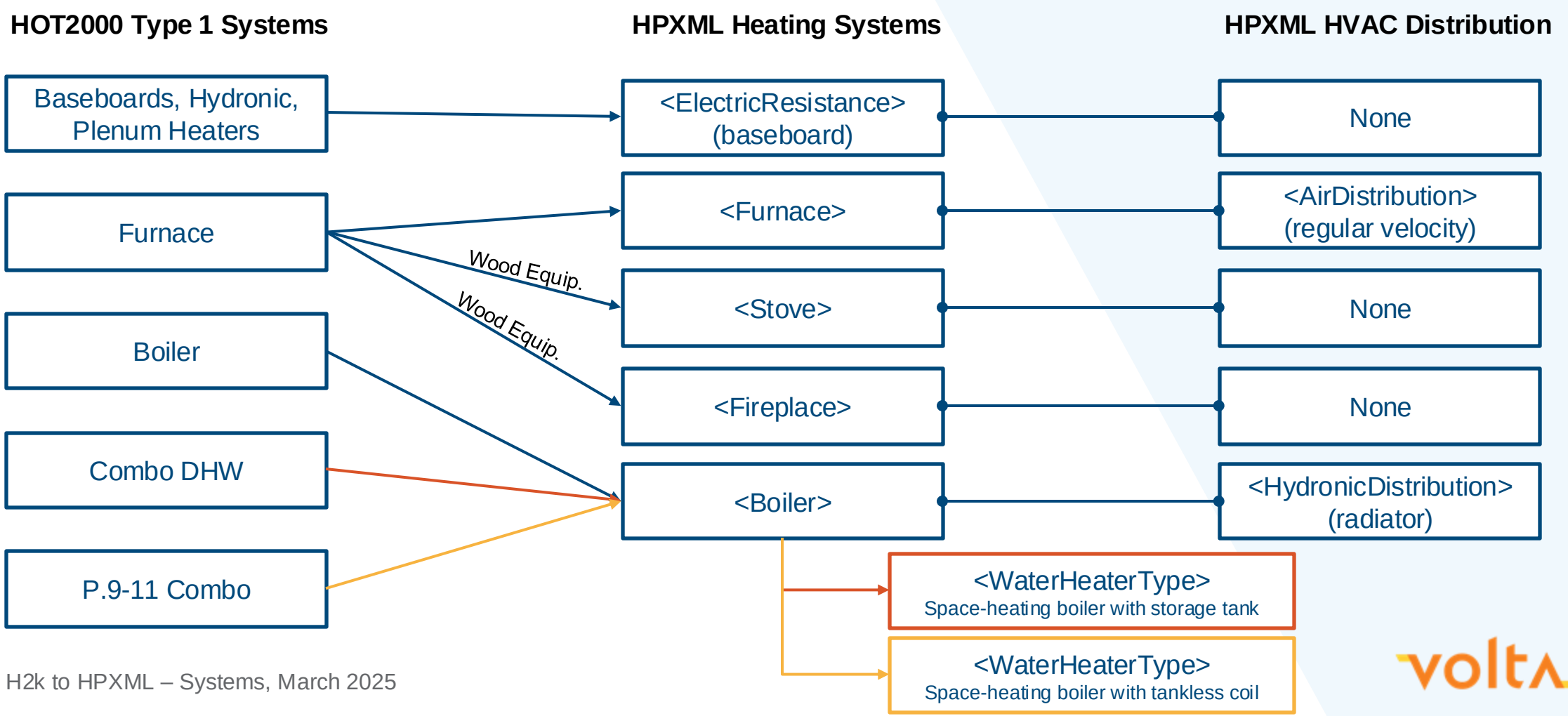
Project Scope

- Current scope: build on previous work to translate all envelope components of home and translate “Systems”
  - Heating Systems
  - Cooling Systems
  - Heat Pumps
  - DHW
  - Ventilation
  - Generation
- Building type limited to Houses, no single unit/whole-home MURBs
  - Note that this *does* include attached houses

Project Status

- Prototype translation process complete and can be run/tested
  - Some gaps not yet addressed
- All Systems translated
  - 1:1 matching not possible in all cases
- Some error handling/alerts
- Preliminary comparison of simulated fuel usage by equipment type

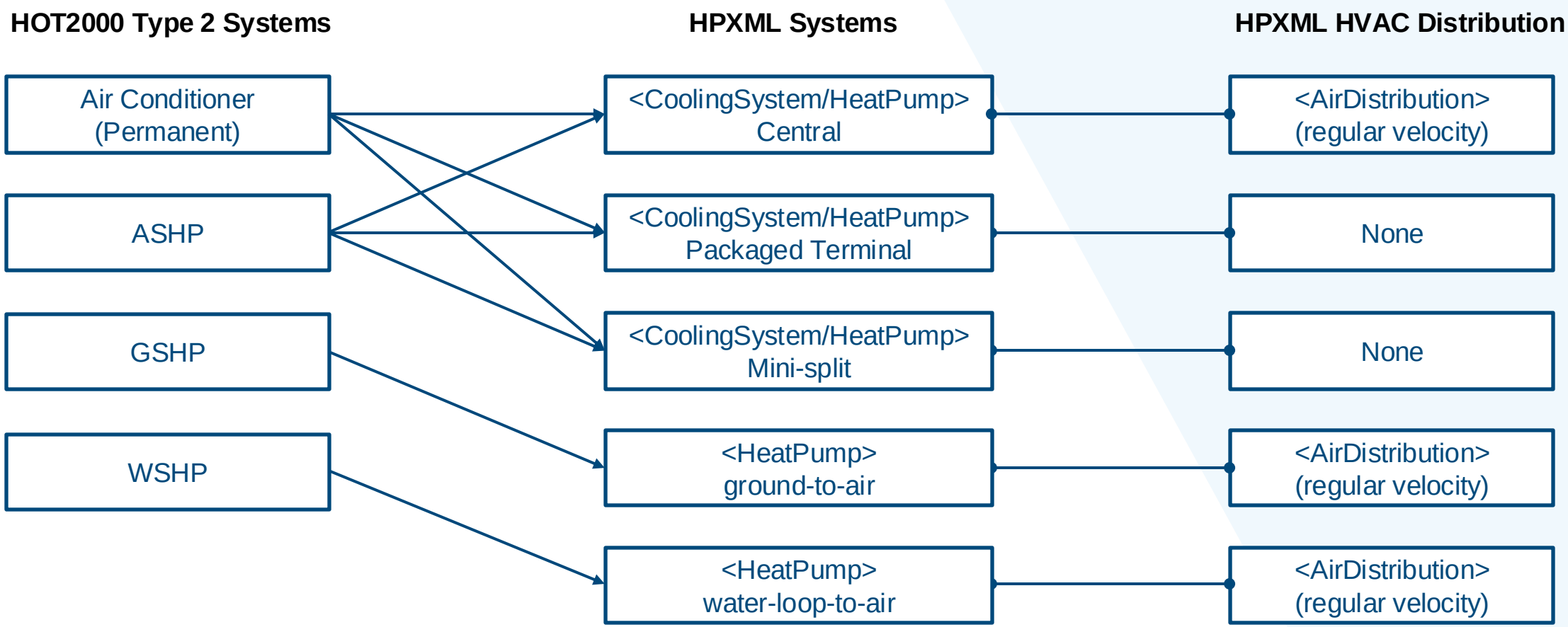
Systems Map – Primary Heating



(P.9-11) Combo Misalignment

- No direct way to account for TPF
- No direct way to model P.9-11 systems connected to air handler coils
- HPXML space heating & water heating efficiencies are coupled

