Alaska Housing
FINANCE CORPORATION

Heating and Hot Water

Funding

Funding for this class was provided by the Alaska Housing Finance Corporation (AHFC).

This course is designed to empower homeowners with the knowledge to live in and maintain a safe, energy efficient home.

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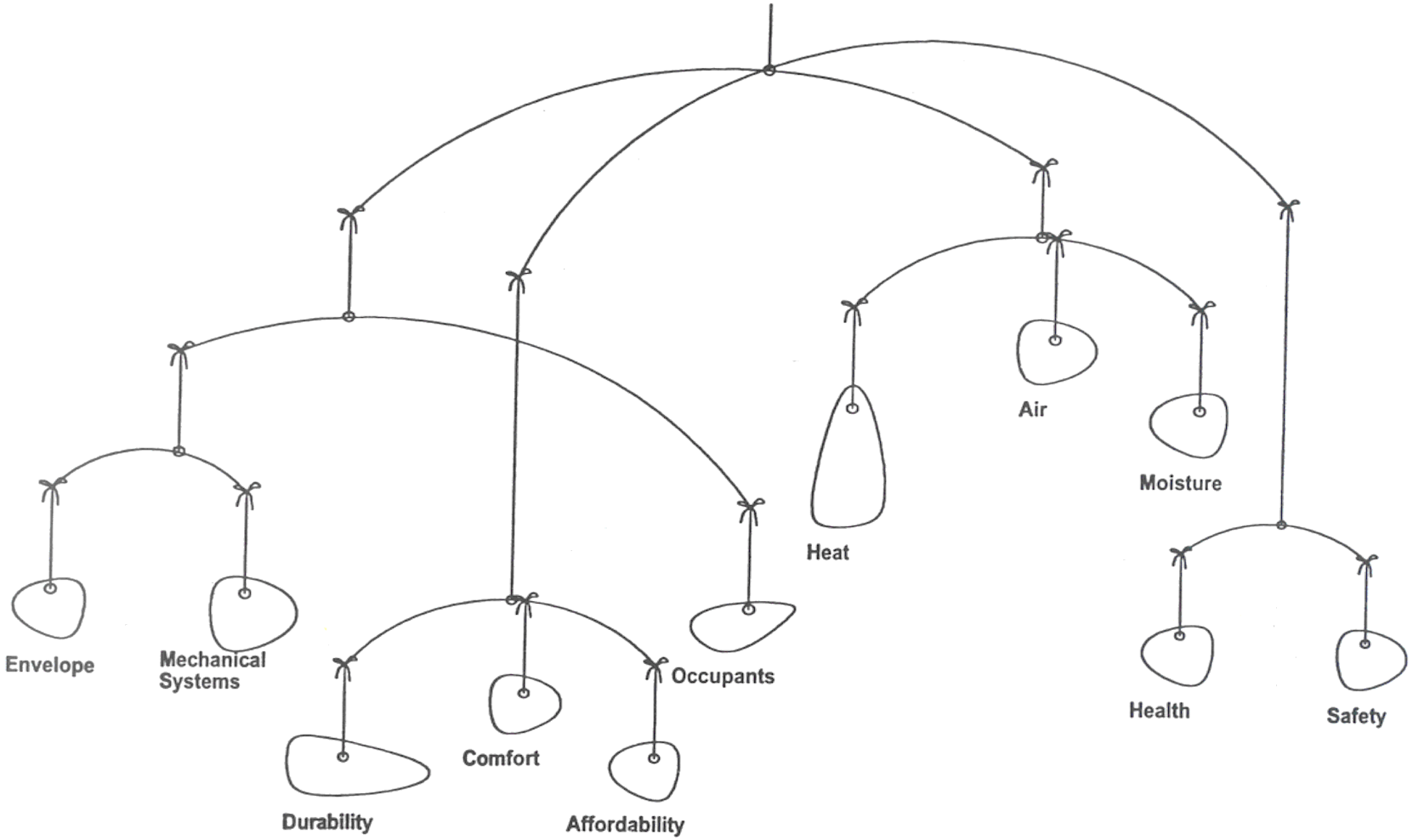
Topics for today:

- AHFC programs
- Heating system considerations
- Heating systems and fuel types
- Efficiency and sizing
- Combustion venting and safety
- System controls

AHFC Energy Efficiency Programs:

- Home Energy Rebate Program
  - www.akrebate.com
- Weatherization Assistance Program
- New Home Rebate
- Second Mortgage for Energy Conservation
- Energy Efficiency Rate Reduction Mortgage
- www.ahfc.us

The house is a system



What is a heating system?

- Heating appliance(s) + water heating appliance(s) + distribution system + control system

- In Alaska
  - Space heating can be up to 80% of home energy use
  - Water heating can be 25% or more of home energy use

Heating system upgrades may be part of an energy retrofit

Most will be done by a heating contractor

Key Considerations

- Heating system appliances MUST be safe
  - Sealed combustion/direct vent appliance OR
  - In sealed room with dedicated combustion air
  - Proper installation
  - CO monitor/alarm(s) installed
- Properly sized
  - Just a bit bigger (10-20%) than required
- Annual maintenance
  - Efficiency, Reliability, Safety

Why?

