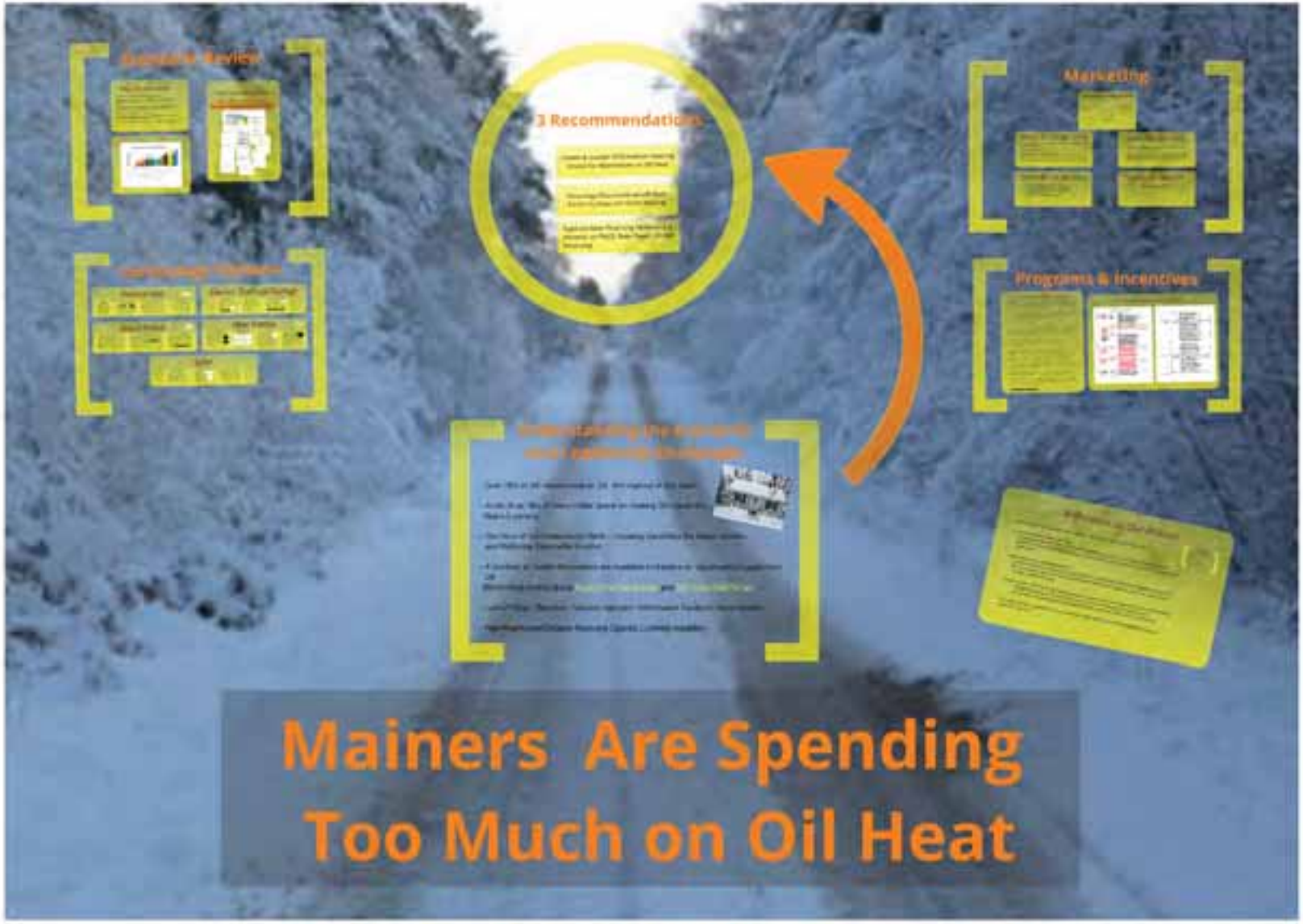

http://prezi.com/iwlsbwptgcbi/team-yellow-full/

or go to prezi.com and search Tau Team Yellow

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Understanding the Economic and Leadership Challenges

- Over 70% of ME Homes Heat w. Oil - the Highest of Any State
- As Much as 78% of Every Dollar Spent on Heating Oil Leaves the Maine Economy
- The Price of Oil Continues to Climb -- Creating Hardships for Maine Families and Reducing Disposable Income
- A Number of Viable Alternatives are Available to Replace or Significantly Supplement Oil

  We're most excited about Electric Thermal Storage and Mini-Split Heat Pumps
- Lack of Clear, Objective, "Solution Agnostic" Information Paralyzes Many Mainers
- Few Progressive/Creative Financing Options Currently Available

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Technology Options

Natural Gas

NG Basics

Distribution in ME

In the Home

Cost Considerations

Electric Thermal Storage

ETS Basics

In the Home

Cost Considerations

Wood Pellets

Pellet Basics

Home Considerations

Cost Considerations

Heat Pumps

HP Basics

How They Work

In the Home

Cost Considerations

Solar

Solar Basics

In the Home

Cost Considerations

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NG Basics

- Natural Gas = Predominantly Methane (different than propane or LP)
- Non-renewable fossil fuel, but cleaner and cheaper than oil + sourced from North America (85% US)
- Saves money for Maine homes, but doesn't keep $$ in Maine.
- Only used in about 5% of Maine homes, compared to over 50% national, but street level pipelines slowly expanding.
- New interstate/transnational pipelines, more affordable eastern sources shale gas (accessed by fracking), and consumer demand in the face of oil prices are driving expansion.

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Distribution in ME

Three gas companies:

- Unitil (www.unitil.com)
- Bangor Gas (http://www.bangorgas.com/)
- Maine Natural Gas (http://www.mainenaturalgas.com/)

Currently offer some street level service in the following communities:

Auburn, Bangor, Biddeford, Bowdoin, Brewer, Brunswick, Cape Elizabeth, Cumberland, Eliot, Gorham, Gorham, Kennebunk, Kittery, Lewiston, Lisbon, Lisbon Falls, New Gloucester, North Berwick, Old Orchard Beach, Old Town, Orono, Portland, Portland, Saco, Sanford, Scarborough, South Berwick, South Portland, South Portland, Topsham, Veazie, Wells, Westbrook, Windham, York.

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In the Home

- Best for central heat, not supplemental. Consider also switching hot water, dryer, range, etc.
- Conversion kits available for many oil furnaces/boilers but these do not increase efficiency.
- For new boilers/furnaces, look for a sealed combustion, high efficiency, condensing units. Pulse combustion burners are also an option (though can be noisy). Dual fuel burners are also an option where NG is imminent or to maximize long-term flexibility.
- In condensing boilers, temperature of return water impacts efficiency so combine with outdoor temperature reset (to modulate combustion level in shoulder seasons) and/or domestic hot water.
- Most new boilers are smaller than existing and can be used with existing hot water baseboard or ductwork.
- May need new drainage pipe and changes to exhaust venting (can be done directly through outside wall) but household disruption is typically minor. Bringing natural gas from street to home can be expensive and requires digging of yard.

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Cost Considerations

Installation costs variables include:

- size/efficiency of home
- options selected (conversion, conventional vs. high efficiency condensing, combination heat/hot water, etc.),
- installation charges, distance from street, incentives/allowances offered by distributor.

Conversions are estimated between $2000-5000 and replacement $8000-12000.

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Natural Gas Brief

Overview – (good background resource: http://www.naturalgas.org)

Natural gas is a combustible mixture of hydrocarbon gases (predominantly methane) that can be used in a growing variety of residential applications. It is a non-renewable fossil fuel but currently has several advantages over oil (although many oil companies do refute these advantages, i.e., http://www.cnbrown.com/oil_oil_gas.aspx). Natural gas is predominantly domestically produced (~85%), with most of the balance coming from Canada; fuel dollars spent on natural gas are still "leaking out of Maine." Burning natural gas gives off a great deal of energy and fewer emissions than other fossil fuels. It is currently less expensive per BTU than oil or propane (though more expensive per BTU than wood pellets).

Natural gas extracted through drilled wells that access deposits deep below the earth's surface. After extracting, natural gas is refined to remove impurities and separate out ethane, propane, butane and pentane for sale separately. Refined gas is transported via thousands of miles of pipelines to "city gates" and from there delivered to its point of use by local distribution companies. Distribution costs typically make up about half of natural gas costs for households and small volume customers

Currently, U.S. reserves represent about 4% of worldwide and are estimated to be sufficient to meet domestic demand for at least 75 years (unclear how much rising demand is factored into forecast, but certainly longer than the life of any boiler/furnace). Canada's vast gas reserves, coupled with its relatively small population and the interconnectedness of U.S. and Canadian pipeline systems, play an important role in stability of long-term supply. Some imported liquefied natural gas (LNG) comes to the U.S. from Trinidad and Tobago, Qatar, and Algeria, Nigeria, Oman, Australia, Indonesia, and the United Arab Emirates.

Natural gas has been used for centuries around the world (documented in 500 B.C. China). The first commercial use began in 1785 in Britain for lighting streets and homes. Use in the U.S. began in 1816 with gas lighting of streets in Maryland. Throughout the 19th century companies such as Lewiston Gas Light Company here in Maine produced natural gas from coal and piped it locally for lighting of streets and homes. The invention of the bunsen burner in 1885 opened the door for safe use in cooking and home heating. Construction of more expanded pipelines began in the 1920s and continued in thru the 1960s.

Venting or flaring (burning) of excess natural gas occurring as a by-product of oil production was common practice through the 1970s but has declined significantly as a function of increased demand and climate change concerns (worldwide practice still "wastes" roughly equivalent to 20% of total US consumption annually). Market volatility in the 1970s-80s had a dampening effect on interest in natural gas, but recent improvements in technology for detection and extraction (opening up new regions for natural gas production), combined with regulatory changes, escalating oil prices, and climate change concerns have reinvigorated the natural gas market. The 1990's saw an increase in electric power generation from natural gas, causing demand to grow substantially (and smoothed out seasonal peaks), which in turn focused the industry on technological improvements and enhanced interstate/transnational pipelines. The relatively new and controversial practice of "fracking" (hydraulic fracturing of underground geology using high pressure injection of water, chemicals, and sand) has

opened up new shale gas reserves throughout the country, including the eastern U.S. (as well as around the around the world).

Today, residential use makes up about 21% natural gas usage in the United States, predominantly for heating and cooking. Over 50% of homes in the U.S. are heated with natural gas, and it is very common in new construction. It can also be used for space heaters, clothes dryers, pool and jacuzzi heaters, fireplaces, barbecues, garage heaters and outdoor lights, and even air conditioning. "Distributed generation" technology, while still in its infancy may someday allow natural gas to be used to generate electricity right at the doorstep to power smaller appliances. It is also used in a compressed form (CNG) to power vehicles (mostly municipal at this point although there are conversion kits available for some cars).

Most forecasts predict that residential natural gas prices will increase slightly over the next 20 years, but much is remains unknown about how deregulation and resulting competition will impact prices for good or bad over the long term. Similar to other competitive commodity markets, prices reflect the ability of supply to meet demand at any one time. Rising costs of oil, climate change concerns, technology advances that increase range of natural gas powered appliances and pipelines that bring gas to new geographies may all contribute to a significant increase in demand (moderated somewhat by the increased efficiency of appliances). The time required to acquire new leases, secure permits, conduct exploratory seismic work, drill wells, and connect pipelines limits how quickly suppliers can response to increase demand. Conversely, shutting off existing wells doesn't make sense for a variety of reasons, making supply from existing wells somewhat inelastic to changes in prices. These factors can lead to price volatility. In addition, because many new reserves (accessed by fracking) occur in areas unfamiliar with energy extraction, emotions are running high and there is much over controversy over environmental, health, and community impacts (just released EPA study: http://www.epa.gov/region8/superfund/wy/pavillion/EPA_ReportOnPavillion_Dec-8-2011.pdf). As advocacy efforts on both sides of these issues come to head, it is reasonable to assume that prices may be affected.

General pro/cons —

Generally, for homes where natural gas is available, this is a sound, seemingly cost effective, option with few downsides. The major barrier to widespread adoption remains access to street-level gas lines outside of major urban areas (**Question: will CNG ever become an alternative for rural areas? Why isn't this used for heating?)**

For some, the use of any fossil fuel or non-renewable resource is repellant. Those who are uncomfortable any risk of price volatility may also wish to consider other alternatives (although prices of natural gas are highly likely to remain below that of oil, long term impacts of deregulation and rising demand are unknown).

Most new furnaces/boilers have a digital interface that can prove daunting for some homeowners.

Homes with significant set-backs (in excess of 100 ft) may find street-level access excessively expensive (most gas companies charge by the foot and those offering incentive program have "allowances" of <100 ft depending on anticipated usage) or disruptive to landscaping.

Current Usage —

Natural gas is used widely used worldwide. As of 2009, over 50% of U.S. homes were heated with natural gas and the majority of new home construction using this option (less than 1% of new construction chooses oil, almost exclusively in regions where natural gas is not an option). Until recently, natural gas was severely limited in ME and not price competitive, because we were at the end of the pipeline. Sources of shale gas on the east coast and in nearby Canada have changed this. Street level gas lines are increasing many urban neighborhoods across the state.

Advances in high efficiency condensing units, coupled with research to establish that their reliability and longevity compares favorably to conventional systems, have increased use worldwide (previous common misconception is that corrosive natural of flue gases/condensate decreased life expectancy — use of corrosive resistant materials mitigate this).

Differences/options –

(good sources of information on tech
http://www.energysavers.gov/your_home/space_heating_cooling/index.cfm/mytopic=12530
http://oee.nrcan.gc.ca/publications/residential/heating-with-gas/39)

Many existing boilers/furnaces can be converted to natural gas, reasonably easily (especially newer boilers). It is worth noting that conversions, while likely to decrease costs (as a function of difference between oil and natural gas price), do not in themselves usually increase efficiency of existing system. As result, these conversions may not be eligible for federal rebates or special financing. In some cases, additional modifications or retrofits can be made to increase efficiency. Costs of conversion and any modifications need to be carefully weighed against remaining lifespan of unit (and program eligibility) to understand whether replacement is more cost effective option. It is necessary to understand if retrofits will meet codes and if they are likely to cause long term damage to boiler (i.e., cast iron boiler parts are not well suited for exposure to corrosive condensate from flue gases).

All new furnaces (hot air) are required to have a minimum efficiency of 78% and all boilers (hot water) must have a minimum efficiency of 80%. To achieve an energy star rating (a criteria for many special financing/incentive programs) both boilers and furnaces must be at least 90% efficient (and a minimum of 95% efficiency is required for eligibility in some programs).

There are a number of brands, models, and variations among new natural gas boilers/furnaces but they fall into two broad categories**: conventional** and **high efficiency condensing** units. Both options typically allow for integrated domestic hot water and with high efficiency condensing units this is often a preferred option to realize maximum efficiency.

The major difference between these designs is the addition of a second heat exchanger in condensing units to extract heat from flue gases (producing condensate, hence the name). Almost all energy star rated furnaces/boilers are condensing units, with only a few conventional furnaces/boilers achieving this status (through use of modulating burners, induced exhaust, more efficient blowers/pumps, etc.). High efficiency condensing units are more expensive than conventional units but can result in significant savings over the life unit.

Most modern gas appliances use an electronic ignition rather than a traditional pilot light and many use modulating burners (burn higher or lower depending on about of heat actually needed). Heat produced

by the burner is stored in a heat exchanger. Air or water is heated by the exchanger then blown into the ducts or pumped through the pipes of the central system. Cooler air is then drawn into the return duct or water returned to the boiler to be heated again until the desired temperature is reached. Air can be passively draw into the flue for venting, where it mixes with the hot gaseous by-products and is drawn outside or it can be induced with a fan, improving burner efficiency.

