Fuel Switching! Moving to Advanced Wood Heat & Heat Pumps

Vermont Energy & Climate Action Network Conference

December 1, 2018

Sarah Wolfe, Energy Action Network

Val Stori, Clean Energy States Alliance

Adam Sherman, Biomass Energy Resource Center

Overview

Why is fuel switching important?

- Thermal emissions in the context of statewide emissions
- Pace necessary to meet Paris Climate Accord

Heat Pump Overview

- Overview of the technology and applications
- Cost savings
- How to encourage adoption

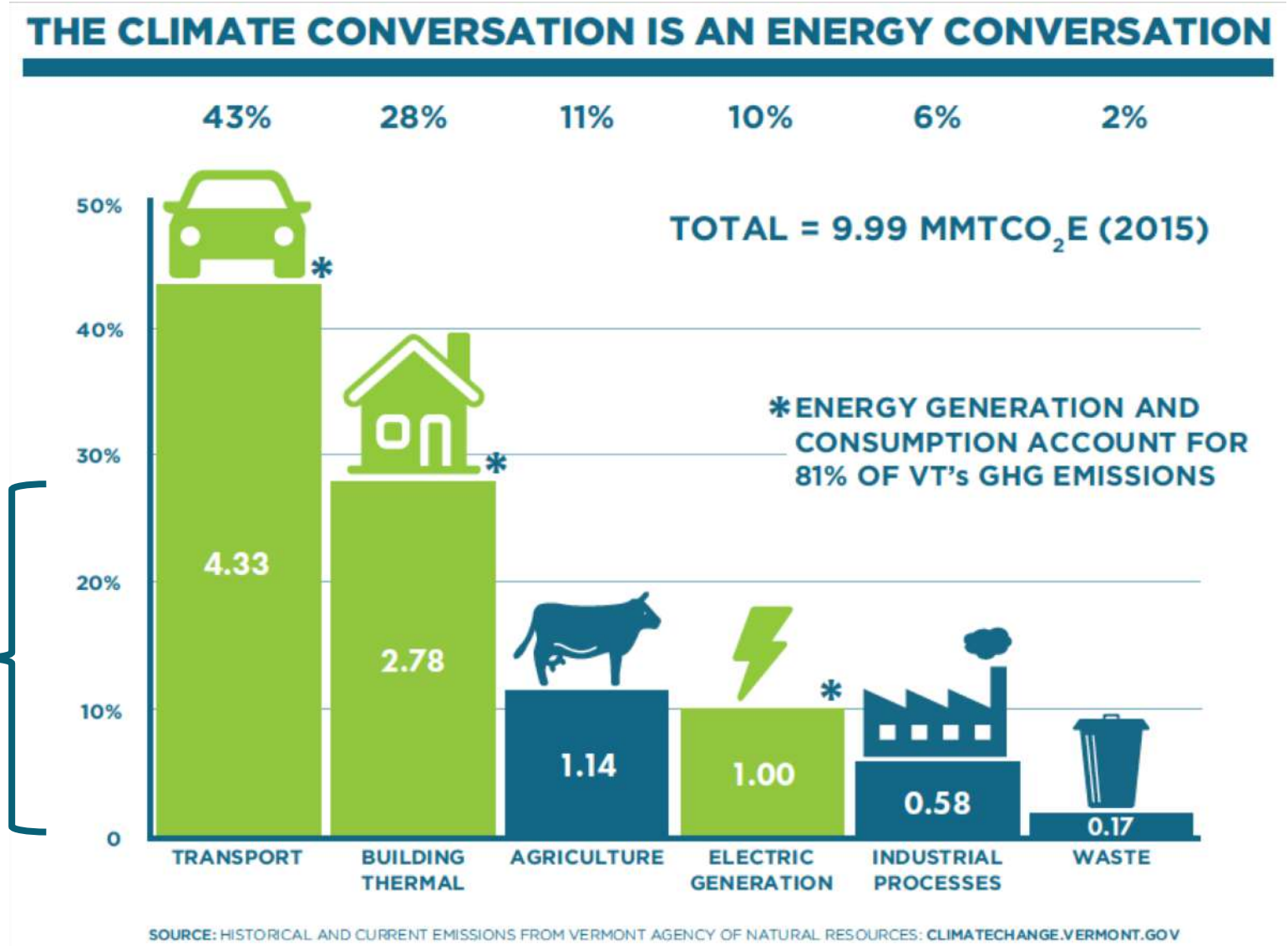
Advanced Wood Heat Overview

- Overview of the technology and applications
- Cost savings
- How to encourage adoption

Q&A

Energy is integral to emissions reduction

The thermal sector makes up 28% of our emissions…



Increase renewability of Total Energy

TOTAL

142 TRILLION BTU

THERMAL

53 TRILLION BTU
38% OF TOTAL

TRANSPORTATION

50 TRILLION BTU
35% OF TOTAL

ELECTRICITY

39 TRILLION BTU
27% OF TOTAL

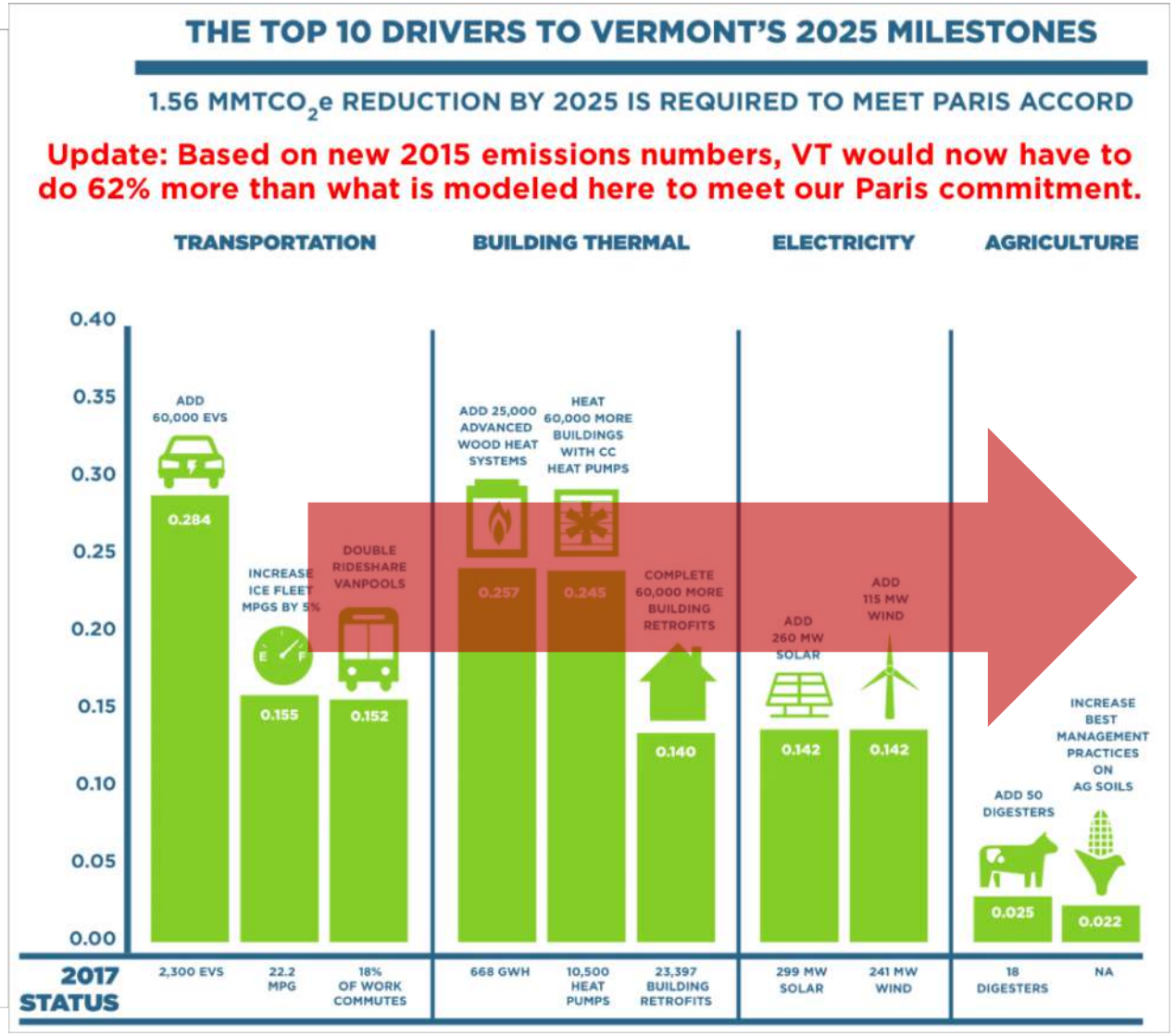
…38% of our energy use,
and is only 20% renewable

Pathway to 2025: Top Ten Drivers

Reaching Vermont's 2025 Milestones

The top 10 drivers to reach Vermont's energy and climate milestones are concentrated in the transportation and thermal sectors.