- Health and safety
  - Minimize danger to occupants
- Proper sizing = efficiency
- Maintain for efficiency and safety

Health and Safety

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Heating Systems and Fuel Types

Heating Appliances

- Boilers heat water
  - Oil, natural gas, propane, wood
- Furnaces heat and move air
  - Oil, natural gas, propane, wood
- Wood stoves, fireplaces
- Electric baseboard and water heaters
- Electric heat pumps
- Solar thermal

Boiler and hydronic distribution

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Furnace and ducts

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Cabinet Heaters

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Others

Water Heating

Boiler with Side-arm

Sealed combustion oil-fired

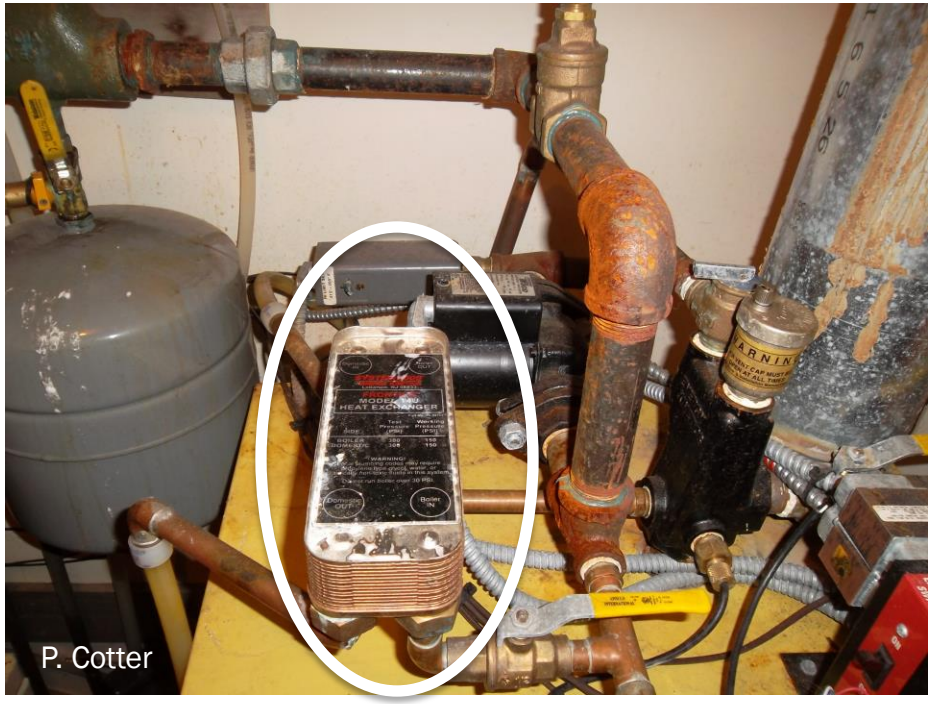
Water Heating

Electric tank

On-demand (tankless)

Water Heating

Gas-fired Tank



Flat plate heat exchanger

Water Heating

Heat pump

Solar thermal

Supplying the heating system with fuel

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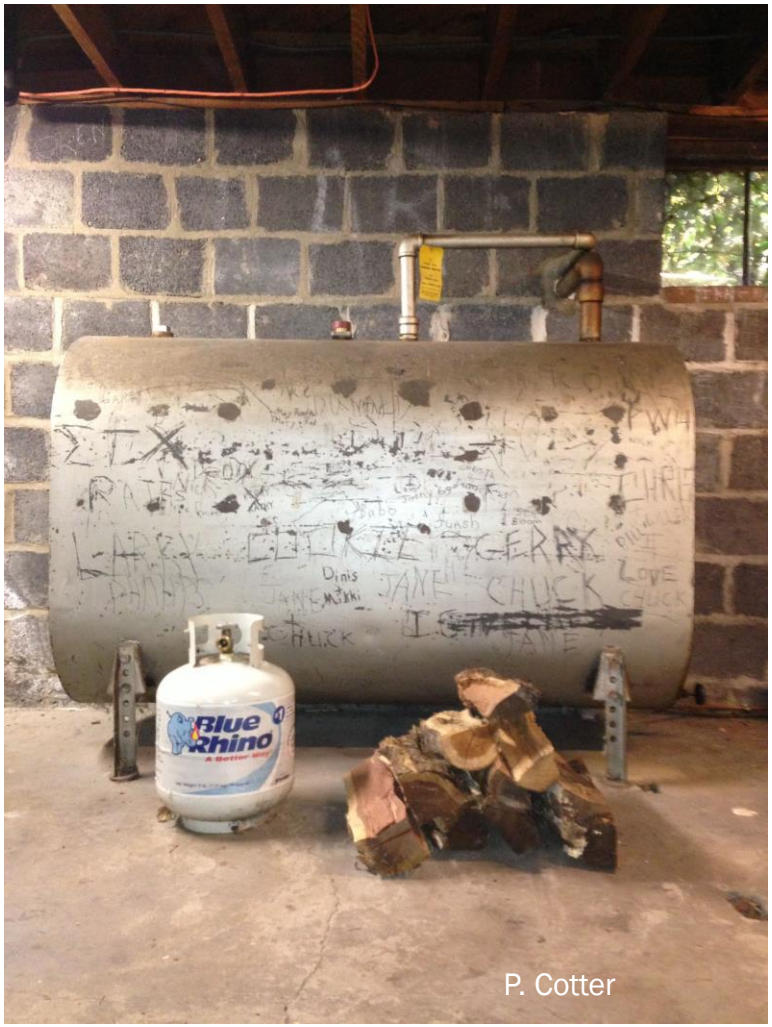

