Optimizing Watergy:
Point-of-Use vs Heat Pump Water Heaters

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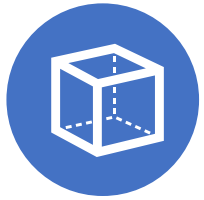
The Issue: Domestic Hot Water

Domestic hot water system considerations

Energy Use
Can we meet Passive House targets?

Water Use
How much are we wasting?



Space & Layout
Equipment vs. architectural requirements.

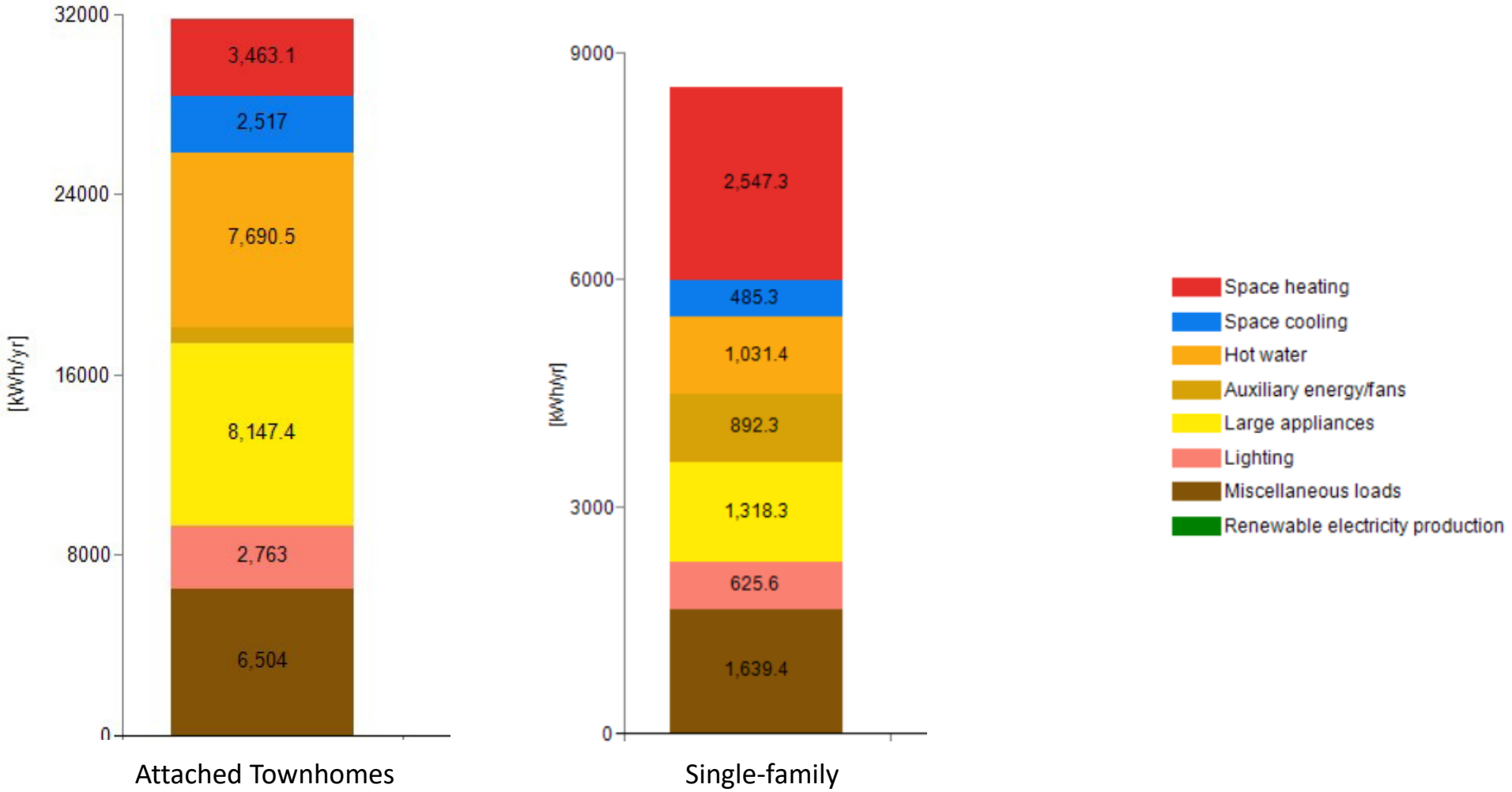
Acoustics
Proximity of HPWH to living spaces.

Comfort
Residual heat or coolth from equipment.

Satisfaction
Time to get hot water.

Cost
Total system cost (water heater + plumbing).

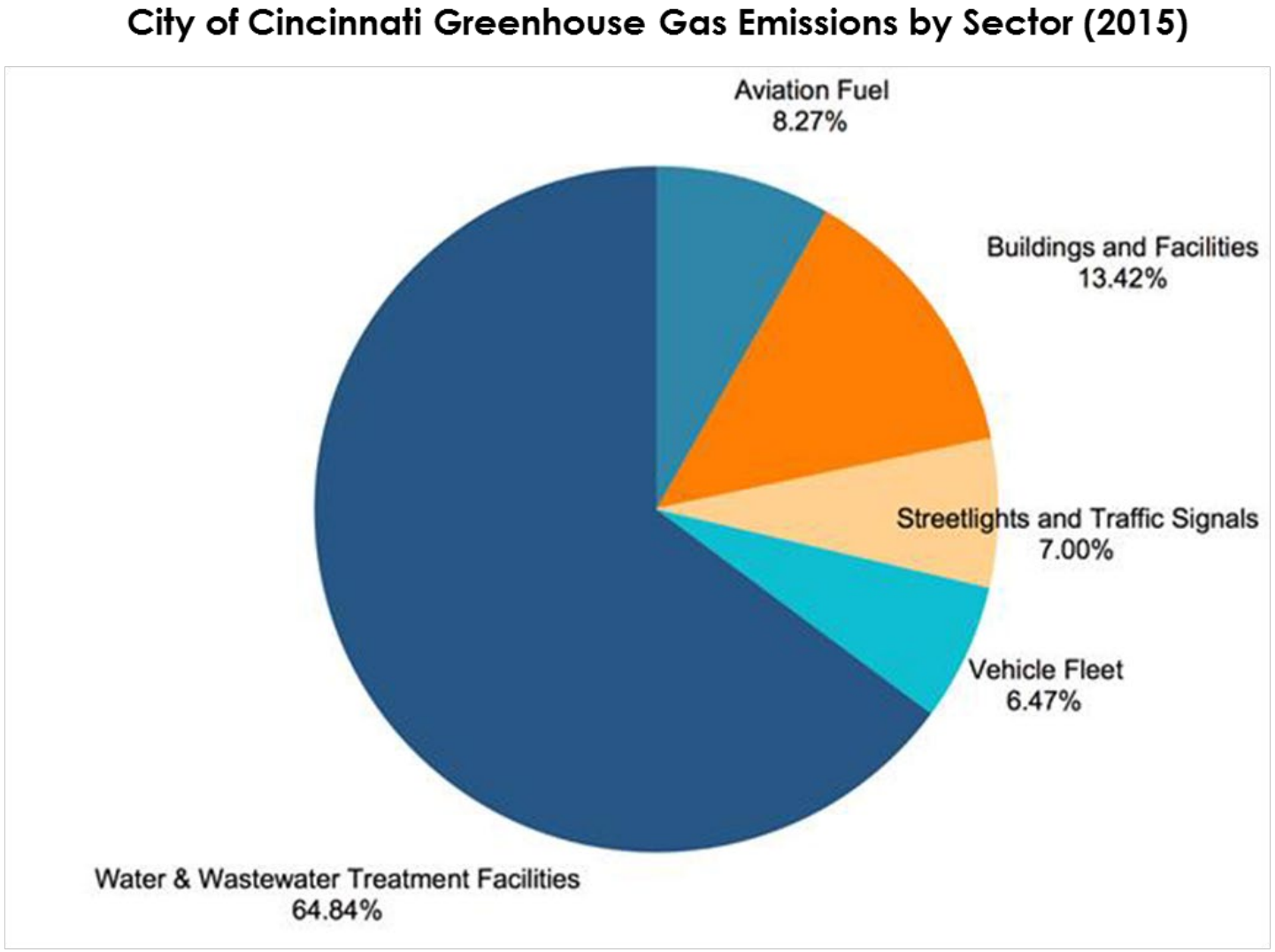
Hot water is a significant energy use in residential Passive House buildings



