Harnessing the Power of the Ground Beneath Our Feet: Encouraging Greater Installation of Geothermal Heat Pumps in the Northeast United States

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INTRODUCTION

Could part of the solution to the problem of the United States' reliance on fossil fuels exist just beneath our feet? The earth provides a major source of a renewable energy, known as geothermal energy, that is widely available in the United States and overlooked by current state financial incentive programs.[1] Geothermal energy, or "energy from the

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1. *See* DAVID BANKS, AN INTRODUCTION TO THERMOGEOLOGY: GROUND SOURCE HEATING AND COOLING 56 (1st ed. 2008) (stating that "ground source heat extraction can be genuinely sustainable" if performed correctly); Sylvia Harrison, *Geothermal Resources*, *in* THE LAW OF CLEAN

heat of the earth,"[2] can be utilized in one of two ways: direct use, i.e., directly heating or cooling buildings, or for the production of electrical energy.[3]

Ground-source heat pumps—also known as geothermal heat pumps[4]—directly use the relative warmth of the ground to heat buildings in the winter and the ground's relative coolness to cool buildings in the summer.[5] Geothermal heat pumps are an attractive source of heating and cooling for three reasons. First, geothermal heat pumps can be utilized anywhere in the United States.[6] Second, ground-source heat pumps can play a meaningful role in meeting the United States' energy needs. In 2010, space heating, space cooling, and water heating accounted for seventy percent of residential site energy consumption.[7] Ground-source heat pumps can convert low-temperature geothermal energy resources into a level of energy that can be used to heat buildings and water, or to cool buildings.[8] Intensive installation of geothermal heat pumps may

ENERGY: EFFICIENCY AND RENEWABLES 423, 425 (Michael B. Gerrard ed., 1st ed. 2011) ("[T]he U.S. Geological Survey has identified more than 120,000 [megawatts] of untapped low-temperature [geothermal] resources."). To put this number in perspective, "each megawatt of rated capacity for a coal plant in the Northeast generates the equivalent amount of electricity consumed by 900 homes in the Northeast." Bob Bellemare, *What is a Megawatt?*, UTILIPOINT INT'L INC. (June 24, 2003), http://www.utilipoint.com/2003/06/
what-is-a-megawatt/#.UGcpPvl27-N.

2. Harrison, *supra* note 1, at 423.

3. *Id.*; BANKS, *supra* note 1, at 71 (describing how geothermal energy can be used for both heating and cooling purposes).

4. *See* U.S. Dep't of Energy, *Geothermal Heat Pumps*, ENERGY.GOV (June 24, 2012, 5:08 PM), http://energy.gov/energysaver/articles/geothermal-heat-pumps (stating that geothermal heat pumps are sometimes referred to as ground-source heat pumps).

5. *See* BANKS, *supra* note 1, at 67, 71 (describing the mechanics of heat pumps); Harrison, *supra* note 1, at 425–26 ("Heat pumps . . . rely on the difference between ambient air temperature and the relatively constant temperature of the shallow subsurface. During winter months, heat can be transferred to a building using air or water heated by the earth; the transfer is reversed during the summer months for cooling, where the earth acts as a heat sink.").

6. *See* BRUCE D. GREEN & R. GERALD NIX, NAT'L RENEWABLE ENERGY LAB., GEOTHERMAL—THE ENERGY UNDER OUR FEET 11 (2006), *available at* http://www1.eere.energy.gov/
geothermal/pdfs/40665.pdf (indicating that the entire United States is suitable for geothermal heat pump installations); *see also* NAVIGANT CONSULTING, INC., GROUND-SOURCE HEAT PUMPS: OVERVIEW OF MARKET STATUS, BARRIERS TO ADOPTION, AND OPTIONS FOR OVERCOMING BARRIERS 9–10 (2009), *available at* http://www1.eere.energy.gov/geothermal/
pdfs/gshp_overview.pdf (explaining that the Northeast is an area suitable for widespread adoption of geothermal heat pumps).

7. U.S. DEP'T OF ENERGY, 2010 BUILDINGS ENERGY DATA BOOK 2–3 (2011), *available at* http://buildingsdatabook.eren.doe.gov/docs/DataBooks/2010_BEDB.pdf.

8. *See* BANKS, *supra* note 1, at 62, 67–68 (explaining that "[a] heat pump raises the temperature of the available heat from an unusable level to a usable one" and that heat pumps take heat from an environmental reservoir to heat buildings by upgrading it "to a temperature . . . that is adequate to support our domestic heating system"); Harrison, *supra* note 1, at 425–26; U.S. Dep't of Energy, *Heat Pump Systems*, ENERGY.GOV (Aug. 30, 2012, 5:33 PM),

obviate the need to build ninety-one to 105 gigawatts of electricity generation capacity in the United States, or forty-two to forty-eight percent of net new capacity that the U.S. Energy Information Administration projects will be needed in the United States by 2030, assuming current growth rates in energy demand.[9]

Third, ground-source heat pumps are environmentally friendly. They are more efficient than standard air conditioners that use the ambient air to cool buildings because geothermal heat pumps use the more constant temperature of the earth to heat and cool buildings.[10] Similarly, they result in the emission of less greenhouse gas than conventional methods of heating and cooling.[11] Finally, geothermal heat pumps have little impact on the surrounding environment, in contrast to other sources of energy, including renewable energy such as wind, solar, and geothermal electric.[12]

http://energy.gov/energysaver/articles/heat-pump-systems ("A desuperheater-equipped heat pump can heat water 2 to 3 times more efficiently than an ordinary electric water heater.").

9. ENERGY INFO. ADMIN., ANNUAL ENERGY OUTLOOK 2008: WITH PROJECTIONS TO 2030, at ii (2008), *available at* http://www.eia.gov/oiaf/aeo/pdf/0383(2008).pdf (explaining that Energy Information Administration projections are "business-as-usual trend estimates"); PATRICK J. HUGHES, OAK RIDGE NAT'L LAB., GEOTHERMAL (GROUND-SOURCE) HEAT PUMPS: MARKET STATUS, BARRIERS TO ADOPTION, AND ACTIONS TO OVERCOME BARRIERS 1 (2008), *available at* http://www1.eere.energy.gov/geothermal/pdfs/ornl_ghp_study.pdf [hereinafter OAK RIDGE 2008 REPORT]; PATRICK HUGHES, OAK RIDGE NAT'L LAB., GHP MARKET STATUS, BARRIERS, AND METHODS TO OVERCOME THE BARRIERS 6 (2009), *available at* http://e2s2.ndia.org/pastmeetings/2009/tracks/Documents/8241.pdf [hereinafter OAK RIDGE 2009 REPORT] (explaining that the projections in the December 2008 report are based on Energy Information Administration projections). To put these numbers in perspective, the Indian Point nuclear power plant possesses a capacity of just over 2000 megawatts—or two gigawatts. *Indian Point Energy Center*, ENTERGY NUCLEAR, http://www.entergy-nuclear.com/plant_information/indian_point.aspx (last visited Jan. 3, 2013).

10. BANKS, *supra* note 1, at 71 (explaining that heat pumps that reject heat from buildings into the ground, which is cooler than the air, operate more efficiently than heat pumps that reject heat into the air).

11. COMMONWEALTH OF MASS. DEP'T OF ENVTL. PROT., GUIDELINES FOR GROUND SOURCE HEAT PUMP WELLS 3 (2012), *available at* http://www.mass.gov/dep/water/laws/gshpguid.pdf ("[Geothermal heat pumps] offer the benefit of reduced generation of air pollution (including greenhouse gases) in comparison with conventional heating and cooling systems.").

12. *Id*. at 73–74 (stating that a geothermal heat pump is "visually unobtrusive" because it usually is "a white box, not unlike a fridge" that "can be tucked away in a cellar or plant room," unlike the "major visual impact" of wind, solar, or geothermal electric projects); Steven A. Parker & Donald L. Hadley, *Ground-Source Heat Pumps Applied to Commercial Buildings*, *in* ENERGY MANAGEMENT HANDBOOK 727, 744 (Steve Doty & Wayne C. Turner eds., 2009) ("There are no significant negative environmental impacts associated with ground-source heat pumps."); Kaveh Badiei, Note, *Geothermal Energy: Is It Attractive Enough to Draw Investors for Construction of Geothermal Electric Plants?*, 7 HASTINGS W.-N.W. J. ENVTL. L. & POL'Y 109, 111–12 (2001) (identifying geothermal electric plants as resulting in noise pollution and altering otherwise undeveloped land through construction of "exposed piping" and the plant itself).

Economically, it is rational to encourage installation of geothermal heat pumps. Widespread installation of geothermal heat pumps could lead to annual savings of thirty-three to thirty-eight billion dollars on customer utility bills nationwide.[13] Moreover, geothermal heat pump retrofits, through energy savings, pay for themselves after five to twelve years.[14] Geothermal heat pumps could also save significant money by negating the need to build costly new power plants to meet rising peak demand for electricity[15] because widespread installation of geothermal heat pumps could lead to a large reduction in peak electricity demand.[16]

Although ground-source heat pumps are an appealing source of renewable energy, they have yet to truly catch on in the United States[17]—especially in the Northeast.[18] The Introduction of this Note will introduce readers to the different types of geothermal heat pumps and their mechanics. Part I will explain how high initial costs, information deficits, and governmental failures to make available equal financial incentives for geothermal heat pumps in the Northeast have inhibited the growth of their usage in the region. Part II will analyze the financial incentives and regulations that impact the use of geothermal heat pumps.

13. OAK RIDGE 2008 REPORT, *supra* note 9, at 1.

14. OAK RIDGE 2009 REPORT, *supra* note 9, at 5.

15. *See, e.g.*, U.S. Dep't of Energy, *Reducing Peak Demand to Defer Power Plant Construction in Oklahoma*, SMARTGRID.GOV, http://www.smartgrid.gov/case_study/news/reducing_peak_demand_defer_power_plant_construction_oklahoma (last visited Jan. 13, 2013) (discussing how Oklahoma Gas & Electric Company's peak demand reduction programs are aimed at eliminating the need to build two new power plants); *Pepco Energy Wise Rewards™ Program Frequently Asked Questions*, PEPCO, https://energywiserewards.pepco.com/md/faq/ (last visited Jan. 3, 2013) (explaining that demand reduction programs "reduce the need to build costly power plants" to meet energy needs during peak demand periods).

16. OAK RIDGE 2008 REPORT, *supra* note 9, at 1.

17. Though domestic ground-source heat pump shipments have increased from 35,581 units in 2000 to 121,243 units in 2008, unit shipments plateaued in 2009 at 115,442 units. U.S. ENERGY INFO. ADMIN., RENEWABLE ENERGY ANNUAL 2009, at 108 (2012), *available at* http://www.eia.gov/renewable/annual/pdf/rea_report.pdf. Moreover, these figures pale in comparison to the size of the construction industry in general; for example, new residential housing starts alone average 1.5 million per year, though this number dipped to 583,000 in 2009. U.S. DEP'T OF ENERGY, ENERGY EFFICIENCY TRENDS IN RESIDENTIAL AND COMMERCIAL BUILDINGS 5 (2008), *available at* http://apps1.eere.energy.gov/buildings/publications/pdfs/corporate/bt_stateindustry.pdf; U.S. DEP'T OF HOUS. & URBAN DEV., NEW RESIDENTIAL CONSTRUCTION IN NOVEMBER 2011, at 2 (2011), *available at* http://www.esa.doc.gov/sites/default/files/ei/documents/2011/December/newresidentialconstructionnovember2011.pdf.

18. *See* GARY PHETTEPLACE, A GUIDE FOR BEST PRACTICES FOR GROUND-SOURCE (GEOTHERMAL) HEAT PUMPS 1, *available at* http://www.efficiencyvermont.com/docs/for_my_business/hvac/GSHP_Best_Practices_Guide.PDF ("[Geothermal heat pump] systems . . . are not common place . . . especially in the Northeastern United States."). The term "Northeastern United States" refers to Pennsylvania, New Jersey, New York, Connecticut, Rhode Island, Vermont, New Hampshire, and Maine. U.S. CENSUS BUREAU, CENSUS REGIONS AND DIVISIONS OF THE UNITED STATES 1, *available at* http://www.census.gov/geo/www/us_regdiv.pdf.

Part III will discuss the barriers to widespread geothermal heat pump adoption and why current laws and regulations are inadequate to address these barriers. Part IV will propose several ways state governments can encourage greater installation of geothermal heat pumps. Specifically, I will argue that a loan program modeled after New York's On-Bill Recovery Program, an enhanced information-forcing regime, better training, and a legislative "fair funding" requirement are necessary to spark an increase in geothermal heat pump use.

I. THE MECHANICS OF GEOTHERMAL HEAT PUMPS AND INSTALLATION CONCERNS

A. Heat Pumps Move Heat from Low-Temperature Areas to High-Temperature Areas

A heat pump is a device that expends mechanical energy to force heat to flow from a low-temperature to a high-temperature environment, and that does not provide electricity.[19] Practically, heat pumps can be used to force heat to flow from "huge reserves of low-grade heat" present in the environment—whether in the atmosphere, the ground, rivers, or even sewage—to heat buildings to a comfortable, higher temperature during winter months.[20] Conversely, heat pumps can be used to reject heat from buildings into higher temperature environments—such as the atmosphere or the ground—in order to cool the buildings to a comfortable temperature during summer months.[21] Geothermal heat pumps and air-source heat pumps both use this type of mechanism to heat and cool buildings.[22] But while geothermal heat pumps operate in a similar fashion to air-source heat pumps, they offer significant energy savings over air-source heat pumps because of their use of the ground for heating and cooling.[23]

19. *See* BANKS, *supra* note 1, at 62; Harrison, *supra* note 1, at 425 (explaining that heat pumps are a form of direct use of geothermal resources, and that direct use is employed when "the temperature of geothermal resources is insufficient for the production of electrical energy").

20. BANKS, *supra* note 1, at 67.

21. *Id.* at 71.

22. *Id.* at 67, 71 (describing the different types of heat pumps, including pumps that use the ground or air as a heat source or heat sink).

23. ERIN R. ANDERSON, NAT'L RENEWABLE ENERGY LAB., DOE WEBINAR—RESIDENTIAL GEOTHERMAL HEAT PUMP RETROFITS 25 (2010), *available at* http://permanent.access.gpo.gov/gpo3502/50142.pdf (detailing the energy savings offered by geothermal heat pumps); Parker & Hadley, *supra* note 12, at 728, 743 (saying that "ground-source heat pumps remain extremely efficient throughout the year in virtually any climate" because the temperature of the ground is "relatively constant throughout the year" and that ground-source heat pumps offer energy and money savings in part "because the equipment operates more efficiently than conventional systems").

Heat pumps use either the atmosphere or the ground to heat or cool buildings.[24] Those that use the atmosphere are known as air-source heat pumps.[25] The traditional air conditioning unit is an example of an air-source heat pump.[26] Geothermal heat pumps, on the other hand, use the ground as a source of heat or as a place to deposit heat.[27] Ground-source heat pumps consist of an aboveground heat pump unit connected to underground piping or a well, which is used to gather heat from the ground or reject heat into the ground.[28]

There are two general categories of ground-source heat pumps: closed- and open-loop systems.[29] Closed-loop heat pumps circulate a fluid—typically water or a water-antifreeze solution—through an underground network of sealed pipes.[30] In heating mode, the fluid draws heat from the ground and then flows into the heat pump where it passes the heat to a refrigerant,[31] which is then used to heat the building.[32] The chilled fluid then reenters the ground, where it restarts the process.[33] In cooling mode, the refrigerant absorbs heat from the building and passes the heat to the fluid which then flows through buried pipes into the ground, where it dissipates the building's heat,[34] before flowing back into the building to restart the process.[35] Open-loop systems—also known as ground-water-source heat pumps[36]—function similarly to closed-loop

24. *See* BANKS, *supra* note 1, at 67, 71.

25. *Id.* at 67.

26. *Id.* at 71.

27. *Id.* at 67, 71.

28. *Id.* at 72 (depicting the schematics of the standard ground-source heat pump).

29. U.S. Dep't of Energy, *supra* note 4 (explaining that there are two general categories of ground-source heat pumps: closed-loop systems, which include horizontal, vertical, and pond/lake systems, and open-loop systems).

30. Parker & Hadley, *supra* note 12, at 731.

31. *See* BANKS, *supra* note 1, at 65 (listing common refrigerants and their characteristics).

32. *See* U.S. ENERGY INFO. ADMIN., GEOTHERMAL HEAT PUMP MANUFACTURING ACTIVITIES 2009, at 103–04 (2012), *available at* http://www.eia.gov/renewable/annual/pdf/rea_report .pdf ("Ground heat is absorbed into . . . the solution flowing in the closed loop. At the heat pump, heat is drawn from . . . the closed loop solution via heat transfer through a heat exchanger, which passes heat to . . . the refrigerant in the heat pump.").