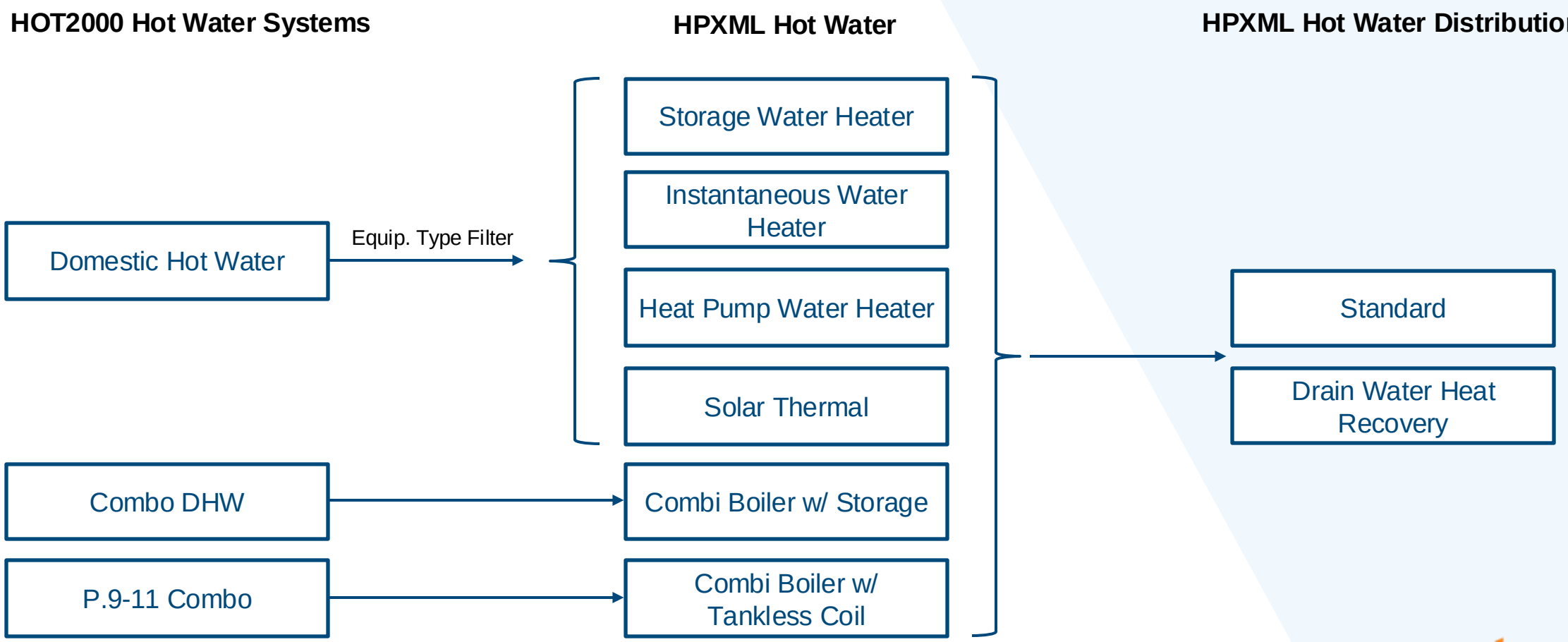
Systems Map – Cooling & Heat Pumps



AC & Heat Pump Potential Misalignment

- H2k's "**Central single package system**" vs. HPXML's "**packaged terminal** air conditioner" / "packaged terminal heat pump"
- H2k's **Water-source-heat-pump** vs. HPXML's "**water-loop-to-air**" heat pump
  - WSHP/GSHP inputs in H2k are identical
- HPXML tends to produce lower cooling consumption than H2k
  - *An engine that hasn't been tested much on low cooling loads?*

Systems Map – Hot Water



Supplementary System Misalignment

- Problem: HPXML requires the fraction of *load* served by supplementary heating systems. Difficult to infer this from the h2k file inputs/outputs.
- HOT2000 supplementary system heating can also exceed requirement of home.
- Current solution: FractionHeatLoadServed = Location Heated / Total Heated Floor Area
- Longer term solution: Requires better understanding of h2k logic, possibly determine correlations/scaling factors.

HOT2000	HPXML
• Usage (Never, Always, % of time) • Location heated (m2, % floor area) • Rated output capacity (kW) • Results: *Consumption* of each system	• Fraction of heat *load* served • Rated output capacity (kW) • Attached to zone (not applicable)

Other Areas of Misalignment

- ASHP capacity inputs: HPXML takes 2 capacity points, or defaults the low-capacity (@ -8.3˚C)
  - Capacity retention of ~56% applied based on h2k ASHP curve
- HPXML requires AFUE for furnaces and boilers and % efficiency for stoves and fireplaces. H2k allows both options for all primary heating equipment types.
- HPXML hot water takes Heating Capacity input, which is not a required parameter in h2k. Defaults if not present based on HPXML's logic.

Results – RESNET HERS

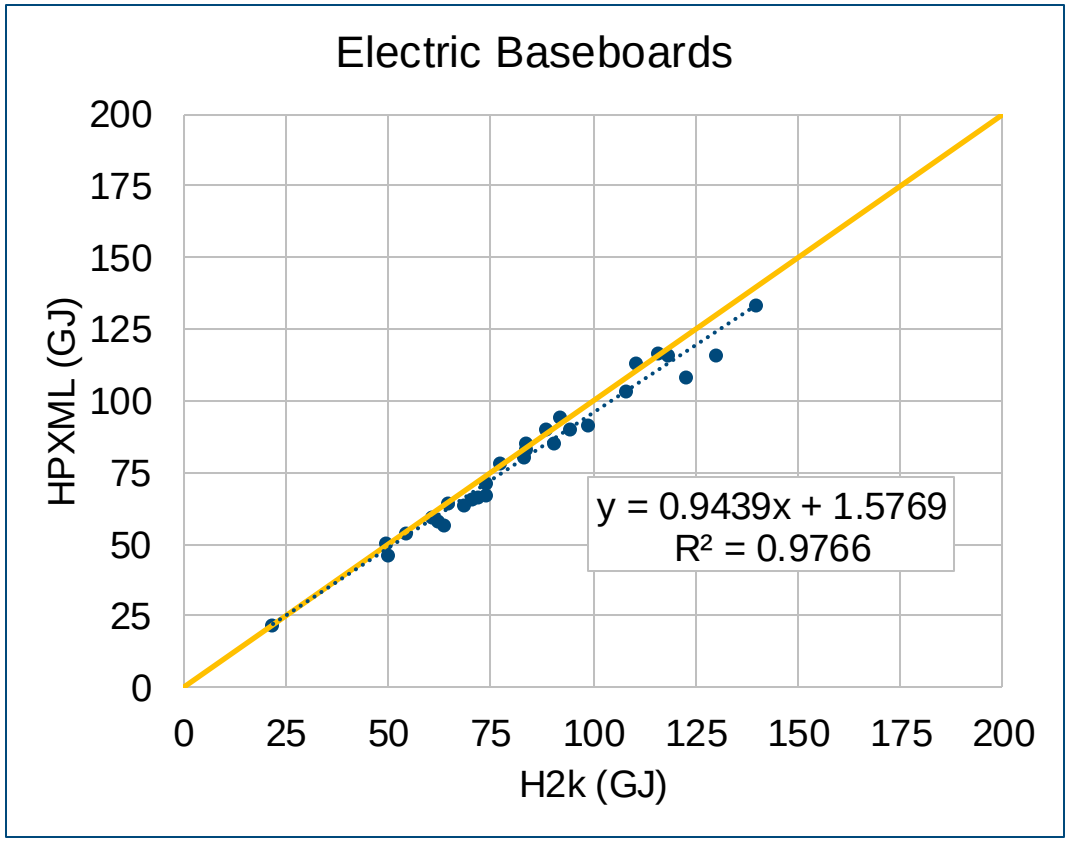
- RESNET HERS defines a set of acceptance criteria for simulation engines tested to the ASHRAE 140 standard.
  - In Nov 2024, RESNET tightened acceptance criteria relative to 2020 ranges.
- Only failing case for H2k-HPXML is a heating load “delta” case, all “absolute values” tests passed.

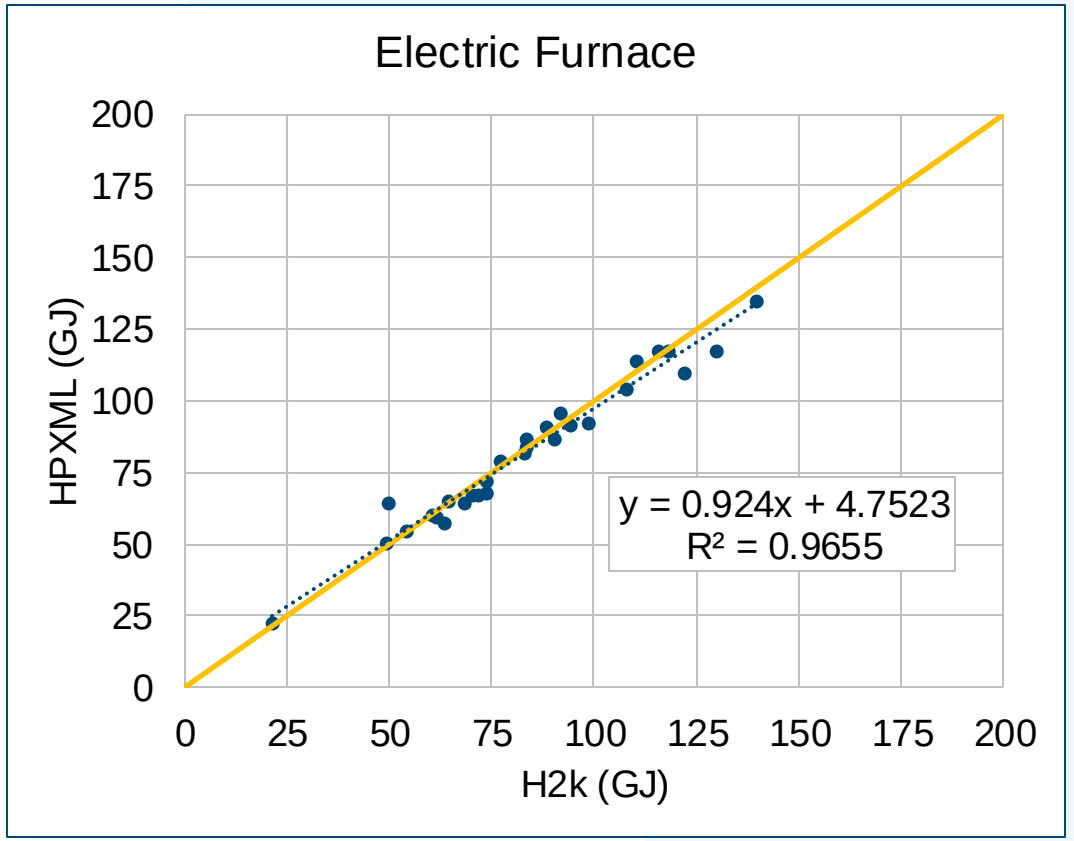
Process	2020 Criteria	2024 Criteria
OS-HPXML	50/50 passes	50/50 passes
H2k-HPXML (->OS)	50/50 passes	49/50 passes

