(Grid) Interactive Heat Pumps

Moderator: Jay Egg / *Egg Geo, LLC*

Panel: Dion Harmsen / *Aztech Geothermal, LLC*
Bob Brown / *WaterFurnace International*
Mikko Ojanne / *Rototec Europe*

Grid Interactive Heat Pumps

1. Thermal Energy Networks are utility-scale infrastructure projects that connect multiple buildings into a shared network with sources of thermal energy like geothermal boreholes, surface water, and wastewater.
2. Wastewater Energy Transfer (WET) systems extract and reject heat from the sewers.
3. Heat (Thermal Energy) is conducted in/out of the mechanical system of buildings.
4. Various geothermal exchange resources absorb or reject thermal energy.
5. Power generation facilities of all types can provide waste heat to a “TEN”
6. Recreational facilities such as ice rinks and waterparks may be connected.
7. Geothermal exchangers under buildings (Piles)…
8. Surface Water Exchange (Rivers, Lakes, Etc.)
9. Office buildings and data centers are cooling dominant, meaning, they reject heat all year long.
10. Thermal Storage & Energy Exchange facilities

NY-GEO Panel Presentation May 21-22, 2025

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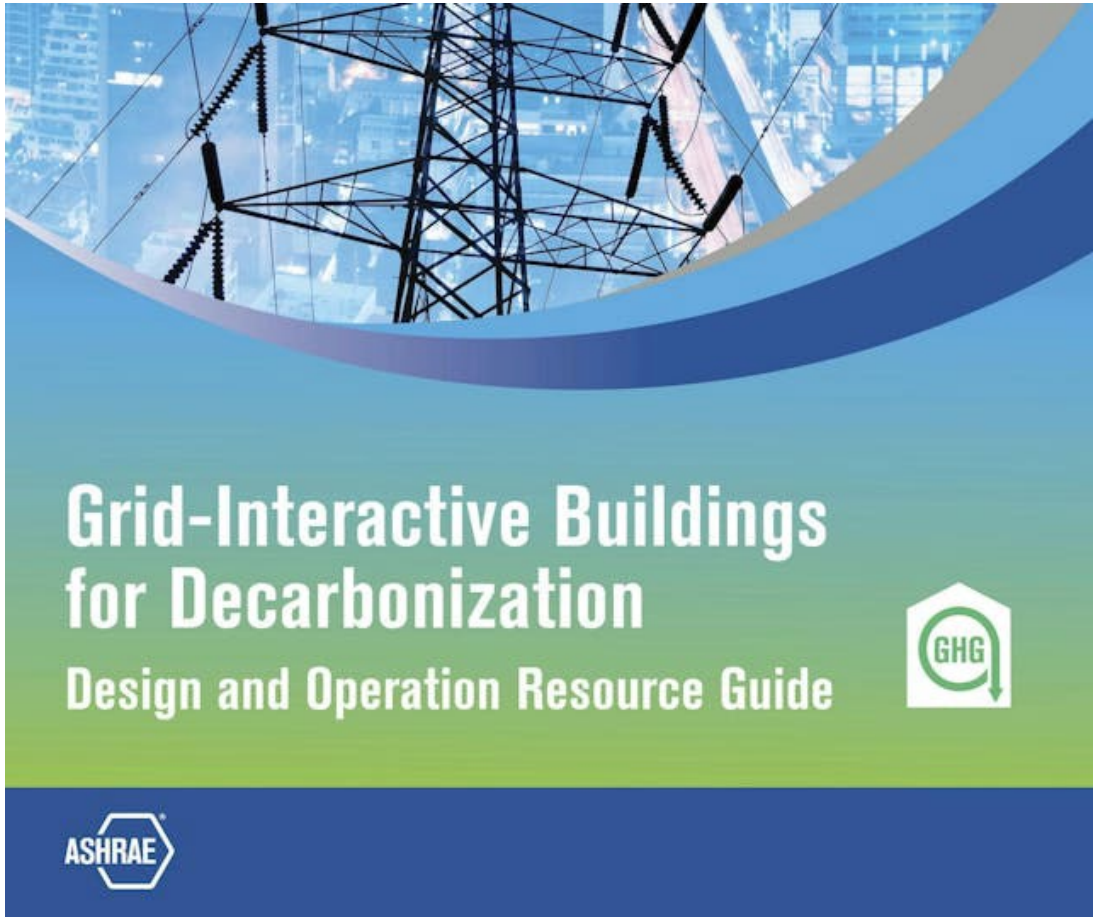
Defining the Future of Geothermal

Grid-Interactive Heat Pumps



For years we have heard about the "smart grid" when a signal from your utility will influence or control your electrical appliances. While this is certainly not pervasive, there are a number of ways heat pumps can be responsive to the electric grid pricing, while also lowering demand. In this program we will hear about some examples of the connected heat pump, some readily available and others requiring significant shifts in the way we regulate and access energy.

ASHRAE releases guide on grid interactivity in the decarbonization process
By Peter Fabris, Contributing Editor Dec. 18, 2023

Dion Harmsen / *Aztech Geothermal, LLC* *(Symphony Data Analysis – HP adjustments)*

Dion Harmsen investigates best practices for heat pumps and geothermal technologies in Europe, working from his office in Switzerland. In addition, Dion is supporting Aztech's Commercial Design Team in the US, with building energy modeling, ground heat exchanger design and engineering CAD drawings. Prior to working for Aztech, he spent 10 years as a Site Manager at the International School of Zug and Luzern (ISZL) in Switzerland.

Bob Brown / *WaterFurnace International*
(Equipment to Utility communication protocol)

Bob has been active in the geothermal/water source heat pump industry since 1981 and began employment at newly formed WaterFurnace International in 1985. He holds several patents in the design, application, and control of geothermal/water-source heat pumps and was responsible for all product development and research of the company for over 30 years.

Mikko Ojanne / *Rototec Europe*
(NIBE Smart Price Adaption)

I am an entrepreneur with a focus on Scandinavia. Technology, green-tech and real estate mainly. The experience is to build from seed to harvest and transfer it to Scandinavia. Love working close to people from all parts of the world. Always curious about what we can do better. Love solving problems. Now we go!!

Analysis of Historical Heat Pump Performance Data to Reduce Demand (kW) & Usage (kWh)

Dion Harmsen

Market Analyst and Engineering Support

Aztech GEOTHERMAL

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Aztech Geothermal, LLC

- 650+ Geothermal Projects (NY & MA)
- Turnkey GSHP HVAC Systems
- Ground Loop Design & Installation
- Consult to MEP Firms
- Provide Inspection & Commissioning
- Formation Thermal Conductivity Tests