33. *See* BANKS, *supra* note 1, at 127 ("The carrier fluid is thus chilled again and ready to start its next circuit through the earth.").

34. *See* U.S. ENERGY INFO. ADMIN., *supra* note 32, at 104 ("At the heat pump, heat is . . . dumped to the closed loop solution via heat transfer through a heat exchanger, which . . . removes heat from the refrigerant in the heat pump.").

35. *See* BANKS, *supra* note 1, at 127 ("[T]he warm carrier fluid from the . . . heat pump . . . descends into the subsurface and conducts a portion of its heat load to the relatively cooler earth. It emerges cooled to re-enter the heat pump or the building's cooling network.").

36. *See* Parker & Hadley, *supra* note 12, at 733.

systems.[37] The crucial distinction is that these systems draw in groundwater or surface body water from the immediate environment to use as the fluid that circulates through the heat pump system, instead of using water or an antifreeze solution.[38] Once heat has been drawn from or absorbed into the water, it is either injected into the ground or discharged onto the surface.[39]

B. Ground-source Heat Pumps Use Electricity More Efficiently than Air-Source Heat Pumps to Heat and Cool Buildings

Geothermal heat pumps are more environmentally friendly than their air-source heat pump counterparts because geothermal heat pumps are more efficient at heating or cooling buildings. Most heat pumps now use electricity to force the heat to flow to or from the building.[40] The amount of electricity required is directly related to the difference between the temperature of the heat source or heat sink and the desired temperature of the building.[41] This is problematic for air-source heat pumps because the temperature of the heat source or heat sink—the atmosphere—is variable, unlike the relatively constant temperature of geothermal heat pumps' heat source or heat sink—the ground.[42] As a result, it takes more electricity for an air-source heat pump to reject heat from a building into the atmosphere on a very hot day.[43]

In comparison, ground-source heat pumps' heat source or heat sink—the ground—possesses a stable, constant temperature a few feet below the surface of the earth, regardless of the weather aboveground.[44] Because of this stable temperature, ground-source heat pumps "remain extremely efficient throughout the year in virtually any climate."[45] Ground-source heat pumps are twenty to forty percent more efficient

37. U.S. Dep't of Energy, *supra* note 4 (describing the mechanics of open-loop geothermal heat pumps).

38. *Id*.

39. *Id*.

40. *See* BANKS, *supra* note 1, at 69.

41. *Id.* ("[Efficiency of heat pumps is] greatest when the difference between . . . the environmental source . . . and . . . the heat delivery temperature . . . is minimised.").

42. *See id.* at 69–71 (explaining that air-source heat pumps are relatively inefficient at rejecting heat on a hot day and at extracting heat from the atmosphere on a cold day, unlike geothermal heat pumps which can use the relatively constant temperature of the earth).

43. *See id.* at 71 ("[Air conditioners] may operate relatively inefficiently because, on a hot summer's day, they are striving to reject heat to a 'sink' (the outside air) that is at a relatively high temperature . . . .").

44. Parker & Hadley, *supra* note 12, at 728.

45. *Id.*

than air conditioners and fifty to seventy percent more efficient than other heating systems.[46]

C. Geothermal Heat Pump Installation Concerns

Geothermal heat pumps pose important environmental, construction, and installation issues. Improperly installed geothermal heat pumps can have two large effects on their surrounding environment. First, both closed-loop and open-loop systems installed by inexperienced drillers pose a risk of contaminating or depleting drinking water supplies.[47] Second, geothermal heat pump systems can significantly change the localized temperature of the ground, which can cause damage to plant roots, surface structures, or buried utility lines and pipes.[48]

A geothermal heat pump's cost-effectiveness is directly correlated to selecting the best type of system for the building and desired use.[49] For example, selecting a model that is too big can cause the geothermal heat pump to cut in and out repeatedly, leading to excessive wear and tear on the heat pump.[50] As a result, it is important that contractors are experienced not just in the installation of conventional heating, ventilating, and air conditioning units, but are specifically experienced with the installation of geothermal heat pumps.[51]

46. ANDERSON, *supra* note 23, at 25.

47. For example, poorly constructed boreholes can accidentally allow surface contaminants to migrate down the borehole and pollute aquifers, can connect aquifers located on different horizons—which is a concern if one aquifer is used for drinking water and the other aquifer is saline—or could puncture an artesian aquifer, resulting in a hard-to-control artesian flow—which "can significantly deplete groundwater resources." BANKS, *supra* note 1, at 275, 283, 286. An artesian aquifer is an aquifer that is "confined under pressure" and may flow to the surface if "tapped by a well." U.S. Dep't of Interior, *Artestian Water and Artesian Wells*, USGS WATER SCI. SCH., http://ga.water.usgs.gov/edu/gwartesian
.html (last modified Dec. 11, 2012, 3:43 PM).

48. If too much heat is injected into the ground, it can cause the ground level to rise. *See* BANKS, *supra* note 1, at 285 (describing how warming of the ground can cause "thermal expansion of rocks" and discussing a terrain heave of twelve to seventeen millimeters in Sweden above a closed-loop system operating at sixty degrees Celsius). If too much heat is extracted from the ground, it can cause the ground to freeze, "causing damage to built structures, buried services, or plant roots." *Id*. at 276.

49. PHETTEPLACE, *supra* note 18, at 4.

50. *See* BANKS, *supra* note 1, at 110.

51. PHETTEPLACE, *supra* note 18, at 4 ("There are many pitfalls that the designer inexperienced in GHP systems can fall into. Even a designer who is entirely successful at HVAC design for commercial systems in applications other than GHP systems may well produce a GHP design that fails or is far from optimal in terms of overall system efficiency.").

II. CURRENT FINANCIAL INCENTIVES AND LEGAL BURDENS ON GEOTHERMAL HEAT PUMP INSTALLATIONS

This section will analyze the current legal framework relevant to geothermal heat pumps and show that, although there are a wide variety of incentives available for renewable energy and energy efficiency systems, many incentives do not apply to geothermal heat pumps. However, because geothermal heat pumps can meet residential and commercial building energy demands,[52] reduce peak energy demand,[53] and, most importantly, provide energy more efficiently and at a lower cost than other renewable energy sources,[54] incentive programs should be expanded to include geothermal heat pumps. Part II.A will discuss federal financial incentives. Part II.B will address state financial incentives that may or may not be available for potential geothermal heat pump owners. Part II.C will address regulation of the installation of geothermal heat pumps.

52. *See* U.S. DEP'T OF ENERGY, *supra* note 7 and accompanying text (discussing the energy demands of buildings).

53. *See* OAK RIDGE 2008 REPORT, *supra* note 9, at vii ("Geothermal heat pumps . . . have been proven capable of producing large reductions in energy use and peak demand in buildings.").

54. To produce one kilowatt of energy capacity from a geothermal heat pump, the cost is approximately $948 to $1138. *See* KEVIN RAFFERTY, HEATSPRING LEARNING INST., AN INFORMATION SURVIVAL KIT FOR THE PROSPECTIVE GEOTHERMAL HEAT PUMP OWNER 12–13 (2011), *available at* http://www.weberwelldrilling.com/kit.pdf (estimating that the installed cost for a three ton capacity ground-source heat pump system—including ductwork, heat pump unit, controls, the ground loop, piping, excavation, and drilling—is between $10,000 and $12,000); U.S. DEP'T OF ENERGY, HOW TO BUY AN ENERGY-EFFICIENT GROUND-SOURCE HEAT PUMP 3 (2001), *available at* http://www1.eere.energy.gov/femp/pdfs/groundsource_heatpumps.pdf (stating that one ton is equivalent to 12,000 BTU/h and 1,000 Btu/h is equivalent to two hundred and ninety-three watts). In comparison, to produce one kilowatt of energy from wind, solar photovoltaic, concentrating solar power, or geothermal electric equipment, it costs approximately $1938–$2145, $4978–$9322, $2024–$6071, and $3941–$4655, respectively. EPA, RENEWABLE ENERGY COST DATABASE (2012), *available at* http://www.epa.gov/cleanenergy/documents/renewables_cost_data.xls (see tab titled "RE Cost Data–2010 Summary"). Once geothermal heat pumps are installed, operation and maintenance costs are low, so the primary point of comparison to other renewable energy systems is the installation cost. *See* INT'L ENERGY AGENCY, RENEWABLE ENERGY ESSENTIALS: GEOTHERMAL 2 (2010), *available at* http://www.iea.org/publications/freepublications/publication/Geothermal_Essentials.pdf (describing ground-source heat pump systems as "low maintenance cost systems"); *see also* INT'L ENERGY AGENCY, RENEWABLES FOR HEATING AND COOLING 56 (2007), *available at* http://www.iea.org/publications/freepublications/publication/Renewable_Heating_Cooling_Final_WEB.pdf (showing that geothermal heat pumps can produce energy at a lower cost than solar thermal equipment).

A. Geothermal Heat Pumps are Eligible for Federal Financial Incentives

Both individuals and businesses are eligible for federal tax credits for geothermal heat pump installations. Individuals are eligible for the Residential Energy Efficient Property ("REEP") tax credit.[55] The program allows individual taxpayers to take a credit against their income tax for up to thirty percent of the costs incurred that year on qualified geothermal heat pump property placed in service before January 1, 2017.[56] A business can claim a tax credit against its income tax for ten percent of the value of geothermal heat pump equipment placed in service before January 1, 2017.[57]

Besides tax incentives, the American Recovery and Reinvestment Act ("ARRA") provides other types of financial incentives for geothermal heat pump installation,[58] including support for a number of state programs.[59] For example, Connecticut offered ARRA-funded rebates for commercial and residential installations of geothermal heat pumps through the end of 2011.[60] ARRA also currently funds many federal financial incentive programs.[61] The ARRA-funded Weatherization Assistance Program assists low-income families in making their homes more energy-efficient by upgrading their heating and cooling systems.[62]

55. *See generally* 33 AM. JUR. 2D *Federal Taxation* §§ 1496–98 (2011) (analyzing the Renewable Energy Efficient Property Tax Credit).

56. I.R.C. § 25D(a)(5) (West 2011); I.R.C. § 25D(g) (West 2011). Individuals are also allowed a similar thirty percent tax credit for solar electric property, solar water heating property, fuel cell property, and small wind energy property. *See* I.R.C. §§ 25D(a)(1)–(4) (West 2011).

57. I.R.C. §§ 48(a)(1), (2)(A)(ii), (3)(A)(vii) (West 2011) ("[offering the tax credit for] equipment which uses the ground or ground water as a thermal energy source to heat a structure or as a thermal energy sink to cool a structure . . . ."); *see supra* notes 19–22 and accompanying text (describing geothermal heat pumps as equipment that heats and cools structures using the earth); *see also* 33A AM. JUR. 2D *Federal Taxation* §§14901, 14903 (2011) (analyzing the business energy credit).

58. The ARRA—also known as the Obama Administration's stimulus bill—was signed into law on February 17, 2009. Walter Mugdan & Gregory Hoffnagle, *Federal Government Initiatives to Promote Green Building and Sustainable Development*, *in* THE LAW OF GREEN BUILDINGS 37, 41 (J. Cullen Howe & Michael B. Gerrard eds., 2010). One objective of the ARRA is "to encourage the development of green technologies." *Id.*

59. *See id.* at 42 ("[the ARRA provides] financial and technical assistance to the states with the goal of improving energy efficiency and renewable energy on a state level.").

60. *See Geothermal Heat Pump Incentive Program—Residential*, CLEAN ENERGY FIN. & INV. AUTH., http://www.ctcleanenergy.com/YourHome/GeothermalIncentiveProgram Residential/tabid/520/Default.aspx (last visited Jan. 3, 2013) (describing geothermal heat rebate program, which has since closed). When the program ended, rebates averaged $5964 for residential installations and $55,674 for commercial installations. *Id.*

61. Kenneth Block et al., *Retrofitting*, *in* THE LAW OF GREEN BUILDINGS 273, 281 (J. Cullen Howe & Michael B. Gerrard eds., 2010). The effectiveness of federal financial incentives is largely beyond the scope of this Note, which focuses on state financial incentives.

62. *Id.*

Similarly, in 2009 the Energy Efficiency and Conservation Block Grant Program provided grants to "nonprofit organizations and government agencies to perform energy efficiency retrofits and to install renewable energy technologies in government buildings."[63]

B. Geothermal Heat Pumps are Eligible for a Variety of Financial Incentives from the Northeastern States

1. Tax Incentives

The majority of Northeastern states offer tax incentives for renewable energy systems.[64] These tax incentives come in three different forms. Renewable energy and energy efficiency technologies—including geothermal heat pumps—are eligible in various states for property tax exemptions,[65] sales tax exemptions,[66] or income tax credits.[67]

63. *Id.*

64. *See infra* text accompanying notes 65–71 (discussing tax incentives in the nine Northeastern states).

65. Connecticut exempts geothermal heat pumps, solar energy systems, wind turbines, and fuel cells. CONN. GEN. STAT. ANN. § 12-81(57) (West 2008 & Supp. 2012); CONN. GEN. STAT. ANN. § 16-1(a)(26) (West 2007 & Supp. 2012). Massachusetts exempts solar energy systems, wind turbines, and hydropower facilities. MASS. ANN. LAWS ch. 59, §§ 5(45), (45A) (LexisNexis 2010 & Supp. 2012). New Hampshire municipalities can exempt solar energy systems, wind turbines, and wood-heating energy systems from local taxes. N.H. REV. STAT. ANN. §§ 72:62, :66, :70 (2012). New Jersey exempts geothermal heat pumps, solar thermal systems, and renewable electrical energy systems. N.J. STAT. ANN. § 54:4-3.113a–b (West Supp. 2012). New York has two property tax exemptions: one that covers geothermal heat pumps, solar energy systems, and wind turbines, and one that applies only to solar energy systems, wind turbines, and farm waste energy systems. N.Y. REAL PROP. TAX § 487 (McKinney 2008 & Supp. 2012) (exempting the increase in value to real property due to the installation of solar systems, wind energy systems, and farm waste energy systems—but not geothermal heat pumps—from real property taxes); N.Y. REAL PROP. TAX § 487-a (McKinney 2008) (exempting "energy conservation measures" from real property taxes so long as they are installed pursuant to an "article VII-A of the public service law" or "any conservation related state or federal tax credit or deduction"); *Assessor's Manual, Volume 4, Exemption Administration*, N.Y. ST. DEP'T TAX'N & FIN., http://www.tax.ny.gov/research/property/assess /manuals/vol4/pt1/sec4_01/sec487_a.htm (last modified July 18, 2012) (stating that heat pumps, certain insulation measures, solar systems, and wind energy systems are eligible for the exemption of N.Y. REAL PROP. TAX § 487-a). New York localities can exempt solar, wind, and biomass energy systems from local taxes. N.Y. REAL PROP. TAX § 487(2) (McKinney 2008 & Supp. 2012). Rhode Island localities may exempt undefined renewable energy systems from local taxes, which could include geothermal heat pumps. R.I. GEN. LAWS § 44-3-21 (2010). Rhode Island caps the value of solar energy systems at the value of conventional heating, cooling, and power systems for property tax purposes. *Id.* § 44-57-4(a)(6). Vermont towns may exempt "alternative energy sources" that generate electricity or produce energy from local taxes, which could cover geothermal heat pumps. VT. STAT. ANN. tit. 32, § 3845(a) (2008). *But see id.* § 3845(b) (failing to include geothermal heat pumps on a non-exclusive list of "alternative energy sources").

66. Connecticut exempts geothermal heat pumps for residential purposes and solar energy systems for any purpose. CONN. GEN. STAT. ANN. § 12-412(117)(A) (West 2008 & Supp. 2012); CONN. AGENCIES REGS. § 16a-14-102(p)(6) (2011). Massachusetts exempts geothermal heat pumps,

Specifically, New Jersey and New York provide property tax exemptions for geothermal heat pumps;[68] Connecticut, Vermont, and Rhode Island potentially provide property tax exemptions for geothermal heat pumps, though eligibility is unclear;[69] Connecticut, Massachusetts, and Rhode Island exempt geothermal heat pumps from sales taxes;[70] and Rhode Island makes geothermal heat pumps eligible for income tax credits.[71]

solar energy systems, and wind turbines. MASS. ANN. LAWS ch. 64H, § 6(dd) (LexisNexis 2001 & Supp. 2012). Maine provided reimbursements for taxes paid on wind turbine equipment until December 31, 2011. ME. REV. STAT. ANN. tit. 36, § 2017(2), (4) (2010). New Jersey exempts solar energy systems. N.J. STAT. ANN. § 54:32B-8.33 (West 2002). New York exempts solar energy systems and wood heating fuel. N.Y. TAX §§ 1105-A(a), 1115(ee) (McKinney 2008 & Supp. 2012). New York localities can exempt solar energy systems from local taxes. *Id.* § 1210(iv)(a)(1)(ii), (b)(4)(n)(1). Rhode Island exempts solar energy systems, geothermal heat pumps, and wind turbines. R.I. GEN. LAWS § 44-18-30(57) (2010). Vermont exempts solar hot water heater systems. VT. STAT. ANN. tit. 32, § 9741(46)(C) (Supp. 2012).