Results – Annual Fuel Consumption

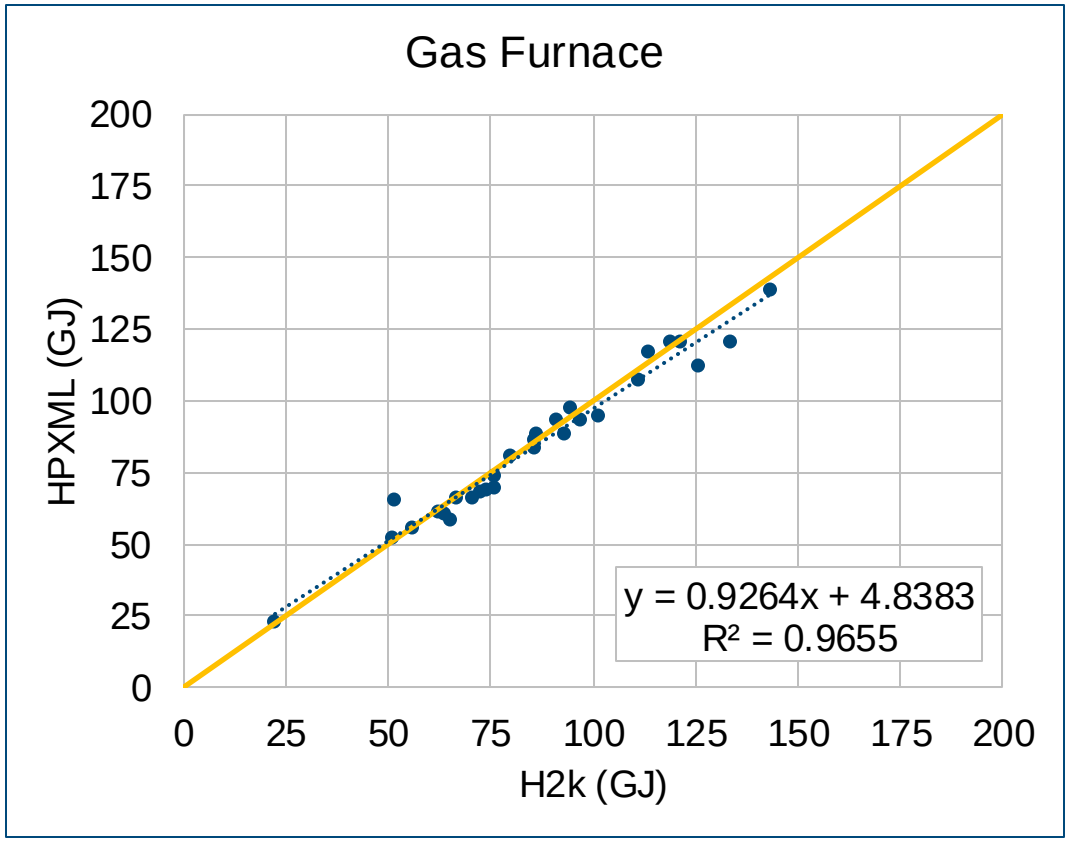
- Fuel consumption compared for a subset of 30 existing housing archetypes
  - Montreal, Ottawa, Vancouver, Edmonton, Halifax
- 30 archetypes selected with the lowest envelope deviation to try to isolate potential discrepancies with “Systems” rather than envelope issues
  - Auxiliary heating energy, Design heating & cooling loads

