JULY 21, 2019 - SOLARFEST

Heat Pumps: Select and Operate for Efficiency

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Agenda

- How do heat pumps do that?
- Mini-splits: Darling of Decarbonization
- Different houses, different heat pumps
- Weatherization, Heat Pump's best friend

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Secrets of Heat Pumps: Making Water Flow Uphill

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Familiar heat pumps

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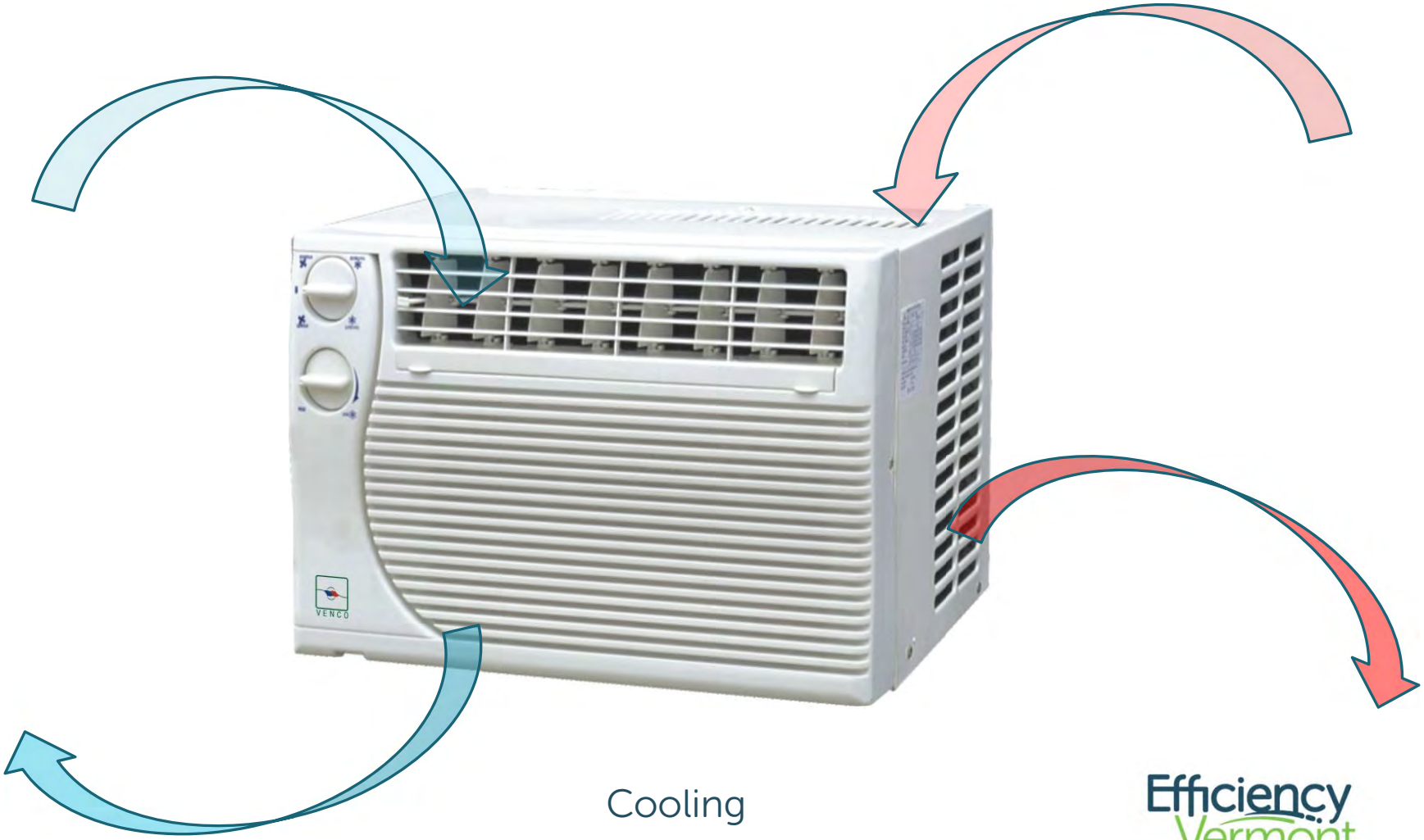
What IS a heat pump, anyway?

