

# Emerging Air-to-water Heat Pump Technology Holds Promise to Remain Operable Down to -30°F

Ryan Moag  
and Margaret Richards

Efforts to decarbonize are taking our nation's buildings sector by storm, with New York State at the forefront of policymaking for climate-friendly buildings. Given that fossil fuel-supported building operations are responsible for 43% of New York State's annual emissions, legislators have set in motion an effort to completely decarbonize six million buildings. The mass departure from fossil fuels is already well underway, with two million homes and buildings on track to be equipped with heat pumps for electric heating and cooling by 2030. This progress is encouraging, but the road to electrifying HVAC in New York and the nation as a whole remains a long one. As of 2020, 52% of U.S. households still use natural gas appliances for space heating. This state of affairs poses substantial technical challenges for utilities and HVAC equipment manufacturers alike.

On the utility side, grid capacity remains a substantial barrier to complete electrification; As things stand, fossil fuel appliances account for trillions of BTUs of energy consumption annually. Although heat pumps are hyper efficient, if we were to displace every fossil fuel heating system overnight, the grid capacity does not yet exist to support it. Along the same lines, a great deal of energy is wasted maintaining capacity in reserve for peak demand. During the summer months back-up generation is left idling in anticipation of spikes in cooling loads. Replacing all fossil fuel heating systems with electric systems has the potential to create a second winter-time peak that utilities will have to account for. In other words, the supply side will need sufficient preparations to accommodate a world where the energy needs of all residences are met sustainably.

This is not to say that we should be discouraged about our efforts to completely electrify HVAC in this country and abroad. Jettisoning fossil fuels from every aspect of our life remains the only real option we have. While many people are working on the issues we have raised on the utility side, it is important to remember that this transition will likely require millions of individual home owners to willingly adopt a new technology at their own expense. It can be difficult to convince people to change how they heat and cool their homes – after all, when an old system fails, homeowners tend to simply replace what was there before.

With these obstacles in mind, the rapid decarbonization of the residential energy sector will require a more holistic approach than installing an air-source heat pump in every household. While a complete revision of our energy infrastructure will bring us in sight of the finish line, if no attention is paid to the habits and preferences of the individual consumer, we may still fall short.

## Air-to-water Heat Pumps

There's a reason that split-system air-source heat pumps are at the center of state and federal climate policy. They



A battery of air-to-water heat pumps provides heats and cools an 18,000 square foot concrete slab of the Basilica Hudson, a popular venue for performances and events in Hudson, New York. The Basilica (on the right) will meet all of their energy needs this year with clean HVAC technologies powered by an on-site solar-photovoltaic system. (Courtesy photos)

are exceptionally efficient, cost effective, and can easily be used to retrofit most standard residences and light commercial buildings. They emit at least three times less greenhouse gasses than the best fossil fuel sources, and their life-cycle emissions will be further reduced as the power grid shifts to carbon free electricity generation.

Government sponsored tax credits and rebates for air-source heat pumps have been instrumental in making the environmentally responsible choice financially favorable. Thus far these programs have been successful in their aim to persuade.

That being said, there remain a few areas where fossil fuel systems retain an edge. For example, heat pumps can produce heat extremely efficiently, but most compressors and common refrigerants are not designed to



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# Mother Nature's Takeover of Our Climate System



Dr. Alan K. Betts

This is a review of the takeover of the climate system by the living Earth, colloquially known as Mother Nature, in response to the refusal of global societies to significantly

reduce the burning of the fossil fuels that are driving the extreme climate change destroying life on Earth. So it covers issues beyond the conventional science perspective. The framework is based on two papers published at alanbetts.com/research in 2022 and 2023 [2, 3].

In 1976, I realized we were heading for a climate disaster because our leaders did not accept responsibility for the Earth. I had unusual PhD training from Frank Ludlam, who could look at the sky, clouds, and winds and infer a complete forecast of the weather. No one else could, so he became the in-flight real-time forecaster on the bomber missions over Europe in WW2. I learnt from him that if an issue was critical and you could see possible solutions, it was your responsibility. In my case the issue was climate change. So, in parallel with my climate research career, I restructured my life, bought land in Vermont and built a passive solar house with a few solar panels.

