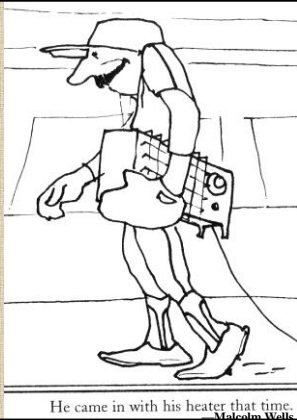


Residential HVAC

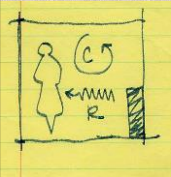
- Heaters
- Coolers
- Ventilators



He came in with his heater that time. Malcolm Wells

1

Just two ways to deliver heat or coolth...



- Convection/conduction**—
- By heating air which heats people
 - By cooling air which cools people
- Radiation**—
- Warmer objects radiate heat to people
 - Cooler objects draw heat from people



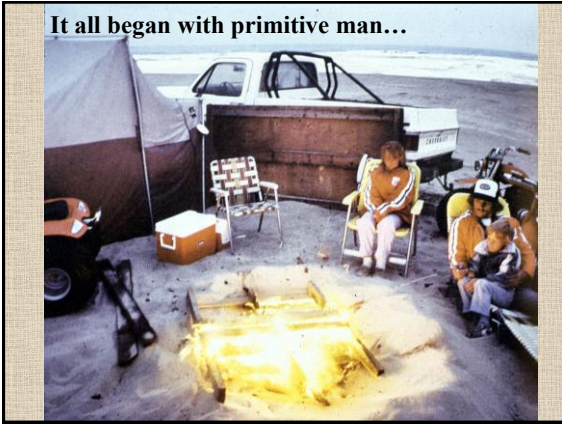
2

Matrix of Choices:

	Heating Sources	Cooling Sources
Radiant	Fireplaces/Stoves	Chilled Beams
	Boilers/Water Heaters	
	Ground/Air-to-Water Heat-Pumps	
Forced-Air	Furnaces	Air-Conditioning
	Ground/Air-to-Air Heat-Pumps	

3

It all began with primitive man...



4

...bringing the fire indoors...



5

A chimney is a stack ventilator...



warmed air from fire rises through chimney

$$Q = 9.4 A \sqrt{h \Delta T} \quad (\text{same formula solving for } Q)$$

where A = area of fire (ft^2)
 h = height of stack
 ΔT = between air at top of stack and room temp



...or Hot Air, Cold Back

6

The Greeks were among the first to try to solve this problem...

The Hypocaust through History

Heating buildings by radiant floors, known from below, is not new. Archaeologists have found examples that predate the Christian Era by centuries.

The kings of Assyria used under-floor channels to heat their palaces in the southwest of Anatolia (Turkey) some 1200 B.C. Similar systems were discovered in northern China and Tibet. At Ti-Kang and Kao-Kang they heated their sister beds from below.

A Roman oyster fisherman, Gaius Sergius Orata, rediscovered central radiance-floor heating about 80 B.C. and used it to heat Roman baths. He did this by circulating hot air and smoke from a combustion chamber through a network of under-floor chambers, thus heating the floor mass in the process. Later Roman builders copied the expression "hypocaust" from the Greek meaning heating from below and applied it to heat entire buildings.

7

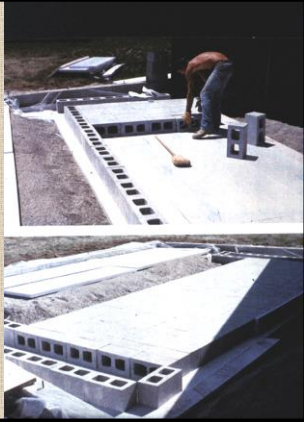
While half a globe away the Chinese k'ang was similar...

8

Back to the future...