No single pathway or driver is sufficient. Getting to the Paris goal would require ALL of these drivers. If Vermont falls short on any one driver, it would need to compensate by making more progress with a different driver.[8]



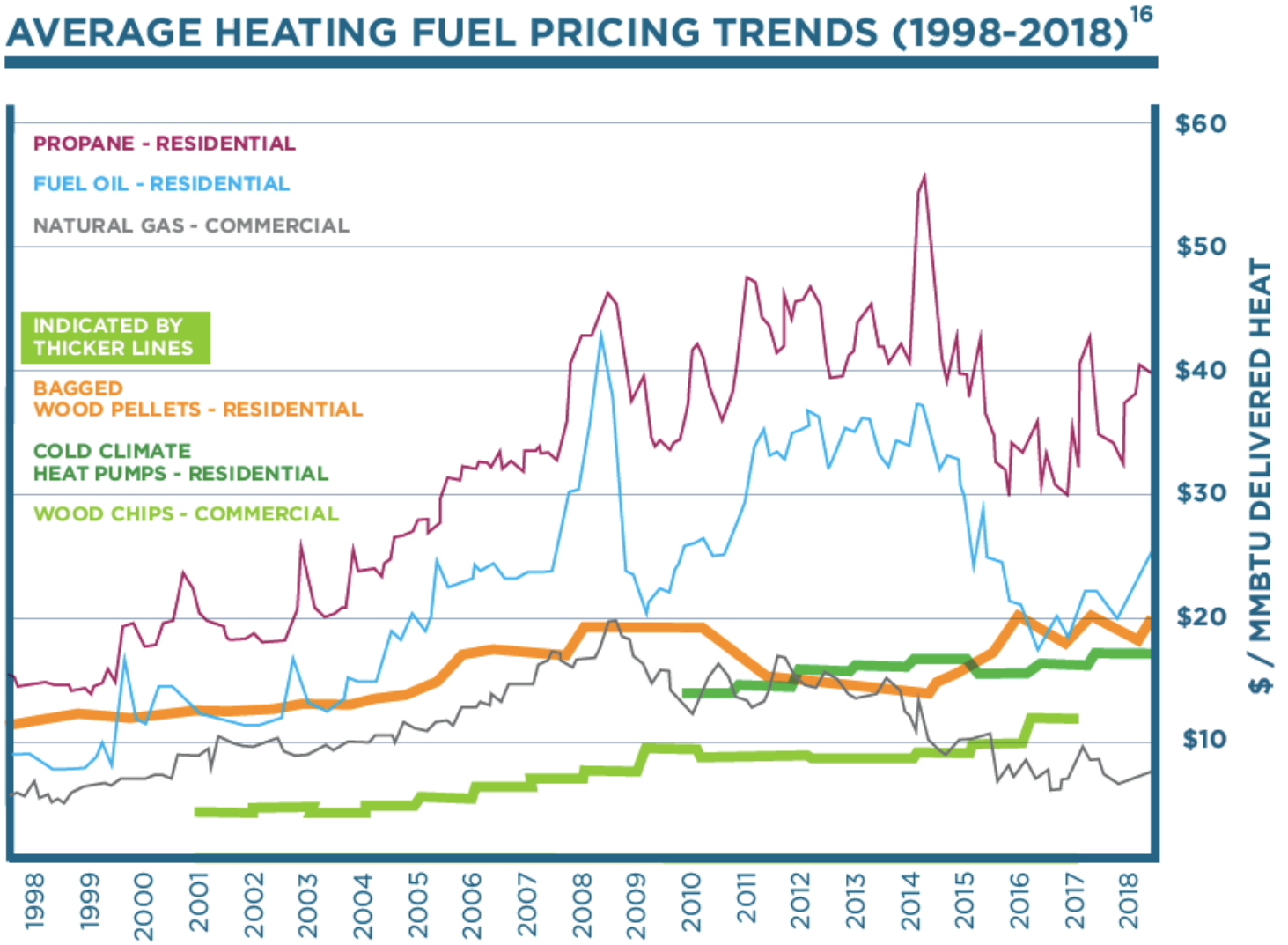
- 87,000 heat pumps
- 25,000 advanced wood heat systems
- 10% from other drivers

Thermal: Economic Opportunity

Stable and low-cost renewables

vs.

Volatile fossil-fuel prices



Total Energy: Economic Opportunity

78¢ OF EVERY $1 SPENT ON FOSSIL FUEL LEAVES VERMONT... NEARLY $1.5 BILLION PER YEAR[22]

...but $$ spent on local renewables creates more jobs for Vermont

VERMONT CLEAN ENERGY JOBS[21]

Up 29% since 2013

Heating Your Home or Business with

Air Source Heat Pumps

Val Stori, Project Director, CESA

VECAN Conference
1 December 2018

Clean Energy States Alliance

ALASKA ENERGY AUTHORITY

STATE OF CALIFORNIA ENERGY COMMISSION

DEPARTMENT OF ENERGY & ENVIRONMENT

EnergyTrust of Oregon

IOWA economic development

MASSACHUSETTS CLEAN ENERGY CENTER

IPA ILLINOIS POWER AGENCY

NEW MEXICO emnrd Energy, Minerals and Natural Resources Department

OEI Wisconsin Office of Energy Innovation

NEW YORK STATE OF OPPORTUNITY. NYSERDA

BPU New Jersey's cleanenergy njcleanenergy.com program

CONNECTICUT GREEN BANK SM

New Hampshire Public Utilities Commission

Maryland Energy Administration

Department of Commerce Innovation is in our nature.

MIEnergy Michigan Agency for Energy Michigan Energy Office

VERMONT CLEAN ENERGY DEVELOPMENT FUND PUBLIC SERVICE DEPARTMENT

Xcel Energy Renewable Development Fund

Rhode Island Commerce CORPORATION

mn COMMERCE DEPARTMENT

MassDEP

SMUD Powering forward. Together.

NREL NATIONAL RENEWABLE ENERGY LABORATORY

Prairie Island Indian Community

DOER Massachusetts Department of Energy Resources

State of Rhode Island Office of Energy Resources

OREGON DEPARTMENT OF ENERGY

Connecticut Energy Environment

Illinois Department of Commerce & Economic Opportunity

Office of the People's Counsel District of Columbia Advocating, Protecting and Educating DC Consumers

NEW HAMPSHIRE DEPARTMENT OF Environmental Services

Smart Electric Power Alliance

ACEP Alaska Center for Energy and Power

www.cesa.org

Technology Overview

- A viable heating option for the Northeast
- Cold climate Air Source Heat Pumps (ccASHPs) can run in temperatures down to -15°F and below
- Save energy, save money, increase home comfort, improve indoor air quality.

How Does an ASHP Work?

- Heat pumps don't generate heat—they move heat!
- ASHPs use electricity to remove heat from the outside air. The cold air runs through a refrigerant, which extracts the heat from the air, compresses it into a hot gas under pressure. As the gas depressurizes, it releases the heat through the indoor unit.
- ASHPs operate in reverse in cooling mode.

- ASHPS can be **ducted** or **ductless**.
  - Ductless systems connect outdoor to indoor units with a small flexible pipe. One or more units can be used with a single outdoor condensing unit. These are known as **mini-splits and multi-splits**.
  - Ducted systems can use existing duct work (if the ducts are in good shape and appropriately sized for the ASHP).

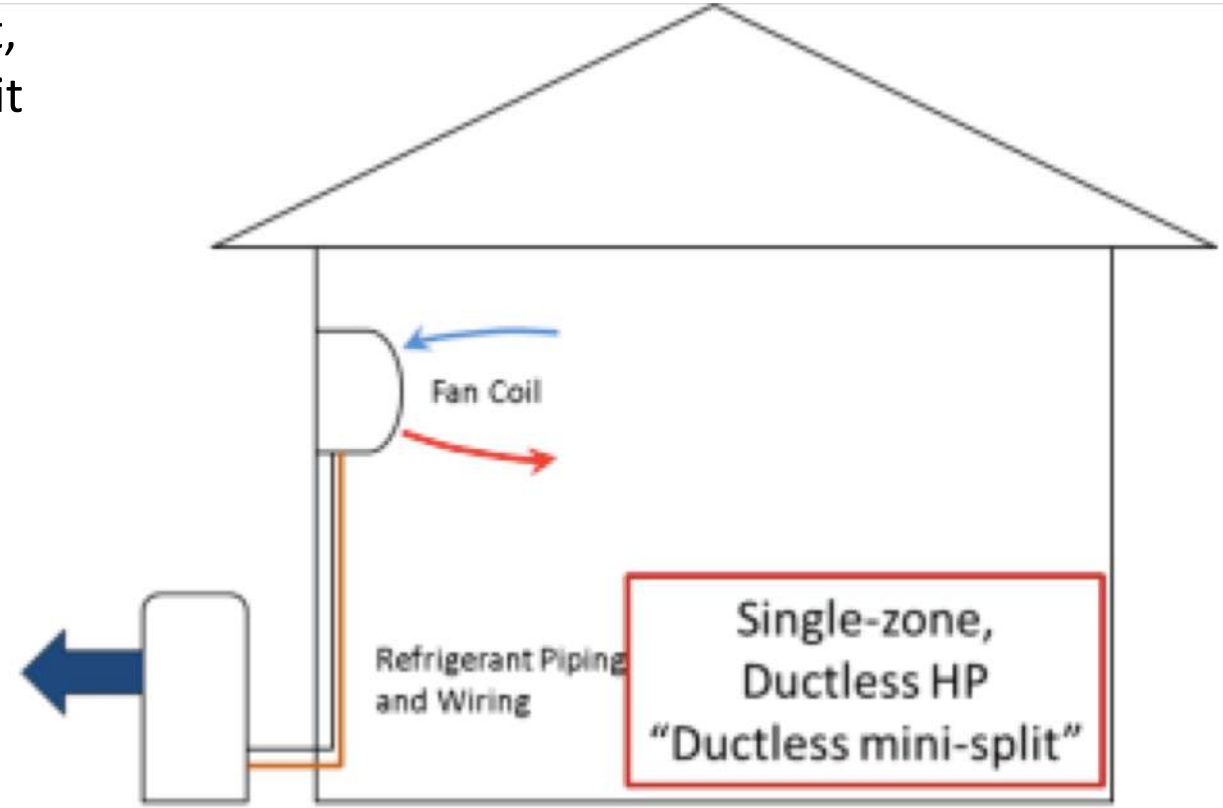
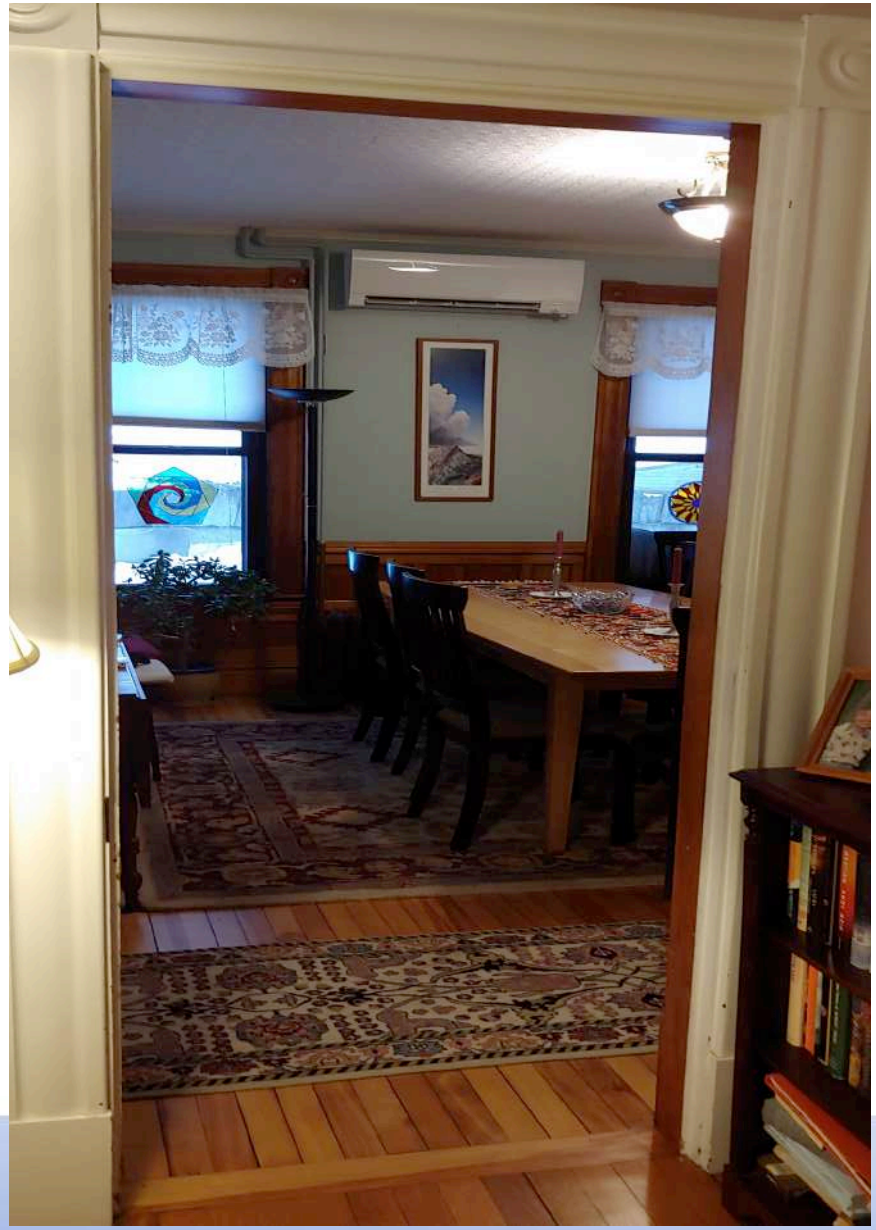