67. In Massachusetts, solar energy systems and wind turbines are eligible. 830 MASS. CODE REGS. 62.6.1(1)–(2) (2012). In New York, solar energy systems are eligible. N.Y. TAX LAW § 606(g-1)(1) (McKinney 2006 & Supp. 2012). In Rhode Island, solar energy systems (photovoltaic systems, solar domestic hot water systems, and active solar space heating systems), geothermal heat pumps, and wind turbines are eligible. R.I. GEN. LAWS § 44-57-1(a) (2010); R.I. GEN. LAWS § 44-57-4(a) (2010); R.I. GEN. LAWS § 44-57-5(a)(3)(iii), (5)(iii) (2010) (capping tax credits at $7000 for geothermal heat pumps and $15,000 for active solar heating systems). A solar domestic hot water system is a "configuration of solar collectors, pump, heat exchanger, and storage tank designed to heat water." R.I. GEN. LAWS § 44-57-2(26) (2010). An active solar space heating system "uses mechanical parts to collect, store, and move heat" in order to "distribut[e] the heat to areas of the house that need heat." *See* R.I. GEN. LAWS § 44-57-2(1), 4(a)(3) (2010). Vermont offers an income tax credit for solar energy systems. VT. STAT. ANN. tit. 32, § 5822(d) (2008). Eligibility for this tax credit is based upon eligibility for the Federal business solar tax credit, which is calculated using IRS Form 3468. *See* VT. DEP'T OF TAXES, TECHNICAL BULLETIN 45 (2010), *available at* http://www.state.vt.us/tax/pdf.word.excel/legal/tb/TB45.pdf.

68. N.J. STAT. ANN. § 54:4-3.113a–b (West Supp. 2012); N.Y. PUB. SERV. § 135-b(4)(e), (g), (h), (j) (McKinney 2011); N.Y. REAL PROP. TAX § 487-a (McKinney 2008); *Assessor's Manual, Volume 4, Exemption Administration*, N.Y. ST. DEP'T TAX'N & FIN., http://www.tax.ny.gov/research/property/assess/manuals/vol4/pt1/sec4_01/sec487_a.htm (last modified Oct. 18, 2012).

69. CONN. GEN. STAT. ANN. § 12-81(57) (West 2008 & Supp. 2012) (creating a renewable energy property tax exemption); STATE OF CONN., OFFICE OF POLICY & MGMT., 2007 STATE LEGISLATION IMPACTING MUNICIPAL ASSESSMENT AND TAXATION 9–10 (2007), *available at* http://www.ct.gov/opm/lib/opm/igp/services/2007legislationaffectingmunicipalassessmentandtaxation.pdf (explaining that the legislation creating CONN. GEN. STAT. § 12-81(57) exempts active solar energy heating or cooling systems and Class I renewable energy sources such as solar energy systems and wind energy systems, but is not clear regarding its treatment of geothermal heat pumps). Rhode Island towns and cities can exempt undefined renewable energy systems, which could include geothermal heat pumps, from local taxes. R.I. GEN. LAWS § 44-3-21 (2010). Vermont towns can exempt non-commercial "alternative energy sources" that generate electricity or produce energy from local taxes, which could cover geothermal heat pumps. VT. STAT. ANN. tit. 32, § 3845(a) (2008). *But see id.* § 3845(b) (2008) (failing to include geothermal heat pumps on a non-exclusive list of "alternative energy sources").

70. CONN. GEN. STAT. ANN. § 12-412(117)(A) (West 2008 & Supp. 2012); STATE OF CONN., DEP'T OF REVENUE SERV., SN 2007(7), 2007 LEGISLATION GRANTING A CONNECTICUT SALES AND USE TAX EXEMPTION FOR SALES OF SOLAR HEATING SYSTEMS, SOLAR ELECTRICITY GENERATING SYSTEMS, AND ICE STORAGE COOLING SYSTEMS 1 (2007), *available at*

2. Renewable Portfolio Standards

Every Northeastern state has implemented a renewable portfolio standard, which either requires or sets non-binding goals that renewable energy satisfy a certain annual amount of electricity demand.[72] Although geothermal heat pumps can displace electricity used by electric water heating or air-source heat pumps,[73] Northeastern renewable portfolio standards as of December 31, 2011 overlooked their value.

The methodology underlying these renewable portfolio standards varies among the states. Connecticut, Maine, Massachusetts, New Jersey, Pennsylvania, and Rhode Island require electricity suppliers to utilize renewable energy sources for a certain percentage of their electricity sales each year.[74] In New Hampshire and Vermont, electricity

http://www.ct.gov/drs/lib/drs/publications/pubssn/2007/sn07-7.pdf (defining geothermal resource systems to include geothermal heat pumps); MASS. ANN. LAWS ch. 64H, § 6(dd) (LexisNexis 2001 & Supp. 2012); R.I. GEN. LAWS § 44-18-30(57) (2010).

71. R.I. GEN. LAWS § 44-57-1(a) (2010) (offering an income tax credit for a "eligible renewable energy system"); R.I. GEN. LAWS § 44-57-4(a)(5) (2010) (defining eligible renewable energy systems to include geothermal heat pumps). Wind energy and solar energy systems are also eligible for income tax credits. *See* R.I. GEN. LAWS § 44-57-4(a) (2010). Despite this seemingly equal treatment, the Rhode Island law favors solar heating because it caps tax credits for geothermal heat pumps at twenty-five percent of $7000, but for solar heating systems at twenty-five percent of $15,000. R.I. GEN. LAWS § 44-57-5(a)(3)(ii)–(iii), (5)(ii)–(iii) (2010).

72. CONN. GEN. STAT. ANN. §§ 16-243q, -245a (West 2007 & Supp. 2012); MASS. ANN. LAWS ch. 25A, § 11F(a) (LexisNexis 2010 & Supp. 2012); ME. REV. STAT. ANN. tit. 35-A, § 3210(3) (2010 & Supp. 2012); N.H. REV. STAT. ANN. § 362-F:3 (2009 & Supp. 2012); 73 PA. CONS. STAT. § 1648.3 (West 2008); R.I. GEN. LAWS § 39-26-4(a) (2006); VT. STAT. ANN. tit. 30, § 8004 (2008); N.J. ADMIN. CODE § 14:8-2 (2012); STATE OF N.Y., PUB. SERV. COMM'N, ORDER REGARDING RETAIL RENEWABLE PORTFOLIO STANDARD 5 (2004), *available at* http://documents.dps.ny.gov/public/Common/ViewDoc.aspx?DocRefId=%7BB1830060-A43F-426D-8948-F60E6B754734%7D (implementing a retail renewable portfolio standard).

73. *See supra* note 8 (discussing the efficiency of geothermal heat pumps in heating water); *supra* notes 40–46 and accompanying text (explaining that geothermal heat pumps use electricity more efficiently than air conditioners and other heating systems).

74. CONN. GEN. STAT. ANN. §§ 16-243q(a), -245a(a) (West 2007 & Supp. 2012) (setting required minimums for Class I, II, and III renewable energy sources; MASS. ANN. LAWS ch. 25A, § 11F(a) (LexisNexis 2010 & Supp. 2012) (setting renewable energy generating source purchase requirements); ME. REV. STAT. ANN. tit. 35-A, § 3210(3-A)(A) (2010 & Supp. 2012) (setting renewable capacity resources requirements); 73 PA. CONS. STAT. §§ 1648.3(a)–(c) (West 2008) (setting minimum amounts of alternative energy sources required); R.I. GEN. LAWS § 39-26-4(a) (2006); N.J. ADMIN. CODE § 14:8-2.3(a) (2012) (setting required minimum Class I renewable energy resource acquisitions). New Jersey also requires electricity providers to purchase a specified percentage of solar renewable energy certificates or make solar alternative compliance payments. N.J. ADMIN. CODE § 14:8-2.2 (2012) (defining "REC" and "SACP"); N.J. ADMIN. CODE § 14:8-2.3(c) (2012) (requirement to retire SRECs or make SACPs). Similar to New Hampshire and Vermont, Connecticut companies may also meet the percentage requirements by purchasing certificates, and if they fail to meet the percentage requirements by purchasing renewable energy or certificates, the companies must make a payment into a clean energy fund. CONN. GEN. STAT. ANN. §§ 16-243q(a), (b), -245(k), -245a(b) (West 2007 & Supp. 2012).

suppliers must annually either purchase a specified number of credits or certificates[75]—each of which represents a set amount of renewable electricity generation[76]—or make set payments into a clean energy fund that is used to promote the development of renewable energy technology.[77] In contrast to the other states, New York does not set mandatory targets for suppliers, but rather articulates statewide goals of generating a certain percentage of electricity from renewable energy sources.[78] The New York State Energy Research and Development Authority ("NYSERDA") grants monetary incentives in order to encourage the development of eligible generating facilities."[79] Revenue for these programs is "raised through a non-bypassable volumetric wires charge on the delivery customers of each of the State's investor-owned utilities."[80]

Similar to the variety of renewable portfolio standard mechanisms, different renewable energy technologies satisfy portfolio requirements or targets in different states. In Maine, Massachusetts, New Jersey, Rhode Island, and Vermont, only renewable energy sources that produce electricity satisfy portfolio requirements,[81] thereby excluding geothermal

75. N.H. REV. STAT. ANN. § 362-F:3 (2009 & Supp. 2012) (requiring electricity providers to purchase a specified amount of certificates); VT. STAT. ANN. tit. 30, § 8004(b) (2008) (requiring an electricity provider to obtain "a certain amount of new renewable resources in its portfolios" by purchasing "eligible new renewable energy credits, new renewable energy resources with renewable energy credits still attached, or a combination of those credits and resources").

76. N.H. REV. STAT. ANN. § 362-F:2(III) (2009 & Supp. 2012) ("[a certificate is a] record that identifies and represents each megawatt-hour generated by a renewable energy generating source."); VT. STAT. ANN. tit. 30, § 8002(8) (2008) ("[A t]radeable renewable energy credit [is] all of the environmental attributes associated with a single unit of energy generated by a renewable energy source.").

77. N.H. REV. STAT. ANN. § 362-F:3 (2009 & Supp. 2012) (describing how an electricity provider must make payments into the Renewable Energy Fund if the provider fails to meet the required percentages of certificates); VT. STAT. ANN. tit. 30, § 8004(e) (2008) (stating that electrical providers can make set payments into "the Vermont clean energy development fund" instead of purchasing credits).

78. STATE OF N.Y., PUB. SERV. COMM'N, *supra* note 72, at 5 (explaining that the New York renewable portfolio standard does not set mandates, but rather sets annual megawatt-hour targets).

79. *Id.* at 3–4.

80. *Id.* at 11.

81. *See* MASS. ANN. LAWS ch. 25A, § 11F(b) (LexisNexis 2012 & Supp. 2012) (defining a "renewable energy generating source" as a source that "generates electricity"); ME. REV. STAT. ANN. tit. 35-A, § 3210(2)(B-3) (2010 & Supp. 2012) (defining a "renewable capacity resource" as including only "source[s] of electrical generation"); R.I. GEN. LAWS § 39-26-4(a) (2006) (requiring electrical energy retailers to obtain an increasing amount of electricity they sell from eligible renewable energy resources); R.I. GEN. LAWS § 39-26-1(a) (2006) (describing one of the purposes of the renewable energy standard as "having electricity supplied in the state come from a diversity of energy sources including renewable resources"); VT. STAT. ANN. tit. 30, § 8004(b) (2008) (requiring electrical providers to acquire a percentage of the electricity they supply from "electricity generated

heat pumps from consideration.[82] As of December 31, 2011, renewable portfolio standards in New York, New Hampshire, and Pennsylvania encompass renewable energy resources that displace electricity.[83] New York and New Hampshire included solar water heating systems and solar thermal systems, but not geothermal heat pumps,[84] even though geothermal heat pumps can be used to displace electricity used by electric water heating or air-source heat pumps.[85] Pennsylvania and Connecticut took a broader approach to their to electricity reduction strategies,[86] choosing to make ground-source heat pumps also eligible for their renewable portfolio standards.[87]

by new renewable resources"); N.J. ADMIN. CODE § 14:8-2.5(b) (2011) (stating that Class I renewable energy includes only electricity generation).

82. *See* BANKS, *supra* note 1, at 67, 71 (describing how geothermal heat pumps can be used to heat or cool buildings).

83. *See infra* notes 84–87 (discussing New York, New Hampshire, and Pennsylvania's portfolio standards).

84. N.H. REV. STAT. ANN. § 362-F:2(XV) (2009 & Supp. 2012) (stating that a "renewable energy source" includes class I and class II sources); N.H. REV. STAT. ANN. §§ 362-F:4(I)–(II) (2009 & Supp. 2012) (explaining that class I sources include electricity production from wind energy, geothermal energy, hydrogen, ocean energy, methane gas, biomass, and "[t]he equivalent displacement of electricity . . . by end-use customers from solar hot water heating systems used instead of electric hot water heating" and Class II sources include the production of electricity from solar technology); STATE OF N.Y., PUB. SERV. COMM'N, *supra* note 72, at 7 (defining "Customer-Sited Tier" as consisting of "behind-the-meter" facilities); STATE OF N.Y., PUB. SERV. COMM'N, ORDER AUTHORIZING CUSTOMER-SITED TIER PROGRAM THROUGH 2015 AND RESOLVING GEOGRAPHIC BALANCE AND OTHER ISSUES PERTAINING TO THE RPS PROGRAM 12, 14 (2010), *available at* http://documents.dps.ny.gov/public/Common/ViewDoc.aspx?DocRefId=%7BC05CD0D6-8EA5-4CB9-A9FA-6ADD3AECB739%7D (stating that solar photovoltaic systems, anaerobic digesters, fuel cells, small wind arrays, and solar thermal systems are eligible for incentives in the Customer-Sited Tier).

85. *See supra* note 8 (discussing the efficiency of geothermal heat pumps in heating water); *supra* notes 40–46 and accompanying text (explaining that geothermal heat pumps use electricity more efficiently than air conditioners and other heating systems). Indeed, on June 19, 2012, New Hampshire amended its renewable portfolio standards to include heating and cooling resulting from geothermal heat pumps. *See* 2012-272 N.H. Rev. Stat. Ann. Adv. Legis. Serv. 3 (stating that "geothermal energy output . . . in the form of useful thermal energy" is a class I source, and that "useful thermal energy" is energy "in the form of direct heat, steam, hot water, or other thermal form that is used for heating, cooling, humidity control, process use, or other valid thermal end use energy requirements and for which fuel or electricity would otherwise be consumed.").

86. CONN. GEN. STAT. ANN. § 16-1(a)(44) (West 2007) ("[Class III sources include] electricity savings created in this state from conservation and load management programs."); 73 PA. CONS. STAT. § 1648.2 (West 2008) (stating that "alternative energy sources" are "existing and new sources for the production of electricity" such as solar photovoltaic and wind power and "strategies in residential, commercial, institutional, or government customers that reduce electricity consumption by those customers.").

87. *See* STATE OF PA., PUB. UTIL. COMM'N, TECHNICAL REFERENCE MANUAL (TRM) FOR PENNSYLVANIA ACT 129 ENERGY EFFICIENCY AND CONSERVATION PROGRAM AND ACT 213 ALTERNATIVE ENERGY PORTFOLIO STANDARDS 46 (2011), *available at* http://paaeps.com/credit/getFilenouser.do?file=trm-090528.pdf&docdir=true (discussing how energy

Alternatively, Vermont created the Sustainably Priced Energy Enterprise Development ("SPEED") program to achieve the goals of its renewable portfolio standard.[88] Through the SPEED program, the Vermont Public Service Board offers contracts to "qualifying SPEED resources with a plant capacity of 2.2 [megawatts] or less," until such resources cumulatively reach a plant capacity of fifty megawatts.[89] Eligible resources include solar photovoltaic systems, hydroelectric facilities, landfill gas facilities, farm methane facilities, wind energy systems, and biomass facilities, but not geothermal heat pumps.[90]

3. Rebates

Renewable energy systems are eligible for a significant number of rebates, which can be categorized into two groups.[91] First, some rebates are directly available for renewable energy equipment. Connecticut offered ARRA-funded rebates for commercial and residential installations of geothermal heat pumps through the end of 2011, with no follow-up programs planned.[92] Although these rebates have expired, Connecticut still offers rebates for solar photovoltaic systems.[93] Massachusetts offers rebates for solar photovoltaic system[94] and small wind project installations.[95] In Maine, businesses that install water-

and demand savings for ground-source heat pumps are calculated for purposes of the Alternative Energy Portfolio Standard); THE UNITED ILLUMINATING CO., UI AND CL&P PROGRAM SAVINGS DOCUMENTATION FOR 2011 PROGRAM YEAR 127–28 (2010), *available at* http://neep.org/uploads/EMV%20Forum/EMV%20Studies/FINAL%202011%20CT%20PSD.pdf (describing the energy savings associated with geothermal heat pumps for purposes of a conservation and load management program).