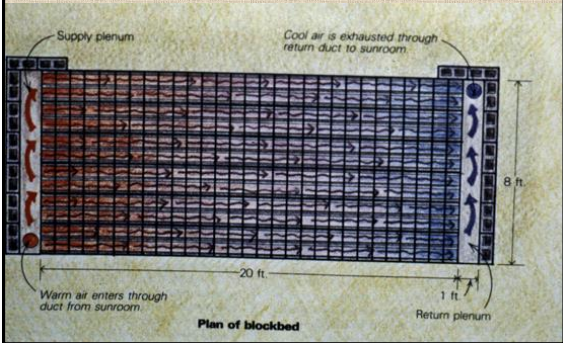
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Solar Hypocaust
...airflow thru
CMU cores

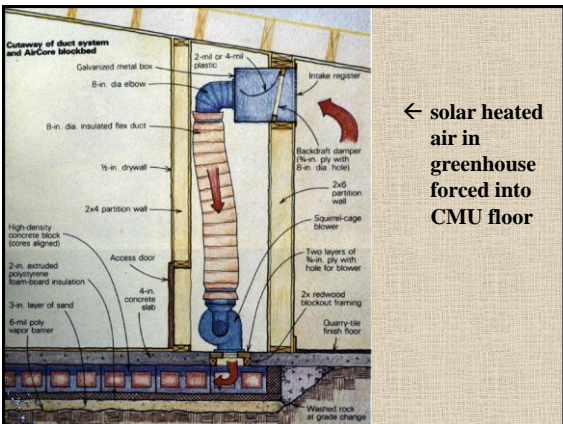


10

Use the block cores as ducts and blocks as
thermal mass...



11



12

Modern heatalators also aim to solve the chimney problem... Add convection air to the radiation of the fire.

Concealed inside concrete mass is simple, double-wall steel firebox. Styrene foam and wood spacers kept vents and firebox openings clear while concrete was poured

MARCH 1987

13

Rüegg Heatflame™ a totally New Fireplace concept from Switzerland. Use your Fireplace as

- a Powerful hot air Heater with elegant glass doors – or
- a Traditional Open Fireplace with glass doors concealed inside the facing.

Optional facings enable a variety of styles.

14

Tested to UL Standards 127

Neoceram thermoglass doors – opening vertically and horizontally (single face also available)

Dealer Inquiries Welcome!

Heatflame by **ruegg**

RUEGG FIREPLACES, INC.
 8785 Route 100 East
 Brickenden, New Jersey 08807
 FAX (201) 526-9189 Phone (201) 526-0309

I am interested in the Rüegg Heatflame Zero-Clearance Fireplace. Please send me details.

Name/Firm: _____
 Address: _____
 City/State: _____
 Zip: _____ Phone: _____

15



16



17



18


Modern wood stoves

The best have:

- Outside air source
- Enclosed firebox
- Pelletized fuel
- Fireproof surround

Some have


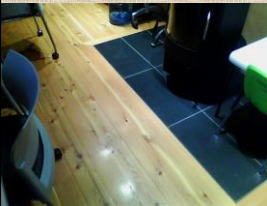

- Heatalators
- A tea pot



19

Revely Classroom Bldg. @ UI Pitkin Nursery

A wood stove was incorporated into the design. To increase the stove's efficiency, a fresh air intake vent was installed, but not connected to the stove:

20


"I DON'T BELIEVE IT"

...AND THAT'S WHAT YOU'D SAY TOO, UNTIL—

Hey! We're moderne...