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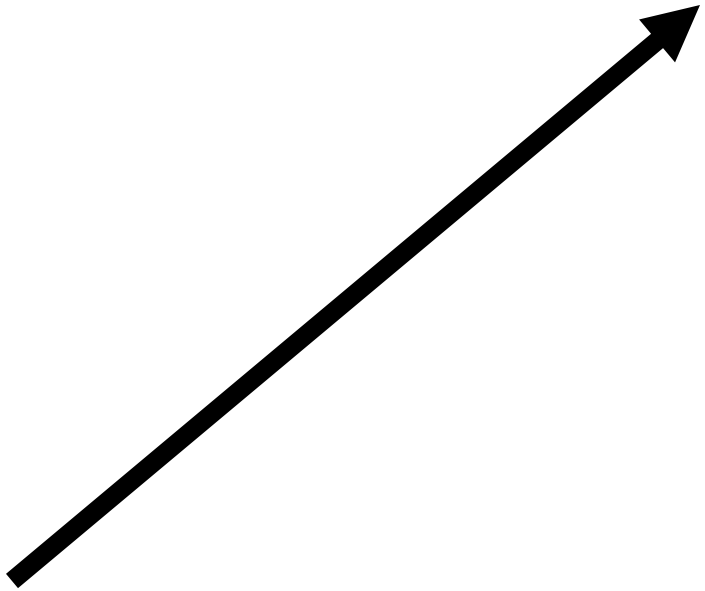
Chemical combustion

$$CH_4 + O_2 \rightarrow H_2O + CO_2 + CO$$



Due to incomplete combustion

Efficiency and Sizing

Efficiency depends on:

- Losses to incomplete combustion
- Off-cycle losses
  - Beginning and ending of burner cycle
  - Influenced by size
- Chimney losses
- Distribution losses
  - Pipes and ducts
    - Can account for huge losses

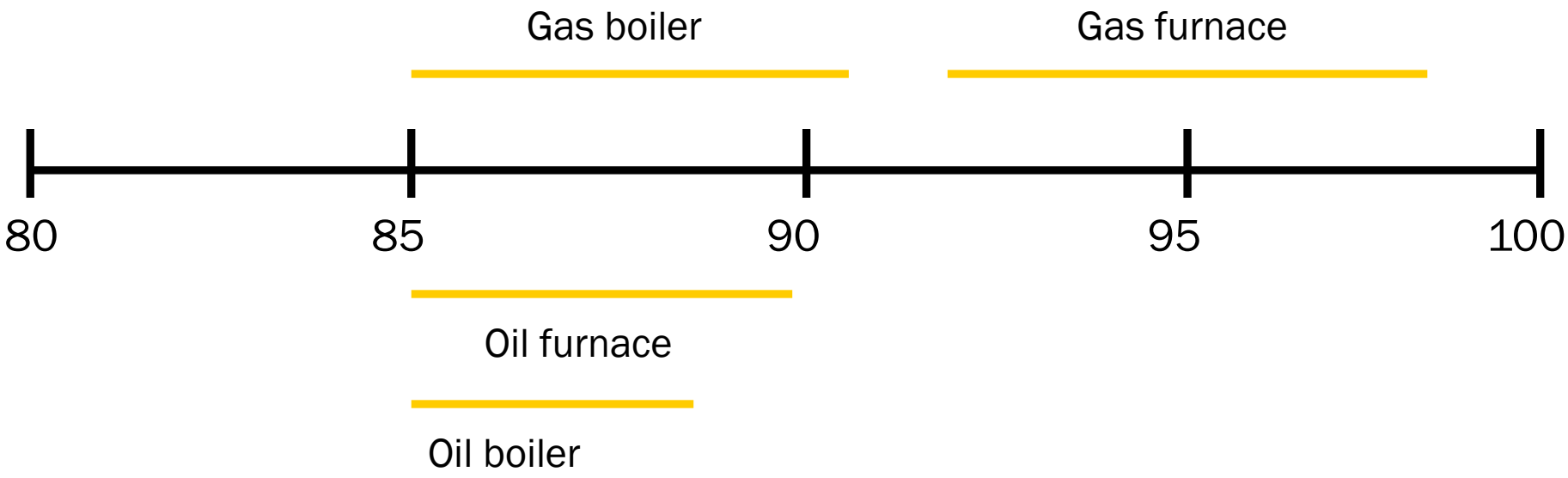
Efficiency types

- Burn efficiency (fuel-burning efficiency)
  - % of potential energy in fuel that is converted to heat
    - Today – 99%+
- Steady-state efficiency
  - % of heat captured by heating fluids
    - air, water, steam
  - Accounts for burn and chimney losses
  - Measured w/ O_2 and CO_2 sensors

Efficiency types

- AFUE – Annual Fuel Utilization Efficiency
  - % of fuel's potential energy entering distribution system
  - Includes burn, chimney, cycling, cabinet losses NOT distribution losses
  - Factory determined
- Delivered heating efficiency
  - % of fuel's potential energy heating living space
  - As low as 35%