GeoCube™
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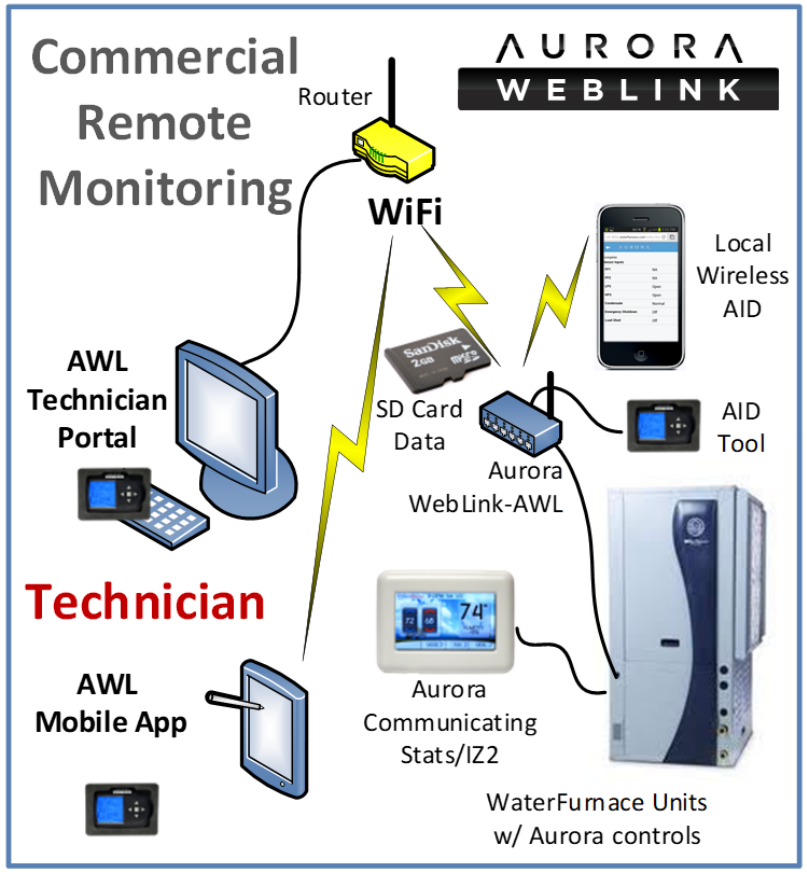
Overview of Symphony

- Analyze historical data of units over the web
- 140 pieces of Data recorded every 10 seconds.
  - Temperatures
  - Pressures
  - Compressor, fan and pump speeds
  - Control signals
  - DIP switch settings
  - Airflow settings
  - Configurations
- Search for faults
- Graphing capability for troubleshooting
- Historical data shown in Troubleshooting Form

Symphony™



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Aztech Customer Data on Symphony

Review of Aztech Customers' Symphony data to identify operating issues, efficiency and relate it to design calculations

- Aux Heat/ Backup Heat- Identify high users
- Heat Pump Staging- relates to system sizing
- Loop Pressure Monitoring- Identify high and Low
- Min. and Max. EWT- Relative to design calculations
- Total Annual kWh

Aztech's review of customers' Symphony data has been *a great tool* for informing more accurate heat pump & ground loop sizing.

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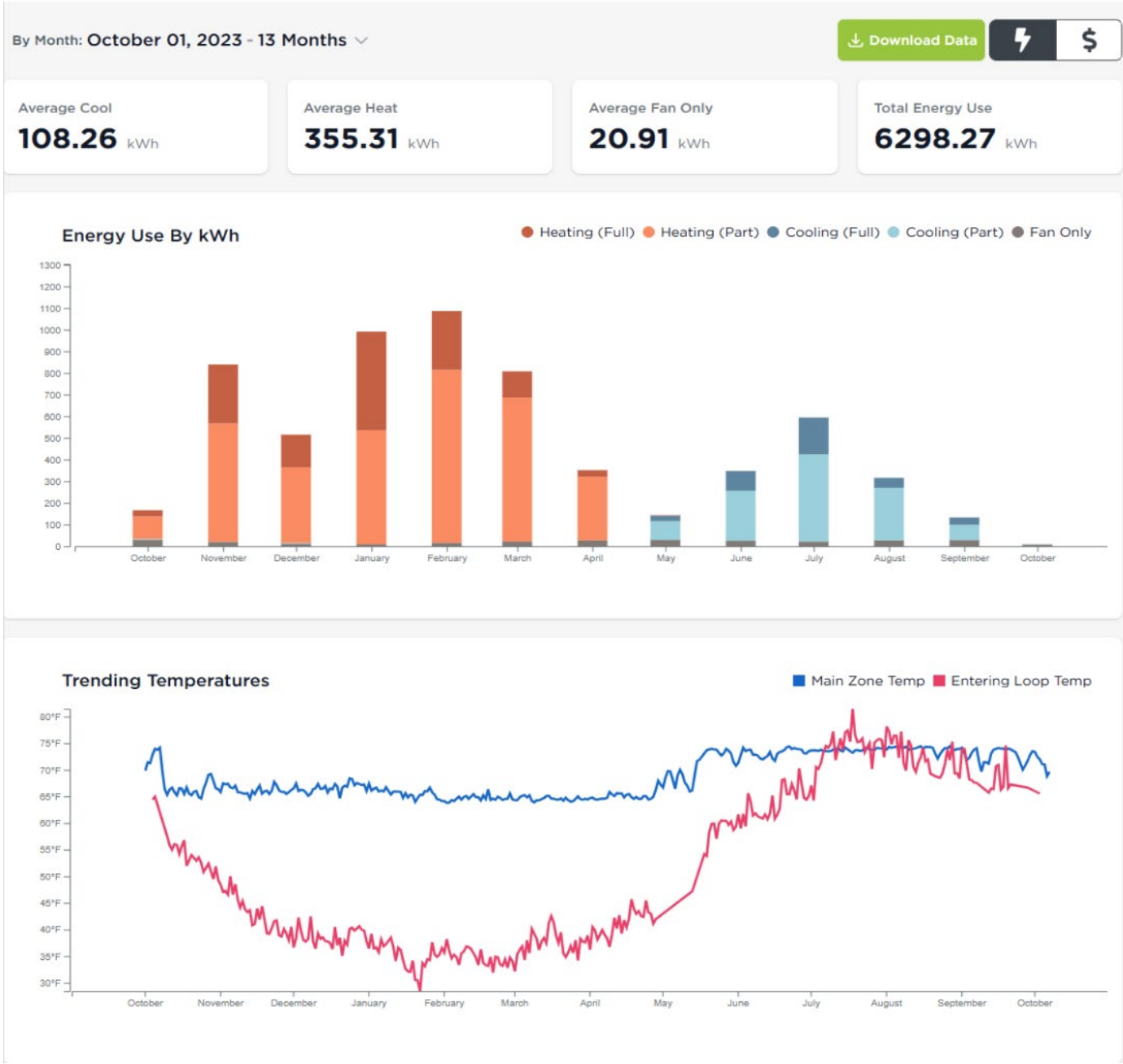
High Aux. Heat / Backup Heat Users

- 300+ customers on Symphony
- 35 were identified as high users, over 5% of annual kWh
  - Thermostat Setback Recovery- accounts for 50% of high Aux. Heat kWh
  - New Customers - Ground loop not connected yet
  - Heat Pump System Failure- Problem with Heat Pump or Ground Loop, required repair
  - Undersized and/ or previous sizing methods

