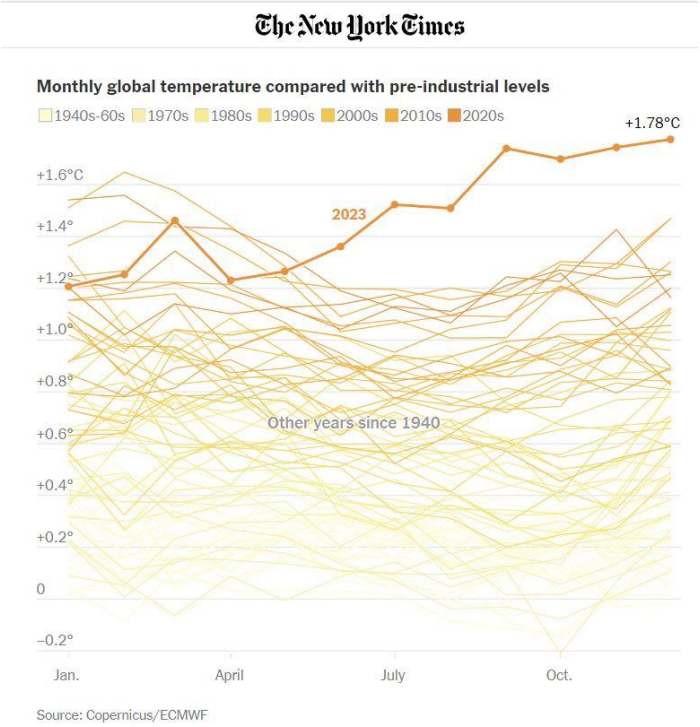
Jan 9th 2024 Climate Meeting Heat Pumps

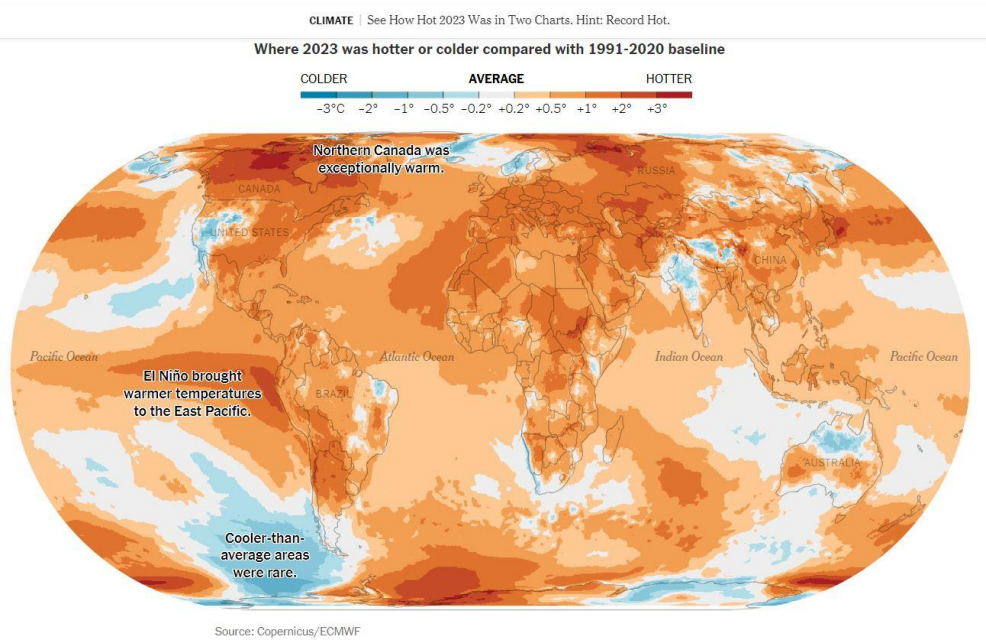
You can find the full recording of the meeting on youtube. You can search on youtube for “Ely Climate Group” or go here: https://www.youtube.com/channel/UCFYEXa0qx5p9Nb25QBXhgbg

This is a summary of the discussion.



