Driving Down GSHP Grid Impacts at the Building Level

Moderator: Mitch DeWein / *CHA Solutions*

Panel:
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Max Ciovacco / *NYSERDA*

Driving Down Grid Impacts: How Does Pump Sizing Affect the Grid and System Efficiency?

Jeff Hammond
International Ground Source Heat Pump Association

2025 NY-GEO Conference, Saratoga Springs, NY

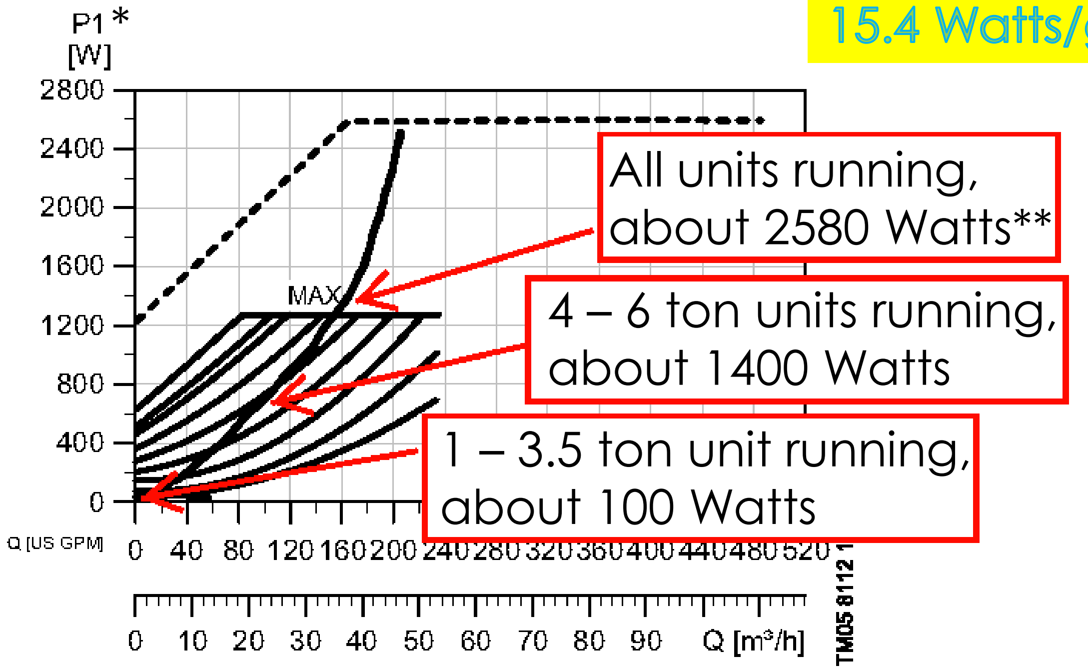
Isn’t Pump kW & kWh a Small Percentage of System kW / kWh?

- Yes:
  - With proper design of piping system
  - With variable speed pumping
  - With consideration of antifreeze concentration and type
- No:
  - Without consideration of system pressure drop / piping system design
  - With constant speed pumps, especially for large systems
  - With unnecessarily high antifreeze concentration
  - Without consideration of pumping configuration / application
  - Without consideration of pump controls

Example Pump Retrofit: Light Commercial (56 ton) Application

- Located in Central Illinois
- 56 tons
- 14 heat pumps (2 to 6 tons)
- 3 – 5 HP pumps, running 24 hrs/day
- 10.5 kW demand for just pumps!
  - If <13 tons operating, pump Watts were more than the heat pump Watts (avg heat pump demand = 0.82 kW/ton in cooling)
- New pumps: Dual-head variable speed @ 2.6 kW max demand

15.4 Watts/gpm



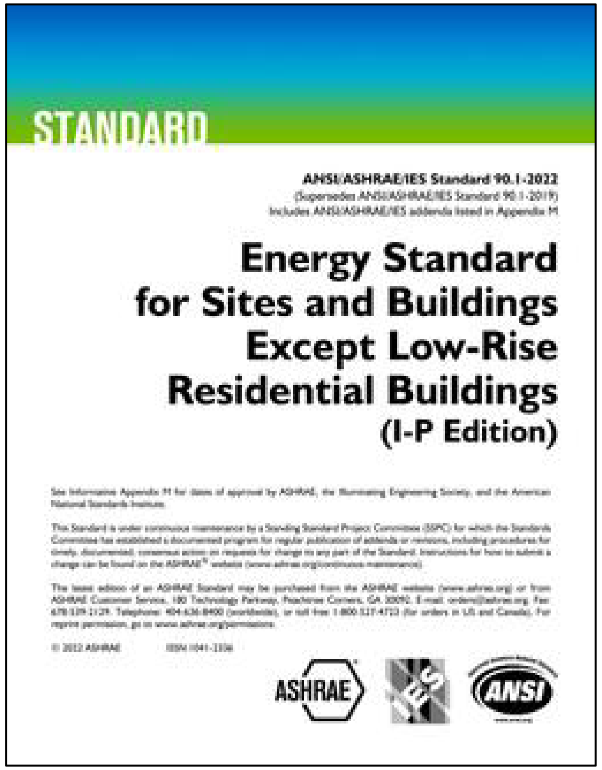
Original 5 HP constant speed pumps ran 24 hours/day at 3500 Watts each X 3 pumps!