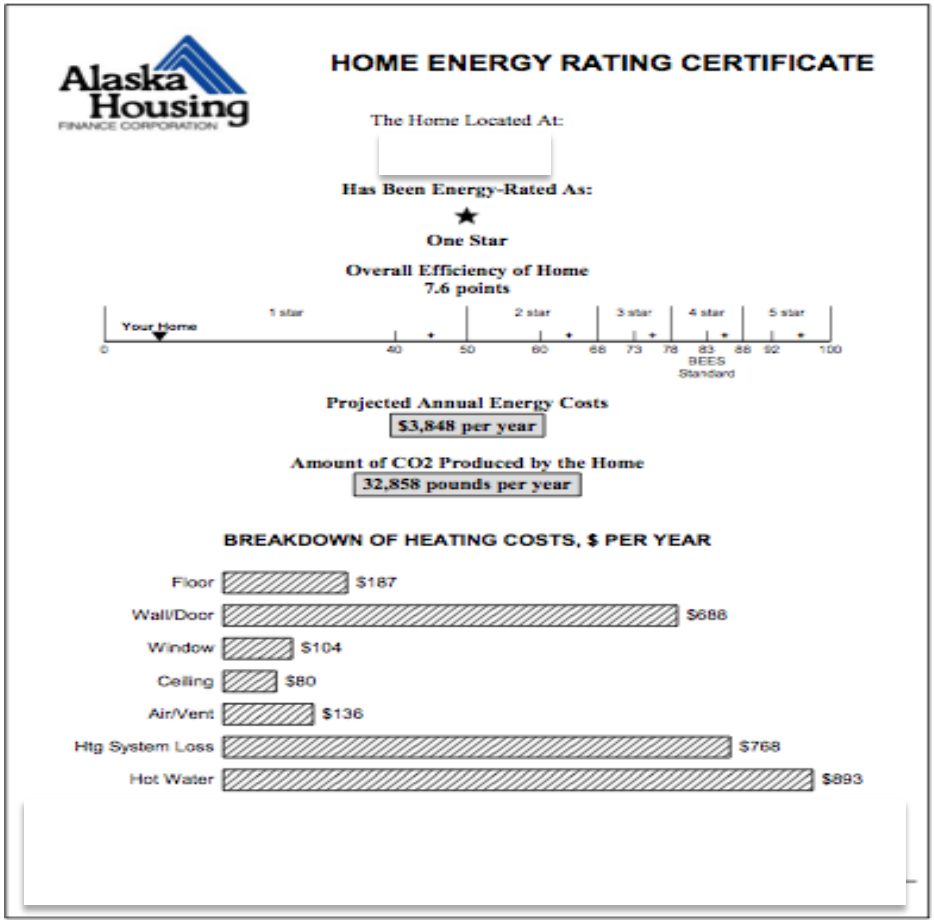
AFUE for modern furnaces/boilers



Size and Efficiency

- Big state, big heaters
  - Commonly oversized in AK
- Oversized combustion appliances = reduced efficiency and comfort
  - Short cycling increases off-cycle losses
  - Diminished control
- Higher installation and operation costs

How big a unit do you need?



HOME ENERGY RATING CERTIFICATE

The Home Located At:

Has Been Energy-Rated As:

★

One Star

Overall Efficiency of Home
7.6 points

Projected Annual Energy Costs
$3,848 per year

Amount of CO2 Produced by the Home
32,858 pounds per year

BREAKDOWN OF HEATING COSTS, $ PER YEAR

The answer is in your energy rating

Look for this page

AkWarm Energy Flows Report

Client:
Home at:

Energy Flows below are in Btu/hour

Month	Hours	Gross Loss	Gross Internal	Useable Internal	Gross Solar	Useable Solar	Natural Infil cfm
Jan	744	28,141	2,853	2,853	260	257	138
Feb	678	25,623	2,770	2,770	659	657	136
Mar	744	22,496	2,657	2,657	1,348	1,345	131
Apr	720	16,468	2,544	2,544	1,568	1,549	122
May	744	11,196	2,461	2,461	1,519	1,478	118
Jun	720	7,349	2,431	2,431	1,651	1,530	109
Jul	744	5,540	2,461	2,461	1,528	1,335	95
Aug	744	6,335	2,544	2,544	1,250	1,160	94
Sep	720	9,919	2,657	2,657	953	948	102
Oct	744	16,754	2,770	2,770	647	644	119
Nov	720	23,418	2,853	2,853	354	350	130
Dec	744	27,639	2,884	2,884	158	156	136

Annual Energy Flows

Gross Loss: 146.4 MMBtu

Gross Internal: [illegible] MMBtu
Useable Internal: 23.3 MMBtu
Internal Utilization: 1.000

Gross Solar: 8.7 MMBtu
Useable Solar: 8.3 MMBtu
Solar Utilization: 0.959

Net Heat Load: 114.8 MMBtu

December UA Values and Design Heat Loss

Living Space UA: 491.8 Btu/hr/deg-F
Garage UA: 0.0 Btu/hr/deg-F
Design Heat Loss (70 deg Indoor, 70 deg Garage): 43,278 Btu/hour

The above value is the required heat output of the heating system. However, heating systems are labeled based on Input Btu/hour. The necessary heating system size (input rating, assuming 85% efficiency, and adding a 20% Safety Margin) is:
Necessary Heating System Size = 61,098 Btu/hour

AkWarmCalc ver. 2.0.4.0, Energy Library ver. 4/10/2009

Design Heat Loss

December UA Values and Design Heat Loss

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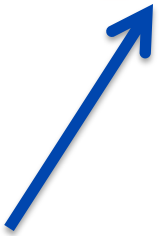

Estimated heat loss at lowest temperatures in your area

Size information is on the unit

101,000 Btu/hour

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Don’t let this happen to you!