Energy usage

- No Aux used



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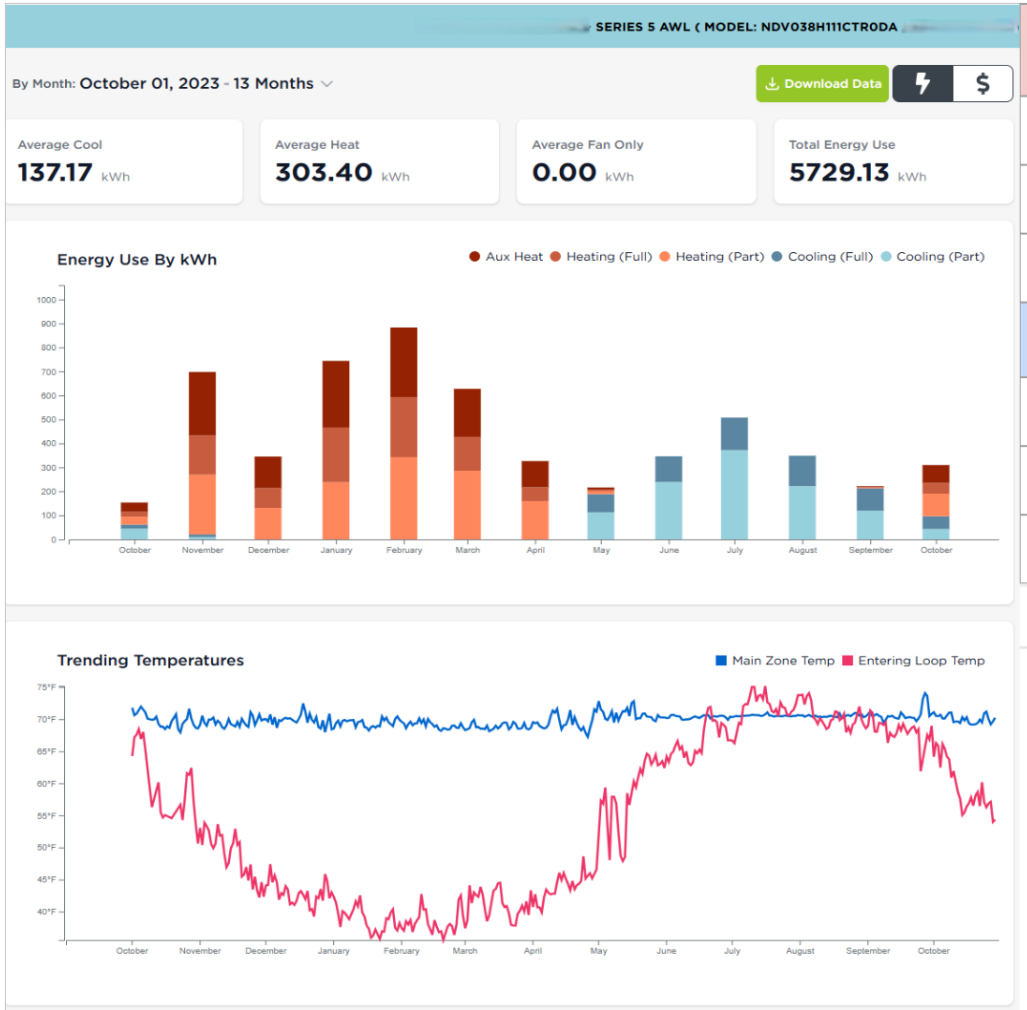
Setback

- 6°F setback at night (67°F - 73°F)
- Home built in the 1920s
- Customer is aware that building upgrade is helpful
- Ground loop not cold -> set back issue
- 3-ton HP amplifies the Aux. %



Heating stage	Energy (kWh)	% of Total
Part	1548.51	39.3
Full	998.24	25.3
Aux Heat	1397.46	35.4
Cooling stage	**Energy (kWh)**	**% of Total**
Part	1162.17	65.2
Full	621.04	34.8
38,000 BTU	1592 sq ft	23.9 BTU/ sq ft
Total Energy Use	3-ton	Vertical ground loop - (2) 275'

- Heating (Part) 1548.51 kWh
- Heating (Full) 998.24 kWh
- Aux Heat 1397.46 kWh
- **Total Heating 3944.21 kWh**
- Cooling (Part) 1162.17 kWh
- Cooling (Full) 621.04 kWh
- **Total Cooling 1783.21 kWh**
- Fan Only 0.00 kWh
- Defrost NaN kWh
- Dehumidification 0.00 kWh
- **Total 5729.13 kWh**

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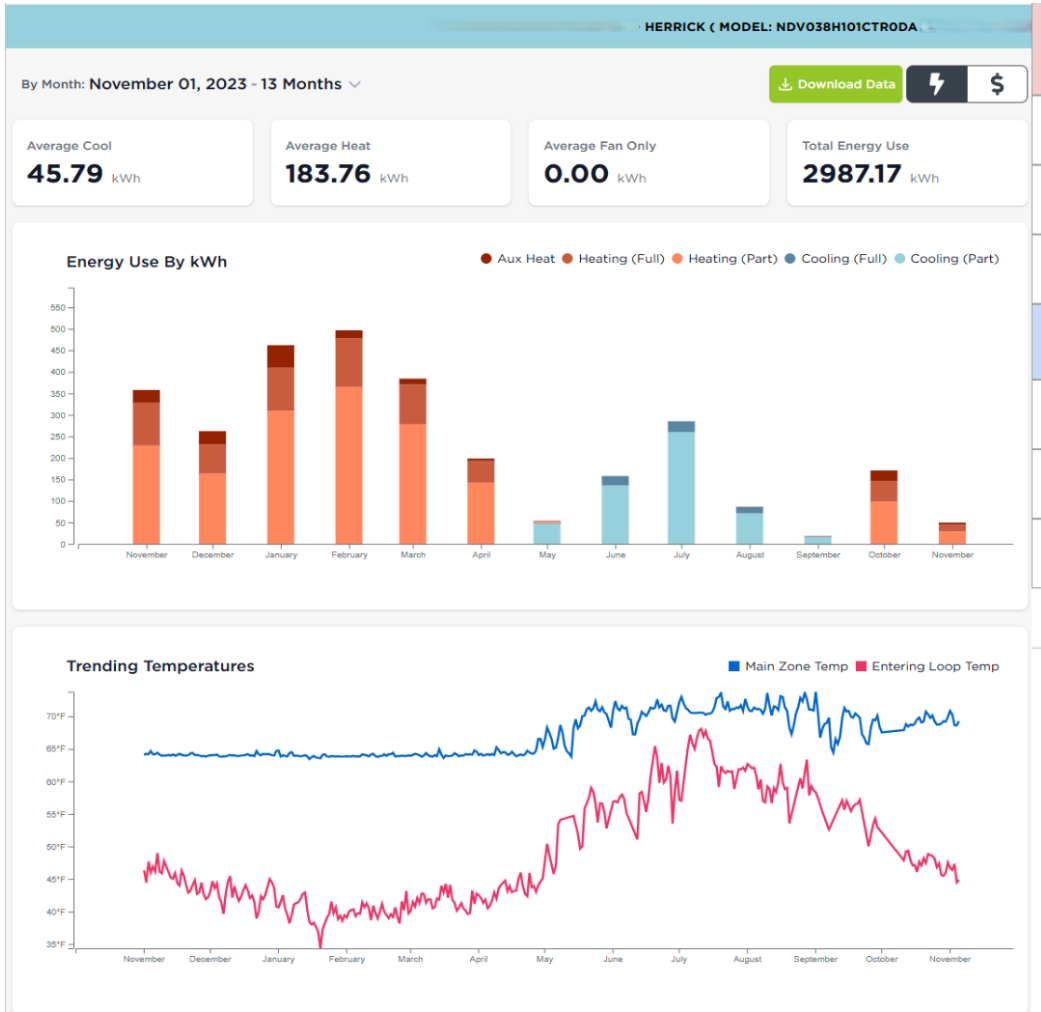
Setback

- 5°F setback (64°F - 69°F)
- To find out setback, had to go into Symphony history to find.