An air conditioner in reverse



Cooling

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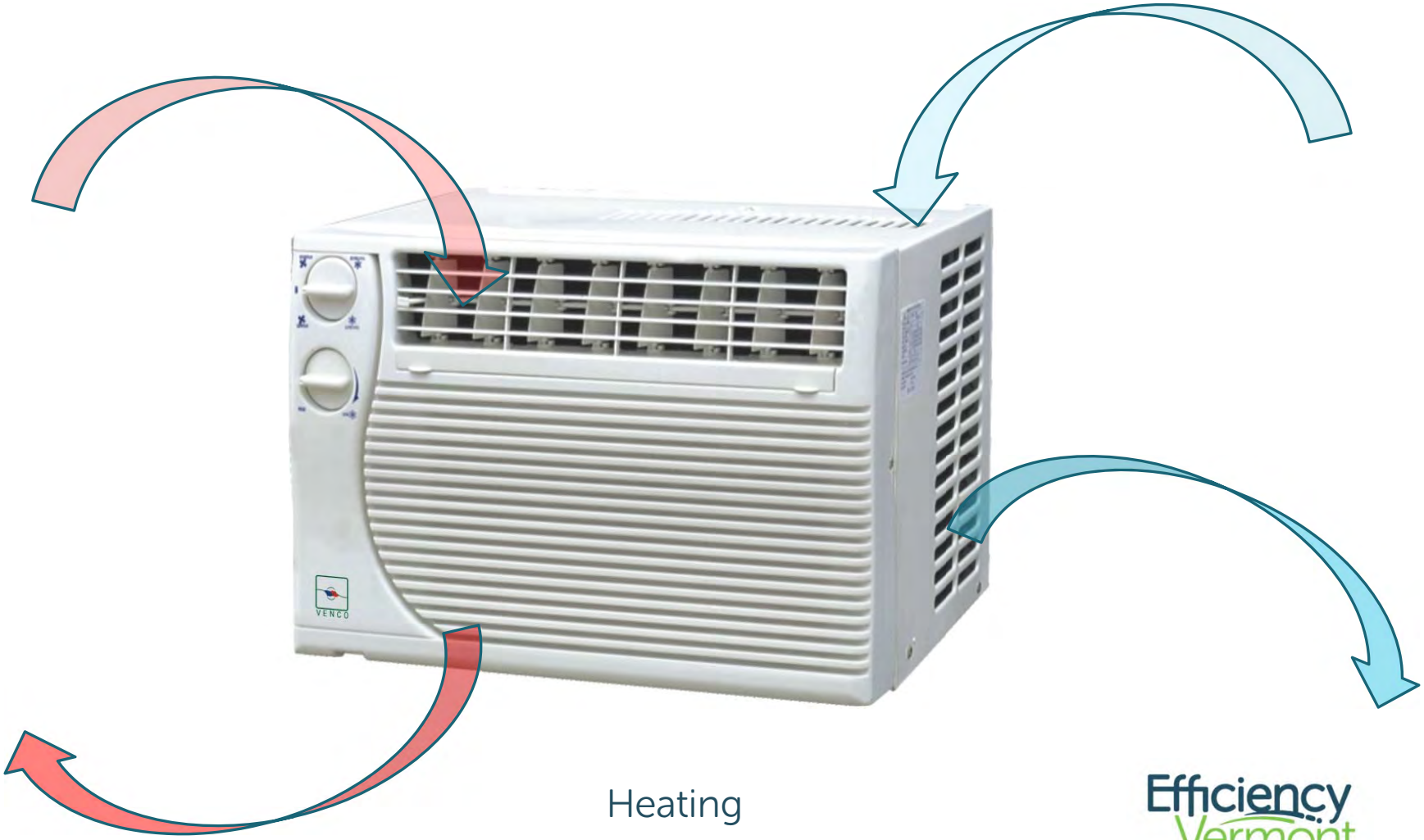

