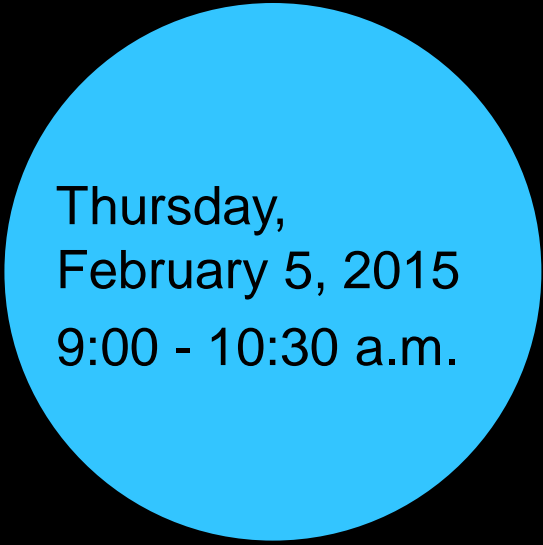




Vermont
Energy Investment
Corporation



Air Source
Heat Pumps in
the Commercial
Market



Thursday,
February 5, 2015
9:00 - 10:30 a.m.

1. Commercial Equipment
Applications, Benefits,
Limitations

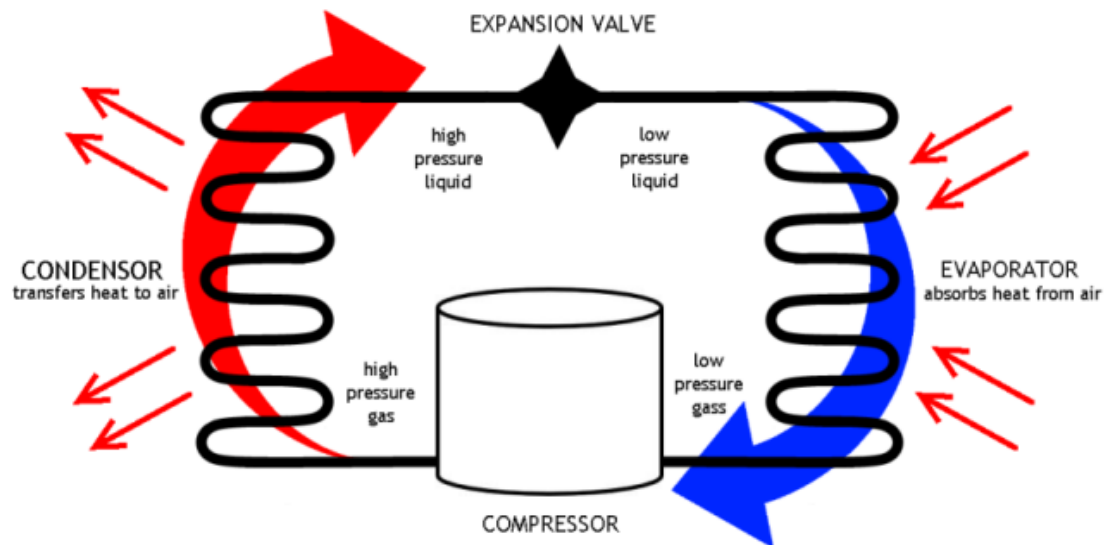
2. Case Studies

3. Efficiency Vermont
Technical & Financial
Support

Agenda

A Quick Overview: Heat Pumps

- A heat pump is...
 - “a device that moves thermal energy opposite to the direction of spontaneous heat flow.”
- Air source heat pump (ASHP)
- Heat pump performance
 - COP



Package Terminal Air Source Heat

Pumps (PTHPs)

Benefits

- Heating COP 1 - 3.5
- Higher cooling Energy Efficiency Ratio (EER)
- Easy one-for-one replacement
- Low incremental cost

Limitations

- VT Commercial Building Energy Standard (No new construction)
- Electric resistance heat for OA temperatures $< 35^{\circ}\text{F}$



Hybrid Rooftop Units

- Heating source is an ASHP and a furnace or coil
- 2 – 100+ tons
- Hybrid RTUs can be used any place a typical RTU would be used



Hybrid RTU

Benefits

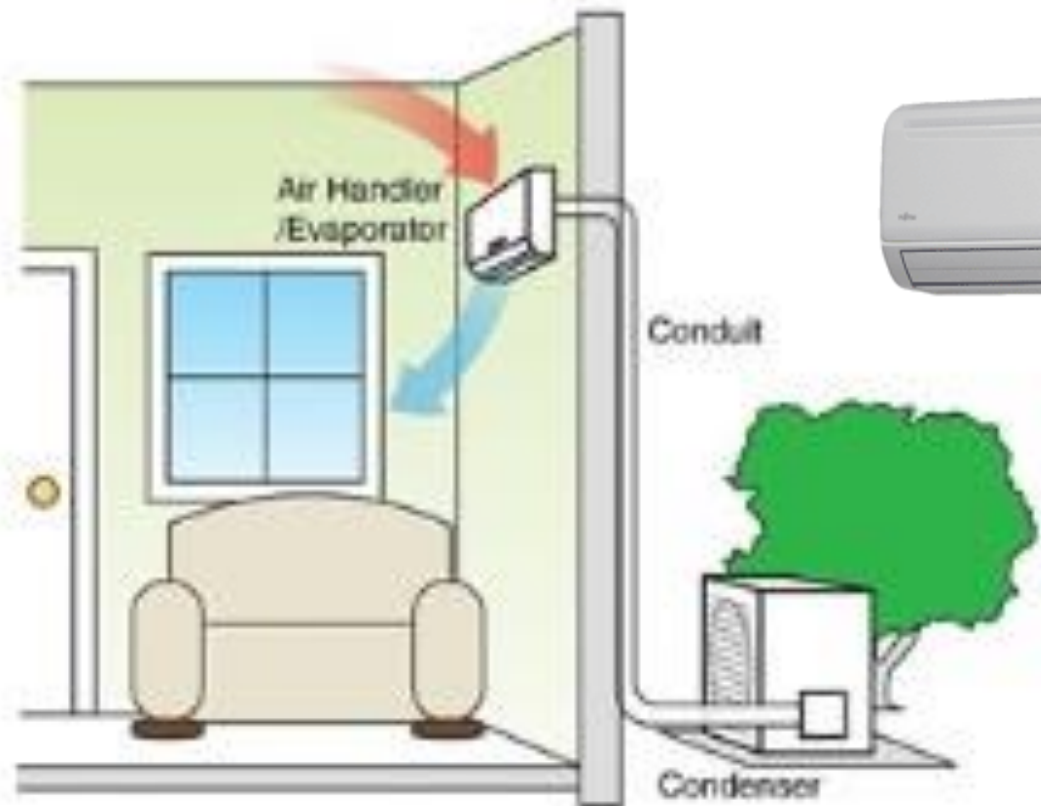
- Operating cost
- Load matching
- Available options
- Comfort
- Reduce dependence on fossil fuel