**Image by Northeast Energy Efficiency Partnership*

What If I Just Want to Offset my Fossil Fuel Use?



Choosing an Efficient Model

- Look for the Coefficient of Performance (CoP) and the Heating Season Performance Factor (HSPF) of the unit you're considering purchasing.
- These efficiencies are captured in NEEP's database of ccASHPs that meet specific performance levels.

An ASHP must have a COP >1.75 at 5°F to be placed on the list.https://neep.org/initiatives/high-efficiency-products/emerging-technologies/ashp/cold-climate-air-source-heat-pump

- ASHPS can deliver heat at low temps, but their efficiency begins to drop dramatically below 5°F.
- Efficiency Vermont maintains a list of equipment eligible for rebates that meet certain efficiency criteria. https://www.efficiencyvermont.com/Media/Default/docs/rebates/qpls/efficiency-vermont-cold-climate-heat-pumps-qualifying-products.pdf

Will I Save Money?

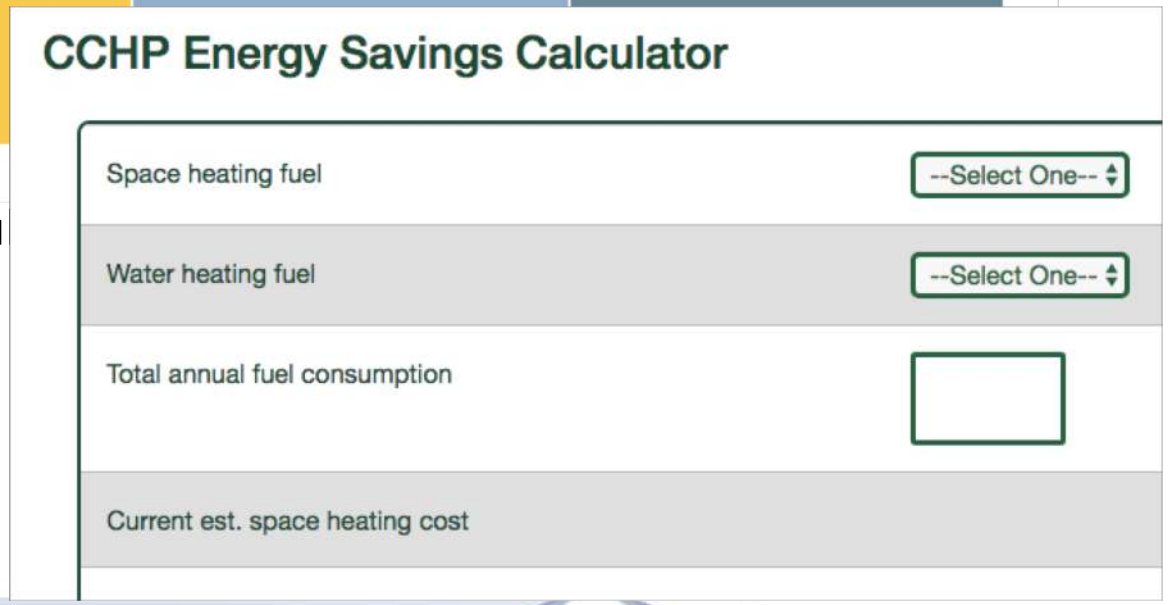
That depends on several factors:

- The price of the fuel you're displacing
- Proper sizing
- The building's weatherization
- Homeowner use
- The average temperature

Air Source Heat Pump Expected Savings**

Fuel Type	Oil	Electricity	Propane	Natural Gas
Fuel Cost	$3.13/gallon	$0.157/kWh	$3.09/gallon	$1.38/therm
Annual Savings	$250	$1,230	$1,000	$(660)
Lifetime Savings	$5,400	$20,200	$16,800	N/A
Years to Payback	9.1	3.9		

Burlington Electric Department offers an energy savings calcu
available here: https://www.burlingtonelectric.com/cchp



*** Image from WePowr. Available at* http://wepowr.com/technology/ashp/savings

Accelerating Market Adoption

First, we should understand the market barriers:

- Lack of consumer awareness
- Misinformation
- Few installers & lack of experience
- Regulatory barriers

Strategies for market acceleration:

- Community bulk-purchase programs modeled on the successful Solarize programs
- Outreach to consumers
- Installer training
- Leasing systems
- Downstream and upstream incentives

Residential and Business ASHP Incentives

Efficiency Vermont offers rebates up to $400

Type	Rebate Amount
Single or multi zone ≤ 2 tons	$300
Multi zone ≥ 2 tons	$400

Your utility may offer additional rebates

Utility	Rebate Amount
Vermont Electric Coop	$150
Burlington Electric Department	$450
Washington Electric Coop	$250

Financing an ASHP

Heat Saver Loans

- Low interest loans
- Up to 15 year loan terms

Val Stori
Val@cleanegroup.org
(802) 223-2554 ext. 211

Learn more at: www.cesa.org

December 1st, 2018

Heat Local!

Advanced Wood Heating for VT

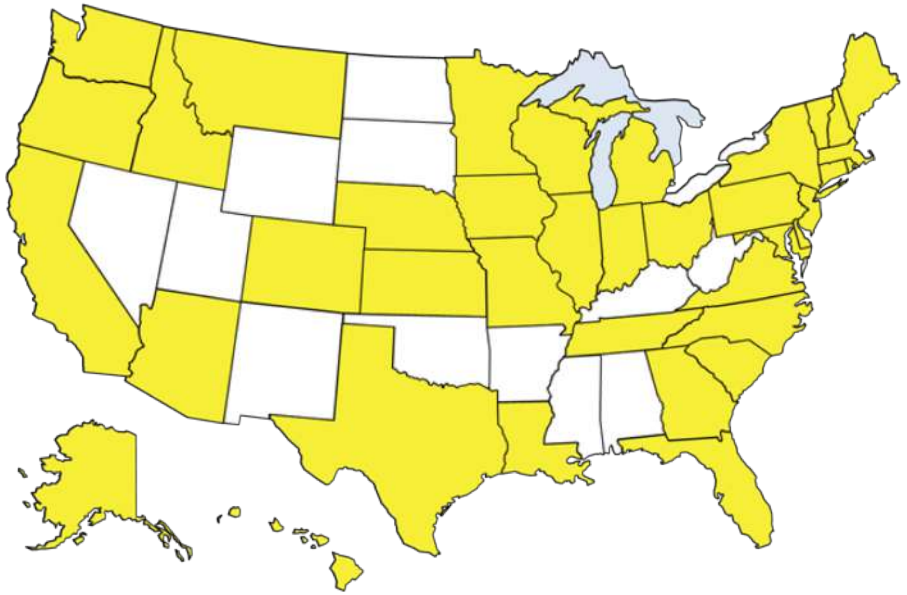
VECAN Conference

Adam Sherman

BERC Biomass Energy Resource Center

About VEIC

- Mission-driven nonprofit
- 30+ years reducing economic & environmental costs of energy
- 300 staff in Vermont, Ohio, & Washington DC
- Design and deliver:
  - ❑ Energy efficiency
  - ❑ Renewable energy
  - ❑ Transportation efficiency
- We “think and do”
  - ❑ 30 Consultants
  - ❑ 60 Engineers and TA experts
  - ❑ 10 Data analytics and EM&V experts
  - ❑ 8 Financing strategy experts



- Clients
  - ❑ Utilities
  - ❑ Government
  - ❑ Regulators / Consumer Advocates
  - ❑ Environmental Organizations
  - ❑ Foundations

VEIC

Major Initiatives

Efficiency Vermont

DC SUSTAINABLE ENERGY UTILITY

EFFICIENCY$MART

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RENEWABLE ENERGY RESOURCE CENTER

Drive Electric Vermont

Commons Energy

Sustainability Benefits

Sun Shares

Presentation Outline

- Wood Fuels
- Wood Heating Equipment
- Integration with Heat Distribution Systems
- Economics
- Conclusion