88. *See* VT. STAT. ANN. tit. 30, § 8005 (2008) (stating that the SPEED program is created to achieve the goals of section 8001 of the title, which is the Renewable Portfolio Standard section).

89. STATE OF VT., PUB. SERV. BD., ESTABLISHMENT OF PRICE FOR STANDARD OFFER UNDER THE SUSTAINABLY PRICED ENERGY ENTERPRISE DEVELOPMENT ("SPEED") PROGRAM 4 (2010), *available at* http://www.dsireusa.org/documents/Incentives/VT36F.pdf.

90. *Id.*

91. *See infra* Part III.A for a set of charts that displays information on state rebate programs, among other state financial incentive schemes.

92. *See* CLEAN ENERGY FIN. & INV. AUTH., *supra* note 60 (describing recently-ended program that offered an average rebate of $5,306.22 for residential projects and an average rebate of $72,390.91 for commercial projects).

93. *See Solar Rebates*, CLEAN ENERGY FIN. & INV. AUTH., http://www.ctcleanenergy.com /YourHome/SolarRebates/tabid/586/Default.aspx (last visited Jan. 11, 2012) (PDF version of the webpage on file with author).

94. Email from Patrick Cloney, Chief Exec. Officer of Mass. Clean Energy Ctr., http://myemail.constantcontact.com/Commonwealth-Solar-II-Program-Update—Block-9.html?soid=1102549393259&aid=_s5RScGzvvs (last visited Jan. 3, 2013).

95. *Commonwealth Wind—MicroWind*, MASS. CLEAN ENERGY CENTER, http://www.masscec. com/index.cfm/page/Commonwealth-Wind-MicroWind/cdid/11395/pid/11159 (last visited Jan. 3, 2013).

source heat pumps are eligible for rebates.[96] Additionally, Maine businesses and residences that install solar air and water heating systems,[97] solar electric photovoltaic systems,[98] or wind generating facilities[99] are eligible for rebates. Through the Renewable Energy Fund,[100] New Hampshire provides rebates for small photovoltaic and wind generation systems,[101] residential solar water heaters,[102] residential bulk-fed wood-pellet central boilers and furnaces,[103] and commercial and industrial solar photovoltaic and solar thermal systems.[104] In New Jersey, commercial and industrial entities that install water-source heat pumps and closed-loop ground-source heat pumps are eligible for rebates[105]—a program that is funded through the state Societal Benefits

96. EFFICIENCY ME., PRESCRIPTIVE HVAC APPLICATION AND INSTRUCTIONS: FOR REPLACEMENT OF OPERATING EQUIPMENT (RETROFIT) 4 (n.d.), *available at* http://www.efficiencymaine.com/docs/1prehvacretro.pdf (describing a rebate of eighty dollars per ton of capacity installed for new retrofits); EFFICIENCY ME., PRESCRIPTIVE HVAC APPLICATION AND INSTRUCTIONS: FOR NEW CONSTRUCTION OR RENOVATION PROJECTS 4(n.d.), *available at* http://www.efficiencymaine.com/docs/1prehvacccnc.pdf (describing a rebate of eighty dollars per ton of capacity installed for new construction or renovation projects).

97. *Solar Thermal Program*, EFFICIENCY ME., http://www.efficiencymaine.com/renewable-energy/solar-thermal (last visited Jan. 3, 2013) (describing rebate of up to $2000 for residential projects and $4000 for commercial projects).

98. *Solar Electric Program*, EFFICIENCY ME., http://www.efficiencymaine.com/renewable-energy/solar-electric (last visited Jan. 3, 2013) (describing rebate of up to $2000 for residential projects and $4000 for commercial projects).

99. *Wind Energy Program*, EFFICIENCY ME., http://www.efficiencymaine.com/renewable-energy/wind (last visited Jan. 3, 2013) (describing rebate of up to $2000 for residential projects and $4000 for commercial projects).

100. *See Renewable Energy Fund*, N.H. PUB. UTIL. COMMISSION, http://www.puc.nh.gov/Sustainable%20Energy/RenewableEnergyFund.html (last visited Jan. 3, 2013) (discussing the creation of the Fund and the Fund's duties).

101. *See* N.H. REV. STAT. ANN. § 362-F:10 (2009 & Supp. 2012); STATE OF N.H., PUB. UTIL. COMM'N, INCENTIVE PRE-APPROVAL APPLICATION 1–2 (n.d.), *available at* http://www.puc.nh.gov/Sustainable%20Energy/Renewable%20Energy%20Rebates/Small%20Renewable%20Electrical%20Generation/Pre-Installation%20Incentive%20Application%20STEP1%20125-4500%20Final%2012-15-10%20rev%2011-11.pdf (describing the maximum incentives and stating that the program is in accordance with N.H. REV. STAT. ANN. § 362-F:10, the Renewable Energy Fund provision).

102. *Residential Solar Water Heating Rebate Program*, N.H. PUB. UTIL. COMMISSION, http://www.puc.nh.gov/Sustainable%20Energy/RenewableEnergyRebates-SWH.html (last visited Jan. 3, 2013).

103. *Residential Bulk-Fed Wood-Pellet Central Boilers and Furnace Rebate Program*, N.H. PUB. UTIL. COMMISSION, http://www.puc.nh.gov/Sustainable%20Energy/RenewableEnergy Rebates-WP.html (last visited Jan. 3, 2013).

104. STATE OF N.H., PUB. UTIL. COMM'N, ESTABLISHING A COMMERCIAL AND INDUSTRIAL RENEWABLE ENERGY REBATE PROGRAM 8 (2010), *available at* http://www.puc.nh.gov/Regulatory/Orders/2010orders/25151e.pdf.

105. *Equipment Incentives*, N.J. CLEAN ENERGY PROGRAM, http://www.njcleanenergy.com/

Charge.[106] In New York, new and substantially renovated multifamily buildings and certain nonresidential buildings are eligible for rebates "for the purchase and installation of energy-efficient equipment"—including geothermal heat pumps.[107] Vermont, through Efficiency Vermont,[108] offers rebates for residential heating system replacements[109] and for commercial water-source heat pumps and wood-pellet boiler and furnace installations.[110] In addition, Vermont provides incentives for wind and solar energy projects through the Vermont Clean Energy Development Fund ("CEDF").[111]

commercial-industrial/programs/nj-smartstart-buildings/tools-and-resources/equipment-incentives/equi (last visited Jan. 3, 2013) (describing an eighty-one dollar per ton rebate for water-source heat pumps and a $450–750 per ton rebate for closed-loop ground-source heat pumps).

106. *New Jersey SmartStart Buildings—New Construction and Retrofits*, DATABASE OF ST. INCENTIVES FOR RENEWABLES & EFFICIENCY, http://www.dsireusa.org/incentives/incentive.cfm?Incentive_Code=NJ18F&re=1&ee=1 (last updated Jan. 3, 2013). The SBC is a "non-bypassable charge imposed on all electric public utility customers and gas public utility customers" set by the New Jersey Board of Public Utilities that permits electric and gas public utilities to recover certain costs, including those expended on funding demand-side renewable energy projects. N.J. STAT. ANN. § 48:3-60(a), (a)(3) (West 2009).

107. N.Y. State Energy Research & Dev. Auth., New Construction Program—Financial Incentives Program Opportunity Notice (PON) 1, 3 (2011), *available at* http://nyserda.ny.gov/Funding-Opportunities/Current-Funding-Opportunities/~/media/Files/FO/Current% 20Funding%20Opportunities/PON%201501/1501summary.ashx; N.Y. State Energy Research & Dev. Auth., NEW CONSTRUCTION PROGRAM INCENTIVES AND SERVICES FOR PROJECTS NOT LOCATED IN CONSOLIDATED EDISON SERVICE TERRITORY 1–4 (2011), *available at* http://nyserda.ny.gov/Funding-Opportunities/Current-Funding-Opportunities/~/media/Files/FO/Current%20Funding%20Opportunities/PON%201501/1501attd.ashx (stating that geothermal heat pumps are eligible for rebates of $400 per ton of capacity, up to a maximum of $200,000 or $400,000 per building depending on the applicable utility company).

108. Efficiency Vermont operates "under an appointment issued by the Vermont Public Service Board." *See About Us*, EFFICIENCY VT., http://www.efficiencyvermont.com/about_us.aspx (last visited Jan. 3, 2013). Efficiency Vermont is funded through "[a]n energy efficiency charge on ratepayers' electric bills." *How Efficiency Vermont Works*, EFFICIENCY VT., http://www.efficiencyvermont.com/about_us/information_reports/how_we_work.aspx (last visited Jan. 3, 2013).

109. *See* EFFICIENCY VT., HOME PERFORMANCE WITH ENERGY STAR® 3 (n.d.), *available at* http://www.efficiencyvermont.com/docs/for_my_home/general_info/2011_FinalIncentiveSheet.pdf ($500 rebate). It is not clear whether this incentive is open to geothermal heat pumps. *See id.*

110. *See* EFFICIENCY VT., 2012 REBATE FORM: HEATING, VENTILATION & AIR CONDITIONING (HVAC) 4, 7 (n.d.), *available at* http://www.efficiencyvermont.org/docs/for_my_business/rebate_forms/HVACRebateForm.pdf (offering a rebate of eighty dollars per ton of installed capacity for water-source heat pumps and $1000 per system for wood-pellet boilers and furnaces).

111. VT. DEP'T PUB. SERV., VERMONT SMALL SCALE RENEWABLE ENERGY INCENTIVE PROGRAM INCENTIVE DESIGN—2012 PROGRAM YEAR 1 (2012), *available at* http://publicservice.vermont.gov/energy/ee_files/cedf/Final%20Draft%20Approved%202012%20Small%20Scale%20RE%20Incentive%20Program%20Design.pdf (stating the incentive levels for solar and wind energy projects); *Clean Energy Development Fund*, VT. DEP'T PUB. SERV., http://publicservice.vermont.gov /energy/ee_cleanenergyfund.html (last visited Jan. 3, 2013) (listing the programs funded through CEDF); *see* VT. STAT. ANN. tit. 30, § 8004(e) (2008) (describing the funding of the CEDF).

Second, some states offer rebates for whole-building improvements, some of which apply to geothermal heat pumps. New York offers rebates—funded through the state System Benefits Charge[112]—to existing and newly constructed multifamily buildings in order to help improve their overall energy performance.[113] Geothermal heat pumps are an eligible technology under the New York program.[114] In Vermont, newly constructed residences can receive a rebate of up to $1500 from Efficiency Vermont if the home achieves certain overall energy savings levels, though the program does not specify the eligible technologies.[115] Using state Societal Benefits Charge funding,[116] New Jersey runs a rebate program for existing single-family homes, townhouses, and multifamily developments that achieve certain levels of energy savings,[117] a program for which geothermal heat pumps are eligible.[118]

4. Loans

A wide variety of loans provided through government entities are available to geothermal heat pumps and other renewable energy

112. *New York Energy Smart Multifamily Performance Program*, DATABASE OF ST. INCENTIVES FOR RENEWABLES & EFFICIENCY, http://www.dsireusa.org/incentives/incentive.cfm?Incentive_Code=NY36F&re=1&ee=1 (last visited Jan. 3, 2013). The System Benefits Charge "supports energy efficiency, education and outreach, research and development, and low-income energy assistance" and is collected "from customers through a surcharge on customers' bills." *System Benefits Charge*, DATABASE OF ST. INCENTIVES FOR RENEWABLES & EFFICIENCY, http://www.dsireusa.org/incentives/incentive.cfm?Incentive_Code=NY07R&re=1&ee=1 (last visited Jan. 3, 2013).

113. *Multifamily Performance Program*, N.Y. St. Energy Res. & Dev. Auth., http://www.nyserda.ny.gov/Multifamily-Performance-Program/Multifamily-Performance-Program.aspx (last visited Jan. 3, 2013) (offering rebates to multifamily buildings with more than five units and four floors).

114. *New York Energy Smart Multifamily Performance Program*, *supra* note 112.

115. EFFICIENCY VT., EFFICIENCY VERMONT RESIDENTIAL NEW CONSTRUCTION SERVICES 1 (n.d.), *available at* http://efficiencyvermont.com/EVT/docs/for_my_home/general_info/Incentive%20Sheet_2_2_11.pdf (stating that homes can receive up to $1500 for achieving a low Home Energy Rating (HERS) score). *See supra* note 108 (describing the mechanics of Efficiency Vermont).

116. *Home Performance with Energy Star Program*, DATABASE OF ST. INCENTIVES FOR RENEWABLES & EFFICIENCY, http://www.dsireusa.org/incentives/incentive.cfm?Incentive_Code=NJ22F&re=1&ee=1 (last visited Jan. 3, 2013); *see supra* note 106 (describing the mechanics of the Societal Benefits Charge).

117. *Benefits and Incentives*, N.J. CLEAN ENERGY PROGRAM, http://www.njcleanenergy.com/residential/programs/home-performance-energy-star/benefits-and-incentives (last visited Jan. 3, 2013) (stating that single-family homes and townhouses can receive a rebate between $2000–$5000); *Eligibility*, N.J.'S CLEAN ENERGY PROGRAM, http://www.njcleanenergy.com/residential/programs/home-performance-energy-star/eligibility (last visited Jan. 3, 2013) (stating that multifamily developments can receive between $500–$1500 per unit and describing eligibility of buildings).

118. *New York Energy Smart Multifamily Performance Program*, *supra* note 112.

technologies. Of these loan programs, New York's is potentially the most effective because it provides a convenient payback option for program participants. In 2009, the New York State Legislature created a revolving loan fund,[119] which is funded through "New York's share of the proceeds from the sale of carbon allowances under the Regional Greenhouse Gas Initiative ("RGGI")."[120] Utility customers who own residential or nonresidential structures can receive loans of up to $13,000 and $26,000 respectively and pay them back "through a charge on [the customer's] monthly utility bill" under the newly-created "On-Bill Recovery Program."[121] Geothermal heat pumps, solar water heaters, and solar thermal systems are eligible for funding through the On-Bill Recovery Program.[122]

Connecticut, New Hampshire, Maine, and Pennsylvania run programs that offer loans to individuals and businesses to specifically cover the cost of the installation of renewable energy technologies such as geothermal heat pumps, solar systems, and wind turbines. Connecticut offers several types of loans. First, Connecticut offers loans, funded through the issuance of state bonds,[123] for geothermal heat pumps, solar systems, and passive solar additions that are installed in single-family homes and multifamily properties.[124] Second, Connecticut provides loans for geothermal systems, electric and natural gas hot water heaters, air-to-air heat pumps, and natural gas furnaces and boilers, among other improvements.[125] These loans are funded through a charge on customer

119. *See* MICHAEL B. GERRARD ET AL., ARNOLD & PORTER LLP, NEW YORK LAW TO HELP FINANCE ENERGY EFFICIENCY IMPROVEMENTS AND ACCELERATE ENERGY GENERATION FACILITY CONSTRUCTION 2 (2011), *available at* http://www.arnoldporter.com/resources/documents /Advisory%20New_Law_NY_Will_Help_Finance_Energy_Efficiency_Improvements.pdf.

120. *Id*.

121. *Id*.

122. *See On-Bill Recovery Loan Program*, N.Y. ST. ENERGY RES. AND DEV. AUTH., http://www.nyserda.ny.gov/en/Statewide-Initiatives/On-Bill-Recovery-Financing-Program.aspx (last visited Jan. 5, 2012) (instructing individuals to first participate in the Home Performance with Energy Star® Program); ENERGY FIN. SOLUTIONS, NY PERFORMANCE WITH ENERGY STAR®: ELIGIBLE MEASURES AND ACCESSORIES MATRIX 1–2 (2011), *available at* http://www.energyfinancesolutions.com/assets/pdfs/newyorkgreenjobs_eligiblemeasures.pdf (last visited Oct. 29, 2012) (describing the technologies that are eligible for Home Performance with Energy Star®).

123. CONN. GEN. STAT. ANN. § 16a-40c (West 2007 & Supp. 2012).

124. *See* CONN. GEN. STAT. ANN. § 16a-40b (West 2007 & Supp. 2012); *Energy Conservation Loan Program*, CONN. HOUSING INVESTMENT FUND INC., http://www.chif.org/page/energy-conservation-loan-program (last visited Jan. 8, 2013) (offering loans of $25,000 for single-family homeowners and $60,000 for multifamily property owners and listing eligible improvements).