Hybrid RTU

Limitations

- Configuration / weight
- Cost
- Sizing for heat
- HP capacity at low OA temps

Ductless Mini Split ASHPs



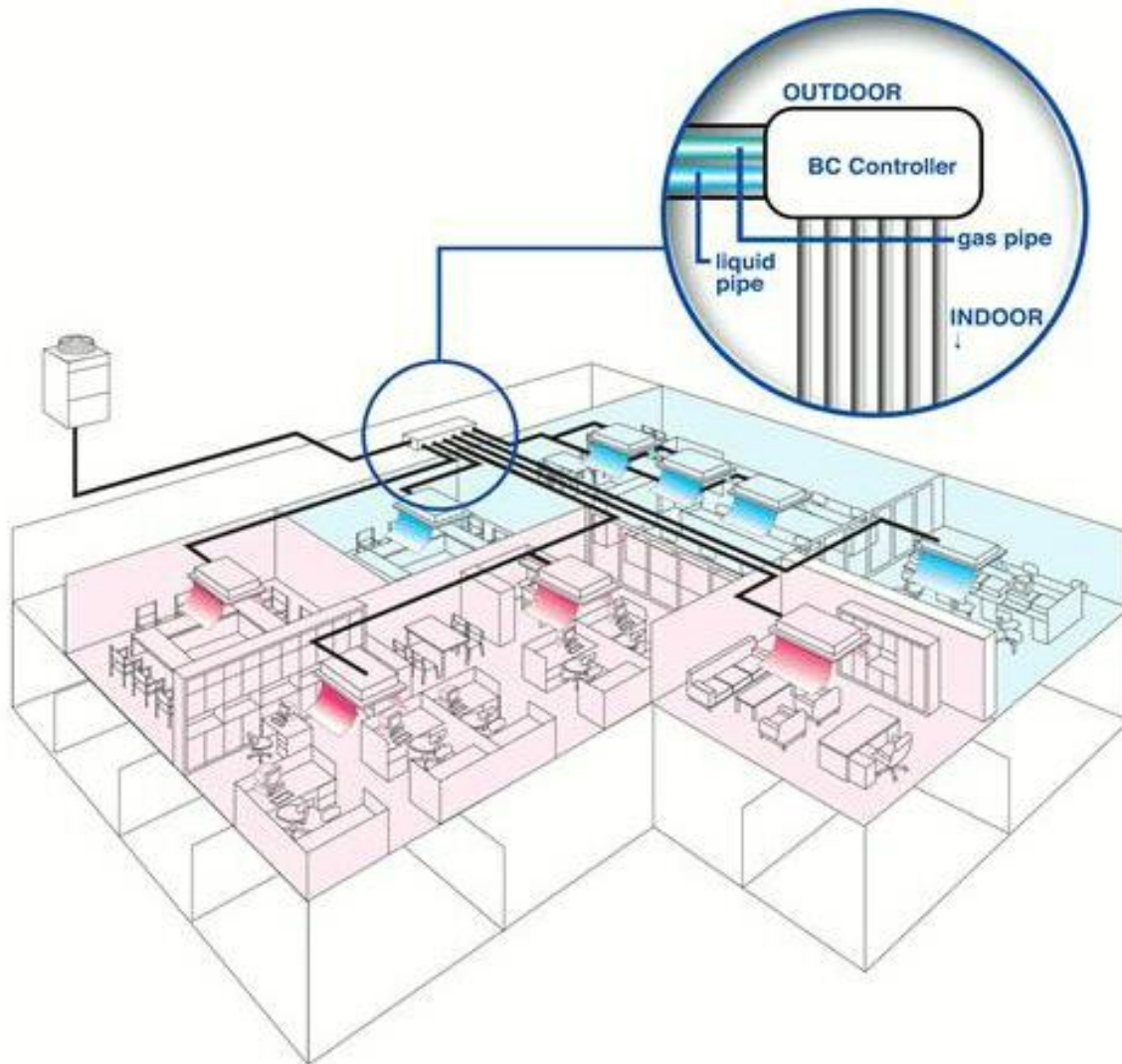
Mini Split Benefits

- Sound
- Zone control
- Design options
- Net zero ready
- Comfort
- Install time
- Energy

Mini Split Limitations

- Decreased capacity at low outdoor air temperatures
- Higher electrical use
- Sizing
- Cost