Attached Townhomes

Single-family

Water use is a major energy use at the municipal scale

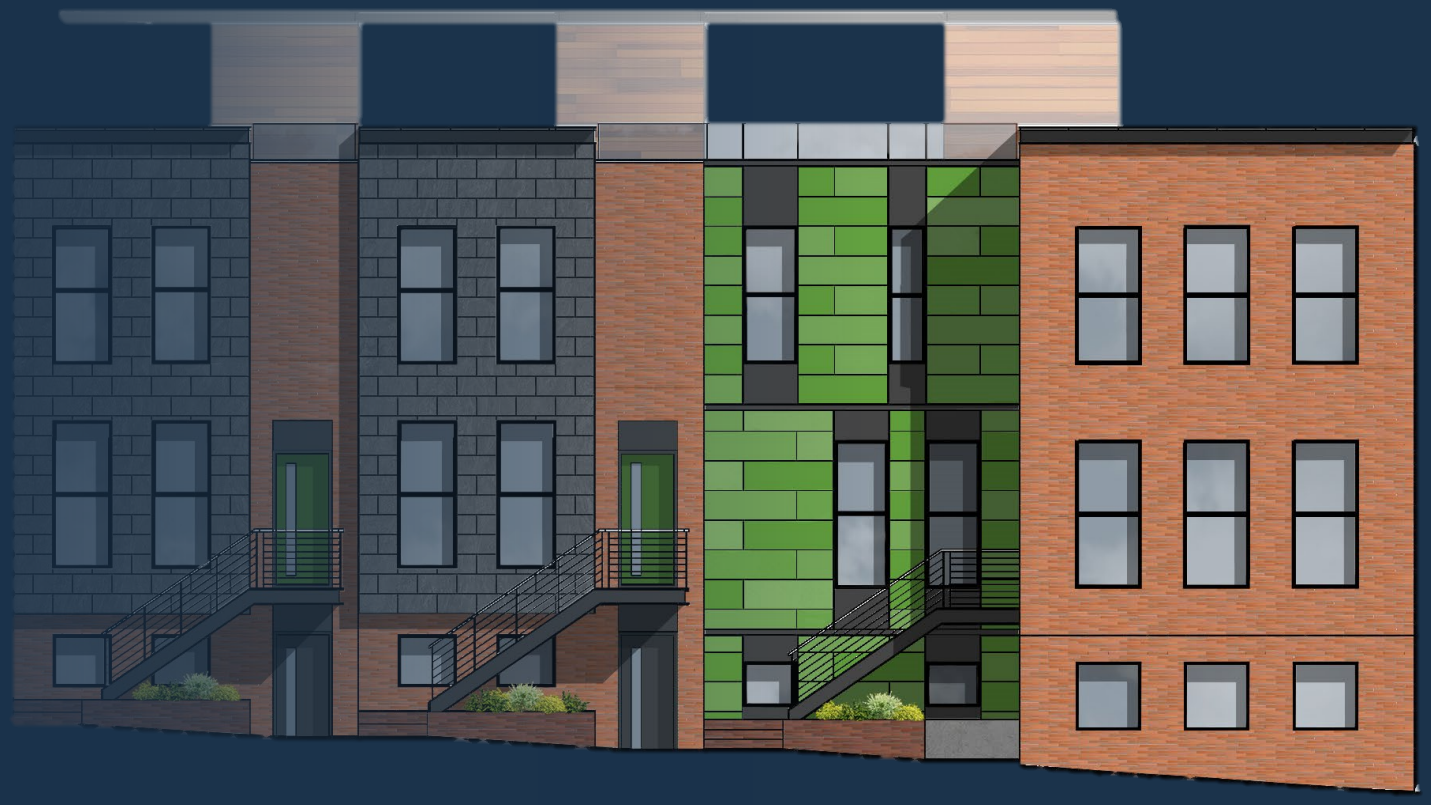


Source: 2018 Green Cincinnati Plan

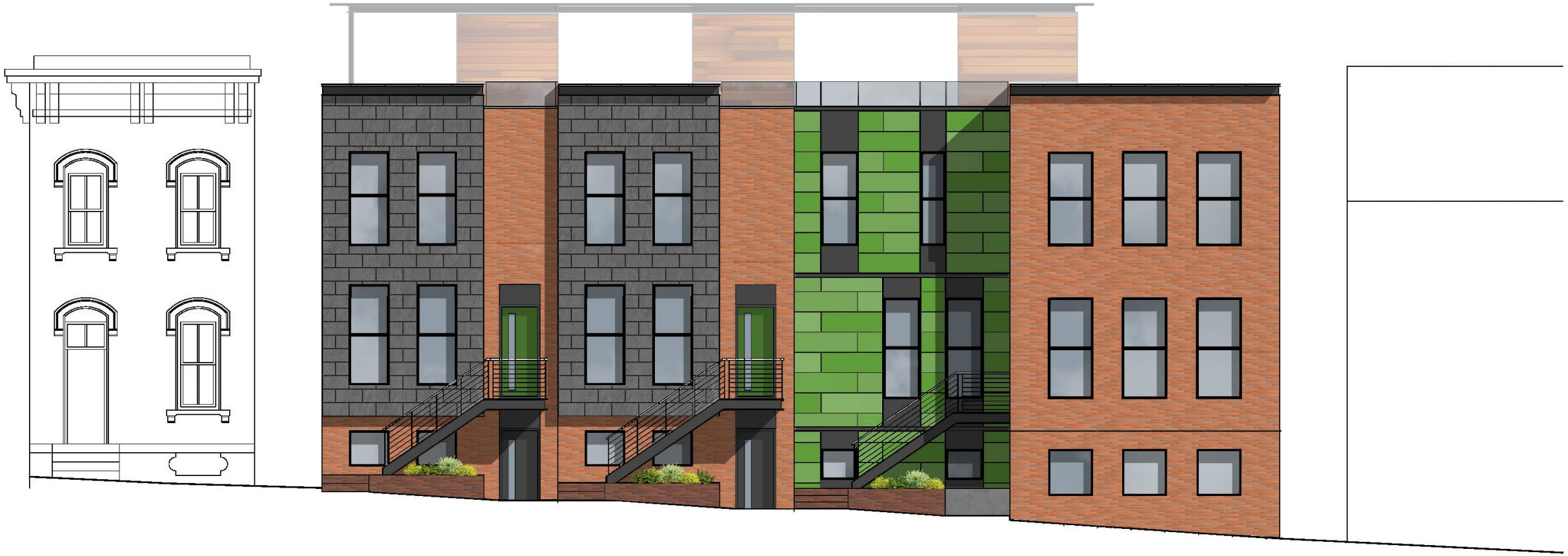
Research questions:

- How much of an energy penalty will we pay for tankless?
- Can the benefits of reduced pipe length offset the penalty?
- Does tankless provide a meaningful reduction in cooling loads?
- How much is the benefit of tankless in terms of water savings & comfort (time to hot water)?