125. *See* CONN. ENERGY EFFICIENCY FUND, RESIDENTIAL FINANCING: 2.99% OR 4.99% FINANCING FOR ENERGY SAVING HOME IMPROVEMENTS 1 (n.d.), *available at* http://www.chif.org/public/uploads/files/pdfs/chif-trifold_final-5-31-11.pdf (describing how

energy bills.[126] Third, Connecticut offers low-interest, long-term loans to customer-sited distributed resources[127] such as fuel cells, photovoltaic systems, or small wind turbines that generate electricity, as well as resources that lead to a reduction in demand for electricity.[128] New Hampshire runs two nonresidential loan programs. One program provides loans for renewable energy projects[129] and the other provides loans for cost-effective energy improvements.[130] In Maine, small businesses can receive loans for energy conservation projects.[131] Pennsylvania provides loans to owners of one- and two-unit residences for geothermal heat pumps that are installed by a Trained or Certified Geothermal Contractor.[132]

New Jersey, Pennsylvania, and Vermont offer loans to building owners who achieve whole-building energy improvements. Though the loan application criteria are not clear for each state, these loans may potentially cover all or part of the installation costs of geothermal heat

customers of only one utility are eligible to receive market rate loans for geothermal systems whereas all utility customers are eligible for low-interest loans for electric and natural gas hot water heaters, air-to-air heat pumps, and natural gas furnaces and boilers, among other improvements).

126. *See id.* at 2.

127. *See* CONN. GEN. STAT. ANN. §§ 16-243j(a)–(b) (West 2007 & Supp. 2012).

128. *See id.* §§ 16-243j(a), -1(40) (West 2007 & Supp. 2012). Geothermal heat pumps may be eligible for this program—even though the statute does not further define demand reduction technologies—because they can provide a reduction in electricity if they replace electric water heaters or air-source heat pumps. *See* sources cited *supra* notes 8, 40–46 and accompanying text.

129. *The Enterprise Energy Fund for Not-for-Profits*, N.H. CMTY. DEV. FIN. AUTH, http://www.nhcdfa.org/energy-efficiency/for-not-for-profits-overview (last visited Jan. 5, 2013). Activities that are specifically eligible include "solar hot water and other solar thermal installations" and "renewable energy systems: wood-pellets, wind generation, photovoltaics, etc." *Enterprise Energy Fund FAQs*, N.H. CMTY DEV. FIN. AUTH., http://www.nhcdfa.org/ energy-efficiency/for-not-for-profits-faqs (last visited Jan. 5, 2013). There is no mention of geothermal heat pumps. *See id.*

130. The term "energy efficiency improvements" is undefined, so geothermal heat pumps could be eligible. *Business Energy Conservation Revolving Loan Fund*, N.H. BUS. FIN. AUTH., http://www.nhbfa.com/BFA_LoanPlans_BizEnergy.html (last visited Jan. 9, 2011) (archived webpage on file with author). The fund has received $2 million in capital from the state, and "[c]ontinued operation of the program depends on the recycling of loan principal repayments and additional appropriations . . . ." *Id.*

131. *See* EFFICIENCY ME., EFFICIENCY MAINE BUSINESS PROGRAM: SMALL BUSINESS LOAN PROGRAM 1 (n.d.), *available at* http://www.efficiencymaine.com/docs/at_work/EMBP 16298SmBus-LoanProgram7-11.pdf (on file with author). Heat pumps, solar water heaters, photovoltaic systems, and wind energy installations are eligible for loans. *Efficiency Maine Small Business Loan Program*, DATABASE OF ST. INCENTIVES FOR RENEWABLES & EFFICIENCY, http://www.dsireusa.org/incentives/incentive.cfm?Incentive_Code=ME04F&re=1&ee=1 (last updated July 18, 2012).

132. *See* AFC First Fin. Corp., *Keystone HELP Geothermal Loans*, KEYSTONE HELP, http://www.keystonehelp.com/info/geothermal.php (last visited Jan. 10, 2012) (archived webpage on file with author). To be a "Trained Geothermal Contractor," an installer must be certified as an Accredited Loop Installer by the International Ground Source Heat Pump Association. *Id.*

pumps if the pumps enable the loan applicant to achieve the required whole-building energy improvements.[133] New Jersey's loan program is open to nonresidential entities only.[134] In Pennsylvania, nonresidential and multi-family residential buildings are eligible for a whole-building loan program.[135] Vermont businesses are eligible for loans that will be used to improve energy efficiency in their buildings.[136]

Finally, Rhode Island and Pennsylvania run programs that offer both loans and grants to eligible entities. In Rhode Island, entities that install electricity-generating renewable energy systems are eligible for loans and grants.[137] Geothermal heat pumps are excluded from eligibility because they do not provide electricity.[138] Pennsylvania offers loans and grants to wind energy systems, geothermal heat pumps, and solar energy systems.[139] Pennsylvania dedicated $25 million in funding for the wind and geothermal program[140] and $180 million for the solar program.[141]

133. Whole-building energy improvements are measures that achieve reductions in the building's energy use. *See Financing Programs–Energy Efficiency Revolving Loan Fund (EE RLF)*, N.J. ECON. DEV. AUTH., http://www.njeda.com/web/Aspx_pg/Templates/Npic_Text.aspx?Doc_Id=1465&menuid=1514&topid=718&levelid=6&midid=1175 (last visited Jan. 9, 2013); *TRF's Building Energy Loans*, REINVESTMENT FUND, http://www.trfund.com/financing/energy/pagelf.html (last visited Jan. 10, 2012); *Vermont Business Energy Conservation Loan Program*, VT. ECON. DEV. AUTH., http://www.veda.org/financing-options/vermont-commercial-financing/vermont-business-energy-conservation-loan-program/ (last visited Jan. 10, 2012).

134. *See* N.J. ECON. DEV. AUTH., *supra* note 133.

135. *See* REINVESTMENT FUND, *supra* note 133. Renewable energy systems are eligible for the program funding so long as they are part of a "larger, building energy conservation and efficiency project." *Id.*

136. *See* VT. ECON. DEV. AUTH., *supra* note 133. Loans can be used to pay for the purchase and installation of thermal envelope improvements and new energy-efficient heating, ventilation, and air conditioning ("HVAC") equipment, among other improvements. *See id.* It's not clear if the program covers ground-source heat pumps, though HVAC equipment is defined elsewhere as including ground-source heat pumps. *See Heating, Ventilation & Air Conditioning (HVAC)*, EFFICIENCY VT., http://www.efficiencyvermont.com/for_my_business/ways-to-save-and-rebates/hvac/general_info/more_info.aspx (last visited Jan. 10, 2012).

137. *See Renewable Energy Fund,* R.I. ECON. DEV. CORP., http://www.riedc.com/business-services/renewable-energy (last visited Jan. 15, 2012) (describing the mechanism of the Renewable Energy Fund); *RIEDC—Renewable Energy Fund Grants*, DATABASE OF ST. INCENTIVES FOR RENEWABLES & EFFICIENCY, http://www.dsireusa.org/incentives/incentive.cfm?Incentive_Code=RI28F&re=1&ee=1 (last visited Jan. 5, 2013) (identifying the technologies eligible under the Renewable Energy Fund).

138. *See* sources cited *supra* notes 19–22 and accompanying text (describing geothermal heat pumps as a technology that provides heating and cooling, not electricity).

139. PA. DEP'T OF CMTY. & ECON. DEV., RENEWABLE ENERGY PROGRAM: GEOTHERMAL AND WIND PROJECTS 1 (2009), *available at* http://www.newpa.com/sites/default/files/uploads/renewable-energy-geothermal-wind_guidelines_09.pdf; PA. DEP'T OF CMTY. & ECON. DEV., SOLAR ENERGY PROGRAM 1–2, 4 (2009), *available at* http://www.newpa.com/sites/default/files/uploads/solarenergyprogram_guidelines_2009_2.pdf.

140. 73 PA. CONS. STAT. § 1649.307(a)(1), (b) (West Supp. 2012).

5. Municipal Property Assessed Clean Energy Programs

Maine, New Hampshire, and Vermont allow municipalities to adopt Property Assessed Clean Energy ("PACE") ordinances and then create PACE programs.[142] Through PACE programs, municipalities can provide funding to property owners for the installation of renewable energy systems,[143] including geothermal heat pumps.[144] The funding is then paid back through a PACE assessment.[145] To secure repayment, a subordinated mortgage is taken out on the property by the municipality.[146] The subordinated mortgages probably address the Federal Housing Finance Agency's (FHFA) recent concern that the priority status that many states with PACE programs assign to PACE mortgages over home mortgages in the event of default would violate underwriting standards.[147]

141. 73 PA. CONS. STAT. § 1649.306(a) (West Supp. 2012); 73 PA. CONS. STAT. § 1649.307(d) (West Supp. 2012); *see* 73 PA. CONS. STAT. § 1649 (West Supp. 2012); LATHAM & WATKINS LLP, INCENTIVES FOR ENERGY EFFICIENCY AND RENEWABLE ENERGY GENERATION: STATE REVOLVING LOAN PROGRAMS 65, 67 (2010), *available at* http://www.cleanenergystates.org/assets/Uploads/Resources-post-8-16/staterevolvingloanprograms.pdf (describing the funding source for the Wind and Geothermal Incentives Program and Solar Energy Incentives Program as the Alternative Energy Investment Act).

142. ME. REV. STAT. ANN. tit. 35-A, § 10154(1) (2010); N.H. REV. STAT. ANN. § 53-F:2(IV) (2012); VT. STAT. ANN. tit. 24, § 3261(b) (Supp. 2012).

143. ME. REV. STAT. ANN. tit. 35-A, § 10157(1) (2010) (stating that property owners who enter into PACE agreements may "purchase . . . all goods and services for the energy savings improvements described in the PACE agreement"); N.H. REV. STAT. ANN. § 53-F:3(VII) (2012); N.H. REV. STAT. ANN. § 53-F:6(I) (2012); VT. STAT. ANN. tit. 24, § 3261(b) (Supp. 2012); 95-648-110 ME. CODE R. § 2(7)(B) (LexisNexis 2011) (stating that "energy savings improvement" includes a "renewable energy installation").

144. N.H. REV. STAT. ANN. § 53-F:1(I), (III) (2012); VT. STAT. ANN. tit. 30, § 8002(2) (2008) ("[Renewable energy is] energy produced using a technology that relies on a resource that is being consumed at a harvest rate at or below its natural regeneration rate."); 95-648-110 ME. CODE R. § 2(25) (LexisNexis 2011) (defining "renewable energy installation" to include a system that produces energy or heat from renewable sources, such as photovoltaic systems, solar thermal systems, wind systems, or geothermal systems). As discussed in the Introduction, geothermal heat pumps meet Vermont's broad definition. *See supra* note 1 (discussing the sustainability of geothermal heat pumps).

145. ME. REV. STAT. ANN. tit. 35-A, § 10154(2) (2010); N.H. REV. STAT. ANN. § 53-F:3(VII) (2012); VT. STAT. ANN. tit. 24, § 3262(a) (Supp. 2012).

146. ME. REV. STAT. ANN. tit. 35-A, § 10156(3)(A) (2010); N.H. REV. STAT. ANN. § 53-F:8 (2012); 2011 VT. ACTS & RESOLVES 216 (amending VT. STAT. ANN. tit. 24, § 3255 so that, effective January 1, 2012, a PACE mortgage is subordinated to "all liens on the property in existence at the time" the mortgage is filed and to a subsequent first mortgage on the property).

147. On July 6, 2010, FHFA ordered Fannie Mae, Freddie Mac and the Federal Home Loan Bank "not to underwrite mortgages with PACE liens" on the grounds that priority of PACE mortgages over home mortgages in the event of default "violated underwriting standards." Editorial, *Green Jobs Program is a Proven Powerhouse*, BRADENTON HERALD, Oct. 2, 2011, *available at* http://www.bradenton.com/2011/10/02/3537942/green-jobs-program-is-a-proven.html; FED. HOUS.

6. Grants

Several states offer grants for renewable energy technologies. Besides the combined loan and grant programs run by Rhode Island and Pennsylvania,[148] Connecticut offers two grant programs, both of which exclude funding for geothermal heat pump initiatives. The Community Innovation Grants Program awards funding to local energy task forces, which are charged with providing micro-grants "to organizations and citizens motivated to start local projects that support clean energy awareness and education within their communities."[149] However, funding is awarded only for grant proposals that will increase sign-ups for the CTCleanEnergyOptions Program,[150] a program that is available solely to wind and small hydroelectric projects.[151] Thus, projects that aim to increase awareness about geothermal heat pumps are not eligible for such grants. A second grant program offers funding to companies and government agencies for renewable projects that generate electricity—namely, solar photovoltaic, wind, fuel cell, landfill gas, biomass conversion, and hydropower facilities.[152] Geothermal heat pump projects are not eligible.[153]

FIN. AGENCY, FHFA STATEMENT ON CERTAIN ENERGY RETROFIT LOAN PROGRAMS 2 (2010), *available at* http://www.fhfa.gov/webfiles/15884/PACESTMT7
610.pdf (stating the effective date of the order). However, all three states' PACE programs are active after the order. *See Local Option—Property Assessed Clean Energy, Maine*, DATABASE OF ST. INCENTIVES FOR RENEWABLES & EFFICIENCY, http://www.dsireusa.org/incentives/
incentive.cfm?Incentive_Code=ME18F&re=1&ee=1 (last visited Jan. 5, 2013) (stating that Maine's PACE program is accepting applications as of April 4, 2011); *Property Assessed Clean Energy (PACE) Districts*, N.H. OFFICE OF ENERGY AND PLANNING, http://www.nh.gov/oep/
programs/energy/pace/index.htm (last visited Oct. 8, 2012) (explaining that New Hampshire modified its PACE statute in 2011 after the FHFA order and advising that municipalities may proceed with PACE programs, albeit cautiously); *Local Option—Property Assessed Clean Energy, Vermont*, DATABASE OF ST. INCENTIVES FOR RENEWABLES & EFFICIENCY, http://www.dsireusa.org/incentives/incentive.cfm?incentive_code=vt38f&re=
1&ee=1 (last visited Jan. 5, 2013) ("Vermont's 2011 amendments [to their PACE legislation] addressed many of FHFA concerns and, as amended PACE is expected to ramp-up in Vermont during 2012.").

148. *See* sources cited *supra* notes 137–41.

149. *Micro-Grants to Support Clean Energy Awareness*, CLEAN ENERGY FIN. & INVESTMENT AUTH., http://www.ctcleanenergy.com/YourCommunity/CommunityInnovationGrants/
tabid/99/Default.aspx (last visited Oct. 8, 2012).

150. *Grant Guidelines: Community Innovations Grant Program*, CLEAN ENERGY FIN. & INVESTMENT AUTH., http://www.ctcleanenergy.com/Portals/0/CIGP%20Grant%20
Guidelines.pdf (last visited Jan. 8, 2012).

151. *Your Options*, CTCleanEnergyOptions, http://www.ctcleanenergyoptions.com
/options.htm (last visited Jan. 8, 2012).

152. *See Supporting On-Site Generation Projects at Commercial and Government Facilities*, CLEAN ENERGY FIN. & INVESTMENT AUTH., http://www.ctcleanenergy.com/YourBusinessor

C. Construction Restrictions

Maine, New Jersey, and Pennsylvania restrict who can construct and repair geothermal heat pump wells. These restrictions are important because there is already a small pool of individuals who can install geothermal heat pumps in these states.[154] This is a problem that will be discussed in detail in Part III.B.[155] In Maine, only a state licensed individual can construct, alter, or repair the well or pump of an open- or closed-loop geothermal heat pump system.[156] In New Jersey, an individual cannot "drill, construct, install, repair, replace, modify, stimulate, or decommission" the well of an open- or closed-loop geothermal heat pump system without a New Jersey well driller's license.[157] Additionally, an individual cannot "install, repair, or replace" the pump or equipment of an open- or closed-loop geothermal heat pump system "without being or employing a New Jersey licensed pump installer or a New Jersey licensed well driller."[158] Pennsylvania limits loans for geothermal heat pumps under one of its loan programs to installers that are certified by the International Ground Source Heat Pump Association[159]—a non-profit organization located on the campus of Oklahoma State University that is dedicated to the advancement of geothermal heat pump installation. This organization also uses cutting-edge facilities to carry out geothermal research and conduct geothermal heat pump installation training.[160]

Institution/OnSiteRenewableDG/OSDGRequestforProposals/tabid/594/Default.aspx (last visited Jan. 8, 2012).

153. *Id*.

154. *See* PHETTEPLACE, *supra* note 18, at 3 ("For both the design and installation of GHP the infrastructure is lacking in Vermont and the Northeast in general when compared to other parts of the country.").

155. *See* sources cited *infra* notes 184–85 and accompanying text.

156. *See* 10-144-232 ME. CODE R. § 101.0 (LexisNexis 2012) ("[A geothermal heat exchange well is a] hole drilled, driven or bored into the earth for the purpose of using the heat exchange capacity of the earth for heating and cooling."); *id.* § 200.0 (saying that only people licensed with the Commission can construct, or repair geothermal heat exchange wells or pumps).