Heating stage	Energy (kWh)	% of Total
Part	1618.86	67.8
Full	591.06	24.7
Aux Heat	178.94	7.5
Cooling stage	**Energy (kWh)**	**% of Total**
Part	530.88	89.2
Full	64.33	10.8
35,000 BTU	2250 sq ft	15.5 BTU/ sq ft
Total Energy Use	3-ton	Vertical - (1) 450'

- Heating (Part) 1618.86 kWh
- Heating (Full) 591.06 kWh
- Aux Heat 178.94 kWh
- **Total Heating 2388.86 kWh**
- Cooling (Part) 530.88 kWh
- Cooling (Full) 64.33 kWh
- **Total Cooling 595.21 kWh**
- Fan Only 0.00 kWh
- Defrost NaN kWh
- Dehumidification 0.00 kWh
- **Total 2987.17 kWh**

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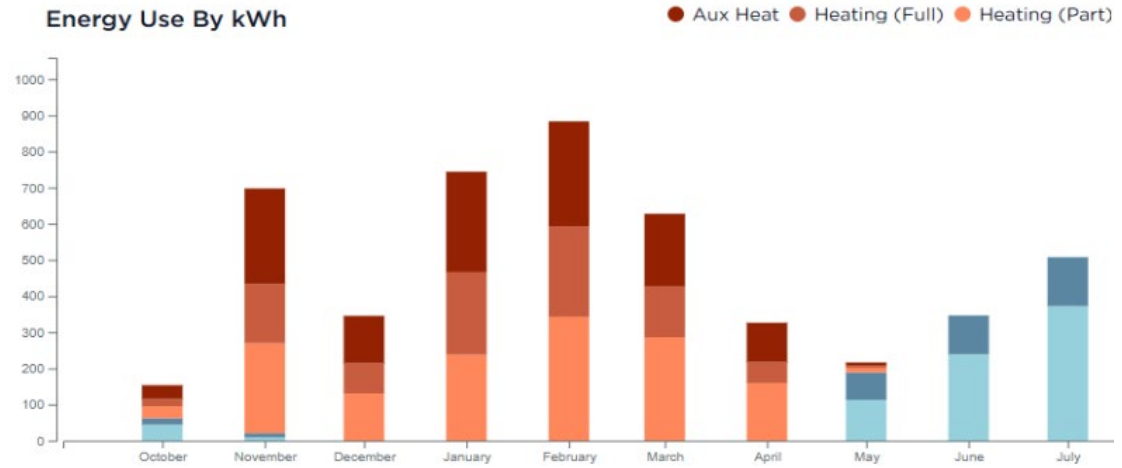
Reducing Setback

- Customers informed during initial walkthrough that setback could cause higher energy use
  - –“Set it and forget it”
  - –Change habits
- Why is setback a problem
- Smart recovery as a possible solution to avoid Aux. Heat



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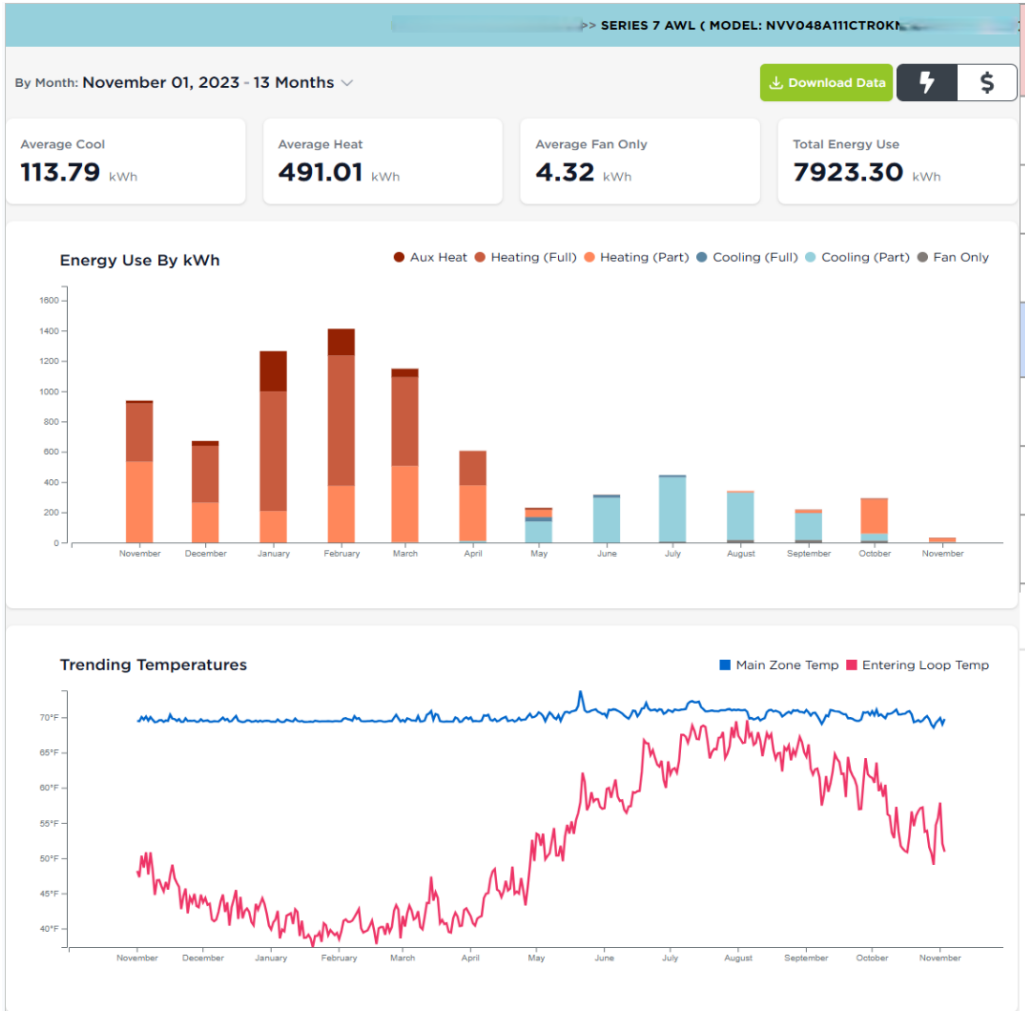
Right-sized or Undersized?

- Previous sizing method included use of Aux. Heat
- No setback
- Aux. Heat only 3 coldest months



Heating stage	Energy (kWh)	% of Total
Part	2572.85	40.3
Full	3245.13	50.8
Aux Heat	565.12	8.9
Cooling stage	**Energy (kWh)**	**% of Total**
Part	1412.38	95.5
Full	66.94	4.5
47,900	3975 sq ft	120.5BTU/ sq ft
	4-ton	Vertical ground loop - (2) 300’

Total Energy Use

Heating (Part)	2572.85 kWh
Heating (Full)	3245.13 kWh
Aux Heat	565.12 kWh
Total Heating	**6383.10 kWh**
Cooling (Part)	1412.38 kWh
Cooling (Full)	66.94 kWh
Total Cooling	**1479.32 kWh**
Fan Only	56.15 kWh
Defrost	NaN kWh
Dehumidification	0.00 kWh
Total	**7923.30 kWh**