Wood Heating Fuels

Chunkwood

- Requires hand firing
- Sold based on volume (4’x8’x4’)
- Wide range of energy value based on moisture (10 – 55%)
- Costs $0 – 20 per MMBtu

Green Woodchips

- Automated fuel feed
- Sold by the green ton
- Variable energy value (MC 35 - 50%)
- Requires indoor fuel storage
- Costs $7-10 per MMBtu

Dry Woodchips

- Automated fuel feed
- Sold by the green ton
- Less variable energy value (MC under 25%)
- Indoor/outdoor fuel storage
- Costs $12-14 per MMBtu

Wood Pellets

- Automated fuel feed
- Sold by the ton
- Very consistent energy value (6-8% moisture)
- Indoor/outdoor fuel storage
- Costs $17-20 per MMBtu

Fuels, Appliances, Thermal Output

Cordwood and Bagged Pellets

Stoves

Point-source Warm Air

Cordwood and Bulk Pellets

Furnaces

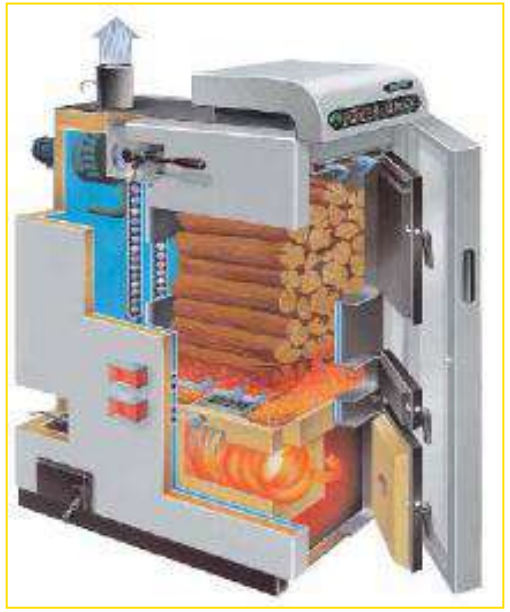
Ducted Warm Air

Cordwood, Bulk Pellets & Chips

Hydronic Heaters (aka Boilers)

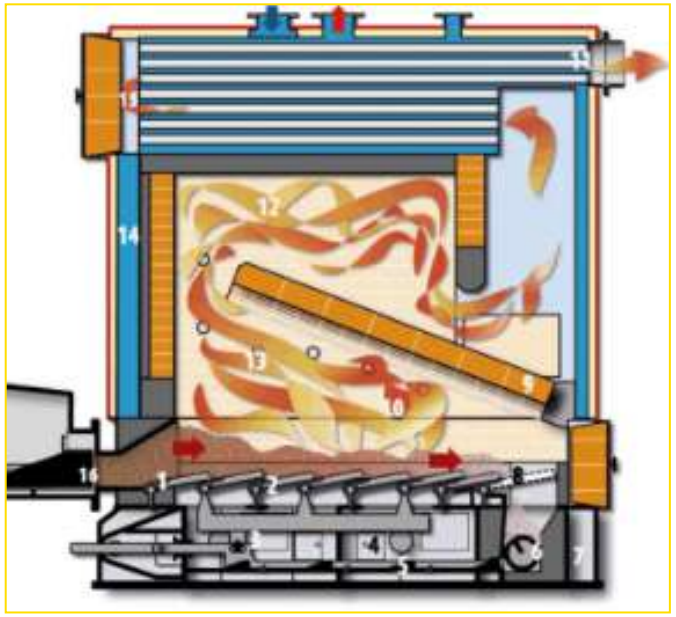
Hot Water (100 – 190 degree F)