Although a condensing boiler may be rated as 90% efficient, it is unlikely to achieve this level of efficiency in real life hot water baseboard or radiator application with a plug and play installation. The temperature of the return water will often exceed 130° F, the maximum temperature to allow condensation of flue gases and thus 2nd level heat exchange to occur (return water temps in a radiant floor application may be close to optimal levels). This can be remedied by using one of a number of set-ups to remove excess heat before the water returns to the boiler. A common technique is the use of an outdoor temperate reset gauge that tells the burner to heat the water to a lower temperature during milder periods (e.g. spring and fall) when the home will lose less heat. Another option is integrating a hot water system that uses excess heat in the return water to passively pre-heat domestic hot water.

As homes are "tightened-up" through improved weatherization it is important to consider risk of back-drafting combustion gases when other appliances (dryers, bathroom fans) are exhausted. **Sealed combustion** units bring outside air directly in to the burner and exhaust flue gases directly to the outside, eliminating the risk of introducing gases into the home.

At some point in the future tiny distributed micro heaters (at each register) the size of a deck of card may replace the centralized systems we know today. This type of design developed by the Pacific Northwest National Laboratory promises to eliminate the thermal and electrical losses central systems, which can easily account for a quarter of their operating costs.

Who in Maine is working with them –

Maine has three natural gas distributors which can provide a starting point for homeowners:

Unitil (was Northern Utilities until a few years ago) www.**unitil**.com
Bangor Gas http://www.bangorgas.com/ (owned by Energy West)
Maine Natural Gas http://www.mainenaturalgas.com/ (owned by CMP parent Iberdrola)

There are numerous installers throughout Maine who are knowledgeable about products. Revision Heat http://www.revisionheat.com/ seems to be an excellent source of information and a thought leader in oil alternatives.

External decision factors –

The single most important factor decision factor is whether natural gas is currently available or anticipated in your neighborhood. Natural gas spurs are being developed in a number of Maine cities and towns, but it remains cost prohibitive for distribution companies to provide street level access in areas where homes are widely spread out or where a majority of homeowners are not ready to convert. For most of rural Maine, it is unlikely that natural gas will be an option at any point in the future.

Those replacing appliances, in areas where natural gas is not yet available, but anticipated, might consider **dual fuel appliances** (fairly common) or those that allow easy conversion.

Whole house/supplemental –

While natural gas space heaters are available, whole house heating is the more likely scenario.

Indeed, the best case is where multiple appliances (furnace/boiler, hotwater, range, dryer, etc.) can be replaced/converted simultaneously. This maximizes fuel savings and likelihood that the distribution company will cover the majority of cost to bring natural gas from street to home.

It is unlikely that one would bring natural gas into a home solely for supplemental heat (or that a distribution company would runs the lines for such limited use without seeking upfront costs from homeowner). In rare instances where natural gas was already in use for other purposes, natural gas space heaters might be used as supplemental heat where capital costs prohibit boiler/furnace conversion or replacement.

Natural gas could serve as a "back-up" or supplement to other oil alternatives (e.g., heat pumps), but ability to recover capital costs of multiple new systems is questionable.

Integrate with existing infrastructure –

In most instances, natural gas furnaces/boilers can be integrated with existing home wide infrastructure (baseboard hot water, radiators, in floor heating, force air duct work, etc.). Some modifications may be needed to maximize efficiency (with hot air ducts significant efficiency losses occur if not properly configured and sealed) but full replacement in most homes would not be required or cost efficient. Modifications/improvement of existing infrastructure may be desired to improve efficiency (e.g. sealing duct work)

Space & Home Modifications

Changes inside the home are usually minor and not disruptive. Most new high efficiency natural gas boilers/furnaces are quite small, requiring less space than conventional oil burners (often about the size of a kitchen cabinet). Many can be wall mounted and vented directly through an exterior wall (usually with PVC pipe); this may necessitate a change in location. Some new plumbing/ductwork may be required if location is changed and/or to maximize efficiency. High efficiency condensing units will need to be connected to a drain, which may require additional plumbing. Because of the corrosive nature of flue gases, a unit vented via a traditional masonry chimney may need a new liner. It is rare unless a home is single story with an unfinished basement (to provide access to pipes/ducts) that a change from hot water to forced air or vice versa, would be considered.

Bringing natural gas from street to home will require digging in the homeowners yard. Depending on distance and substrate this can be minor task or cause significant disruption (though usually short-lived) In some cases hook-up is done by boring an underground tunnel and in some cases it means digging and recovering a deep ditch across the yard.

On-going maintenance –

Because natural gas is clean burning, minimal maintenance is required. Cleaning and testing should be performed annual by a qualified technician.

Qualified install/service –

There are numerous licensed install/service technicians across Maine (distributors can help identify). Selection is a critical part of switching to natural gas, especially with high efficiency units, since they are rarely just plug and play. Efficiency gains can be compromised or even eliminated if not installed correctly. An installer will need to be familiar with the unit of choice (and ideally can advise is selection based on home needs). They will not only install but test and adjust for efficiency. They will need to understand all aspects of the unit (burner, exchangers, plumbing in the case of a boiler, external resets, controller panels, etc.).

Tradeoffs (e.g., heat capacity, control) –

Homes converting to natural gas should see very little difference in heat vs. oil except in cost. Some systems featuring combined hot water capacity may see a limit flow of hot water that can be simultaneously drawn from different sources (but not total volume).

Costs –

As of November 28th a conversion to million Btu yields as price comparison of fuels as follows:

Oil - $26.25
Natural Gas - $15.00
Propane - $34.27
Wood pellets - $14.30
Cord wood $11.25

Installation costs variables include:

- size/efficiency of home,
- options selected (conversion, conventional vs. high efficiency condensing, combination heat/hot water, etc.),
- installation charges
- distance from street, incentives/allowances offered by distributor.

Conversions are estimated between $2000-5000 and replacement $8000-12000.

Pellet Basics

- Pellets are a renewable fuel that is produced here in Maine (among many other states).
- Made from pulverized sawdust (often waste wood) pressurized to form small, uniform and very dense capsule-sized pieces.
- Good option for homes in rural areas without access to natural gas and who want cleaner (functionally and environmentally), more convenient, less labor intensive alternative to cordwood.
- Existing infrastructure in ME can supply at least 10% of Maine homes.
- Can be used for both supplemental (free standing stove – available at hardware or big box home improvement stoves) or central heating (furnace of boiler).
- Boilers/furnaces have become increasingly/fully automated and inclusive of domestic hot water and multiple zones
- Choice of heating unit depends on how much work homeowner wants to do. Small free standing stoves with small hoppers require homeowner to handle bags. of pellets daily. Whole house systems with pellets delivered just like oil and only extra maintenance is ash removal (simple self-contained unit) about 1 x month.
- Some stoves/boilers/furnaces can burn corn, woodchips, or pellets made from other types of biomass (technology is advancing, witness grass pellets being tested in Aroostook county).

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ood Pellets

Home Considerations

- Interior pellet boilers/furnaces sized about the same as conventional boilers and can typically occupy the same space, however the bins used to store the pellets can be significantly larger than an oil tank and will require room for feeder pipes.
- Free standing stoves, while often requiring minimal clearances, typically require some sort of hearth.Can be installed in an existing fireplace, along an outside wall, or in the basement. Pellet stoves require venting which is generally less expensive than conventional masonry or metalbestos chimney.
- Maine Energy Systems seems to be the only company offering bulk deliveries similar to oil (http://www.maineenergysystems.com/index.php), but only within about twenty-five miles of their storage facilities in Bangor, Bethel/Rumford/South Paris, Lewiston/Auburn, Mid-coast, and Portland.
- Revision Heat also seems very knowledgeable about pellet boilers. http://www.revisionheat.com/.
- Can be a problem for those with asthma or who have trouble lifting over 40lbs (unless bulk delivery is available).
- Bagged pellets are widely available (~40lbs each).
- A new pellet boiler/furnace can generally be hooked up to existing hot water baseboard, radiant flooring, or hot air ductwork with minimal changes.
- Conversion kits are available for some boilers/furnaces though not all meet code. Major concerns include decreased efficiency and increased maintenance (maybe not set-up for additional ash production)

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Cost Considerations

- Sparsely used in US except in rural areas, but widely used in residential heating Sweden, Austria and Finland, with rapid growth in a number of others (Germany, France, Italy, Denmark, Belgium and Norway).
- Currently, there is an ample supply of pellets, but shortages are not unheard of – European shortages initial driver for U.S. manufacture. ME saw shortages in 2008 (though production did catch up).
- A typical pellet stove will cost between costs from $1700 to $3000 (though higher end stoves are certainly available and you get what you pay for in terms of aesthetics and to some degree function).
- A fully automated pellet boiler can be around $15,000 (not including installation).
- According to Maine Energy Systems "A home that burns 1,000 gallons of #2 heating oil would burn approximately 7.5 tons of premium wood pellets." Bagged pellets are currently selling going for about <$250 ton (roughly equivalent to $2.05/gallon of oil.
- Cost savings Calculator http://www.maineenergysystems.com/userfiles/files/PelletsPropaneOil.swf
- Cost Comparison calculator http://pelletheat.org/pellets/compare-fuel-costs/
- Some conversion rates: http://pelletheat.org/pellets/benefits-of-pellets/

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Overview

Wood pellets are made from wood that has been pulverized and then pressurized to form small, uniform and very dense capsule-sized pieces. Sources can be waste wood (or sawdust) from other applications such as lumber production or from trees cut specifically for the purpose. Pellets are a renewable fuel that is produced here in Maine (among many other states). Current projects based on studies by the Maine Forest Service seem to indicate capacity within Maine's forest and processing structure to heat about 10% of Maine homes with pellets.

While burning wood is traditionally thought to produce significant air pollution, pellets with their low moisture content, have very high combustion efficiency, qualifying as low emission appliances. Pellets burn cleaner than cordwood (although modern woodstoves are far clearer than their predecessors), with less ash, chimney deposits, and emissions. Most pellet stoves are at least 78-85% efficient, qualifying for special federal rebate programs, and some reach 90% efficiency. Qualification for special financing programs such as PACE would look for 25% savings space and/or hot water heating which would depend on what solution is chosen (a new whole house system probably would qualify but a small free standing stove in a large home might not).

Pellets can be used as fuel in a variety of free standing stoves, as well as for burners with boilers (hot water) or furnaces (hot air). An ignition element is required to light the pellets (and often can be thermostatically controlled), while an auger connected to an attached hopper or adjacent storage bin feeds pellets to the burner as they are needed.

Good Sources of Info: http://www.maineenergysystems.com/Wood-Pellets.htm
http://www.revisionheat.com/renewable-heating-products/convert-to-wood-pellet-boiler-heat/pellet-stoves/
http://www.fpl.fs.fed.us/documnts/fplrp/fpl_rp656.pdf
http://www.ecoheatsolutions.com/heatingsolutions/woodpelletboiler.html

General pro/cons

Generally pellets can be a good oil alternative for Mainers who do not have access to natural gas. While not as economical as cordwood (especially for Mainers who have access to a woodlot), burning pellets is less labor intensive, provides great convenience/freedom, and can be cleaner (both environmentally and functionally – hauling wood into the home can be messy).

Bulk delivery is still somewhat limited; only offered by Maine Energy Systems within about twenty-five miles of their storage facilities in Bangor, Bethel/Rumford/South Paris, Lewiston/Auburn, Mid-coast, and Portland. Almost all Mainers can access bagged pellets, typically for home delivery by pallet, or at least by pick-up at local hardware or home and garden centers. This means some degree of work managing the pellets – moving ~ 40lb bags into hoppers at some regular interval – which may difficult or undesirable for some homeowners.

While typically cleaner burning than cordwood stoves, burning pellets may be a risk factor for some asthma patients, from the smoke or from the dust if the homeowner needs to handle pellets directly.

Electricity is needed to power auger, ignition, and blowers/pumps (this sometimes can be achieved with a backup battery or generator for power outages).

Noise from blowers in some pellet stoves may bother some homeowners.

Currently, there is an ample supply of pellets, but shortages are not unheard of – indeed one of the initial driving forces for pellet manufacturing in the US was to meet increased demand from European countries. Here in Maine, 2008 saw short-term shortages that frightened some homeowners who had recently purchased pellet stoves/central units (though ultimately, production did catch up with demand). While there has been a steady upward trend in prices over the past couple decades, pellets have not seen volatility of some other fuel markets. Yet, because the most economical production of pellets is from the waste products of other wood products industries, changes in other markets, such as new home construction can have a significant impact on the price of pellets (decreased demand for lumber, means, less quality sawdust available from lumber mills for pellet production).

It is hard to predict how much prices may rise as demand increases (and how capacity responds), though it seems likely that they will remain low enough in the short term for homeowners to recoup capital costs. Maine has strong tradition of forest products industries, but much of our infrastructure has diminished over the past few decades; it's unclear if this could be ramped back up, if demand for pellets increased rapidly and exponentially, exceeding raw materials available from other forest products industries (though to do so could be a boon to the Maine economy).

Current Usage

Although wood pellets as a heating fuel probably originated in the U.S. as early as the 1930, it was the energy crisis of the 1970's that initiated growth in the industry. Today, pellets are widely used in residential heating in several European countries (Sweden, Austria and Finland) with rapid growth in a number of others (Germany, France, Italy, Denmark, Belgium and Norway). Between 2009 and 2020, it is anticipated that European consumption could jump from 8 million tons/yr. to as much as 50 million tons/yr. Pellet use, is still relatively sparse in the U.S. According to the Pellet Fuels Institute there are about a million homes in the U.S. using pellets for some form of supplemental or whole house heating, but this trend has accelerated in the past couple years because of oil price spikes. Domestically, pellets are most common in rural areas.

Recent advances

Most Mainers are probably generally familiar with the concept of a pellet stove (they have been readily available for a number of years, at local hardware stores and big box home supply stores), the concept of whole house heating (including hot water) with pellets is relatively new. Boilers/furnaces, while increasingly common in Europe, are relatively new the U.S. As they become increasingly/fully automated and inclusive of domestic hot water and multiple heating zones, there is an increased perception of pellets as a mainstream alternative to oil.

Differences/options among each category

Pellets heating options fall into three broad categories with a wide range of BTU output and convenience factors within each. One of the major differences is how much work does the home owner want to do? Options range from small free standing stoves with small hoppers where homeowner mush handle bags of pellets to whole house systems with pellets delivered just like oil and only extra maintenance is ash removal (simple self-contained unit) about 1 x month.

Pellet stoves: A simple, widely accepted option, stoves are useful for decreasing oil consumption (sometimes dramatically) but for most homes and homeowners are not a suitable for whole house heating (because of work involved and difficulty heating from a single point source). The exception might be a small, well insulated home (using less than 500 gallon of oil annually) with a very hands-on homeowner. Stoves can be sized to heat a single room or multiple rooms (depending on placement) and their use broadened by combining with a more automated backup system (e.g., keeping existing oil system for use during extended periods away from home).

Interior boilers/furnaces: These whole house units can be either partially or fully automated, and work more like the boilers/furnaces to which most homeowners are accustomed. The major variable is how frequently the homeowner needs to attend to them (to replenish pellets, clean soot, empty ash, etc). The best, fully automated systems, operate almost exactly like a conventional furnace/boiler. Set the thermostat and schedule an automatic delivery of bulk pellets.

Exterior burners: Larger burner units that a located outside the home and pumps heated water into the home through insulated underground piping. A heat exchanger is then used to bring heat to existing baseboard hot water plumbing or forced hot air ducts. These don't seem to be terribly common in Maine for residential use.

Though less common in Maine than in some other parts of the county, fuel flexibility is another factor to consider. In addition to standard pellets, some stoves/boilers/furnaces can burn corn, woodchips, or pellets made from other types of biomass (technology is advancing, witness grass pellets being tested in Aroostook county). Some feel that augers set-up for more than one fuel are more prone to malfunction but there doesn't seem to be concrete data.

