Article XXX [Prohibition on New Fossil Fuel Infrastructure in Major Construction]

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To see if the town will amend the General By-Laws by adopting a new article 8.39 entitled "Prohibition on New Fossil Fuel Infrastructure in Major Construction" as set forth below.

8.39.1 Purpose

This By-Law is adopted by the Town of Brookline, under its home rule powers and its police powers under Massachusetts General Laws, Chapter 40, Sections 21 (clauses 1, 18) and 21D, and Chapter 43B, Section 13, to protect the health, safety and welfare of the inhabitants of the town from fuel leaks and explosions and from air pollution, including that which is causing climate change and thereby threatens the Town and its inhabitants.

8.39.2 Definitions

"On-Site Fossil Fuel Infrastructure" is defined as fuel gas or fuel oil piping that is in a building, in connection with a building, or otherwise within the property lines of premises, extending from a supply tank or from the point of delivery behind a gas meter.

"New Building" is defined as a new building or new accessory building (a building devoted exclusively to a use accessory to the principal use of the lot) that is associated with a valid building permit application on or after the effective date of this article.

"Significant Rehabilitation" is defined as a renovation in which the work area, not including any added space, is more than 50% of the building floor area prior to the project, and that is associated with a valid building permit application on or after the effective date of this article.

8.39.3 Applicability

A. The requirements of this article shall apply to all permit applications for New Buildings and Significant Rehabilitations proposed to be located in whole or in part within the Town.

B. The requirements of this article shall not apply to the use of portable propane appliances for outdoor cooking and heating, or to fuel pipes whose exclusive purpose is to fuel backup electrical generators.

C. The requirements of this article shall not apply to utility service pipe connecting the grid to a meter, or to a gas meter itself.

[1] Point of contact

D. The requirements of this article shall not apply to any building being constructed subject to a Waldo-Durgin Overlay District Special Permit, as described in Section 5.06.4.k of the Zoning By-Law.

8.39.4 Effective Date and Enforcement

Effective June 1, 2020, no permits shall be issued by the Town for the construction of New Buildings or Significant Rehabilitations that include the installation of On-Site Fossil Fuel Infrastructure, except as otherwise provided in section 8.39.3.

8.39.5 - Severability

Each provision of this by-law shall be construed as separate to the extent that if any section, sentence, clause or phrase is held to be invalid for any reason, the remainder of the by-law shall continue in full force and effect.

Or act on anything relative thereto.

Article XXX, General By-Law Explanation

Summary

This by-law will prohibit installation of fossil fuel piping in new buildings and in major renovation of existing buildings. Consequently, this policy will require heat, hot water, and appliances that are installed during new construction and gut renovation to be all-electric. For situations in which electric is not practical or cost effective, this by-law provides for exemptions, including for fuel piping for backup generators. An exception is also included for the Waldo-Durgin development, because it is the only major commercial project requiring a zoning change that has not yet pulled a building permit.

Rationale

We are facing a global climate crisis. This climate crisis directly affects Brookline residents and businesses. Massachusetts is one of the fastest-warming states in the country[2]. We have seen a rapid increase in extreme heat events that threaten the health of our children, our seniors, and those who need to work outside, not to mention our fragile ecosystem, our plants and wildlife. Rising seas and increased flooding threaten Boston and coastal communities[3]. Public health risks include an increase in heat-related illnesses and deaths, as well as outbreaks of insect-borne and waterborne diseases[4]. As natural ecosystems change or collapse, Massachusetts farmers, fishermen, and residents will suffer[5].

In its Climate Action Plan, Brookline has committed to reducing its carbon emissions to zero by 2050[6]. Every new building constructed with fossil fuel infrastructure makes this goal harder to achieve, by lighting a new fire that will burn, on and off, for thirty years or more. To meet our climate goal, each of these fires will need to be put out through the retrofitting of buildings, which account for 60-70% of our Town emissions[7]. It is unfair to the next generation to continue to install infrastructure that we already know will need to be replaced in a very short time.

