December 16th, 2020

RE: Comments from Dandelion Energy on the EEAC Three Year Plan 2022-2024

Dear Mass EEAC Team,

Thank you for the opportunity to comment on the 2022-2024 Three Year Energy Efficiency Plans and share more information about the potential of geothermal energy in Massachusetts.

Dandelion is the leading residential geothermal company in the United States. We provide high-efficiency, ground source heat pumps (GSHPs) and are on a mission to democratize the geothermal market and enable any homeowner to afford and install a geothermal system and see instant energy bill savings. Harnessing the thermal energy in the ground beneath our feet, geothermal systems are the most efficient, reliable, and lowest carbon approach to electrifying home heating and cooling.

The geothermal industry is where solar and wind were 15 years ago. Customer adoption is just beginning to accelerate. Despite the high efficiency and tremendous potential of GSHPs, they currently account for only a small fraction of the heating and cooling market. This, historically, is due to higher up-front costs, low consumer awareness, and inadequate state incentives. Dandelion, through a combination of rapid technological innovation and economies of scale, is working to overcome the awareness and cost barriers.

Over 18.5 million households are heated with oil and propane nationwide[1], including around 750,000 in Massachusetts[2]. Nationally, Massachusetts ranks 3rd in terms of oil customers[3]. Massachusetts homeowners with dirty and expensive heating fuels, like oil and propane, should be offered adequate incentives to replace old systems with GSHPs

[1] EIA, Residential Energy Consumption Survey, 2015, https://www.eia.gov/consumption/residential/data/2015/hc/php/hc1.1.php
[2] US Census, American Community Survey, House Heating Fuel, 2018 Data, https://data.census.gov/cedsci/table?q=B25040%3A%20HOUSE%20HEATING%20FUEL&g=0400000US25&tid=ACSDT1Y2018.B25040&hidePreview=true
[3] US Census, American Community Survey, House Heating Fuel, 2018 Data, https://data.census.gov/cedsci/table?q=B25040%3A%20HOUSE%20HEATING%20FUEL&g=0100000US.04000.001&tid=ACSDT1Y2018.B25040&hidePreview=true

as it is the most efficient, clean electric alternative that will have the greatest reduction on their annual bills in the long-term.

As Massachusetts moves to meet the Commonwealth's ambitious target to reduce greenhouse gas emissions by 80% by 2050 as outlined in the Global Warming Solutions Act[4], it will need not only to decarbonize its electricity grid, but to dramatically reduce its reliance on the fossil fuel energy sources that currently heat over 75% of the Commonwealth's residential buildings[5]. About 18% of Massachusetts greenhouse gas emissions came from heating and cooling in residential buildings in 2018[6].

Massachusetts should be a national leader in geothermal energy. However, the Commonwealth's current incentives for GSHPs are a fraction of leading states like New York and Connecticut. As a result, Dandelion has not yet entered the Massachusetts market. In these comments, we will respectfully make recommendations to accelerate the growth of geothermal heating and cooling in Massachusetts. If meaningful incentives for GSHPs were put in place as part of the Mass Save program, Dandelion would make plans to immediately enter Massachusetts, bringing jobs and economic development to the Commonwealth.

Summary of Dandelion's recommendation:

To develop significant demand for geothermal and allow entrepreneurial companies like Dandelion to enter the market and drive costs down, we respectfully encourage the EEAC to take the following actions:

1. **Recommend the creation of at least $2,000 per ton incentives for high-efficiency GSHPs as part of the 2022-2024 Three Year Energy Efficiency Plans, which is in line with the incentives offered by New York and Connecticut utilities**

2. **Ensure new geothermal well requirements allow for the adoption of innovative new products, configurations, or designs so long as they follow industry standards and use industry accepted methods and materials. This will allow the industry to scale and drive down costs for homeowners over time.**