Who in Maine is working with them

Maine Energy Systems seems to be the only who is doing bulk deliveries similar to oil. They work with a number of installers.
http://www.maineenergysystems.com/index.php

Revision Heat also seems very knowledgeable about pellet boilers. http://www.revisionheat.com/

External decision factors

Maine has recently reexamined or is considering a number of laws related to pellets – from use of conversion kits, to venting through chimney shared with an oil combustion application. These changes help shape accessibly to of pellets for some homeowners.

Whole house or supplemental or both

With a range of options from small to large pellet stoves to whole house boiler/furnace systems pellets are well suited for both whole house and supplemental heating.

Integrate with existing infrastructure A new pellet boiler/furnace can generally be hooked up to existing hot water baseboard, radiant flooring, or hot air ductwork with minimal changes.

Conversion kits are available for some boilers/furnaces though few technically meet code in Maine, because burner and boiler/furnace would not have been tested together (Q: did legislature recently change this… they were considering it?). Decreased efficiency is a major concern with conversions (and in many cases an older unit may already be operating at less than 78% efficiency) as are increased maintenance. Most oil/propane units are not made to accommodate the ash that results from burning pellets. Laws may also have changed or changes in the work to allow a pellet stove to be vented through an existing chimney shared with an oil/gas furnance/boiler.

Home Modifications/Space Usage

Interior pellet boilers/furnaces sized about the same as conventional boilers and can typically occupy the same space, however the bins used to store the pellets can be significantly larger than an oil tank and will require room for feeder pipes (which have to be a certain angles etc.).

Free standing stoves, while often requiring minimal clearances, typically require some sort of hearth. They can typically be installed in an existing fireplace, along an outside wall, or in the basement. Pellet stoves will require venting which is generally less expensive than conventional masonry or metalbestos chimney.

On-going maintenance

Any pellet system will require more maintenance that what a homeowner may be used to with oil. If bulk delivery is not available, bagged pellets need to be loaded about every week, depending on size of bin/hopper. Many units need to have the heat exchanger cleaned regularly (as often as weekly), a task that because of its frequency falls to the homeowner. Even fully automated systems, require an ash bin to be emptied periodically. In higher end units this is a self-contained unit that is opened similar to many bagless vacuums… no direct contact with ashes or boiler parts. In economy units or free standing stoves, ash removal can be more involved. Annual maintenance by a professional is generally recommended twice a year (as opposed to annual with a fossil fuel appliance).

Some feel that pellet systems are also more complex and have expensive components that can break down – only time will tell with the newer automated boilers.

Installation/service

Maine has a growing number of qualified installers and technicians.

Any tradeoffs in terms of heat capacity, control

This depends on the unit chosen. A fully automated unit operates almost exactly like an oil boiler/furnace in terms of how it heats the home. Less automated systems, or free standing stoves, require more effort and attention on the part of the homeowner. Stoves do not have the all over consistent warmth of a centralized hot water/hot air system (warmer near the stove, colder in more remote sections of the house). This is partially mitigated by adding a blower, but the noise and constant air flow may be undesirable for some homeowners.

Costs, for unit and installation, longevity

A typical pellet stove will cost between costs from $1700 to $3000 (though higher end stoves are certainly available and you get what you pay for in terms of aesthetics and to some degree function). A fully automated pellet boiler can be around $15,000 (not including installation).

According to Maine Energy Systems "A home that burns 1,000 gallons of #2 heating oil would burn approximately 7.5 tons of premium wood pellets." Bagged pellets are currently selling going for about <$250 ton (roughly equivalent to $2.05/gallon of oil.

Cost savings Calculator
http://www.maineenergysystems.com/userfiles/files/PelletsPropaneOil.swf

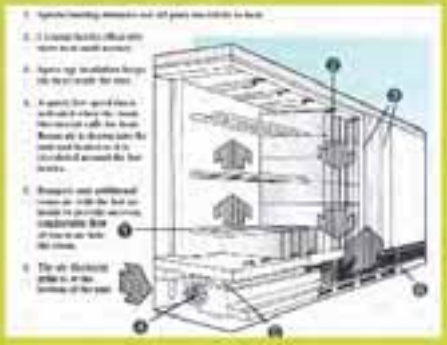
Cost Comparison calculator
http://pelletheat.org/pellets/compare-fuel-costs/

Some conversion rates:
http://pelletheat.org/pellets/benefits-of-pellets/

The current price of pellets $250/ton is roughly equal to oil at $2.05 gallon.

ETS Basics

- Converts and stores energy from variable generation sources (such as off-peak electricity, wind or solar) to heat.
  - ETS system contains electric heating elements within ceramic bricks.
  - Bricks are capable of storing heat for extended periods of time.
- Stores heat for use 24 x 7.
- Environmentally friendly. No smoke or fumes. Clean and reliable.
- Technology is relatively new in USA. Has been around and used in Europe for over 20 years.
  - Steffes (www.steffes.com)
  - Beford Rural Electric Cooperative (www.bedfordrec.com)



- Video at: http://www.heatforlessnow.com/?id=24

Prezi

1. Special heating elements use off-peak electricity to heat.

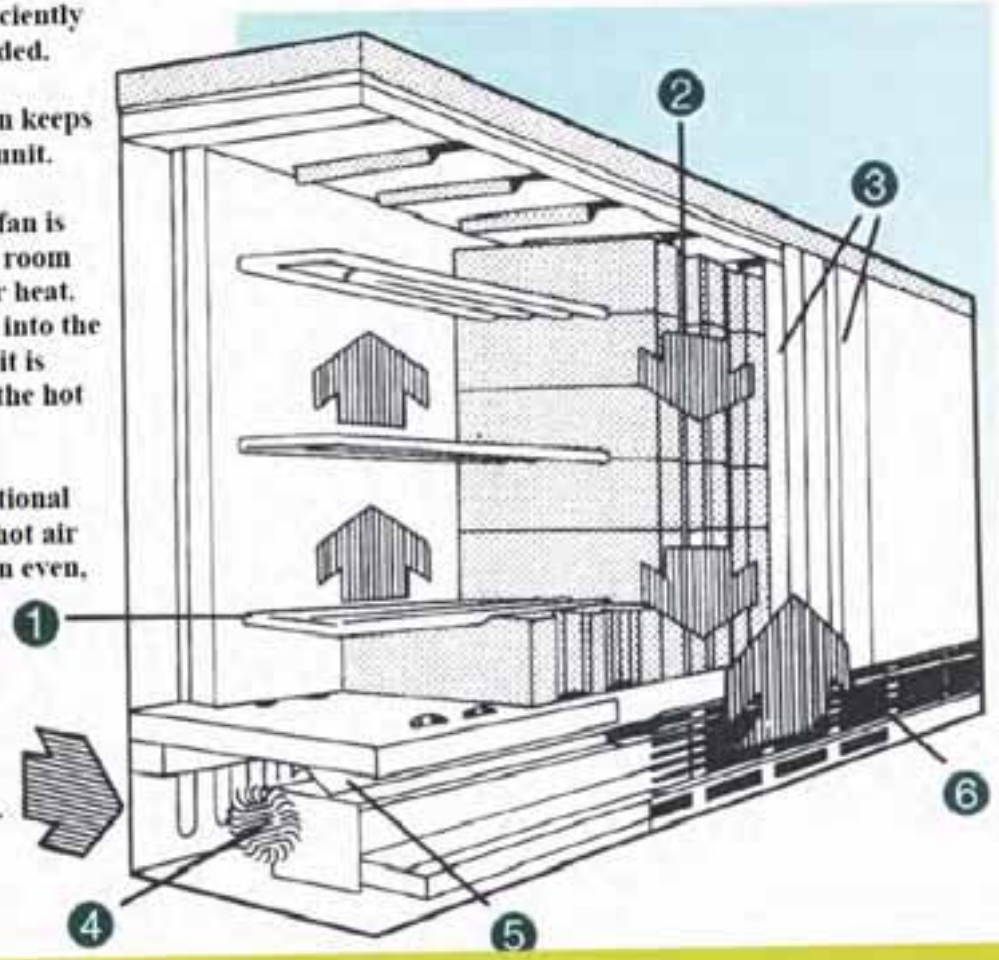
2. Ceramic bricks efficiently store heat until needed.

3. Space age insulation keeps the heat inside the unit.

4. A quiet, low speed fan is activated when the room thermostat calls for heat. Room air is drawn into the unit and heated as it is circulated around the hot bricks.

5. Dampers mix additional room air with the hot air inside to provide an even, comfortable flow of warm air into the room.

6. The air discharge grille is at the bottom of the unit.



PREZI

In the Home

- Several systems available:
  - Room Heater: Non-ducted heater designed to heat a specific room or area.
  - Forced Air Furnaces
    - Ducted heating system with variable speed blower
    - Can be used in conjunction with heat pump or air conditioner.
  - Hydronic Furnaces:Uses heat exchanger to transfer heat to water/glyco systems including radiant floor, baseboard and other zoned delivery systems.
- Imperative to size appropriately based on requirements (size of area, off-peak hours available, etc).

Prezi

Cost Considerations

1. Room heater unit alone can range from $2,500 – 5,000.
2. Furnace can range from $10,000 - $20,000.
3. Saves 40 to 70% on heating bills ($500 to $2,000 annually).
4. Low-cost method of heating with electricity.
5. Makes electricity competitive with fossil fuels.
6. No routine maintenance, annual cleanings, recertifications or servicing.
7. Some electrical companies don't price differently for peak or off-peak.
8. Expected 20+ year unit life.
9. Rebates may be available ($75 per kW of storage up to max of $750 per home)
10. Cost comparison:
    (http://www.heatforlessnow.com/?id=4&page=Calculate+Your+Savings)

Prezi

Location:	Maine
Home Size:	medium
	Annual Heating Cost
Electic Heat	$ 3595
Propane	$ 3457
Fuel Oil	$ 2764
Natural Gas	$ 1172
Steffes Heating System with Air Source Heat Pump	**$ 998**
Steffes Heating System	**$ 1797**

PREZI

HP Basics

- Can be used to both heat and cool

- Many different kinds of heat pumps, but two broad categories are most common: ground source (or geothermal – can draw heat out of ground or underground water) and air source

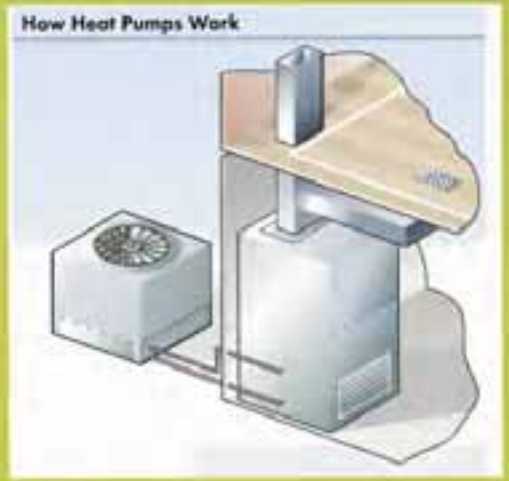
- Extremely efficient, because they simply transfer heat, rather than burn fuel to create it
  - In air sourced systems a fan blows relatively low temperature air over refrigerant filled coils. As the refrigerant heats up it is pumped into a higher temperature area (either into or out of home depending on whether heating or cooling is desired), where another fan blows the heat away from the coils.
  - With ground source systems heat is absorbed directly by buried pipes filled with water or a refrigerant. In closed loop systems, the same liquid circulates repeatedly, open loop systems pump water from an underground well or a man-made lake.

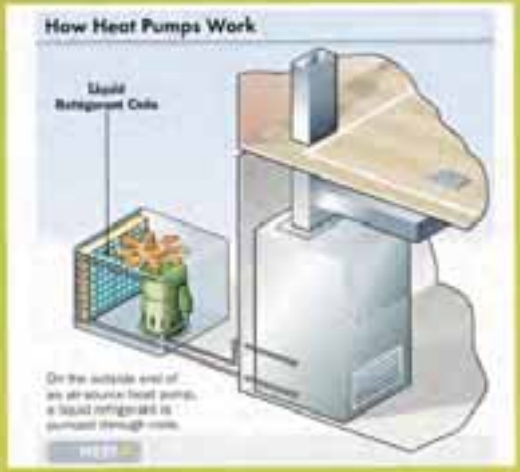
•Traditionally used in moderate climates but newer models designed to work at cold temperatures (still best above freezing). At very cold temps unit uses more energy to extract the available heat

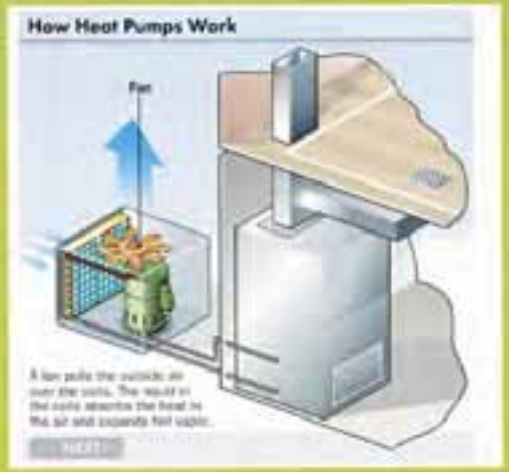
•Most commonly use electricity to power heat transfer but absorption models can use natural gas, solar power, propane

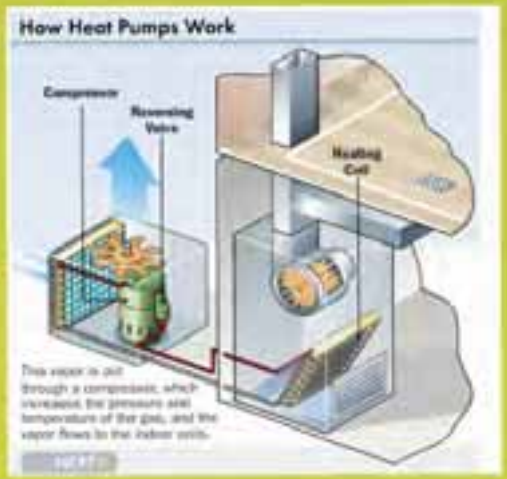
Prezi

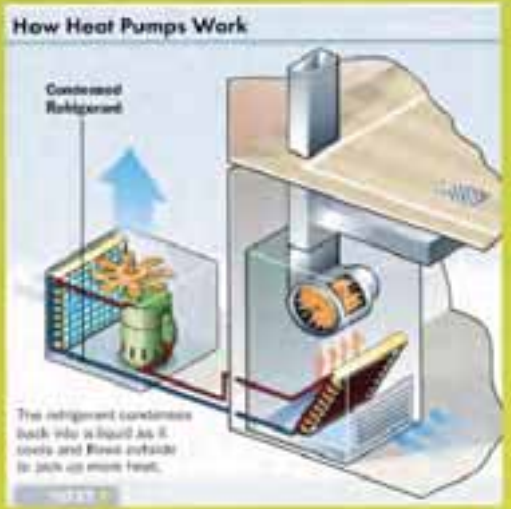
How They Work

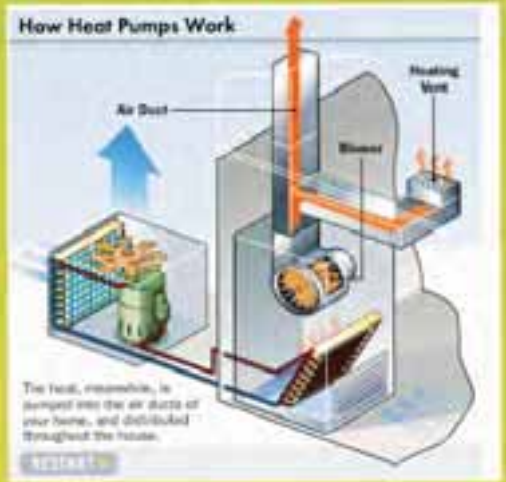












Prezi

In the Home

- Ground source unit require some excavation (to lay network of pipes or dig well)

- Air source units for the home have both outdoor and indoor components connected with conduit installed through the wall.