The Context: Spring Green Townhomes

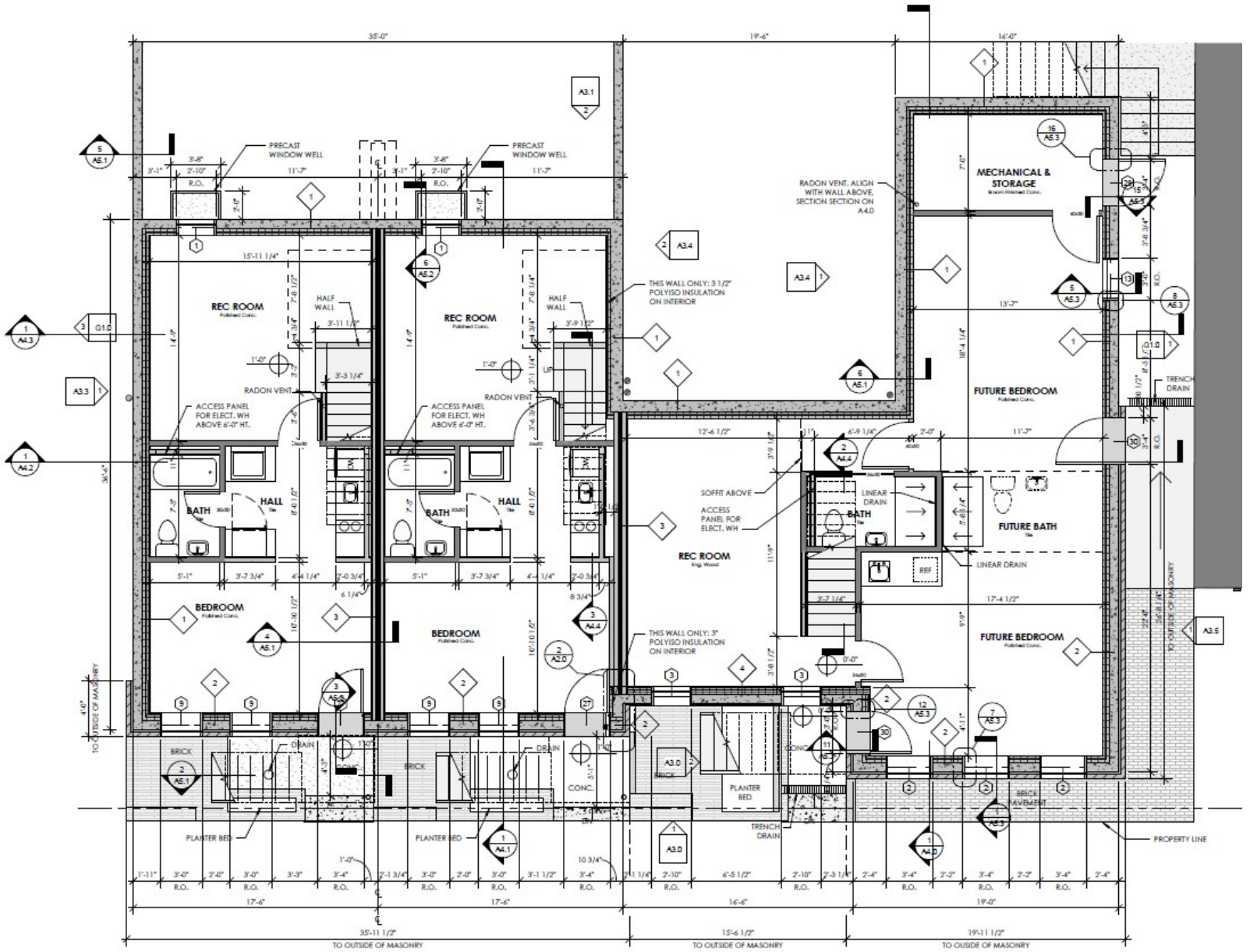


Spring Green Townhomes: Infill, Passive House, Living Building Challenge

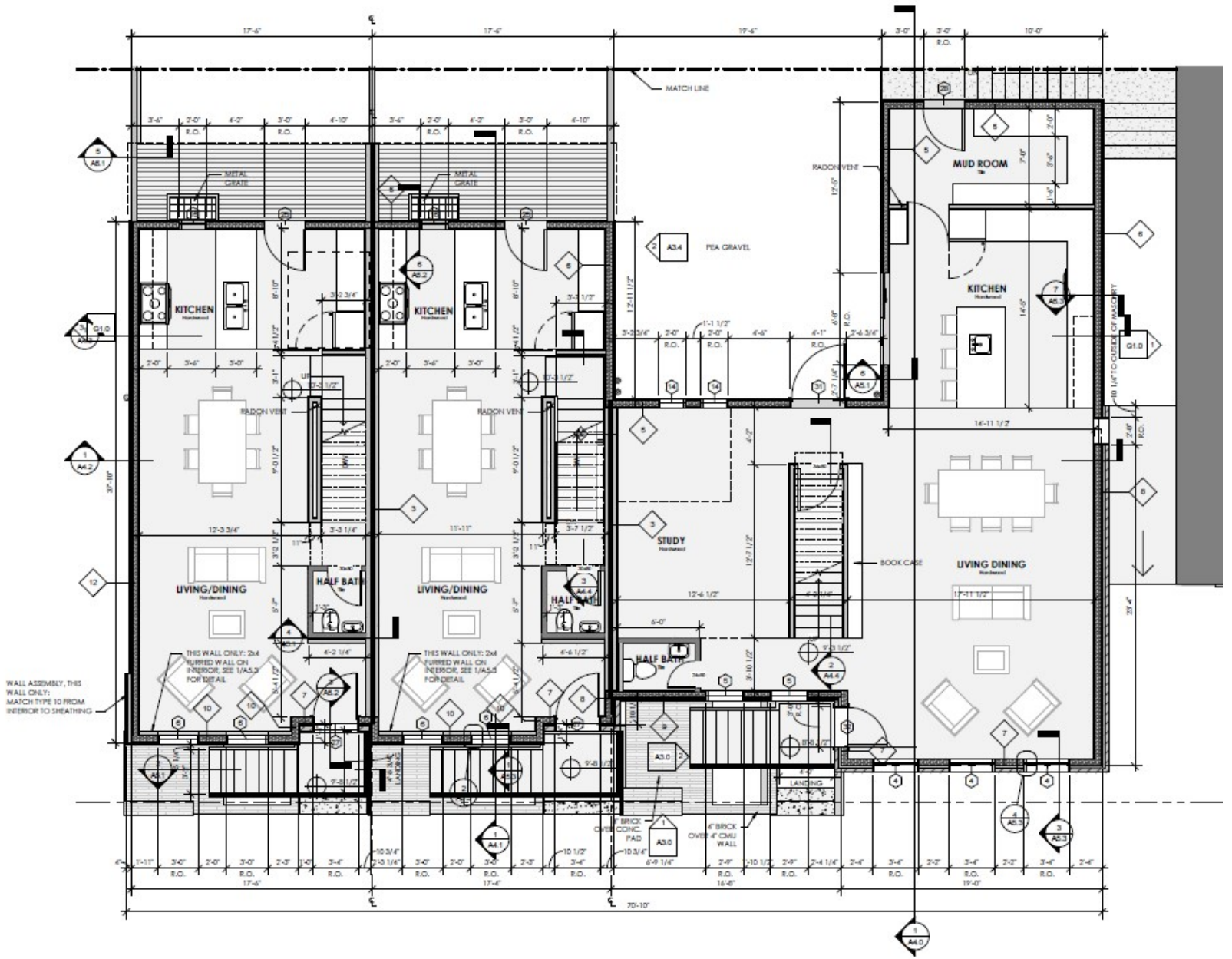