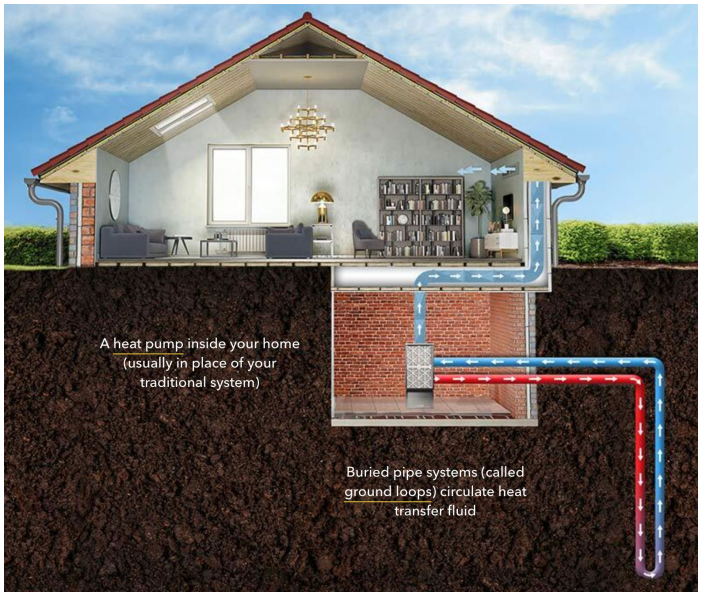
[4] Mass EEA, Global Warming Solutions Act, https://www.mass.gov/service-details/global-warming-solutions-act-background
[5] US Census, American Community Survey, House Heating Fuel, 2018 Data, https://data.census.gov/cedsci/table?q=B25040%3A%20HOUSE%20HEATING%20FUEL&g=0400000US25&tid=ACSDT1Y2018.B25040&hidePreview=true
[6] 2018 data, Mass DEP, Appendix C: Massachusetts Annual Greenhouse Gas Emissions Inventory: 1990-2017, with Partial 2018 & 2019 Data, https://www.mass.gov/lists/massdep-emissions-inventories#2

BACKGROUND ON DANDELION AND GEOTHERMAL

1. How Ground Source Heat Pumps Work:

GSHPs work by collecting heat from the ground, where it remains a constant 55 degrees Fahrenheit year round, and transferring it to heat your home. In the summer, the system works in reverse, collecting heat from the home and transferring it to the ground. Dandelion installs residential geothermal in two steps. First, we drill vertical holes underground and insert buried pipes filled with fluid (called ground loops) that are used to transfer heat between the home and the ground. We then connect these loops to the interior of the home. Second, we install a heat pump inside the home that exchanges and concentrates heating energy between the home and the loops (for a deeper explanation, please visit: dandelionenergy.com). The system life is estimated at up to 24 years for the heat pump and 50+ years for the ground loop[7]. Dandelion systems also include a desuperheater[8], which preheats hot water and can reduce hot water bills by up to 50%[9].

Figure 1: How Geothermal Works



[7] DOE, Geothermal Heat Pumps, https://www.energy.gov/energysaver/heat-and-cool/heat-pump-systems/geothermal-heat-pumps

[8] As defined by the DOE: "A desuperheater is a small, auxiliary heat exchanger that uses superheated gases from the heat pump's compressor to heat water. This hot water then circulates through a pipe to the home's storage water heater tank." https://www.energy.gov/energysaver/water-heating/heat-pump-water-heaters

[9] IGSHPA, Residential and Light Commercial Design and Installation Manual (#21025), Chapter 9, https://igshpa.org/manuals/

For electric utilities, GSHPs offer significant grid benefits by increasing baseload demand without meaningfully increasing seasonal peaks. This is in contrast to technologies such as air source heat pumps (ASHPs), which provide electrification benefits, but also increase peak usage dramatically. A study by the Brattle Group found that fully electrifying Rhode Island's heating sector using GSHPs would only minimally impact peak demand and leave energy prices unchanged, whereas switching to ASHPs would nearly double the peak and increase electricity prices by up to 20%[10].

2. **Energy and Emission Benefits of Geothermal Energy:**

GSHPs are recognized by both the U.S. Environmental Protection Agency[11] and the MassCEC as "arguably the most efficient home heating solution around"[12]. In its 2020 review of the Massachusetts Alternative Energy Portfolio Standard, Daymark Energy Advisors further noted that "small renewable thermal systems achieve emissions reductions for the lowest cost"[13].

All of Dandelion's products exceed Energy Star Tier 3 requirements, which for closed-loop, water to water means they have an EER 17.1 and a COP of 3.6[14]. On average, a 2,500 SQFT oil home in Westchester, NY that is replaced with a Dandelion geothermal system for heating and central A/C eliminates 421,250 lbs of CO_2 in heating and cooling over the 25 year lifetime of the heat pump[15].