Worsening gas leaks in underground pipes constitute their own significant dangers. Recent gas explosions in the Merrimack Valley[8], which killed one person and injured many more, and non-injurious explosions in Brookline[9], have put citizens at risk. 25% of the natural gas pipelines in

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[2] https://www.washingtonpost.com/graphics/2019/national/climate-environment/climate-change-america/
[3] https://ss2.climatecentral.org/#13/42.3232/-71.1423?show=satellite&projections=0-K14_RCP85-SLR&level=5&unit=feet&pois=hide
[4] https://www.annualreviews.org/doi/full/10.1146/annurev.publhealth.21.1.271
[5] https://www.mass.gov/service-details/climate-change-in-massachusetts-and-its-impacts and https://19january2017snapshot.epa.gov/sites/production/files/2016-09/documents/climate-change-ma.pdf and https://www.massaudubon.org/our-conservation-work/climate-change/effects-of-climate-change
[6] https://www.nature.com/articles/s41586-019-1364-3
[7] https://www.brooklinema.gov/ArchiveCenter/ViewFile/Item/628 (see footnote on sidebar)
[8] https://en.wikipedia.org/wiki/Merrimack_Valley_gas_explosions
[9] https://boston.cbslocal.com/2019/05/26/brookline-hammond-street-closed-manhole-fire-explosions/, https://patch.com/massachusetts/brookline/manhole-explosion-coolidge-corner-shuts-down-area, https://www.youtube.com/watch?v=Rbc11T8Vynw .

Massachusetts are leak-prone and need repair and replacement[10]. Gas utilities, including in Brookline, are not adequately maintaining natural gas infrastructure by fixing unsafe leaks. Gas leaks have also killed trees in many places in Brookline.

In addition, the burning of fossil fuels inside buildings produces harmful indoor emissions[11] that emit nitrogen dioxide (NO_2), carbon monoxide (CO), and formaldehyde (HCHO), each of which can cause various respiratory and other health ailments[12,13]. Cooking with gas has been linked to asthma and other adverse health effects, with children and low-income households particularly affected[14,15]. Nitrogen dioxide from gas stoves is linked to increased asthma rates among low-income preschoolers, and gas stoves are especially dangerous in smaller apartments with poor ventilation[16] and when they are used for supplemental heat. If the Clean Air Act applied inside homes, the air quality produced by cooking with gas would be illegal[17].

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[10] https://eeaonline.eea.state.ma.us/DPU/Fileroom/dockets/bynumber (search by number for 18-GLR-01)

[11] Additional footnotes for statement on indoor emissions from: https://healthyindoors.com/2018/07/cooking-indoor-air-pollution-emissions-natural-gas-stoves/

1. Klug VL, et al. Cooking Appliance Use in California Homes—Data Collected from a Web-based Survey. LBNL-5028E. Berkeley, CA:Lawrence Berkeley National Laboratory (August 2011). Available: http://homes.lbl.gov/sites/all/files/lbnl-5028e-cooking-appliance.pdf [accessed 5 December 2013].
2. Jarvis D, et al. The association of respiratory symptoms and lung function with the use of gas for cooking. Eur Respir J 11(3):651–658 (1998); http://www.ncbi.nlm.nih.gov/pubmed/9596117.
3. Jarvis D, et al. Association of respiratory symptoms and lung function in young adults with use of domestic gas appliances. Lancet 347(8999):426–431 (1996); http://dx.doi.org/10.1016/S0140-6736(96)90009-4.
4. EPA. Formaldehyde: Hazard Summary [website]. Washington, DC:U.S. Environmental Protection Agency (updated 18 October 2013) Available: http://www.epa.gov/ttnatw01/hlthef/formalde.html[accessed 5 December 2013].