This meeting is about heat pumps. But first a small digression. Here are 2 amazing items just released about the state of our planet in the year 2023.

The first graph shows the average global temperature by month for each year since 1940. 2023 was hotter than all prior years from June through December. This has been attributed to a combination of climate change and El Nino. The global average for the year was 1.48C above preindustrial conditions, close to the somewhat arbitrarily set 1.5C goal. That goal will not be deemed broken until many years’ global averages exceed 1.5C



The geographic distribution shows that almost (but not all) all areas were warmer than the recent average including most of the USA.

Note that heat pumps help with cooling as well as heating your home.

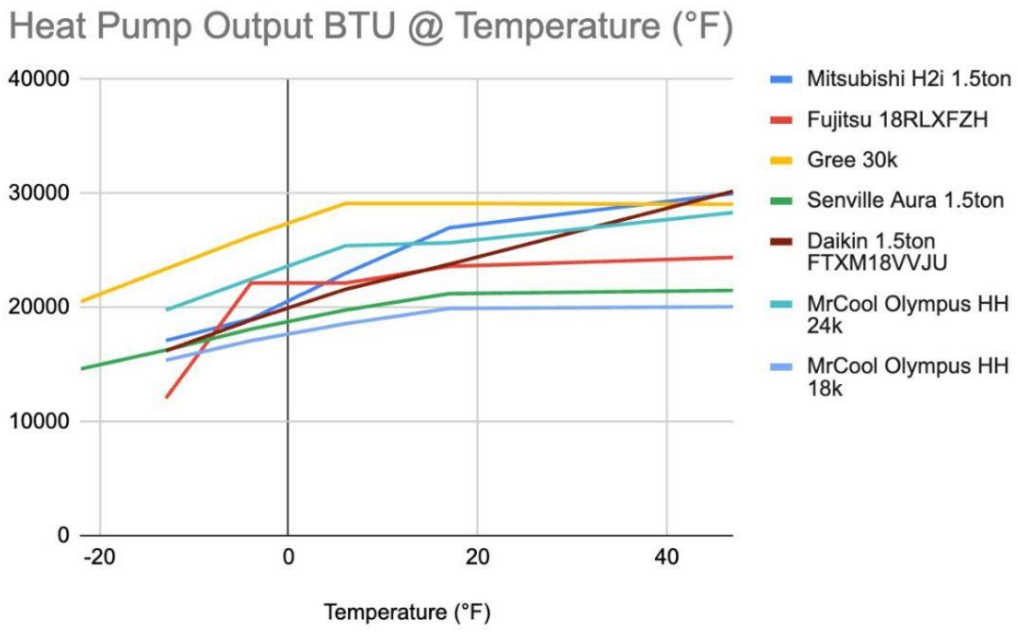
Air source heat pumps can provide efficient heating and air conditioning, saving GHG emission and monthly bills. Rebates and tax incentives are available through the federal IRA and MN state programs.

Hudson set the scene using an article from the Guardian which describes how these devices work. You can find it here: https://www.theguardian.com/technology/ng-interactive/2023/dec/23/heat-pumps-science-visualised

If you have a fridge in your kitchen, you have a heat pump. It moves heat from the air (and hence the contents) inside of your fridge to the air in the kitchen. The fridge gets colder and the kitchen gets warmer. A heat pump for a house in winter heating mode, moves heat from the air outside the house (which gets colder) to the inside of your house which gets warmer. In summer in reverse mode it moves heat from the inside of your house and dumps it outside becoming an air conditioner. Because the pump does not MAKE heat but just MOVES it, it can have efficiencies better than 100%. So compared with electrical resistance heating it can be up to 3 times more efficient. However the colder the outside air, the lower the heat pump efficiency.