Given that there are still around 750,000 oil and propane homes in the Commonwealth, which have the potential to switch from dirty, expensive fuels to clean, affordable, renewable heating and cooling, the aggregate carbon reduction potential is enormous. Converting all these homes to geothermal could save over 5.4 million Mt of CO_2 per year[16].

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[10] The Brattle Group, Heating Sector Transformation in Rhode Island: Pathways to Decarbonization by 2050, Pages 30-31
[11] US EPA, ENERGY STAR: Geothermal Heat Pump Website, https://www.energystar.gov/products/heating_cooling/heat_pumps_geothermal
[12] Massachusetts Clean Energy Center, "A Geothermal Resurgence", 5/2/2018: https://www.masscec.com/blog/2018/05/02/geothermal-resurgence
[13] Daymark Energy Advisors, ALTERNATIVE ENERGY PORTFOLIO STANDARD REVIEW 2020, Page 4 https://www.mass.gov/doc/alternative-energy-portfolio-standard-review/download
[14] ENERGY STAR® Program Requirements for Geothermal Heat Pumps, Version 3.1, https://www.energystar.gov/sites/default/files/specs/private/Geothermal_Heat_Pumps_Program_Requirements%20v3.1.pdf
[15] Dandelion Air Environmental Impact, https://dandelionenergy.com/environmental-impact
[16] Uses Dandelion Air Environmental Impact estimates (link above) based on an average Westchester, NY home and applies this to all fuel oil and propane homes in the Massachusetts market.

At scale, a national analysis by the Oak Ridge National Laboratory found that switching all buildings to GSHPs could reduce yearly CO2 emissions by 356.3 million Mt, and reduce yearly U.S. energy costs by $49.8 billion[17].

In applying its cost benefit test to GSHPs in New York, NYSERDA has found three significant areas of benefit beyond energy savings[18]:

- The value to ratepayers of reducing systemwide peak electric load.
- The so-called "inverse cost shift" effect, which can result in heat pump customers paying for more than their fair share of fixed electric grid costs, reducing burdens on other ratepayers.
- The societal value of reducing greenhouse gas emissions ("carbon value")

3. Dandelion's History, Target Customer, and Job Creation Potential:

Dandelion's goal is to bring geothermal to the mass suburban market. Dandelion's software-guided system design and smaller drilling rigs allow us to right-size systems and offer geothermal to middle class homeowners on smaller lots than what is accessible by traditional geothermal installers. Dandelion also offers a financing option for customers without the ability to put down money upfront for a geothermal system, which approximately half of our customers select.

While we install geothermal systems in homes of all sizes, our ideal customer has a 1500-3000 SQFT home currently heated by fuel oil or propane, which we can easily and cost-effectively convert to geothermal using a single 4 or 5 ton heat pump system.

When customers select geothermal, they do so not simply because of the health and greenhouse gas benefits, but also because the economics work for them. In the event that they choose a financed option, they're looking for savings on day one, which we're able to offer in New York and Connecticut with adequate state incentives.

Dandelion is headquartered in New York State. Since launching in 2017, we've created over 100 jobs, 75% of which are either drilling or HVAC installation jobs. To service new markets, we typically open new warehouses and train new drilling crews and

[17] Oak Ridge National Laboratory, GeoVision Analysis Supporting Task Force Report: Thermal Applications— Geothermal Heat Pumps, Page 1, https://info.ornl.gov/sites/publications/Files/Pub103860.pdf

[18] NYSERDA, New Efficiency: New York - Analysis of Residential Heat Pump Potential and Economics, Page 58, https://www.nyserda.ny.gov/-/media/Files/Publications/PPSER/NYSERDA/18-44-HeatPump.pdf

installers, resulting in an average of 50 jobs per warehouse and multiple warehouses per state. Just as the solar industry retrained local contractors, the geothermal industry does the same for the HVAC contractors and for oil, gas, and water well drillers. This extends to our leadership team. Dandelion recently hired a VP of Drilling, Jason Smith, who transitioned to geothermal after 18 years in the oil and gas industry due to tremendous growth potential in the geothermal industry[19].