Then in 1980, I posed the question: "How do we merge science with wisdom?" I was sent to Tiruvannamalai in southeast India. To my utter surprise, as I sat in a meditation room upon arrival, the Creator took me through my whole life to show me it was all known to her — leaving me ecstatic, transformed with the tools needed to understand living saints and sages.

These are four keys for understanding the living Earth in human terms.

First, the shift to a more colloquial image "Mother Nature is taking over the climate system" is powerful, because this indigenous concept is understood by local communities. It has another huge advantage that it is also free from the male power syndrome that has been dominant for thousands of years and has contributed so much to the exploitation of people, the planet and the current destruction of life on Earth for profit.

## CLASH OF REALITIES

### MOTHER NATURE

- Indigenous world
- Preserve web of life
- She is the Truth that sets you Free
- Power Unlimited
- Join her: she can help you!

### CAPITALISM/FOSSIL EMPIRE

- Human/natural resources
- Exploit people and the Earth for profit
- Maximize \$ profit
- Use money and lies to bribe and control
- "We're in charge"

This Figure from three frames the clash of realities between Mother Nature's powerful perspective and the 45 years of criminal behavior by the capitalist 'Fossil Empire'.

The second is that, for European culture, the Council of Nicaea in 325 AD was critical.

The Roman Catholic Church was created to meet the needs of the Roman Emperor Constantine for male power for warfare and over women, Indigenous people and nature. Constantine insisted that the Aramaic gospels of the Indigenous Aramaic-speaking teacher Yeshua (whom we know as Jesus) be destroyed, because they referred to the birther of the cosmos and the creation — a female concept. The original Aramaic gospels have only recently been retranslated. The male Catholic priests worshiped a male god safely removed to heaven, so he would not interfere with their human power. Indirectly, the priests ruled societies and influenced the rise of science for more than 1,500 years. Christianity split into many groups, but almost none understand how Yeshua and his disciples as indigenous people revered women, and chose the truth of Mother Nature over male power. In the present era, Pope Francis understands many of these issues, and has pushed successfully for wise strategies



Mother Nature is hot. (Flickr/Philip Edmondson)

on global climate change, and apologized for the abuse of women and indigenous people by priests. Other male power groups like the Southern Baptists still allow their priests to rape women.

The third is that the Indigenous world view which understands Mother Nature takes precedence over amoral capitalism. Historically,

this relates to why European and North American societies tried so hard to stamp out indigenous thought, and suppress the culture. For many centuries, Catholic priests supervised the killing of millions of Indigenous people, both to seize their land, and because they feared the Indigenous teachers, who had a better understanding of the teachings of the Indigenous Jesus. On a more humorous note, there are three groups of Indigenous people across Canada, who are associated with three sets of grizzly bears that have not interbred in the past thousand years. Scientists are puzzled how this is possible. But the Indigenous people laugh. They are "our bears" — we have been together through the seasons for a thousand years.

Will you come into the forest so you can meet mine?

The fourth is the powerful concept that it is the "Truth that set us Free" to act on behalf of the Creation and Mother Nature. We attribute this deep understanding to the Indigenous Aramaic teacher Yeshua. He had an intimate connection to the Creation, and embraced women as his disciples, so the Jewish and Roman authorities had to kill him, since he was a threat to their male power. However, it is important to understand that the overt takeover of the climate system by Mother Nature is not a religious issue. It is just the reality of the entire web of life and the Creation here on Earth that Yeshua understood so well. However, this truth is still today a direct threat to human power over nature. Many believe we are the "only" intelligent species and that we are "in charge." Apart from indigenous people, we are the only species on Earth that does not listen to, or communicate directly with Mother Nature, even though we could. The Fossil Fuel Empire lies to bury the fact that "business as usual capitalism" is destroying the stable climate system and much of life on Earth for profit. So Mother Nature, which is far more powerful than we are, appears to be taking over on behalf of all of life on Earth. Buried in well-funded webs of lies, very few in our world can face the truth.