Heating

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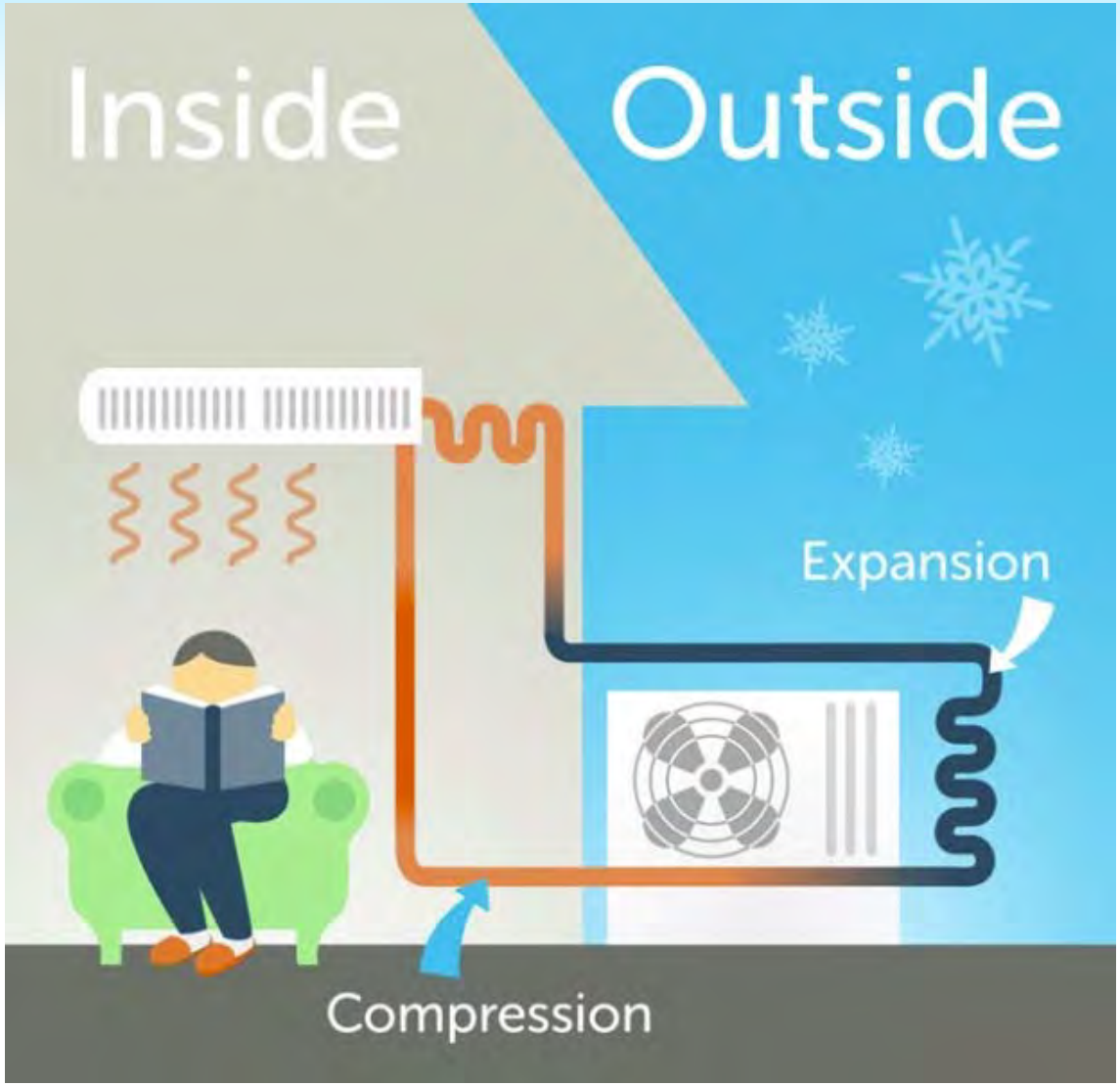

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Air to Air Heat Pumps

Air source heat pump

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Air to Air Heat Pumps

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Mini-split Heat Pumps

aka

"ductless heat pump"

"ductless mini-split"

"heat pump"

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Mini-split Heat Pumps

- Cheap and easy to install
- Pretty efficient
- Plays nicely with an existing heating system
  - Especially wood heat
- Air conditioning!
- Electrification, zero energy and decarbonization

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Low Load Home, Huntington, VT

- 2100 conditioned square feet
- 14.7 KBtu/hr total heat loss
- 6.2 Kbtu/hr total heat gain
- 3 br, 2 ba, finished basement
- Built 2018, modular construction
- Ducted HRV, HPWH

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Single Zone Mini-split vs Multi-split