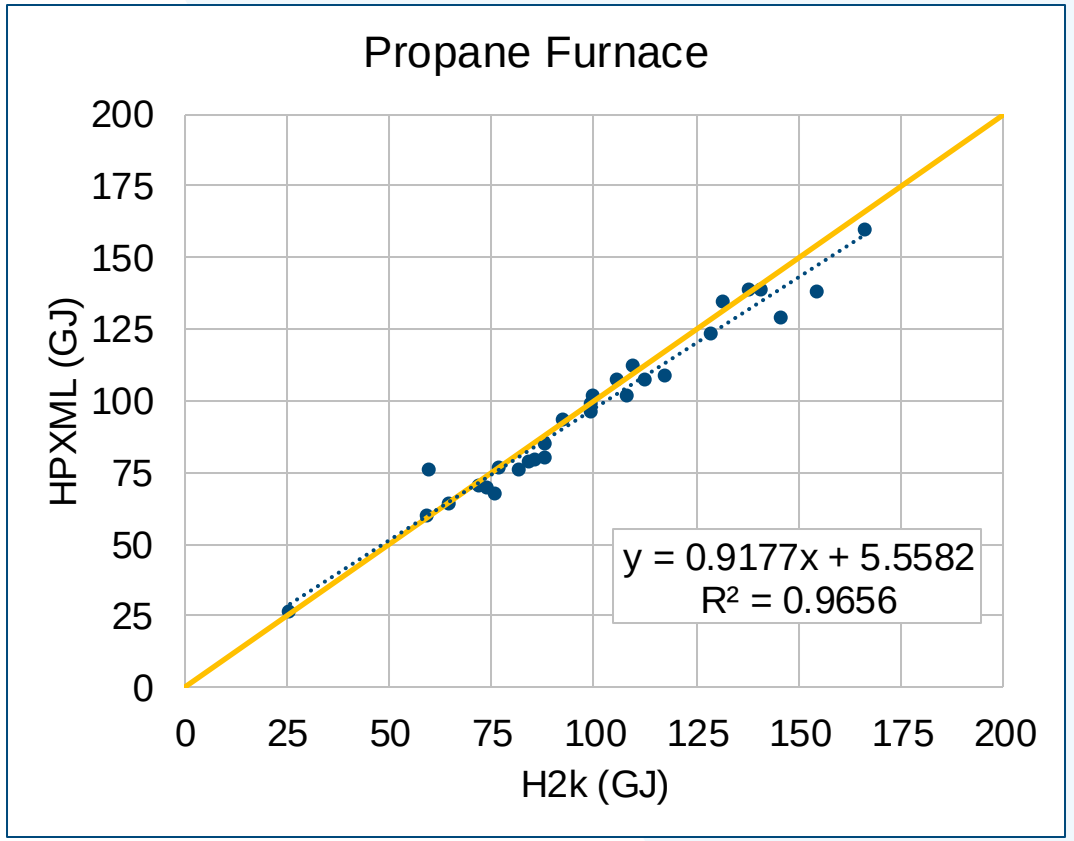
Space Heating Electricity Consumption



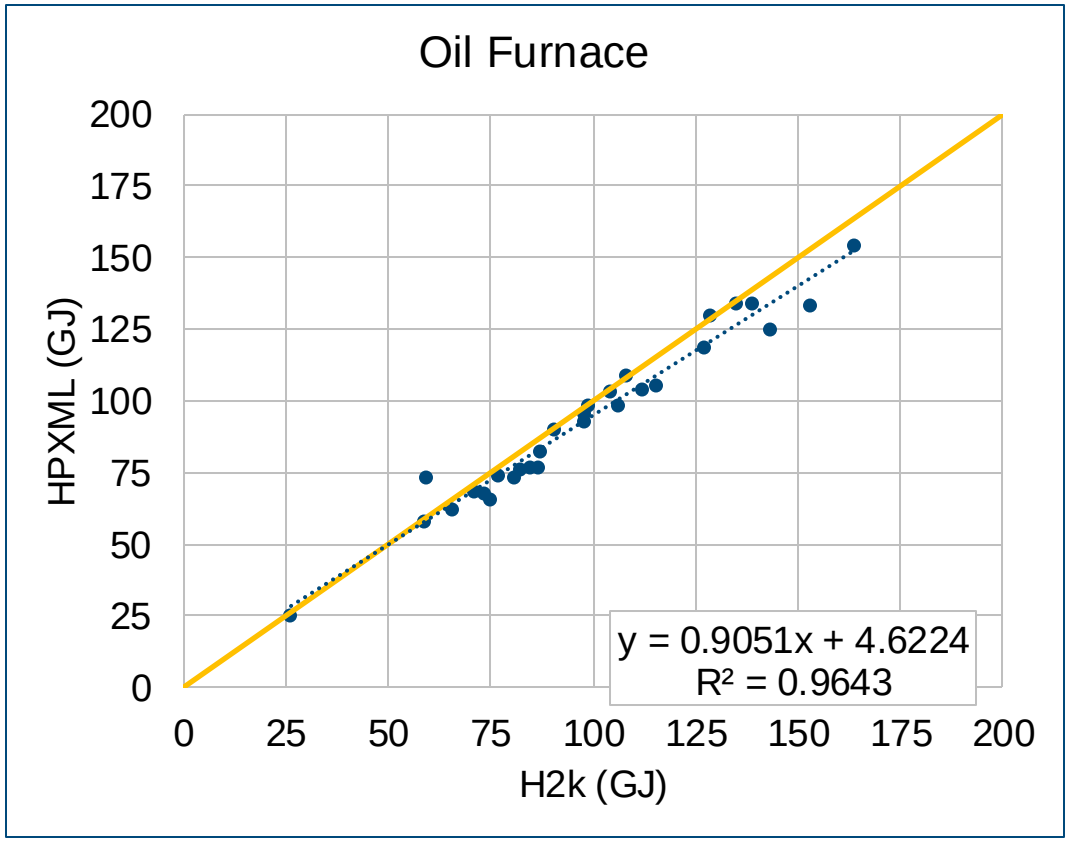


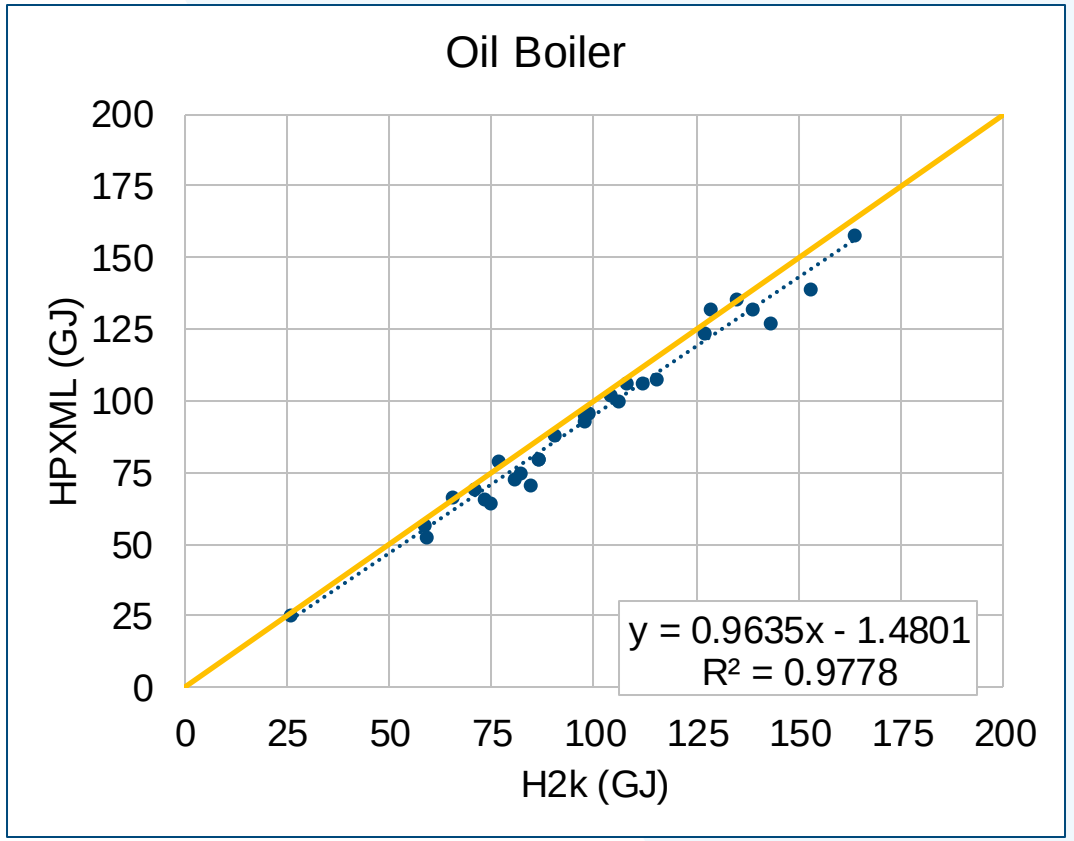
Space Heating Gas & Propane Consumption



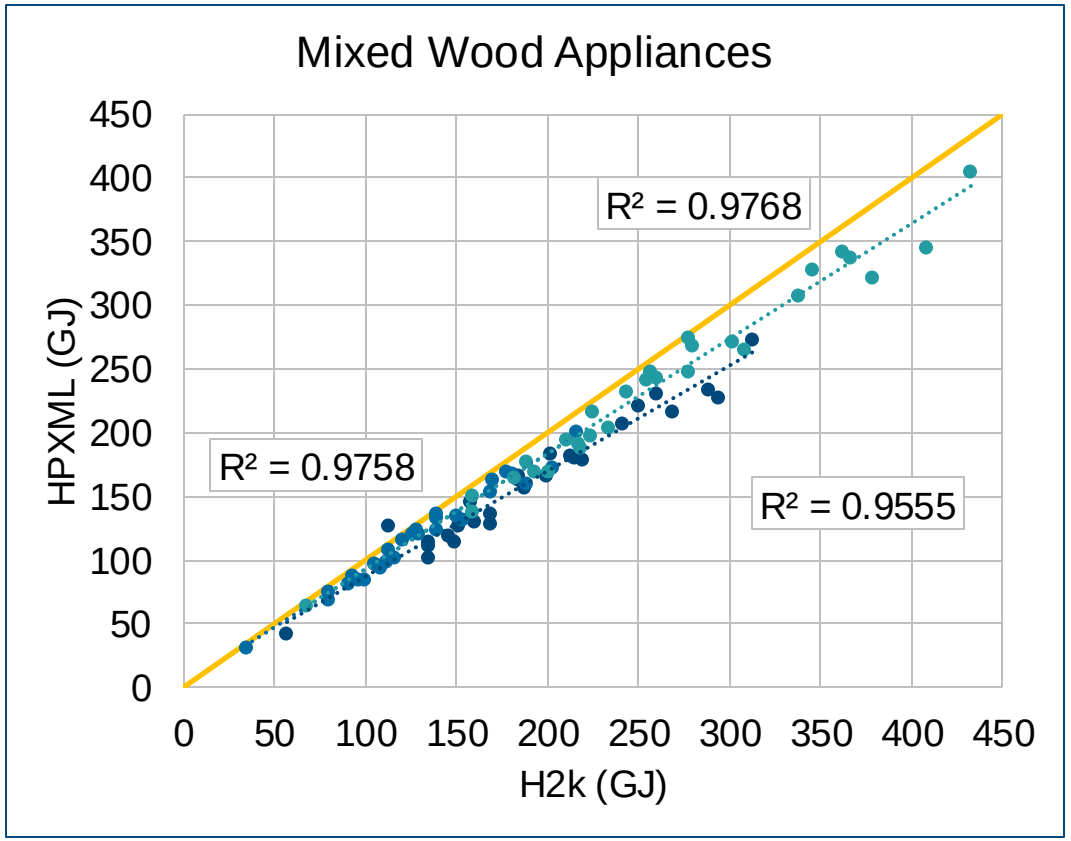


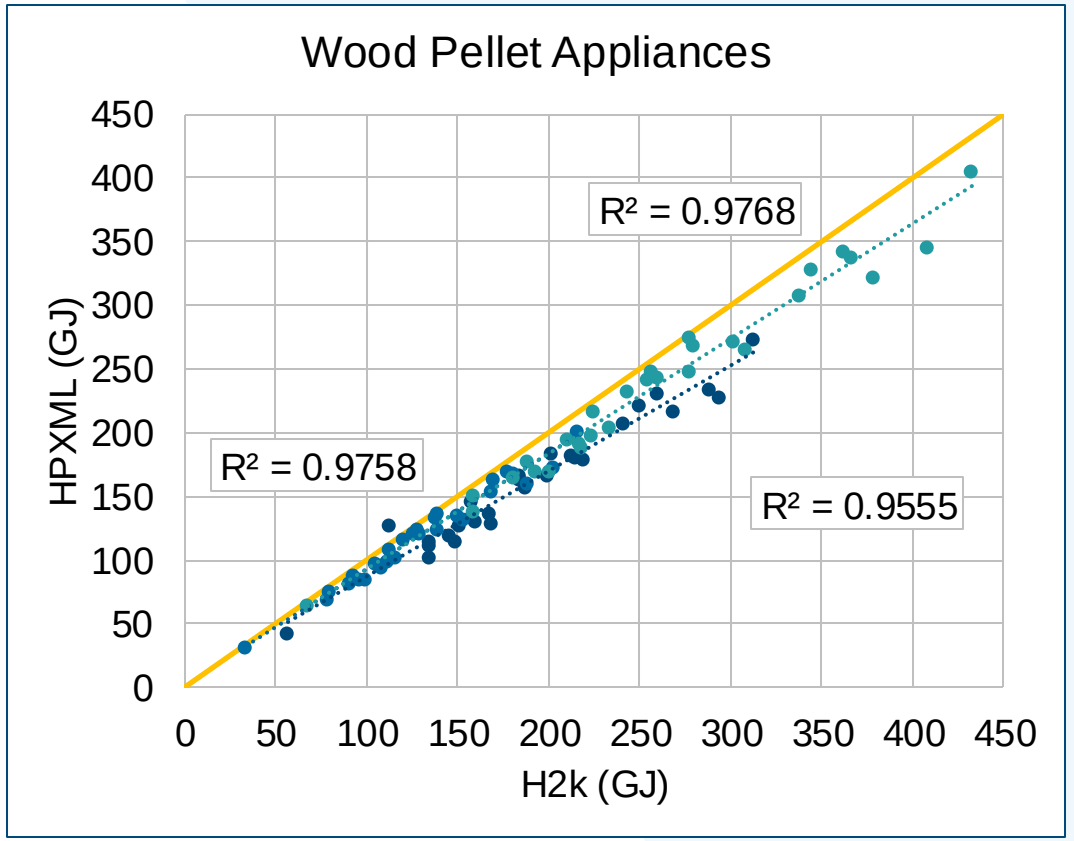
Space Heating Oil Furnace & Boiler Consumption