*Watts per pump
**Both pumps running

What Resources Are Available?

ASHRAE 90.1 – 2022*

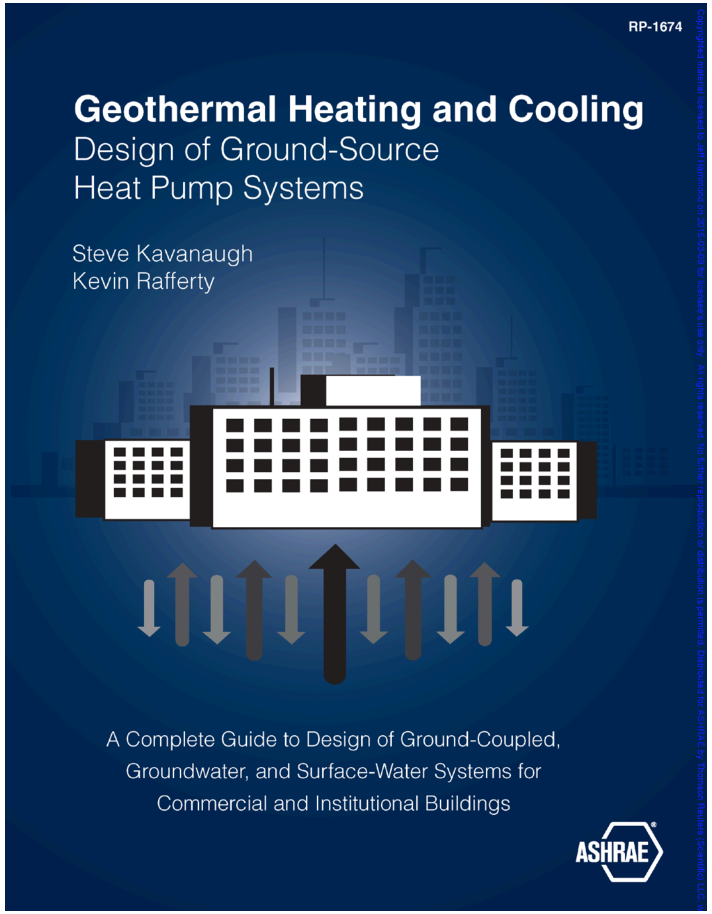
- **6.5.4.5.2** Hydronic heat pumps and water-cooled *unitary air conditioners* having a total *pump system power* exceeding 5 hp shall have controls and/or devices (such as variable-speed control) that will result in *pump* motor *demand* of no more than 30% of design wattage at 50% of design water flow.



* ASHRAE (American Society of Heating, Refrigerating, and Air Conditioning Engineers) Standard 90.1 is a benchmark for commercial building energy codes in the United States, and a key basis for codes and standards. The standard provides the minimum requirements for energy-efficient design of most sites and buildings, except low-rise residential buildings. The 2022 edition is the latest publication.

ASHRAE Design Manual (“Blue Book”)

- Pump power benchmarks
  - Watts/ton
  - Available head*
  - Grade: A though F
- Impact of pump power information & examples
- Piping fundamentals / pressure drop calculation
- Pump fundamentals



* Guidance on piping selection / pressure drop

Pump Power Benchmarks*

Table 6.2 GSHP System Pump Power Benchmarks

Installed Pump Power	Power into Pump Motor		Grade	Available Head with 70% Efficient Pump at 3 gpm/ton
< 5 hp/100 tons	< 45 W/ton	< 15 W/gpm	A	< 46 ft of water
5 < hp/100 tons ≤ 7.5	45 < W/ton ≤ 65	15 < W/gpm < 22	B	46 to 69 ft of water
7.5 < hp/100 tons ≤ 10	65 < W/ton ≤ 85	22 < W/gpm < 28	C	69 to 92 ft of water
10 < hp/100 tons ≤ 15	85 < W/ton ≤ 125	28 < W/gpm < 42	D	92 to 138 ft of water
> 15 hp/100 tons	> 125 W/ton	> 42 W/gpm	F	> 138 ft of water
Installed Pump Power	**Power into Pump Motor**		**Grade**	**Available Pressure with 70% Efficient Pump at 3 L/m·kW**
< 10.5 W_m/kW_t	< 13 W_e/kW_t		A	< 140 kPa
10.5 < W_m/kW_t ≤ 16	13 < W_e/kW_t ≤ 19		B	140 to 210 kPa
16 < W_m/kW_t ≤ 21	19 < W_e/kW_t ≤ 25		C	210 to 280 kPa
21 < W_m/kW_t ≤ 32	25 < W_e/kW_t ≤ 36		D	280 to 420 kPa
> 32 W_m/kW_t	> 36 W_e/kW_t		F	> 420 kPa