- Automatic heat
- Cheap
- Clean
- Easy
- Coal Burner

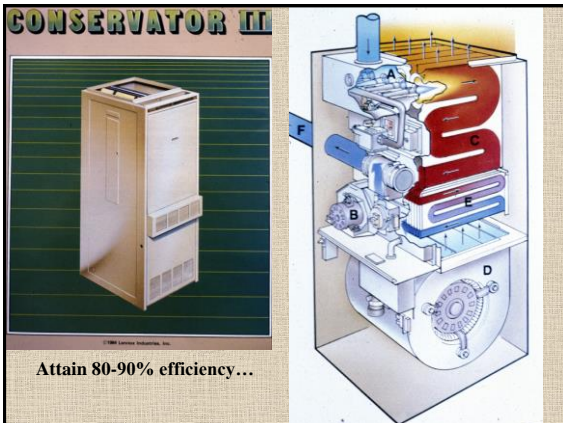
—American Home 1937



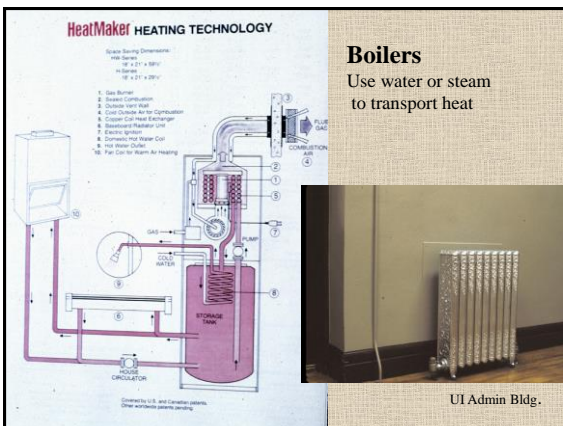
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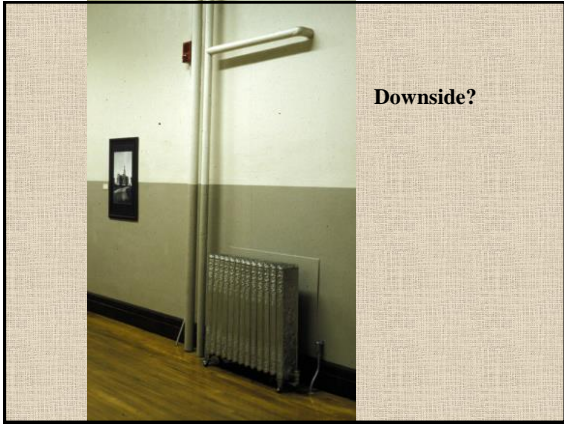
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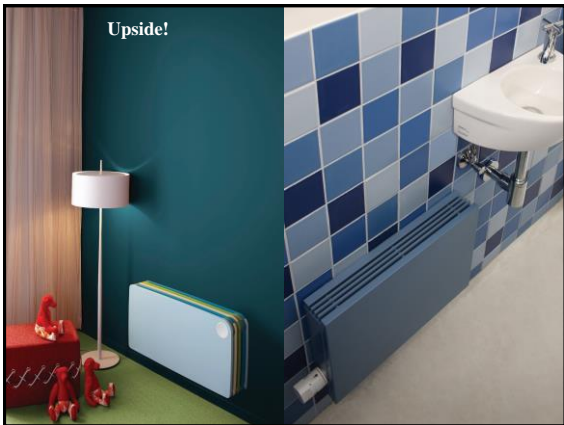
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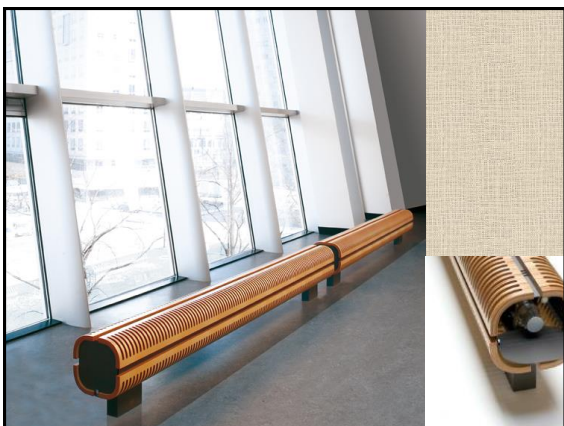
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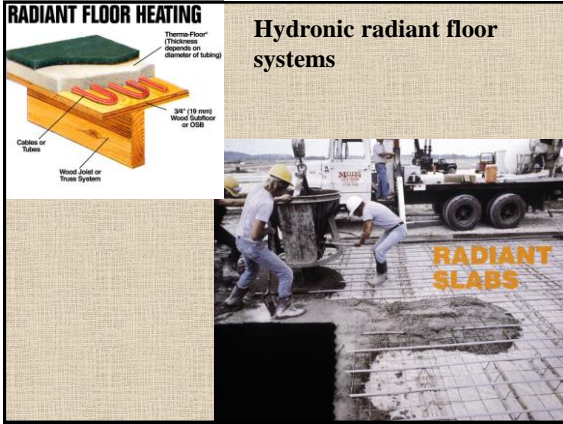
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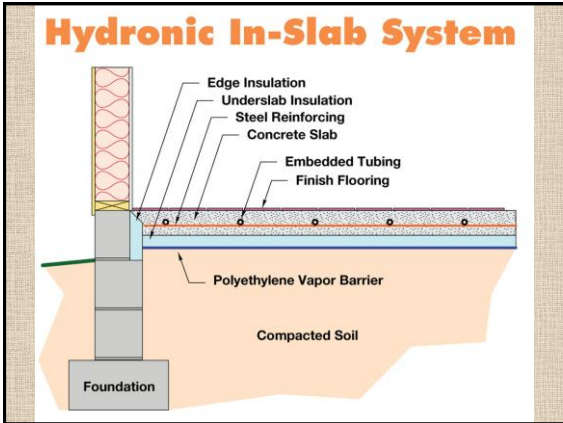
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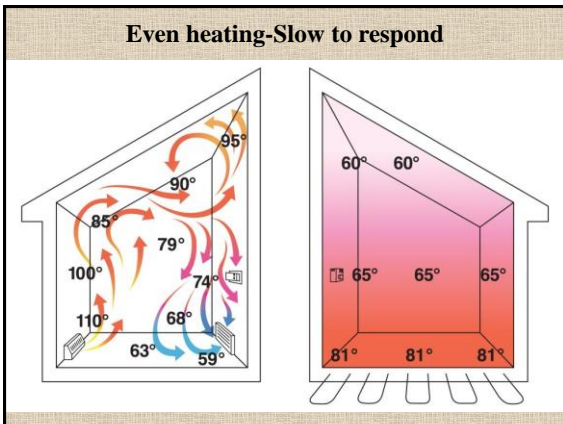
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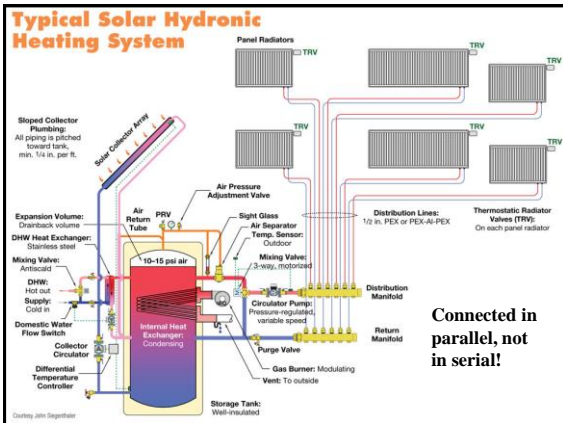
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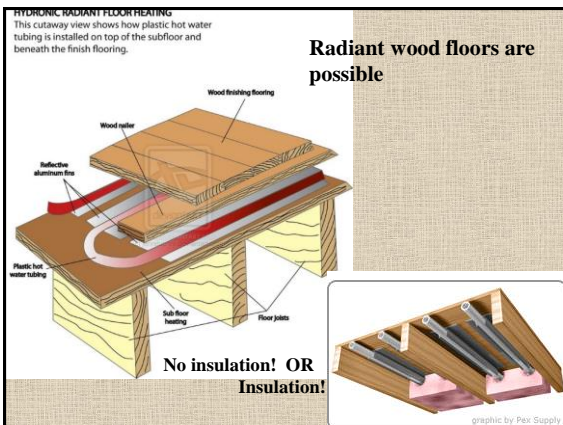
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31