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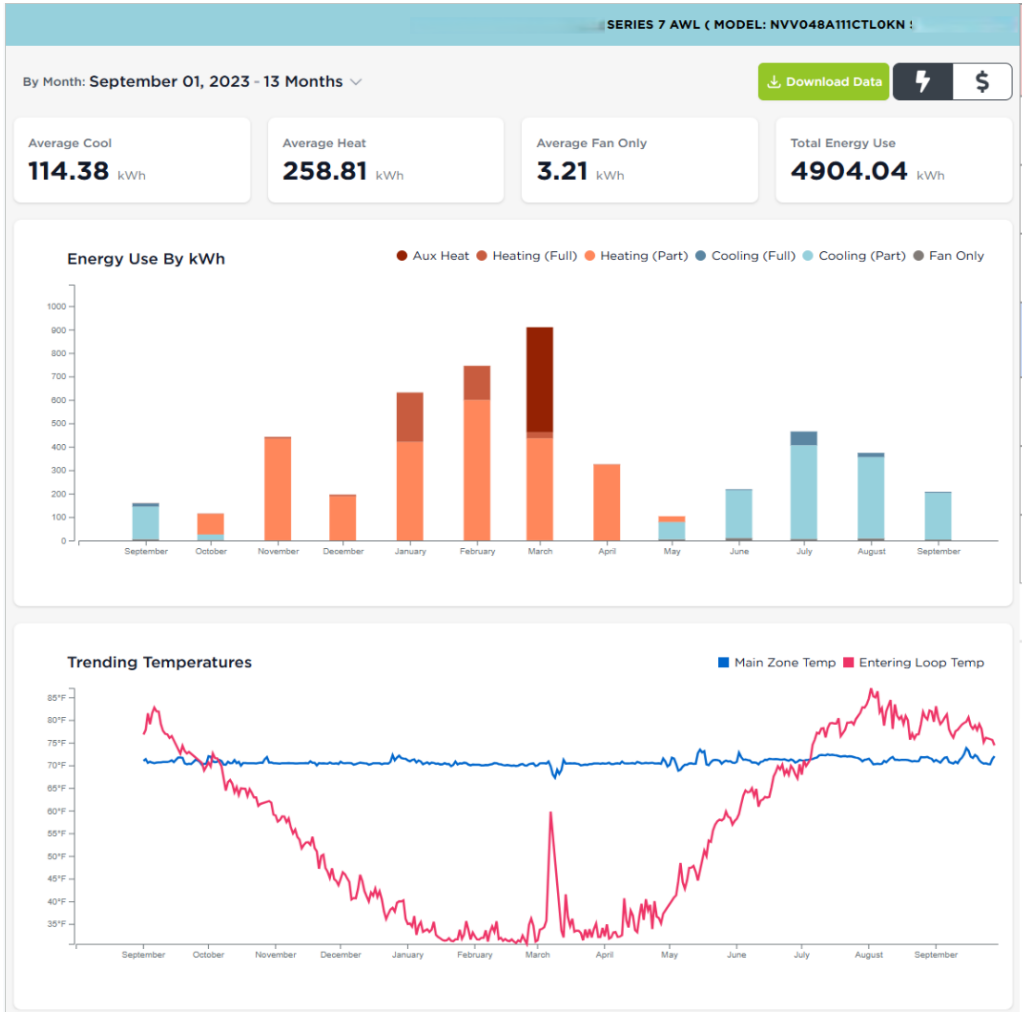
Repairs

- Temporary high Aux. Heat due to repairs
- Well-insulated home
- Customer: Set it and forget it
- Aux. Heat ran for a week



Heating stage	Energy (kWh)	% of Total
Part	25141.68	74.7
Full	401.91	12
Aux Heat	448	13.3
Cooling stage	**Energy (kWh)**	**% of Total**
Part	1386.23	93.2
Full	100.76	6.8
44,550	5250 sq ft	8.48 BTU/ sq ft
Total Energy Use	4-ton	(4) 120’ long trenches, 4’ wide x 6’ deep

Heating (Part)	2514.68 kWh
Heating (Full)	401.91 kWh
Aux Heat	448.00 kWh
Total Heating	**3364.59 kWh**
Cooling (Part)	1386.23 kWh
Cooling (Full)	100.76 kWh
Total Cooling	**1486.99 kWh**
Fan Only	41.73 kWh
Defrost	NaN kWh
Dehumidification	0.00 kWh
Total	**4904.04 kWh**

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Summary

- Online platform for data is good for optimizing current and new systems
- Setback problem for energy efficiency
- Smart recovery

The Cloud Connected Heat Pump For Demand Response

Bob Brown

VP of Engineering and Regulatory Affairs

WaterFurnace®
Smarter from the Ground Up™

2025 NY GEO SARATOGA SPRINGS, NEW YORK

Demand Response
IFTTT Cloud Solution

The Demand IFTTT Demand Response Solution?

- Smart Home Technology is ever changing
- Too many products/manufacturers to individually consider
- ‘If This Then That’ (IFTTT) allows general compatibility for most or all systems
- How? Set up Internet of Things (IoT) proxy server with API access to variety of parameters.

The Basics First: Cloud Control and API

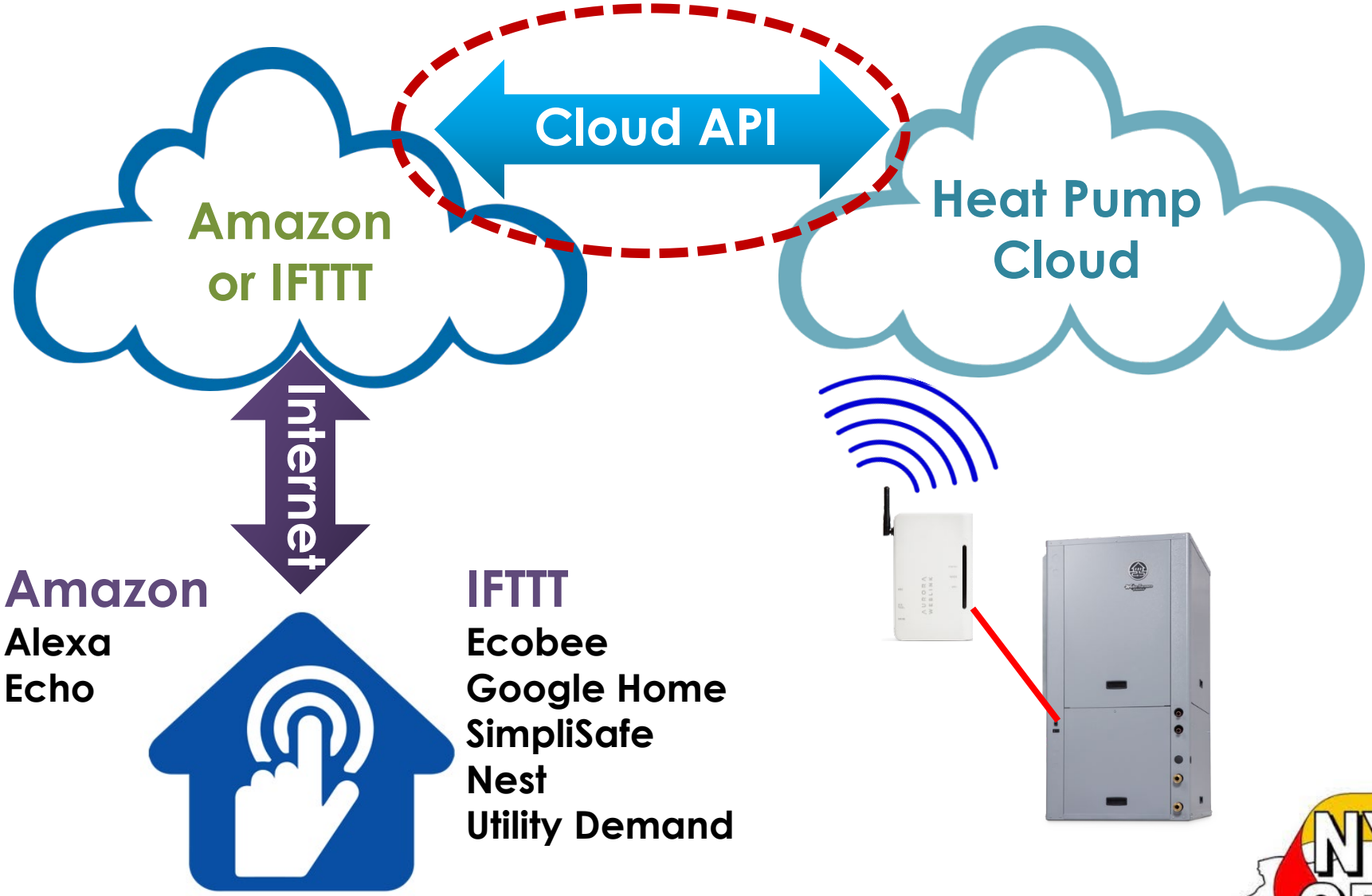
What is an API?