[12] https://www.nytimes.com/2019/05/01/opinion/climate-change-gas-electricity.html

[13] https://www.nytimes.com/2019/05/01/opinion/climate-change-gas-electricity.html

[14] https://www.sciencedaily.com/releases/2014/09/140929180523.htm and https://www.ncbi.nlm.nih.gov/pubmed/22082993 and https://scopeblog.stanford.edu/2018/03/06/use-your-range-hood-for-a-healthier-home-advises-indoor-air-quality-researcher/ and http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.277.9376&rep=rep1&type=pdf

[15] https://www.nytimes.com/2019/05/01/opinion/climate-change-gas-electricity.html

[16] http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.277.9376&rep=rep1&type=pdf

[17] https://well.blogs.nytimes.com/2013/07/22/the-kitchen-as-a-pollution-hazard/ and http://rebuildgreenexpo.com/wp-content/uploads/2019/06/ElectricMFGuide.pdf

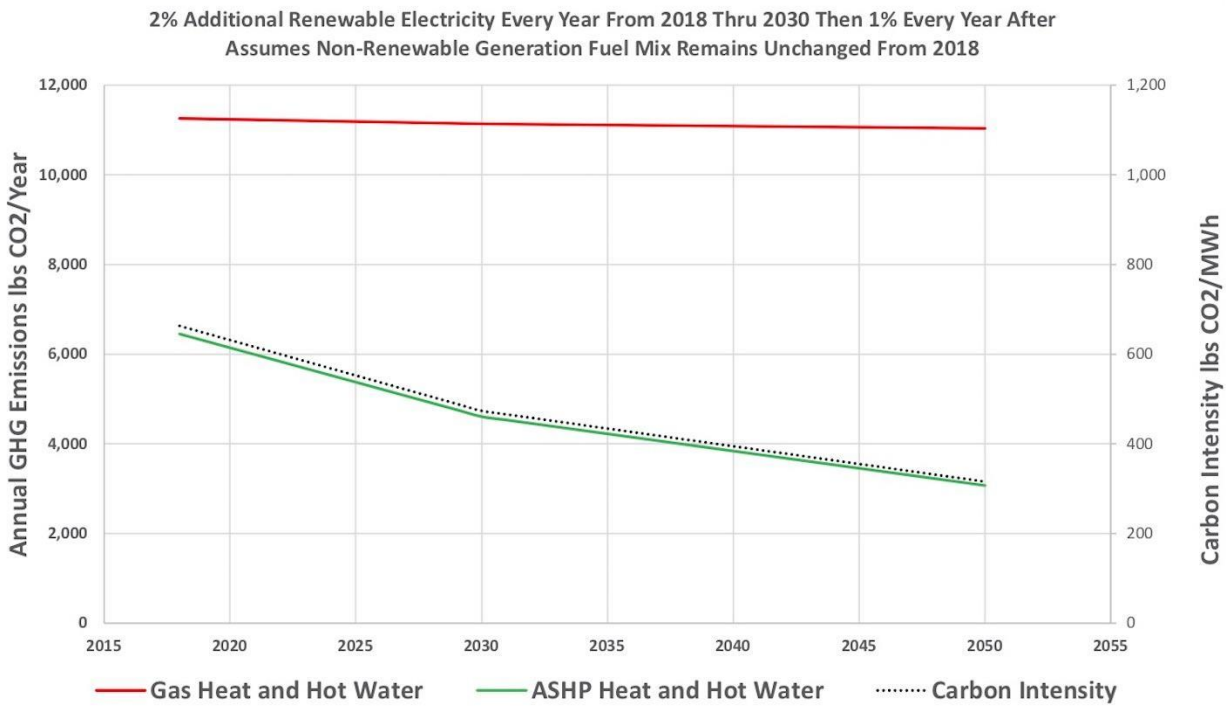

Figure 1: Comparing the Greenhouse Gas Emissions of an All-Electric House With Air Source Heat Pumps to a House With Natural Gas Heat and Hot Water

All-electric buildings are healthier and can operate immediately with zero emissions through the purchase of 100% renewable electricity with programs like Brookline Green Electricity[18]. Even buildings using the default New England electrical grid mix become greener every year as the electrical grid incorporates more and more renewable electricity generation, with a state-mandated minimum 60% renewable energy by 2050[19,20]. Figure 1 compares projected carbon emissions for a single family home built in Massachusetts using air-source heat pumps to provide electric heat and hot water with a similar home that uses gas heat and gas hot water. This projection assumes the home uses the default provider of electricity, which will become more renewable overtime. An all-electric home that elects to use 100 percent renewable electricity will have no carbon emissions from heat and hot water.

