Picking Winners

Are geothermal heat pumps economically sustainable in an unsubsidized market?

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The U.S. geothermal heat pump industry was breaking out the champagne on Feb. 9, 2018. That's the day President Donald Trump signed the Bipartisan Budget Act of 2018, a bill that boosted government spending by hundreds of billions of dollars. A tiny part of that bill served as the "sled" for reinstating the 30% federal income tax credit on geothermal heat pump systems that had expired on Dec. 31, 2016. Those credits, which were originally put in place in 2009 as a *temporary* way to stimulate market growth, are now back in place through the end of 2022.

Those who took their chances with geothermal heat pump installations during 2017 also had reason to celebrate. The same spending bill made the tax credits retroactive to Jan. 1, 2017. It is as if the 30% federal tax credits never went away at the end of 2016.

The geothermal heat pump industry maintained an aggressive lobbying effort spanning more than 13 months that resulted in achieving, in their words, "equity" with other tax credits for renewable energy sources such as solar photovoltaic, solar thermal and wind energy systems.

Meanwhile, other heat pump systems (air-to-water and ductless mini-splits), as well as wood and pellet-fired boilers, all of which use a combination of renewable fuels and electricity (from a variety of sources), go without subsidies.

Is that "equitable?" Draw your own conclusions.

The reality of what happened on Feb. 9 is that efforts made by the geothermal heat pump lobby, combined with the manner in which federal legislation is crafted, bartered and eventually passed, paid off. The 30% tax credits are once again the law, and the American HVAC industry can and should use them to their fullest advantage.

Economic sustainability

The "sausage-making" process used in developing federal legislation has never appealed to me. I'm more interested in the technical attributes of one approach versus another, assuming an unsubsidized free market.

So, for the sake of discussion, let's compare the performance of a typical geothermal water-to-water heat pump system to that of a low ambient air-to-water heat pump system. Let's assume that either heat pump could supply a low temperature radiant panel heating system in a relatively cold climate.

I made that comparison assuming that either heat pump was used in a house with a modest design load of 36,000 Btu/h located in Syracuse, New York. The total space heating energy requirement was estimated at 49.7 MMBtu / heating season based on the 6,720° F•day climate.

I used software available from a geothermal heat pump manufacturer to model the performance of the water-to-water heat pump. I also used software from a supplier of air-to-water heat pumps to model the air-to-water heat pump. The comparison was only for heating mode, which dominates in the upstate New York climate.

Each heat pump was assumed to supply a radiant panel heating system with a required supply water temperature of 110° under design load. Since the distribution systems are identical, I only compared the cost of the heat pump subsystems, up to the point where each would connect to the same buffer tank. The geothermal system was assumed to have a vertical earth loop, and the cost of that loop field were based on estimates obtained from a local drilling contractor. The operating cost comparison was based on the current average price for electricity of $0.10/kWh. The installed cost comparison does include the 30% federal income tax credit on the geothermal heat pump system (excluding distribution system). No tax credit or other financial incentive was assumed for the air-to-water heat pump.

Here are the numbers for each system:

GEOTHERMAL WATER-TO-WATER HEAT PUMP OPTION:

Based on simulation software, and a nominal 3 ton water-to-water heat pump supplying this load from a vertical earth loop has a seasonal COP = 3.28.

Estimated installed cost = $11,800 (earth loop) + $8,750 (balance of system) = $20,550

Deduct for 30% federal tax credit: (-$6,165)

Net installed cost: $14,385 (not including distribution system)

AIR-TO-WATER HEAT PUMP OPTION:

Based on simulation software, a nominal 4.5 ton split system air-to-water heat pump supplying this load has a seasonal COP = 2.8.

Estimated installed cost = $10,600 (not including distribution system)

ANNUAL SPACE HEATING COST COMPARISON:

Air-to-water heat pump (COPave= 2.8) = $520/year

Geothermal heat pump (COPave = 3.28) = $445/year

Difference in annual heating cost: $75/year

Difference in net installed cost: $3,785

Simple payback on higher cost of geothermal HP: 3,785 / 75 ≈ **50 years**

The geothermal heat pump definitely outperforms the air-to-water heat pump based on COP. However, you don't pay for COP. You pay for Kilowatt-hours of electrical energy used. Assuming that electricity prices don't increase, it will take about 50 years to pay for the higher installed cost of the geothermal heat pump. Needless to say, that geothermal heat pump is very unlikely to be operating on its 50th birthday.

The current 30% federal income tax credit for geothermal heat pump systems drops to 26% in 2020, and 22% in 2021. After that, assuming Congress doesn't reinstate the already reinstated credits, geothermal heat pumps will have to have to compete on the free market. What a concept.

If there were no federal income tax credit on either of the above heat pump options, the geothermal heat pump installation would be $9,950 higher than the air-to-water heat pump installation. At a current savings of $75 per year, none of us will live long enough to ever see the breakeven point.

Based on this comparison you might assume that I'm "anti-geothermal." That's not the case. Over the years I've designed several geothermal/hydronic radiant systems, and helped install some of them, including one in my own house. They've worked well.

Still, the day of free market reckoning is coming, and the hydronic heating pros who work with geothermal heat pumps need to be ready — 2017 provided a portent of what happens when significant cost subsidies are removed. The trade association **GeoExchange.org** reported a 50% drop in geothermal heat pump shipments during 2017. Ouch!

After the tax credits are gone, I'm sure there will be continued opportunities for geothermal systems, but, as past experience has consistently shown, the numbers will surely diminish in the post-subsidized market.

It's also likely that alternatives such as low-ambient air-to-water heat pumps will become increasingly competitive, as has happened in Asian and European markets. In June of last year, the Japanese HVAC publication JARN reported the 2017 global demand for air-to-water heat pumps was 2.66 million units.

My suggestion is to be ready.