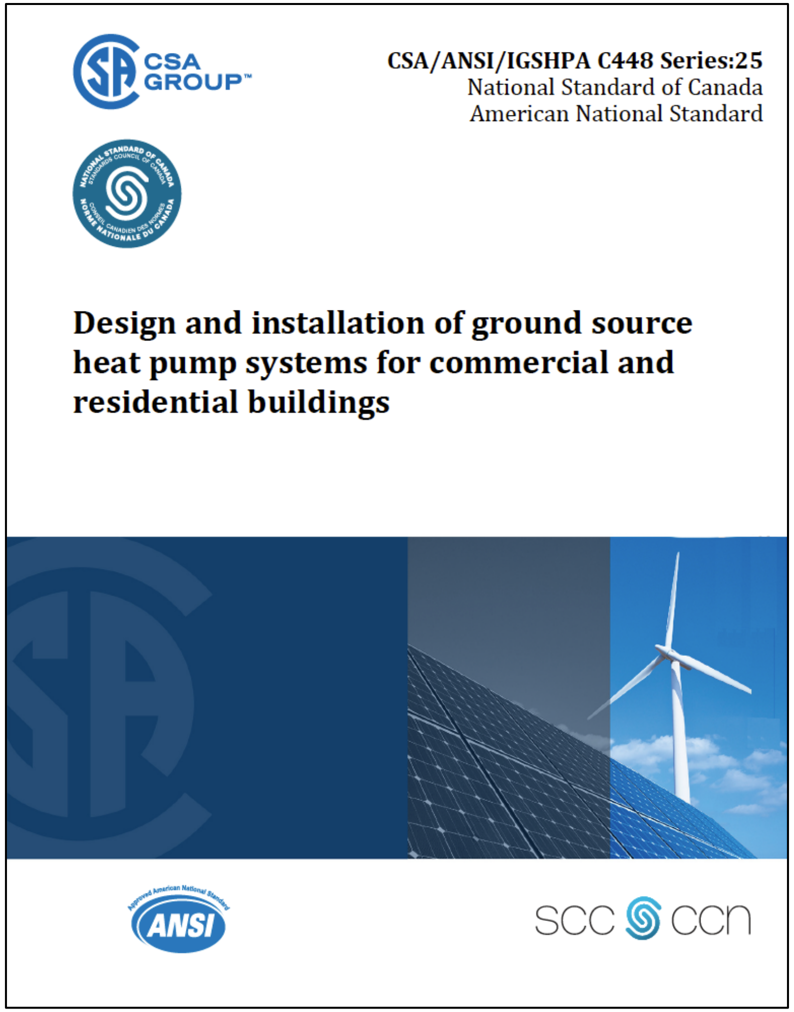
W_m ≡ watts mechanical, W_e ≡ watts electrical, kW_t ≡ kilowatts thermal

* Green text added to the table for comparison to gpm at 3 gpm/ton.

CSA/ANSI/IGSHPA C448 Standard*

- Minimum requirements for:
  - Ground Heat Exchanger
  - Piping
  - Heat Transfer Fluid
  - Heat Pump Selection
  - Flushing/Purging
  - Testing, startup

All of the above effect pump performance

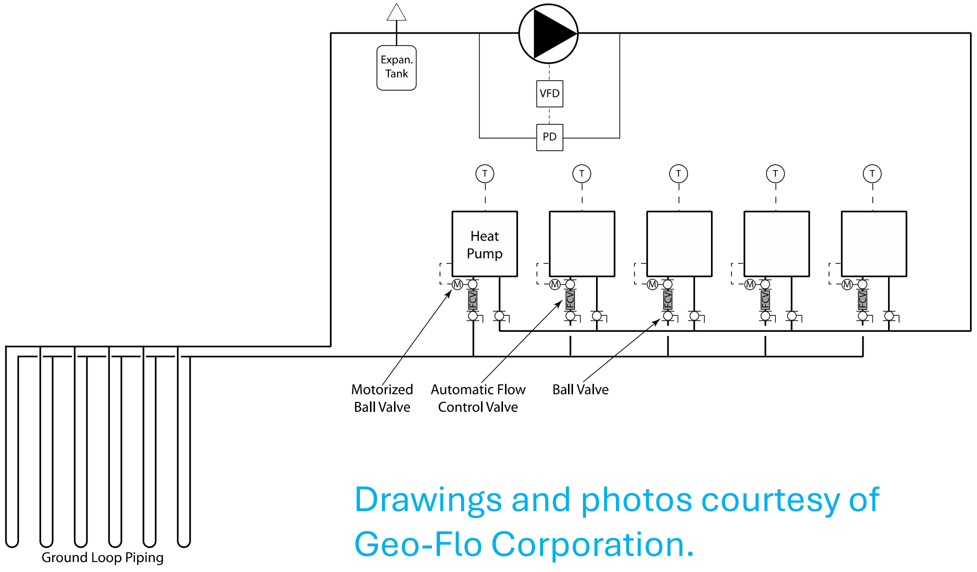


* 2025 edition includes district systems.