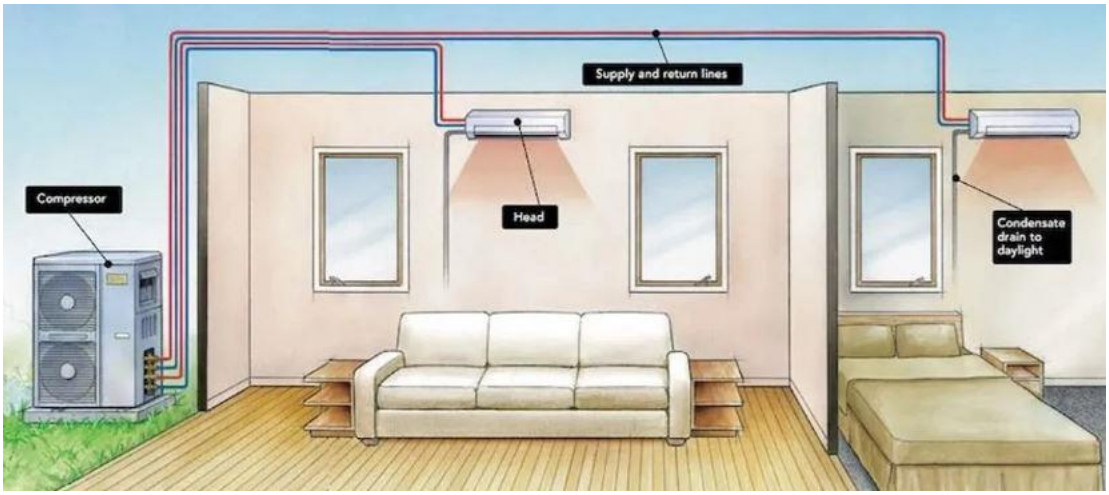
It can be surprising that there is a lot of energy available in the cold outside air. Air at 0F contains 88% as much thermal energy as air at 50F. But if you want the inside of the house to be at temps comfortable for humans you have to push that outside heat up a bigger temperature gradient when it is cold outside. That makes for a lower efficiency.

The graph shows how the performance of actual heat pumps changes with outside air temperature.



Some manufacturers make heat pumps optimized for colder temperatures, these are the units to look for in our northern climate. Hudson is happy with his 3 ton Daikin Aurora unit. It is recommended that for times when the outside temperature goes below -10F to -20F you maintain a supplementary heat source to keep your home comfortable. Our Minnesota night time winter low temperatures are less severe than 20 years ago, but it does still occasionally happen.

This is what the physical setup looks like. There is an outside unit called a compressor. This extracts heat from the outside air and transfers it to the fluid in thee supply and return lines. Heat is then extracted from the warm fluid in the “head” inside the house. A fan pushes the heat into the room. A compressor can drive more than one head. This system is called a “mini-ductless” setup. If your house already has a furnace that feeds heat around through ducts, there are heat pump formats that can feed heat into your ducts instead of using the “heads” show here.



Here are some of Hudson’s slides

- But heat pumps don’t only make your house more hot/cold without burning stuff, they are also **extremely efficient**.
  - Normal electric heating can produce about **95 kwh** of heat with **100 kwh** of energy.
  - Heat pumps can produce about **270 kwh** of heat with **100 kwh** of energy.
  - Ground source heat pumps are more efficient than that because they are drawing from a consistent source.
  - By contrast, green hydrogen furnaces in the home would produce about **46 kwh** of heat with **100 kwh** of energy.
- Heating can be a huge cost to rural and low-income people. Along with weatherization, changing to more efficient heating allows folks to save money while living considerably cozier lives.

- The International Energy Agency’s “1.5 Celsius” analysis requires exponential installation of new heat pumps by 2030
- “Around 10% of space heating needs globally were met by heat pumps in 2021, but the pace of installation is growing rapidly with sales at record levels. . . . The IEA estimates heat pumps globally have the potential to reduce global carbon dioxide (CO_2) emissions by at least 500 million tonnes in 2030 – equal to the annual CO_2 emissions of all cars in Europe today.”
- Government support up front is necessary, 30 countries have supports for heat pumps already.
  - Minnesota is doing well on promoting heat pumps, but big things on the horizon!