Spring Green Townhomes: Infill, Passive House, Living Building Challenge

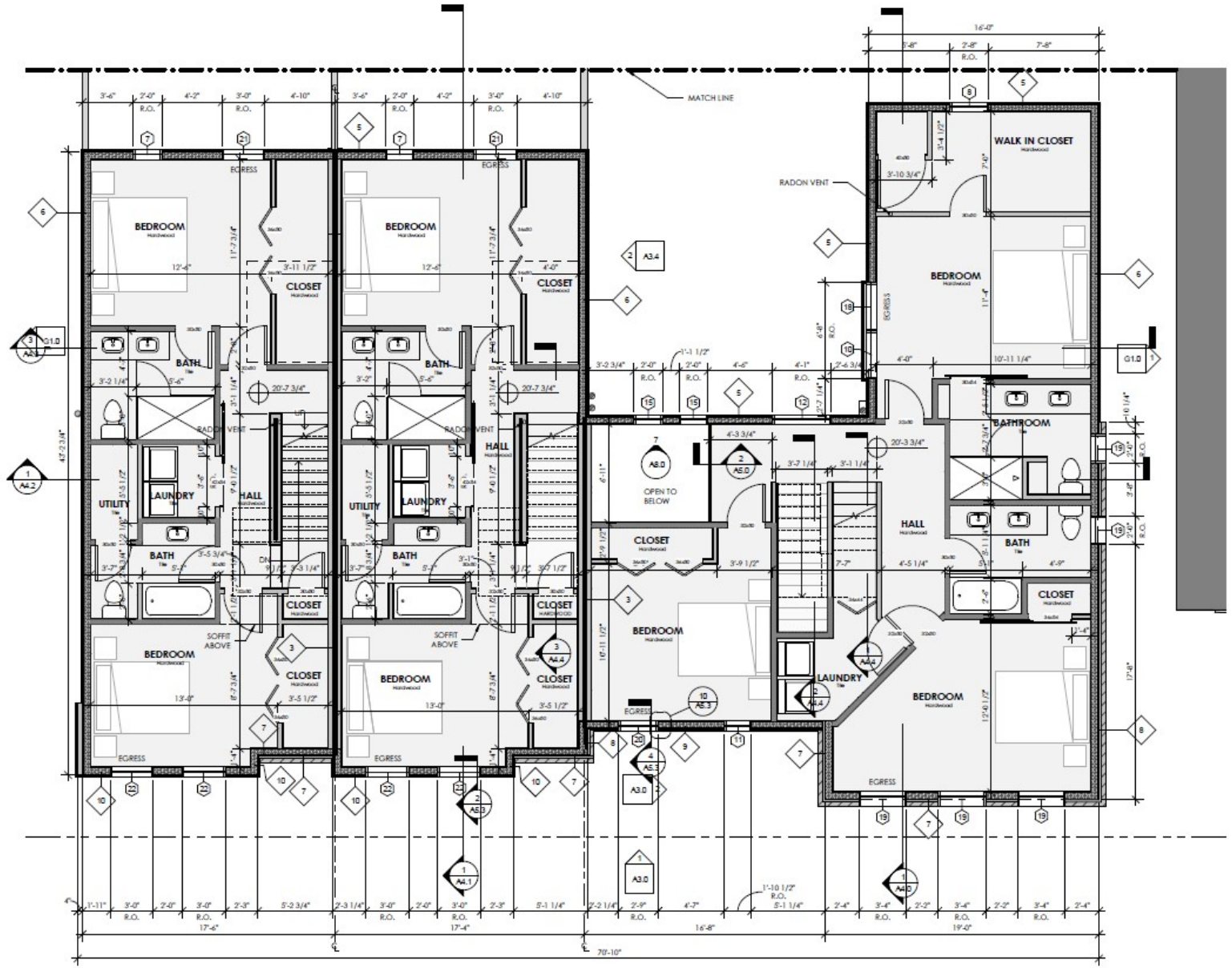
Spring Green Townhomes: Lower Level Floor Plan



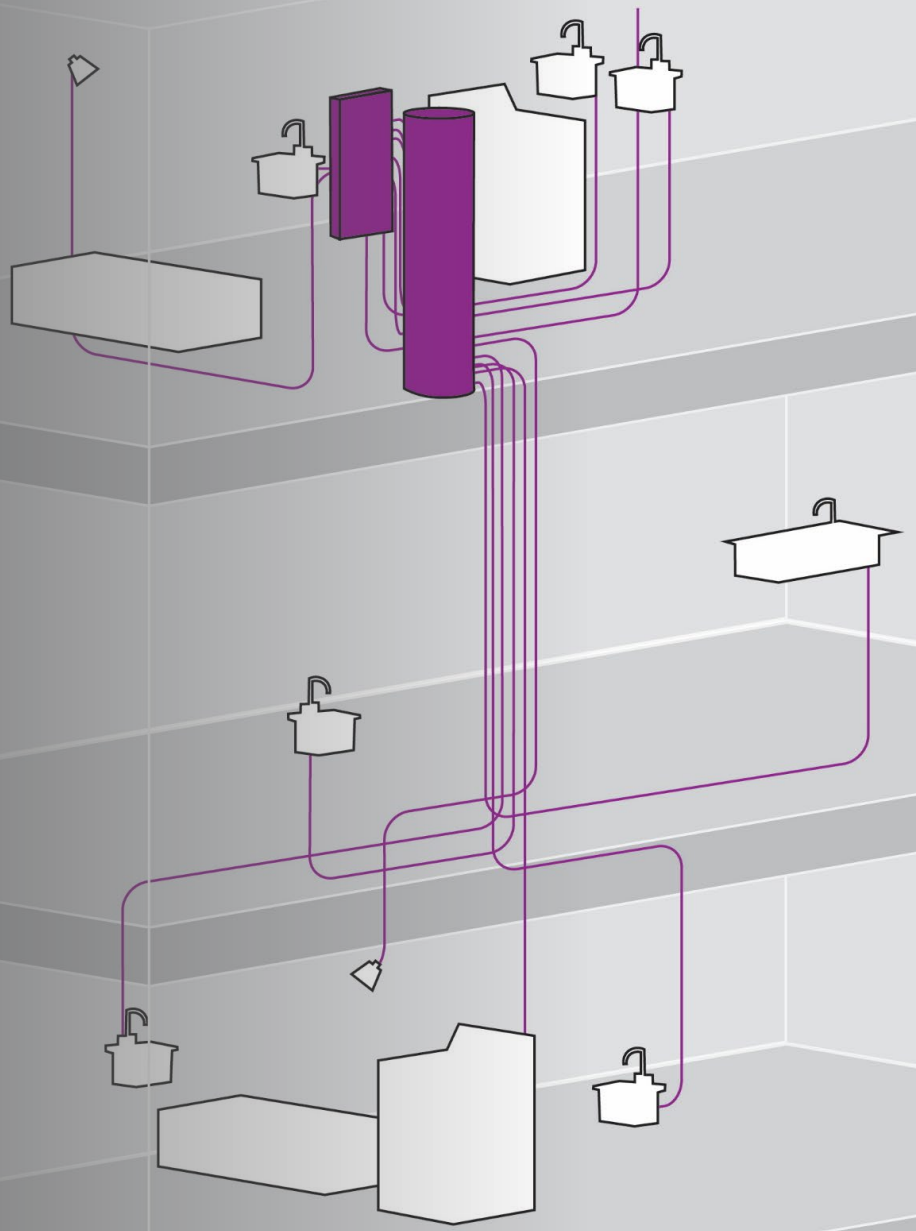
Spring Green Townhomes: First Floor Plan