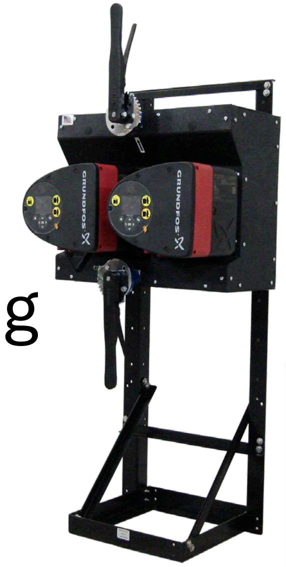
What Are Some Common Pumping Configurations?

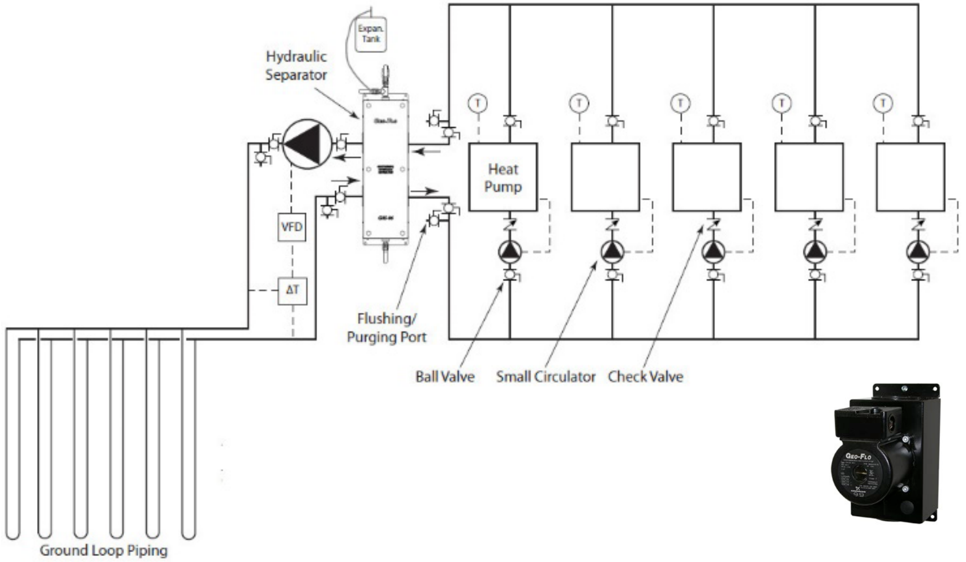
Pumping Arrangement has Implications on Pump Power

- Central pump
  - Central Variable Speed pump provides flow through ground heat exchanger (GHX) and all heat pumps
- Primary/Secondary
  - Primary pump circulates fluid in the GHX
  - Secondary pumps circulate fluid through the heat pumps
- Other options available, depending upon application



Drawings and photos courtesy of Geo-Flo Corporation.





Summary

- Pumping <u>should</u> be a small percentage of the overall system peak demand kW and total kWh usage
- Resources and training are available for guidance
- Variable speed pumping should be considered when possible
- Improper pump selection / piping design / controls can have a major effect on system performance and grid impact (kW demand)
- Strive to get an “A” on your design!

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DRIVING DOWN GRID IMPACTS AT THE BUILDING LEVEL

NY-GEO

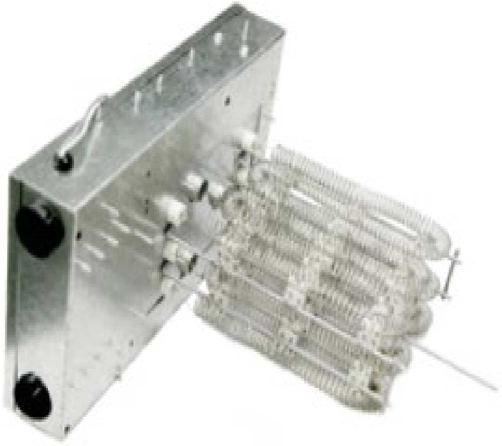
THE POWER OF COMMUNICATION

You are the voice of reason in helping them make the right decision, impacting many for multiple decades!

