

Clean Heat for Arlington

Sustainable Buildings Now!

Fossil Fuel Infrastructure Warrant Article



Frequently Asked Questions

What is Being Proposed?

Arlington's Clean Energy Future Committee (CEFC) has voted unanimously to propose a **bylaw to prohibit the installation of fossil fuel piping, and oil and gas heating in both new construction and significant rehabilitation projects.** Town Meeting Members will vote on the Article beginning April 27, 2020.

Why is it Being Proposed?

We are facing a global climate crisis of extreme proportions, and Massachusetts is one of the fastest-warming states in the country. Cities and towns must **reduce carbon emissions to zero by 2050 to prevent catastrophic global warming.** Emissions cannot be lowered if we continue to rely on fossil fuels. To reach these goals, Arlington can act now to begin to decarbonize buildings, which account for approximately 60% of all emissions in our town. This Warrant Article focuses on the most practical and cost-effective steps we can take to reduce fossil fuel use in buildings. Every building we build today with fossil fuel infrastructure defeats Arlington's emissions goals and will require an expensive retrofit in the future.

The U.S. looks to Massachusetts. Massachusetts looks to Arlington and similar proactive and forward-thinking communities for innovative solutions.

www.cleanheatforarlingtonma.org

How will this help Arlington and Mass. reduce emissions?

The Warrant Article is a necessary first step toward meeting our commitment to net zero emissions by 2050. It is also one of the easiest steps, as it is practical and cost-effective to avoid installing fossil fuel infrastructure during new construction and major renovations. **But it won't get us to our 2050 goal.** This warrant article addresses only one piece of a large puzzle, achieving approximately a 15% reduction in the number of fossil fuel buildings over 30 years. The Article is focused only on new construction and major gut renovations. Taken together with other efforts, this Article will be key to reducing building-related emissions in the coming years.

Are all-electric systems effective for buildings in Arlington?

Air source heat pumps are an affordable and effective clean heating and cooling alternative, sourced by electricity. Installation of these systems is actually cheaper than installing gas systems, given state and federal subsidies. With new insulation code requirements, the operating cost of electric heat pumps is comparable for new construction and significant rehabs. For some buildings, ground source heat pumps may be an alternative.



How will this new law affect construction projects in Arlington?

In the construction of new buildings, the Article will prohibit the installation of gas and oil piping; in gut renovations, it will prohibit the installation of new gas or oil piping. We estimate that this will affect an average of no more than 73 construction projects per year (residential and commercial). For commercial and most multi-family buildings, the construction work area must affect more than 50% of the building floor area to trigger the bylaw. For residential buildings, only gut renovations, not smaller jobs, will trigger the bylaw.

What would be exempt?

The Warrant Article only applies to infrastructure (piping) on the customer's side of the meter. It expressly exempts piping for emergency generators, residential and commercial cooking, central hot water in large buildings, and more. In special situations where the owner can prove that application of the law would be financially infeasible, waivers may be granted.

If I live in a multi-unit condo building and do a full "gut rehab" of my entire unit, would the Article's prohibitions apply?

The bylaw would compare the work area of the renovation project to the floor area of the whole building, so it is unlikely that the gut rehab of one unit would exceed 50% of the entire building area. Thus in most cases the new Arlington law would not apply.

Can I replace my old oil-fired boiler with an energy-efficient gas boiler?

Yes, as long as the boiler replacement is not part of a gut renovation that meets the definition of "significant rehabilitation."

Why electrify if electricity is partially generated by fossil fuels?

Electric buildings produce lower emissions than buildings fueled by oil and gas from the start, and electric buildings become cleaner and cleaner each year as the state-mandated electrical grid mix increases the proportion of renewables. In addition, Arlington residents can opt up to 50% or 100% renewable electricity today through the Town Community Choice Aggregation program at <https://arlingtoncca.com/>.

Get Involved and Learn More:

- Contact the [Select Board](#) to ask for a favorable recommendation on this Warrant Article.
- Explain your concerns to your Town Meeting members and ask them to vote YES at [Town Meeting](#).
- If you are a Town Meeting Member speak with your colleagues about responsible climate action in Arlington, and ask them to join you in voting YES on this Warrant Article.
- Learn more at www.cleanheatforarlingtonma.org, and contact us to volunteer or ask questions.