- **A**pplication **P**rogram **I**nterface (API or a ‘Butler’)
- House Without API – House is open door for anyone to wreak havoc inside
  - Retrieve sugar yourself and also help yourself to money and jewels!
- With API - Allows “controlled access to selected items in house”
  - Butler retrieves cup of sugar for you but denies you entrance to home.
- **Allows Cloud to Cloud Communication**

No API

With API

DIY Smart Home Solution - IFTTT

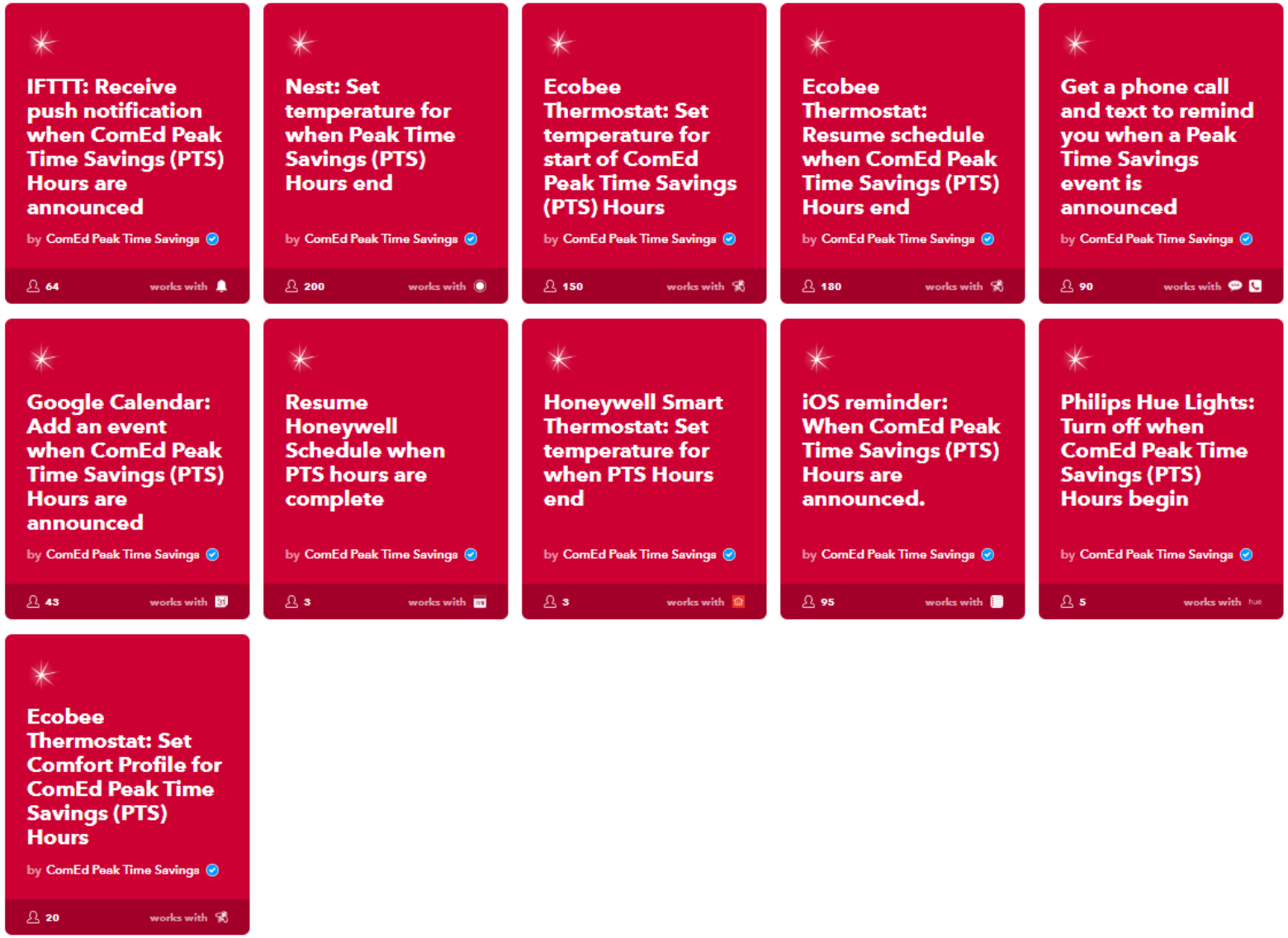


IFTTT - Utility Demand Response?

- Utility Demand Response (DR)
  - 1st Level - General Peak - Unoccupied setpoints (i.e. Daily 2-6 pm)
  - 2nd Level - Critical Peak (i.e. Aurora Smart Grid – 5 hrs per year)
  - Requirement - Positive feedback of equipment response to utility
- IFTTT Applet is first step to utility demand integration.