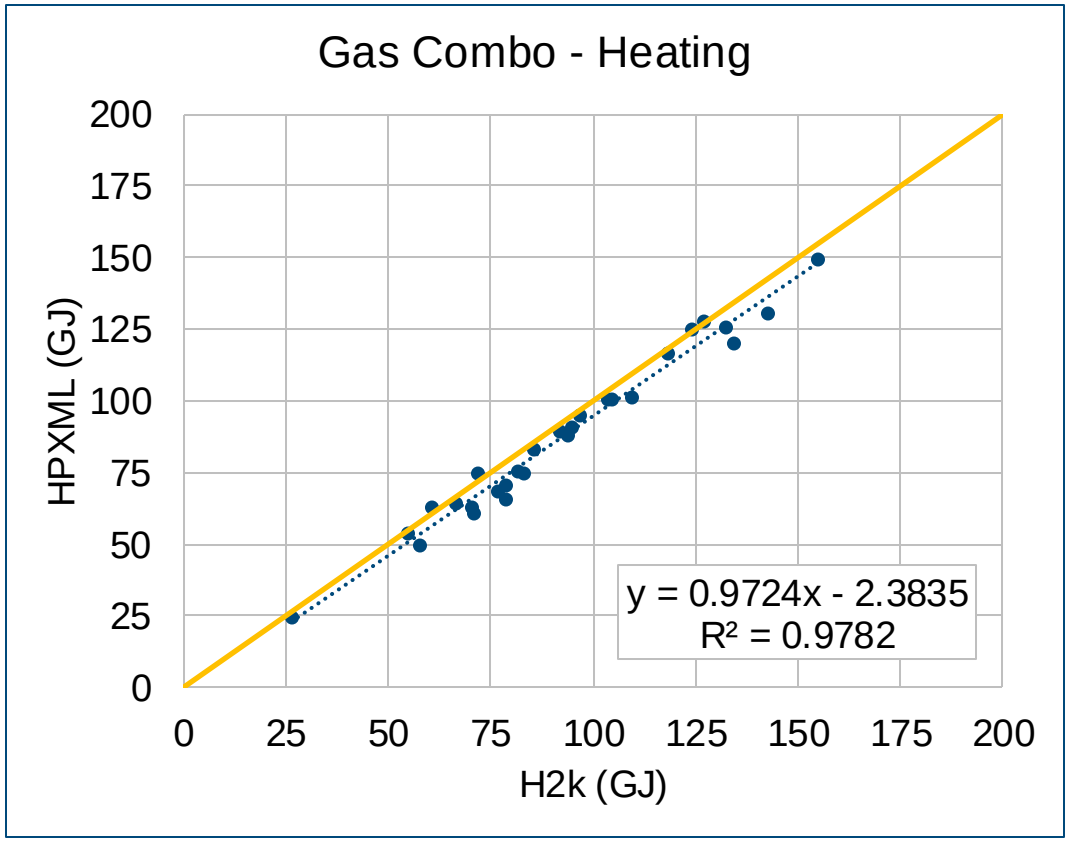


Space Heating Wood Consumption

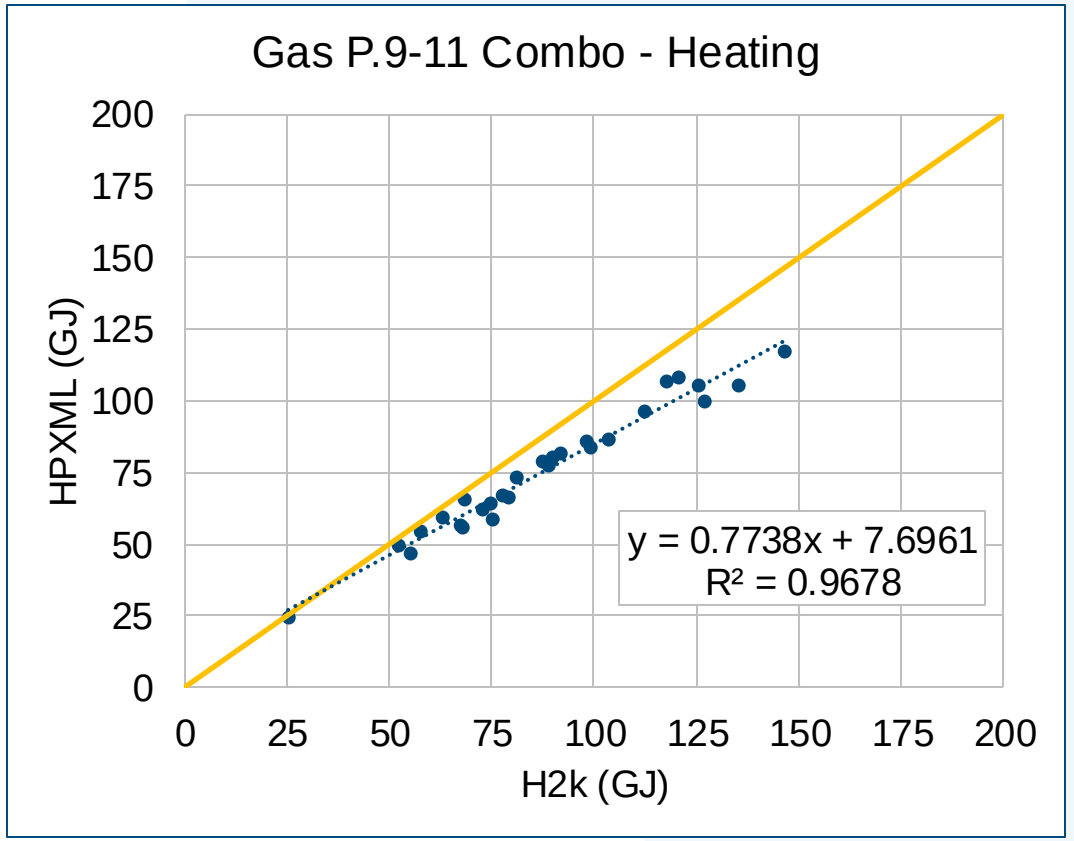




Combo Space Heating Consumption

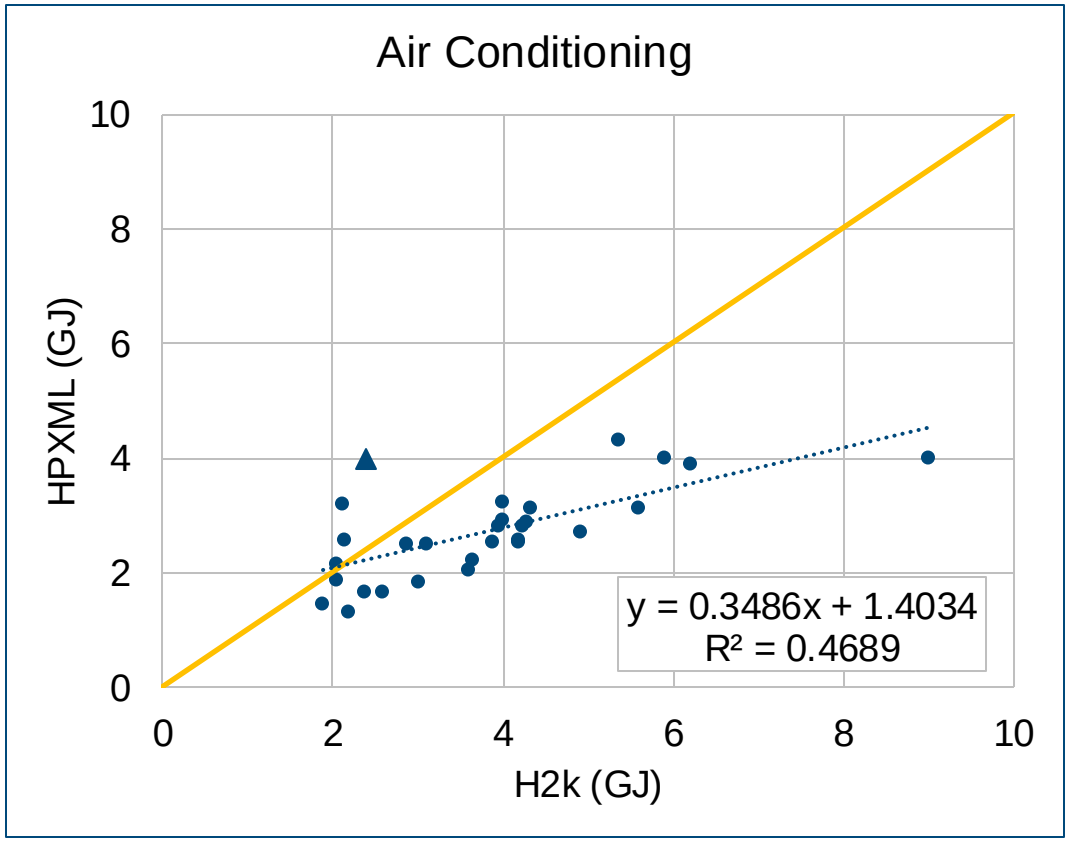


Furnace AFUE as the *overall* efficiency
HPXML water consumption 1.7x H2k



TPF as the *overall* efficiency
HPXML water consumption 1.5x H2k

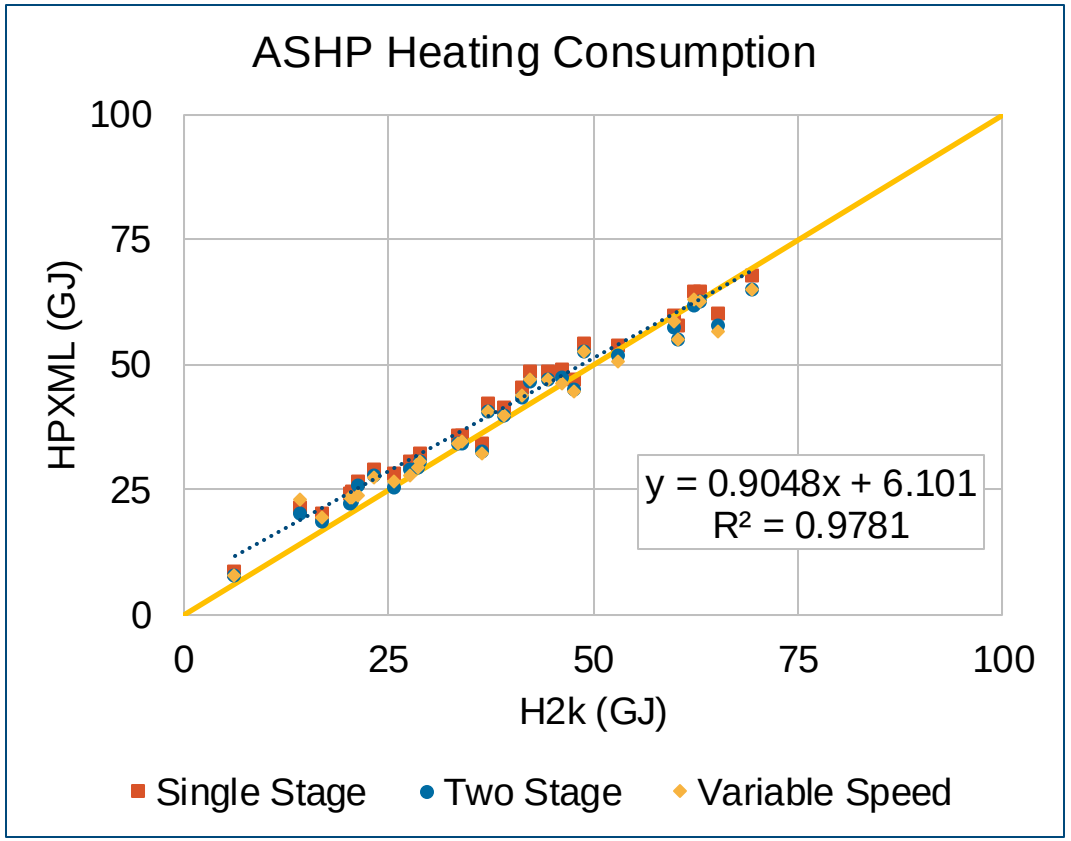
AC Cooling Energy Consumption

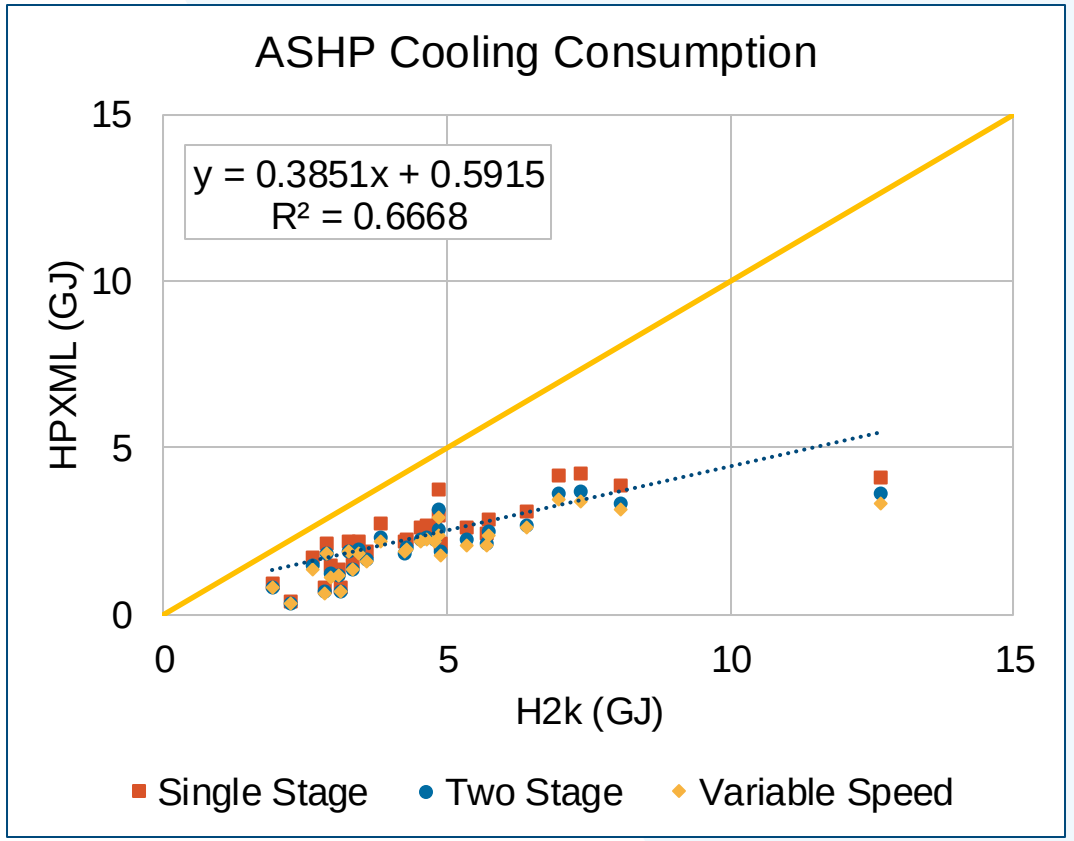