All-electric construction is practical and feasible now. Numerous all-electric buildings have been built recently in Massachusetts (Appendix D), demonstrating the feasibility and practicality of all-electric construction. Assuming that 0.5% of the building stock in Brookline is rebuilt or significantly renovated per year, this by-law would decarbonize 15% of our buildings by 2050. Decarbonizing in this manner, during new construction or major renovations is by far the most cost-effective way to decarbonize.

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[18] https://www.brooklinema.gov/1340/Brookline-Green-Electricity

[19] https://www.greenribboncommission.org/wp-content/uploads/2019/01/Carbon-Free-Boston-Report-web.pdf

[20] blog.greenenergyconsumers.org/blog/rps-res-in-plain-english

Practicality of all-electric buildings

All-electric construction is, in most cases, highly practical and essentially cost neutral. For example, one model commissioned for MassSave estimates a $754 construction cost premium for a 2,500 sq ft all-electric single family home[21], compared to the same home fitted with the most efficient gas heat and hot water systems and electric central air conditioning[22]. This premium is less than a 0.1% increase in cost for a typical new home like this in Brookline[23].

A relevant cost operations comparison comes from the same MassSave model cited above. Under this model, operation of a brand-new all-electric home in Massachusetts would be slightly more expensive than that of a brand-new gas home (by $41 per month). However, this $41 per month cost premium must be put into context. First, it is less than 1% of expected monthly costs on a newly built 2,500 sq ft Brookline home, including utilities, mortgage, and real estate tax payments. Second, if an electric ground source heat pump were used instead of an air source heat pump, the all-electric home would actually be less expensive to operate than the gas home. Third, when a new all electric building is compared with an existing building, the new all-electric one will be significantly less expensive to operate than gas, due to the far better air sealing and insulation required in new buildings.

Notably, building operation costs vary widely depending on building type, whether a building is new or retrofitted, whether a ground source or air source heat pump is used, whether solar is installed, the extent of air sealing and insulation, and other variables. To cite one example, buildings that are air sealed and insulated to Passive House standards can use less than 90% of the energy of buildings built to the minimal air sealing and insulation standards in the Massachusetts building code.

Space heating and cooling

Heat pumps are air conditioners that can operate in reverse. Even in cold weather, they extract heat from outside air and move it into the building. Because they move heat rather than generating it, they are very efficient. Dramatic improvements in heat pump technology and building envelope technology now make it practical and cost-effective to heat new buildings with electricity in our climate[24]. (Electric heat pump heating should not be confused with electric resistance heat, which is inefficient and expensive[25].)

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[21] built to the Massachusetts stretch energy code (a requirement in Brookline for new construction).
[22] http://ma-eeac.org/wordpress/wp-content/uploads/RLPNC_17-14_MiniSplitCost_27NOV2018_Final.pdf
[23] Assumes $1,000,000 purchase price.
[24] http://ma-eeac.org/wordpress/wp-content/uploads/RLPNC_17-14_MiniSplitCost_27NOV2018_Final.pdf
[25] Most electric heat in existing Brookline buildings is baseboard resistance heat, in which heat is generated, not moved. Electric resistance heat costs about three times as much to operate as a modern heat pump. In the past, heat pumps in MA were typically installed with electric resistance backup for the very coldest days of the year. Due to continual improvement of heat pump technology, the cold climate heat pumps recommended for use in New England either no longer include resistance heating elements or only use it a few days each year.

Buildings are becoming better insulated and more tightly sealed every year. As this happens, less and less heating and cooling is needed, and the cost of the HVAC systems decreases. Because more and more buildings are being built with air conditioning, heat pumps save money in two ways. First, only a single system needs to be installed rather than separate air conditioning and heating systems. Second, heat pumps are more efficient than old-fashioned air conditioning and save on electricity costs.

