NYSERDA Case Study:

Dandelion Energy

Final Report

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NYSERDA Case Study: Dandelion Energy

Executive Summary

NYSERDA's Grant to Dandelion Energy

- Founded in 2017, Dandelion Energy ("Dandelion") offers ground source heat pump (GSHP) drilling and installation services for residential and commercial customers across the United States.
- NYSERDA awarded Dandelion $375,000 in 2018 to purchase a compact sonic drill, which Dandelion hypothesized would reduce drilling costs, minimize negative impacts to customers' yards, and expand the company's addressable market by reducing the outdoor space requirements for drilling.
- A compact sonic drill is smaller and lighter than the drills traditionally used by geothermal installers in the US and emits high-frequency sonic vibrations to penetrate the ground.
- Dandelion was the first US-based company to use a compact sonic drill for GSHP installation, although the technology is commonplace in the European geothermal industry.
- Dandelion determined that the sonic element of the drill did not improve efficiency or reduce costs as anticipated due to differences in geologic conditions between New York State (NYS) and Europe. However, the company did determine that the smaller size of the drill was beneficial for increasing the number of potential customers and reducing the amount of damage to customers' yards.

NYSERDA's Impact on the NYS Geothermal Market

- NYSERDA's grant signaled Dandelion's credibility to investors and helped the company secure an additional $86 million in venture capital funding between 2018 and 2024.
- Dandelion used some of this follow-on investment to purchase another compact drill (this time *without* the sonic drilling technology). NYSERDA's initial award helped reduce the corporate risk of investing in subsequent drills by allowing Dandelion to prove the feasibility of the compact drilling approach.
- Between 2018 and 2023, Dandelion installed approximately 2,600 GSHPs, of which approximately **1,560 projects (60 percent) would not have been possible without compact drilling** (i.e., space constraints precluded the use of a larger drill).
- Given current trends in GSHP adoption, this case study estimates that **an additional 54,700 residential GSHPs could be installed in NYS through 2050 given the increase in addressable market due to the innovative use of compact drilling proven by Dandelion with support from NYSERDA**.
- By 2050, this case study estimates that the additional 54,700 GSHPs deployed in NYS because of compact drilling would generate:
  - **58 million MMBtu** in net energy savings,
  - **3.6 million $MTCO_2e$** in avoided net GHG emissions, and
  - **$707 million** in avoided damages from net GHG emissions.

Project Background

NYS CLEAN HEAT INITIATIVE

NYSERDA partners with utilities on NYS Clean Heat, an initiative that promotes the adoption of energy-efficient electric heat pumps by offering rebates and financing to lower the cost of installation. The program aims to help homeowners save energy, reduce carbon emissions, and keep their homes comfortable year-round. NYSERDA's efforts are focused on upstream support and marketing to advance clean heat technology, while utility efforts are focused on rebate and incentive distribution.

Dandelion Energy, Inc. (hereafter "Dandelion") is a company offering ground source heat pump (GSHP) drilling and installation services in the United States. GSHPs leverage the stable temperature of earth's sub-surface to heat and cool buildings. The GSHP (or "geothermal") system circulates a thermal transfer fluid through a network of underground pipes, absorbing heat from the ground in the winter and releasing it back into the ground during summer. GSHPs are highly energy efficient and environmentally friendly, especially when powered by renewable electricity.[1]

Founded in 2017, Dandelion has installed over 2,000 GSHPs to date.[2] The company initially focused on residential retrofits and has recently expanded into residential new construction (single and multifamily) and commercial projects. Dandelion is vertically integrated, meaning that it can oversee projects from end-to-end, including site design, drilling, installation, and commissioning of a Dandelion-branded GSHP. Vertical integration is rare in the geothermal industry, as most firms specialize in site design and installation, but procure drilling services from external providers. Offering in-house drilling services is central to Dandelion's business model and a key component of its success over the past eight years. However, in Dandelion's early days, the company encountered several drilling-related barriers to market growth:

- **High upfront cost**: The cost to drill and install a GSHP was high compared to traditional gas-fired equipment replacements. Dandelion needed to figure out how to drill more quickly and efficiently to reduce overall GSHP installation costs.[3]
- **Yard damage from drill rigs**: The drill rigs traditionally used for GSHP installation in the US at the time were large and heavy (typically water well rigs) and could damage landscaping, displace large volumes of soil, and occasionally require the removal of trees and fences.
- **Yard size restrictions**: Traditional drill rigs require adequate outdoor space to maneuver and operate, meaning that urban and suburban homes with small or narrow yards were ineligible for GSHPs, which significantly restricted Dandelion's addressable market.[4]

Dandelion hypothesized that replacing its traditional water well drill with a *compact sonic drill* could help address all three barriers by decreasing costs through improved drilling efficiency, minimizing yard damage, and broadening the market by reducing the outdoor space requirements for drilling. As the name suggests, a compact sonic drill is smaller and lighter than a traditional drill and uses high-frequency sonic vibrations to penetrate the ground. Compact sonic drills are the preferred technology for geothermal

[1] U.S. Energy Information Administration, 2022. https://www.eia.gov/energyexplained/geothermal/geothermal-heat-pumps.php.

[2] Dandelion Energy, 2025. https://dandelionenergy.com/faqs.

[3] GSHP retrofit costs for a single-family home in NYS range from $28,400-$50,500, while a traditional HVAC replacement averages $5,000-$12,000. https://www.nyserda.ny.gov/-/media/Project/Climate/Files/2022-Comments/NY-Building-Electrification-Cost-Full-Report-June2022

[4] The turning radius of a large, conventional rig is about 43 feet, whereas a compact rig has an 11-foot radius (Dandelion PON 3519 Performance Review Slides, 2021). In addition, traditional rigs are about nine feet wide, whereas Dandelion's compact rig can operate in spaces as narrow as six feet (https://dandelionenergy.com/drilling).

installations across Europe due to their efficiency, ability to operate in tight spaces, and compatibility with local geologic conditions, but were not yet used in the US.