- Many unknowns with cooling:
  - H2k gives us auxiliary heating energy, gross heat loss, design heating load. Only design cooling load on cooling "side"
- Assumptions occurring in both engines
  - How do we get from Capacity and SEER to actual consumption numbers?
- Inconsistencies based on system size:
  - Design cooling loads within 2%

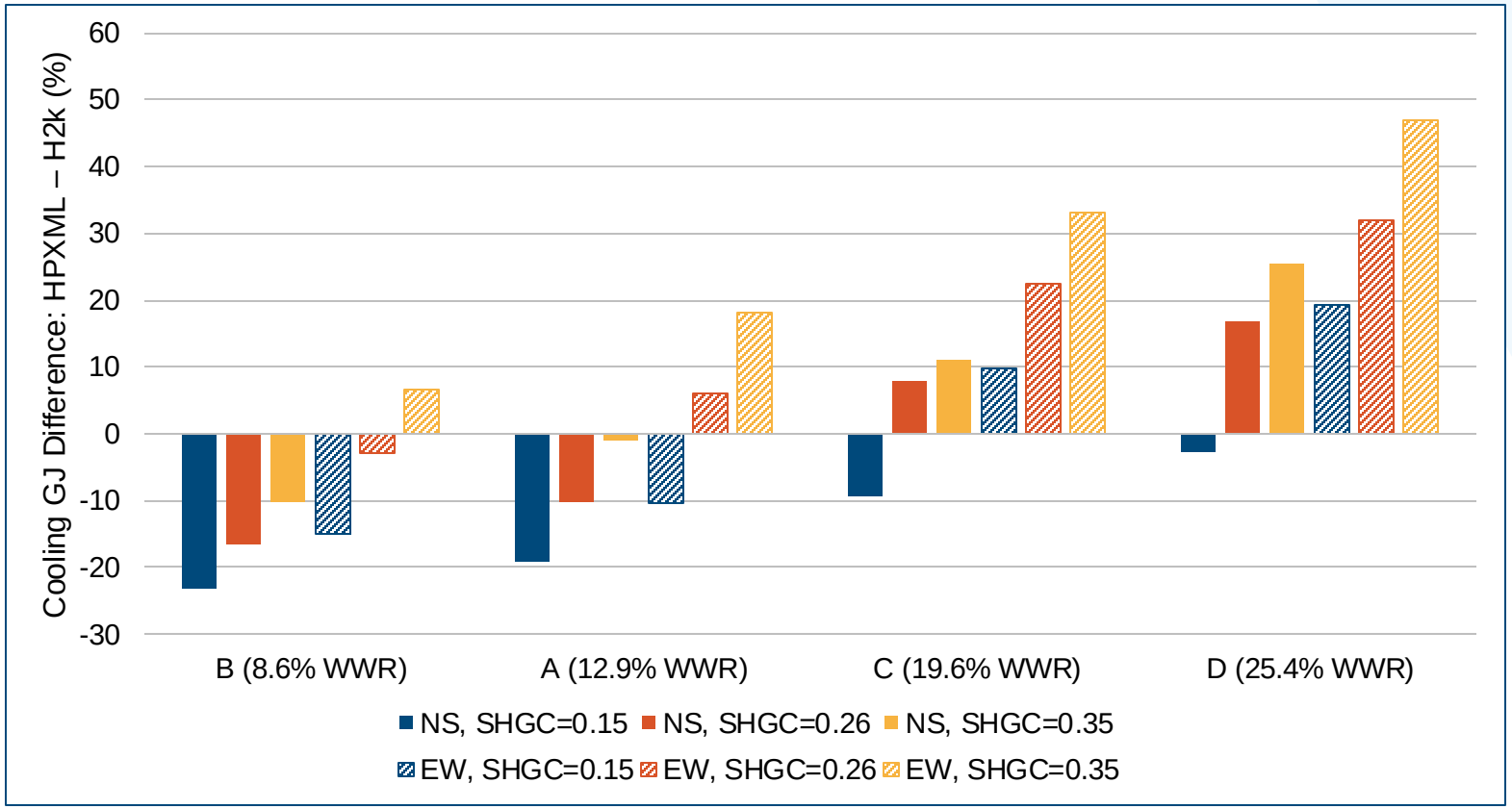
Type	*SEER*	*kW*	*H2k (GJ)*	*HPXML (GJ)*
AC	16	9	2.4	4.0
ASHP	16	13	4.9	3.8