Advanced Combustion & Heat Exchange



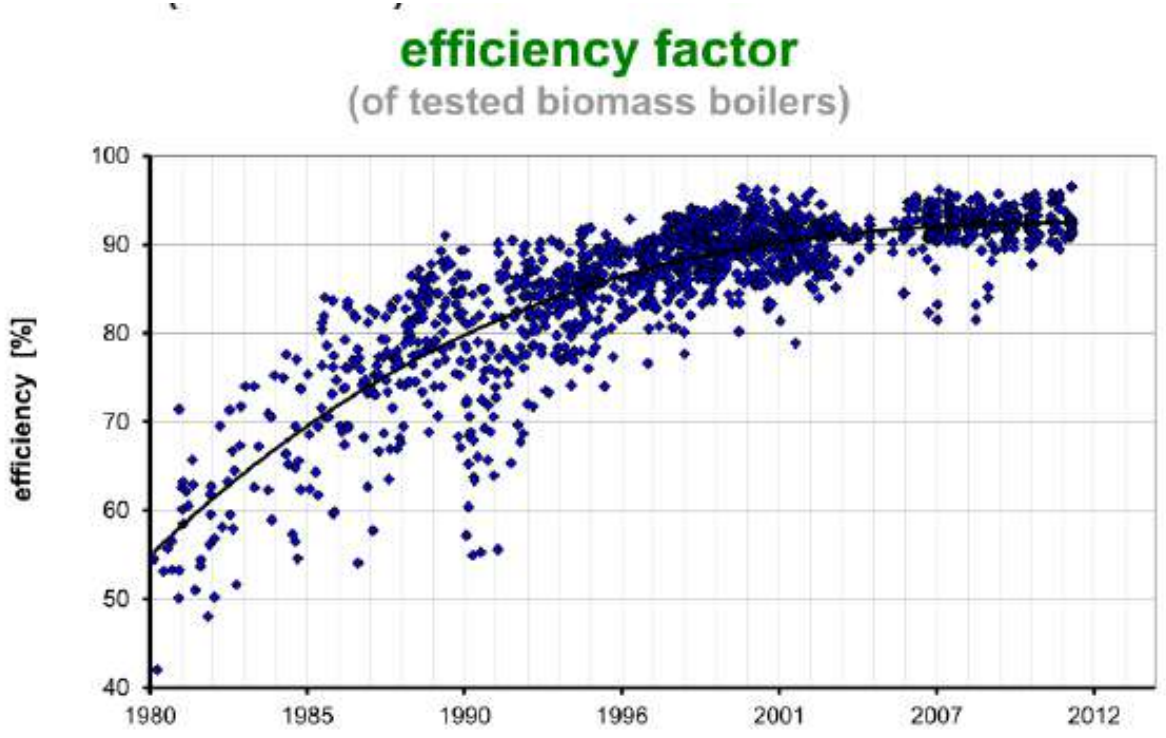
Cordwood system

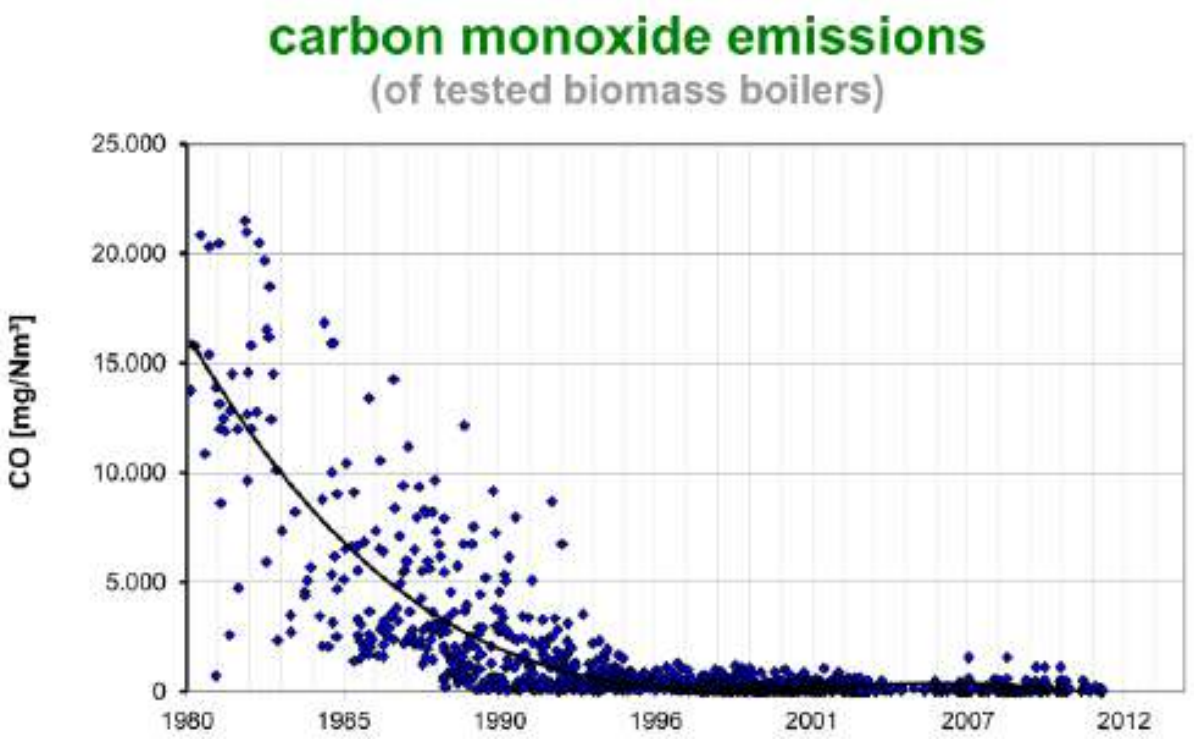
Pellet system



Woodchip system

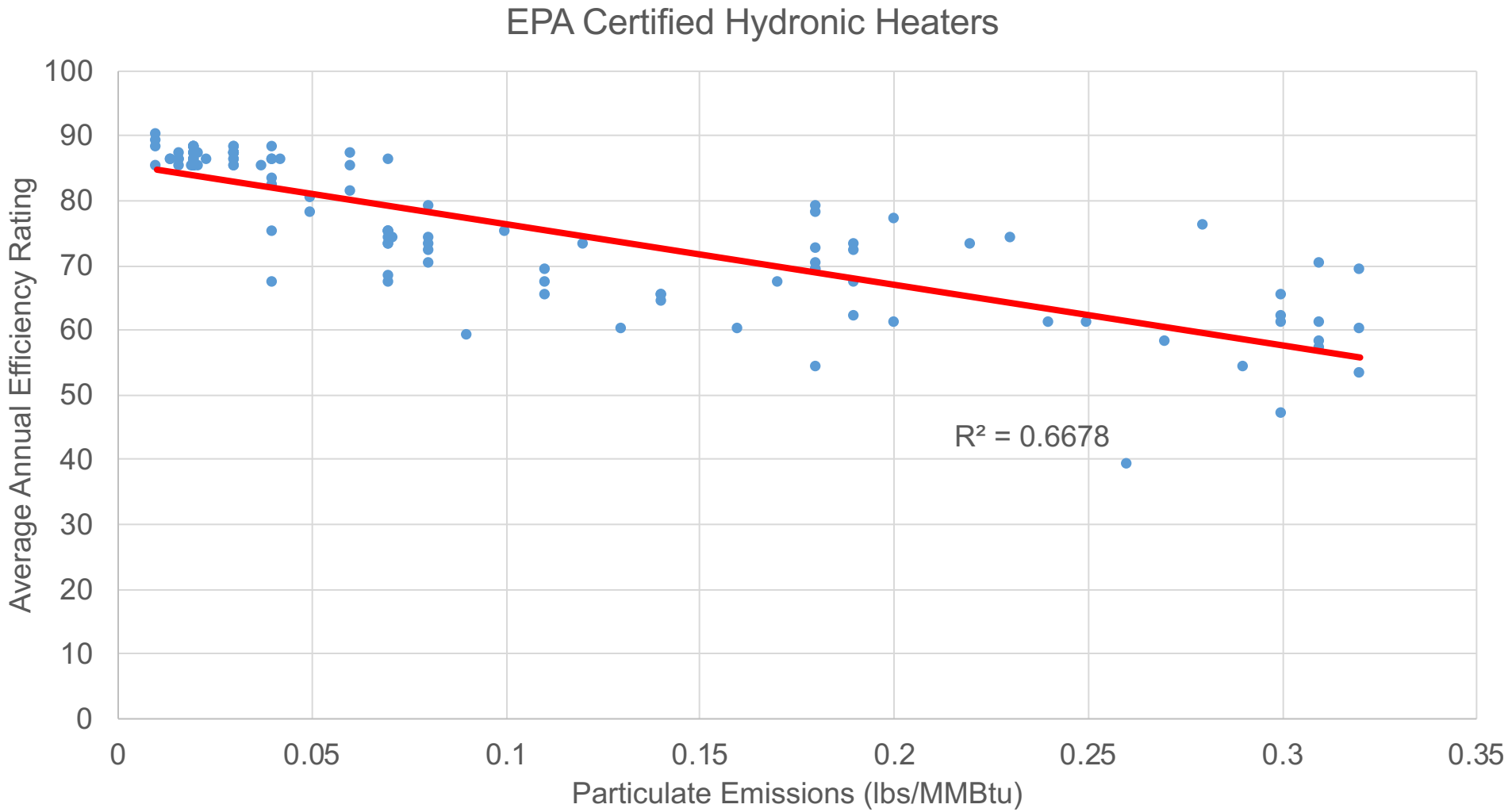
Advancements in Modern Combustion



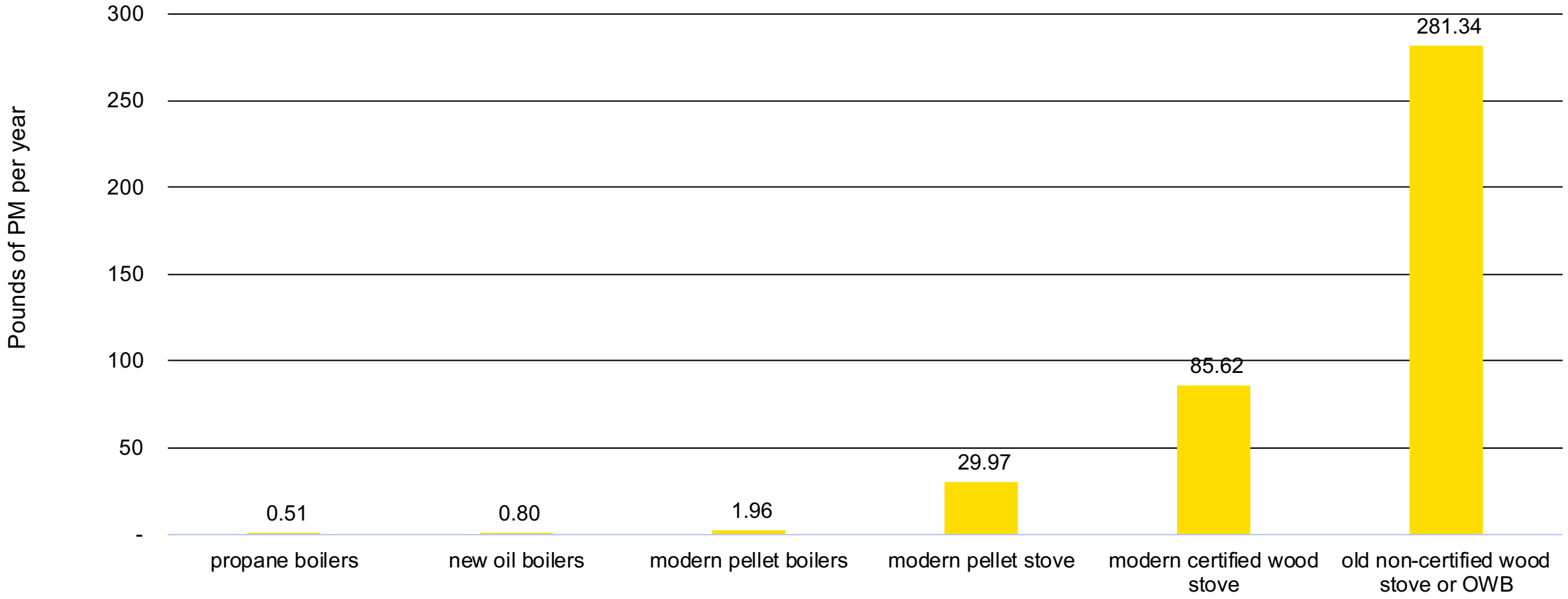


Source: BioEnergy 2020+

Efficiency & Emissions

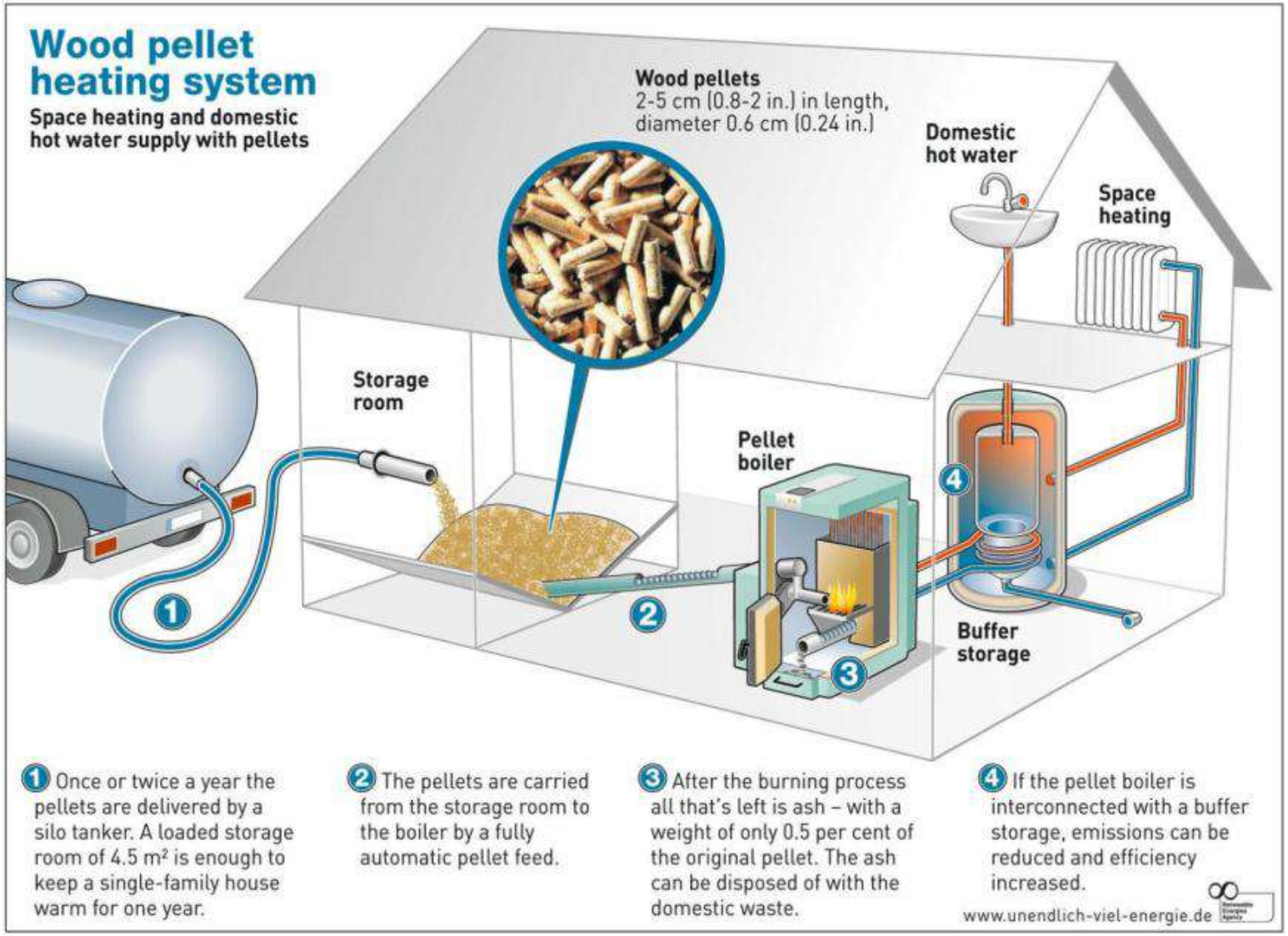


Annual PM Emissions for a Typical Residential Heating System



Source: EPA Burnwise program and BERC Analysis

Automated Heating with Bulk Pellets



Bulk Pellet Heating System Configurations

Indoor Storage Bag