In 2018, Dandelion sought funding from NYSERDA to test its hypothesis that compact sonic drilling for geothermal would be faster and more cost-effective than traditional drilling. NYSERDA awarded Dandelion $375,000 to purchase a compact sonic drill from Terra Sonic International. Dandelion teamed with the Rochester Institute of Technology (RIT) to conduct a study comparing the costs of drilling using Dandelion's suite of conventional equipment with its new compact sonic drill.[5,6] The RIT study found that the NYSERDA-funded compact sonic drill resulted in *higher* average installation costs than the conventional rig ($1,860/ft compared to $1,680/ft), mostly due to technological and logistical inefficiencies that increased total installation time and, thus, labor costs.[7] Although the study did not find that the compact sonic drill generated cost savings, it did suggest the new drill minimized yard damage and allowed for geothermal to be installed on smaller residential properties than previously possible. In addition, lessons learned from the study helped Dandelion improve its installation procedures and informed the company's search for additional drilling equipment.

Case Study Purpose and Methods

This case study explores and attempts to quantify how NYSERDA's initial grant to Dandelion for the compact sonic drill helped the company evolve and expand the residential market for GSHPs in New York State (NYS).[8] In addition to market development, the case study also explores project benefits related to energy savings, emissions reductions, and improved customer satisfaction (**Table 1**). The case study relies on three sources of data:

- Information provided by Dandelion Energy (e.g., GSHP installation estimates, equipment details, qualitative perspectives on the benefits of NYSERDA's award, etc.)
- Publicly available data and academic research on heat pump market trends[9,10,11]
- Interviews with key stakeholders (six total), including Dandelion leadership, a Dandelion customer, and representatives from four other geothermal drilling and installation companies[12]

[5] RIT Center of Excellence in Advanced and Sustainable Manufacturing, 2021. "Final Report for Dandelion Energy, Incorporated: Validation of Geothermal Vertical Ground Loop Installation Comparison."

[6] Three different drilling equipment suites are described in the RIT report. The "conventional" and "modified conventional" suites include the traditional water well drill rig, a support truck, and a grout truck. Dandelion's suite includes the compact sonic drill rig, which provides ultrasonic excitation, along with a casing handler, grout trailer, air compressor, a "Mud Slayer®" for processing soil and rock slurry, and a forklift.

[7] Inefficiencies noted in the RIT report include a longer equipment setup time and a slower process for removing soil from drill casings (compared to the conventional equipment). However, the authors note several factors specific to the Dandelion installations that complicate the comparison, including installations being closer to buildings and other obstacles, colder weather conditions, and a greater emphasis on safety.

[8] This case study relies on the most recent publicly available NYSERDA heat pump data, input from Dandelion, and historical technology growth rates from the academic literature to provide an indication of market expansion. This case study is *not* an in-depth GSHP market potential study, as that type of new analysis is beyond the scope of this work.

[9] New York State Clean Heat Program Annual Reports for 2021, 2022, and 2023.

[10] NYSERDA, 2019. "New Efficiency: New York – Analysis of Residential Heat Pump Potential and Economics."

[11] Nemet *et al.*, 2023. "Dataset on the adoption of historical technologies informs the scale-up of emerging carbon dioxide removal measures," *Nature Communications - Earth & Environment*, Volume 4, Article 397.

[12] NYSERDA and Dandelion Energy identified an initial list of key stakeholders for interviews, including a Dandelion customer and partners Aztech Geothermal and PeekAB. During the interview process, Dandelion's partners recommended two additional industry stakeholders for interviews due to their recent market entrance and/or adoption of compact drilling: Rototec USA and Brightcore Energy.

Table 1. Project Benefits

Category	Benefit	Beneficiaries
Market Development	Increase in Dandelion's addressable market	Dandelion, Dandelion customers
	Increase in total addressable market in NYS via replication by other GSHP installers	Other GSHP installers, building owners, society
Energy	Avoided energy use (MMBtu)	Dandelion customers, society
Environmental	GHG emissions avoided (Metric tons CO_2e)	Society
	Value of avoided GHG emissions ($)	Society
Customer Satisfaction	Level of customer satisfaction with GSHP installation	Dandelion customers

Market Development Benefits

The market development benefits associated with NYSERDA's grant to Dandelion for the purchase of a compact sonic drill include: (1) an increase in Dandelion's addressable market for residential GSHPs, and (2) an increase in NYS's total addressable market for geothermal given replication of Dandelion's compact drilling approach by other installers. This section summarizes Dandelion's impact on market development using qualitative information from interviews, then attempts to estimate the amount of market expansion attributable NYSERDA's grant for the compact sonic drill.

> "Water well drill rigs are some of the heaviest road vehicles that exist. We have to think carefully about our plan to get the drill in place and minimize the number of times we need to turn it."
>
> *- Geothermal Driller*

Compact Drills Attractive for Suburban Geothermal

Prior to Dandelion's purchase of the compact sonic drill with NYSERDA funds, geothermal providers in NYS were limited to installing GSHPs mainly in rural areas with adequate yard access for traditional drills. Industry stakeholders interviewed for this case study confirmed that small yard size is a frequent disqualifier of potential geothermal projects, and found the idea of a smaller rig "very attractive" for increasing business in suburban areas.