Spring Green Townhomes: Second Floor Plan

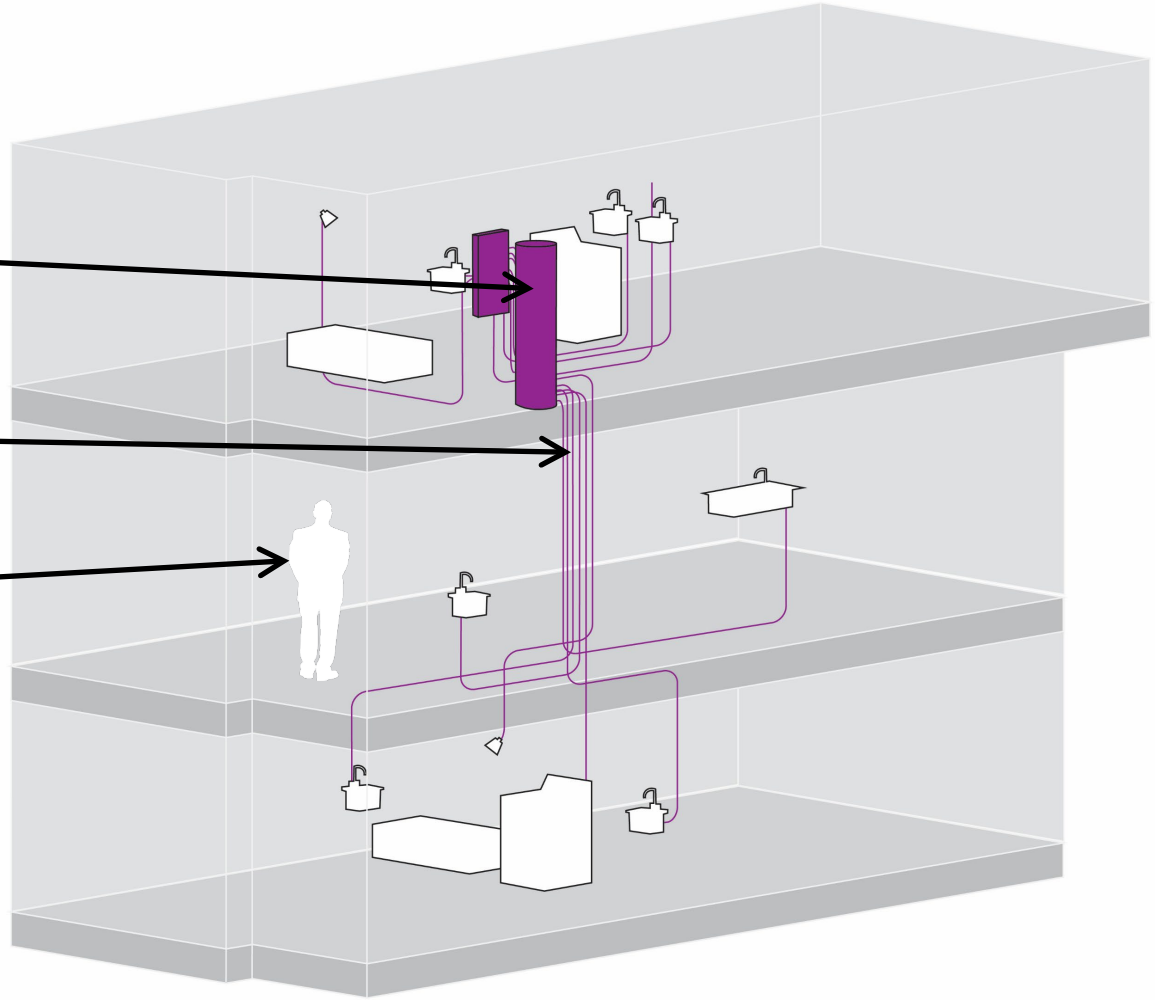


The Analysis



Hot water energy use is driven by:

- **Water heating equipment**
  (tank vs tankless)
- **Distribution system**
  (plumbing length & volume)
- **Usage**
  (flow rates & habits)



Key Variables & Assumptions

- Water heater type – HPWH vs Electric Point-of-Use
- Plumbing length – used manifold system
- Pipe diameter – standard vs optimized
- Mini-split efficiency – used design case, Annual Heating COP 3.16
- HPWH efficiency – used design case, EF 3.69 (UEF 3.55)
- NOT considered: reduced quantity of hot water use in low-flow scenarios (used PHIUS+ default of 6.6 gal/person/day)

Research questions:

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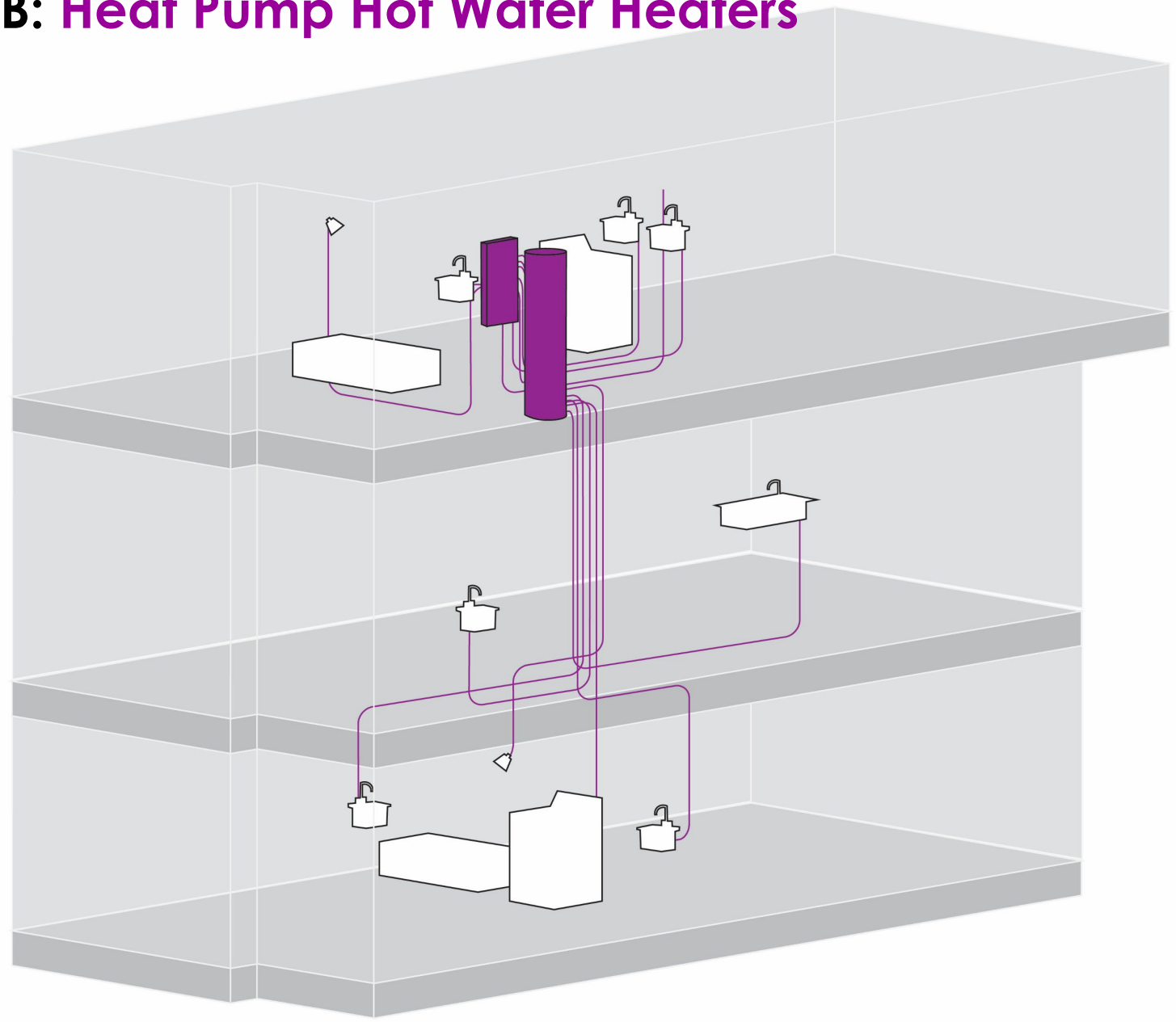
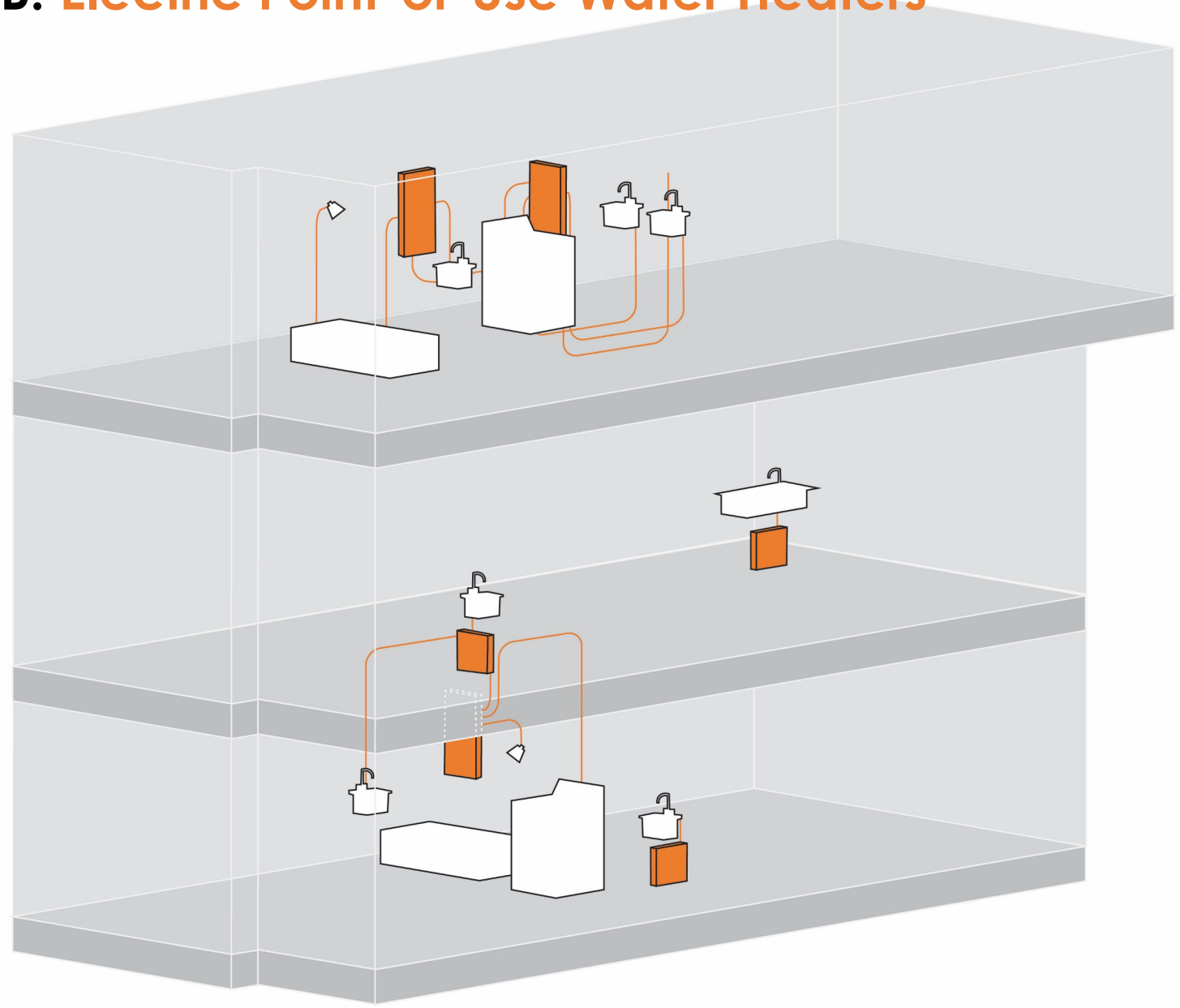
Scenarios

1A.	Heat Pump Water Heater – standard pipe sizing	**HPWH standard**
1B.	Heat Pump Water Heater – optimized pipe sizing	**HPWH optimized**
2A.	Electric Point-of-Use – standard pipe sizing	**POU standard**
2B.	Electric Point-of-Use – optimized pipe sizing	**POU optimized**

Scenarios 1A & 1B: Heat Pump Hot Water Heaters



Scenarios 2A & 2B: Electric Point-of-Use Water Heaters



WUFI Analysis

Hydronic heating | DHW | Cooling | Ventilation | Supportive device / auxiliary energy