YOUR GUIDANCE MATTERS

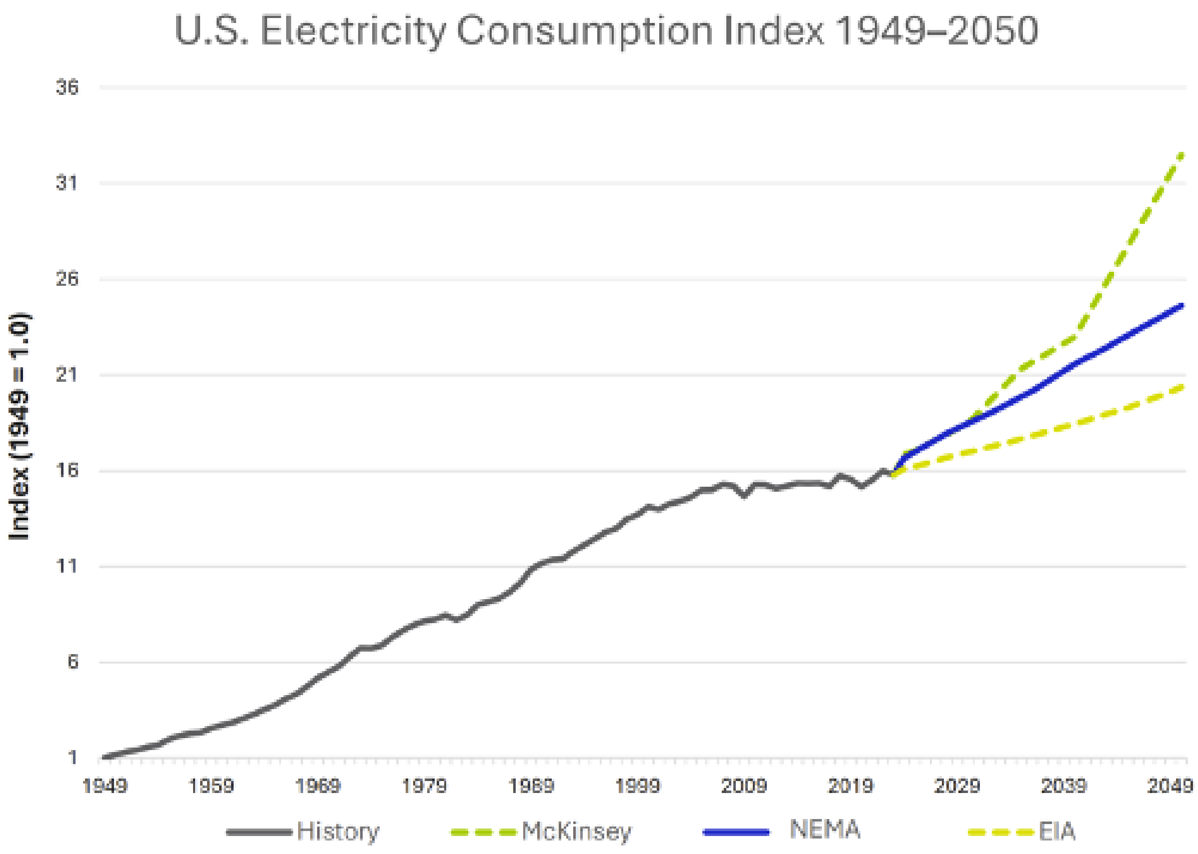
BELT & SUSPENDERS:
EITHER ONE WILL DO THE JOB…

IMPLIES multiple conservative approaches with redundancy



WHAT'S AT STAKE?

Electricity Demand Surges Through 2050



Electricity consumption is projected to grow in unprecedented ways

- **300%** projected growth in data center energy consumption over next 10 years
- **9000%** projected growth in E-mobility power consumption through 2050
- Electricity projected to grow from 21% of final energy use to **~32% by 2050**

Regionality in generation and consumption adds complexity

- Mid-Atlantic and Texas will see largest **data center** electricity demand growth through 2035
- Northeast and West will experience largest electricity demand growth from **EVs** through 2050
- Storage, wind, and solar generation will increase by **300%**
- Renewables will **exceed 50% of generation** capacity in Western U.S., New York, and Southeast

Adoption of new technologies and supporting policies needed to meet demand growth

SYSTEM DESIGN & SIZING DOES MATTER

Projects must be sized to meet at least 100% of the load of the project scope at design conditions and serve at least 80% of the building's total square footage...NYS CLEAN HEAT

Other areas around the country require sizing to 80% or 90 of Peak Load. A delicate balance of installed price, market penetration with utility funding, engagement and understanding what matters to them.