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Frequently Asked Financial Questions.

Are all-electric systems cost effective to install?

Yes! Cold climate air-source heat pump systems are already a popular alternative to fossil fuel based systems. **These systems are far more efficient and cost effective than the old electric “resistance” heat systems.** Because only one system is needed, rather than a separate furnace and air conditioner, they can be comparable or cheaper to install even before rebates. “Doing it right the first time” is better than requiring expensive retrofits to these homes later.

While each project will be unique, in 2018 consultants NMR Group Inc. issued a report for MassSave in which a 2,500 SF single family Energy code compliant Massachusetts home was modeled. **They found that all electric equipment costs about \$750 more to install, a negligible cost when considering new construction.** But with current rebates and incentives, it can be over \$5,000 cheaper. With the high prices that new homes command in Arlington (98% over \$1 million in 2018 and 2019), the entire heating system contributes a mere 2% to the total cost of the home, so the cost differences are a fraction of a percent. The table below shows data scaled up to a more typical 3,000 SF house:

Construction Costs:

Rebate Case Example:

Air Source Heat Pump Rebate for a new 3,000 SF

Single Family Home

Gas Heat, Domestic Hot Water and central A/C

Equipment and Installation	\$14,040
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Mini Split Air Source Heat Pump and Hot Water

Equipment and Installation	\$14,974
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Alternative Energy Credit	\$2,600
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Mass CEC Rebate	\$2,500
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Mass Save Rebate	\$1,700
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Equipment and Installation Net Cost	\$8,174
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Source: 2,500 square foot home example: NMR group, RLPNC 17-14: Mini split heat Pump Incremental Cost Assessment; Brookline by-law team research. Costs scaled to 3,000 SF home, with no change to rebates.

How much will it cost to run?

With efficient Stretch Energy code compliant houses, **the operating cost of an air-source heat pump is close to natural gas for new construction and gut renovations**. While every project is unique, the NMR Group report (scaled up to Arlington's 3,000 SF new house size) suggests that air-source heat pumps may be a little more expensive to run than gas. However, the cost difference of \$49/month would be under 1% of the \$6,000+ monthly costs of a new Arlington home (mortgage, taxes, insurance etc)

Monthly Operating Costs

3,000 SF new home

	Traditional Gas	Heat Pump	Cost Difference
Heating	\$125.20	\$173.70	\$48.50
Cooling	\$13.20	\$12.40	-\$0.80
Hot water	\$10.58	\$12.17	\$1.59
Total HVAC	\$149	\$198	\$49

Cost Difference Comparison



Assuming \$1.50/therm; \$0.2063/kWh; 20% down payment, 4% interest rate on 30yr mortgage. Assumed average price of \$1.2million. Homes sold in 2019 for between \$1million and \$1.5 million had a 3,196 SF average.

Get Involved and Learn More: Learn more at www.cleanheatforarlingtonma.org, and contact us to volunteer or ask questions.

Sources: NMR Group Inc., RLPNC 17-14: Massachusetts Building Code Mini split heat Pump Incremental Cost Assessment; Zillow.com; MLS Property Information Network, Inc; Mass CEC testimony related to Brookline bylaw fall 2019.

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Frequently Asked Environmental Questions.

What is the environmental motivation for the proposed bylaw?

We are facing a global climate crisis of extreme proportions, requiring significant actions to prevent the worst outcomes. Massachusetts is one of the fastest-warming states in the country. We have seen a rapid increase in extreme heat events that threaten our health the ecosystems we rely on. Rising seas and increased flooding threaten Boston and coastal communities. Climate change brings significant public health risks, including heat-related illnesses and deaths, as well as worse disease outbreaks. As natural ecosystems change or collapse, Massachusetts farmers, fishermen, and residents will suffer.