Variable Refrigerant Flow (VRF)



Applications

- Lodging
- Office
- Mixed use
- Retrofit
- Multifamily

VRF Benefits

- Sound
- Zone control
- Design options
- Net zero ready
- Comfort
- Install time
- Energy
- No integrated ventilation

VRF Limitations

- Decreased capacity at low outdoor air temperatures
- Higher electrical use
- Compliance with ASHRAE Standard 15
- No integrated ventilation

Case Studies

1. New hybrid heat pump RTU
2. Gut rehab heat and cool with ASHP
3. Add central AC to building

Case Study 1: Replace RTU with ASHP

Vishay Tansitor
Mixed-use light industrial

Existing conditions

- 30-year-old 10-ton RTU with electric heat serving shipping / receiving
- At end of useful life
- Constant volume
- Metered electric heat use



Case Study 1: Replace RTU with ASHP

- Purchase new, high-efficiency RTU for heating and cooling
- Heating options
 1. Convert from electric heat to propane, direct fired at 80% AFUE
 2. New electric heat
 3. Selected hybrid heating option with heat pump and electric heat

Case Study 1: Replace RTU with ASHP

Final Design

- 10-ton Daikin Rebel RTU with air source heat pump; 36 kW electric backup
- Used meter data to calculate the savings with the ASHP
- Variable speed supply fan
- Note: Heat pump not “cold climate”; therefore reduction in efficiency and capacity

Ultra-Quiet
ECM Supply Fan
w/Built-in VFD

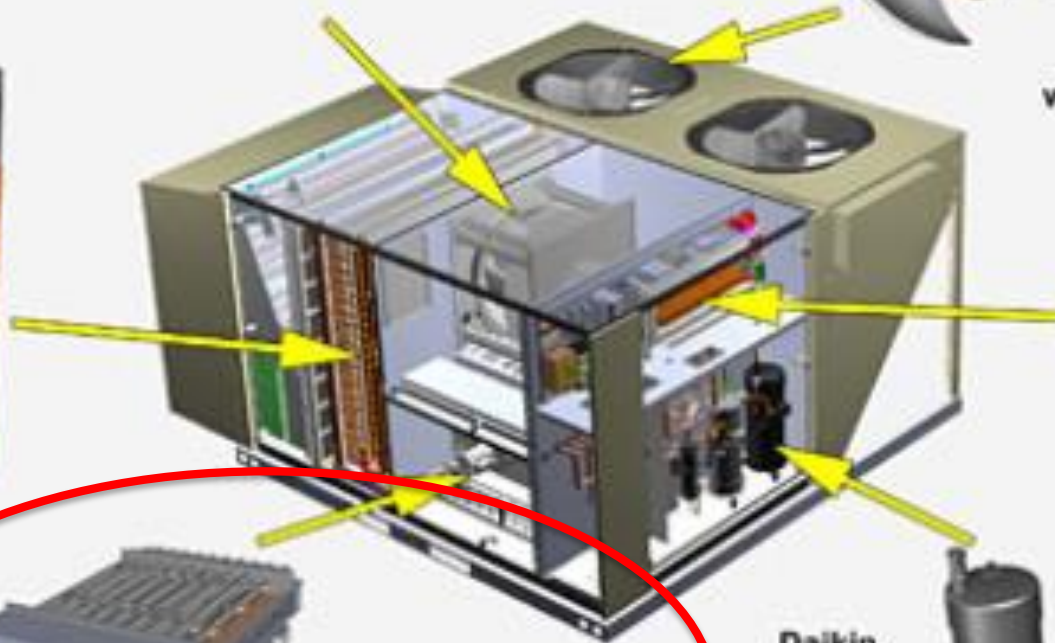
Ultra-Quiet Daikin
Condenser Fans
w/DC Motors