157. *See* N.J. ADMIN. CODE § 7:9D-1.5 (2011) (" [a well is] a hole or excavation larger than four inches in diameter or a hole or excavation deeper than 10 feet in depth"); *id.* § 7:9D-1.6(a) (establishing a licensing requirement for well drilling).

158. N.J. ADMIN. CODE § 7:9D-1.5 (2011) (defining the word "pump" for the purposes of the statute); *id.* § 7:9D-1.6(c) (establishing a licensing requirement for replacing well pumps and well equipment).

159. *See supra* note 132 and accompanying text.

160. *See About Us*, INT'L GROUND SOURCE HEAT PUMP ASS'N, http://www.igshpa.okstate .edu/about/about_us.htm (last visited June 29, 2012); *see also Training: Accredited Installer Workshops*, INT'L GROUND SOURCE HEAT PUMP ASS'N, http://www.igshpa.okstate.edu/ training/drillers.htm#2 (last visited June 29, 2012).

III. WHY GROUND-SOURCE HEAT PUMPS HAVE NOT BEEN WIDELY ADOPTED IN THE NORTHEAST

Ground-source heat pumps are environmentally friendly.[161] Indeed, "[t]here are no significant negative environmental impacts associated with ground-source heat pumps."[162] Individuals and businesses in the Northeast that install ground-source heat pumps are eligible to receive a number of financial incentives. Although the payback period typically ranges from five to twelve years, these incentives should encourage individuals and businesses to invest in geothermal heat pumps.[163] Given these facts favoring installation of geothermal heat pumps, why are geothermal heat pump systems infrequently installed, especially in the Northeastern United States?[164]

A number of factors have worked against widespread adoption of geothermal heat pumps in the Northeast. Part III.A will analyze the incentives available as of December 31, 2011 to geothermal heat pump installers and show that these incentives inherently award more financial incentives to installers of certain other forms of renewable energy systems than to installers of geothermal heat pumps. Part III.B will discuss why the high upfront costs of geothermal heat pump installations in the Northeast render most incentives that were available to geothermal heat pump installers as of December 31, 2011 inadequate. Part III.C will examine the lack of understanding among the general public in the Northeast about geothermal heat pump installation. Together, these factors have slowed the adoption of geothermal heat pumps in the Northeast.

A. Fewer Financial Incentives Are Available to Geothermal Heat Pumps

Figure 1: Analysis of Financial Incentives on a State-by-State Basis[165]

State	Incentives not	Incentives open to geo.	Incentives only	Unclear

161. *See* sources cited *supra* notes 10–12 (discussing the benefits of ground-source heat pumps over other forms of renewable energy and air-source heat pumps).

162. Parker & Hadley, *supra* note 12, at 744.

163. *See* Parts III.A–B (discussing the financial incentives available to individuals and businesses that install ground-source heat pumps and other renewable energy systems); BANKS, *supra* note 1, at 295 (arguing that governments should provide subsidies for geothermal heat pumps because subsidies encourage adoption of a product when the product has a high initial cost and a long payback period); OAK RIDGE 2008 REPORT, *supra* note 9, at 24 (describing the payback period of geothermal heat pumps in residential and commercial facilities).

164. PHETTEPLACE, *supra* note 18, at 1 (saying that geothermal heat pumps are "not common place . . . , especially in the Northeastern United States").

165. Chart compiled by author from sources cited *supra* notes 64–153 and accompanying text.

	open to geo. heat pumps	heat pumps and other renewable energies	open to geo. heat pumps	eligibility criteria
CT	2	4[166]	1[167]	2
ME	2[168]	3	—	—
MA	4	1	—	—
NH	2	1	—	2
NJ	2	2	1	1
NY	6	4	—	—
PA	0	2[169]	1	1
RI	3	2[170]	—	1
VT	4	3	—	4

Figure 2: Analysis of Financial Incentives by Type of Incentive[171]

Incentive	Incentives closed to geo. heat pumps	Incentives open to geo. heat pumps and other renewable energy systems	Incentives only open to geo. heat pumps	Unclear eligibility criteria
Tax Incentives	12[172]	6	—	3
RPS	7	2	—	—
Rebates	4	5[173]	1[174]	2

166. This total overstates the availability of financial incentives for geothermal heat pumps because it includes a rebate program that ended with respect to geothermal heat pumps in late 2011, but still supports solar energy technology. *See supra* notes 92–93 and accompanying text.

167. Only customers of one state utility company are eligible for support for geothermal heat pumps, whereas customers of all state utility companies are eligible for support for other types of energy efficiency technologies. *See* CONN. ENERGY EFFICIENCY FUND, *supra* note 125, at 1.

168. This total includes a tax incentive open only to wind energy systems that only applied to systems installed on or before December 31, 2011. *See* ME. REV. STAT. ANN. tit. 36, § 2017(2), (4) (2010).

169. Though open to geothermal heat pumps, wind energy systems, and solar energy systems, Pennsylvania's loan program provides $180 million for solar and only $25 million for geothermal and wind energy systems. *See* sources cited *supra* notes 140–41.

170. One program included in this total—though open to geothermal heat pumps—favors solar energy systems because it caps tax credits for geothermal heat pumps at twenty-five percent of $7000, but for solar heating systems at twenty-five percent of $15,000. *See* R.I. GEN. LAWS § 44-57-5(a)(3)(ii)–(iii), (5)(ii)–(iii) (2010).

171. Chart compiled by author from sources cited *supra* notes 64–153 and accompanying text.

172. This total includes an expired Maine tax credit for wind energy systems and a Rhode Island tax credit that favors solar energy systems. *See supra* notes 66, 71.

173. This total overstates the current availability of rebates for geothermal heat pumps because it includes a Connecticut rebate program that ended with respect to geothermal heat pumps in late 2011, but still supports solar energy technology. *See supra* notes 92–93.

174. This total is misleading because under the referenced program, only customers of one state utility company are eligible for support for geothermal heat pumps, whereas customers of all state

Loans	2	4[175]	2	6
PACE Programs	—	3	—	—
Grants	2	—	—	—

As demonstrated in Figure 1 and Figure 2, state financial incentive schemes encourage businesses and individuals to install other renewable energy systems over geothermal heat pumps by providing more funding options for these technologies.[176] In most states, a significant portion of the state's financial incentives is not available or not clearly available to geothermal heat pumps, whereas few incentive programs are exclusively available to geothermal heat pumps.[177] For example, five states have more financial incentives programs not open to geothermal heat pumps than programs open to geothermal heat pumps.[178] In addition, every state other than Pennsylvania has more financial incentives programs that are not open to geothermal heat pumps than programs exclusively open to geothermal heat pumps.[179] Furthermore, on a regional basis, a large number of tax incentives, RPS, rebates, and grants are largely or wholly unavailable to individuals and businesses that wish to install geothermal heat pumps.[180]

B. Existing Incentives for Geothermal Heat Pumps to Counteract High Initial Costs are Inadequate, Poorly Funded, or Harmful to the Interests of the State

Financial incentives are of the utmost importance because of the high initial costs required for the installation of geothermal heat pumps. However, not all financial incentives are appropriate to incentivize geothermal heat pump installation. As will be discussed below, tax incentives are inappropriate because they are generally an unstable incentive scheme, and they are limited in the range of individuals and businesses whose decision making they can influence.[181] Rebates and

utility companies are eligible for support for other types of energy efficiency technologies. *See* CONN. ENERGY EFFICIENCY FUND, *supra* note 125, at 1.

175. This total overstates the availability of loans to geothermal heat pumps because of a Pennsylvania program that provides $25 million for wind energy systems and geothermal heat pumps and $180 million for solar energy systems. *See supra* notes 140–41.

176. *See supra* Figure 1 and Figure 2.

177. *See supra* Figure 1.

178. *See supra* Figure 1.

179. *See supra* Figure 1.

180. *See supra* Figure 2.

181. *See infra* notes 189–92 (discussing tax incentives).

grants are inappropriate because—unlike loan programs—they are unsustainable when they are properly sized to incentivize geothermal heat pump installation.[182]

Geothermal heat pumps are normally the most expensive heating and cooling option for residential and commercial retrofits and residential new construction.[183] In the Northeast, this high initial cost is even greater than in other areas of the country because the shortage of geothermal heat pump installation professionals makes installation costs one hundred to four hundred percent higher.[184] In Maine, New Jersey, and Pennsylvania, this shortage is exacerbated by restrictions on who can drill geothermal heat pump wells and install pumps.[185]

Excluding the higher costs caused by the shortage of geothermal heat pump installation professionals, a geothermal heat pump system constructed for an existing home in the Northeast costs at least $10,000 and potentially more than $12,000.[186] In comparison, an air-source heat pump or a gas heating unit plus an air conditioning system for the same home costs around $6000.[187] Thus, for existing homes, financial incentives should be in the range of $4000 to $6000 in order to make a difference in a homeowner's decision-making process. Though some customers may take eventual cost savings into account when deciding

182. *See infra* notes 193–95 (discussing rebate and grant programs).

183. OAK RIDGE 2008 REPORT, *supra* note 9, at 24. Retrofitting buildings for geothermal heat pumps may be more expensive than installing geothermal heat pumps in new buildings for two reasons. First, new buildings tend to possess a tighter building envelope, preventing heated air from escaping the building in the winter or hot outside air from entering the building in the summer. *See* PHETTEPLACE, *supra* note 18, at 2 (saying that geothermal heat pumps work best in "tight buildings with lower heating and cooling loads per square foot," which "tends to favor newer construction as opposed to retrofit"). Second, geothermal heat pumps are more expensive if elements of the building's existing heating and cooling system cannot be used. U.S. DEP'T OF ENERGY, GEOTHERMAL HEAT PUMPS DELIVER BIG SAVINGS FOR FEDERAL FACILITIES 4 (2004), *available at* http://www1.eere.energy.gov/femp/pdfs/ghptf
.pdf. As an example of incompatibility with existing heating systems, geothermal heat pumps cannot generate high enough temperatures to work with hydronic heating systems, which are popular in certain locations. PHETTEPLACE, *supra* note 18, at 8.

184. *See* PHETTEPLACE, *supra* note 18, at 3–4.

185. *See supra* Part II.C (analyzing construction restrictions).

186. *See* RAFFERTY, *supra* note 54, at 12–13 (estimating the installed cost for three ton capacity ground-source heat pump systems—including ductwork, heat pump unit, controls, the ground loop, piping, excavation, and drilling); U.S. DEP'T OF COMMERCE, 2011 CHARACTERISTICS OF NEW HOUSING 389 (2011), *available at* http://www.census.gov/
construction/chars/pdf/c25ann2011.pdf (illustrating that since 1988, the average size of new homes in the Northeast has been at least 2,000 square feet); Merle Henkenius, *Geothermal Heating*, POPULAR MECHANICS (Oct. 1998, 12:00 AM), http://www.popular
mechanics.com/home/improvement/energy-efficient/1274631 ("A newer 2000- to 2400-sq.-ft. home will require 3 tons of capacity . . . .").

187. RAFFERTY, *supra* note 54, at 13.

whether to install a more expensive geothermal heat pump, cost savings likely do not appreciably lower the need for a financial incentive because the payback periods are long, making cost savings only a factor for the owner that plans to own the building for the entire payback period.[188]

Tax incentives are inappropriate to address this high initial cost for a number of reasons. First, state income tax incentives do not appeal to the many homeowners that have little or no taxable income.[189] Second, tax incentives are unstable because they depend upon the health of municipal and state budgets and the economy in general.[190] This instability is problematic because it inhibits investments by individuals and businesses that depend upon on stable long-term incentives.[191] For example, such instability might dissuade geothermal heat pump installers from starting a business in a region.[192]

Similarly, rebates and grants are not appropriate means to combat high initial costs. Given the large difference between the costs of geothermal heat pumps and standard heating and cooling units, the rebate would have to be quite large to make a difference in an individual's decision making.[193] However, as the rebate or grant grows larger, the incentives program also grows less stable.[194] This relationship between size and

188. OAK RIDGE 2008 REPORT, *supra* note 9, at 24 (discussing how, given the lengthy payback periods, residential geothermal heat pump installation is limited to a small subset of particular homeowners who plan to occupy the building for sufficiently long period of time).

189. Jerome L. Garciano, *Green Energy Tax Policies: State and Federal Tax Incentives for Renewable Energy and Energy Efficiency*, 25 NAT. RES. & ENV'T 12, 14 (2011).

190. *Id.* ("[S]tate and municipal budgets, which have seen unprecedented strain the past few years, have had cuts in energy tax incentives.").

191. *See* INT'L ENERGY AGENCY, RENEWABLE ENERGY ESSENTIALS: GEOTHERMAL, *supra* note 54, at 3 (saying that one barrier to geothermal development is the "uncertainty about the future" of incentive schemes); *see also* S. GOUCHOE, ET AL., NAT'L RENEWABLE ENERGY LAB., CASE STUDIES ON THE EFFECTIVENESS OF STATE FINANCIAL INCENTIVES FOR RENEWABLE ENERGY 3 (2002), *available at* http://www.nrel.gov/docs/fy02osti/32819.pdf ("Many incentives offered during the 1980s were subject to annual appropriations, creating an uncertainty that prohibited sustained growth.").

192. *See, e.g.*, Erin Dewey, Note, *Sundown and You Better Take Care: Why Sunset Provisions Harm the Renewable Energy Industry and Violate Tax Principles*, 52 B.C. L. REV. 1105, 1132 (2011) (concluding that uncertainty about the continued existence of the federal Production Tax Credit ("PTC") due to sunset provisions chills private investment in the renewable energy industry because the PTC makes renewable projects cost competitive).

193. *See* sources cited *supra* notes 186–88 and accompanying text, (discussing the difference in cost between geothermal heat pumps and air-source heat pumps).

194. *See, e.g.*, *Geothermal Heat Pump Incentive Program—Residential*, *supra* note 60 (describing Connecticut's expired rebate program, which offered large rebates for geothermal heat pumps); *see also* Kristin Underwood, *Australian Solar Rebate Program Abruptly Cancelled,* TREEHUGGER (Oct. 8, 2009), http://www.treehugger.com/solar-technology/australian-solar-rebate-program-abruptly-cancelled.html (describing how the Australian solar rebate program was cancelled after the program received too much demand).

instability is one possible reason why most Northeastern states that offer rebates or grants for geothermal heat pumps do not offer sufficient funding.[195]

Besides tax incentives, rebates, and grants, Northeastern states also have established loan programs. States that run loan programs receive repayments (with interest) from program participants, making these programs more sustainable.[196] The importance of loan programs in addressing high upfront costs of geothermal heat pumps is discussed further in Part IV.A.

C. Lack of Familiarity with Geothermal Heat Pumps and Failure to Consider Geothermal Heat Pumps is a Barrier to Adoption

A significant barrier to the adoption of geothermal heat pumps is the public's lack of familiarity with them,[197] a problem especially evident in the Northeast.[198] This lack of information is even more pronounced in the commercial sector. More specifically, the installation of geothermal heat pumps "in larger, commercial-style facilities is lagging, in part because of limited experience with the technology by those in decision-making positions."[199]

Additionally, the lack of effective financial incentives also contributes to this barrier. While some state programs require applicants to perform an energy audit of their building before becoming eligible for incentives[200]—a process that can highlight the costs and benefits of

195. *See* sources cited *supra* note 96 (discussing Maine's rebate program for commercial ground-source heat pumps, offering eighty dollars per ton of capacity); *Equipment Incentives*, *supra* note 105 (discussing New Jersey's rebate program for commercial and industrial geothermal heat pumps, offering $81 per ton of capacity for open-loop systems and $450–750 per ton of capacity for closed-loop systems); EFFICIENCY VT., *supra* note 110, at 4 (describing Vermont's rebate program, which offers a rebate of $80 per ton of installed capacity for commercial water-source heat pumps).

196. *See, e.g.*, *Business Energy Conservation Revolving Loan Fund*, *supra* note 130 (describing how New Hampshire's Business Energy Conservation Revolving Loan Fund received $2 million from the state to capitalize the loan fund and can continue to operate the fund only so long as loan principal repayments are made).

197. *See* BANKS, *supra* note 1, at 73–74 (explaining that the low visibility of geothermal heat pumps in comparison to solar panels and turbines means that geothermal cannot advertise for itself because geothermal heat pumps are contained within the building it heats and cools, instead of located outside like solar panels or wind turbines).

198. PHETTEPLACE, *supra* note 18, at 1 (describing how geothermal heat pump systems are not commonplace in the Northeast, leaving "aspects of their design and installation . . . foreign to designers and installers of 'conventional' HVAC systems.").

199. Parker & Hadley, *supra* note 12, at 727.

200. *See, e.g.*, *Business Energy Conservation Revolving Loan Fund*, *supra* note 130 (requiring a loan applicant to perform an energy audit before being eligible for a loan); *Efficiency Maine Small Business Loan Program*, DATABASE OF ST. INCENTIVES FOR RENEWABLES & EFFICIENCY, *supra*

geothermal heat pumps[201]—such a requirement only targets those already interested in pursuing renewable energy measures. It does not solve the information deficiency of those simply content with switching from one gas heater to another gas heater.