Cooking -- additional benefits of modern electric induction cooktops

Induction cooking has additional benefits beyond improved indoor air quality, health, and emissions reductions. Induction cooking is safer, more precise, and faster than cooking with gas.[26] Local professional Chef Ming Tsai of Blue Ginger and Blue Dragon fame has been using induction cooking for 20 years[27]. Local chef Barbara Lynch has one in her professional home kitchen[28]. Induction cooking keeps the kitchen cooler -- a major advantage in commercial kitchens -- and it can be so finely regulated that it can be used to melt chocolate without a double-boiler.[29]

Hot water heating. An electric heat pump hot water heater can be purchased from local home improvement stores and costs about the same to buy and operate as a gas-fired hot water heater. Costs of gas, electric resistance, and electric heat pump hot water heaters are described in Appendix B.

Clothes dryers. Many buildings already use electric resistance dryers. An alternative option, less expensive to operate, is the heat pump electric dryer. Compared to gas or most electric resistance dryers, heat pump dryers have the advantage of not requiring any outside venting. Costs of gas, electric, and electric heat pump dryers are described in Appendix C.

Appendix A -- Frequently Asked Questions

Q: If Brookline bans new fossil fuel infrastructure in major construction, do I get to keep my gas stove?

A: Yes. You can even replace it with a new one. You just can't install a new one in a brand new building or as part of a gut renovation. By 2050, 15% of Brookline's buildings would lack gas infrastructure, so even at that point there would under this policy be a lot of choice.

Q: Does this bylaw apply if I want to build an addition to my house?

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[26] https://www.consumerreports.org/electric-induction-ranges/pros-and-cons-of-induction-cooktops-and-ranges/

[27] http://sponsored.bostonglobe.com/frigidaire/induction/

[28] https://www.nytimes.com/video/dining/100000004082419/in-the-kitchen-with-barbara-lynch.html?action=click&module=RelatedCoverage&pgtype=Article&region=Footer

[29] Induction cooking should not to be confused with the dramatically inferior but often very similar-looking electric resistance cooking.

A: It applies only if the project also includes major renovations to the existing part of your house AND if the renovated portion exceeds 50% of the area of the original building.

Q: Will this measure be effective (even if adopted beyond Brookline), or will the consequence simply be that more fossil fuels will be consumed in electricity generation?

If the occupant of a new all-electric building chooses to buy 100% renewable electricity, that all-electric building will be carbon-free from the moment it begins to operate.

Assuming the occupant relies on the standard grid mix, a new all-electric building built today would have lower overall emissions than an otherwise identical building with gas heat and appliances in the first year of operation (see chart above). These emissions savings will increase each additional year, as the grid greens through an existing statewide legislative mandate that requires a minimum 60% carbon-free grid by 2050. This grid greening is likely to be accelerated further at the state level and through Brookline's Green Electricity program. Thus, the emissions savings are very large compared to a building that burned natural gas over the course of those 31 years.

Q: Is there a good alternative for gas cooking, particularly in commercial settings?

Induction cooking is amazing. Many chefs who've tried it don't ever want to go back to gas, particularly in commercial settings[30,31]. It's safer, faster, and easier to control. It keeps the kitchen much cooler. The entire Bradley wing of LAX is all-electric[32], and the 24 restaurants there have induction and electric cooking but no gas ovens, stoves, or other gas infrastructure.

Q: What happens if the electricity goes out ? Will we be able to have gas back-up generators? Do you have exemptions or waivers for certain facilities that would need back-up systems such as nursing homes or daycares?

In short this policy would not affect what happens when the power goes out, which is that most buildings would lose their heat. The reason is that today's boilers and furnaces typically require both the gas AND the electrical grid, because they have electronic ignition systems that lack battery backups. Therefore, most buildings in Brookline are already fully dependent on the electrical grid for their heat.

For the few buildings, including schools and nursing homes, that need or want backup heating, the proposed policy includes an exemption for fuel pipes for backup generators.