- Central units usually distribute heat through duct work, but can be adapted to other types systems (e.g., radiant floor). Integration with existing infrastructure can be difficult.

- Ductless, mini-split air sourced units, feature an outside unit that can be connected (via a 3 inch conduit that passes through the wall) to one or more small interior air handlers – a great choice for retrofitting a home.

- At very cold temps (think January), a backup system is needed to keep home comfortable. Adding mini-splits, while keeping an existing oil system in place for coldest days can reduce annual oil costs signficantly.

- Heat produced by heat pumps isn't as intense as gas or oil-burning furnace (circulating air may feel cool), which may uncomfortable for some; though heat tends to distribute evenly reducing cold spots.

Prezi

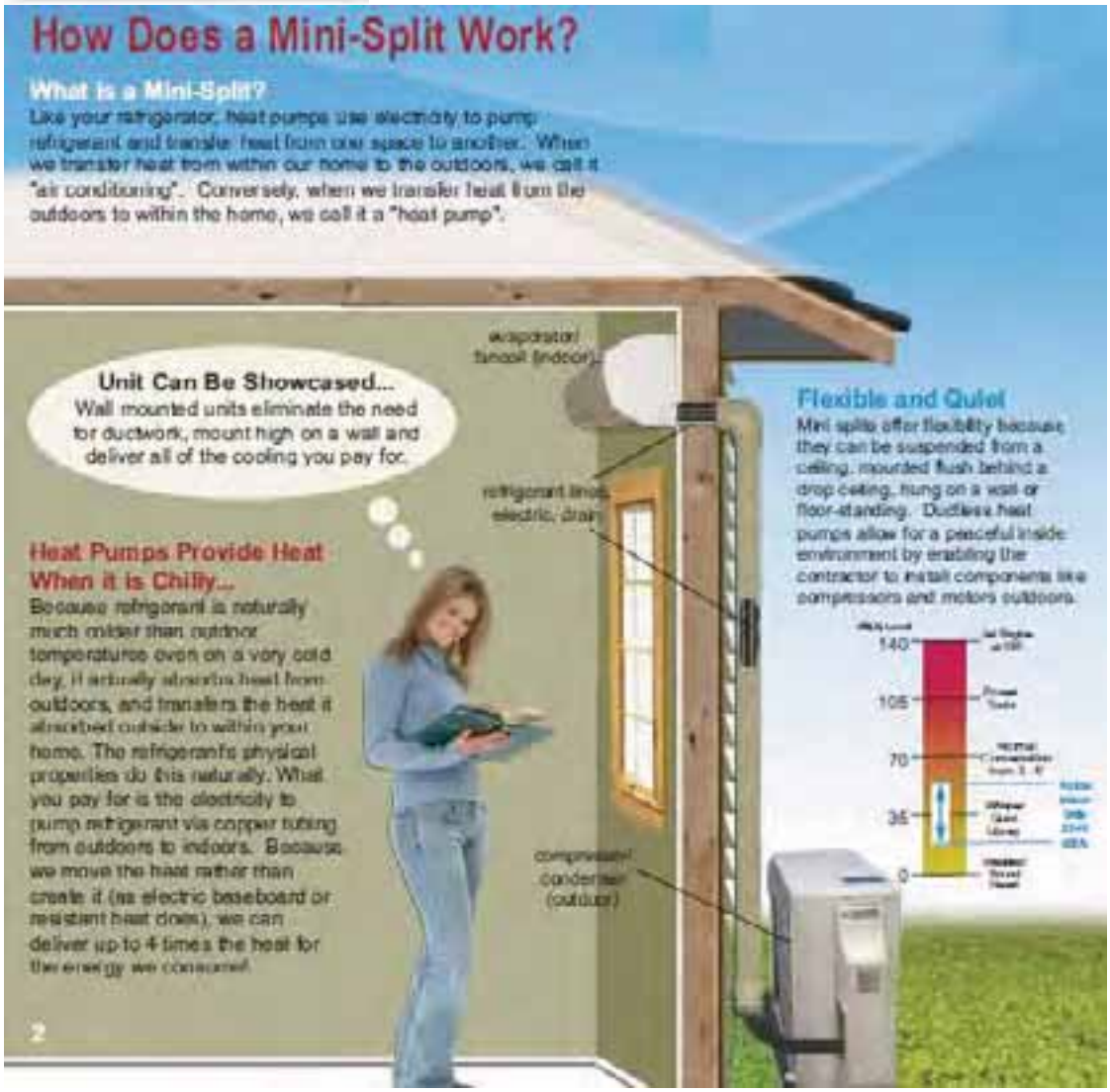
Cost Considerations

- May save you between 30-40%; if correctly installed and maintained.
- High electricity prices decrease savings, especially during very cold months.
- Manufacturers rate efficiency two ways: 14- 18 is a good seasonal energy efficiency rating (SEER) = BTU/watts in cooling mode & 8-10 is a good heating seasonal performance factor (HSFP) starts = same ratio in heating mode+supplemental heating needs & energy to defrost.
- More expensive units may include a variety of enhancements to improve efficiency (heat reclaimers, specialized compressors, and motors)
- Ground source units tend to be 3-5 times more expensive (and depending on terrain, installation costs can vary widely), but are less expensive to run. They tend to have fewer repairs but those on underground pipes can be very expensive.
- Air-source units are less complex, and easier to install ($1400-4000); they are easy to access and service, but they may need more regular maintenance because they're exposed to the elements. Also, air-source heat pumps may use more supplemental energy to run, especially in colder climates, which may increase electric bill.
- Need at minimum annual professional maintenance and monthly filter changes (if used consistently) Should last between 10 and 30 years, with geothermal units leading the way in longevity; may outlast capacity to service. Technology is improving.

Prezi

This information came from the following three places:

1. How stuff works [1] http://home.howstuffworks.com/home-improvement/heating-and-cooling/heat-pump3.htm/printable
2. Department of Energy website
3. Fujitsu mini split heat pump users manual http://www.fujitsugeneral.com/pdf_06/halcyon06_brochure.pdf



[1] This is a very clever website on a variety of topics. They have a saying in the upper left, some "Unraveling the universe one quantum vibration at a time." And "we void warrantees so you don't have to" and "we figure it out so you don't have to" and "making you smarter while you eat lunch" and "we make the complex simple" and "we blew up chemistry sets in school too" and "smart is contagious" and "Demystifying the world" and "making you the smartest person at your water cooler" and "reverse engineering the world" and "knowledge junkies wanted"

How Heat Pumps Work

by Laura Cowan and Emilie Sennebogen

When you think about cooling a hot building, you probably don't think of heat pumps. In fact, the words "air conditioner" are likely the first things that come to your head unless you're tight with your pennies. Then you might go with "window fans." As it turns out, a heat pump can both heat and cool, and in some applications, it's preferred to separate heating and cooling systems.

Simply put, a **heat pump** is a device that uses a small amount of energy to move heat from one location to another. Not too difficult, right? Heat pumps are typically used to pull heat out of the air or ground to heat a home or office building, but they can be reversed to cool a building. In a way, if you know how an air conditioner works, then you already know a lot about how a heat pump works. This is because heat pumps and air conditioners operate in a very similar way.

One of the biggest advantages of a heat pump over a standard heating ventilating and air conditioning (HVAC) unit is that there's no need to install separate systems to heat and cool your home. Heat pumps also work extremely efficiently, because they simply transfer heat, rather than burn fuel to create it. This makes them a little more green than a gas-burning furnace. And they don't just heat and cool buildings. If you've ever enjoyed a hot tub or heated swimming pool, then you probably have a heat pump to thank. They work best in moderate climates, so if you don't experience extreme heat and cold in your neck of the woods, then using a heat pump instead of a furnace and air conditioner could help you save a little money each month.

Read on to get a glimpse of the innards of a heat pump.

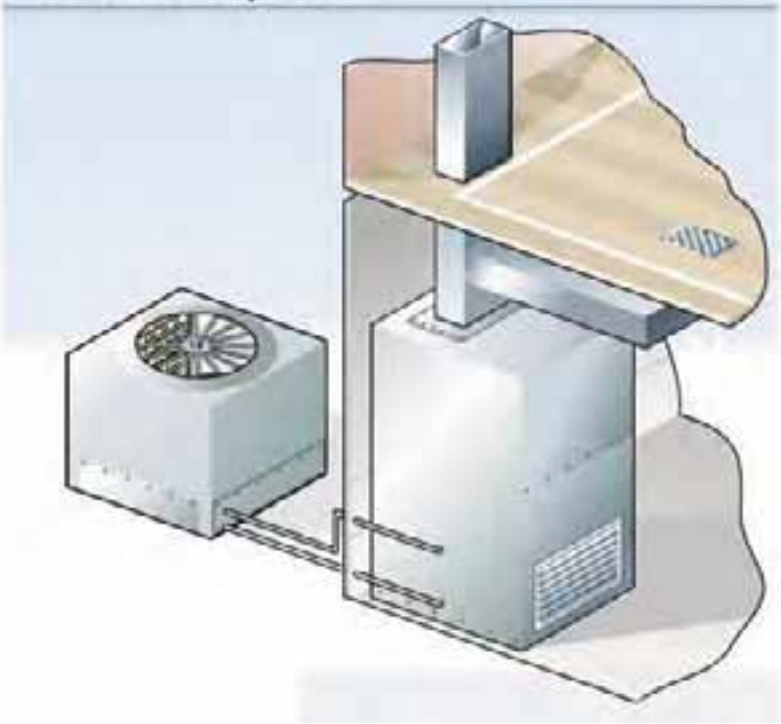
Heat Transfer and Air-Source Heat Pumps

There are many different kinds of heat pumps, but they all operate on the same basic principle -- **heat transfer**. This means that rather than burning fuel to create heat, the device moves heat from one place to another. There's a key to making this all happen -- heat naturally flows downhill. This means that it tends to move from a location with a high temperature to a location with a lower temperature. Pretty simple. What a heat pump does is use a small amount of energy to switch that process into reverse, pulling heat out of a relatively low-temperature area, and pumping it into a higher temperature area. So heat is transferred from a "heat source," like the ground or air, into a "heat sink," like your home.

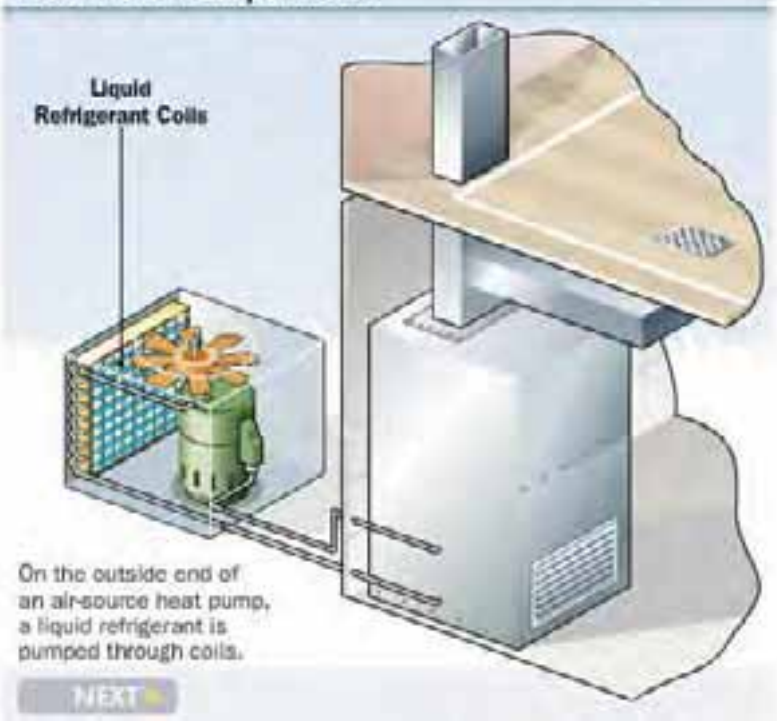
One of the most common types of heat pumps is the **air-source heat pump**. This marvel of modern technology takes heat from the air outside your home and pumps it inside through refrigerant-filled coils, not too different from what's on the back of your fridge. The air source variety is pretty basic, and you'll find two fans, the refrigerator coils, a reversing valve and a compressor inside to make it work.

And since you asked, here's how this kind of heat pump works:

How Heat Pumps Work

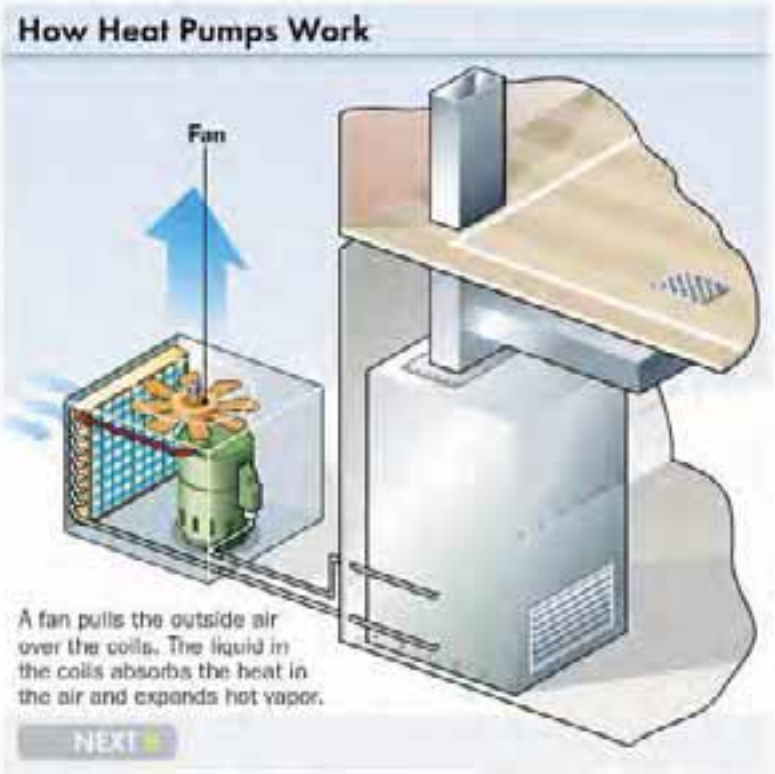


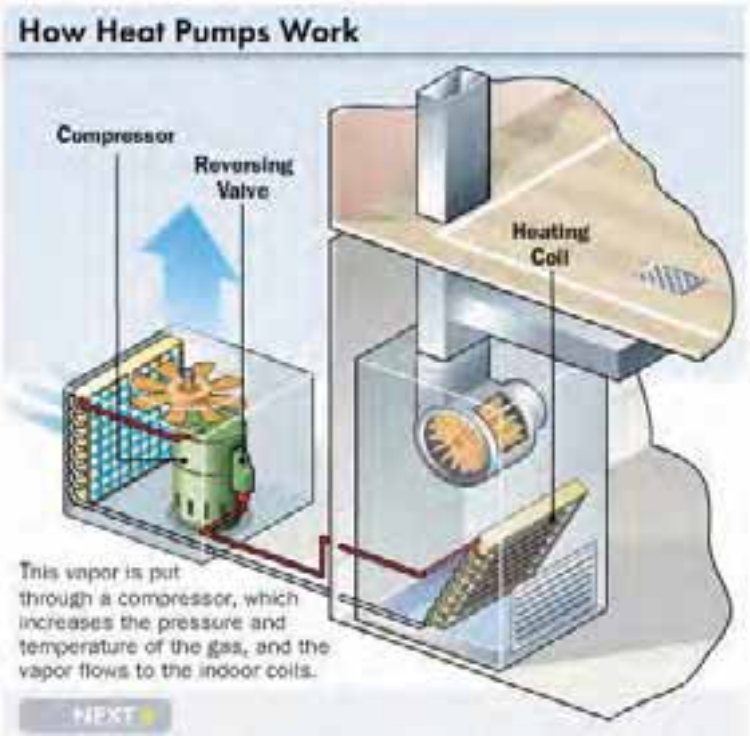
How Heat Pumps Work

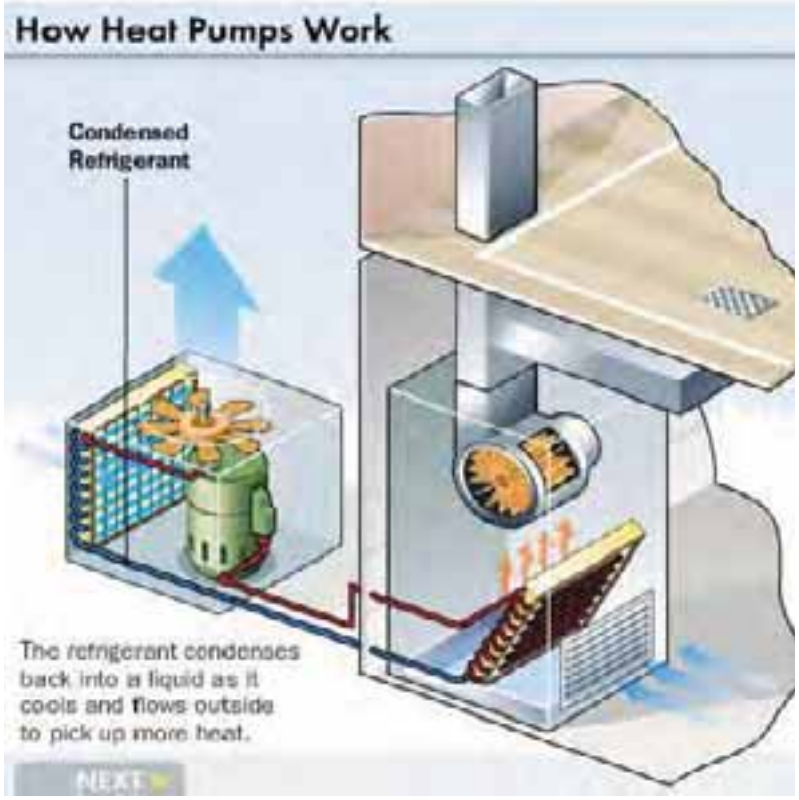


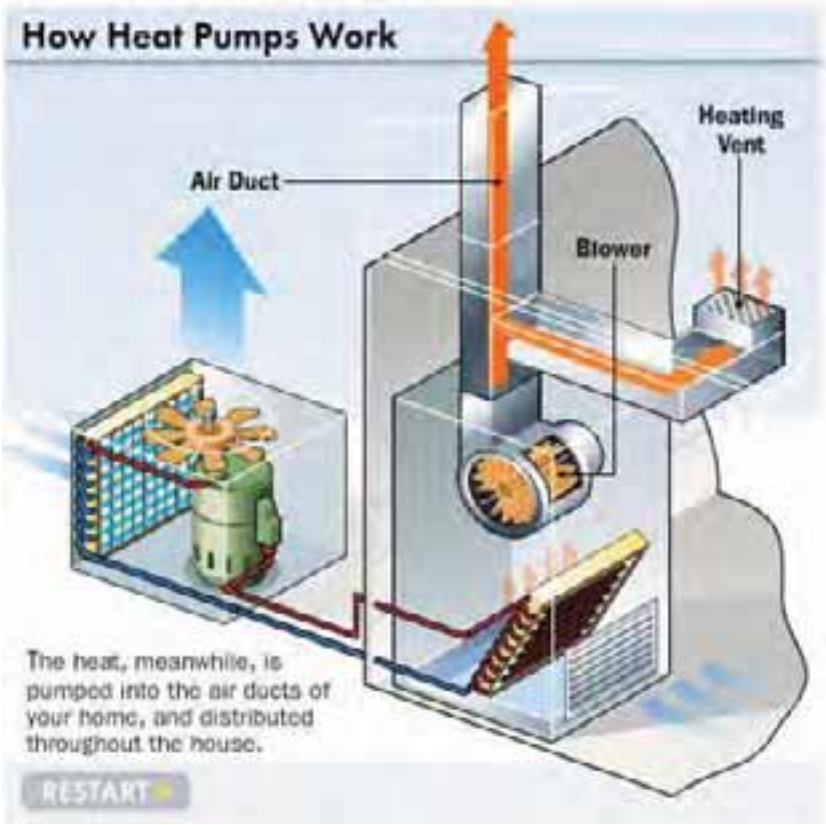
On the outside end of an air-source heat pump, a liquid refrigerant is pumped through coils.

NEXT


How Heat Pumps Work
Fan
A fan pulls the outside air over the coils. The liquid in the coils absorbs the heat in the air and expands hot vapor.
NEXT


How Heat Pumps Work
Compressor
Reversing Valve
Heating Coil
This vapor is put through a compressor, which increases the pressure and temperature of the gas, and the vapor flows to the indoor coils.
NEXT





This system is more commonly known as an **air-air heat pump,** because it takes heat from outdoor air and transfers it to indoor air ducts. With the right kind of modifications, air-source systems can also work with other types of indoor heating systems.

The key to allowing the air-air heat pump to also cool is the reversing valve. This versatile part reverses the flow of the refrigerant, so that the system begins to operate in the opposite direction. So instead of pumping heat inside your home, the heat pump releases it, just like your air conditioner does. When the refrigerant is reversed it absorbs heat on the indoor side of the unit and flows to the outside. It's here that the heat is released, allowing the refrigerant to cool down again and flow back inside to pick up more heat. This process repeats itself until you're nice and cool.

Air-Source, Ground-Source, and Absorption Heat Pumps

By now, you've learned that **air-source heat pumps** use an outdoor fan to bring air over refrigerant-filled coils. Two sets of these coils transfer this heat indoors, where it's then blown away from the coils by a second fan, and distributed through your home as cool goodness. Some air-source heat pump systems consist of a single packaged unit containing both sets of coils in one box. This box is then installed on the roof of a building with the ductwork extending through the wall. You'll see a lot of larger systems for commercial buildings installed in this way. Home heat pumps are usually split systems with an outdoor and an indoor component installed through the wall. Depending on the type of system, there may be one or more indoor components to distribute heat.

Ground-source heat pumps are a little different. They absorb heat from the ground or an underground body of water and transfer it indoors, or vice versa. The most common type of ground-source heat pump transfers heat directly from the ground by absorbing it through buried pipes filled with water or a refrigerant. These liquid-pumping pipes can be either **closed-loop** or **open-loop** systems, and they operate pretty much exactly how they sound. In a closed-loop system, the same refrigerant or water circulates through the pipes repeatedly. In an open-loop system, water is pumped out of the underground water source, like a well or a man-made lake. From there, the heat is extracted from the water, and that water returns to the well or surface lake. More water is then pumped from the well to extract more heat in a continuous open loop.

If that's not enough to blow your mind, consider the **absorption heat pump** -- air-source pumps that are powered by natural gas, solar power, propane or geothermal-heated water, rather than by electricity. Absorption pumps can be used for large-scale applications, but are now available for homes on the larger side. The main difference between a standard air-source heat pump and an absorption pump is that instead of compressing a refrigerant, an absorption pump absorbs ammonia into water, and then a low-power pump pressurizes it. The heat source then boils the ammonia out of the water, and the process starts all over again.

When you go to check out an absorption heat pump, it helps to know how they're rated. Manufacturers rate them using a measurement called a **coefficient of performance** (COP), which sounds pretty complicated. All you need to know is to look for a COP above 1.2 for heating and above 0.7 for cooling. And don't worry; we'll discuss ratings for standard heat pumps a little later.

Air-source, ground-source and absorption heat pumps are the most common kinds of heat pumps, but they won't work in every situation. Read on to learn about special kinds of heat pumps.

Other Kinds of Heat Pumps

If your home doesn't have air ducts to distribute heat, don't fear. You could potentially use a special kind of heat pump called a **mini-split heat pump**. The cutest of all heat pumps, it connects an outdoor air-source unit to multiple indoor units. These indoor units connect to water heat or space heaters. These ductless mini-split systems are useful for retrofitting a home with a heat pump system because their locations outside and inside the home are flexible. Another plus is that the installation only requires a 3-inch (7.6 centimeter) conduit to come through the wall, which is pretty unobtrusive. They're also versatile. The indoor air handlers can be installed in walls, ceilings or on the floor, and they're small to boot.

And who can forget the **reverse cycle chiller** (RCC) heat pump? Instead of heating and cooling air, this bad boy heats and cools water, and can operate efficiently in below freezing temperatures. In an RCC system, the heat pump connects to an insulated water tank that it either heats or cools. Then, a fan and coil system pump heated or cooled air away from the tank and through the ductwork to one or more heating zones. An RCC system can also pump hot water through a radiant floor heating system, so when those bare feet are comfy on a toasty tile floor this winter, you can thank your RCC.

In a typical air-source heat pump, there's the need for a backup burner to supply temporary heat when the system switches into reverse to defrost the coils. This backup burner prevents the system from blowing cold air through the registers while the coils defrost, which is key if your goal is to stay warm. Some might say that the RCC system is superior in that it uses the hot water from the tank to defrost the coils, so no backup burner is needed. This also means the system never blows cold air when it shouldn't, and the result is that you stay nice and warm.

A new type of heat pump showing promise for extreme climates is the Cold Climate heat pump, which operates efficiently at extremely low temperatures -- even below 0 degrees Fahrenheit (-18 degrees Celsius). The Cold Climate heat pump detects the minimum amount of energy needed to provide the desired level of heating or cooling and adjusts its output up or down, so it never wastes energy. It's an extremely green alternative, but is still in its early stages of implementation because of delays in funding, which slowed research. In 2011, Canada invested $4 million in Cold Climate heat system development.

The **All-Climate** heat pump is yet another new kind of pump, which can operate in temperatures as cold as -30 degrees Fahrenheit (-34 degrees Celsius) and can increase efficiency by up to 60 percent over a standard heat pump [source: EERE]. The All-Climate heat pump is designed primarily for heating, though, and won't work efficiently in climates where the heat pump would be in cooling mode most of the time.

Even special heat pumps have limitations. Read on to learn about the pros and cons of heat pumps, and what you need to know before buying one.

Pros and Cons of Heat Pumps

Heat pumps can help consumers save on utilities, but they have limitations. First, they tend to be somewhat ineffective in any climate where the outdoor air temperature falls near or below freezing on a regular basis, although innovators are working to improve upon this. This is because moving heat from a very cold area to a hotter one takes more energy than moving heat

between two areas with a more moderate temperature difference. There's also more heat available outside in a moderate climate than in a cold climate. It's important to note that even in a cold climate, there's still heat in the outside air to be pumped indoors, but the unit needs to work harder to extract the heat that's available. Supplemental energy may be required to make the heat pump produce enough warmth to comfortably heat your home when the temperature falls below freezing, and that's no good.

The heat produced by heat pumps isn't as intense as the heat produced by a gas or oil-burning furnace. People who are used to traditional furnaces can be uncomfortable with the milder heat produced by these systems. Other people prefer the warmth produced by heat pumps, because heat pumps distribute heat evenly throughout the house, meaning there are no cold spots. A heat pump will also turn on and off less often than a gas furnace, and most systems have eliminated the blowing of cold air through the vents that used to occur when the system temporarily switched into reverse to defrost the coils.

Before you install a heat pump, you'll need to consider what kind of supplemental or backup heating you may need to use when the heat pump can't work efficiently. Many heat pumps use supplemental electrical heating, but you might also use some kind of oil burner or an adapted gas furnace. Whatever type of heating system is common in your area is likely the most efficient and cost-effective backup method. You can always call your local utility company for information.

Ground-source heat pumps are better dehumidifiers than normal air conditioners, because these systems typically have a larger, flat return coils that conditions and dehumidifies more air than the corresponding coil in an air-conditioning system. Air-source heat pumps have about the same dehumidifying capabilities as air conditioning systems. If you have any humidifying or dehumidifying needs, take this into consideration.

Now that you know the pros and the cons of heat pumps, read on to learn what to look for when you buy a heat pump.

What to Look for in a Heat Pump

When you start shopping for a heat pump, there are a few things you need to look for. First, manufacturers rate the efficiency of most heat pumps in two ways: SEER and HSFP ratings. Higher SEER and HSFP ratings indicate a more efficient unit.

- SEER stands for seasonal energy efficiency rating, and is a ratio of how much energy (measured in BTUs) is pumped outside in cooling mode divided by the electricity used (in watts) for cooling. Look for a SEER rating between 14 and 18.
- HSFP stands for heating seasonal performance factor. It calculates the ratio of energy pumped indoors for heating to energy used for heating, but it's a more complicated equation than the SEER rating because it also takes into account supplemental heating needs and the energy used to defrost the unit. Look for an HSFP rating between 8 and 10.

Heat pumps often feature options that make them more efficient. These include:

- A desuperheater coil that heats water by recycling waste heat (or on an RCC system, a refrigerant heat reclaimer that also uses the pump's extra capacity to heat water during mild winter weather).

- Dual-mode compressors and motors that save energy by adjusting up or down according to the level of heating or cooling needed.
- Scroll compressors that are quieter, more efficient and last longer than traditional compressors.

Though many of these features can only be found on more expensive heat pumps, they make up for the initial expense by helping heat pumps work more efficiently and save more energy throughout the pump's life.

So you now know how to buy a heat pump, but will it really save you money?

Do Heat Pumps Save You Money?

The cost to install and run different kinds of heat pumps varies quite a bit. Geothermal heat pumps are more expensive to install than air-source heat pumps, as much as three times as much, because ground-source pumps require you to dig down to a heat source and involve more complex heat transfer systems. That can get a little pricey depending on the terrain on your property. Expect to pay as much as $5,000 to $7,500 for a ground-source heat pump system. Air-source heat pumps can be found for much cheaper, averaging around $1,500 to $4,000, because the units tend to be simpler, and installation is easier.

The cost required to run and repair a heat pump varies with the type of system. It's less expensive to run a ground-source heat pump because the ground and water have a relatively constant temperature that allows the heat pump to operate efficiently. Ground-source systems also have the advantage of not being exposed to the outdoor weather, which prevents a lot of wear and tear. On the downside, they can be costly to repair if you need to access an underground portion of the system. Air-source systems are easy to access and service, but they may need more regular maintenance because they're exposed to the elements. Also, air-source heat pumps may use more supplemental energy to run, especially in colder climates, and this will cost you more on your utility bill.

Heat pumps may save you anywhere between 30 and 40 percent or more on your utility bill, but neglect will reduce a heat pump's efficiency over time [source: EERE]. It's important to factor in the climate where you'll be using the heat pump to make sure you select a system that can run efficiently in your area. In the end, heat pumps can save you a lot of money on utilities if you're a good candidate and you install the right kind of pump for your area.

Read on to find out the cost of running and repairing your new heat pump.

Heat Pump Maintenance

If you use your heat pump on a regular basis, you should change the filter about once a month. You could probably get away with only changing the filter once every three months if you only run the unit periodically. Keep fans and coils clean and free from debris, and have your heat pump inspected by a professional once every year or two.

Common problems with heat pumps include low airflow, leaky or noisy ducts, temperature problems, using the wrong refrigerant charge, rattles, squeaks and grinding noises. If you can, try to isolate the location of the problem. Is the airflow only low coming out of one register, or do all

registers have low airflow? Is the offending noise coming from the air ducts or within the heat pump unit itself?

There are a few things you can do to identify and possibly fix a heat pump problem before calling for professional help. First, if the unit isn't working, try resetting its motor. Check the pump ignition system for problems, and make sure you don't have a tripped circuit breaker or blown fuse. Check the thermostat to make sure it's working properly. Change the filter if it's dirty, and make sure there are no airflow blockages. If the air ducts are making noise when they expand and contract, you could try putting a dent in the side of the duct to make the surface more rigid. Rattles may be fixed by fastening loose parts, and if you're hearing squeaks inside the unit, you may need to replace or adjust the fan belt connecting the motor and the fan. A grinding noise may indicate that the bearings on the motor are worn out, which will require the help of a professional to fix.