Demand Response

Example: Common Wealth Edison Applets

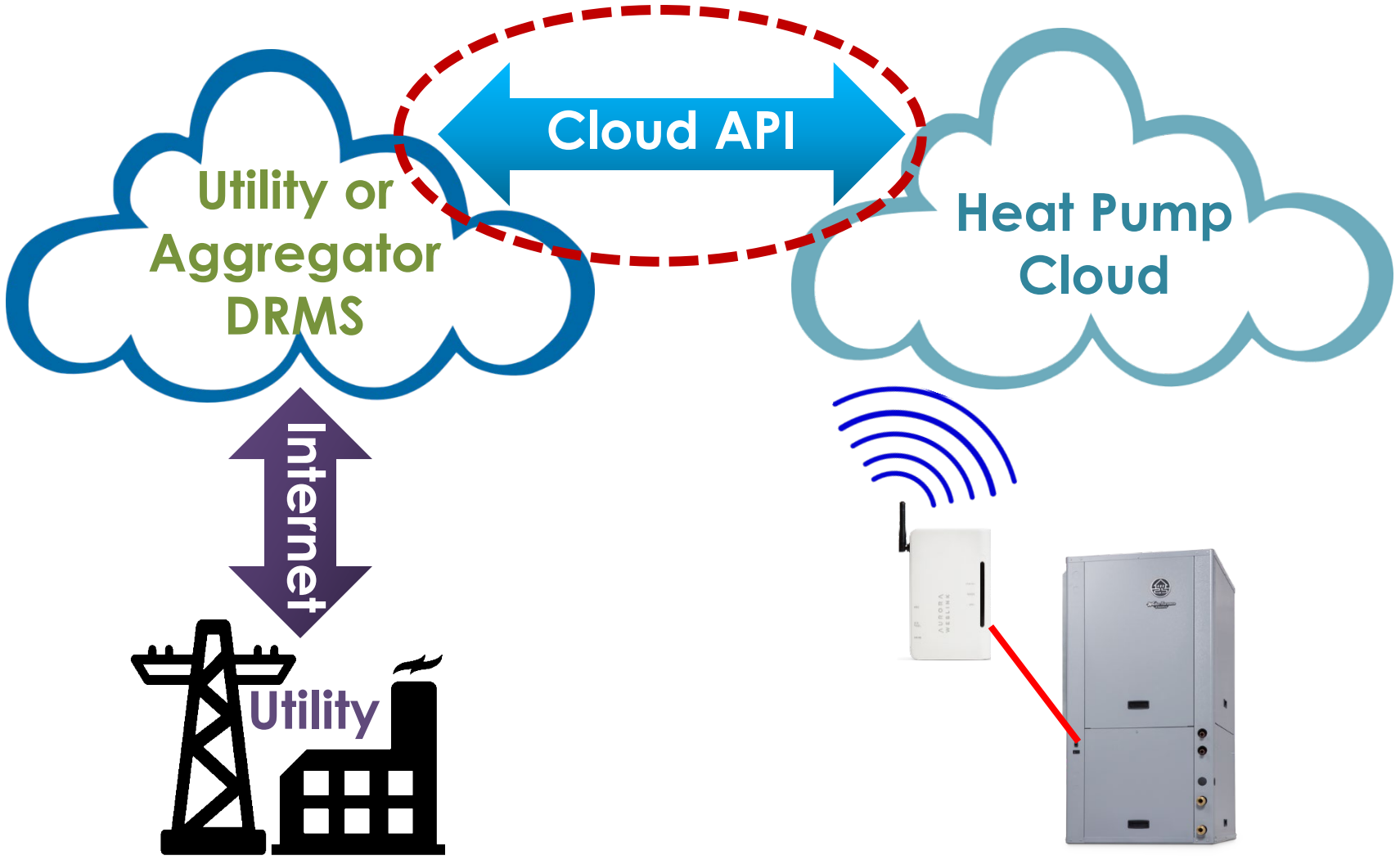


Demand Response Thru IFTTT Summary

- Requires a “techy” consumer to implement
- Typically a simple communication, simple demand response with little verification.
- Only a few utilities have utilized it.

Demand Response – Utility/Aggregator Cloud API Solution

Demand Response Solution - Utility Cloud Direct



Basic Utility Demand Response?

- Utility Demand Response (DR)
  - 1st Level - General Peak - Unoccupied setpoints (i.e. Daily July-August 2-6 pm)
  - 2nd Level - Critical Peak (i.e.– predictions 5 hrs per year)
  - Requirement - Positive feedback of equipment response to utility
  - Advanced Dynamic Pricing Response

Common Demand Response Protocols

- CTA-2045-A –
  - Mostly Components such as water heaters etc.
  - Limited application and diminishing use
- OpenADR 2.0a
  - Sophisticated but complicated programming
  - Limited use due to programming
- OpenADR 2.0b
  - Expanded capability more complex demand response
  - Still complicated and limited use due to programming
- OpenADR 3.0
  - Easier programming variation
  - Supports simplified messaging and dynamic pricing
  - Gaining traction as the solution

API Access to These Protocol Parameters

API	WF IoT Proxy Server API Description	Read	Write	Alexa	IFTTT
Basic IFTTT					
1	Current Zone Setpoint Cooling	X	X	X	X
2	Current Zone Setpoint Heating	X	X	X	X
3	Thermostat Mode (Heat, Cool, Auto, Off)	X	X	X	X
4	Current Zone Temp	X		X	X
5	Set Comfort profile (Occupied/Unoccupied/Vacation)	X	X		X
6	Notify homeowner email thru Symph text and email system		X		X
7	Set Continuous Fan On or Auto	X	X		X
8	Read Active Fault Code	X			X
9	Activate Smart Grid Mode		X		X
10	Check for permanet hold or override.	X			X
11	Writeable Outside Air Temp	X	X		X
Energy Monitoring					
12	Compressor Amps	X			X
13	Fan Amps	X			X
14	Pump Amps	X			X
15	Aux Amps	X			X
16	Total Amps	X			X
17	Comp Power	X			X
18	Fan power	X			X
19	Pump Power	X			X
20	Aux Power	X			X
21	Total Power	X			X
Equipment Status					
22	Current active Mode	X			X
23	Compressor Speed	X			X
24	Fan Speed	X			X
25	Room Temp	X			X
26	Active Fault	X			X
WF Aurora Demand Management					
27	Aurora Smart Grid Selection	X	X		X
28	Engage Smart Grid (Max Peak)	X	X		X
29	Engage Unoccupied Mode (Daily Peak)	X	X		X
30	Demand Response Confirmation	X			X
31	Max Peak Time - Aurora Smart Grid Engage	X			X
32	Load Shed	X	X		X
33	Emergency Shutdown	X	X		X

Utility Demand Management (AHRI 1380 OpenADR 2.0)					
34	Verifying connectivity - oadrPoll	X	X		X
35	Utility SetupoadrCreatePartyReg	X	X		X
36	Registration - oadrRegisterReport	X	X		X
37	Cancel Registration - oadrCancel PartyReg	X	X		X
38	Re-Registration - oadrRequest ReRegister	X	X		X
39	Status Report Request - oadrRegisterReport	X	X		X
40	Manufacturer	X	X		X
41	Model Number	X	X		X
42	Serial Number	X	X		X
43	Type (WA GSHP)	X	X		X
44	Tonnage	X	X		X
45	Unloading Type	X	X		X
46	Benchmark power heating	X	X		X
47	Benchmark power cooling	X	X		X
48	Current Mode	X	X		X
49	General Curtailment 70% - oadrDistributeEvent	X	X		X
50	Critical Curtailment 40% - oadrDistributeEvent	X	X		X
51	Turn Off (Emerg Shutdown) - oadrDistributeEvent	X	X		X
52	End Active Events - oadrDistributeEvent	X	X		X
53	Utility peak Load Events (unoccupied)- oadrDistributeEvent	X	X		X
54	Customer override Event - oadrCreateOpt	X	X		X
Utility Demand Management (AHRI 1380 CTA-2045-A)					
55	Verifying connectivity	X	X		X
56	Equipment Capabilities	X	X		X
57	Determining Degree of unloading	X	X		X
58	Max Indoor Temp Offset	X			X
59	Operatinal State Query	X			X
60	General Curtailment	X	X		X
61	Critical Curtailment	X	X		X
62	Turn Off (Emerg Shutdown)	X	X		X
63	End Active Events	X	X		X
64	Advanced Notification	X	X		X
65	Cancel Schedule	X	X		X
66	Utility Peak Load Price	X	X		X
67	Customer override Event - oadrCreateOpt	X	X		X

AHRI Demand Response Standards

- **AHRI 1380 – Demand Response in Residential VS ASHP's**
  - Supported both CTA-2045-A and OpenADR 2.0 for nearly 10 years
  - Required in some VS heat pumps for advanced energy efficiency programs but largely unused.
  - Not a lot of utility action in last 10 years
  - Next revision under development currently will expand to OpenADR 3.0

- **AHRI 1390 – Commercial Equipment Smart Grid**
  - Likely much more broad scope than 1380
  - Requires BACnet and other building protocols
  - Integration of whole building in demand response
  - Initial standard is **under development in 2025**

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Heat Pump Demand Response Summary

- Utilities/Aggregators so far have mostly gone their own way.
  - Custom hardware systems (thermostats and water heater type controls)
  - AHRI 1380 is 10 years old and HVAC mfr's have reported very little activity surrounding demand response
  - Cloud solutions have been limited
- ***The Industry is hopeful that:***
  - ***the benefits of OpenADR 3.0 will unify the effort and consolidate the industry around a single protocol.***
  - ***AHRI 1390 will open whole commercial building to demand response.***

QUESTIONS?