Interviewees also confirmed that the cost and inconvenience of yard damage poses a secondary barrier to widespread geothermal adoption, and agreed the potential for a compact drill to minimize this type of disruption to customers is valuable. One driller noted that compact rigs are lighter and move on tracks rather than wheels, making them easier to maneuver and less likely to create rutting. Maneuverability also increases drilling speed and efficiency, which has the potential to drive down project costs. One of Dandelion's suburban customers spoke about their experience with the compact drill. The customer lives on just three-quarters of an acre in Westchester County and had a positive experience with the installation, noting minimal yard disruptions.[13]

> "I was prepared for my yard to become trashed, but the impacts ended up being really minimal. I was very satisfied with the condition of my yard at the end."
>
> *- Dandelion Customer*

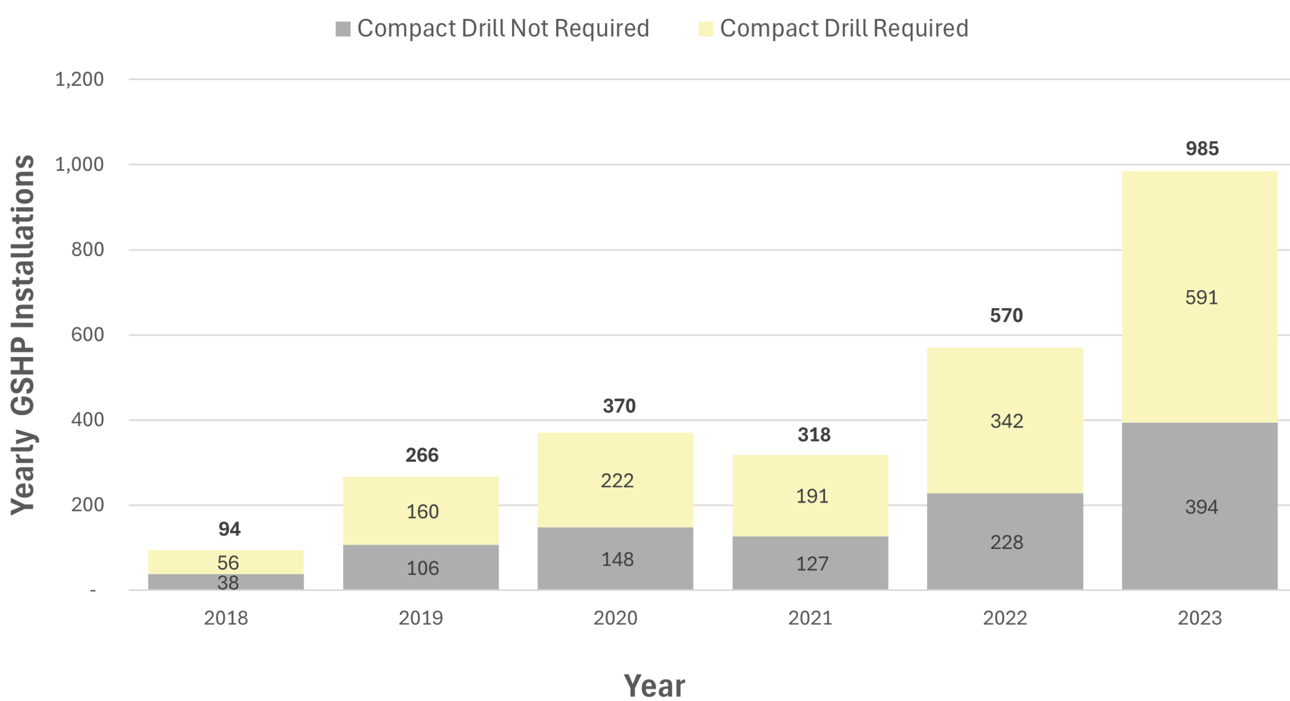
[13] Dandelion suggested only one previous customer for the Evaluation Team to interview to assess customer satisfaction benefits, but the anecdotes gleaned from the interview (about compact drilling being minimally disruptive to landscaping compared to traditional methods) are aligned with statements from other drilling industry interviewees, along with the findings from Dandelion's NYSERDA-funded RIT study.

Compact Drilling Boosts Dandelion's Growth Rate

Dandelion's purchase of the compact sonic drill using NYSERDA's funding created two pathways for growth: First, the company could now take on projects for customers it would not previously have been able to serve due to outdoor space constraints. Second, NYSERDA's award created a "signaling effect" that demonstrated Dandelion's credibility to other funders. Since 2018, Dandelion has raised $86 million in venture capital across three funding rounds ($16 million in 2019, $30 million in 2021, and $40 million in 2024).[14,15,16] Dandelion used a portion of this funding to purchase a new compact drill *without sonic drilling technology*. President Kathy Hannun said that lessons learned from the NYSERDA pilot study "informed Dandelion's search" for the new, non-sonic compact drill, which the company believed would be better suited to the geology of the Northeast US and more efficient at drilling.

President Hannun shared that Dandelion has installed about 2,600 residential GSHPs since purchasing the original compact sonic drill, and she estimates that 60 percent of the company's jobs since 2018 have *required* a compact drill (i.e., space constraints precluded the use of a larger drill).[17] This suggests that the compact drill is responsible for the majority of Dandelion's market growth between 2018 and 2023 and that Dandelion installed about 1,560 GSHPs during this period that it would not have otherwise have installed (**Figure 1**).[18] Over the same period, the company grew at an average annual rate of 72 percent as measured by the number of installations, which is unusually high for an emerging clean tech firm.[19]

Figure 1. Dandelion Energy Residential GSHP Installations (2018-2023) by Type of Drill Required



[14] Series A (2019): https://dandelionenergy.com/dandelion-energy-raises-16mm-series-led-gv-comcast-ventures.