Dandelion made New York our first point of market entry for two primary reasons. First, there are nearly 1.5 million residential buildings still dependent on expensive fuel oil heating systems. Second, New York's incentives and targets for GSHPs have created a friendly regulatory environment for geothermal energy to grow and thrive. Dandelion recently entered Connecticut following an increase in state incentives for geothermal and is now actively considering what markets to enter next, including Massachusetts. The policy environment will be a major driver of our decision.

DETAILED RECOMMENDATIONS:

1. **Recommend the creation of at least $2,000 per ton incentives for high-efficiency GSHPs as part of the 2022-2024 Three Year Energy Efficiency Plans, which is in line with the incentives offered by New York and Connecticut utilities**

In September 2020, the $2,000/ton incentives offered by MassCEC closed[20], creating a huge gap in the state market and threatening GSHP gains in recent years. GSHPs should become a core part of the Mass Save program, just as New York and Connecticut have made them core parts of their utility energy efficiency programs.

In neighboring markets where we've seen the successful adoption of GSHPs, such as New York and Connecticut, the average incentives offered to a homeowner have been $1,500 - $2,850 per ton, with levels adjusted based on local cost of electricity, labor, and constraints on current gas infrastructure.

Below are the current incentive levels for all investor owned utilities in New York:

[19] Eletrek, This Fossil-Fuel Exec Jumped to Geothermal. He Tells us Why, https://electrek.co/2020/10/08/this-fossil-fuel-exec-jumped-to-geothermal-he-tells-us-why/
[20] MassCEC, https://www.masscec.com/residential/clean-heating-and-cooling

Chart 1: New York Utility Incentives[21]		
Utility Incentive	**$ per ton**	**Total for 5T system**
Central Hudson	$2,000	$10,000
ConEd	$2,850	$14,250
National Grid	$1,500	$7,500
NYSEG/RGE	$1,500	$7,500
O&R	$2,000	$10,000

After incentives were updated in Connecticut in 2020 to similar levels Dandelion immediately entered the market and began selling systems. As a direct result, Dandelion is on track to expand operations and open a warehouse with 50-100 employees in the state in 2021.

We believe that at least a $2,000 per ton incentive is appropriate in Massachusetts for the following reasons:

1. A $2,000/ton incentive has already been piloted in Massachusetts as part of the MassCEC program.
2. Incentives at this level have been proven to be effective inducements to consumer demand in areas with comparable electricity rates in New York.
3. Incentives at this level make geothermal more affordable for households with lower income or credit.

In a blog posted titled “Stop Using Oil and Propane and Go Electric”, Ekotrope, the maker of the most widely used HERS-Accredited rating software, estimates that homeowners in Massachusetts switching from oil to a GSHP would reduce annual heating and hot water bills by 60% and save over $1,300 per year.

Dandelion’s model further shows that a GSHP retrofit of a fuel oil system in a 2,500 sqft home in Boston, Massachusetts would reduce its total energy usage by 45% per year[22], which is more than 10x the 4% savings this same home could get from switching to LED lightbulbs[23][24].

[21] NYS Clean Heat Statewide Heat Pump Program, http://documents.dps.ny.gov/public/Common/ViewDoc.aspx?DocRefId={22191788-C743-40AF-B680-762A19FA4B1E}
[22] Heating and cooling load and savings modeled using Looplink GSE, https://looplinkgse.com/
[23] EIA, Use of Energy Explained: https://www.eia.gov/energyexplained/use-of-energy/homes.php
[24] EIA, LED Lighting, https://www.energy.gov/energysaver/save-electricity-and-fuel/lighting-choices-save-you-money/led-lightin

Per-ton incentives at the level described above allow Dandelion to scale effectively in a state market and continue to drive down costs that will result in lower prices for customers in the future. For example, in 2017, Dandelion was paying nearly twice as much on average per heat pump. With increased demand in New York and following new incentive structures, Dandelion obtained access to scaled pricing and direct-sourced contract manufacturing. In 2019 we were able to bring on a second manufacturing partner at similarly competitive prices because of our growing order volume. As scale continues to increase, heat pump prices should become even more competitive than they are today, driving costs for homeowners down further.

2. **Ensure new geothermal well requirements allow for the adoption of innovative new products, configurations, or designs so long as they follow industry standards and use industry accepted methods and materials. This will allow the industry to scale and drive down costs for homeowners over time.**

The existing requirements for vertically bored closed-loop systems put in place for the incentive programs run by APS and MassCEC are very rigid. In their current form, they prevent installers from innovating on system design to improve performance and reduce costs for homeowners.