Keep in mind that if you aren't mechanically inclined then you probably shouldn't attempt to do this kind of repair work. And because heat pumps can contain hazardous materials, that's another good reason to get some professional assistance. A chemical leak is bad news and you can easily injure yourself handling a broken device.

A heat pump should last between 10 and 30 years, with geothermal units leading the way in longevity. In fact, some components of ground-source heat pumps can last even longer. Keep in mind that technology may change before your heat pump has worn out, so you may find your heat pump outlasts a technician's ability to service it. New technologies may make heat pumps safer or more efficient, so you may wish to keep an eye out for new kinds of heat pumps.

Solar Basics

- Utilization of Photovoltaic (PV) cells to absorb photons of sun light to produce DC current electricity.
- Inverter then converts DC current to AC for use in residential setting.
- Has been around since the 1860s, regained interest in 1970s and within last decade.
- Renewable resource, zero emissions.
- Sunlight is readily available in all geo locations making this a viable solution.
- Cells are long-lasting with little maintenance required.
- Solar radiation is only available during daytime.
- Weather, location and season can affect performance.
- Requires considerable surface area for strong power.

Prezi

In the Home

Most common systems:

- Grid-Tied:
  - Connected to main power grid.
  - Net metering arrangement is designed to sell power back to utility company.
  - Any excess power is pumped into the power grid
- Off -Grid
  - Completely independent of utility company.
  - Used for homeowner's draw only.
  - Energy is stored in battery array for future use.
  - Charge controller regulates current and voltage being transferred to battery.
- Imperative to size appropriately based on requirements worksheets and calculations (load, geographic location, season, surface area available).

Prezi

Home

1. Solar Panels - Solar panels collect molecules of sunshine, which are little packets of energy, and converts them into an electric current.
2. DC to AC Inverter - DC to AC inverters convert the DC current generated by a solar panel into AC current that can be used to power appliances in your home.
3. **Electrical Distribution Panel** - This is the panel that feeds all of the homes circuits.
4. **AC Loads** - Once your solar panels have converted the Sun's light into an eclectric current and that current has been coverted from direct current (DC) to alternating current (AC), it can then be used to power your lights and appliances.
5. **Electric Meter** - Your home solar power system can actually cause your electric meter to spin backwards as it feeds the electricity it generates into the main power grid and you earn credit on your electric bill.
6. **Main Power Grid** - Once electricity generated by your residential solar power system is directed onto the power grid, it can then be used by someone else and adds to the overall total of kilowatt hours produced by a clean and renewable energy source - the Sun!

rid

SOLAR ARRAY
OFF-GRID SYSTEM
CHARGE CONTROLLER
BATTERY BANK
DC TO AC INVERTER
AC CURRENT
NO GRID REQUIRED
DC POWER LOAD
AC POWER OUTLET

nts

on

Cost Considerations

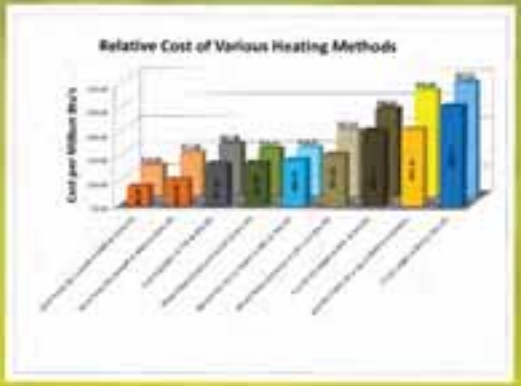
1. Large capital outlay ($10,000 to $40,000k).
2. Rebates and tax incentives available to help recoup investment (30%).
3. Cost effective long-term.
4. Net metering can generate utility credits based on usage and generation.
5. No routine maintenance, annual cleanings, recertifications or servicing.
6. Expected 25+ year life.

Prezi

Economic Review

Key Considerations

- Heat quality differs among "fuels" - compare BTU's for consistency
- Efficiency ratings are important - and need to consider whether possible under installed conditions.
- Need to figure in upfront costs (grid + installation), as well as ongoing operation (to produce heat), maintenance, and any financing to understand savings and calculate ROI.
- No one best solution - depends on home and homeowner
- Cost comparisons designed to sell a product, can conveniently overlook some variables. Look for transparency in how numbers were determined.
- Homeowners need to take time to educate themselves about what is best for their situation.



Use a Heat Calculator

www.eia.gov/neic/experts/heatcalc.xls
http://www.eia.gov/tools/faqs/faq.cfm?id=8&c=7

PREZI

Key Considerations

- Heat quality differs among "fuels" - compare BTU's for consistency.
- Efficiency ratings are important – and need to scrutinize whether possible under installed conditions.
- Need to figure in upfront costs (unit + installation), as well as on-going operation (to produce heat, maintenance, and any financing) to understand savings and calculate ROI.
- No one best solution – depends on home and homeowner
- Cost comparisons designed to sell a product, can conveniently overlook some variables. Look for transparency in how numbers were determined.
- Homeowners need to take time to educate themselves about what is best for their situation.

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INSTRUCTIONS and GUIDANCE

(Scroll down to see all information.)

Overview

This calculator allows you to compare fuel prices on the basis of dollars per millions of Btu of the fuel and the "cost" of the fuel based on the efficiency of the heating system.

Type into the yellow-colored cells the prices of fuels you want to compare and the efficiency rating for the type of heating system you have or are considering buying. The calculated prices and costs are presented in the green-colored cells.

Default values are presented for initial comparison.

This calculator was developed to assist in the comparison of fuels and heating system types and the effect of heating system efficiency on the cost of heating fuels. There are numerous factors that are important when deciding on the type of heating system to purchase besides the price of fuels at a specific point in time and system efficiency ratings.

Below are explanations for the items in the columns.

Fuel Unit

This is the physical unit by which the fuel is normally sold.

Price Per Unit

The Prices per Unit that are already in the yellow cells are the most current average national prices available as of the date indicated at the upper left corner of the calculator and are for examples only. Links to price data sources are at the right and also in the ENERGY PRICES tab below.

For electricity prices, which are normally expressed in cents per kilowatt-hour (kWh), type in the decimal equivelant; for example 10 cents per kWh = 0.10 dollars per kWh.

Your local fuel prices can and will vary substantially from the national average. For the greatest accuracy, you should use local prices from a recent bill or local retailers/providers. Use the total delivered price including taxes. For example, divide your total bill by the total units (gallons, kWh, therms, etc) consumed or delivered during the period of the bill.

Fuel Heat Content

Fuel Heat Content per Unit is the number of British Thermal Units (Btu) of heat contained in a single unit of the fuel. Click on the HEAT CONTENT tab for more information on fuel heat contents.

Price per Million Btu

The Calculator calculates the price in dollars per million Btu based on the price per unit and fuel heat content per unit.

Heating Appliance Type

This is the type of heating appliance or system that you have or considering buying. Furnace means a forced-air, central heating system with a furnace that heats air that is distributed in ducts and includes a fan or blower to move heated air through duct system. Boiler is a hydronic central heating system with a boiler that heats water (or produces steam) and that uses pipes and radiators for heat distribution. Heater/stove is a stand-alone heating appliance without heat distribution ducts or pipes normally used to heat a single room. Air-Source heat pumps are central heating systems that remove latent heat from the outside air and use a fan and duct work to distribute the heat. This Calculator applies specifically to air-source heat pumps that use only electric resistance heat as the auxillary heat source. Geothermal heat pumps are types of heat pumps that use heat from the earth or water in the ground, ponds, lakes etc. Heat pumps also provide cooling in the summer. Consult with local heating and cooling contractors regarding heating (and cooling) system options.

Type of Efficiency Rating

Central heating systems (gas and oil fired furnaces and boilers and heat pumps) are rated on the efficiency by which they convert energy/fuels to useful heat. There are different ratings used depending on the type of heating appliance. There are definitions and more detail on the ratings in the EFFICIENCY INFO tab at the bottom of the Calculator.

Because there are no efficiency ratings for electric resistance heating systems (such as electric baseboard, stand-alone room heaters, radiant heaters, etc), or for kerosene, wood, pellet, corn and coal burning heaters, estimated “ratings” are provided.

Efficiency Rating or Estimate

This is the actual, adjusted or estimated efficiency rating for the heating appliance. The default ratings are the minimum allowable efficiencies as required by law at the time when this Calculator was last updated. Some types of heating appliances are not subject to minimum efficiency standards, and for those types of appliances an estimate default efficiency is provided.

The rated HSPF of an air-source heat pump should be adjusted to account for the effects of climate on the operating performance of the system. See footnote 5 of the calculator and the procedure for obtaining an adjusted air-source HSPF.

If you want to change the rating, type in the rating you obtain into the yellow-colored cells. For example, if the AFUE for a specific model of a natural gas-fired boiler is 90, type 90 into the yellow-colored cell for that fuel and appliance type. Do not type in 0.90

Approx. Efficiency (%)

This is the approximate system efficiency expressed as a percentage and is calculated.

Cost Per Million Btu

This is the “cost” of the fuel in dollars per million Btu as determined by the price of fuel and the efficiency of the heating appliance.

For more information on this calculator, contact: Paul Hesse: 202-586-8800; InfoCtr@eia.gov

HEATING FUEL COMPARISON CALCULATOR

1/6/2012 *Version: HEAT-CALC-Vsn-D_1-09.xls*

This "calculator" can be used to compare residential heating fuel prices and costs. To use this calculator, enter information into the yellow-colored cells as necessary. The information in the green cells is calculated for you. **Scroll down and right to see all information on this page.** Detailed instructions are provided in the Instructions (click on tab at bottom of your screen).
Contact local suppliers for most accurate prices. This calculator will not provide an estimate of the cost to heat your home.

Fuel Type	Fuel Unit	Fuel Price Per Unit (dollars)	Fuel Heat Content Per Unit (Btu)	Fuel Price Per Million Btu (dollars)	Heating Appliance Type	Type of Efficiency Rating [4]	Effiency Rating or Estimate[5]	Approx. Efficiency (%)	Fuel Cost Per Million Btu (dollars)	CO_2 Emission (kg CO_2/kWh)	Default Fuel Price Sources (click on links below); see also Prices tab below.	Notes
Fuel Oil (#2)	Gallon	$3.69	138,690	$26.61	Furnace or Boiler	AFUE	78.0	78%	$34.11	0.26	http://www.eia.gov/dnav/pet/pet_pri_wfr_dcus_nus_m.htm	Used U.S. average for October 2010 to March 2011.
Electricity	KiloWatt-hour	$0.140	3,412	$41.03	Furnace or Boiler	Estimate	98.0	98%	$41.87	Dependent on Electricity Source	http://www.eia.gov/totalenergy/data/monthly/#prices See Table 9.9	Used average for Residential October 2010 to March 2011.
					Air-Source Heat Pump [6]	HSPF [6]	7.7	226%	$18.18			
					Geothermal Heat Pump	COP	3.3	330%	$12.43			
					Baseboard/Room Heater	Estimate	100.0	100%	$41.03			
Natural Gas [1]	Therm [2]	$1.57	100,000	$15.70	Furnace or Boiler	AFUE	78.0	78%	$20.13	0.23	http://www.eia.gov/totalenergy/data/monthly/#prices See Table 9.11	Used U.S. average for October 2010 to March 2011. To convert prices in $/MCF to $/therm, divide the price by 10.27
					Room Heater (Vented)	AFUE	65.0	65%	$24.15			
					Room Heater (Unvented)	Estimate	100.0	100%	$15.70			
Propane	Gallon	$3.15	91,333	$34.49	Furnace or Boiler	AFUE	78.0	78%	$44.22	0.24	http://www.eia.gov/dnav/pet/pet_pri_wfr_dcus_nus_m.htm	Used U.S. average for October 2010 to March 2011.
					Room Heater (Vented)	AFUE	65.0	65%	$53.06			
Wood [3]	Cord	$210.00	22,000,000	$9.55	Room Heater (Vented)	Estimate	55.0	55%	$17.36	0.39	www.hearth.com/econtent/index.php/fuels/	No endorsement of web site implied.
Pellets	Ton	$175.00	16,500,000	$10.61	Room Heater (Vented)	Estimate	68.0	68%	$15.60	0	www.hearth.com/econtent/index.php/fuels/	No endorsement of web site implied.
Corn (kernels) [3]	Ton	$200.00	14,000,000	$14.29	Room Heater (Vented)	Estimate	68.0	68%	$21.01	0	www.hearth.com/econtent/index.php/fuels/	No endorsement of web site implied.
Kerosene	Gallon	$4.01	135,000	$29.70	Room Heater (Vented)	Estimate	80.0	80%	$37.13	0.26	www.nyserda.org/Energy_Information/nyeph.asp	Used NY state-wide average Oct. 2010 to March 2011.
Coal (Anthracite)	Ton	$396.00	25,000,000	$15.84	Furnace/Boiler/Stove	Estimate	75.0	75%	$21.12	0.37	www.hearth.com/econtent/index.php/fuels/	No endorsement of web site implied.

NOTES:

1 Natural gas is typically sold to residential customers in units of "therms," but may be sold in units of hundreds of cubic feet (ccf).

2 One therm = 100,000 Btu, and is equivalent to about 97.378 cubic feet (or 0.974 ccf), when there are 1,027 Btu/cf.
To convert prices in $/Mcf (1,000 cubic feet) to $/therm, divide the $/Mcf price price by 10.27 .

3 The heat content for a cord of wood varies by tree species and is greatly affected by moisture content; 20 million Btu per cord is a rough approximation.
The heat content of a unit (ton or bushel) of corn can also vary widely; see reference for Corn Burning Stoves in Efficiency Info tab/worksheet.

4 For definitions of Efficiency Ratings and referrals to where they can be obtained, click on the EFFICIENCY INFO tab below.
Some types of heaters do not have efficiency ratings; the ratings in the yellow cells are comparable estimates for new appliances with basic features.

5 The default values are the minimum efficiency standards set by the U.S. Department Energy. Estimated "ratings" are provided for heating equipment for which there are no DOE standards.

6 Air-Source Heat Pump Ratings: The actual heating efficiency and seasonal performance of a "conventional" air-source heat pump may vary significantly from its rated heating season performance factor (HSPF). Below is a procedure for determining an adjusted HSPF for your location *for an air-source heat pump that uses only electric resistance heating as the auxillary heat source* . There are so-called "dual-fuel" or "hybrid" heat pump systems that are basically a heat pump integrated with a forced-air combustion appliance that uses natural gas, fuel oil or propane. In general, these systems use the heat pump for heating until outside temperatures reach the low 40's/high 30's (F), then switch to the combustion appliance for heating. The adjustment below does not apply to those types of hybrid heat pump/combustion appliance heating systems.
See the Technical Note for Air Source Heat Pumps in the EFFICIENCY INFO tab below for details on how the adjusted HSPF is calculated.

Adjust Air-Source Heat Pump HSPF rating for Your L

If the rated HSPF **is less than 8.5**, type it here----- 7.7

If the rated HSPF **is 8.5 or greater** type it here ---- 9.0

Then look in the table below to find the Adjusted HSPF for the city nearest you, and use the adjusted HSPF in the calculator.