[15] Series B (2021): https://dandelionenergy.com/dandelion-raises-30-million-funding-round-led-by-bill-gates-breakthrough-energy-ventures.

[16] Series C (2024): https://dandelionenergy.com/dandelion-energy-closes-40m-series-c-funding-round-to-expand-geothermal-offerings-nationwide.

[17] Email correspondence with Dandelion President Kathy Hannun, April 2024.

[18] 2,600 * 60% = 1,560.

[19] (183% [*2018-19 growth rate*] + 39% [*2019-20*] + -14% [*2020-21*] + 79% [*2021-22*] + 73% [*2022-23*])/5 = 72% average annual growth

A recent *Nature Communications* article reports that, historically (1900 to present), emerging technologies in the household energy appliance category (which includes all types of heat pumps) have grown at a rate of 2 percent to 10 percent per year.[20] NYSERDA's 2019 *New Efficiency: New York* report on the market for residential heat pumps – developed prior to Dandelion's adoption of compact drilling – estimated that GSHP installations would grow 2.5 percent annually from 2019 to 2025.[21] The Evaluation Team attributes the large difference between Dandelion's actual growth rate (70 percent average annual growth from 2018-2023) and the expected growth rate for heat pump technologies to its adoption of compact drilling and associated market expansion to previously unreachable suburban households.

Other Geothermal Installers Replicate Dandelion's Approach

Other geothermal companies in NYS have followed Dandelion's example and adopted compact drilling technology. The Evaluation Team interviewed leadership at two companies identified by Dandelion's industry partner Aztech Geothermal as new entrants into the compact drilling space: Rototec USA and Brightcore Energy, LLC. Interviewees from both companies cited Dandelion as a pioneer of compact drilling in the US. They reported that Dandelion's move towards compact drilling was "on point" and that NYSERDA's grant allowed Dandelion to demonstrate to the rest of the industry that compact drilling for geothermal is a viable and cost-effective business strategy in the US.

Rototec USA (hereafter "Rototec") is the US subsidiary of Rototec Group, the largest geothermal drilling company in Europe operating in Finland, Sweden, and Norway.[22] Influenced in part by Dandelion's success in NYS, Rototec established a subsidiary in Westchester County in September 2023. In contrast to Dandelion's vertically integrated business model, Rototec works exclusively as a drilling subcontractor on both commercial and residential GSHP projects. The company uses two drill setups (conventional and compact) but plans to use the compact drill for most of its projects in NYS. The Rototec interviewee was enthusiastic about their company's US expansion, stating, "The market [in NYS] is huge and the drilling condition is very good." They noted that being the "first mover" to use compact drilling for geothermal in the US was "risky and expensive" for Dandelion, but emphasized that Dandelion's risk-taking benefitted all companies in the geothermal space by driving the market forward. Rototec intends to build on Dandelion's momentum and expand its customer base in Westchester County, NY and beyond.

Another company that recently adopted compact drilling in the Northeast is Brightcore Energy, LLC (hereafter "Brightcore"), a NYS-based engineering firm that provides renewable energy solutions to commercial customers, including GSHP drilling and installation.[23] Brightcore specializes in large commercial projects, especially in high-rise commercial buildings in New York City. Recently, the company has begun drilling geothermal boreholes *inside* large urban buildings, which requires disassembling the drill and then reassembling it within a building's basement – a technique previously impossible with traditional drill rigs.[24]

> "Dandelion's investment [in compact drilling] is driving the market forward for everyone, and their aggressive marketing benefits all players in the geothermal drilling space."
>
> *- Geothermal Installer*

[20] Nemet *et al.* (2023), "Dataset on the adoption of historical technologies informs the scale-up of emerging carbon dioxide removal measures," *Nature Communications - Earth & Environment*, Volume 4, Article 397. https://www.nature.com/articles/s43247-023-01056-1

[21] "New Efficiency: New York – Analysis of Residential Heat Pump Potential and Economics," NYSERDA Report Number 18-44, January 2019.

[22] https://www.rototec.us/

[23] https://brightcoreenergy.com/

[24] See Canary Media (2023) for an example: https://www.canarymedia.com/articles/geothermal/why-this-nyc-apartment-complex-will-use-a-giant-underground-heat-pump

The Brightcore interviewee from explained that Dandelion was the first US-based geothermal company to "shout about compact drilling from the rooftops." From their perspective, NYSERDA's grant to Dandelion showed that getting into the compact drilling space was possible and influenced Brightcore's decision to purchase its own compact drills. Brightcore plans to continue using compact rigs to install geothermal for commercial and utility-scale customers in NYC and the greater Northeast region.

NYSERDA's Grant Contributes to NYS Geothermal Market Expansion

Given the compact drill's expansion of Dandelion's potential customer base, and evidence of other NYS geothermal firms following Dandelion's lead and adopting compact drilling, NYSERDA's grant helped expand the State's addressable market for geothermal**. The Evaluation Team estimates that, all else equal, the introduction of compact drilling could be responsible for approximately 46,700 *additional* residential ground source heat pumps in NYS by 2050 (on top of the number that would have been installed without compact drilling).** [25,26] To arrive at this estimate, the Evaluation Team used the following process and assumptions:

1. **Estimate the number of residential GSHPs installed in NYS from the year of NYSERDA's grant to Dandelion (2018) to present (2023) using the following:**
    - **2018-2019:** NYS GSHP installation data for 2018-19 comes from NYSERDA's GSHP Rebate Program database.[27] The database includes all GSHP projects that received NYSERDA funding during this period.
    - **2020-2023:** The NYS Clean Heat Program was established in April 2020 and began publishing annual reports with detailed GSHP installation metrics in 2021.[28,29]
2. **Project GSHP installations from 2024 to 2050 using a baseline growth scenario (the market without compact drilling), compared to a growth rate with compact drilling.**
    - **Baseline market growth (without compact drilling) is 2.5 percent per year**, **which is the projected GSHP growth rate used in NYSERDA's *New Efficiency: New York* report**.[30] This 2.5 percent baseline growth rate is also supported by the academic literature on emerging energy technologies, which finds the historical growth rate of household energy appliances to be 2-10 percent per year.[31]
    - **Market growth with compact drilling follows the S-curve model.** As discussed in the literature, emerging technologies follow an S-shaped growth curve: The growth rate is low

[25] This case study relies on the most recent publicly available NYSERDA heat pump data, input from Dandelion, and historical technology growth rates from the academic literature to provide an indication of market expansion. This case study is *not* an in-depth GSHP market potential study, as that type of new analysis is beyond the scope of this work.

[26] Assume a supportive policy environment, stable market conditions, and adequate workforce to meet rising demand.

[27] NYSERDA's GSHP Rebate Program Database can be accessed here: https://data.ny.gov/Energy-Environment/NYSERDA-Supported-Ground-Source-Heat-Pump-Projects/sgz6-5fuh/data

[28] NYS Clean Heat Program Annual Reports for 2020-2023.

[29] NYS Clean Heat was subject to the "NYS on PAUSE" Executive Order that restricted its activities for part of 2020. The program still incentivized about 5,700 projects that year, but its annual report does not specify the exact number of GSHPs installed. IEc assumes the same proportion (2 percent) of GSHPs were installed as in 2021.

[30] "New Efficiency: New York – Analysis of Residential Heat Pump Potential and Economics," NYSERDA Report Number 18-44, January 2019.

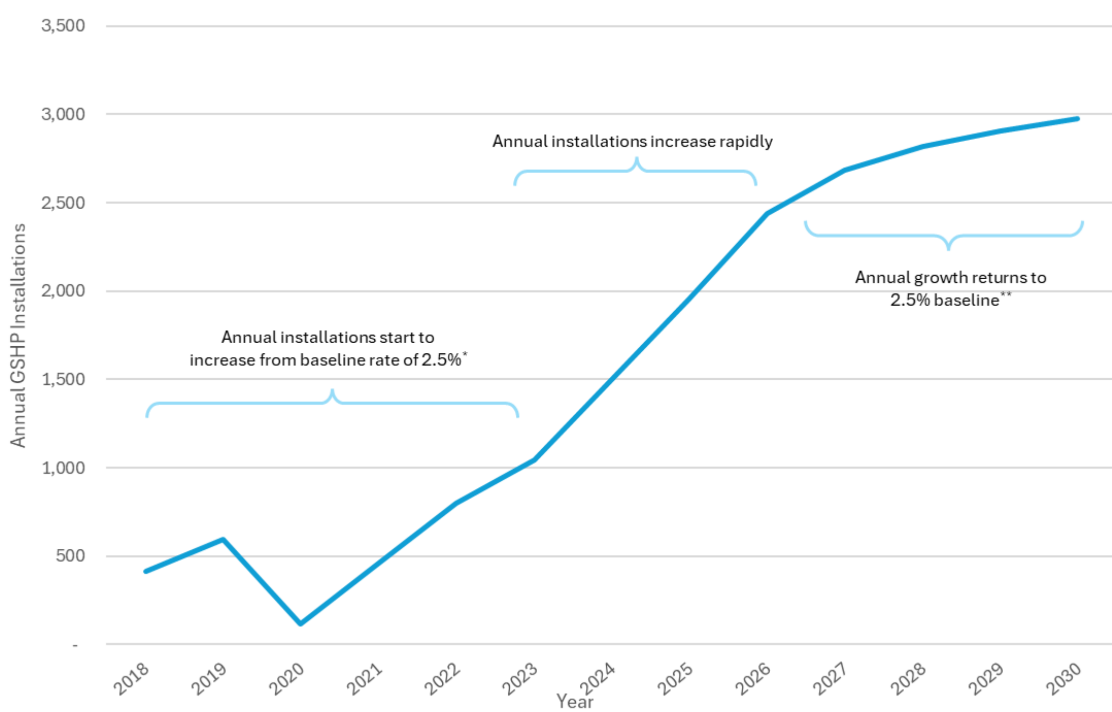
[31] Nemet *et al.* (2023), "Dataset on the adoption of historical technologies informs the scale-up of emerging carbon dioxide removal measures," *Nature Communications - Earth & Environment*, Volume 4, Article 397. https://www.nature.com/articles/s43247-023-01056-1

(around 2.5 percent) during a technology's "formative phase" and then increases sharply during the first few years of market expansion. As the market becomes saturated, the growth rate reaches an inflection point and eventually drops back to the annual baseline of 2.5 percent. Growth rate estimates in this case study follow the same S-shaped concept, with high growth from 2024-2029 (as Rototec, Brightcore, and others enter the market) that levels off to 2.5 percent from 2030-2050.

- **The accelerated growth rate reflects the increase in GSHP market potential due to compact drilling (which was not accounted for in the baseline scenario)** and is informed by Dandelion's own substantial growth from 2018-2023 (roughly 70 percent average annual growth). The estimates used in this case study reflect the S-curve model and assume that the market will continue to grow at a high rate for the next five years as new firms enter and more homeowners adopt GSHPs. As firms become established in the market and meet existing demand, the growth rate will gradually return to the baseline rate of 2.5 percent per year, as informed by academic literature on emerging technology growth patterns.[32] Specifically, market growth increases sharply through the mid-to-late 2020s, levels out to the baseline rate of 2.5 percent per year by 2030, and then continues to grow at the baseline rate through 2050 (**Figure 2**).