Indoor Dedicated Room

Outdoor Silo

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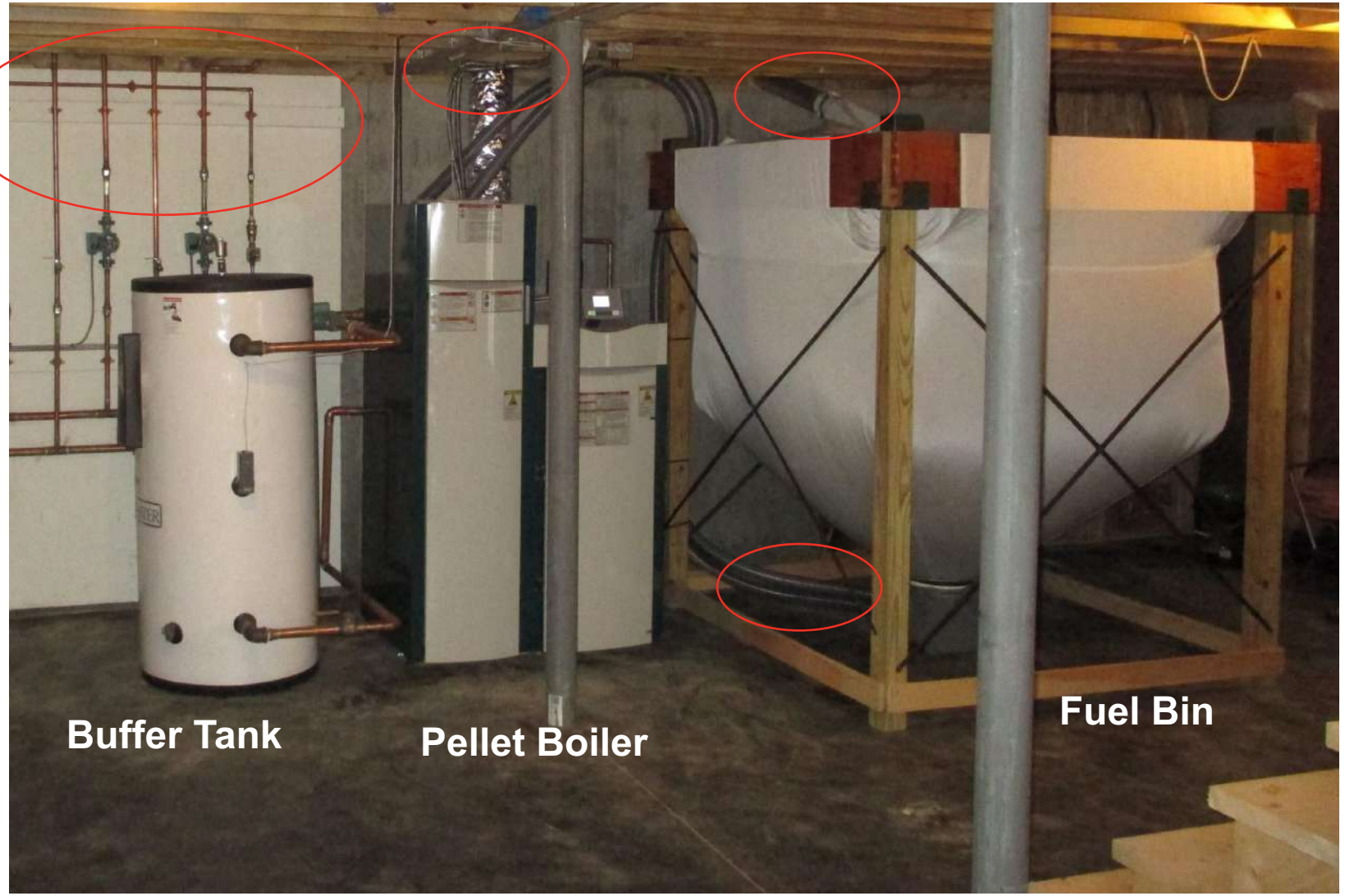
Typical Residential System



Advanced Wood Heating Applications

Residential and Small Commercial



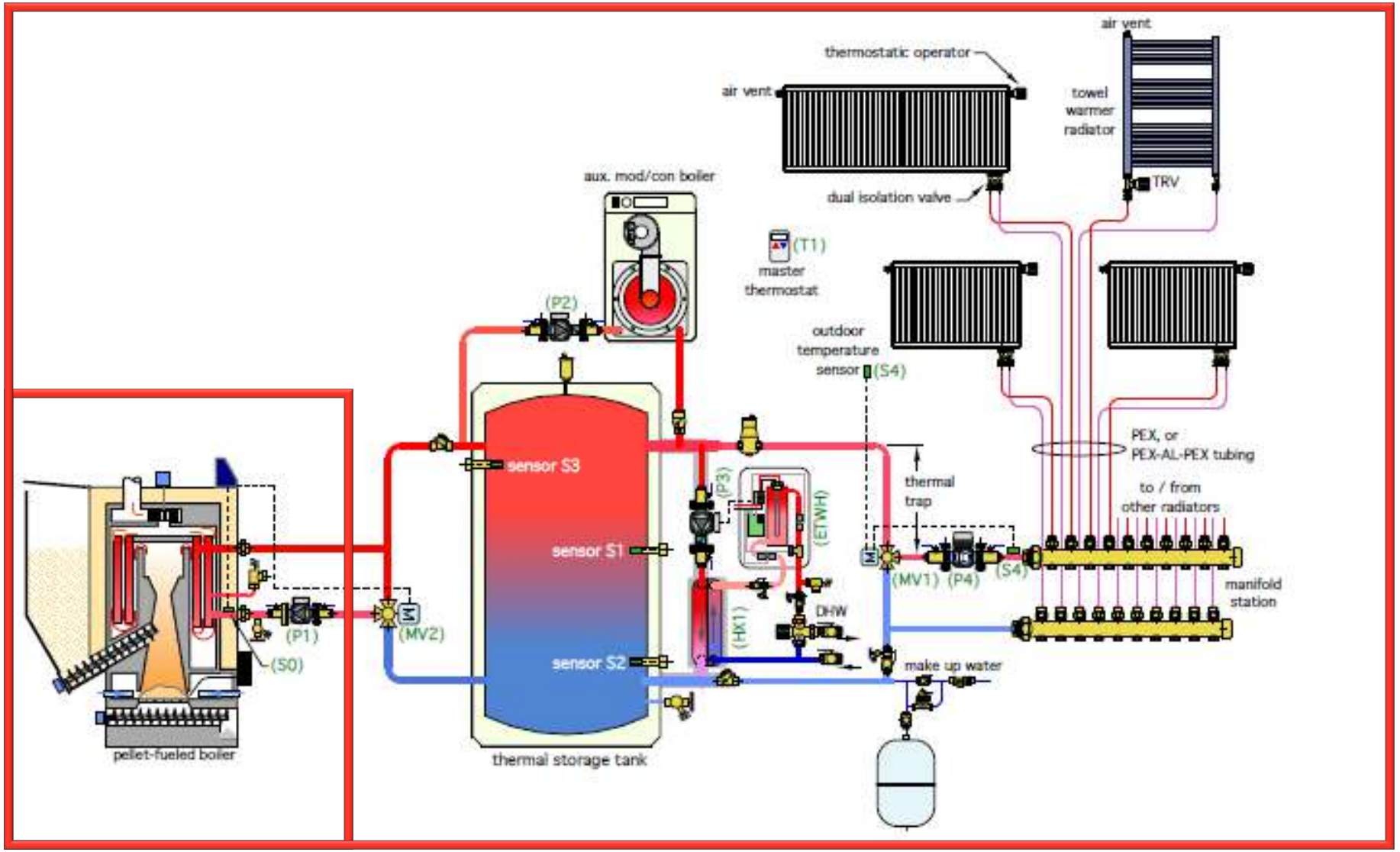



Large Commercial/Institutional






Integration with Heat Distribution System



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Heat Distribution Systems

Why Water rather than air?

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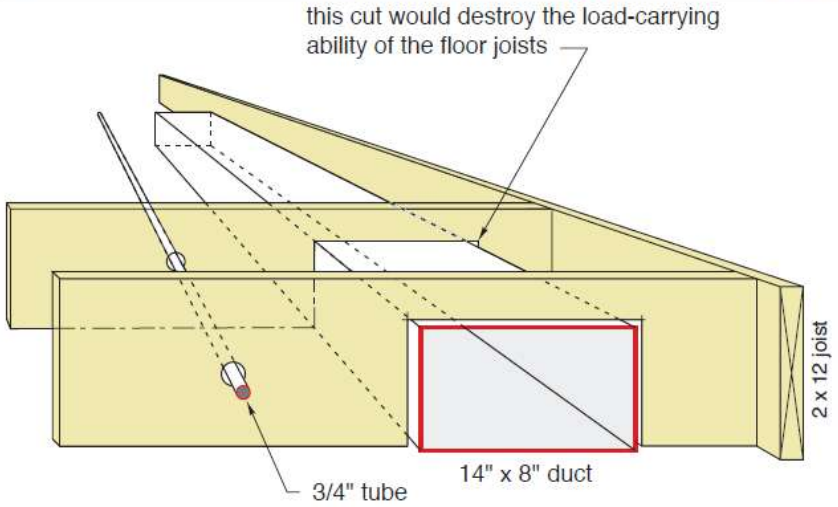
Heat Distribution Systems