		Manufacturer's Data				AHRI Data	
		Cooling Kbtu/hr		Heating Kbtu/hr		SEER	HSPF
		min	max	min	max		
down	AOU9RLS3H	3.1	12	3.1	22	33	14.2
up	AOU12RLS3H	3.1	13.6	3.1	22	29.3	13.8
house	AOU24RLXFZH	6.1	27	6.8	29.8	20	10.3
house	AOU36RLXFZH	12	39	12	42	20	10.3
		NEEP Data					
		COP	COP	COP	Capacity at -15F		
		47F	17F	-15F	min	max	
down	AOU9RLS3H	5.3	3.36	1.44	1.5	11	
up	AOU12RLS3H	4.64	3.18	1.26	1.6	11.5	
house	AOU24RLXFZH	4.04*	NA	NA	NA	NA	
house	AOU36RLXFZH	4	NA	NA	NA	NA	

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Single Zone Mini-split vs Multi-split

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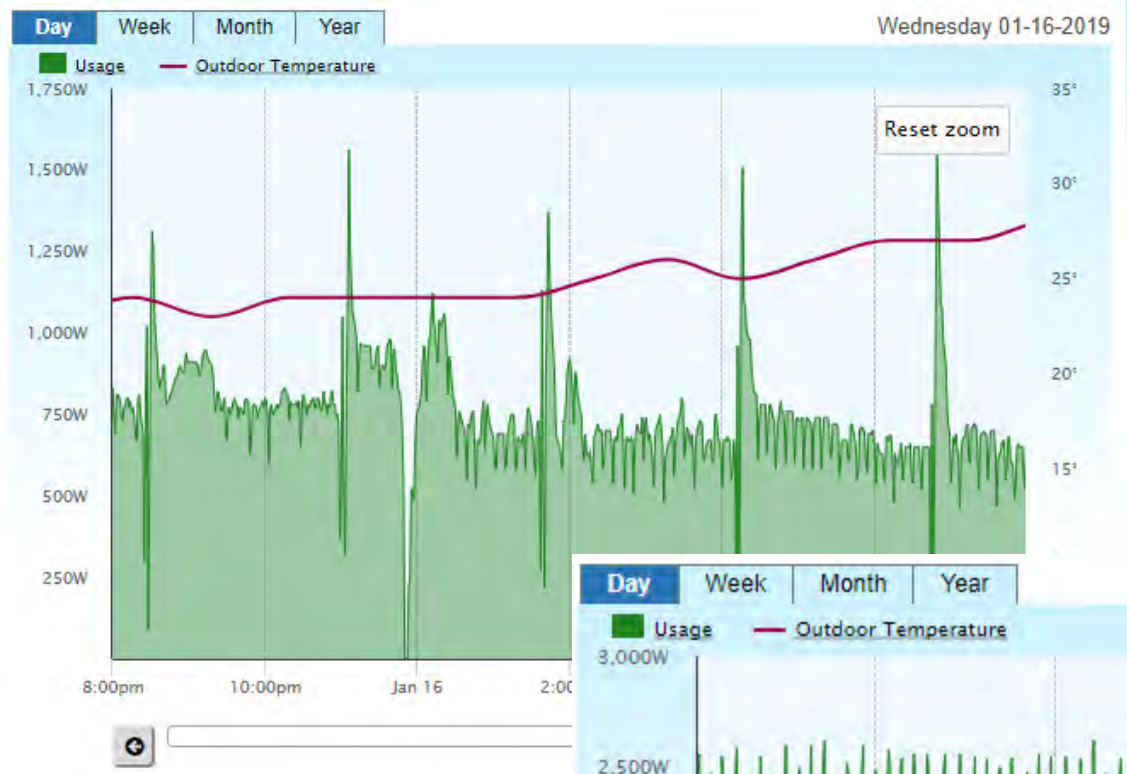
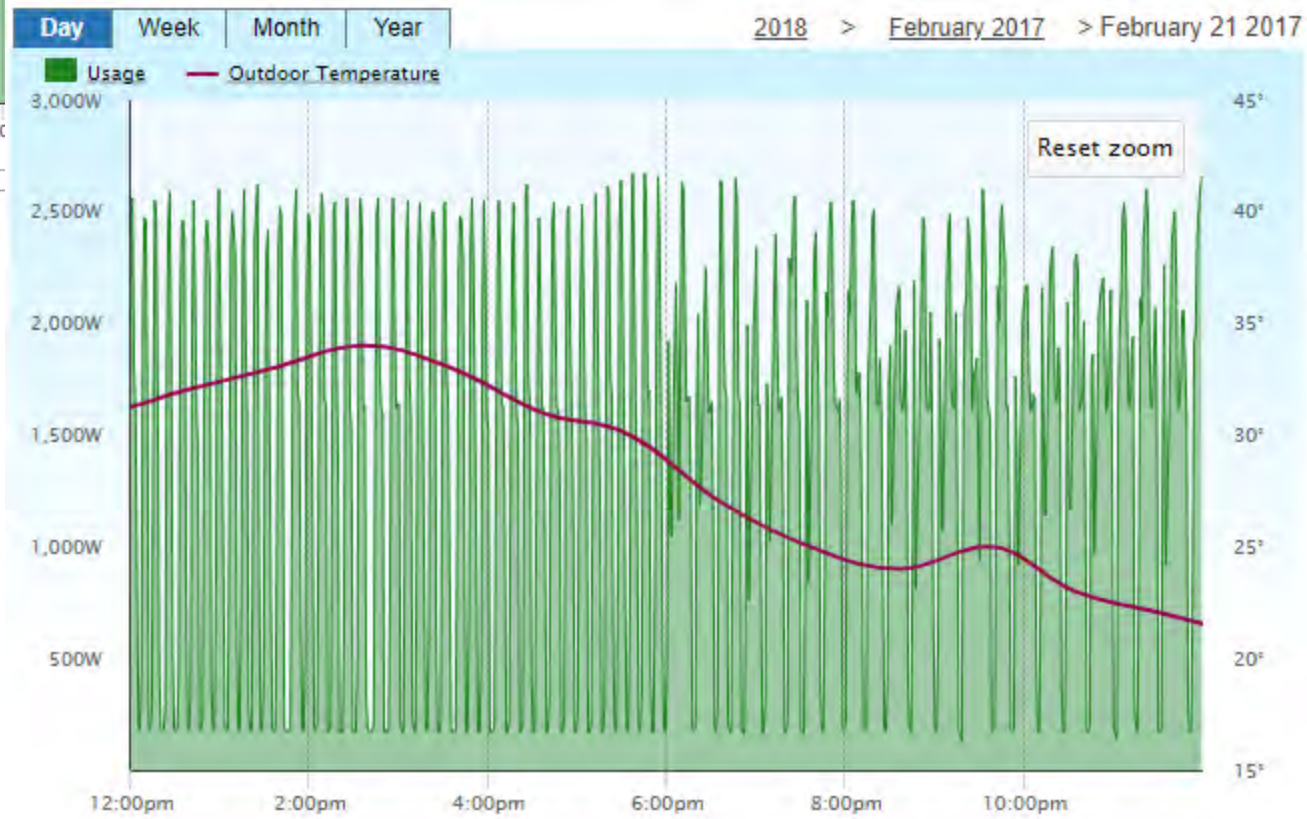