32



33



Coil placement strategies

34



Insulated!

35



Swamp (Evaporative) Coolers
• Require hot, dry air

36

Central air-conditioning

- Ducted
- One-way heat pump w/indoor and outdoor components (compressor & condenser)

37

Heat Pumps heat and cool

Heat pump heating and cooling side by side

- Air-coupled
- Water-coupled
- Ground-coupled (up to 320% efficient)

38

When does it pay to replace a furnace/boiler with a heat pump?

HEAT PUMP EMISSIONS SAVINGS: SHORT-TERM GRID

HEAT PUMP EMISSIONS SAVINGS: LONG-TERM GRID

Answer: Almost always!

39

Window and wall mounted units (exterior clutter)



40

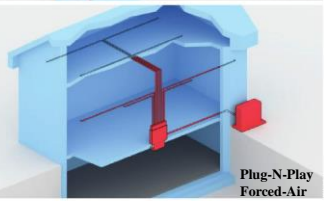
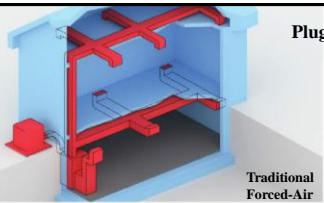
Ductless wall-mounted heat pumps (interior delight)

Forced-air



41

Driving high-performance Traditional systems (right) often are inefficient and result in increased energy. Plug-N-Play Systems (left) are designed to serve a localized system of matching ducts.