The younger generation must face the truth of the real world we live in, which means also stepping into a frame where Mother Nature can read their minds and help them in deeper collaboration. All the work you do to help the renewable transition will then benefit.

The sequence of papers on my experience are at alanbetts.com/research. The first in an introduction to climate change and the Fossil Empire. The second is a review of my life and journey. The third has this review in the introduction.

(1) Betts AK, (2021). *Climate Change and Society*. AIMS Geosciences, 7, (2): 194–218. DOI: 10.3934/geosci.2021012. (2) Betts A.K. (2022): *The Earth's view of climate change*. AIMS Geosciences, 8(2): 224–232. DOI: 10.3934/geosci.2022013. (3) Betts, A. K. (2023): *Accelerating Climate Change and the Living Earth*. *International Journal of Environment and Climate Change*, 13, 2, pp 1-11. DOI: 10.9734/ijec/2023/v13i21639

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## Emerging Air-to-water Heat Pumps – Cont'd from p. 21

reach the temperatures most traditional water-based space heating requires.

A heat pump system that can act as a turnkey replacement fossil-fuel boiler would enable a more rapid adoption of clean heating and cooling equipment. Hydronic (water-based distribution) space heating has long been appreciated for its exceptional comfort and effectiveness. Radiative heat transfer over a large surface can be better for people with allergies because it doesn't distribute allergens like forced air systems can.

Until recently, ground-source heat pumps (also known as geothermal) were the primary means of providing hot-water for residential space heating using the heat pump concept.

Geothermal systems are highly effective, but they come with a substantial installation cost as a typical system's heat exchanger requires a large trench to be dug. In recent years, a few promising alternatives have hit the market. Air-to-water heat pump manufacturers like Spacepak and EnerTech have developed systems capable

of providing space heating, cooling and domestic hot water in a single package. These systems can run a low-temperature radiant loop year-round without a backup. They can remain operable down to -30°F and can meet building energy demands at a level of efficiency approaching that of a geothermal system. However, these systems do not necessarily function as a direct replacement for the average boiler. With lower water temperature output, these systems often require additional points of distribution.

This means more radiators, air handlers or a larger radiant loop. These products are still an excellent choice for consumers who want climate-friendly water-based HVAC systems, but industry leaders are determined to take their designs a step further.

### What's on the horizon?

Carbon dioxide is a substance that we have become all too familiar with due to the deleterious effects of its steadily increasing concentration in our atmosphere. Ironically, it may play an important role in

our transition to more sustainable heating and cooling technologies.

Carbon dioxide when utilized in a heat pump system as a refrigerant can enable heat pumps to produce much higher water temperatures. Industry leader Mitsubishi has launched a commercial hot water system using carbon dioxide to efficiently produce high volumes of domestic hot water, and a number of carbon dioxide based boiler replacements have just begun to be commercialized. In 2022, a multinational Swedish company - Vattenfall successfully launched a direct boiler replacement that is now available in its local market. It won't be long until comparable products reach the United States. It is also worth noting that these systems come with the added benefit of using a refrigerant that has a much lower warming potential than common refrigerants like R-410a.

Heat pumps continue to defy their historical limitations as manufacturers continue to iterate on their functional designs and new competitors enter the market. Combustion processes are inherently less efficient than the vapor-com-

pression refrigeration cycle. If heat pumps can be brought to market that can provide the same functionality as their fossil fuel equivalent, then the path to electrification begins to seem inevitable. Legislators should be swift to update existing programs to support these technologies as they are rolled out, and fortunately for those residing in New York and Massachusetts, more funding is now on the table.

For Massachusetts residents, you may be eligible for up to \$10k per home for an air-to-water heat pump system through the Mass Save® Program. New York has also recently begun to weave air-to-water heat pump systems into their regulatory framework. New incentives for heat-recovery systems and heat-pump chillers through the Clean Heat Program were announced on September 1, 2023. If you're in the market for a new boiler – first consider if an air-to-water heat pump system might be a better choice.

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