Smart homes

Mikko Ojanne

2025-04-24

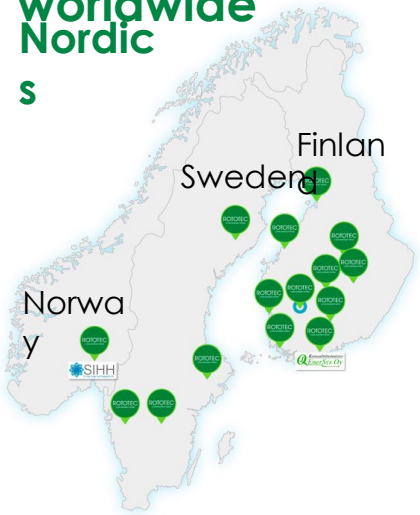
Rototec Group in a nutshell

About us

We deliver geoenergy (shallow geothermal) fields for ground source **heating and cooling** especially for large properties and industries and provide consulting services for geoenergy projects.

Locations worldwide

Nordics



USA

Germany

In numbers

6.5

Million feet of energy wells drilled per year

140

Employees

66

Modern drilling units

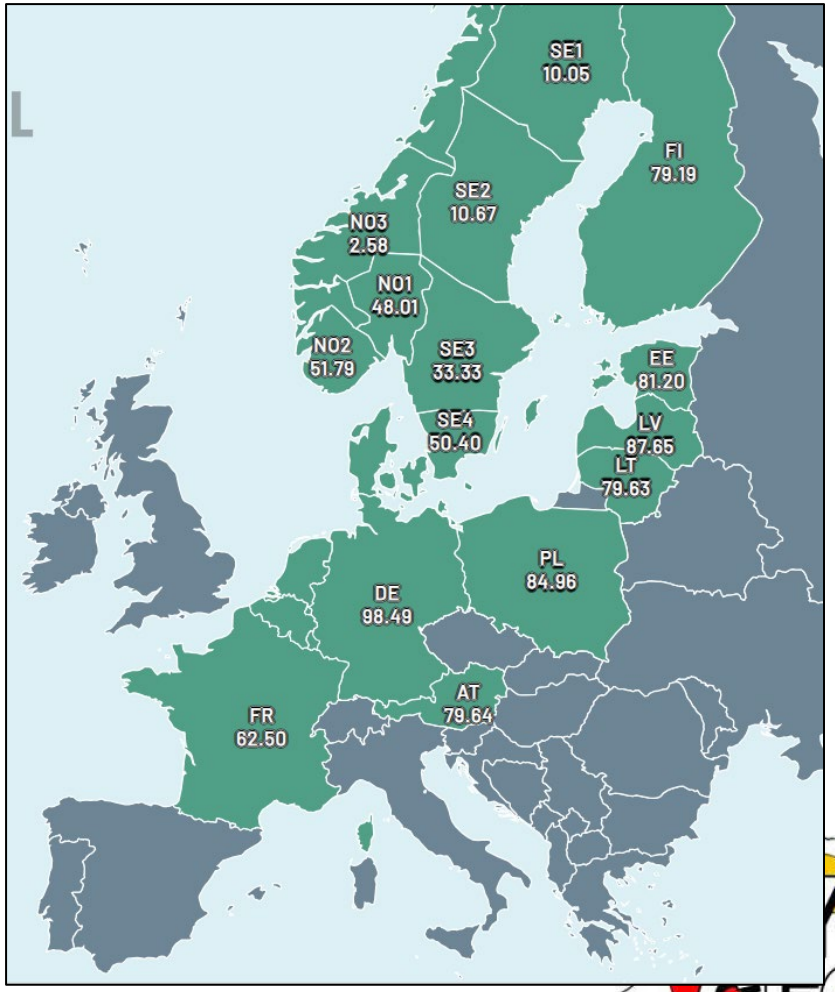
310 000

Tonnes/year reduction in CO_2 emissions thanks to Rototec's energy wells

Hourly pricing of electricity is used in many European countries

Consumers can buy exchange-traded electricity with hourly pricing

- Electricity is traded on the Nord Pool exchange. Originally, the Nord Pool area covered the Nordic and Baltic countries, but it has now been extended to several Central European Countries as well
- Hourly prices in the day-ahead market are published at 13:00 CET/CEST. Actors in the power market submit their bids an hour earlier based on their models and forecasting
- Different prices in different countries and area markets. Some countries are divided into several area markets (e.g. Sweden)
- In the Nordic countries, it is very common also for residential consumers to have electricity contracts with hourly pricing. E.g. in Finland, about 1/3 of households have hourly contracts
- For balancing out supply and demand mismatches in the day-ahead market, there is also an intra-day market, but consumers cannot participate in it
- On 12 June 2025, the day-ahead market will move from hourly pricing to 15-minute pricing



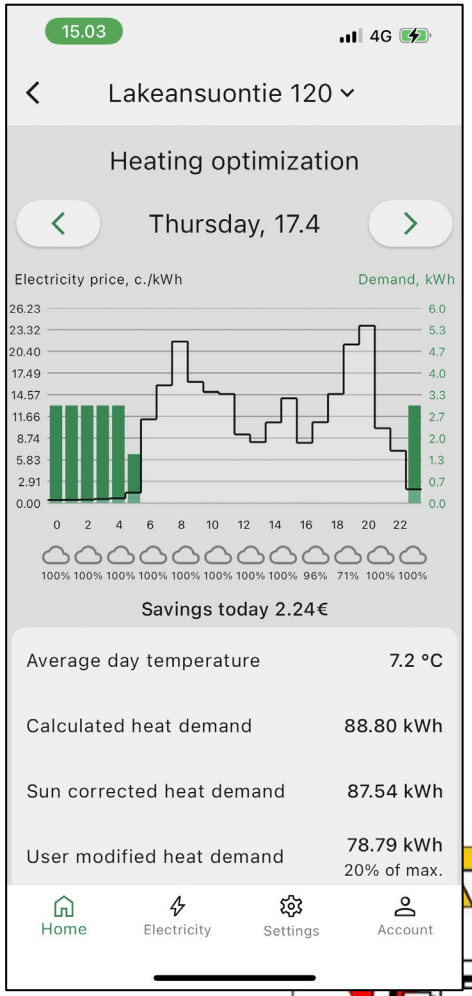
Intelligent operation of the heat pump can yield significant savings for the homeowner

Operating principle

- Most new heat pumps sold in Europe can be optimised to utilise the cheapest hours. All that is needed is an Internet connection for reading the hourly prices and weather forecast once a day
- For older heat pumps, different add-ons and software exist for electricity price optimisation
- The thermal mass of the building helps to maintain a steady indoor temperature. Especially buildings with an underfloor hydronic system tend to have a large thermal mass, ideal for maintaining steady temperatures with a heating supply that fluctuates over time
- The software allows the homeowner to set bounds within which the indoor temperature has to stay

Maximising savings

- The property owner can reap significant savings by concentrating the operation of the heat pump to the cheapest hours of the day
- Combining intelligent operation of the heat pump with battery storage and solar PV can lead to even greater savings for the property owner



Future trends

Demand response becoming ever more important

- In the Nordics and all across Europe, the share of renewables in the electricity mix is increasing rapidly. This leads to an ever more fluctuating supply
- Demand response through technologies such as intelligent heat pump operation and battery storage helps to balance out the demand side to better match fluctuating supply. This helps towards keeping price fluctuations reasonable and maintaining stability of the

Increasing importance of battery technology

- With 15-minute pricing coming soon, there will likely be even more price fluctuation across the day. For instance, there is likely to be a significant peak each weekday morning at 7 am, when many factories start up
- Battery technology will be even more important to cover some of these fluctuations. Solar PV will then be easy to integrate in the system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Grid Interactive Heat Pumps

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Defining the Future of Geothermal

(Grid) Interactive Heat Pumps

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