We as a Town and as a State have committed to try to tackle these threats. The 2006 Global Warming Solutions Act mandates that the state reduce emissions by 2050 to 80% below 1990 levels. Arlington and many other municipalities in MA have committed to having net zero emissions by 2050 or earlier, and Gov. Baker has recently committed the state to reach Net Zero by 2050. **There is no way to meet these legally mandated goals while including large-scale use of fossil fuels for home heating.** Every new building constructed with fossil fuel infrastructure makes the Net Zero goal harder to achieve because the use of these carbon-emitting fuels continues unabated. 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.

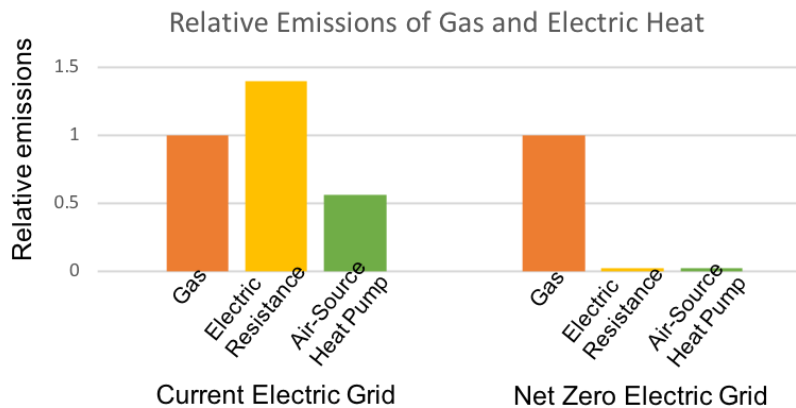
Is building heat a significant source of emissions in Arlington?

Residential and commercial building heat is one of the largest sources of emissions in Arlington. According to Arlington's 2005 Climate Action Plan, **residential and commercial buildings accounted for 60% of the Town's overall emissions**. According to the U.S. Energy Information Administration, in Massachusetts space and water heating account for 75% of residential building energy use. This makes heating alone one of the largest sources of emissions in Arlington.

If natural gas is used to generate electricity, does switching to electric heat actually lower emissions?

For modern cold-climate Air Source Heat Pumps the answer is a clear yes. These systems use electricity to move heat around rather than creating it directly, allowing them to be extremely efficient, even down to temperatures as low as -12 °F. **They are so efficient that averaged over the whole winter, with natural gas currently producing about 50% of the electricity we use, using a heat pump results in roughly half the emissions of burning natural gas in your**

home. More importantly, however, electric heating is the only way to get close to Net Zero emissions. This will never be possible with burning fossil fuels for home heating.



Many towns considering fossil fuel bans also have green community choice aggregation programs, as in Arlington, which use a higher default percentage of renewable energy and also give you the opportunity to opt-up to higher percentages of renewables. Learn more at <https://arlingtoncca.com/>

Can our electric grid handle this?

Yes! Electrical demand is currently declining in New England due to both solar panels on building roofs and gains in energy efficiency through retrofits such as LED light bulbs for street lights. There are declines in both annual and peak demand, and these declines are expected to continue. Furthermore, the proposed bylaw 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%.

While peak consumption is already a significant challenge to manage, it is currently 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.**

Get Involved and Learn More: Learn more at www.cleanheatforarlingtonma.org, and contact us to volunteer or ask questions.

Data sources: Relative emissions from "Northeast/Mid-Atlantic Air-Source Heat Pump Market Strategies Report, 2016 Update." Northeast Energy Efficiency Partnerships (NEEP). January 2017. Grid resource mix, electricity use trends, and variability are from ISO-NE "Key Grid and Market Stats." <https://www.iso-ne.com/about/key-stats>

WA #13 Detailed Testimony

By Amos Meeks, Anne, Wright, and Pat Hanlon



Background

Ongoing climate change is a serious issue that is already negatively impacting Arlington residents through more extreme weather, extreme heat, flooding, sea level rise, and degradation of our natural environment.¹ Climate change is caused by the release of CO₂ into the atmosphere from the burning of fossil fuels like methane, otherwise known as natural gas. The scientific consensus is that in order to avoid a high likelihood of worldwide catastrophe we must limit global temperature increase by the end of this century to 1.5 °C. Doing so requires reaching net zero emissions by 2050, with negative emissions for decades thereafter.²

Arlington and the state of Massachusetts are committed to tackling these issues head on. In 2018 Arlington's Select Board formally committed the Town to a goal of being net zero by 2050. On the state level, the 2008 Global Warming Solutions Act committed the state to reduce emissions by 80% by 2050.³ In addition, on January 21st 2020 Governor Baker announced a goal of reaching net zero emissions by 2050.⁴ These are ambitious but necessary goals that show our commitment to helping create a livable future, both here in Arlington and globally.