Day
Week
Month
Year
Wednesday 01-16-2019
Usage
Outdoor Temperature
Reset zoom
1,750W
1,500W
1,250W
1,000W
750W
500W
250W
35°
30°
25°
20°
15°
8:00pm
10:00pm
Jan 16


Day
Week
Month
Year
2018 > February 2017 > February 21 2017
Usage
Outdoor Temperature
Reset zoom
3,000W
2,500W
2,000W
1,500W
1,000W
500W
45°
40°
35°
30°
25°
20°
15°
12:00pm
2:00pm
4:00pm
6:00pm
8:00pm
10:00pm

Wise Mini-split Design

Good Candidates for Mini-split

- Modestly-sized home
- Well-insulated and –air-sealed
- Open-ish floor plan
  - At least one large, multi-purpose, well-used room
- Zoned heating
- Engaged, willing occupants
- Functioning central heat
- If you're building new…
  - Integrated design

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Mini-split Design Best Practices

- Know what you're trying to accomplish
- Accept indirect heating/cooling
- Single-zones only
- Get a load calculation
- Don't confuse your thermostat
- Never in a small room
- Consider noise and air currents
- Outdoor unit placement

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			Indoor temperature							
		°FDB	60		65		70		75	
Outdoor temperature	°FDB	°FWB	TC	IP	TC	IP	TC	IP	TC	IP
	-15	-17	15.8	2.23	15.4	2.28	15.0	2.32	14.3	2.41
	-5	-7	17.6	2.26	17.1	2.31	16.7	2.35	15.9	2.44
	5	3	19.3	2.29	18.9	2.34	18.4	2.38	17.5	2.47
	14	12	20.7	2.33	20.2	2.38	19.7	2.42	18.7	2.51
	23	19	21.6	2.43	21.1	2.48	20.5	2.53	19.5	2.63
	32	28	21.8	2.63	21.3	2.68	20.7	2.73	19.7	2.83
	41	37	23.8	2.32	23.2	2.37	22.7	2.42	21.5	2.52
	47	43	25.1	2.17	24.5	2.21	23.9	2.26	22.7	2.35
	50	47	27.7	1.94	27.1	1.98	26.4	2.02	25.1	2.10
	59	50	28.7	1.95	28.0	1.99	27.4	2.03	26.0	2.11

												70°F / 21.1°C				
												Rated	75%	50%	25%	
65	18.3	Q[Btu/h]	37925	27614	20711	-	-	17793	39317	28627	21471	-				
		W	3336	1897	1599	-	-	1065	3213	1826	1540	-				
60	15.6	Q[Btu/h]	34415	26178	19634	-	-	16433	35746	27191	20393	-				
		W	3185	1837	1549	-	-	1044	3066	1768	1491	-				
55	12.8	Q[Btu/h]	31200	24742	18557	-	-	15028	32478	25755	19316	-				
		W	3056	1753	1477	-	-	1031	2915	1671	1409	-				
50	10.0	Q[Btu/h]	28412	23306	17479	-	-	13628	29648	24319	18239	-				
		W	2897	1645	1386	-	-	1008	2790	1584	1335	-				
47	7.2	Q[Btu/h]	26099	22444	16833	-	-	12258	27278	23457	17593	-				
		W	2763	1632	1376	-	-	995	2636	1557	1313	-				
42	4.4	Q[Btu/h]	21738	18907	14180	-	-	10869	22787	19819	14864	-				
		W	2602	1687	1422	-	-	972	2483	1609	1357	-				
35	1.7	Q[Btu/h]	24347	18909	14182	-	-	17584	25495	19800	14850	-				
		W	2517	1956	1649	-	-	1652	2386	1884	1589					
32	-1.1	Q[Btu														
		W														
27	-3.9	Q[Btu														
		...														

INDOOR	OUTDOOR TEMPERATURE (°FWB)											
EDB	5		14		23		32		43		50	
°F	TC	PI	TC	PI	TC	PI	TC	PI	TC	PI	TC	PI
59.0	4.76	0.55	5.72	0.58	6.68	0.60	8.99	0.79	10.34	0.83	11.25	0.86
70.0	4.47	0.56	5.43	0.59	6.39	0.62	8.64	0.81	10.00	0.85	10.90	0.88
71.6	4.35	0.57	5.31	0.60	6.27	0.62	8.50	0.82	9.86	0.86	10.76	0.89
75.2	4.23	0.57	5.19	0.60	6.15	0.63	8.37	0.82	9.72	0.87	10.62	0.89
77.0	4.17	0.58	5.13	0.61	6.09	0.63	8.30	0.83	9.65	0.87	10.56	0.90
80.6	4.06	0.58	5.02	0.61	5.98	0.64	8.16	0.83	9.51	0.88	10.42	0.90

Life With a Mini-split

- Leave bedroom doors open
- Overheat the primary zone
- Do not set temperature back
  - Even risky to do this during vacation
- Use high fan speed during very cold weather
  - Increases efficiency and heat output
  - OK for night or absence; your house will hold the heat
- No “Auto” mode; consider disabling some features
- Clean filters regularly
- Check outdoor unit during snowstorms

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Different Houses, Different Heat Pumps