MicroTech III Controls
w/Open Choices™, BACnet,
& LonMark 3.4
Communications



Modulating Hot
Gas Reheat and
Humidity Control



Daikin Inverter
Compressor for
True Variable Flow

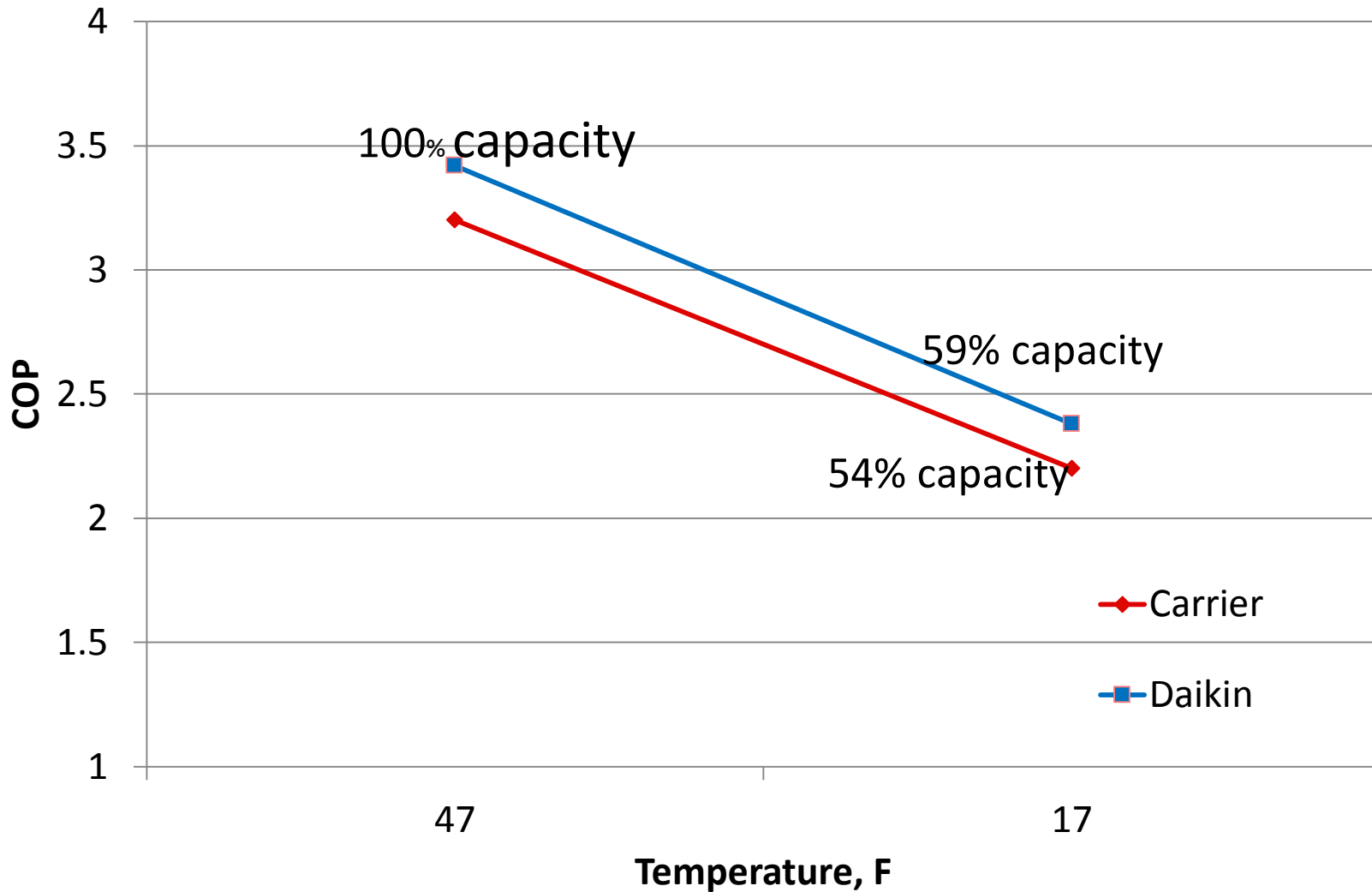


Daikin
Variable Heat
Pump

Hybrid Heat Options
(Gas, SCR Electric Heat,
Heat Pump, Hot Water)



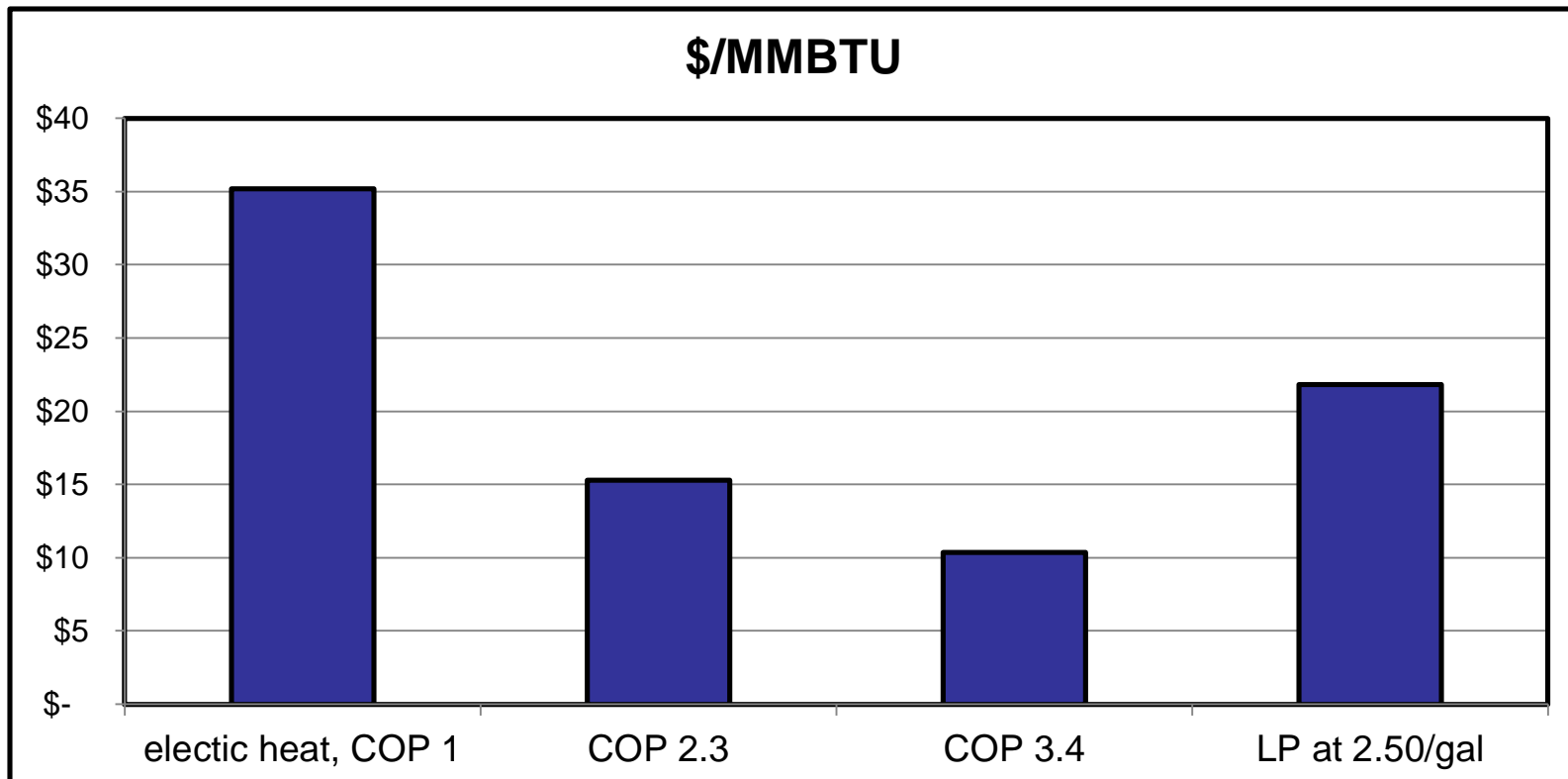
Hybrid RTU COP vs. Temperature



Economics - Operating Costs per Year

Electric heat	Hybrid Heat Pump (includes electric heat)	LP Option
\$5,000	\$2,250	\$4,900