3. **Quantify the additional GSHPs that would not have been installed without compact drilling** by subtracting the cumulative installations under the baseline growth scenario from the accelerated scenario.

Figure 2. Estimated GSHP Growth Follows An "S-Curve"



*The dip in installations in 2020 is attributable to the NYS on PAUSE Executive Order COVID-19.

**Annual growth remains steady at baseline rate of 2.5% from 2030 through 2050.

[32] Ibid.

Energy Savings Benefits

GSHPs do not require the direct use of fossil fuels and are highly energy efficient.[33] Thus, every home that replaces its traditional heating and air conditioning system with a GSHP will save energy every year for the life of the heat pump. **The Evaluation Team projects that the additional 54,700 heat pumps installed in NYS between 2018 and 2050 as a result of compact drilling would generate total energy savings of 58 million net MMBtu (1.8 million MMBtu per year).** Energy savings are estimated using the following methodology:

- Estimated energy savings are reported by the type of heating fuel the homeowner used prior to installing the GSHP (the "counterfactual" fuel). The three counterfactual fuels considered are electric resistance heating, fuel oil, and natural gas. Energy savings are reported as annual MMBtus saved for a typical 4-ton GSHP.[34]
- The per-unit energy savings by fuel type are multiplied by the estimated number of *additional* heat pumps installed due to compact drilling generated in the market expansion analysis above. Fuel switching assumptions come from the *New Efficiency: New York* report: 64 percent switch to GSHPs from natural gas, 30 percent from fuel oil, and 5 percent from electric resistance heat.
- The lifespan of a GSHP is 20 years and energy savings benefits accumulate each year for 20 years.[35] For example, GSHPs installed in 2030 accumulate benefits annually through 2050.

Environmental Benefits

Using the annual energy savings calculated above, the Evaluation Team estimates that **the additional GSHPs installed between 2018 and 2050 as a result of compact drilling would save 3.6 million net MTCO$_2$e (108,000 MTCO$_2$e per year).** To calculate greenhouse gas savings:

- Multiply the cumulative energy savings by fuel type (MMBtu for electric resistance, gas, and oil) by each fuel's respective emissions factor to obtain total annual savings in metric tons CO$_2$e.[36]

In addition, **the additional GSHPs installed as a result of compact drilling are estimated to result in approximately $707 million (2023 dollars) of avoided damages from net carbon emissions**. Avoided damages for this analysis are calculated using values from the NYS Department of Environmental Conservation (DEC):

- The NYS DEC provides social cost of carbon (SCC) estimates for 2020-2050 (in 2020 dollars) per metric ton CO$_2$e. Estimates are presented across four discount rate scenarios ranging from zero to three percent. The evaluators report the SCC using a 2 percent discount rate, which is the DEC's preference (see **Appendix Table A6** for the complete SCC range across discount rates).[37]

Additional Insights and Market Expansion Opportunities

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[33] Heat pumps do require electricity, which, depending on the composition of the grid, is generated by some percentage of fossil fuels.

[34] NYS DPS Technical Resource Manual V.12 (2025).

[35] Ibid.

[36] New York State emissions factors are updated periodically. For this analysis, the Evaluation Contractor referenced the following: Hammer et al. (2022). "Projected Emissions Factors for New York State Grid Electricity." NYSERDA Report 22-18.

[37] NY State Department of Environmental Conservation (2023). "NYS Value of Carbon Guidance – 2023 Update." Appendix, pg. 2.

> “Our main competitor is the status quo.”
>
> *- Dandelion Energy*

The market expansion benefits of compact drilling are documented by this case study and supported by perspectives shared by Dandelion and other NYS geothermal companies in interviews. However, there are additional opportunities for expanding and/or accelerating the GSHP market in NYS. The main opportunity categories cited by interviewees include **cost**, **labor supply**, and **regulations**.

Ground source heat pumps are highly energy efficient and can generate significant energy cost savings for homeowners (depending on interest rates, available rebates, and energy prices). Compared to the abundance of HVAC companies that specialize in oil- or gas-fired home heating technologies or even electric air source heat pumps, the number of companies that install geothermal in NYS is quite limited. In fact, Dandelion considers its main competitor to be the “status quo,” meaning a homeowner’s choice to replace their current home heating system with a newer model of the same kind rather than switching to a GSHP. This “status quo” decision not to switch is largely driven by the high upfront costs of geothermal.

> “To be profitable in the end, you need a lower cost for the customer and you need the density of installations.”
>
> *- Geothermal Installer*

To accelerate geothermal market growth, greater awareness of GSHP technology is needed and installed costs must be competitive with traditional heating technologies. Dandelion is investing heavily in marketing to increase customer awareness. However, based on current market conditions, cost-competitiveness can only be achieved through rebates and incentives. In addition to cost, interviewees mentioned that customer density (i.e., many potential customers in a small geographic area) is another critical component for profitability. Compact drilling will drive a much higher density of installations in urban and suburban areas, but policies that support a reduction in installed costs are also important for convincing customers to adopt geothermal.

> “Access to financing is super important for homeowners, but often the slow payback process of financing can lead to a cash flow problem for drillers. It’s the same with rebate programs – 75% of the money shows up at the very end of the project.”
>
> *- Geothermal Driller*

Related to installed costs, interviewees also suggested simplifying the financing and rebate application process for installers. Financing and rebates lower the upfront cost of geothermal for homeowners, increasing the likelihood they make the switch from the “status quo.” However, installers find that the current process leads to cash flow problems and is a disincentive for working with customers who cannot pay up front. One interviewee estimated that three-quarters of the money for a typical geothermal installation arrives after project completion. Innovative financing models, such as leases for heat pumps rather than outright ownership, could help address this barrier.