IV. OVERCOMING BARRIERS TO THE ADOPTION OF GEOTHERMAL HEAT PUMPS

A. Use of Loans and Training Programs as a Means to Combat High Initial Costs

1. New York's On-Bill Recovery Program as the Model

In contrast to rebate programs, grant programs, or tax incentives, a properly-funded loan program modeled in part after New York's On-Bill Recovery Program can be a sustainable approach that helps to tackle the high initial costs that plague geothermal heat pumps. In general, loan programs are sustainable because states or municipalities that run loan programs receive principal repayments plus interest as the borrower pays the monthly utility bill,[202] unlike rebate programs in which the government gives away money and receives little or nothing directly in return.[203]

note 131 (stating that a business must complete an energy audit that identifies energy improvements is required before it can receive loans).

201. *See* Barney L. Capehart, et al., *Energy Auditing*, *in* ENERGY MANAGEMENT HANDBOOK 25, 33 (Steve Doty & Wayne C. Turner eds., 2009) (stating that part of an energy audit involves an inspection of heating, air conditioning, and ventilating equipment, which "will allow later analysis to examine alternative equipment and operations that would reduce energy costs for heating, ventilating, and air conditioning").

202. *See* ERIC LANTZ, NAT'L RENEWABLE ENERGY LAB., STATE CLEAN ENERGY POLICIES ANALYSIS: STATE, UTILITY, AND MUNICIPAL LOAN PROGRAMS 14 (2010), *available at* http://www.nrel.gov/docs/fy10osti/47376.pdf ("The fact that the funds disbursed through loan programs can be reused or recycled multiple times—unlike a grant or rebate, which represent a onetime distribution of funds—is often seen as an advantage of loan programs."); CLEANENERGY STATES ALLIANCE, DEVELOPING AN EFFECTIVE STATE CLEAN ENERGY PROGRAM: CLEAN ENERGY LOANS 2, (2009), *available at* http://www.cleanenergy states.org/assets/Uploads/CESA-cleanenergy-Loan-Programs-March09.pdf ("[I]f a state does not have a steady source of new revenue for its fund, a loan program can allow the fund to continue to assist clean energy project development for many years."); CHARLES KUBERT & MARK SINCLAIR, CLEANENERGY STATES ALLIANCE, DISTRIBUTED RENEWABLE ENERGY FINANCE AND POLICY TOOLKIT 14 (2009), *available at* http://www.cleanenergystates.org/assets/ Uploads/CESA-renewableenergy-FinancePolicy-toolkit2009.pdf (saying that a loan program is sustainable because it "allows the state to deploy capital and recover it with a return, to be used or loaned again").

203. *See* KUBERT & SINCLAIR, *supra* note 202, at 8 ("Rebate programs use up program funding with no recovery. Once the funds are awarded, they are spent with no return back to the fund.").

Funding for an on-bill finance program should come from a stable source of funding. Programs and financial incentives that rely upon one-time federal funding such as ARRA or annual state appropriations are unsustainable in the long run, discouraging growth in the geothermal heat pump industry.[204] Even RGGI, the source of funding relied upon by the New York On-Bill Recovery Program, is unstable because the survival of RGGI itself is not assured.[205] Instead, funding that comes from a surcharge on utility customers is more desirable because it does not depend upon annual approval from a state legislature or sporadic one-time federal funding.[206]

Meanwhile, on-bill finance programs are attractive to potential borrowers because they do not saddle program participants with new debt. The geothermal heat pump systems pay for themselves through the energy bill,[207] and the responsibility of repaying the loan "stays with the property upon its sale or lease."[208] In addition, a loan program modeled after New York's On-Bill Recovery Program is ideal because it does not require a borrower to "tak[e] out a loan from a third-party lender that requires payment through a separate invoice:" funds are borrowed from the state and repaid through the borrower's utility bill.[209] This removes much of the complexity inherent in other loan programs.

While PACE programs also avoid the problems associated with debt and third-party lenders,[210] such programs are inadequate because they require municipalities to adopt PACE-implementing ordinances.[211]

204. *See Geothermal Heat Pump Incentive Program—Residential*, *supra* note 60 and accompanying text (discussing Connecticut's expired geothermal heat pump rebate program, which relied on ARRA funding); sources cited *supra* notes 189–92 (analyzing the disadvantages of tax incentives).

205. *See* Envtl. Regulation Comm., Energy Bar Ass'n, *Report of the Environmental Regulation Committee*, 32 ENERGY L.J. 637, 653–54 (2011) (highlighting challenges in New Jersey, New Hampshire, and Maine to their membership in RGGI).

206. *See, e.g.*, *supra* note 112 and accompanying text (detailing how New York uses funding from a charge on utility customers to fund renewable energy systems); *supra* note 106 (discussing how New Jersey funds demand-side management programs through a charge on electric and gas utility customers); *supra* note 108 (explaining how Efficiency Vermont is funded through a charge on electric utility customers).

207. *See* OAK RIDGE 2009 REPORT, *supra* note 9, at 5 (estimating typical payback periods of five to twelve years for residential and commercial installations).

208. GERRARD ET AL., *supra* note 119, at 1.

209. *Id.*

210. ME. REV. STAT. ANN. tit. 35-A, §§ 10154(2), 10155(1)(A) (2010); N.H. REV. STAT. ANN. § 53-F:3(VII) (2012); VT. STAT. ANN. tit. 24, §§ 3261(b), 3262(a) (Supp. 2012); 95-648-110 ME. CODE R. § II(4)(A)(1)(c) (LexisNexis 2011).

211. *See* sources cited *supra* note 142. PACE programs cannot simply be carried out at the state level because PACE programs "rely on a building block of the municipal finance system—the land-secured financing district," so these programs require municipal involvement. *See* NAT'L RES. DEF.

Ordinance requirements complicate the funding process by demanding municipal action before loans are made available to potential borrowers.[212] PACE ordinances may encounter resistance from municipalities facing pressure to address other municipal needs.[213]

2. Reducing High Initial Costs by Expanding the Number of Installers

Because the high initial cost of geothermal heat pumps in the Northeast stems in part from the lack of experienced installers, their number must be increased.[214] Although expanding long-term demand for geothermal heat pumps will likely lead to an increase in the supply of trained installers, more leadership is necessary.[215]

State "green jobs" trainings programs modeled after an expanded version of Massachusetts's Green Jobs Initiative provide the best solution.[216] The Massachusetts initiative awards grants to state "public institutions of higher education" and qualified vocational technical schools "to facilitate workforce development efforts and train and retain students in clean energy industries."[217] States should expand jobs training initiatives to encompass skills necessary for the installation and maintenance of geothermal heat pump technology. Geothermal heat pumps are not included in the enumerated list of technologies that are

COUNCIL ET AL., WHITE PAPER: HELPING ACHIEVE ENVIRONMENTAL SUSTAINABILITY AND ENERGY INDEPENDENCE, IMPROVING HOMEOWNER CASH FLOW AND CREDIT PROFILE, PROTECTING MORTGAGE LENDERS, AND CREATING JOBS 7 (2010), *available at* http://pacenow.org/wp-content/uploads/2012/07/PACE-White-Paper-2010.pdf; *see also* Steve Heaney & Ken Powell, *A Guide to Funding Infrastructure through Land-Secured Bonds*, LAND DEV., Spring 2007, at 36, 37, *available at* http://www.nahb.org/fileUpload_details.aspx?contentID=161951 (discussing the mechanics of land-secured financing districts).

212. For example, only 105 out of approximately 488 Maine municipalities had adopted PACE ordinances as of December 14, 2011. *See* EFFICIENCY ME., MUNICIPALITIES THAT HAVE PASSED A PACE ORDINANCE AND SUBMITTED AN ADMINISTRATIVE CONTRACT TO EFFICIENCY MAINE AS OF 12-14-11, at 1 (2011), *available at* http://www.efficiencymaine.com/docs/PACE/List-of-PACE-municipalities-12_14.pdf; U.S. CENSUS BUREAU, MAINE 1 (n.d.), *available at* http://www2.census.gov/govs/cog/2007/me.pdf (listing the number of municipalities in Maine).

213. *See* Joel B. Eisen, *Can Urban Solar Become a "Disruptive" Technology?: The Case for Solar Utilities*, 24 NOTRE DAME J.L. ETHICS & PUB. POL'Y 53, 84–86 (2010) (discussing the disadvantages of PACE programs).

214. *See* PHETTEPLACE, *supra* note 18, at 3–4 (explaining that the installation cost of geothermal heat pumps is higher because "[f]or both the design and installation of [geothermal heat pumps] the infrastructure is lacking in . . . the Northeast in general when compared to other parts of the country").

215. *See* OAK RIDGE 2008 REPORT, *supra* note 9, at 8, 21 (explaining that the geothermal heat pump industry could expand rapidly, but that installation infrastructure would require special attention and that customers who currently are excited about geothermal heat pump technology cannot find individuals to affordably install geothermal heat pumps).

216. *See* MASS. ANN. LAWS ch. 23J, § 8 (LexisNexis 2010) (creating the Green Jobs Initiative).

217. *Id.*

considered "clean energy" in the Massachusetts Green Jobs Initiative statute, although solar, wind energy, and biomass technologies are mentioned.[218] Additionally, the Massachusetts initiative currently offers only "weatherization technician courses" and a "Weatherization Business Development" course.[219]

Given that Maine and New Jersey require all geothermal heat pump installers to be licensed and Pennsylvania requires geothermal heat pump loan applicants to work with certified geothermal heat pump installers,[220] the arguably cheapest solution is for these states to allow unapproved installers who are experienced with "conventional" heating, ventilation, and air conditioning systems to engage in geothermal heat pump installations. However, eliminating licensing and certification requirements might be problematic because installing geothermal heat pumps is a difficult task that raises complex construction and environmental concerns and should not be left to novices.[221] Instead, all states should follow an approach that blends the Maine and Pennsylvania approaches: states should only allow a state-licensed or International Ground Source Heat Pump Association ("IGSHPA")-certified individual to construct, alter, or repair the well or pump of any geothermal heat pump system. This mixed approach would be ideal because it would set up strict requirements as to who may install geothermal heat pumps, but at the same time allow individuals to choose the best method for them to become eligible installers. Moreover, allowing IGSHPA-certified installers to work on installations in all states would reduce the burden of obtaining multiple state licenses for companies that may want to work across state borders. Additionally, in order to expand the workforce with qualified installers, states must offer funding to incentivize educational institutions to set up geothermal heat pump installation training courses.

218. MASS. ANN. LAWS ch. 23J, § 1 (LexisNexis 2010).

219. *MassCEC Announces Next Round of Energy Efficiency Trainings through the MassGreen Initiative*, MASS. CLEAN ENERGY CENTER, http://www.masscec.com/index.cfm/pid/11150/cdid/11834 (last visited Jan. 9, 2012).

220. *See supra* Part II.C.

221. *See* BANKS, *supra* note 1, at 281, 286 (explaining how contractors who are not familiar with drilling the types of wells necessary for geothermal heat pumps may not be aware of the risks involved and cause significant environmental damage); *Frequently Asked Questions*, INT'L GROUND SOURCE HEAT PUMP ASS'N, http://www.igshpa.okstate.edu/geothermal/faq.htm (last visited Aug. 6, 2012) (stating that only licensed professionals should install geothermal heat pumps because "[n]on-professional installations may result in less than optimum performance, which could cancel out anticipated savings"); *see also supra* Part II.C (discussing the environmental and construction concerns common to geothermal heat pump installations that make installation of geothermal heat pumps inappropriate for novice, unlicensed geothermal heat pump installers).

B. Counteracting the Failure of Governments to Offer Equal Financial Incentives to Different Types of Renewable Energy Systems

1. Creating a Findings Requirement Before Financing Programs

One way to address the failure of government to offer equal financial incentives to all types of renewable energy systems—as discussed in Part III.A—is for each state to pass a law requiring state agencies to issue a report whenever they award financing that favors specified renewable technologies over others. In the report, the state agency would be required to provide evidence why favoring certain technologies over others is in the best interests of the state. Each state could also pass a law requiring a specified agency to produce and deliver to lawmakers a report analyzing technology-neutral alternatives whenever the legislature is considering a bill that favors one technology.[222]

Under such laws, the reports would serve a similar purpose as environmental impact statements under the National Environmental Policy Act.[223] The reporting requirements would improve agency and legislature decision making with regard to allocating funds for renewable energy technologies by rigorously evaluating trade-offs between various alternatives.[224]

These proposed laws would not create a burdensome reporting regime because government agencies would not necessarily be required to engage in extensive fact-finding before offering financing for renewable energy technologies. They could avoid the reporting requirement by making their financial incentives technology-neutral—allowing any renewable energy technology to be eligible.

222. *See, e.g.*, VA. CODE ANN. § 30-19.1:4 (2011) (requiring a state agency to issue reports when the legislature promulgates certain types of laws). The law requires a state agency to prepare a fiscal impact statement for any bill being considered by the state legislature that would result in certain impacts on state correctional facilities and then send copies of the impact statement to the state House and Senate for the consideration of the bill's patrons and the chairmen of the relevant legislative committees. *See id.* § 30-19.1:4(A), (G). The fiscal impact of the bill as determined by the fiscal impact statement must be placed on the bill's face. *See id.* § 30-19.1:4(E).

223. National Environmental Policy Act of 1969 § 102, 42 U.S.C. § 4332 (2006).

224. *See* SERGE TAYLOR, MAKING BUREAUCRACIES THINK: THE ENVIRONMENTAL IMPACT STATEMENT STRATEGY OF ADMINISTRATIVE REFORM 251 (1984) (explaining that when agency analysts are able to explore the "trade-offs of a wide range of alternative designs, environmentally better decisions are likely to result," and when "environmentally concerned outsiders pay attention to the EIS process, some of the worst projects—those projects with the greatest environmental costs and little political support within the agency and among its other constituencies—get eliminated").

2. Opening Renewable Portfolio Standards to Geothermal Heat Pumps

Another way to end the unequal financial incentives to geothermal heat pumps is to expand renewable portfolio standards to include energy obtained from geothermal heat pumps. In most states, the largest barrier to the inclusion of geothermal heat pumps is the fact that the standards only give electric utilities credit for acquiring electricity obtained from renewable energy resources[225]—which rules out geothermal heat pumps since they use thermal energy to provide heating and cooling,[226] but do not provide electricity.[227] New York's renewable portfolio standard is an exception that would only need slight modification to make geothermal heat pumps an eligible technology. In New York, the reduction in electricity demand from new solar thermal hot water systems counts towards the renewable portfolio standard even though they do not provide electricity.[228] Since December 31, 2011, New Hampshire has amended its renewable portfolio standards to include heating and cooling resulting from geothermal heat pumps.[229] The change to New Hampshire's renewable portfolio standard shows that geothermal heat pumps, which provide heated water more efficiently than electric water

225. *See* statutes cited *supra* note 72. As of December 31, 2011, Pennsylvania and Connecticut were the only states that made geothermal heat pumps eligible. *See* sources cited *supra* notes 86–87 and accompanying text.

226. *See What is Geothermal?*, INT'L GROUND SOURCE HEAT PUMP ASS'N, http://www.igshpa.okstate.edu/geothermal/geothermal.htm (last visited July 1, 2012) ("Ground source heat pumps (GSHPs) are electrically powered systems that tap the stored energy of . . . the earth. These systems use the earth's relatively constant temperature to provide heating, cooling, and hot water . . . .").

227. *See* sources cited *supra* notes 19–22. Although geothermal heat pumps do not provide energy in the form of electricity, geothermal heat pumps use thermal energy—also known as heat—to provide or remove heat from buildings. BANKS, *supra* note 1, at 56 (explaining that extraction of heat from the ground or rejection of heat into the ground can be "genuinely sustainable"); Harrison, *supra* note 1, at 425 (discussing the ability of geothermal heat pumps to directly use geothermal heat energy in residential and commercial buildings); *What's in a Name?*, GEOEXCHANGE, http://www.geoexchange.org/
index.php?option=com_content&view=article&id=69:whats-in-a-name&catid=375:
geothermal-hvac&Itemid=32 (last visited July 1, 2012) (describing how geothermal heat pumps use thermal energy of the earth to heat or cool buildings); BBC, *Science: Forms of Energy*, GCSE BITESIZE, http://www.bbc.co.uk/schools/gcsebitesize/science/aqa_pre_2011/
energy/heatrev4.shtml (last visited July 1, 2012) (identifying heat, or thermal energy, as a form of energy).

228. *See* STATE OF N.Y. PUB. SERV. COMM'N, ORDER AUTHORIZING CUSTOMER-SITED TIER PROGRAM THROUGH 2015 AND RESOLVING GEOGRAPHIC BALANCE AND OTHER ISSUES PERTAINING TO THE RPS PROGRAM, *supra* note 84, at 12–13.