General | Hot water piping

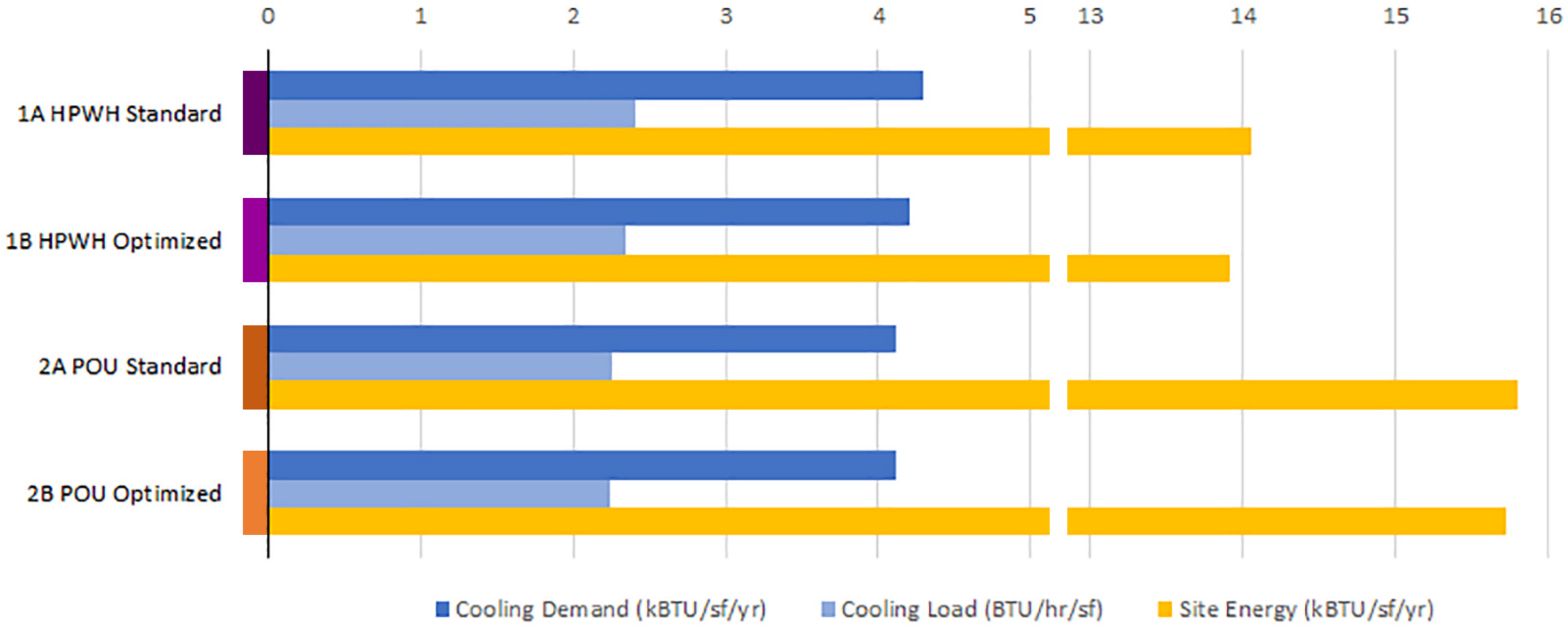
Trunk

Nr.	Name	Demand recirculation	Pipe material	Piping diameter [in]	Piping length [ft]	Heat capacity [Btu/°F]	Count units or floors	Volume [oz]	Cumulative volume [oz]
1	Corner Townhouse	☐	Copper M	3/4	2	0.51	1	6.86	6.86
2	Middle Townhouse	☐	Copper M	3/4	2	0.51	1	6.86	6.86
3	North Townhouse	☐	Copper M	3/4	2	0.51	1	6.86	6.86

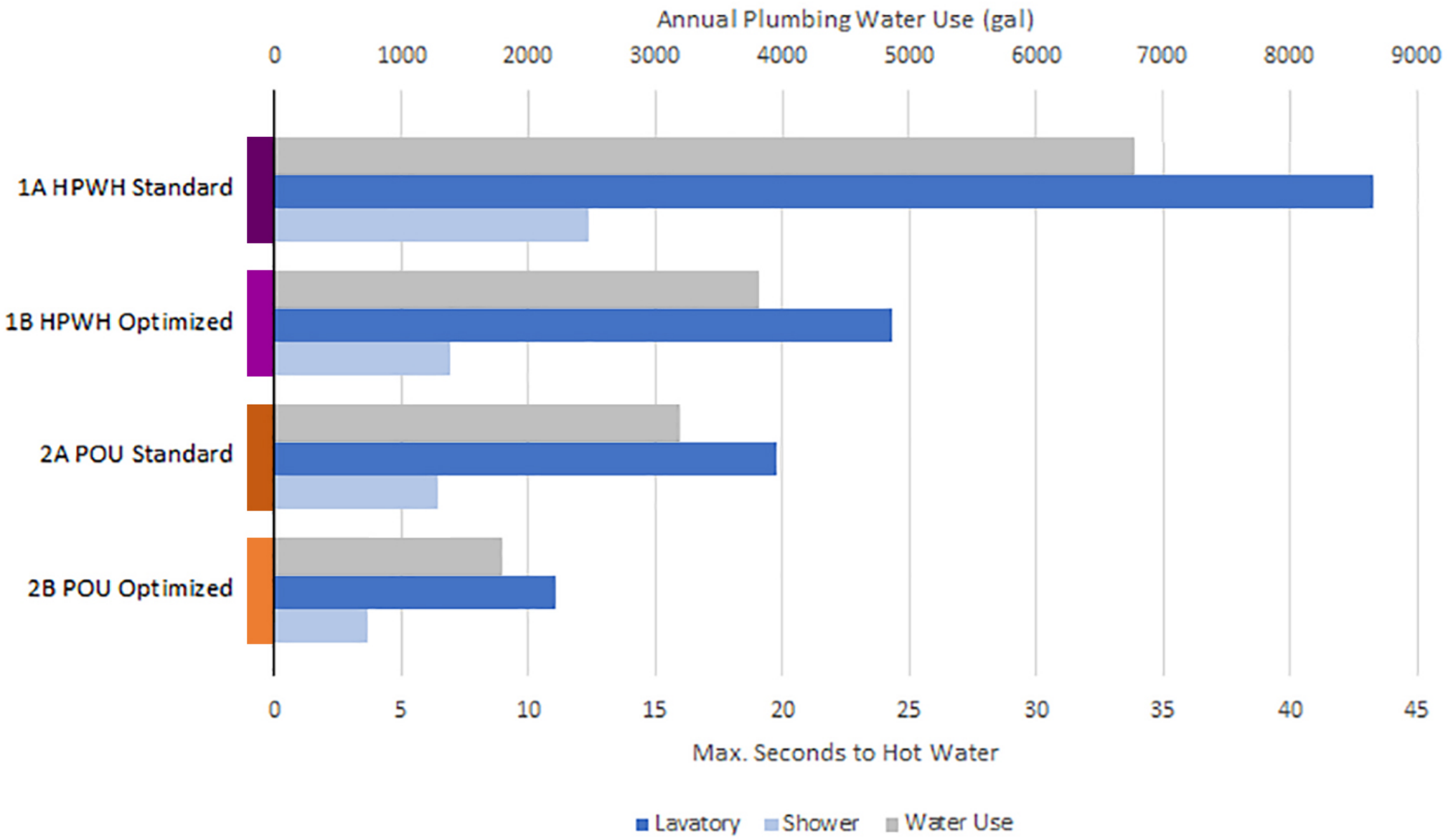
Branch: Trunk 1, Corner Townhouse

Nr.	Label	Pipe material	Piping diameter [in]	Piping length [ft]	Heat capacity [Btu/°F]	Volume [oz]	Upstream volume [oz]	Branch cumulative volume [oz]	Cumulative volume [oz]
1	LL Future Kitchen	PEX-AL-PEX	3/8	24.28	1.84	15.3	6.86	15.3	22.16
2	LL Future Dishwasher	PEX-AL-PEX	3/8	24.28	1.84	15.3	6.86	15.3	22.16
3	LL Future Lavatory	PEX-AL-PEX	3/8	14.789	1.12	9.32	6.86	9.32	16.18
4	LL Future Shower	PEX-AL-PEX	1/2	18.918	2.33	24.78	6.86	24.78	31.64
5	LL Lavatory	PEX-AL-PEX	3/8	25.581	1.93	16.12	6.86	16.12	22.98