ASHP Energy Consumption



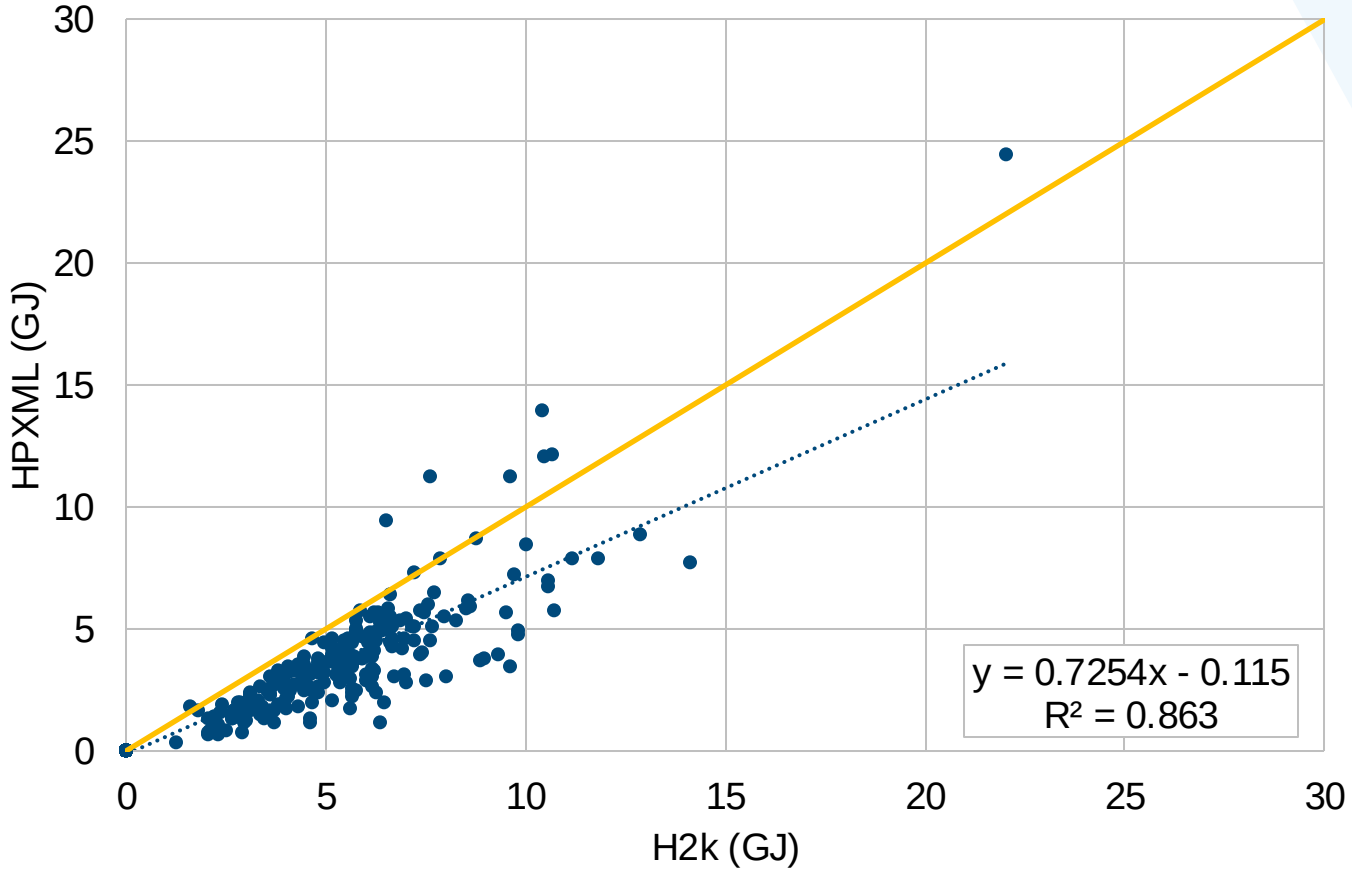


Cooling Consumption – SHGC & WWR



- PCF 1617 files used for analysis, Toronto climate
- Larger window areas and greater SHGCs result in HPXML overestimating cooling relative to HOT2000
- Largest discrepancies ~2GJs

Cooling Consumption – 560 Archetypes

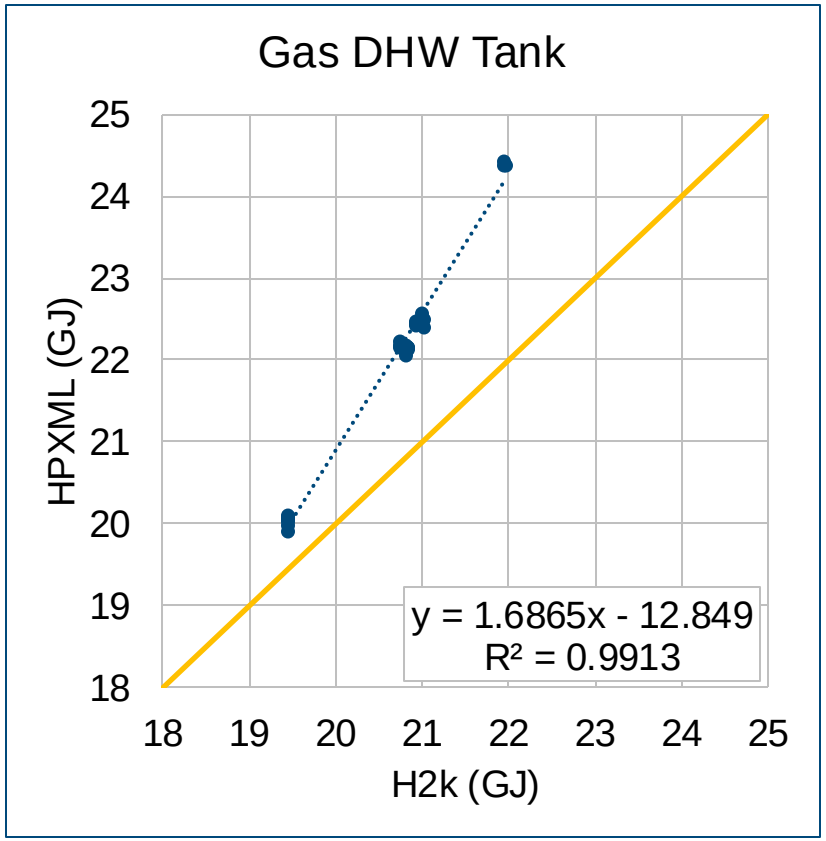


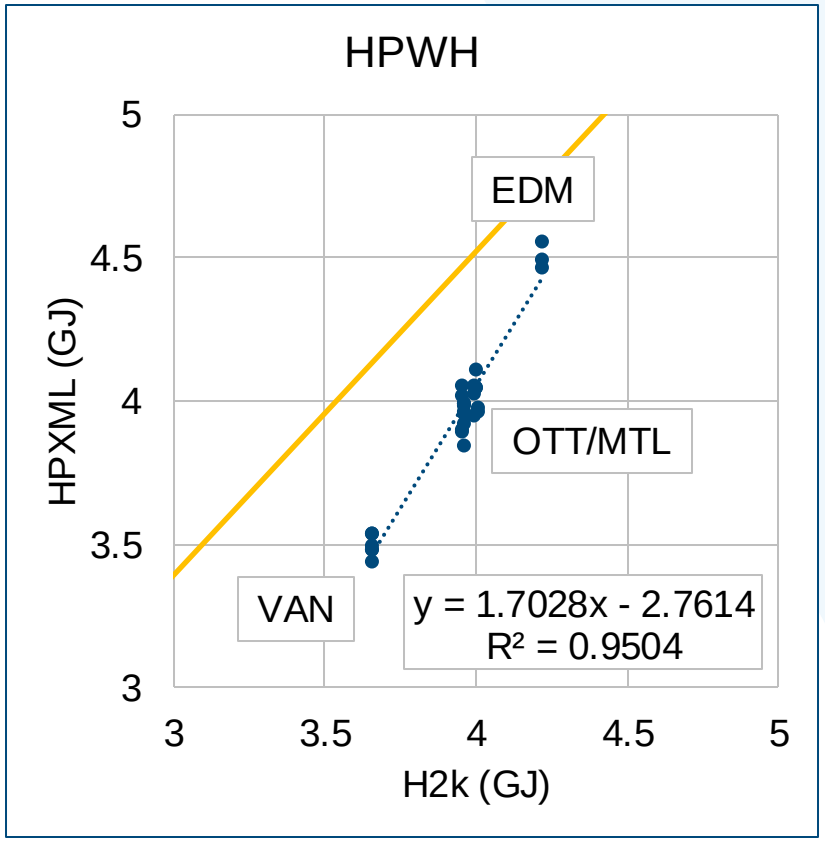
- Cooling energy for a random sample of 560 archetypes (240 with cooling)
- All systems that provide cooling included (AC, ASHP, GSHP)