	Geo Size	System Cost	Clean Heat	Contract Cost	Tax Credits	Investment Total	Vertical Cost	Total Bore	Geo kWh	Aux kWh	Operating Cost
>150 ft. Bores	3-ton	54750	5820	48930	19679	29251	28750	700	7500	1020	1363.2
	4-ton	57500	7980	49520	19856	29664	30500	750	7788	91	1260.64
	5-ton	61500	9840	51660	20498	31162	32500	800	7733	4	1237.92

IMPACTS TO CONSIDER

HOMEOWNER / BUILDING OWNER

GUIDE THEM – FROM MISINFORMATION

- More informed buyers
- Truthful about ASHP, cold climate vs. geothermal
- Balance point…
- Smart controls = alerts / monitoring for peace of mind

CONTRACTOR

REALIZE YOUR INFLUENCE

- Share options (unit & applications choices, ground loop, aux
- Electrical service implications
- Multiple system – Do you need aux in each system?
- Consideration for 1 vs. 100 or 500 in your assessment
- Just because we can, should we?

UTILITY

GRID FRIENDLY DECISION – VIEW THROUGH THEIR LENS

- Do other systems have a redundant back-up (gas)?
- T.E.N. – aux or backup-up at all?
- Aux/Back-up 15 or 20kw?
- Consideration for 1, 100 or 500 home development
- Grid infrastructure impact
- Consistent load – low & predictable kw demand – winter & summer

THANK YOU

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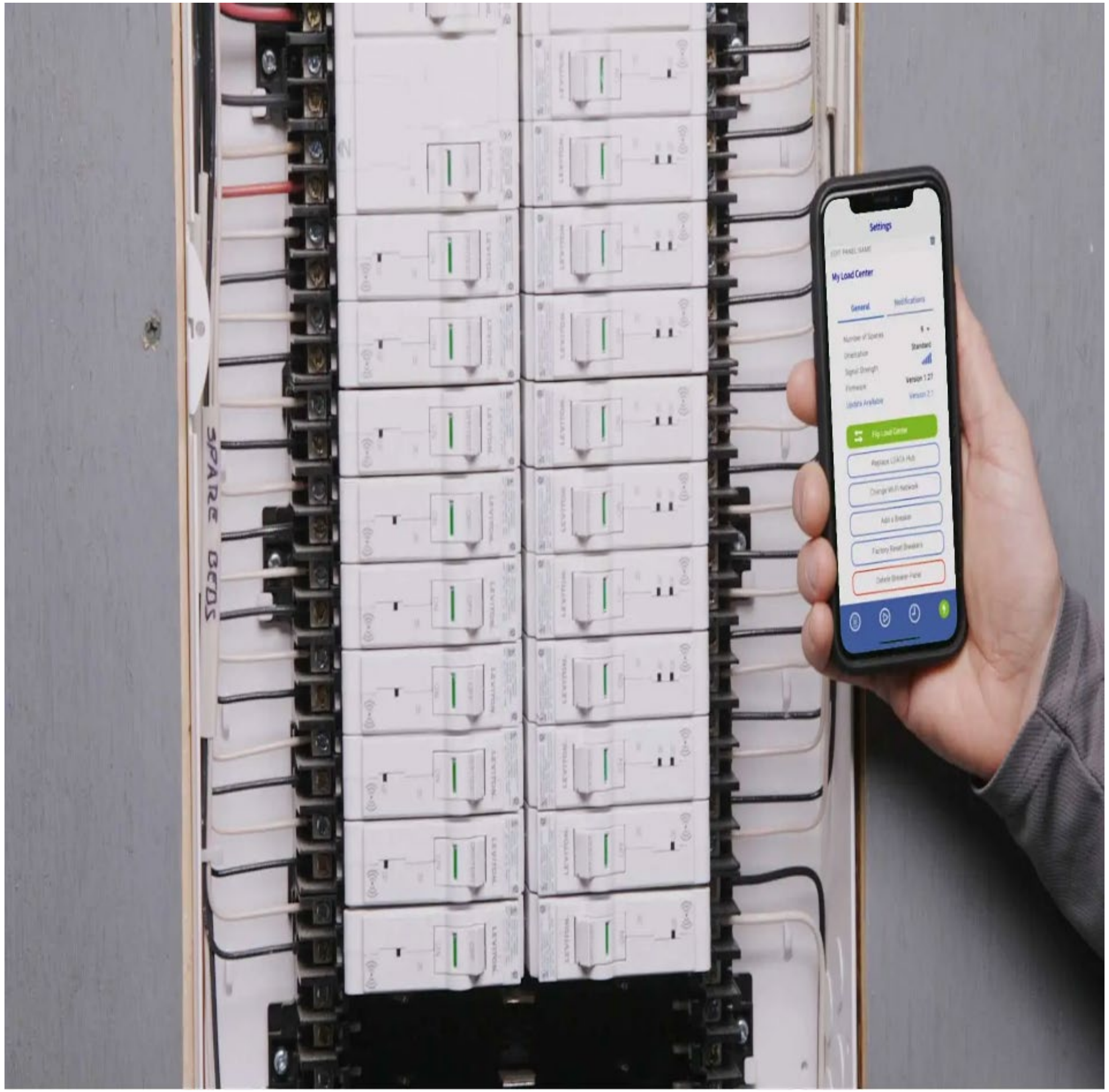
WaterFurnace
Smarter from the Ground Up™