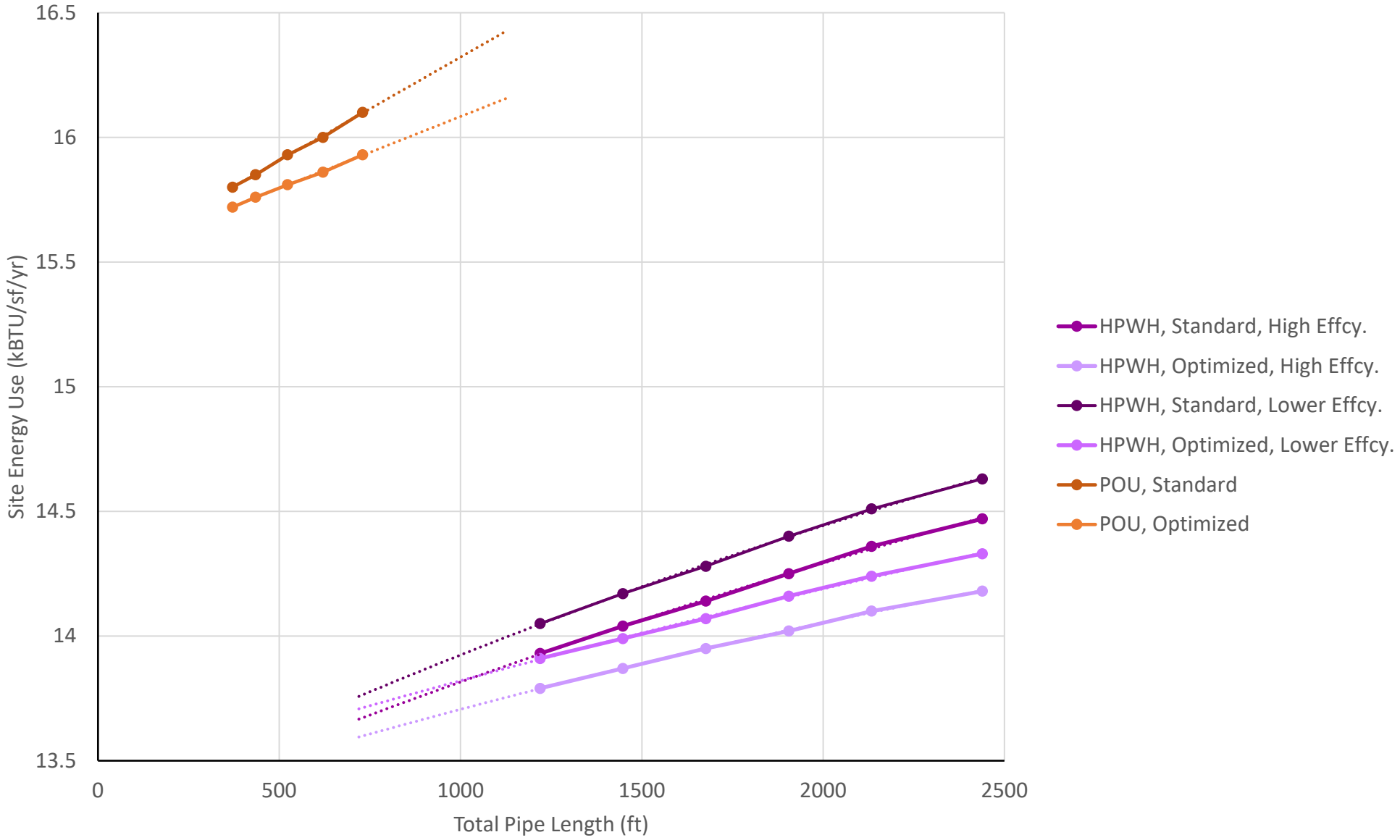
Results – Energy Use & Cooling Loads



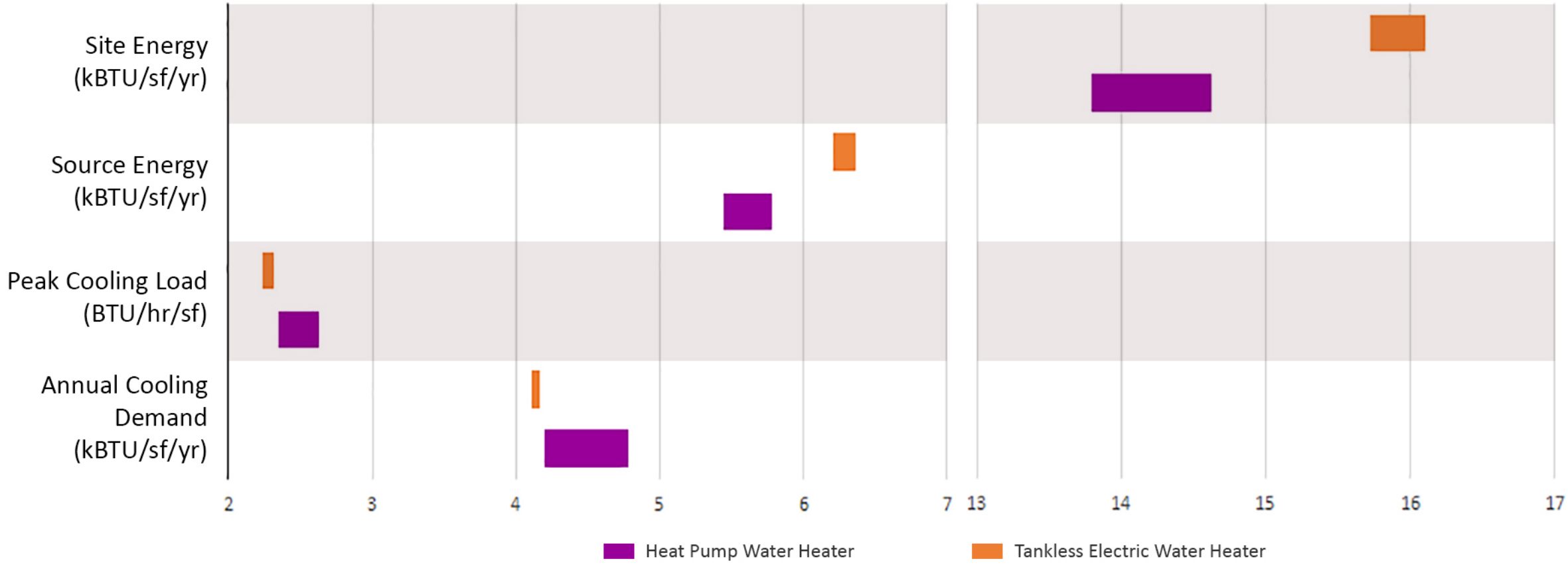
Results – Water Use & Time to Hot Water



Sensitivity Analysis – Results



Sensitivity Analysis – Results



Summary / Key Takeaways

Electric tankless resulted in a **12-16% increase in overall energy use**

Electric tankless **reduced Cooling Demand by 3-5%**, and **Cooling Load by 4-7%**, compared to HPWH

Electric tankless **reduced time to hot water by 17-74%** (reduction of 8-32 seconds in our example)

Electric tankless **reduced hot water use 5-18%** by reducing stored volume

If using electric tankless, optimize pipe size and locate as close as possible to water fixtures — point-of-use is best

Questions?

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