The ground loop parameters that impact how well a geothermal heat pump performs are the flow rate and entering water temperature coming into the heat pump. The goal of a geothermal system designer is to ensure the heat pump receives enough flow within the right temperature range. One of the areas of innovation that Dandelion is pursuing is understanding enough about the thermal conductivity in each area we drill in to be able to install the correct amount of footage based on the geology.

The requirement specifying that there has to be 150 feet per 12,000 BTU/hr of heating load limits the ability to make drilling more efficient for homeowners that don't need that amount of bore because they are located in an area with geology that's more thermally conductive. For example, in areas with high ground conductivity, installing less than 150 feet per ton of loop results in the same entering water temperatures as installing more loop in areas with lower conductivity. Using data to drill the required amount of footage ensures we are not overcharging homeowners for ground loops.

To date, the average bore lengths for Dandelion systems in New York have been closer to 125ft. We estimate that adhering to Massachusetts' requirements could add $2,000

g#:~:text=Residential%20LEDs%20%2D%2D%20especially%20ENERGY,savings%20in%20the%20United%20States.

or more in installation costs per system, and would limit additional cost-savings in the future.

Similarly, the requirement specifying that there must be at least 15 feet of separation between closed-loop bore holes prevents Dandelion from modifying system design to accommodate smaller lots, where software modeling permits it. This tends to disproportionately impact less affluent homeowners with smaller lots, for whom a couple feet could mean the difference between system eligibility and ineligibility.

Loop design software is able to resize the loops to accommodate closer spacing. For example, if we needed to install loops 12 feet apart, we could do so by adding additional depth to both loops to compensate for any thermal interference between the loops.

Our goal in suggesting improvements is to provide flexibility for installers to improve system performance and design while keeping bad actors from using rule of thumb design to create ineffective systems. The requirements should allow for the adoption of innovative new products, configurations, or designs so long as they follow industry standards and use industry accepted methods and materials.

As the EEAC explores the creation of a new GSHP program as part of Mass Save, we recommend updates to the below following language currently found in "Well Requirements" bullets 8, 9 and 10 in Section 2.5 of the Residential and Small-Scale GSHP Program Manual[25] and the online APS requirements for Small GSHP Generation units[26]:

Current language

All GSHP units must...

- *have a minimum depth of 150 per 12,000 Btu/hr if vertically bored closed-loop systems*
- *have a grout conductivity equal to or greater than anticipated earth conductivity of the drill site up to 1 Btu per hour-foot-degree Fahrenheit if closed-loop system*
- *have at least 15 feet of separation between closed-loop bore holes*

Proposed language:

[25] Massachusetts Clean Energy Center, Residential and Small-Scale Ground-Source Heat Pump Program Program Manual, https://files-cdn.masscec.com/Residential_Small-Scale_GSHP_Program_Manual_0.pdf
[26] Massachusetts Department of Energy Resources, Qualifying Ground Source Heat Pump in the APS, https://www.mass.gov/service-details/qualifying-ground-source-heat-pump-in-the-aps

We would recommend replacing these specific system requirements with the following:

All GSHP units must…

- *Be designed using software that satisfies the criteria in CSA C448.2-16, Section 7.1.5.*
- *Maintain a minimum entering water temperature of at least thirty degrees Fahrenheit and a maximum entering water temperature of no more than 90 degrees Fahrenheit.*
- *Be built using approved ground loop methods and materials per CSA C448.0-16, Chapter 5.*

Conclusion: Scaling GSHPs in Massachusetts

Dandelion thanks the EEAC for allowing us to provide comments on this planning process and for evaluating opportunities to improve incentives for GSHPs in Massachusetts.

We encourage the EEAC to recommend flexibility in designing geothermal systems, so long as contractors follow industry standards and use industry accepted methods and materials, and recommend that Mass Save program administrators create meaningful per-ton incentives for GSHPs in line with New York and Connecticut levels for high-efficiency GSHPs of at least $2,000 per ton. Incentives at this level will allow Dandelion and other contractors to confidently enter the market and scale at a rate that will drive down the cost of installation over time.

Sincerely,

Michael Sachse

CEO

Dandelion

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