Driving Down GSHP Grid Impacts at the Building Level- Smart Panel’s

Maximillian Ciovacco, Project Manager

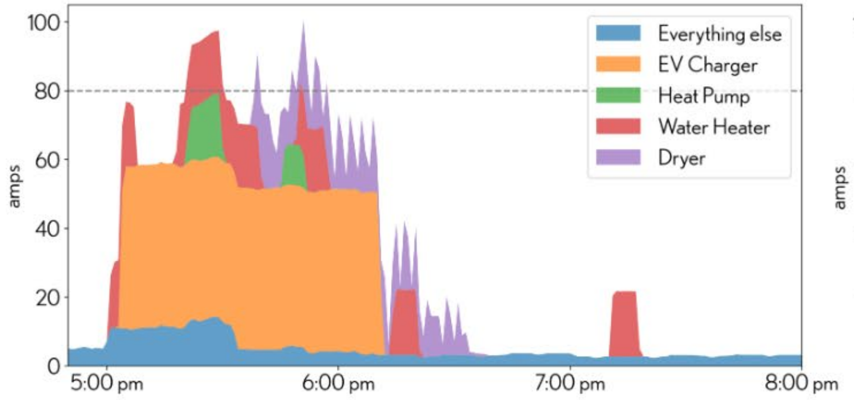
What is a Smart Panel?

- A Smart panel is an internet connected, software-controlled circuit breaker panel where each circuit has a current sensor, and a relay built into each circuit breaker.
- At a high level, the current transformer allows the system to know exactly how much electricity is flowing through each branch circuit
- With this information you can determine how much power each circuit uses and with the software you can control when a particular circuit is allowed to draw power at a time you specify.

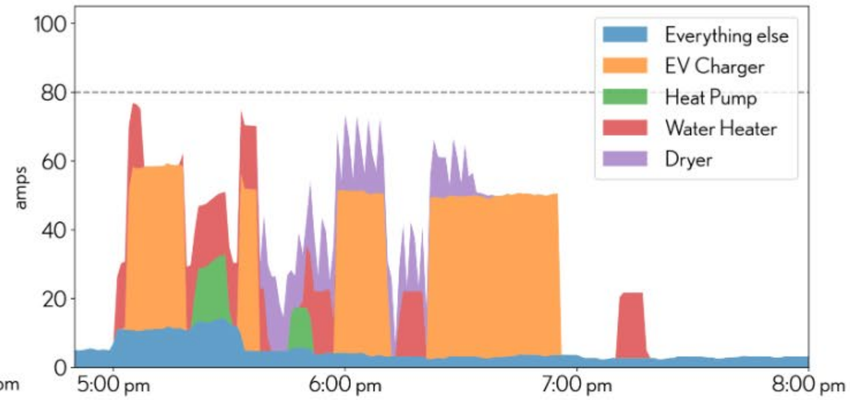


Addressing Existing Service Limitations

- Intelligent building solutions can reduce service upgrades, cutting cost and time to electrify
- 80% of electric home peak events are under 12 minutes
- Shifting the operation of just one load can mitigate 90% of peak events



Coincident loads exceeding desired peak



Same event shifting 40 mins of EV charging

Data provided by Span.IO, Inc. and analyzed by Rewiring America.