Hudon and Maggie have 3 indoor heads in the kitchen (left) bedroom (center) and hallway (right). The compressor is just outside the kitchen. 3tons is not the weight of the unit, but it's a measure of the heating/cooling power. The compressor supplies heat (or cold) to coils in the heads. The fan inside the head moves the room air over the coils heating or cooling the room. These 3 units heat the part of the house used the most and keeps the whole house warm. The original heating system is in reserve for extreme conditions. Warranties on these units is about 15 years, they should run a good long time. The cost was $13,000. There are subsidies and tax breaks – more on those soon.

There are heat pump systems that heat water for radiators or under floor heating coils, and systems that interface with an existing forced air system. Some of these are fairly new technology.

At -18F Hudson's system turns itself off, otherwise it runs continually. It is important to keep it free of ice and snow. The compressor is usually placed above the ground maybe 18" high and must be shoveled out from snow drifts after a big snow storm. You can build a snow fence or a roof for it as long as the air flow is open.

Hudson's Experiment:

Hudson's system was installed in the summer of 2022. Here is hiis electrical energy use for the winter of 2021/22 though December 2023. The blue line is typical outside temperature. The brown shows the energy use. Dark brown is cheaper power for heating and light brown is regular power. Before the heat pump the energy use and bills were high.In one week in Jan 2022 they used 900 kWh electrical energy to run baseboard heaters. For 2022/23 winter usingg the heat pump the use was considerably less (typically 150 kWh per week) and so far this winter it remains low.

There are also heat pump water heaters. These take heat from the air arund the heater and move it into coils that heat the water. These also save energy.

Heat pumps and efficiency – Hudson's experiment

There are tax rebates and incentives. Some of these have not yet been activated. Rebates are getting better as states get their beaurocracy organised. These refunds "stack", you can add them together. In some cases (especially people with lower income) you can get up to $15,000 off the cost! Note that houses running off solar power that are not grid tied usually do not have enough solar panels or batteries to run a heat pump.

Heat pumps and incentives - $$$$$$$$$$

- From the federal IRA there are both Tax Credits and Rebates:
  - Tax Credits of $2000 per heat pump available now
  - Rebates can go as high as $8000 (but are tied to income)
- From your utility there are likely rebates:
  - Minnesota Power gives between $400-$1000 rebate for heat pumps (depending on type and whether they're for cold weather climate), for air-to-water it can go higher
  - Lake Country Power has similar rebates
- State of Minnesota rebate (not here yet) is set to be $4000 more!

This means that you could get anywhere between $3000 and $15,000 off the price of a heat pump!

General Discussion:

Q. Why not use ground source heat pumps? Has anyone dome that?

A. Yes, several places have used it and it works beautifully as the depp ground stays much warmer than the cold winter air. The main issue is the rocky ground making installation very expensive in most local sites. Using lake water as a heat source is almost certainly illegal.

Q . How well do heat pumps work as air conditioners in the summer?

A. Experience shows that they perfom well, make lots of cold air and are efficient. People in hot climate are installing them promarily for cooling.

Q. Is the compressor noisy?

A. Hudson cannot hear it inside the house. Outside can hear the fan which runs constantly with no click or on/off cycles.

Q. This seems experimental. Are there studies on efficiencies of various units?

A. You can get good information from the Minnesota Air Sounrce Heat Pump Collaborative. This is well established technology that saves energy and carbon pollution. It will continue to improve and mature. Before you install get an energy audit on your home to see where the heat leaks can be fixed. Contact CERTs (Clean Energy Resource Teams) for an audit. There may be a small fee.

Q. As the grid gets cleaner the carbon savings of a heat pump decrease, although it may still save $$.

A. Yes, but with a heat pump 3 houses can be made comfortable with the energy that used to be used to heatt just one house. More people can live in comfort.

Note: On the afternoon of Feb 3rd (Saturday of winter festival) at the DQ there will be demo of a variety of new EVs. You can take one for a test drive and get some hot chocolate. The DQ has installed 6 new pretty fast EV chargers.