(Assume \$0.12 / kWh; \$2.50 / gal LP)



Comparison of First Costs

- **Carrier**

\$1,000 upgrade from electric heat to hybrid heat

- **Daikin**

\$10,000 - \$15,000 DOE-qualified, high-performance RTU with hybrid heat pump (heating, cooling, and fan energy savings)

Case Study 2: Rockingham Public Library

Renovation The Building

- ~17,000 sq. ft.; fully renovated library
- Needed all-new heating, cooling, ventilation, and lighting
- Masonry historic building; significant limitation to building modifications



Comparison of HVAC First Costs

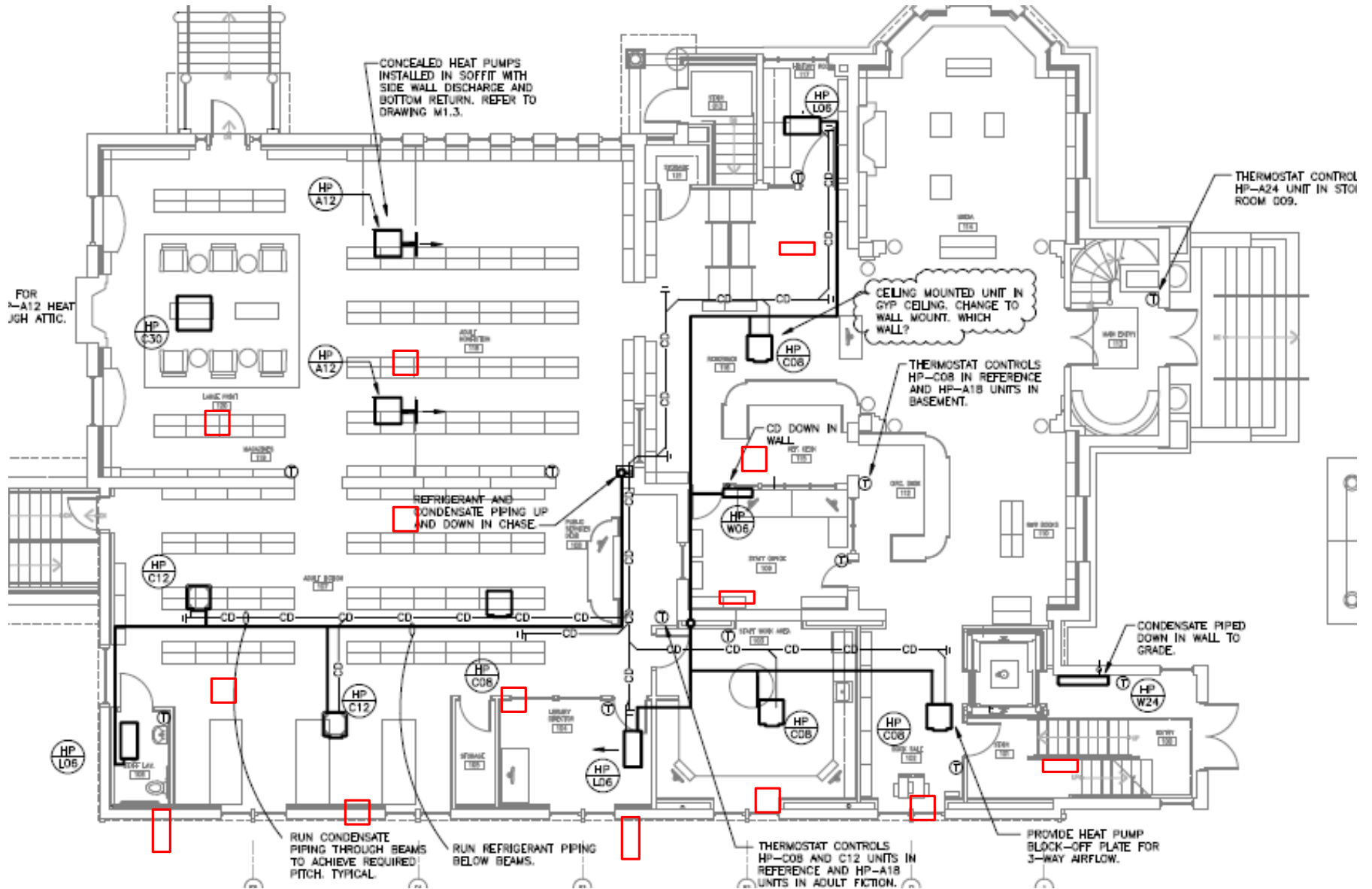
System Type	First cost per sf *	Efficiency	Equipment
VRF heating & AC	\$15	High	Terminal units and refrigerant piping, outdoor condensing and compressor units
4-pipe fan coil	\$19	High	Fan coils, chiller, boiler, pumps
WSHP	\$17	Medium	WSHPs, boiler, pumps, heat rejection (water or air cooled)