Plug-N-Play Systems

< Size ducts

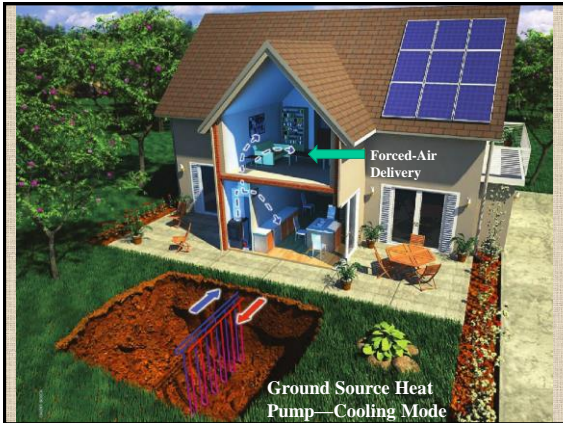
Vs.

< Count ducts

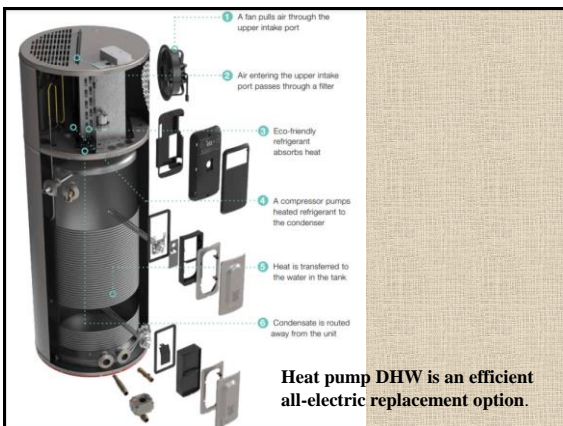
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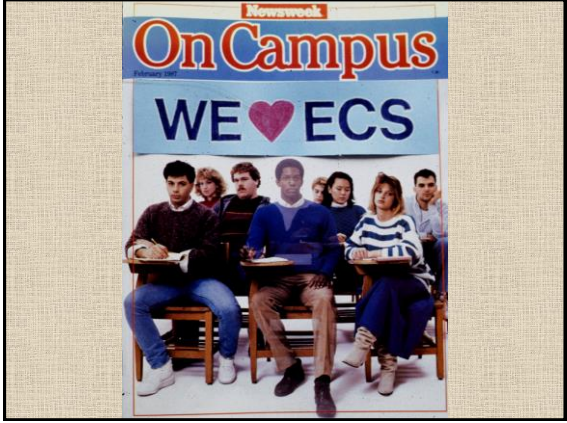
First cost is steeper, but operating costs are significantly lower.

SEE HOW PROTERRA STACKS UP AGAINST OTHER WATER HEATERS*

	PROTERRA HYBRID ELECTRIC WITH LEAGUARD	STANDARD ELECTRIC	STANDARD GAS
SIZE	ProTerra Annual Operating Cost	Electric Annual Operating Cost	Natural Gas Annual Operating Cost
40 Gallon	\$104	\$419	\$208
50 Gallon	\$104	\$419	\$208
5 Operating Modes	✓	X	X
10-Year Warranty	✓	5-Year	6-Year
Water Leak Detection	✓	X	X
Auto Water Shut-off	✓	X	X
Energy Saving Scheduling	✓	X	X
Local Utility Rebates	✓	X	X
Federal Tax Credit	✓	X	X

*Based on comparison of the 50-gallon Hybrid Electric model against the estimated annual operating cost of a standard electric water heater of the capacity manufactured prior to 2016 under ENERGY STAR which is being replaced. Energy varies per gallon capacity. Based on review of available residential electric water heaters. Payback based on cost of product initial compared to alternative product initial, and estimated annual energy cost savings. Based on internal testing and the ENERGY STAR cost for peak/off peak pricing and season difference. NSF International connection and Proterra EcoFit App required. Connection between water heater and app dependent on external factors beyond Proterra's control. Based on NSF International connection and Proterra EcoFit App required. Connection between water heater and app dependent on external factors beyond Proterra's control. Based on NSF International connection and Proterra EcoFit App required.

46



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