Cooling Energy Consumption

- HPXML exports cooling load information, H2k does not
- Need to better understand assumptions within both systems
  - How are equipment efficiencies interpreted (e.g. how is a given SEER rating interpreted by each engine)
- Option to use HPXML's "detailed performance inputs" to match COP/Capacity curves used in H2k
  - Would help isolate between differences in cooling load determination and cooling system performance

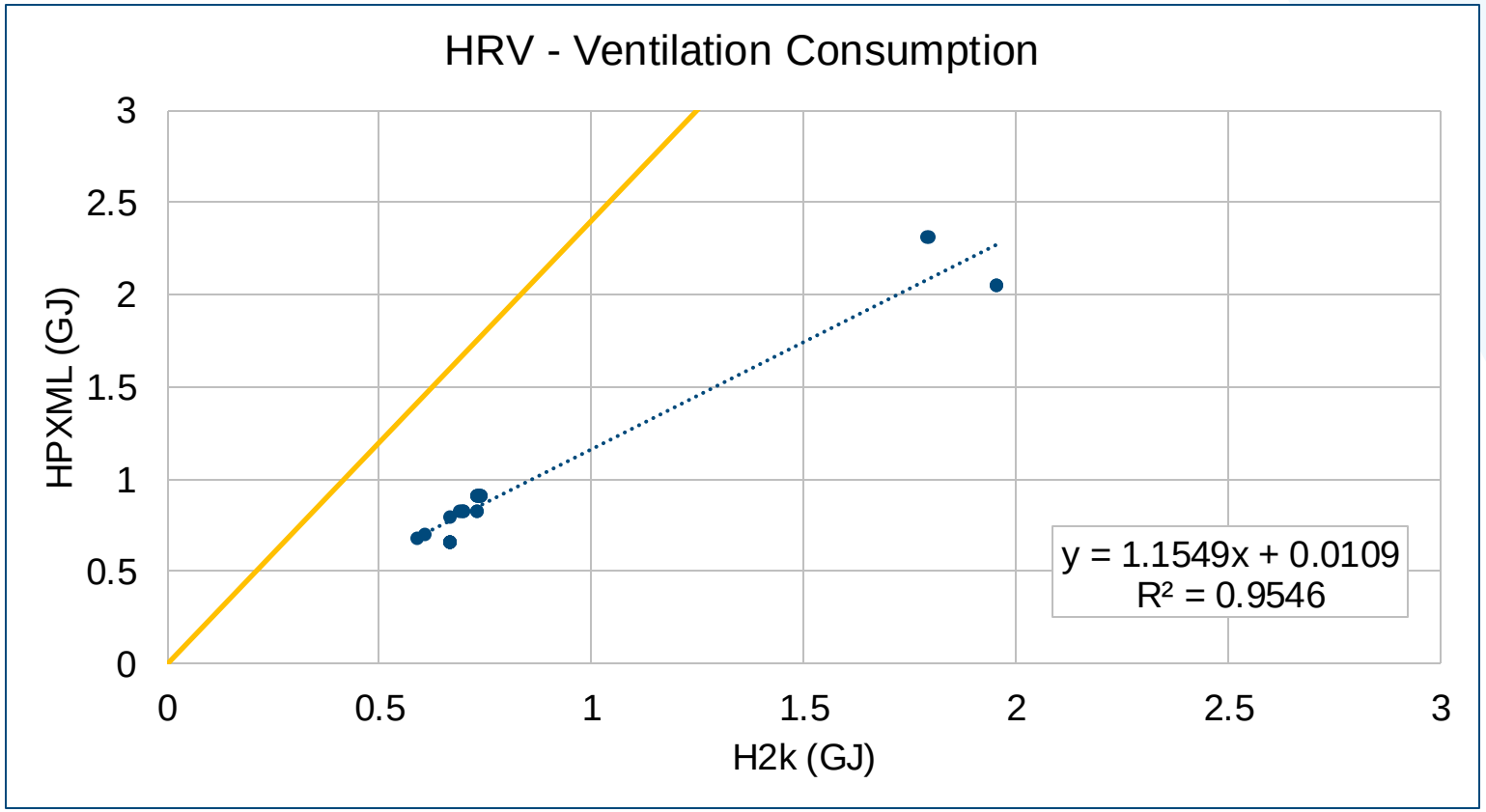
Hot Water Consumption





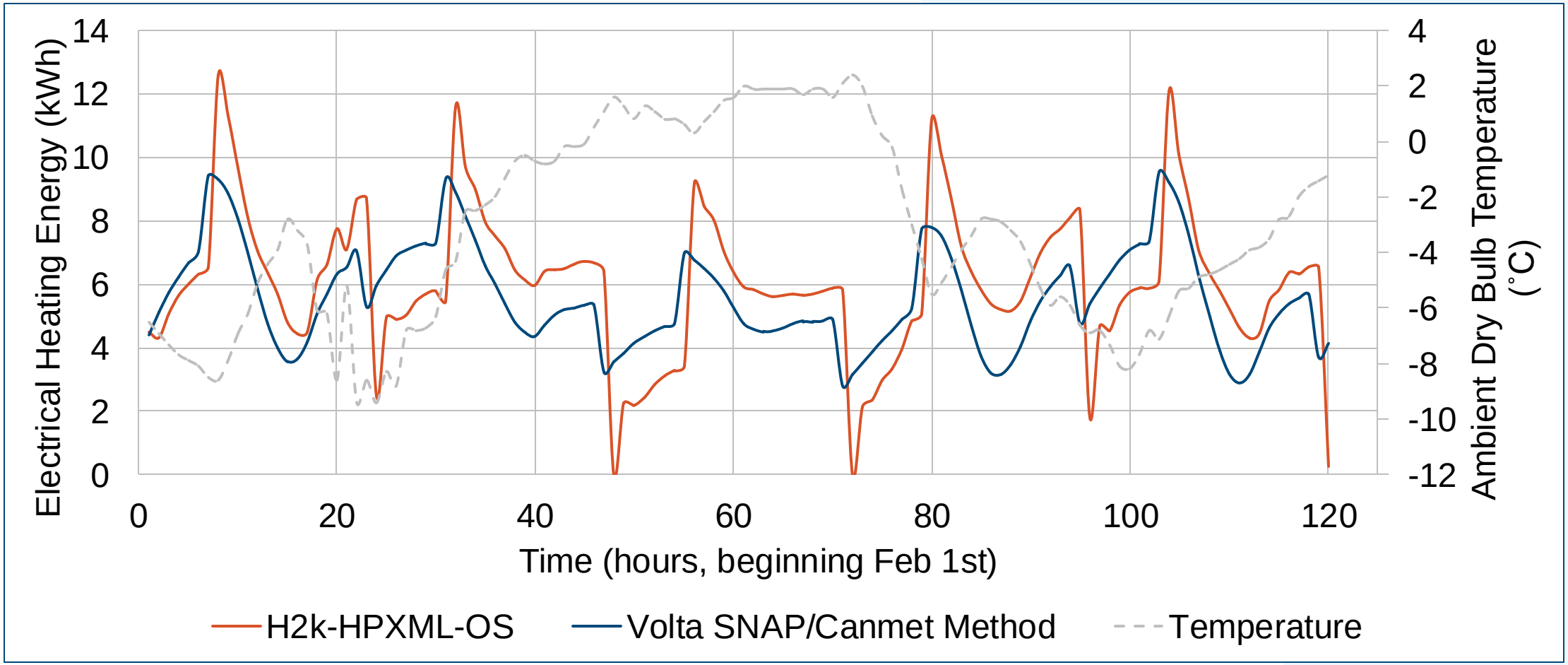
- Water usage not yet calibrated to different locations usage (Hardcoded to Ottawa SOC)
- Will use “Water Fixtures Usage Multiplier” to avoid conflicting with base load consumption

HRV – Ventilation Consumption



- No major issues

Hourly Electrical Loads – Baseboards Example



Identified Gaps & To-dos

1. Calibrate hot water usage based on location variations
2. Combo efficiency/energy factor decoupling
3. Detailed cooling/heating performance curves to better match H2k
4. Determine pathway forward for supplemental heating (requires more testing)

Future Work

- MURBs
- Alignment with non-SOC operating conditions
- Full-scale testing

Questions