*Cost estimates from ASHRAE-sponsored Hill Phoenix training seminar on heat pumps

Final Design Selected

Mechanical system

- Heat recovery ventilation
- VRF for heating and cooling
- No back-up heat
- 2 16-ton AC units (4 outdoor compressor / condensor units)
- 2 200kBTU capacity heat pumps
- ~ 40 indoor terminal units








PARKING

Case Study 3: College Science Building

Existing conditions

1. Building lacked central AC; dedicated split systems provided AC only for certain spaces
2. Heat primarily from fan coil units supplied by campus steam system
3. Immediate need for ventilation improvements in Chemistry Lab; other areas have acceptable ventilation

Case Study 3: College Science Building

Goals

1. Add centralized AC
2. Install dedicated ventilation system for Chemistry Lab
3. Complete work within limited budget

Solution

1. VRF system: 3 20-ton outdoor units serving ~70 indoor units
2. Space heat by VRF and central steam system via fin-tube radiation / fan coil units
3. Dedicated ventilation system for Chemistry Lab
4. Re-work existing ventilation system to serve remaining spaces

Case Study 3: College Science Building

Results

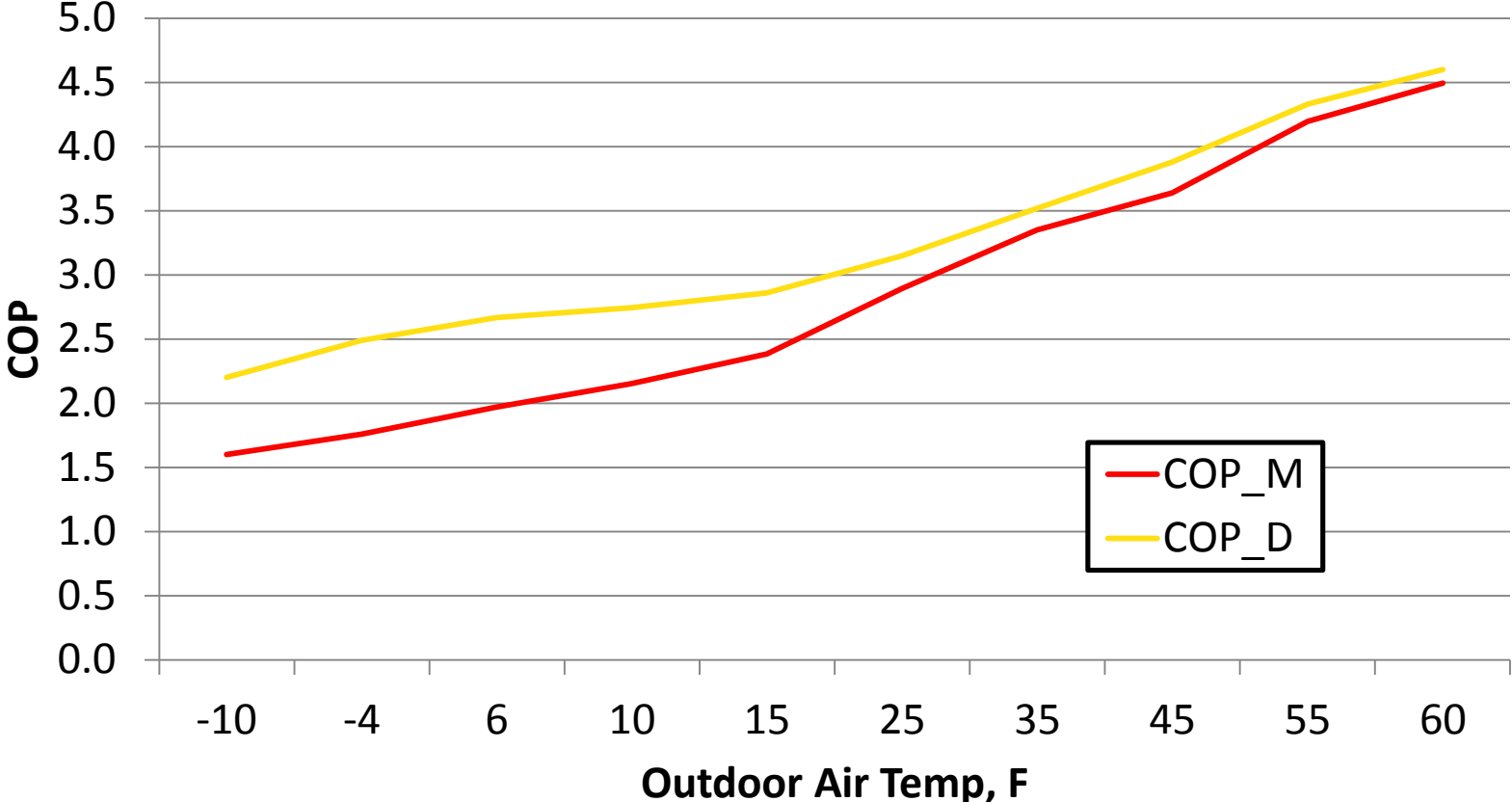
- Central AC, individual zones: improved occupant comfort
- Decoupling space conditioning from ventilation: improvements where required; reused existing ventilation system elsewhere to conserve money