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[30] http://sponsored.bostonglobe.com/frigidaire/induction/

[31] Drifter's Wife in Portland ME is recommended for best new restaurant that focuses on natural wines. "The entire kitchen is two induction burners and an oven," Li said. "The food they're putting out is amazing, and the wine experience overall is fantastic." https://www.boston.com/travel/travel/2017/04/22/this-new-england-city-is-a-favorite-food-destination-for-boston-chefs

[32] https://www.urwairports.com/lax/retailer-category/dine/

Q: In light of the heat wave and the power outages in NYC, if we go all electric what happens to the stress or overloading of the Grid? Will there be more power outages as a result?

Electrical demand is currently declining in New England due to solar panels on building roofs and gains in energy efficiency (e.g., LEDs). There are declines in both annual and peak demand, and these declines are expected to continue[33]. The proposed bylaw policy affects too few buildings, too slowly, to affect the electrical grid significantly. It is the job of the utilities and the grid operator ISO-NE to keep the electricity flowing, and they should be capable of it -- and held to it. Nonetheless, both the gas and electrical grids do fail sometimes, as we saw last winter with the explosions and fires caused by the Columbia Gas infrastructure failure in the Merrimack Valley.

Our electrical grid is currently adding a lot of renewable generation -- utility-scale wind and solar. This new building policy will affect such a small fraction of buildings on the grid (~1% turnover in any one year, even if adopted across the entire New England grid territory), that it should not have an appreciable impact on the power grid, which already has year-on-year variation exceeding 1%[34].

Peak consumption is already a significant challenge to manage. But right now peak consumption is a summer problem, when AC kicks in on hot days. In the winter the bigger problem is actually natural gas shortages, which should be slightly alleviated by this policy. Because winter heating and summer AC are the biggest consumers of electricity in buildings, the proposed all-electric requirement would not have a very large impact on summer peaks. (People already use electricity for AC.)

Q: If this by-law is challenged in court, will it pass muster?

Like any ground-breaking law, this bylaw may be challenged. But its rationale has been carefully thought through, and it is based on several months of legal consultations and research. We consulted with 14 lawyers, including the Berkeley outside counsel and the head of the Massachusetts Attorney General's Municipal Law Unit. Brookline Town Counsel then also provided advice. We believe that it will withstand a challenge, but the only way to find out for sure is to pass it. A crucially important strategy in fighting the fossil fuel industry is to win in court in defending new legal approaches to decarbonization.

Q Will there be only a few contractors that can design build these systems? Will that drive cost up?

This is very simple technology and many HVAC contractors have significant experience installing ASHPs. Ground source heat pump systems (GSHPs, sometimes referred to as

[33] https://www.iso-ne.com/about/key-stats/electricity-use/
[34] https://www.iso-ne.com/about/key-stats/electricity-use/

“geothermal systems”) have also been installed all over Massachusetts and the country for several decades.

Q: What if this by-law triggered the need for a significant upgrade of the electrical service to an existing building? For example, a 50-unit building that has original wiring from the street to the building from the 1940’s. What if the electrical upgrade costs $200,000?

If one were doing a significant rehab of such a building, one would be spending millions to tens-of-millions of dollars. The $200,000 must be considered in that context. This is precisely why the trigger is major rehabilitations and new construction.

Q: Renovations and expansions are the most problematic. Think of a situation where someone has previously installed efficient gas boilers, etc. and they are trying to add on to their house, but they want to just use the same infrastructure. Are we really telling them that half of their house can still be gas but they need all new equipment for the second half?

As currently written, the work area *in the original space* would have to be over 50% of the original structure to trigger the by-law in the context of an addition. Just an addition alone without major rehabilitation in the existing portions of the building would not trigger this by-law. The vast majority of additions, such as adding a porch or remodeling a kitchen, do not meet this threshold.

Even if the work area *in the original space* exceeded the 50% floor area threshold, it would still be permissible to keep the efficient gas boiler. In other words ducts or water/steam pipes could be extended from the existing boiler or furnace into the addition. However, in this instance, fuel piping could not be installed into the new addition.