Supporting efforts to recruit and train new drillers on compact drilling technology will alleviate current labor supply constraints (reported by interviewees) and is another opportunity for market growth. Although compact drills are different from traditional drills, training drillers on this new technology does not require extensive re-education. Interviewees noted that the labor supply issues are driven by a general lack of drillers of *any* specialty. Organizations are already taking steps to address this issue: Sustainable Westchester, in collaboration with a variety of partners including Dandelion and Brightcore, is developing a comprehensive Geothermal Driller Training Program.[38] More initiatives like Sustainable Westchester's will help address labor shortages and ensure the geothermal market can continue to grow.

> "We're currently seeing much greater demand than we could ever serve [*due to labor constraints*]."
>
> *- Geothermal Driller*

Finally, streamlining state and local drilling regulations could lessen the paperwork burden on installers, reduce costs, and accelerate GSHP market expansion. Current regulations were written with conventional drilling technology and uses in mind and tend to vary across municipalities. One interviewee explained that a large amount of time and effort goes into finding location-specific drilling regulations before each new project. Applicable regulations range from allowable borehole depth and spacing to the specifics on dumpster size and placement (dumpsters are used to hold project-related waste). Some efforts are underway to update drilling regulations. For example, New York State Governor Kathy Hochul signed Senate bill S6604 in September 2023, which exempts certain geothermal projects from the 500-foot borehole depth maximum that applies to oil and gas drilling. Increasing allowable borehole depth will improve the economics of geothermal by reducing the total number of boreholes required per project.[39] Additional efforts to update and streamline regulations around geothermal drilling will help hasten market growth for this promising technology.

> "It's a huge effort before every new project to find all the correct, location-specific drilling permits and regulations."
>
> *- Geothermal Installer*

Conclusion

NYSERDA's $375,000 grant to Dandelion for the purchase of a compact drill catalyzed an expansion of the addressable market for geothermal in NYS and beyond. Dandelion proved the technical potential of compact drilling in small residential lots previously unable to accommodate the necessary equipment for conventional geothermal installations. Dandelion's industry peers are following suit and adopting compact drilling technology for their own projects across the commercial sector, for residential retrofits, and for new construction.

This case study estimates that Dandelion installed 1,560 *more* GSHPs between 2018 and 2023 than it would have installed without compact drilling technology, the purchase of which was made possible by NYSERDA's initial award. As a result of this increase in total addressable market, an *additional* 46,700 GSHPs could be installed in NYS by 2050. These additional heat pumps would generate an estimated 49 million MMBtu in energy savings, an emissions reduction of 3 million $MTCO_2e$, and $604 million in avoided damages.

Since this analysis was completed in early 2025, the federal economic and policy environment has shifted significantly away from electrification in favor of fossil-fueled technologies. However, geothermal has emerged as a favored technology in the 2025 One Big Beautiful Bill Act and has received bipartisan support in the House of Representatives, meaning that it remains a promising area for NYSERDA's market development efforts.[40,41]

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[38] Sustainable Westchester (2024). https://sustainablewestchester.org/geothermal-driller-training-program/

[39] New York State Senate (2023). Bill No. S6604: https://www.nysenate.gov/legislation/bills/2023/S6604

[40] https://e360.yale.edu/features/united-states-geothermal-republican-spending-bill

[41] https://clearpathaction.org/streamlining-thermal-energy-through-advanced-mechanisms-act-or-steam-act-s-456-h-r-1077/

APPENDIX

Table A1. Historical GSHP Adoption (2018-2023) and Future Projections by Growth Rate (2024-2030)

		NYSERDA GSHP Rebate Program (2018-19) & NYS Clean Heat Program (2020-23)												
Growth Rate	Annual/Cumulative	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Low	Annual Installations	414	595	114	459	798	1,043	1,069	1,096	1,123	1,151	1,180	1,210	1,240
	Cumulative Installations	414	1,009	1,123	1,582	2,380	3,423	4,492	5,588	6,711	7,862	9,042	10,252	11,492
Middle	Annual Installations	414	595	114	459	798	1,043	1,095	1,150	1,207	1,268	1,331	1,398	1,468
	Cumulative Installations	414	1,009	1,123	1,582	2,380	3,423	4,518	5,668	6,875	8,143	9,474	10,872	12,340
High	Annual Installations	414	595	114	459	798	1,043	1,147	1,262	1,388	1,527	1,680	1,848	2,033
	Cumulative Installations	414	1,009	1,123	1,582	2,380	3,423	4,570	5,832	7,221	8,748	10,427	12,275	14,308
Variable	Annual Installations	414	595	114	459	798	1,043	1,502	1,952	2,441	2,685	2,819	2,903	2,976
	Cumulative Installations	414	1,009	1,123	1,582	2,380	3,423	4,925	6,877	9,318	12,003	14,822	17,725	20,701
Delta (High - Low)	Annual Installations	-	-	-	-	-	-	78	166	265	376	500	638	793
	Cumulative Installations	-	-	-	-	-	-	78	244	509	885	1,385	2,023	2,816
Delta (Var - Low)	Annual Installations	56	160	222	275	479	626	433	857	1,317	1,533	1,639	1,694	1,736
	Cumulative Installations	-	-	-	-	-	-	433	1,290	2,607	4,140	5,779	7,473	9,209

Notes:

1. Low, Middle, High, and Variable growth rate rows (white) report the annual and cumulative GSHP installations at different growth rate scenarios (see Tables A2 and A3 for growth rate specifics).
2. Delta rows (gray) represent the estimated number of GSHPs installed as a result of compact drilling, subtracting the number of total GSHPs in the Low scenario from either the High scenario or the Variable scenario.
3. Numbers highlighted in green are used as final case study estimates and serve as inputs to all benefits calculations.