Ongoing investigation

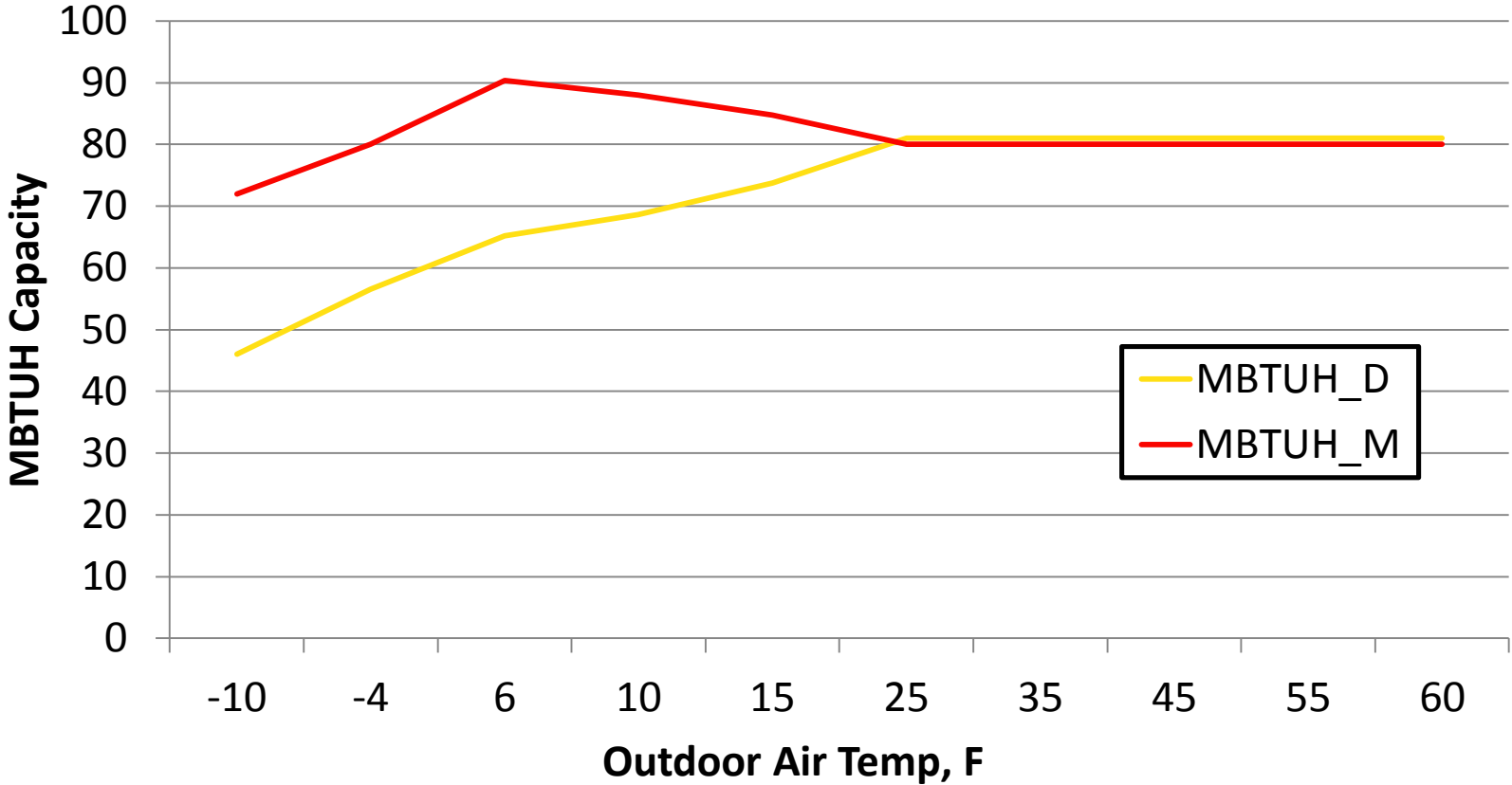
1. Campus has inexpensive steam
2. Cost effectiveness of using steam for space heating