State	City	Adjusted HSPF when rated HSPF is: < 8.5	Adjusted HSPF when rated HSPF is: = or > 8.5	ASHRAE Design Temps
AL	Huntsville	6.9	7.8	20
	Mobile	8.0	9.1	30
	Montgomery	7.6	8.7	27
AK	Anchorage	4.8	5.1	-9
	Juneau or Va	5.8	6.4	7
	Sitka	7.0	7.9	21
AR	Fayetteville	6.3	7.0	13
	Little Rock	7.0	7.9	21
	Texarkana	7.4	8.4	25
CA	Arcata/Eureka	8.2	9.4	32
	Barstow/Dagg	8.2	9.4	32
	Los Angeles	9.9	11.5	45
	Mount Shasta	7.0	7.9	21
	Sacramento	8.3	9.5	33
	San Francisco	9.1	10.5	39
CO	Alamosa	4.7	5.0	-11
	Denver	5.5	6.0	3
	Grand Junctio	5.8	6.4	7
	Limon	5.3	5.9	1
	Trinidad	5.7	6.3	6
CT	Bridgeport	6.2	6.9	12
	Hartford	5.7	6.3	6
	Windsor Locks	5.9	6.5	8
DC	R.R. Ntl Airport	6.9	7.8	20
DE	Dover (AFB)	6.7	7.6	18
	Wilmington	6.4	7.1	14
FL	Jacksonville and Pensacola	8.2	9.4	32
	Miami	10.6	12.4	50
	Orlando	9.5	11.0	42
	Tallahassee	7.7	8.8	28
	Tampa	9.2	10.6	40
MI	Detroit and Grand Rapids	5.6	6.2	5
	Lansing and Traverse City	5.4	5.9	2
MN	Duluth	4.4	4.8	-16
	Minneapolis-St. Paul	4.7	5.0	-11
MS	Biloxi	8.6	9.8	35
	Jackson	7.4	8.4	25
	Tupelo	7.1	8.0	22
MO	Kansas City	5.6	6.1	4
	Springfield	5.9	6.6	9
	St. Louis	5.9	6.5	8
MT	Helena	4.7	5.1	-10
NE	Lincoln and Omaha	5.1	5.6	-2
NV	Elko	5.3	5.9	1
	Las Vegas	8.0	9.1	30
	Reno and Tonapah	6.3	7.0	13
NH	Concord	5.1	5.6	-2
	Portsmouth	5.9	6.6	9
NJ	Atlantic City	6.3	7.0	13
	Trenton	6.4	7.2	15
NM	Albuquerque	6.7	7.6	18
	Gallup	5.6	6.2	5
	Roswell	6.9	7.8	20
NY	Albany	5.1	5.6	-2
	Buffalo	5.6	6.2	5
	NY (JFK)	6.4	7.2	15
NC	Asheville	6.5	7.3	16
	Charlotte	7.2	8.2	23
	Raleigh/Durham	6.9	7.8	20
	Willmington	7.6	8.7	27
ND	Bismarck	4.4	4.8	-16
OH	Cincinnati	6.2	6.9	12
	Cleveland and Columbus	5.7	6.3	6
	Toledo	5.5	6.0	3
OK	Oklahoma City	6.4	7.2	15
OR	Medford	7.3	8.3	24
	Pendleton	6.1	6.8	11
	Salem	7.4	8.4	25
PA	Erie	5.8	6.4	7
	Harrisburg	6.3	7.0	13

GA	Athens	7.4	8.4	25
	Atlanta	7.2	8.2	23
	Savannah	7.9	9.0	29
HI	Hilo and Honolulu	12.7	14.9	63
	Kaneohe	13.5	16.0	68
	Molokai	12.3	14.5	61
ID	Boise	5.9	6.6	9
	Idaho Falls	4.9	5.3	-6
IL	Chicago (O'Hare Airport)	5.2	5.7	-1
	Springfield	5.4	5.9	2
IN	Evansville	5.9	6.6	9
	Indianapolis and South Bend	5.5	6.0	3
IA	Cedar Rapids	5.0	5.4	-5
	Des Moines	5.0	5.5	-4
KS	Dodge City	5.7	6.3	6
	Topeka	5.6	6.1	4
	Wichita	5.9	6.5	8
KY	Bowling Green	6.4	7.1	14
	Lexington	6.0	6.7	10
	Paducah	6.3	7.0	13
LA	Baton Rouge	8.0	9.1	30
	Monroe	7.6	8.7	27
	New Orleans (Intl. Airport)	8.4	9.7	34
ME	Augusta	5.3	5.9	1
	Portland	5.4	5.9	2
MD	Baltimore	6.4	7.2	15
	Salisbury	6.7	7.6	18
MA	Boston	6.2	6.9	12
	Worcester	5.6	6.2	5
	Pittsburg and Wilkes-Barre/Scranton	5.8	6.4	7
RI	Providence	6.0	6.7	10
SC	Charleston	7.7	8.8	28
	Columbia	7.3	8.3	24
SD	Pierre	4.8	5.1	-9
TN	Jackson	6.7	7.6	18
	Memphis	7.0	7.9	21
	Nashville	6.5	7.3	16
TX	Amarillo	6.2	6.9	12
	Austin	8.0	9.1	30
	Dallas/Ft. Worth	7.3	8.3	24
	El Paso	7.4	8.4	25
	Houston (Intl. Airport)	8.1	9.3	31
UT	Cedar City	5.9	6.5	8
	Salt Lake City	6.1	6.8	11
VT	Burlington and Montpelier	4.9	5.3	-6
VA	Norfolk	7.3	8.3	24
	Richmond	6.7	7.6	18
WA	Olympia	7.2	8.2	23
	Seattle	7.7	8.8	28
	Spokane	5.8	6.4	7
	Yakima	6.1	6.8	11
WV	Charleston and Morgantown	6.1	6.8	11
	Martinsburg	6.4	7.1	14
WI	Milwaukee	5.1	5.6	-2
WY	Cheyenne	5.3	5.8	0
	Rock Springs	5.1	5.6	-2

	Electric Thermal Storage	Natural Gas
Existing Fuel Cost per Million BTU (Dollars) post appliance	36.98	36.98
Proposed Switch Fuel Cost per Million BTU (Dollars) post appliance	17.58	20.13
Capital Cost of Proposed System	5000.00	6000.00
Annual Maintenance Cost	50.00	100.00
Annual Fuel Use (#2 oil)	1200.00	1200.00
Convert to Million BTU	166.43	166.43
Annual Fuel Savings	3228.70	2804.31
Annual Maintenance Cost/Savings	50.00	0.00
Annual Savings	3278.70	2804.31
ROI (years no interest)	1.52	2.14

Input fuel cost post appliance from the fuel calculator
Do your homework ….get a quote from local installer, ask about annual maintenance costs, collect your existing fuel bills

Output of calculator, identifying annual fuel savings, overall savings (fuel+/- maintenance) and ROI in years

The user is encouraged to look at a range of fuel prices and consider the longterm stability of the fuel source

RESIDENTIAL FUEL / ENERGY PRICE LINKS

Click on the links in column E to EIA website pages and to other non-EIA price data for residential heating fuel prices.

Contact local suppliers in your area for more accurate price information

Fuel/Energy Type	Price Type/Periodicity	Geographic Coverage	Periodicity of publication	Links to data (click on link)	Link Notes
Fuel Oil (# 2 Distillate)	Retail, Weekly	National, regional & selected states	Weekly, Oct to Mar	http://www.eia.gov/d	.
	Retail, Monthly average	National, regional & selected states	Weekly, Oct to Mar	http://www.eia.gov/d	.
	Spot prices, daily	NY Harbor	Weekly	http://www.eia.gov/d	.
	Futures, daily for 4 contracts	NYMEX	Weekly	http://www.eia.gov/d	.
	Retail, Monthly	National, regional & selected states	Monthly	http://www.eia.gov/d	.
	Retail, Monthly	National and regional	Monthly	http://www.eia.gov/t	See Tables 9.8 a, b and c.
	Forecast, Retail, monthly, 2 yrs.	National and regional	Monthly	http://www.eia.gov/f	See Table 2 for national averages.
	Forecast, Retail, Annual, 20 to 25 yrs	National and regional	Annual	http://www.eia.doe.g	See Regional Energy Consumption and Prices by Sector Tables 11-20
Electricity	Retail, Monthly	National	Monthly	http://www.eia.gov/t	See Table 9.9
	Retail, Most recent month avail.	Regional and state	Monthly	http://www.eia.doe.g	See Table 5.6.B
	Retail, Running month avg. for calendar yr.	Regional and state	Monthly	http://www.eia.doe.g	See Table 5.6.A
	Retail, Annual average	State	Annual	http://www.eia.doe.g	.
	Forecast, Retail, monthly, 2 yrs.	National and regional	Monthly	http://www.eia.gov/f	See Table 7.c for national and regional averages.
	Forecast, Retail, Annual, 20 to 25 yrs	National and regional	Annual	http://www.eia.doe.g	See Regional Energy Consumption and Prices by Sector Tables 11-20
Natural Gas	Retail, Monthly and annual	National	Monthly	http://www.eia.gov/t	See Table 9.11
	Retail, Monthly and annual	State	Monthly	http://www.eia.gov/d	.
	Spot & Futures, daily for one week	Henry Hub, NY, and Chicago	Weekly	http://www.eia.gov/d	.
	Spot: HH Hub, & Futures: daily for 4 contrac	Henry Hub and NYMEX	Weekly	http://www.eia.gov/d	.
	Forecast, Retail, monthly, 2 yrs.	National and regional	Monthly	http://www.eia.gov/f	See Table 5.b for national and regional averages.
	Forecast, Retail, Annual, 20 to 25 yrs	National and regional	Annual	http://www.eia.doe.g	See Regional Energy Consumption and Prices by Sector Tables 11-20
Propane	Retail, Weekly	National, regional & selected states	Weekly, Oct to Mar	http://www.eia.gov/d	.
	Retail, Weekly and monthly	National, regional & selected states	Weekly, Oct to Mar	http://www.eia.gov/d	.
	Spot prices, daily	Mont Belvieu, TX	Weekly	http://www.eia.gov/d	.
	Retail, Monthly	National and regional	Monthly	http://www.eia.gov/d	.
	Retail, Monthly	National and regional	Monthly	http://www.eia.gov/t	See Table 9.7.
	Forecast, Retail, Annual, 20 to 25 yrs	National and regional	Annual	http://www.eia.doe.g	See Regional Energy Consumption and Prices by Sector Tables 11-20
Kerosene	Retail, Monthly	National, regional & selected states	Monthly	http://www.eia.gov/d	.
	Retail, Monthly	National and regional	Monthly	http://www.eia.gov/t	See Table 9.7.
	Retail, Weekly	NY State	Weekly	http://www.nyserda.	Prices of New York only.
Wood	NA	NA	NA	Contact suppliers. www.hearth.com/ec	No endorsement implied
Pellets	NA	NA	NA	www.hearth.com/ec	No endorsement implied
Corn (number	NA	NA	NA	www.hearth.com/ec	No endorsement implied
Coal	NA	NA	NA	www.hearth.com/ec	No endorsement implied

HEAT CONTENT

For information on the content of different fuels, click on the links below.

For petroleum products (heating oil, propane, kerosene):
http://www.eia.gov/totalenergy/data/annual/pdf/sec13_1.pdf
Note that there are 42 U.S. gallons in a barrel.

For natural gas:
http://www.eia.gov/totalenergy/data/annual/pdf/sec13_4.pdf

For electricity:
http://www.eia.gov/totalenergy/data/annual/pdf/sec13_6.pdf

For coal:
See Anthracite, Bituminous, Lignite, and Subbituminous in Glossary at:
http://www.eia.doe.gov/glossary/index.html
Average annual coal heat contents by consuming sectors:
http://www.eia.gov/totalenergy/data/annual/pdf/sec13_5.pdf

Wood, Pellet, Corn (kernel)
see links in Efficiency Info sheet/tab

LINKS TO OTHER CONVERSION FACTORS

Metric conversion factors, prefixes, and other conversion factors
http://www.eia.gov/totalenergy/data/annual/#appendices

DEFINITIONS FOR APPLIANCE EFFICIENCY RATINGS

AFUE, Annual Fuel Utilization Efficiency, is the measure of the seasonal or annual efficiency of a gas or oil furnace or boiler. It takes into account the cyclic on/off operation and associated energy losses of the heating unit as it responds to changes in the load, which in turn is affected by changes in weather and occupant controls. The higher the AFUE, the higher the efficiency.

HSPF, Heating Season Performance Factor, is the measure of the seasonal efficiency of an air-source heat pump in heating mode. It takes into account the variations in temperature that can occur within a season and is the average number of Btu of heat delivered for every watt-hour of electricity used by the heat pump over a heating season. The higher the HSPF, the higher the efficiency. Note: Air-Source Heat Pumps are also rated on their cooling efficiency in terms of **SEER** (Seasonal Energy Efficiency Ratio). The SEER ra cannot be used in this spreadsheet to estimate heating costs.

COP, Coefficient of Performance, is a measure of the energy efficiency of geothermal heat pumps in heating mode, and is the ratio of the average heating capacity to the amount of electrical energy input. The higher the COP, the higher the efficiency. Note: Geothermal Heat Pumps are also rated on their cooling efficiency in terms of **EER** (Energy Efficiency Ratio). The EER rating cannot be used in this spreadsheet to estimate heating costs.

Estimated, because no official or standardized testing and rating system in place for measuring heating efficiency.

TECHNICAL NOTE: AIR-SOURCE HEAT PUMPS, with electric resistance auxillary heat.

The actual heating efficiency and seasonal performance of an air-source heat pump that uses electric resistance heating as the auxillary he source may vary significantly from the rating it receives when tested under the standard procedures and conditions that manufacturers use t determine heat pump efficiency. For a detailed discussion of this issue, see the article:
"Climate Impacts on Heating Seasonal Performance Factor (HSPF) and Seasonal Energy Efficiency Ratio (SEER) for Air Source Heat Pum Fairy, et al, *ASHRAE Transactions* , American Society of Heating, Refrigerating and Air Conditioning Engineers, Inc., Atlanta, GA, June 200
http://www.fsec.ucf.edu/en/publications/html/fsec-pf-413-04/
The method in the form of the regression equations presented in that paper is used in this "calculator" for calculating an adjusted HSPF for "conventional" air-source heat pumps - those that use only electric resistance heating as the auxillary heat source. This method is assur to provide a rough approximation of the actual HSPF that a conventional air-source heat pump will experience in different locations in the US

SOLID-FUEL - WOOD, PELLET, CORN, COAL - HEATING SYSTEMS

There are no existing U.S. standards for the heating efficiency of solid-fuel combustion appliances. The U.S. Environmental Protection Ager sets standards for emissions from wood burning appliances. However, these do not directly correspond to the efficiency standards set by th U.S. Dept. of Energy for heating equipment using electricity, heating oil, natural gas, and propane.

The following are U.S. Environmental Protection Agency's documents with information on wood heater "efficiencies":
List of Certified Wood Stoves
http://www.epa.gov/Compliance/resources/publications/monitoring/caa/woodstoves/certifiedwood.pdf
Guidance for Quantifying and Using Emission Reductions from Voluntary Woodstove Changeout Programs in State Implementation Plans
http://epa.gov/ttn/oarpg/t1/memoranda/guidance_quantfying_jan.pdf

In lieu of another available published source, the default efficiencies used in this Calculator are the "net efficiencies" listed in "Table B-1 Summary of Woodstove Net Efficiencies" in the EPA *Guidance...* document above.