- Design heat loss ~ 90,000 btu

- Installed
  - 2 x 420,000 btu boilers
  - 1 X 40,000 btu space heater
  - Total = 880,000 btu

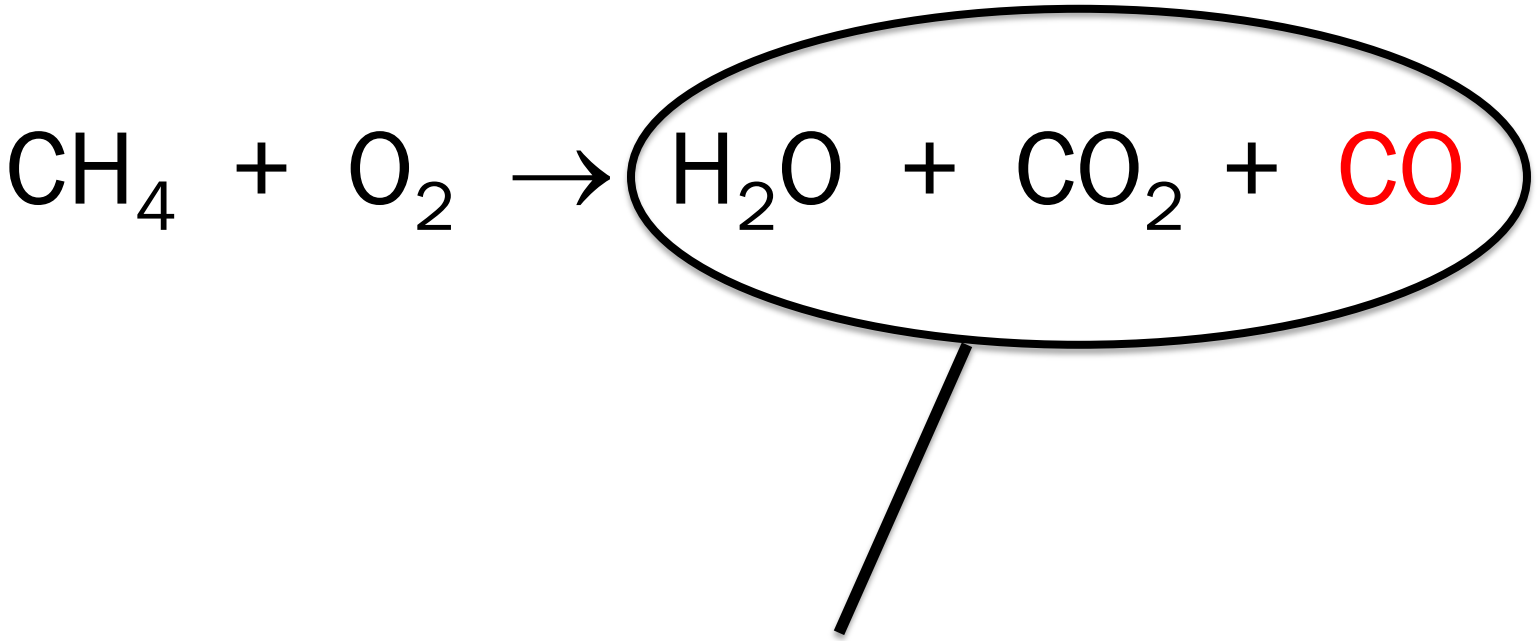
~10x oversize!