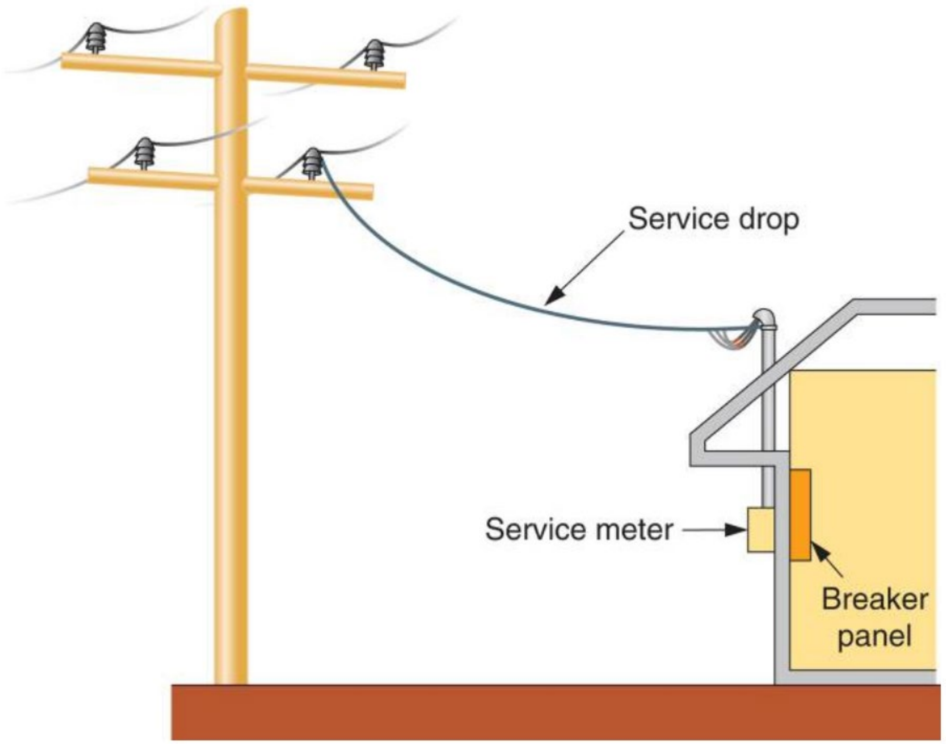
Opportunities

1. Integrate intelligent building control system to reduce/avoid service panel upgrade
2. Leverage service panel upgrade to smart panel instead – IRA $600 tax credit

Barrier to Electrification

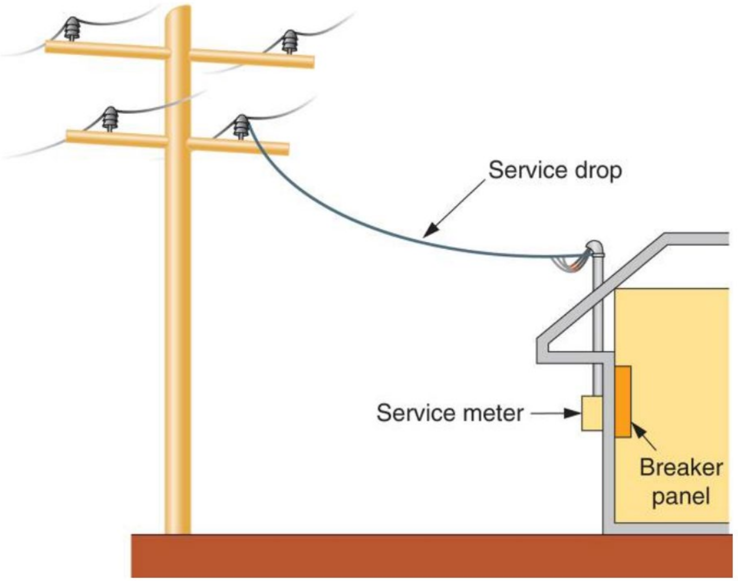
- Full home electrification typically requires at least 200 Amp service
- This exceeds the existing panel capacity of 75% NYS homes and apt units!
- EV Level 2 charging would require an additional 80 Amps

- Upgrading to 200-Amp panel costs $1,500 - $3,000
- If street utility lines require upgrades, it can cost $10,000+



Barrier to Electrification - Existing Service Capacity

- Electrification of space conditioning, hot water, and cooking exceeds the electrical service capacity in the vast majority of existing buildings
- If utility transformer and power lines need to be upgraded the additional cost can be a $10K dollars plus
- EV Home Charging Station (Level 2) will require an additional 20 to 40 Amps



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Example Loads

Electric Load	Electric Service Required
Range /Stove (Induction)	208/240V 40A
Hot Water Heater (50 Gal)	208/240 VAC Single Phase 30A
Heat Pump	208-230V 1Ph 45A
Heat Pump Dryer	30A
Refrigerator	120 V 15 or 20A
Washer	120 V 15 or 20A
Misc	25A
Total	200 Amps

Vintage	Electrical Service	% of Residential Units
Before 1950	30A Fuse Panel - No 240 V	41%
1951-1965	60A Fuse Panel - 240 V Feed	28%
1966-Late 1980s	100A Circuit Breaker 120-240 Volt Circuit	17%
1990s-	200 A Circuit Breaker	15%
5.2 Single Family Units (through 2011)		

More than ¾ of existing residential units will require electrical service upgrades to enable complete building electrification

ENABLING INNOVATIVE CLEAN ENERGY BUILDING SOLUTIONS (PON 5982)

The New York State Energy Research and Development Authority (NYSERDA) seeks demonstration projects at a New York State site that 1) address one of the following Innovation Topic Areas and 2) have received government or foundation funding that advanced and readied the solution for demonstration. NYSERDA anticipates making five $1 million awards under this solicitation to support the advancement of solutions in the five following Innovation Topic Areas:

1. **Building Envelope**
2. **Clean Heating and Cooling**
3. **Intelligent Grid-interactive Building Controls**
4. **Low-GWP Refrigerant Applications and Leak Detection**
5. **Thermal Storage**

Thank You

Max.Ciovacco@NYSERDA.ny.gov

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