Mini-split Alternatives

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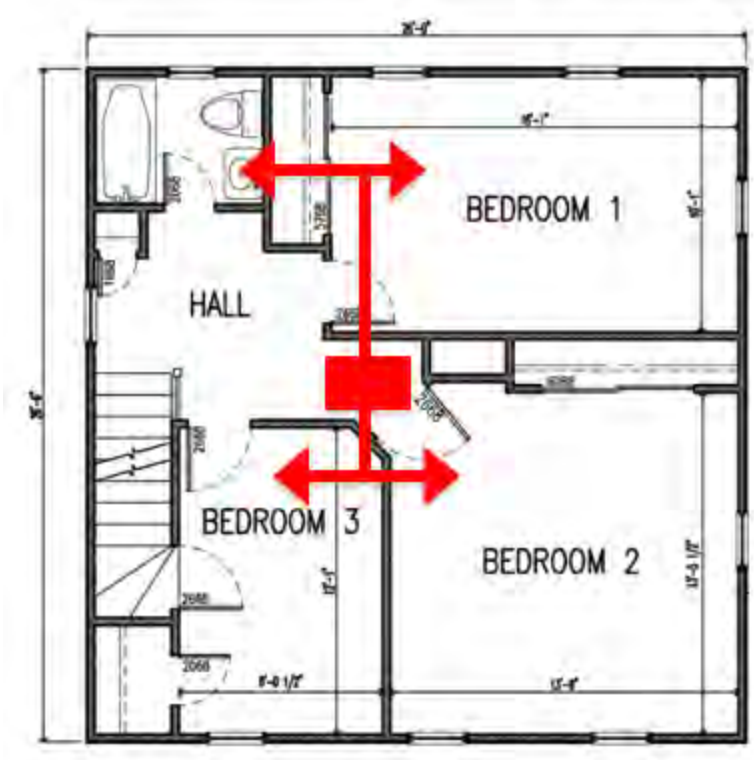
Compact Ducted Heat Pump

- Distribute heat without a central heat plant



Images courtesy of Mike Duclos, DEAP Energy Group

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Compact Ducted Heat Pump

Indoor Unit: SEZ-KD18NA

Remote Controller: PAR-21MAA

Outdoor Unit: SUZ-KA18NA

Indoor Unit

MCA	1 A
Fan Type x Quantity	Sirocco Fan x 4
Fan Motor Type	Direct-driven DC Brushless Motor
Fan Motor Output	96 W
Fan Motor	0.74 F.L.A.
Airflow (Lo - Med - Hi)	423 - 529 - 635 Dry CFM 381 - 476 - 572 Wet CFM
Air Filter	Polypropylene Honeycomb
External Static Pressure	0.02 - 0.06 - 0.14 - 0.20"WG
Sound Pressure Level (Lo - Med - Hi)	30 - 34 - 38 dB(A)

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Compact ducted Bottom Line

- Better option than multi-split
- Use a ducted zone to match load to capacity
- Careful, creative duct layout keeps ducts short: essential with mini-ducted
- Provide access to air handler and filter
- DO NOT OVERSIZE

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Centrally Ducted Heat Pump

- Whole House system
- Mitsubishi multi-position air handler with outdoor unit PUZ/PVA 36KBtu
- Vertical or horizontal installation
- Higher static pressure capability
- ECM motor
- NEEP cold climate air source heat pump

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Dual Fuel and Balance Point Heating

- ccHP replacement for central AC
- NEEP cold climate listed
- Uses furnace ducts, whole building solution
- EVT rebates available

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Air: Distribution & Equipment

Dettson

Chinook

SMART DUCT SYSTEM

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Air to Water Heat pump

- Can act like a boiler
  - Electric
  - Operates at low water temperature
  - Temperature-dependent output and efficiency, like all air source heat pumps
  - Fully zonable

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Cooling with Air-to-Water

Radiant cooling

- Requires whole-house dehumidification
- Floors, walls, ceilings heat and cool

"Ductless" cooling

- Separate zone just for cooling
- Non-distributed
- Can be used for heating

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Air to Water Bottom Line

- More design required than mini-splits or ducted systems
- Can be a water heating solution
- Distribution system must be designed for lower temperatures
  - Hard to do in existing homes
- Distribution flexibility
  - Warm floors, panels, baseboard

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Ground Source Heat Pump

- Established industry
- Watch out for pumping loads: not included in listed COP
- Oversized pumps are common
- Closed loop versus open loop
- Needs to be paired with careful distribution