Combustion Venting

Recall…

$$CH_4 + O_2 \rightarrow H_2O + CO_2 + CO$$

Recall…

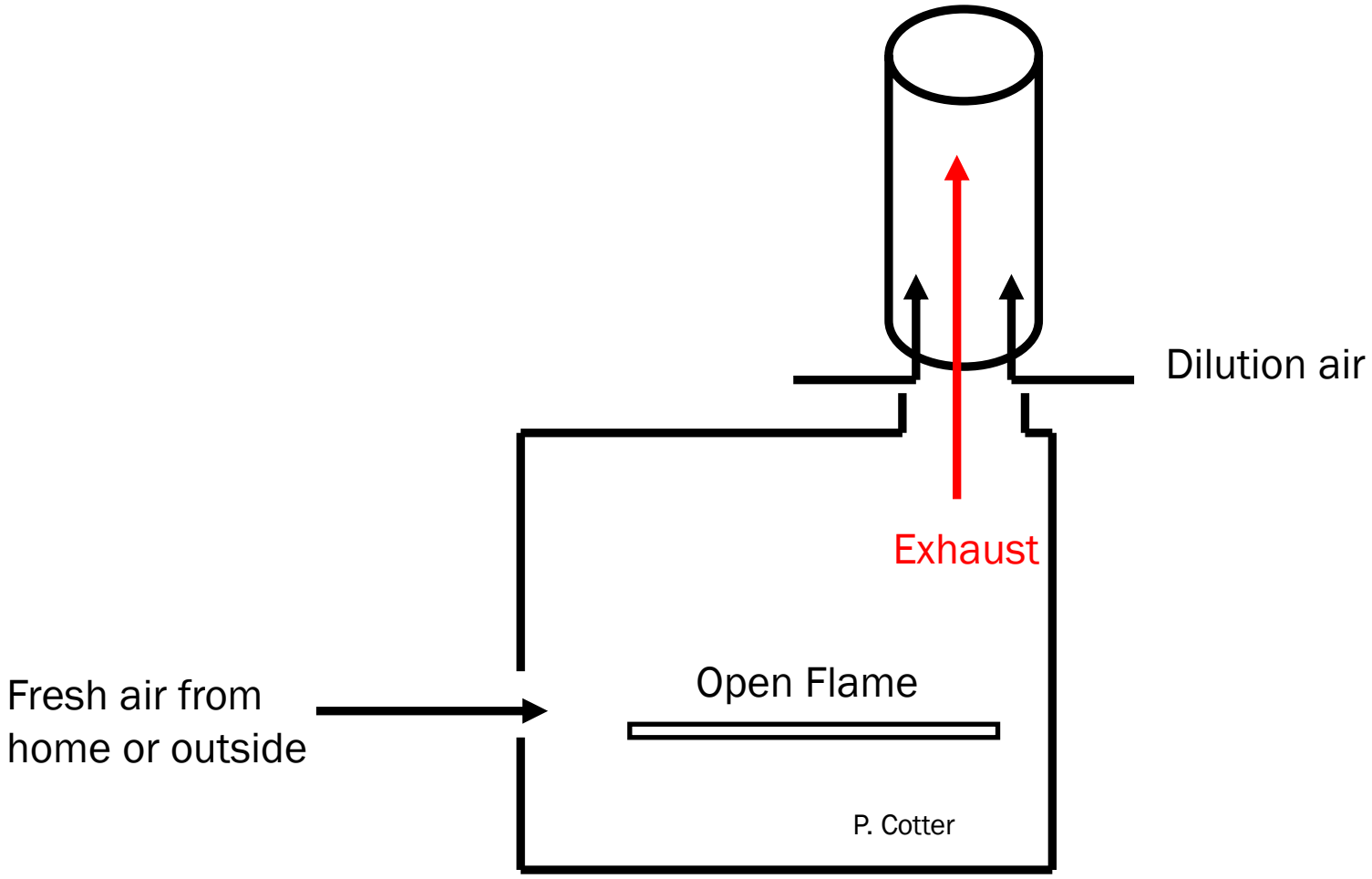


Must be removed from the house by venting

Combustion venting - 3 types

- Atmospheric draft/open combustion
  - Inefficient
  - Easily backdrafted
- Power vented/induced draft
  - More efficient
  - Less easy to backdraft
- Direct vent/sealed combustion
  - Most efficient
  - Resists backdrafting

Atmospheric draft/Open combustion



Atmospheric draft/Open Combustion

Atmospheric draft/Open Combustion

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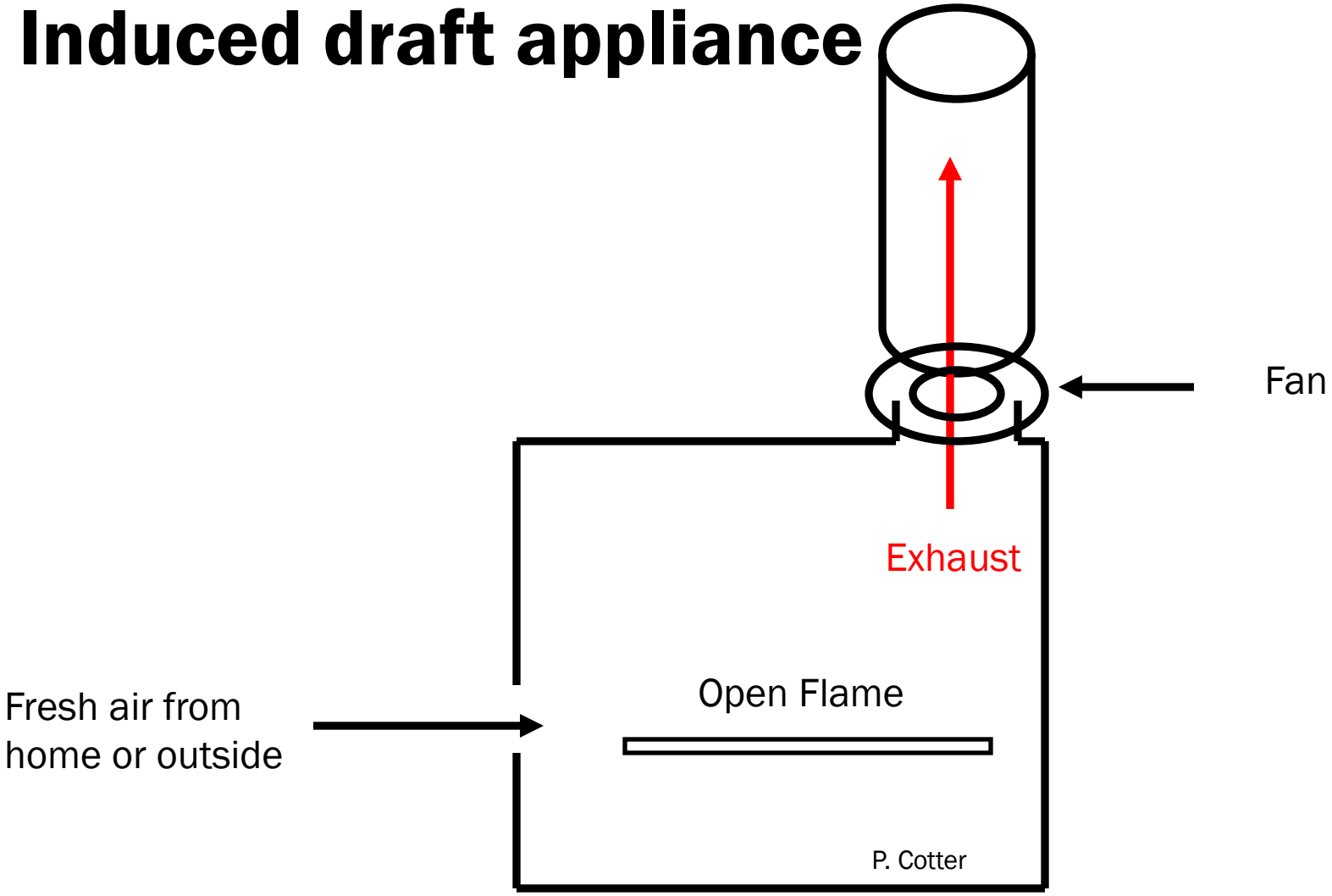
Induced draft appliance