Water is vastly superior to air for conveying heat

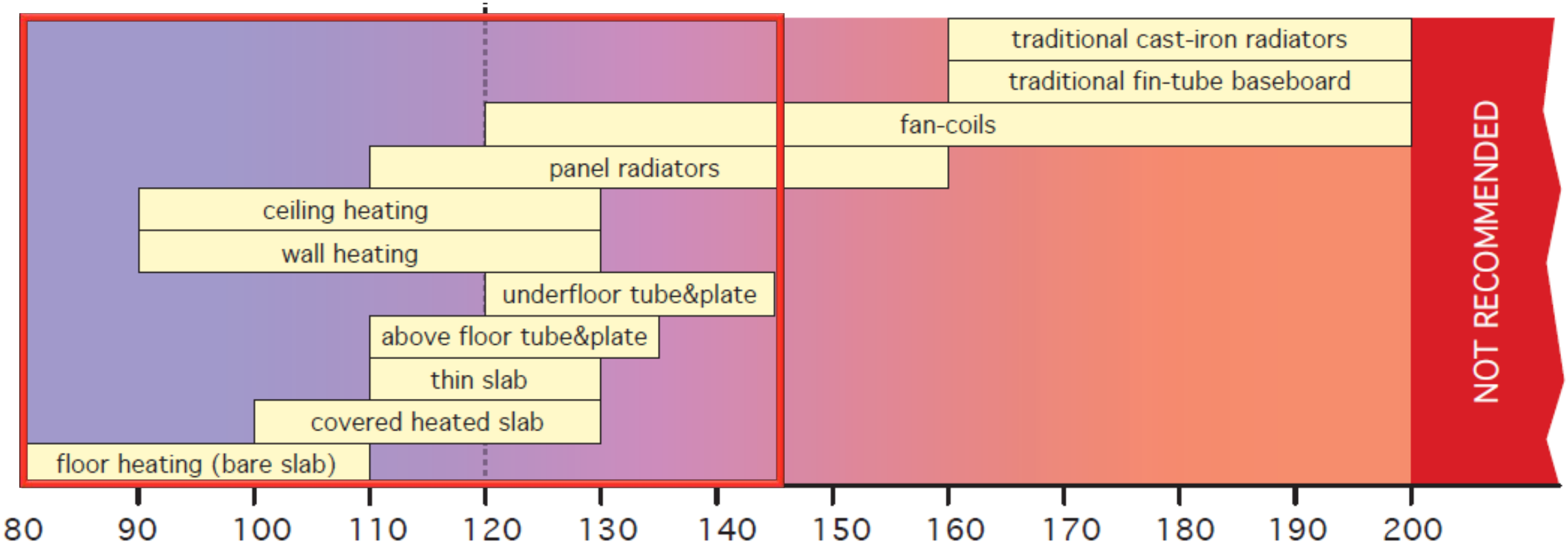
Material	Specific heat (Btu/lb/°F)	Density* (lb/ft³)	Heat capacity (Btu/ft³/°F)
Water	1.00	62.4	62.4
Concrete	0.21	140	29.4
Steel	0.12	489	58.7
Wood (fir)	0.65	27	17.6
Ice	0.49	57.5	28.2
Air	0.24	0.074	0.018
Gypsum	0.26	78	20.3
Sand	0.1	94.6	9.5
Alcohol	0.68	49.3	33.5



$$\frac{62.4}{0.018} = 3467 \approx 3500$$

A given volume of water can absorb almost 3500 times as much heat as the same volume of air, when both undergo the same temperature change

Heat Distribution Systems



Hydronic Heat Emitters

Traditional cast-iron radiator

Modern panel radiator

Baseboard Radiator

Radiant Flooring

Woodstoves

Burn Wise
Program of U.S. EPA

This wood-burning appliance meets 2020 U.S. Environmental Protection Agency clean air standards.

Heating Area	Heats Up To 2500 sq. ft.
Efficiency	83%
Smoke Emissions	EPA Maximum Allowed 2.5 g/hr; This model xx g/hr

MANUFACTURER
Wood Stove Inc.

MODEL NO.
1850M

FUEL TESTED

- Pellets: ground wood or biomass that is compressed into a pellet.
- Crib wood: cut 2"x4" or 4"x 4" lumber that is stapled together.
- Cord wood: typical firewood, and a better measure of how a heater will perform in homes.

For more information, refer to the Owner's Manual and www.epa.gov/burnwise.

Efficiency and emissions are provided by an EPA-approved third party lab. Heating area is estimated by the manufacturer.

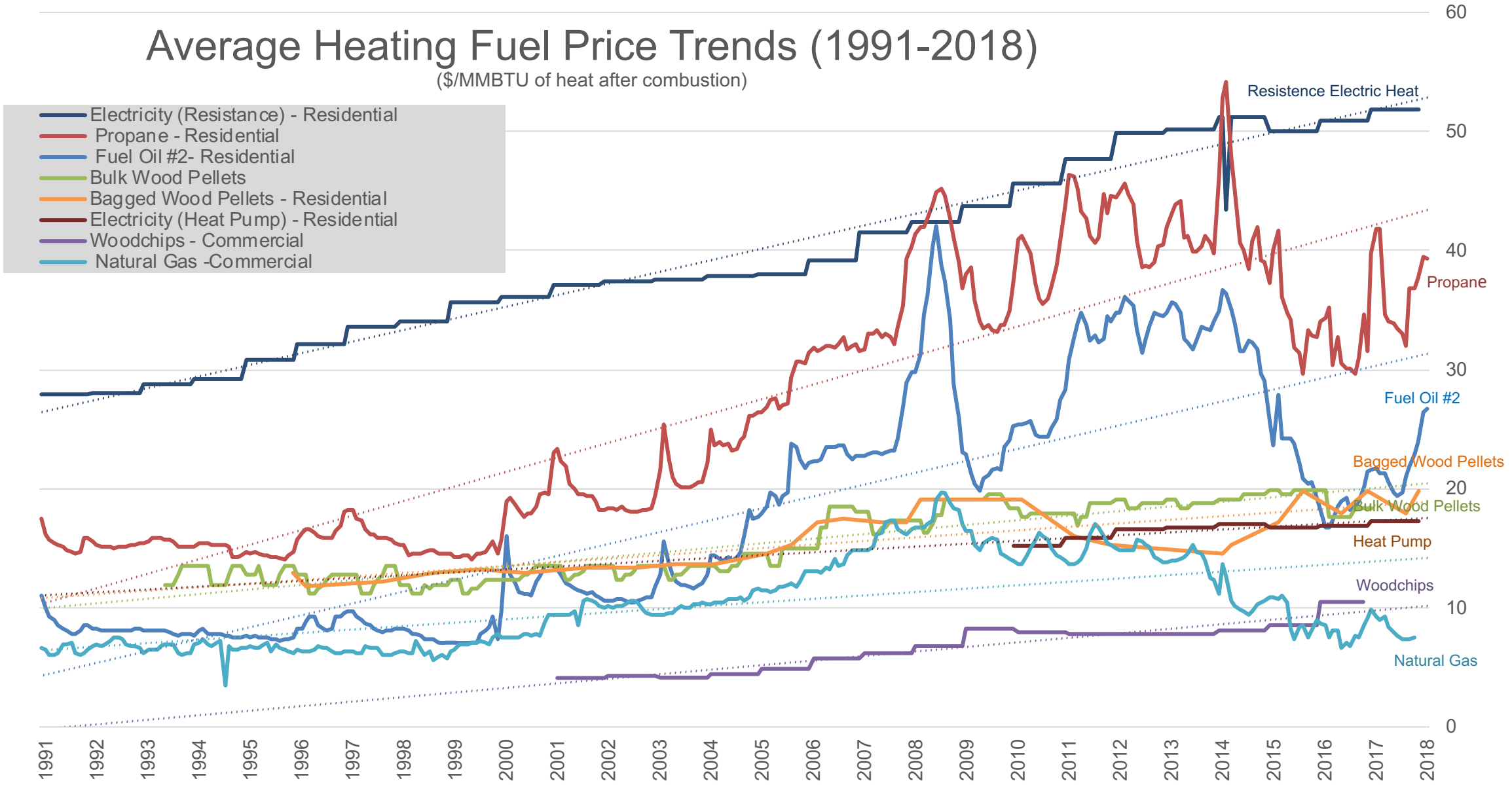
EPA

Burn Right

https://www.burnrightvermont.org/

Average Heating Fuel Price Trends (1991-2018)

($/MMBTU of heat after combustion)



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Incentives for Bulk Pellet and Woodchip Central Heating Systems

Market	Building Area	EVT Incentive	CEDF Incentive	Application Process
Residential	Any	$3,000	$3,000	EVT Residential Rebate form.
Existing Building Commercial	≤ 5,000 ft^2	$3,000	$3,000	EVT Commercial HVAC Rebate form.
	> 5,000 ft^2	$1.25/$ ft^2	$3,000	Contact EVT to enroll.
Commercial New Construction	> 5,000 ft^2	$0.20/$ ft^2, Minimum $4,000	$3,000	Contact EVT to enroll.

Stove Incentives

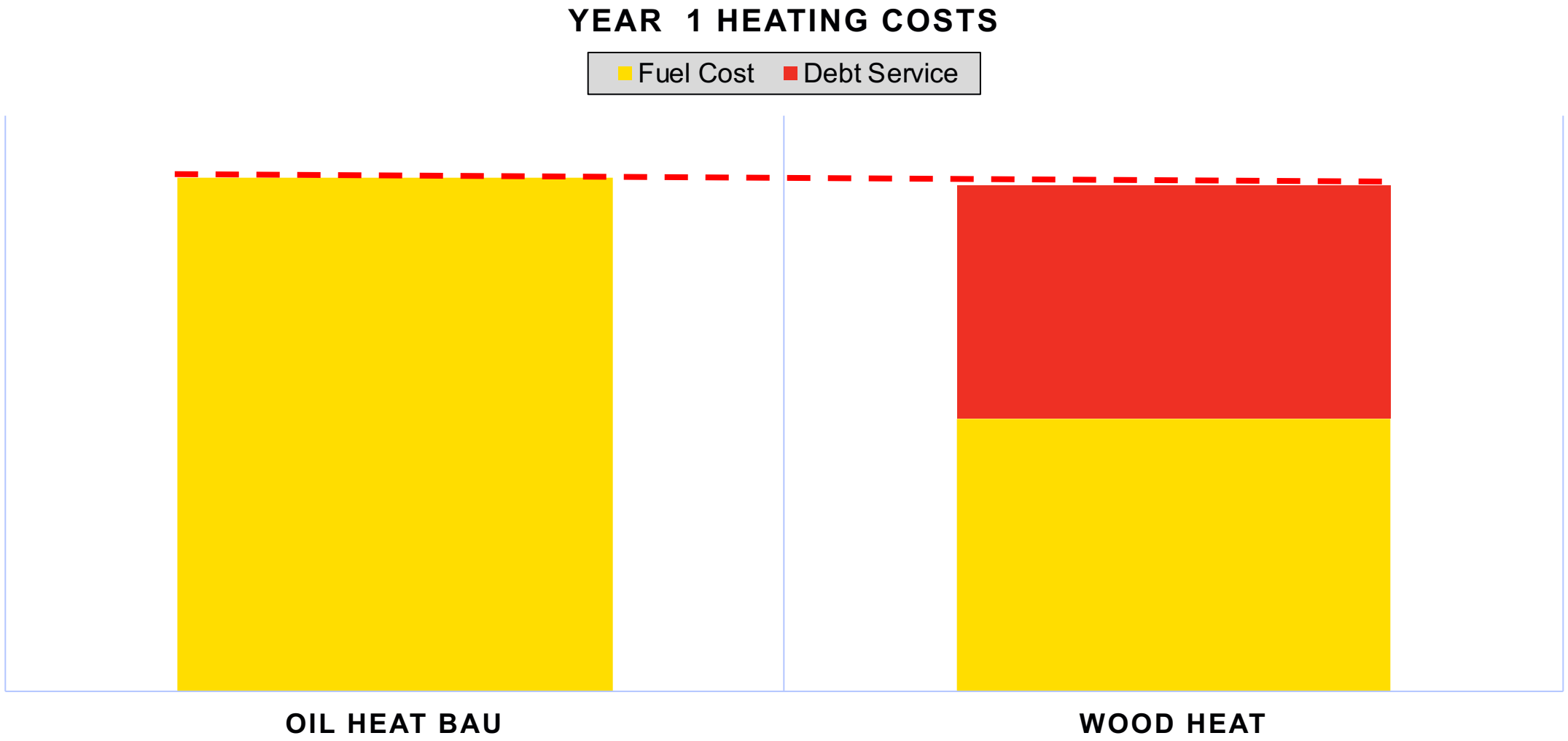
- Support from the Efficiency Vermont
  - $650 per stove
  - $100 adder if disposing of old stove
- Support from CEDF
  - $800 per cord wood stove
  - $1,000 per pellet stove
  - Disposal of non-EPA unit is required
- Point of purchase discount