72 MBH VRF OA Temp vs. COP



72 MBH VRF

OA Temp vs. Capacity MBTUH

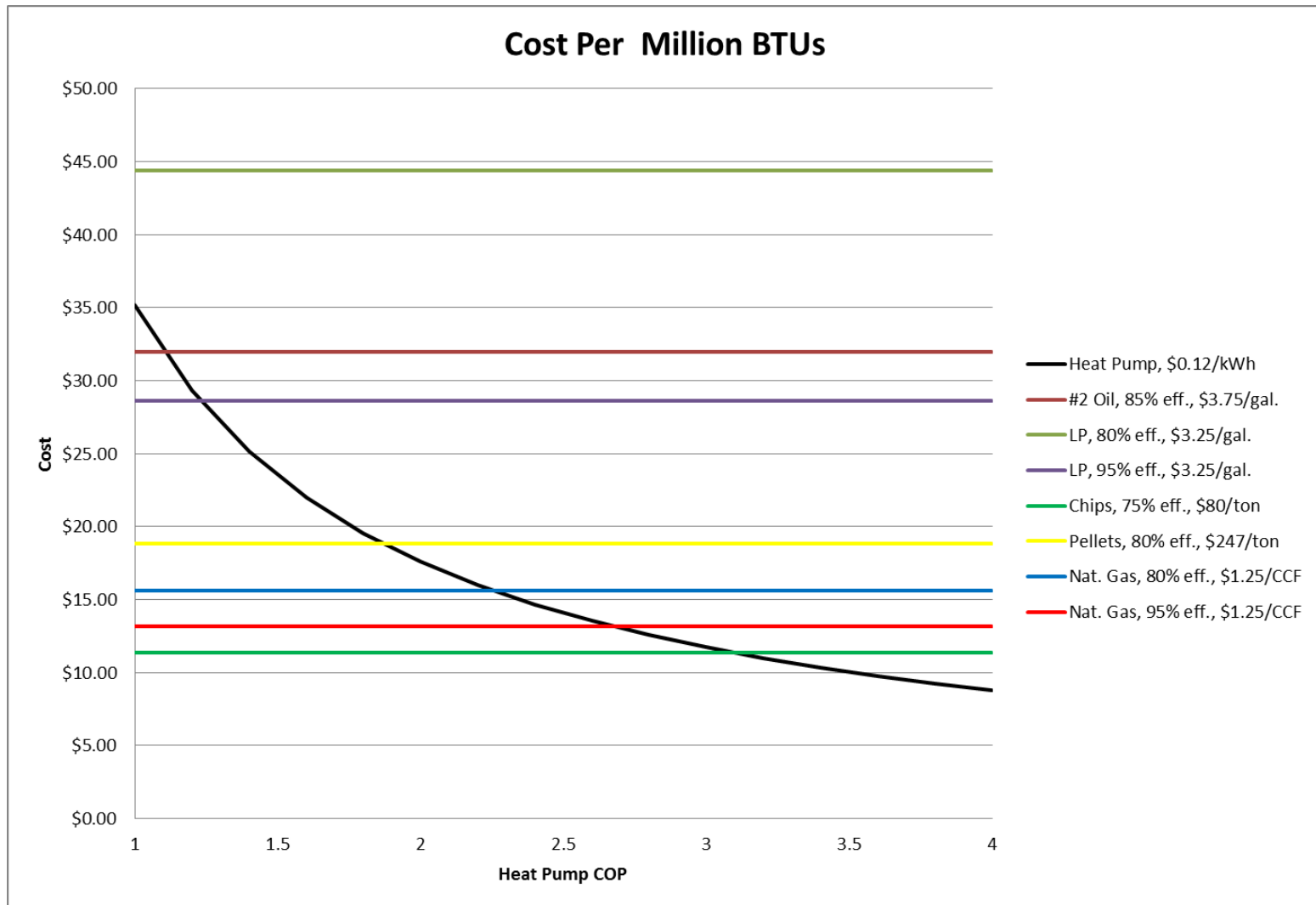


Working with Efficiency Vermont



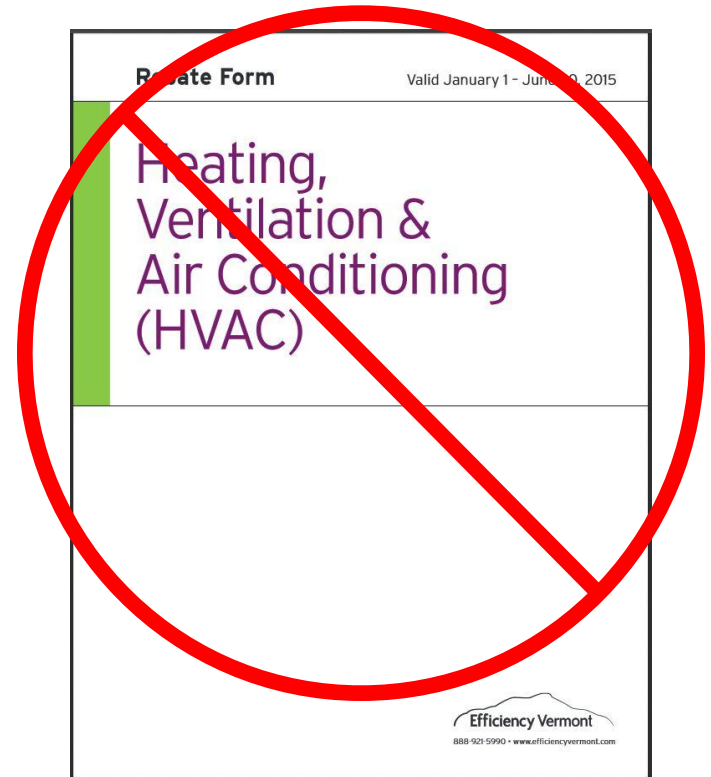
- Technical support
- Efficiency Vermont staff can help
 1. Evaluation of your application: Is an ASHP a good choice?
 2. Project financial analysis
 3. Equipment selection / specification
- Customer support
 - www.encyvermont.com or (888) 921-5990
- Account-managed customers: Contact your Efficiency Vermont Account Manager!

Working with Efficiency Vermont



Working with Efficiency Vermont

- Incentives
- ASHPs: Not in standard offer rebate; eligible for custom projects or upstream incentives only
- Incremental costs, savings, and incentives in Incentive Agreement assume code-compliant electric system
 1. Energy Consultant can help estimate changes in fossil fuel versus conventional systems



Working with Efficiency Vermont

Cold Climate Heat Pump Upstream Program

- $\leq 65,000$ BTU / h (5.42 tons) nominal capacity
- Single / multi-port ductless OR dedicated (slim) ducted
- All components AHRI certified (indoor / outdoor units)
- Compressors must be variable speed (inverter-driven)
- HPSF 10.3, SEER 20.0, EER 12.0 (minimum)
- 1.75 COP: 5⁰F; guaranteed heat pump operation: -5⁰F
- List of qualifying products: www.encyvermont.com
- \$300 / outdoor unit, marked down at time of sale at distributor



Working with Efficiency Vermont: Custom Projects

PTHPs

- Valid for replacing existing PTACs only, not new installations
- Efficiency Vermont incentive is typically \$50 - \$75 / unit (custom, not standard offer)
- Typical incremental cost is \$75 - \$150 / unit
- Additional incentives available for incorporating controls
- Occupancy-based setback controls



Working with Efficiency Vermont: Custom Projects

Hybrid RTUs and VRF systems

- Presently not covered by Efficiency Vermont's standard-offer incentives
- Efficiency Vermont Energy Consultant will provide case-specific project analysis, savings estimate, and incentive offer





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