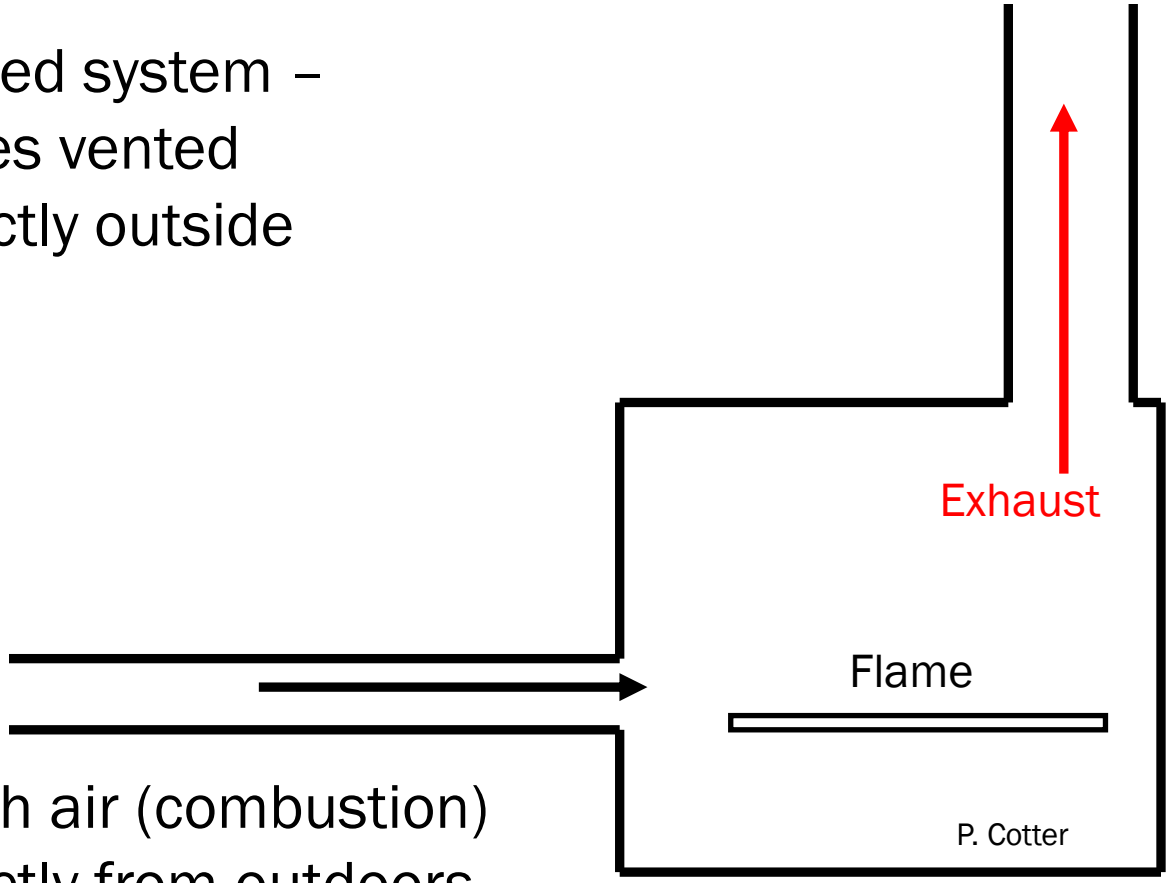


Induced Draft/Power Vented

Atmospheric and Induced Draft Appliances require an independent air source

Sealed combustion appliance

Closed system –
gases vented
directly outside

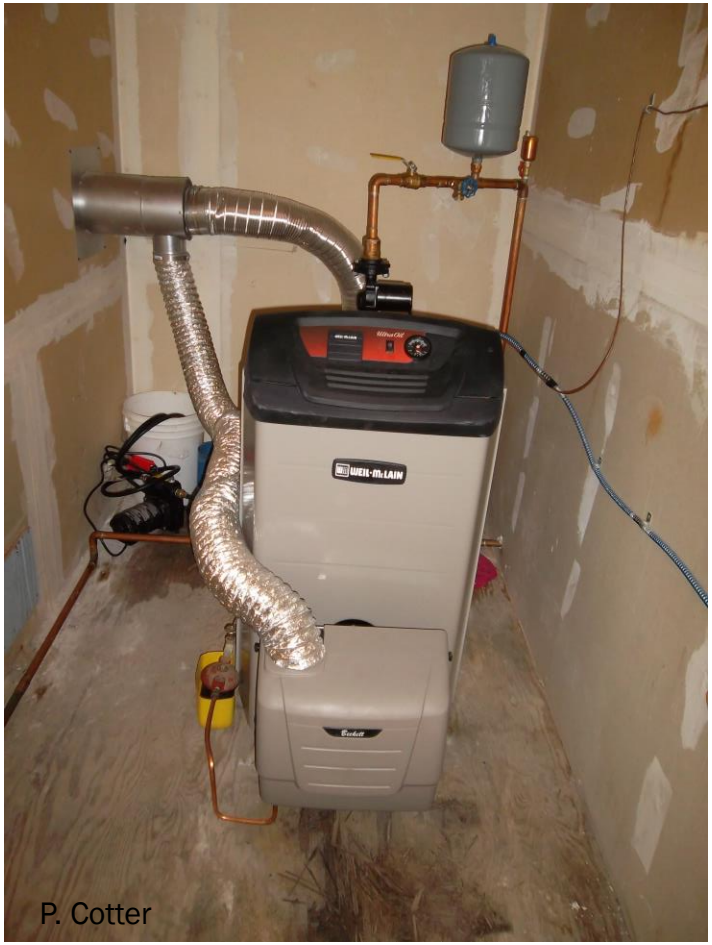


Fresh air (combustion)
directly from outdoors

Sealed Combustion/Direct Vent

Natural Gas

Oil



Sealed Combustion

P. Kaluza

Sealed vs. Open combustion

- Sealed combustion advantages
  - Higher efficiency
  - Safer
  - Doesn't backdraft
  - Cheaper over time
- Open combustion advantages
  - None, really

Caution!

If extensive air sealing is performed, the house MUST be tested for susceptibility to backdrafting

Heating System Controls

Thermostat

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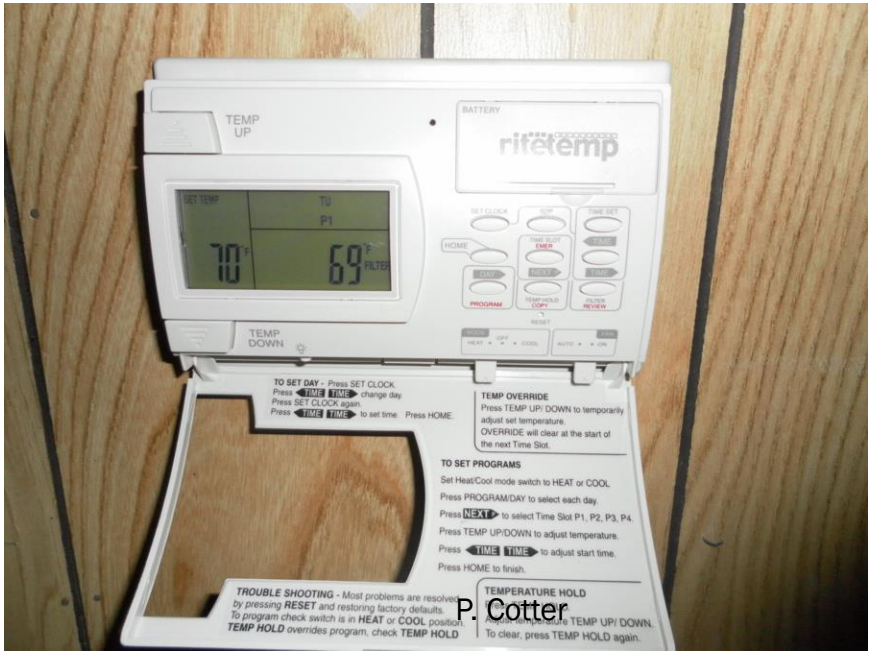
Yesterday

Today



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Programmable Thermostat

- Combined clock/thermostat
- Setback temperature when away from home and/or during night
- Work best with regular occupant schedule
- Only saves energy if you program it

Modulating Aquastat

- Used with boilers
- Adjusts output temperature of boiler depending on outdoor temperature

Summary

- Variety of fuels and heating systems
- Regular maintenance is key for safety and performance
- Backdrafting can occur with open combustion appliances
- Modern controls help save energy

Resources

- AHFC - Research Information Center
- Alaska Residential Building Manual
  www.ahfc.us
- Cold Climate Housing Research Center
  www.cchrc.org
- One stop shop for AK Energy Efficiency information
  www.akenergyefficiency.org