Table A1 (Continued). Future Projections by Growth Rate (2031-2040)

Growth Rate	Annual/Cumulative	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
Low	Annual Installations	1,271	1,303	1,335	1,369	1,403	1,438	1,474	1,511	1,548	1,587
	Cumulative Installations	12,763	14,065	15,400	16,769	18,171	19,609	21,083	22,594	24,142	25,729
Middle	Annual Installations	1,541	1,618	1,699	1,784	1,873	1,967	2,065	2,168	2,277	2,391
	Cumulative Installations	13,881	15,499	17,198	18,982	20,855	22,821	24,886	27,055	29,332	31,722
High	Annual Installations	2,236	2,459	2,705	2,976	3,273	3,601	3,961	4,357	4,793	5,272
	Cumulative Installations	16,543	19,003	21,708	24,684	27,957	31,558	35,519	39,876	44,668	49,940
Variable	Annual Installations	3,050	3,127	3,205	3,285	3,367	3,451	3,538	3,626	3,717	3,810
	Cumulative Installations	23,752	26,878	30,083	33,368	36,735	40,187	43,724	47,350	51,067	54,877
Delta (High - Low)	Annual Installations	965	1,157	1,370	1,607	1,871	2,163	2,487	2,846	3,244	3,685
	Cumulative Installations	3,781	4,938	6,308	7,915	9,786	11,949	14,436	17,282	20,526	24,211
Delta (Var - Low)	Annual Installations	1,780	1,824	1,870	1,917	1,964	2,014	2,064	2,115	2,168	2,223
	Cumulative Installations	10,989	12,813	14,683	16,600	18,564	20,578	22,641	24,757	26,925	29,148

Table A1 (Continued). Future Projections by Growth Rate (2041-2050)

Growth Rate	Annual/Cumulative	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050
Low	Annual Installations	1,627	1,667	1,709	1,752	1,796	1,840	1,887	1,934	1,982	2,032
	Cumulative Installations	27,356	29,023	30,732	32,484	34,280	36,120	38,007	39,940	41,922	43,954
Middle	Annual Installations	2,510	2,636	2,767	2,906	3,051	3,204	3,364	3,532	3,709	3,894
	Cumulative Installations	34,232	36,868	39,635	42,541	45,592	48,796	52,159	55,691	59,400	63,294
High	Annual Installations	5,799	6,379	7,017	7,718	8,490	9,339	10,273	11,301	12,431	13,674
	Cumulative Installations	55,739	62,118	69,135	76,853	85,343	94,683	104,956	116,257	128,687	142,361
Variable	Annual Installations	3,905	4,002	4,103	4,205	4,310	4,418	4,528	4,642	4,758	4,877
	Cumulative Installations	58,782	62,784	66,887	71,092	75,402	79,820	84,348	88,990	93,748	98,624
Delta (High - Low)	Annual Installations	4,172	4,712	5,308	5,967	6,695	7,499	8,387	9,367	10,449	11,642
	Cumulative Installations	28,383	33,095	38,402	44,369	51,064	58,563	66,949	76,316	86,765	98,407
Delta (Var - Low)	Annual Installations	2,278	2,335	2,393	2,453	2,515	2,578	2,642	2,708	2,776	2,845
	Cumulative Installations	31,426	33,761	36,155	38,608	41,122	43,700	46,342	49,050	51,826	54,671

Table A2. Growth Rate Assumptions – Low, Middle, and High Scenarios

Scenario	Growth Rate
Low Growth	0.025
Middle Growth	0.050
High Growth	0.100

Note: Growth rate scenarios informed by Nemet et al. (2023).

Table A3. Growth Rate Assumptions – Variable Scenario

Year	Growth Rate
2024	0.440
2025	0.300
2026	0.250
2027	0.100
2028	0.050
2029	0.030
2030	0.025
2031-50	0.025

Note: Variable growth rate scenario informed by Nemet et al. (2023).

Table A4. CO2e Emissions Factors by Fuel Type (Metric Tons/MMBtu)

Fuel Type	Emissions Factor
Electricity	0.09174
Fuel Oil	0.07396
Natural Gas	0.05306

Note: Emissions factors derived from Hammer et al. (2022). "Projected Emissions Factors for New York State Grid Electricity." NYSERDA Report 22-18.

Table A5. Annual Energy Savings (MMBtu) and GHG Savings (Metric Tons CO2e) by Fuel Type

	Energy Savings (MMBtu)		GHG Savings (Metric Tons CO_2e)	
	Total	Average	Total	Average
Electric Resistance	2,057,133	62,337	188,711	5,719
Fuel Oil	19,519,383	591,496	1,443,654	43,747
Natural Gas	36,349,569	1,101,502	1,928,708	58,446
Total	**57,926,085**	**1,755,336**	**3,561,073**	**107,911**

Table A6. Damages Avoided (2023 Dollars)

Discount Rate	Total Damages Avoided	Average Annual Damages Avoided
0%	$ 9,058,685,802	$ 274,505,630
1%	$ 2,055,434,386	$ 62,285,890
2%	$ 707,360,674	$ 21,435,171
3%	$ 337,027,817	$ 10,212,964

Note: 2% discount rate used in case study estimates.

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