Financing

- Heat Saver Loan (Residential Only)
  - Boilers/Furnaces & Stoves
  - Low interest
  - Streamlined application process
- Business Energy Loan (Commercial)
  - Pellet/Chip systems
  - Up to $50,000
  - Minimal verification
  - Low interest

VSECU

Economic Tipping Point

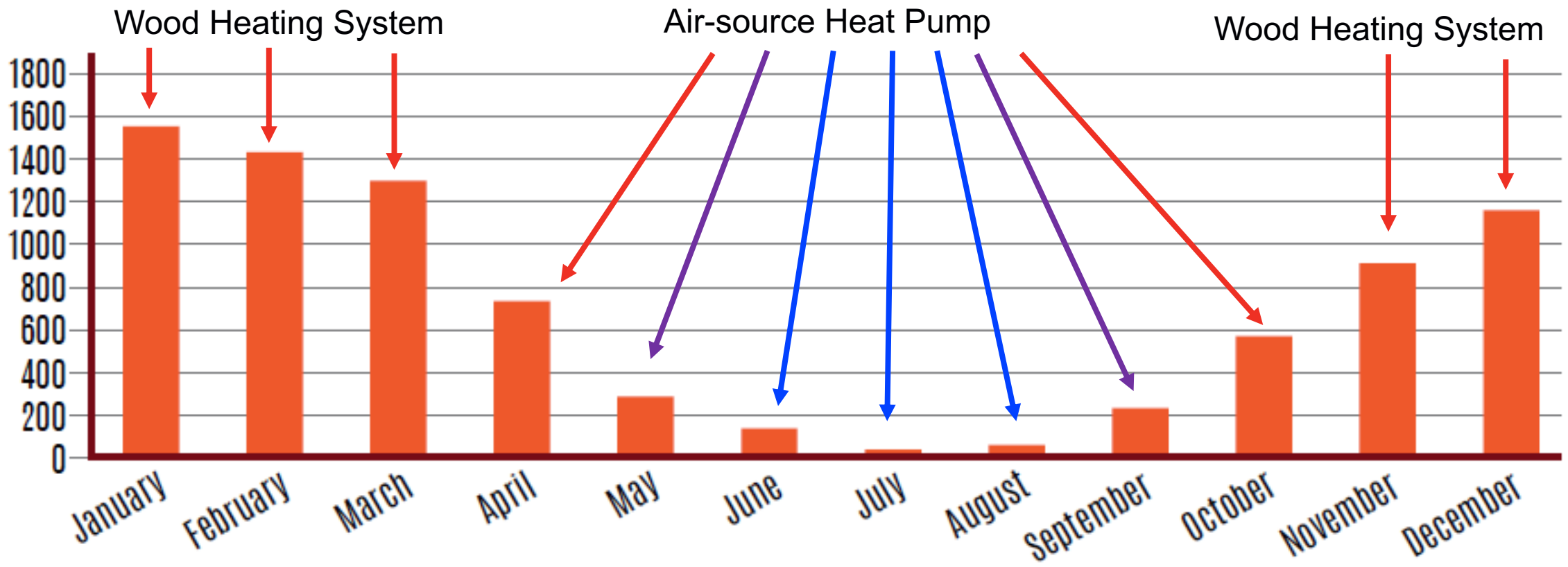


Feel Good Heat Campaign

https://feelgoodheat.org

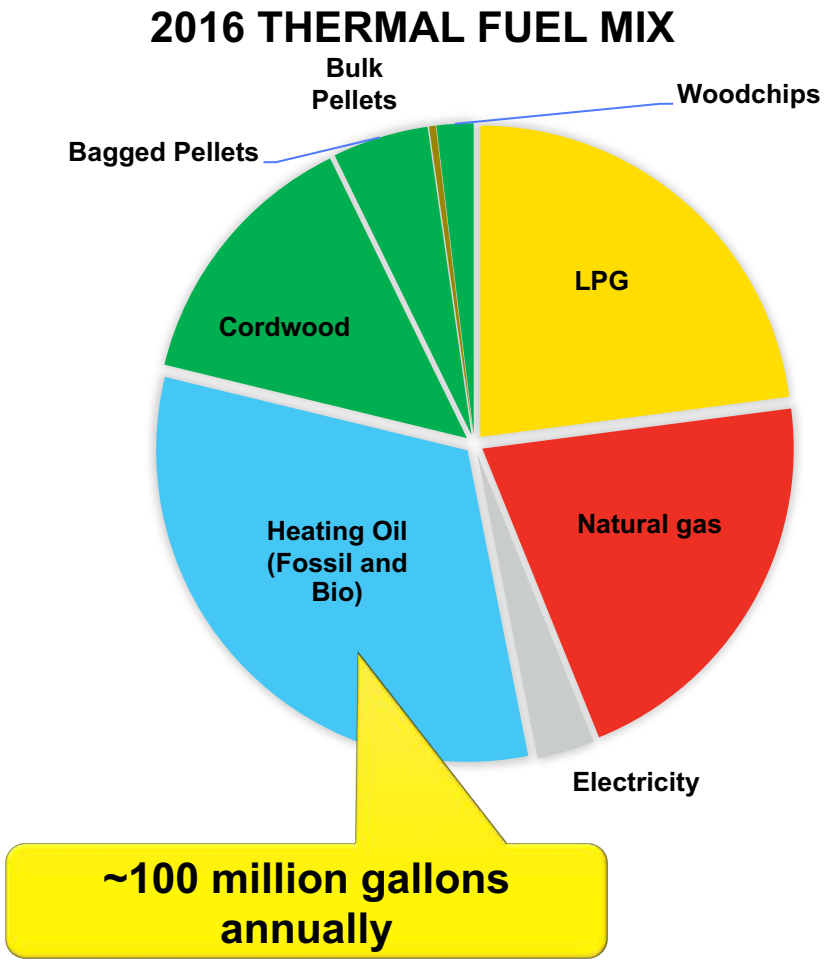
Wood Heat and ASHP Living in Harmony

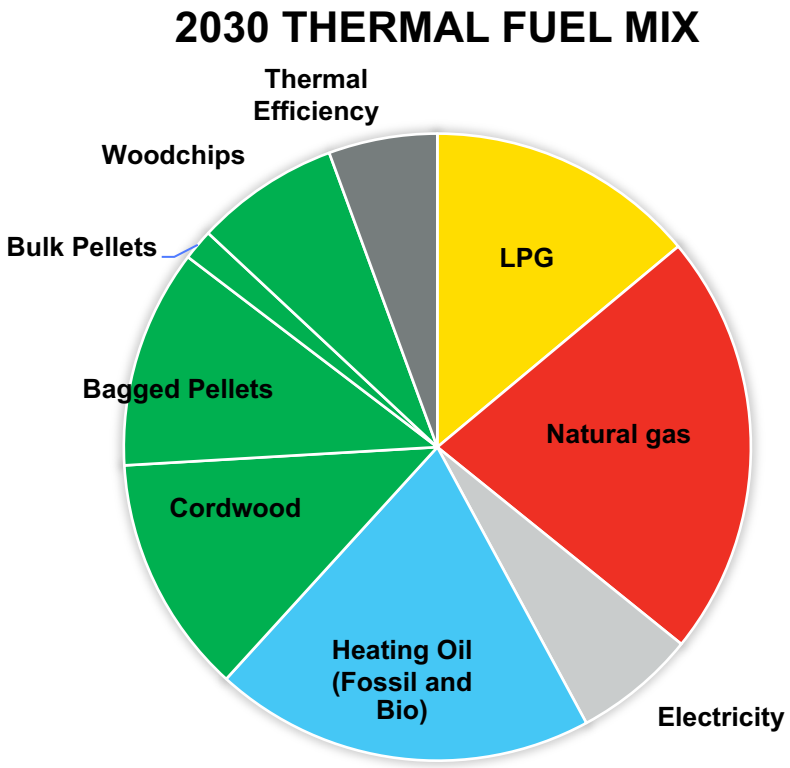
Heating Degree Days



Vermont Energy Goal –

35% of Thermal Energy from Wood Heat by 2030





Questions?

Adam Sherman
asherman@biomasscenter.org

BERC
Biomass Energy
Resource Center

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Energy Action Network
swolfe@eanvt.org

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Clean Energy States Alliance
val@cleanegroup.org

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