LINKS TO ADDITIONAL RESOURCES

DOE Appliance Energy Efficiency Standards Program
http://www1.eere.energy.gov/buildings/appliance_standards/

DOE/EPA Energy Star Program
http://www.energystar.gov

DOE Information for Consumers On Space Heating, etc
www.energysavers.gov

Federal Trade Commission - Appliance Labeling
www.ftc.gov/bcp/conline/edcams/eande/index.html

Residential Heating and Cooling Appliances - All Types
Directory of Certified Performance
http://www.ahridirectory.org/ahridirectory/pages/home.aspx
published by the Air-Conditioning, Heating, and Refrigeration Institute
http://www.ahrinet.org/

Geothermal Heat Pumps
Geothermal Heat Pump Consortium (GHPC)
www.geoexchange.org

International Ground Source Heat Pump Association (IGSHPA)
www.igshpa.okstate.edu

National Ground Water Association (has information on "water-source" geothermal heat pumps)
www.ngwa.org

Wood, Pellet, Corn (kernel) and Coal Heaters
U.S. Environmental Protection Agency
http://www.epa.gov/burnwise

Hearth Education Foundation
http://heartheducation.org

Hearth Net
http://hearth.com

Wood Heat.org
www.woodheat.org

Heating With Wood , Clemson (University) Extension, 2004.
http://www.nasdonline.org/docs/d001201-d001300/d001235/d001235.html

Pellet Fuels Institute
http://pelletheat.org

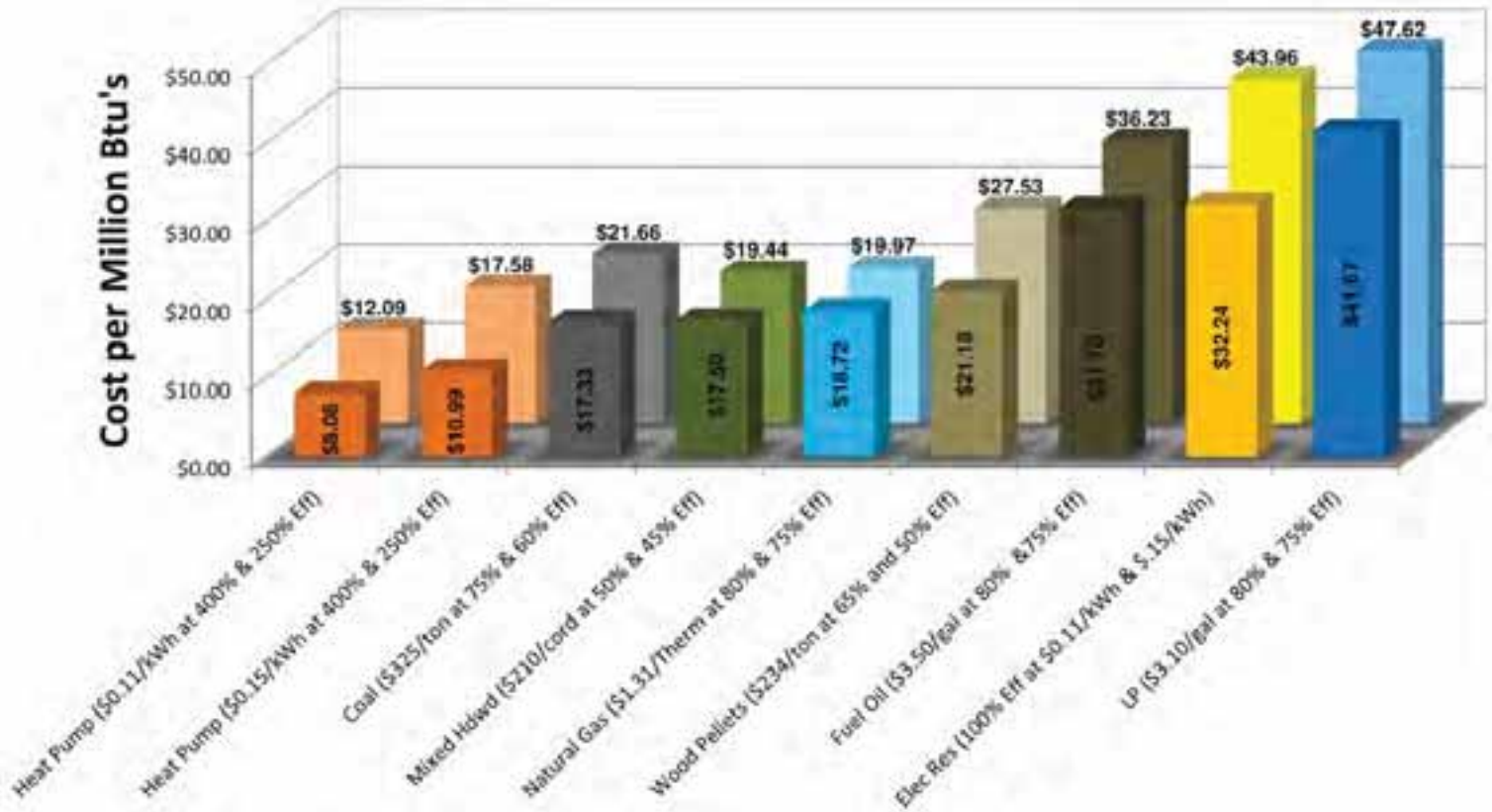
Corn (kernel) Burning Stoves
http://energy.cas.psu.edu/energycontent.html

Professional Trades Associations
Air Conditioning Contractors of America (ACCA)
www.acca.org

American Society of Heating, Refrigerating, and Air-Conditioning Engineers
www.ashrae.org

Air-Conditioning, Heating, and Refrigeration Institute
http://www.ahrinet.org/

Relative Cost of Various Heating Methods



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Programs & Incentives

Programs Available through Efficiency Maine:

Power Saver - A new program where HUD and Efficiency Maine have teamed up that allows homeowners who want to weatherize their homes to save energy and costs may receive loans up to $25,000 @ 4.99% interest with no closing costs.

- Projects must reduce energy consumption and cost by a minimum of 20%
- Must meet eligibility requirements
- Receive an energy assessment by approved energy advisors
- Apply for loan
- Use registered contractor

PACE Loans - A program that allows homeowners who want to upgrade heating systems, weatherize, or make home improvements to save energy to receive loans up to $25,000 @ 4.99% interest with no closing costs.

- Must meet eligibility requirements
- Receive an energy assessment by approved energy advisors
- Apply for loan
- Use registered contractor

Renewable Energy - State and Federal incentives available up to $2,000 available for solar thermal, solar electric, biomass heating, and wind energy

Refrigerator Recycling - Refrigerator picked up for free and receive $50

Appliance Rebates - Purchase ENERGY STAR® washers, refrigerators, and dehumidifiers and receive a $25 -$50 mail-in refund incentive

Residential Lighting - Efficiency Maine provides a list of retailers they have worked with to negotiate lower cost energy efficient lighting products

Electricity Monitor Loaner - A program that many Maine state libraries will loan out electricity monitors free of charge allowing consumers to assess electricity consumption and cost of appliance use

http://www.efficiencymaine.com

Summary of Bills Related to Residential Energy

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Programs Available through Efficiency Maine:

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http://www.efficiencymaine.com

Bill #	Title
LD 795	An Act to Expand Net Energy Billing
LD 476	An Act to Establish a Sales Tax Holiday for Energy Efficient Appliances and Fixtures
LD 761	An Act to Provide Rebates for the Purchase of Certain Solar and Wind Power Equipment
LD 1066	An Act to Increase Home Weatherization and Energy Independence
LD 1204	An Act to Create Jobs through Home Energy Efficiency
HR 882	Home Energy Affordability Tax Relief Act of 2011

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Bill #	Title	Sponsor	Description	Link
LD 795	An Act to Expand Net Energy Billing	Sen. Whittemore (Somerset)	This bill defines "eligible customer" for the purposes of net energy billing and requires the PUC to permit net energy billing of any eligible customer that has legal rights to energy generated by an eligible generator located within the same transmission and distribution utility service territory as the eligible customer.	http://www.mainelegislature.org/legis/bills/display_ps.asp?ld=795&PID=1456&snum=125
LD 476	An Act to Establish a Sales Tax Holiday for Energy Efficient Appliances and Fixtures	Rep. Edgecomb (Caribou)	Set a state tax holiday for energy efficient appliances & fixtures for April 18. Died on adjournment.	http://www.mainelegislature.org/legis/bills/display_ps.asp?ld=476&PID=1456&snum=125
LD 761	An Act to Provide Rebates for the Purchase of Certain Solar and Wind Power Equipment	Rep. Berry	Originally to re-establish the solar and wind energy rebate program. Amended to allow for rebates for renewable energy technologies to be eligible for funding from the Renewable Resource Fund rather than reinstating an assessment on electricity for the purpose of providing rebates for certain solar and wind technology, as proposed in the bill. The amendment also adds an appropriations and allocations section.	http://www.mainelegislature.org/legis/bills/display_ps.asp?ld=761&PID=1456&snum=125
LD 1066	An Act to Increase Home Weatherization and Energy Independence	Rep Beliveau (Kittery)	This bill establishes an assessment on #2 heating oil, kerosene and propane to fund weatherization and heating fuels efficiency programs. It provides a rebate for low income households until the household participates in weatherization or heating fuels efficiency programs. Indefinitely postponed despite passing initial votes in Maine Senate, House	http://www.mainelegislature.org/legis/bills/display_ps.asp?ld=1066&PID=1456&snum=125
LD 1204	An Act to Create Jobs through Home Energy Efficiency	Rep. Celli (Brewer)	The bill establishes the Maine Residential Energy Conservation Program within the Efficiency Maine Trust. It requires an owner of a residential property who is applying for a permit for substantial renovation of a residential structure or a seller of a residential property to obtain an energy audit by an energy advisor, providing a copy of the audit report to a buyer in the case of a sale. DEAD	http://www.mainelegislature.org/legis/bills/display_ps.asp?ld=1204&PID=1456&snum=125
HR 982	Home Energy Affordability Tax Relief Act of 2011	US Rep. William Owens (NY-23)	Home **Energy** Affordability Tax Relief Act of 2011 or the HEATR Act of 2011- Amends the Internal Revenue Code to allow an individual taxpayer an income-based refundable tax credit for **energy** costs for the taxpayer's	http://thomas.loc.gov/cgi-bin/bdquery/D?d112:1:./temp/~bdytgL::|/home/LegislativeData.php|

			principal residence. Limits such credit to the lesser of 33% of such costs or $500. Terminates such credit on December 31, 2012. Last action: Referred to the House Ways & Means Committee (3/911)	
S. 1914	Cut Energy Bills at Home Act	US Sen. Olympia Snowe (ME)	Cut **Energy** Bills at Home Act - Amends the Internal Revenue Code to allow individual taxpayers a tax credit for the cost of a qualified whole home **energy** efficiency retrofit for the purpose of reducing the **energy** use of the taxpayer's principal residence. Limits the amount of such credit to the lesser of $5,000 or 30% of the qualified home **energy** efficiency expenditures paid by the taxpayer to reduce **residential energy** use. Sets forth requirements for a qualified whole home **energy** efficiency retrofit, including design, testing, and documentation requirements. Terminates such credit after 2016. Directs the Secretary of the Treasury to establish a review process for home **energy** efficiency retrofits, including an estimate of usage of the tax credit and an analysis of the average actual **energy** use reductions. Introduced 11/18/11; Read twice and referred to the Senate Finance Committee.	http://thomas.loc.gov/cgi-bin/bdquery/D?d112:8:./temp/~bdytgL::|/home/LegislativeData.php|
S. 1126	REAL Act of 2011	US Sen. Sheldon Whitehouse (RI)	Renewable **Energy** Access Through Leasing Act of 2011 or the REAL Act of 2011- Amends the **Energy** Independence and Security Act of 2007 to authorize the Secretary of Housing and Urban Development (HUD) to make loan guarantees for the financing of renewable **energy** systems leased for **residential** use. Introduced 5/26/11 and referred to the Senate Energy & Natural Resources Committee	http://thomas.loc.gov/cgi-bin/bdquery/D?d112:7:./temp/~bdytgL::|/home/LegislativeData.php|
		Sen Collins	Home boilers allowed to be finance by FHA	

Marketing

Audience Attributes

Tactics 18 – 35 Age Group

Create a Facebook group where this group could share ideas and best practices, post heating options and information.

Facebook page could link to links to:

1. YouTube videos (content informational and amusing)
2. App which could be an energy calculator and house information to links to retailers, etc.

Partner with Google to develop an approach to provide information to the masses on energy.

Tactics 66+ Age Group

Use community members like SMAA, Home Heating Innovation (HHI), Maine Community Action, etc. to propagate information.

Create a Community Bank Campaign for Home Heating Education for Seniors by bringing together Maine banks to focus on the elderly population of their customers who, most likely, still conduct banking through a physical branch. The branch could display information and educational pieces around essential heating options.

Tactics 36 – 65 Age Group

Marketing campaign partner: Example: Ben & Jerry's

1. Create a customized flavor (have a contest to create the flavor)
2. Create customized pint containers with info on the packaging
3. Use wrapper delivery trucks displaying the flavor and cause
4. Spack on Ben & Jerry's website
5. Sampling tables and displays at grocery stores

Funding for Outreach:

- In-events of grouse review and public donations
- $250K goal for outreach program

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Audience Attributes

Age Range	Attributes
18 – 35	Buying their first/starter home Environmentally aware Technology savvy, users of Facebook, YouTube, applications on smart phones and tablets
36 - 65	Higher disposable income, purchasing second home (customize and can afford to invest in latest and greatest options) Learn and do research via a combination of Facebook, Google and information gathering via literature Face to face consultations are important Pick up information from exposure to data through day-to-day activities like at the grocery store (Ben & Jerry's example)
66+	Retirement age, downsizing, fixed income, $ mean more than environmental concerns Use community partners/agencies, newspaper, mail distribution, and television campaigns to gather information

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Tactics 18 – 35 Age Group

Create a Facebook group where this group could share ideas and best practices, post heating options and information.

Facebook page could house links to:

1. YouTube video (content informational and anecdotal)
2. App which could be an energy calculator and house information to links to retailers, etc.

Partner with Google to develop an approach to provide information to the masses on energy.

Tactics 36 – 65 Age Group

Marketing campaign partner: Example: Ben & Jerry's

1. Create a customized flavor (have a contest to create the flavor)
2. Create customized pint container with info on the packaging
3. Use wrapped delivery trucks displaying the flavor and cause
4. Space on Ben & Jerry's website
5. Sampling tables and displays at grocery stores

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Tactics 66+ Age Group

Use community members like SMAA, Home Heating Association (DHHS), Maine Community Action, etc to disperse information.

Create a Community Bank Campaign for Home Heating Education for Mainers by bringing together Maine banks to focus on the elderly population of their customers who, most likely, still conduct banking through a physical branch. The branch could display information and educational pieces around residential heating options.

Funding for Outreach:

ID sources of private sector and public donations
= $250k goal for outreach program

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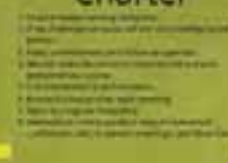
Reflections on Our Process

Charter



Initial Scoping Involved Most Team Debate - Agreeing on Task Was Hardest Part

Initially Focused on Electricity Costs

- Independent Research into Drivers Followed by Group Discussion: Obvious Solutions Lie in Redefining Very Complicated Markets = Conclusion (By Concensus) Little Upside for Further Team Exploration

Next, Explored Oil Heat Dependence

- As Much or More Challenging for Home Owners (as Electricity), with More Opportunities to Take Personal Action: Conclusion (By Concensus) Something That Team Can Get Arms Around, More Tangible = Worth Pursuing

Divide into Four Sub Teams: Technology Options, Economic Review, Programs/Incentives, Marketing

- Independent Research & Summaries Back to Team; Followed By Group Discussion
- Mostly Met Around Regularly Scheduled Meetings with Some Sub Team Calls/Meetings

Very Little Conflict -- Equally Busy Team Members, Defined Roles Enabled Independent Progress Toward Group Goal

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Charter

1. Ensure respect among the group.
2. If we challenge an issue, we are not challenging the person.
3. Keep commitments and follow an agenda.
4. We will make decisions by majority and support, everyone has a voice.
5. Live transparency and inclusion.
6. Rotate facilitator after each meeting.
7. Meet at a regular frequency.
8. Methods of communication may include email, conference calls, in-person meetings, and Base Camp.

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3 Recommendations

Create & Sustain Information Clearing House for Alternatives to Oil Heat

Encourage/Require/Allow Off-Peak Electricity Rates for Home Heating

Approve New Financing Options: e.g., Variants on PACE, Rate-Payer, On-Bill Financing

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