229. *See* 2012-272 N.H. Rev. Stat. Ann. Adv. Legis. Serv. 3 (discussing the amendments to New Hampshire's renewable portfolio standard).

heaters[230] and use electricity more efficiently than air conditioners and other heating systems,[231] can also provide a source of electricity displacement.[232]

Studies show that geothermal heat pump installations can greatly reduce peak electricity demand in buildings.[233] If each state with a renewable portfolio standard allowed electricity displacement to serve as a means to meet the standards' targets, and if all of the states required utilities to acquire a certain amount of certificates representing electricity displacement from geothermal heat pumps, it would put geothermal heat pumps on equal footing with other renewable energy sources and create a new source of funding for geothermal heat pump installations.[234] This new source of funding would help overcome the high initial cost barrier facing geothermal heat pumps.

C. Increasing Familiarity with and Consideration of Geothermal Heat Pumps

1. Requiring Consideration of Renewable Energy Systems During State Environmental Impact Review Processes

One method to compensate for the lack of familiarity with geothermal heat pumps is to require applicants to consider incorporating geothermal heat pumps and other renewable energy sources during a state environmental impact review process. Massachusetts, Connecticut, and New York all require agencies to complete environmental impact reviews in certain circumstances.[235] The Massachusetts and New York requirements apply to projects that may have a significant effect on the environment and are undertaken by, funded by, or require the approval of a local or state agency, including projects that require a permit.[236]

230. *See* U.S. Dep't of Energy, *supra* note 8.

231. *See* sources cited *supra* notes 40–46 and accompanying text.

232. *See* OAK RIDGE 2008 REPORT, *supra* note 9, at 1.

233. *See id*.

234. *See, e.g.*, *Sports Betting OK Caps Busy Day*, RECORD, Jan. 10, 2012, at A-1, A-6, *available at* http://www.northjersey.com/news/136993908_Sports_betting_OK_caps_busy_day.html?page=all (discussing how requiring New Jersey utilities to acquire a certain percentage of electricity from solar energy would support the funding of solar energy projects in the state).

235. CONN. GEN. STAT. ANN. § 22a-1b(c) (West 2006 & Supp. 2012); MASS. ANN. LAWS ch. 30, § 61 (LexisNexis 2007 & Supp. 2012); N.Y. ENVTL. CONSERV. § 8-0109(2) (McKinney 2005 & Supp. 2012).

236. MASS. ANN. LAWS ch. 30, § 61 (LexisNexis 2007 & Supp. 2012) (requiring agencies to "review, evaluate, and determine" the environmental impact resulting from projects they undertake or permits they issue); *id.* § 62 (LexisNexis 2007) (defining "project" as including an activity undertaken by a person who requires agency funding); N.Y. ENVTL. CONSERV. § 8-0109(2) (McKinney 2005 & Supp. 2012) (mandating that agencies prepare an environmental impact

Connecticut's requirement is more limited in scope, demanding an environmental impact statement for actions that may significantly affect the environment undertaken, initiated, or financed by a state agency.[237]

In Massachusetts, there are two steps in the process determining when consideration of geothermal heat pumps and other renewable energy resources should be required. Projects that exceed a specified review threshold[238] require the preparation of an Environmental Notification Form ("ENF"), which is used to determine whether a full Environmental Impact Review ("EIR") is necessary.[239] The ENF must describe the project and alternatives.[240] If an EIR is required, the document must describe "reasonable alternatives to the proposed project."[241] The Massachusetts Environmental Protection Agency should promulgate regulations stating that one alternative that must be considered in an ENF and EIR is an alternative that incorporates all available cost-effective renewable energy technologies, including geothermal heat pumps.[242]

Similarly, there are two points in the New York environmental impact review process when consideration of geothermal heat pumps should be required. Unless an action definitively does not require an environmental impact statement ("EIS"), an environmental assessment form ("EAF') must be filed, which is used to determine whether an action may have a significant effect on the environment.[243] If an EIS is required, it must discuss "alternatives to the proposed action."[244] The New York Department of Environmental Conservation should promulgate regulations mandating that all EISs and EAFs consider an alternative that incorporates all cost-effective renewable energy

statement for actions that will significantly affect the environment); N.Y. COMP. CODES R. & REGS. tit. 6, § 617.2(c) (2012) (defining agency as a "local or state agency"); *id.* § 617.2(b), (e), (aa) (2012) (explaining what is an action).

237. CONN. GEN. STAT. ANN. § 22a-1b(c) (West 2006 & Supp. 2012) (requiring agencies to evaluate environmental impacts of agency actions); CONN. AGENCIES REGS. § 22a-1a-1.2 (2011) (defining "action").

238. Review thresholds are met by certain categories of projects—such as construction of a new airport—or when projects will have impacts of a particular size or nature on the environment—such as a proposal that will result in the withdrawal of 1,500,000 or more gallons per day of water from a source of groundwater. *See* 301 MASS. CODE REGS. 11.03 (2012).

239. 301 MASS. CODE REGS. 11.01(4)(a) (2012) (setting out the ENF requirement and relationship to EIRs).

240. 301 MASS. CODE REGS. 11.05(4)(a) (2012).

241. MASS. ANN. LAWS ch. 30, § 62B (LexisNexis 2007).

242. The Massachusetts Environmental Protection Agency is empowered to "promulgate reasonable rules and regulations" to implement Massachusetts' environmental impact review statute. *Id.* § 62H (LexisNexis 2007).

243. N.Y. COMP. CODES R. & REGS. tit. 6, § 617.6(a)(1)(i), (iv), (2) (2012).

244. N.Y. ENVTL. CONSERV. LAW § 8-0109(2)(d) (McKinney 2005 & Supp. 2012).

technologies, including geothermal heat pumps.[245] In the case of EAFs, this would be a departure from the current law because EAFs currently do not mandate a consideration of alternatives.[246]

In Connecticut, the best time to require consideration of geothermal heat pump installation would be during the preparation of the EIS. All EISs must describe alternatives to the proposed action.[247] The Connecticut Department of Environmental Protection should promulgate regulations regarding alternatives similar to those advised above for Massachusetts and New York.[248]

One concern with these new environmental impact review requirements is that environmentalists and neighbors might use them as a strategic tool to slow down or stop development projects by arguing that another party's environmental impact review document is insufficient because it fails to adequately discuss the alternative technologies.[249] However, such challenges are not necessarily problematic because a competent attorney could draft an environmental impact review document that complies with statutory and regulatory requirements, averting serious legal challenges.[250]

2. Requiring Installation of Cost-Effective Renewable Energy Systems Before Subdivision Map Approval

Another way to address the lack of awareness of geothermal heat pump systems is to utilize the subdivision map process. Subdivision map approval is an ideal time for municipalities to encourage installation of geothermal heat pumps and other renewable energy technologies because

245. The New York Department of Environmental Conservation is empowered to adopt rules and regulations to implement New York's environmental impact review statute. N.Y. ENVTL. CONSERV. LAW § 8-0113 (McKinney 2005 & Supp. 2012).

246. N.Y. COMP. CODES R. & REGS. tit. 6, § 617.2(m) (2012).

247. CONN. GEN. STAT. ANN. § 22a-1b(c)(4) (West 2006 & West Supp. 2012).

248. The Connecticut Department of Environmental Protection is empowered to adopt rules and regulations to implement Connecticut's environmental impact review statute. CONN. GEN. STAT. ANN. § 22a-1g (West 2006 & West Supp. 2012).

249. *See, e.g.*, Laurel Heights Improvement Ass'n of S.F. v. Regents of Univ. of Cal., 764 P.2d 278, 280 (Cal. 1988) (finding that the environmental impact review statement was inadequate in part because of an inadequate "discussion of alternatives"); Stewart E. Sterk, *Environmental Review in the Land Use Process: New York's Experience with SEQRA*, 13 CARDOZO L. REV. 2041, 2041 (1992) ("[State environmental policy acts have] become a powerful weapon in the hands of development opponents who seek not to preserve the environment, but to protect their own economic self-interest, or to promote their own prejudices.").

250. *See, e.g.*, Sean Stuart Varner, Comment, *The California Environmental Quality Act (CEQA) After Two Decades: Relevant Problems and Ideas for Necessary Reform*, 19 PEPP. L. REV. 1447, 1483 (1992) (discussing how in California, "adequate drafting" of a state environmental impact review report can avoid delays).

it gives municipalities the power to require developers to meet certain subdivision improvements standards.[251] Additionally, requiring consideration of geothermal heat pumps and other renewable energy technologies in new buildings before approval of subdivision maps is important because geothermal heat pump installation costs are lowest during new construction.[252]

States should modify the subdivision map process by inserting a requirement that municipalities may approve subdivision maps only after developers have considered installing cost-effective geothermal heat pump systems and other renewable energy systems into planned buildings. Indeed, some states already have subdivision law provisions that *allow* municipalities to encourage renewable energy system installations,[253] and Connecticut even *requires* municipalities' subdivision regulations to "encourage energy-efficient patterns of development and land use, the use of solar and other renewable forms of energy, and energy conservation."[254] Requiring municipalities to have developers consider cost-effective renewable energy systems would simply be an extension of these provisions. Since every state already either requires municipalities to review and approve subdivision maps[255] or empowers them to review and approve subdivision maps,[256] such a provision could have a far-reaching effect on new construction.

251. ROBERT C. ELLICKSON & VICKI L. BEEN, LAND USE CONTROLS: CASES AND MATERIALS 416 (3d ed. 2005); *see also* Marygold Shire Melli, *Subdivision Control in Wisconsin*, 1953 WIS. L. REV. 389, 392–93 (1953) (arguing that high maintenance costs are a problem facing communities and that the most economical way to meet this problem is for municipalities to control the original subdivision of land).

252. *See* PHETTEPLACE, *supra* note 18, at 2 (discussing why the installation of geothermal heat pumps during new construction may be the most cost-effective time to install them).

253. *See* MASS. ANN. LAWS ch. 41, § 81M (LexisNexis 2006) (stating that the subdivision powers of a municipality may be exercised to encourage the use of solar energy); N.H. REV. STAT. ANN. § 674:36(II)(k) (2008 & Supp. 2012) (stating that a municipality's subdivision regulations may encourage the installation "of solar, wind, or other renewable energy systems"); 53 PA. CONS. STAT. § 10503, 10503(6) (West 2011) ("[A municipality's] subdivision and land development ordinance may include . . . [p]rovisions for encouraging the use of renewable energy systems and energy-conserving building design.").

254. CONN. GEN. STAT. ANN. § 8-25(b) (West Supp. 2012).

255. *See* CONN. GEN. STAT. ANN. § 8-25(a) (West Supp. 2012); MASS. ANN. LAWS ch. 41, § 81O (LexisNexis 2006); ME. REV. STAT. ANN. tit. 30-A, § 4403(1) (2011); 53 PA. CONS. STAT. § 22769 (West 1998); R.I. GEN. LAWS § 45-23-26(a) (2009).

256. *See* N.H. REV. STAT. ANN. § 675:6 (2008); N.J. STAT. ANN. § 40:55D-38 (West 2008); N.Y. GEN. CITY LAW § 33(1), (2) (McKinney 2003); N.Y. TOWN LAW § 276(1) (McKinney 2004); N.Y. VILLAGE LAW § 7-728(1) (McKinney 2011); 53 PA. CONS. STAT. § 10501 (West 2011); VT. STAT. ANN. tit. 24, § 4418 (2007).

3. Building Codes

To complement the new subdivision provision, states should modify their building code to require homeowners and building owners to consider the installation of geothermal heat pumps. Subdivision regulations mostly govern new construction;[257] thus, owners of existing buildings and homes would be unaffected by subdivision regulations and would remain uninformed about geothermal heat pumps. For this reason, states should modify their building codes to require that building owners and homeowners complete an energy audit detailing the costs and benefits of installing a geothermal heat pump and other renewable energy technologies before receiving a building permit to completely replace heating and central air conditioning systems or carry out other major renovations.[258] Geothermal heat pump installation can be particularly attractive for the building owner or homeowner when heating and central air conditioning systems are replaced or major renovations are undertaken.[259] To help defray the costs, states should pay for most or all of the energy audit.

A strong argument against requiring an energy audit is that it could deter individuals from undertaking necessary and beneficial renovations[260] or encourage them to try to complete a renovation without obtaining a building permit in order to avoid taking on the extra cost and responsibility of completing an energy audit.[261] However, there are two ways to answer these concerns. First, the statute would not require an energy audit for small modifications, such as replacing fan blades. Second, since states would pay for all or part of the energy audit, the cost

257. *See* 1-9 MATTHEW BENDER & CO., LAND USE LAW § 9.01 (2011) ("Subdivision controls . . . apply design, public facility and related requirements to new subdivisions . . . .").

258. Building code laws in the Northeast take one of two forms: some states leave adoption of building codes to the municipalities, whereas other states have created a state building code. *See* CONN. GEN. STAT. ANN. § 29-252(a) (West 2009); MASS. ANN. LAWS ch. 143, § 94(a) (LexisNexis 2007); ME. REV. STAT. ANN. tit. 30-A, § 4101 (2011); N.Y. SECOND CLASS CITIES LAW § 156 (McKinney 1994); N.Y. TOWN LAW § 130(1) (McKinney 2004 & Supp. 2012); 35 PA. CONS. STAT. § 7210.301(a)(1) (West 2003 & Supp. 2012); R.I. GEN. LAWS § 23-27.3-100.1.3(a) (2012); VT. STAT. ANN. tit. 24, § 3101(a) (2005 & Supp. 2012); N.J. ADMIN. CODE § 5:23–2.14(a) (2008). However, the recommendations of this section apply equally to both types of code.

259. It is cost-effective to replace an existing system at the end of its useful life. *See, e.g.*, Parker & Hadley, *supra* note 12, at 739. Also, if a building or homeowner is engaging in a major renovation that requires replacement of an existing heating and cooling system and a modification to the building envelope, this may be an ideal time to consider install ductwork and a building envelope that is conducive to geothermal heat pump installation. *See* PHETTEPLACE, *supra* note 18, at 2.

260. *See* ELLICKSON & BEEN, *supra* note 251, at 449 (discussing how building codes can discourage rehabilitation).

261. *See id.* at 455 (explaining how it can be easy to complete a "substantial alteration without the building department's knowledge").

of the energy audit would not be a significant factor, if at all, in a building owner's or homeowner's decision-making process.

V. CONCLUSION

The use of geothermal heat pumps to heat or cool a home or building—by utilizing the relatively constant temperature of the earth to heat or cool a structure—seems like a very simple concept. But the benefit of geothermal heat pumps can be immense. In 2010, heating and cooling needs accounted for roughly seventy percent of residential site energy consumption.[262] In meeting these needs, geothermal heat pumps can greatly reduce energy use and peak demand for electricity in buildings.[263] Indeed, because geothermal heat pumps use the constant temperature of the ground to heat and cool buildings, geothermal heat pumps use electricity more efficiently than air-source heat pumps.[264] Thus, adoption of geothermal heat pumps can reduce demand for electricity.[265] Reducing peak demand for energy can mitigate the need to run "dirtier, more expensive" fossil fuel power plants that are turned on solely to meet times of peak demand,[266] which reduces the emission of greenhouse gasses into the atmosphere. Geothermal heat pumps can reduce this demand with few environmental costs.[267] However, to spur the installation of geothermal heat pumps, regulators and legislators need to address the high initial costs of geothermal heat pumps and the public's lack of familiarity with them. Solutions that build upon current laws and regulations can go a long way towards a greener future.

262. U.S. DEP'T OF ENERGY, *supra* note 7, at 2–3.

263. OAK RIDGE 2008 REPORT, *supra* note 9, at 1.

264. *See* sources cited *supra* notes 40–46 for a discussion of how geothermal heat pumps are more efficient than air-source heat pumps.

265. *See* sources cited *supra* notes 15–16 for a discussion of how geothermal heat pumps can reduce demand for electricity.

266. Erica Gies, *The Challenge of Storing Energy on a Large Scale*, N.Y. TIMES, Sept. 29, 2010, http://www.nytimes.com/2010/09/30/business/energy-environment/30iht-renstore.html (explaining how utilities usually fire up additional fossil fuel power plants to meet peak demand and that these plants are dirtier and more expensive); *see also* SW. ENERGY EFFICIENCY PROJECT & ENV'T COLO. RESEARCH & POL'Y CTR., THE CLEAN ENERGY SOLUTION TO XCEL ENERGY'S PLAN 22 (2004), *available at* http://www.swenergy.org/news/news/documents/file/Xcel-Pueblo_Plant_White_Paper_092004.pdf.

267. *See* BANKS, *supra* note 1, at 295 ("[T]he potential benefits in terms of savings in [carbon dioxide] emissions from space heating far outweigh concerns over possible groundwater pollution from a few litres of ethylene glycol solution.").