Appendix B -- Comparing Hot Water Heater Options

Manufacturer	Model	Type	Description	Price	Annual Energy Cost
A O Smith	ATI 240H 101	Tankless	Gas: Condensing	$912	$280
Rinnai	(RU1601) REU-N2530FF-US	Tankless	Gas: Condensing	$1,460	$280
Rinnai	(RUR1991) REU-NP3237FF-US	Tankless	Gas: Condensing	$2,014	$280
Rinnai	REU-VC2025FFU-US	Tankless	Gas: Condensing	$687	$282
Westinghouse	WGR050**076	Tank	Gas: Condensing	$1,951	$290
Rheem	XE80T10HD50U1	Tank	Electric: ASHP	$1,700	$306
A O Smith	HPTU-50N	Tank	Electric: ASHP	$1,380	$346
A O Smith	HPTU-66N 120	Tank	Electric: ASHP	$1,679	$356
Rheem	XG50T12HE40U0	Tank	Gas: Non-Condensing	$689	$407
Rheem	XE50M09EL55U1	Tank	Electric: Resistance	$524	$796

Comparing the Price and Operating Cost of a Variety of Hot Water Options

New homes in Brookline typically have a water heater with an Energy Star rating from the US Department of Energy. High efficiency (condensing) gas hot water heaters are available as hot water tanks and on-demand (tankless) models. High efficiency air source heat pump (ASHP) hot water tanks are another option. This table compares various types of hot water heaters based on data from the US Department of Energy. The prices are from Home Depot or similar outlets. The energy costs are based on what Brookline customers would be charged by Eversource and National Grid

Appendix C -- Comparing Clothes Dryer Options

Make	Model	CEF				Drum Size, Cubic Feet	Annual Energy Use	Price
Miele	PDR980 HP	9.75	Electric	Heat Pump	Ventless	4.6	87 kWh/Yr	
Miele	TWB120 WP	6.37	Electric	Heat Pump	Ventless	4.1	133 kWh/Yr	
Miele	TWF160 WP	6.37	Electric	Heat Pump	Ventless	4.1	133 kWh/Yr	$1,499
Samsung	DV22N685*H*	5.85	Electric	Heat Pump	Ventless	4.0	145 kWh/Yr	
Whirlpool	WHD560CH**	5.2	Electric	Hybrid Heat Pump	Ventless	7.4	460 kWh/Yr	$1,259
Whirlpool	WHD862CH**	5.2	Electric	Hybrid Heat Pump	Ventless	7.4	460 kWh/Yr	
Whirlpool	WGD6620H**	3.48	Gas		Vented	7.4	687 Equivalent kWh/Yr	$900
Whirlpool	WGD9500EW*	3.48	Gas		Vented	8.2	687 Equivalent kWh/Yr	
Bosch	WTG86401UC	2.73	Electric	Condensing	Ventless	4.0	311 kWh/Yr	$1,125
Bosch	WTG86402UC	2.73	Electric	Condensing	Ventless	4.0	311 kWh/Yr	
Haier	QFT15ES*N***	2.68	Electric	Condensing	Ventless	3.1	317 kWh/Yr	

Price Range is roughly $600 to $1,000 for Conventional Electric Dryers
Price range is roughly $700 to $1,200 for Conventional Gas Dryers

Comparing the Price and Efficiency of Clothes Dryers

Stores have recently added a new option for buyers of clothes dryers: heat pump clothes dryers. The prices above are from Home Depot or similar outlets. Heat pump clothes dryers cost about the same to buy, but they are more efficient than gas dryers, so at current gas and electricity pricing, both cost about the same to operate. In addition, they don't have to be vented to the outside so they can be good for use in apartments and condominiums. The efficiency rating, CEF, is used by the US Department of Energy to rate the performance of clothes dryers. The higher the CEF, the higher the efficiency.