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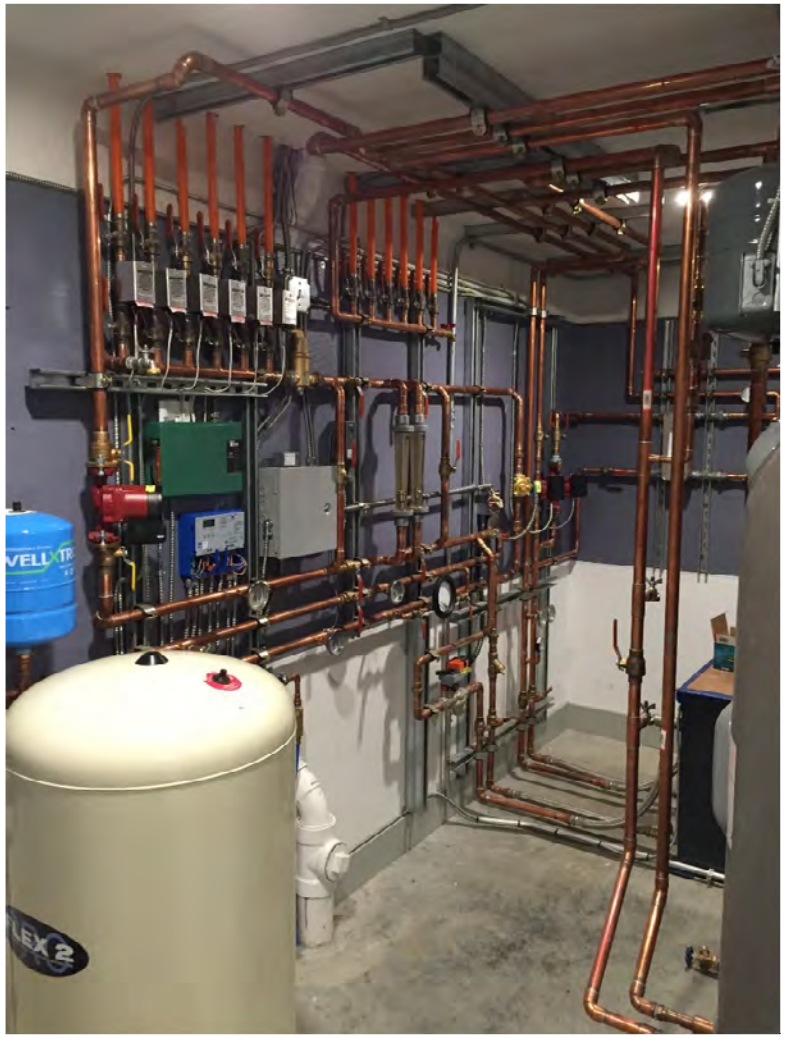
Low Temp Hydronic Distribution



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Hydronic Distribution and equipment

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Weatherization

Heat Pump's Best Friend

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Weatherization

- Better comfort
- Smaller load for your heating system
- Better control over air quality
- Lasting improvement
- Win the heat loss battle!

Weatherization makes your heat pump go further.

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Zero Energy Home

Thank You

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NEEP Guide to Sizing and Selecting Air-Source Heat Pumps
neep.org/sites/default/files/Sizing%20&%20Selecting%20ASHPs%20In%20Cold%20Climates.pdf

NEEP Guide to Installing Air-Source Heat Pumps in Cold Climates
neep.org/sites/default/files/Installing%20Air-Source%20Heat%20Pumps%20in%20Cold%20Climates.pdf

Efficiency Vermont's operator guide for mini-splits
contractors.efficiencyvermont.com/Media/Default/docs/resources/printable-resources/ProductProgramInfo/8%20ways%20NOT%20to%20use%20a%20heat%20pump.pdf

Efficiency Vermont's residential technical resources
contractors.efficiencyvermont.com/programs/new-construction

Efficiency Vermont's mini-split qualified list
www.efficiencyvermont.com/Media/Default/docs/rebates/qpls/efficiency-vermont-cold-climate-heat-pumps-qualifying-products.pdf

Efficiency Vermont's air-to-water heat pump qualified list
www.efficiencyvermont.com/Media/Default/docs/rebates/qpls/efficiency-vermont-awhp-qpl.pdf

GBA article on shared ductwork
www.greenbuildingadvisor.com/article/ductwork-ervs-dehumidifiers-forced-air-heating-systems

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