Appendix D - Partial list of buildings in New England with electric systems

Residential (up to 3 family)

Building name	Heating and Cooling	Hot water	Location
All-electric house, rehabilitated in 2018	ASHP	Electric	Fisher Hill, Brookline, MA
David Green's house	ASHP	Electric	Dover, MA
Holland House, Passive, LEED Platinum	ASHP	Electric	Vineyard Haven, MA
Torcellini residence	ASHP, GSHP	Electric	Eastford, CT
South End Row home by ZED	ASHP	Electric	Boston, MA
Dartmouth Oceanfront House by ZED	ASHP	Electric	Dartmouth, MA
Wellfleet modern house by ZED	ASHP	Electric	Wellfleet, MA
Thoughtforms Net positive farmhouse by ZED	ASHP	Electric	Lincoln, MA
Mediterranean style green home by ZED	ASHP	Electric	Newton, MA
Marshview house by ZED	ASHP	Electric	Chatham, MA

ASHP = Air Source Heat Pump, an all-electric technology for cooling and heating a building that is similar to an air conditioner but can also function in reverse to provide heat.
GSHP = ground source heat pump, similar to an ASHP but is more efficient due to its use of the ground, rather than the air, for heat transfer to and from the building.

Office buildings

Building name	Heating and Cooling	Hot Water	Location
Walden Pond Visitor Center, LEED, Passive, 5,575 sf	ASHP	Electric	Concord, MA
Bennington Superior Courthouse, Net Zero ready	GSHP		Bennington, VT
Massachusetts Fish & Wildlife Headquarters, Net Zero	GSHP	Electric	Westborough, MA

The Studio for High-Performance Design and Construction, Passive	ASHP	Electric	Newton, MA
185 Dartmouth	Heat pumps		Boston, MA
Olympia Place	Heat pumps	Propane	Amherst MA

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GSHP = ground source heat pump, similar to an ASHP but is more efficient due to its use of the ground, rather than the air, for heat transfer to and from the building.

Educational facilities (including universities and schools)

Building name	Heating and Cooling	Hot water	Location
King Open School (middle school, elementary school, administrative offices, public pool)	GSHP	Electric	Cambridge, MA
Lexington Children's Place, Net Zero	Heat pumps	Electric	Lexington, MA
Hastings School, Net Zero	GSHP	Electric	Lexington, MA
The Putney School Field House, New Zero, LEED Platinum	ASHP	Electric	Putney, VT
R.W. Kern Center, Hampshire College	ASHP	Electric	Amherst, MA
Smith College, Bechtel Environmental Classroom	ASHP	Electric	Whately, MA
Trustees of Reservations, Powisset Net Positive Barn (demo kitchen with induction stoves, administrative offices, educational learning space, root cellar)	ASHP		Dover, MA

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GSHP = ground source heat pump, similar to an ASHP but is more efficient due to its use of the ground, rather than the air, for heat transfer to and from the building.

Housing projects (large-scale)[35]

Building name	Heating and Cooling	Hot water	Location
Auburn Court Lot C. 9	Heat pumps		Cambridge, MA
Concord Highlands □	VRF ASHP		Cambridge, MA
Bayside Anchor, Passive House □	Electric baseboard heating[36], electric ventilation		Portland, ME
Bristol Common, Lexington Gardens □	ASHP		Taunton, MA
Highland Woods □	ASHP		Williamstown, MA
Parsons Village □	Heat pumps		Easthampton, MA
Millbrook Apartments	Heat pumps		Somerville, MA
Hyatt Centric Hotel	Heat pumps		Boston, MA
Distillery North	Heat pumps		Boston, MA
One East Pleasant	Heat pumps		Amherst, MA
Kendrick Place	Heat pumps		Amherst, MA
Whittier Street Apartments □	Heat pumps		Boston, MA
Factory 63	Heat pumps		Boston, MA

□= Affordable housing

ASHP = Air Source Heat Pump, an all-electric technology for cooling and heating a building that is similar to an air conditioner but can also function in reverse to provide heat.

GSHP = ground source heat pump, similar to an ASHP but is more efficient due to its use of the ground, rather than the air, for heat transfer to and from the building.

[35] Some central hot water systems for very large buildings are serviced by gas or oil. Those are indicated with a blank space in the Hot Water column.

[36] While generally inefficient, resistance electric heating is highly affordable in Passive House buildings due to their extremely low heating load.