It will not be possible to meet these goals while continuing the widespread use of fossil fuels for building heat.⁵ In Arlington, buildings account for about 60% of emissions.⁶ Space heating and water heating account for about 75% of residential energy use⁷, making these by far the largest single contributors to building emissions. Currently around 85% of buildings in MA use oil or gas heating,⁸ and about 85% of new construction is built with a natural gas heating system.⁹ This,

¹ "Town of Arlington Community Resilience Building Workshop Summary of Findings & Recommendations." Kleinfelder. May 2018. <https://www.arlingtonma.gov/home/showdocument?id=43409>
Also see "FOURTH NATIONAL CLIMATE ASSESSMENT Volume II: Impacts, Risks, and Adaptation in the United States." <https://nca2018.globalchange.gov/>

² IPCC, 2018: *Global Warming of 1.5°C. An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty* [Masson-Delmotte, V., P. Zhai, H.-O. Pörtner, D. Roberts, J. Skea, P.R. Shukla, A. Pirani, W. Moufouma-Okia, C. Péan, R. Pidcock, S. Connors, J.B.R. Matthews, Y. Chen, X. Zhou, M.I. Gomis, E. Lonnoy, T. Maycock, M. Tignor, and T. Water eld (eds.)]. In Press. <https://www.ipcc.ch/sr15/>

³ <https://www.mass.gov/service-details/global-warming-solutions-act-background>

⁴ <https://www.mass.gov/info-details/ma-decarbonization-roadmap>

⁵ "Massachusetts Gas versus Massachusetts Climate Goals." Applied Economics Clinic. December 2019. https://static1.squarespace.com/static/5936d98f6a4963bcd1ed94d3/t/5dfa5edf2ef84a2cce2117c9/1576689375660/MA+Gas+vs+MA+Climate+Goals_AEC+brief_18Dec2019.pdf

⁶ "Arlington Sustainability Action Plan, Volume 1: Climate Action Plan." May 2005. http://www.wearestillin.com/sites/default/files/sustainability-plan/arlington_sustainability_action_plan.pdf

⁷ "Massachusetts Residential Energy Use." Energy Information Administration. https://www.eia.gov/consumption/residential/reports/2009/state_briefs/pdf/ma.pdf

⁸ Ibid.

combined with the hundred year lifetime of buildings and the multi-decade lifespan of heating equipment, means that action must be taken now to decarbonize building heating in order to meet our net zero goals.

Fortunately there is a clear path to the decarbonization of building heat. First is to electrify everything, using highly efficient heat pumps as the sole source of heat. This results in an immediate, large reduction in greenhouse gas (GHG) emissions that continue to decrease over time as the grid approaches the net zero goal. Effort towards the electrification of building heat are already underway, including the incredibly successful recent HeatSmart campaign.¹⁰ However, HeatSmart focused mostly on retrofits of existing buildings, while at the same time many new buildings are installing gas technology that will need to be retrofitted in the future at greater expense. The policy that we are proposing, to prohibit the installation of fossil fuel infrastructure in new construction and gut rehabilitations, is the most practical, easy, and economical step that we can take towards the goal of widespread electrification.

Below we go into more detail on the details behind the practicality of the proposed bylaw. We start by considering the immediate emissions benefits of using a heat pump system compared to natural gas, even though about 50% of our electricity is generated with natural gas. Then we go into detail on the economic and practical questions of using heat pumps in new construction. We end with an overview of the commonsense exemptions that are included in the proposed bylaw as well as the waiver process included to assure that no one is subject to unforeseen undue burdens. We also include a brief FAQ addressing some common concerns.

Emissions Impact

When considering the emissions impact of the proposed bylaw it is important to reiterate that the goal is not immediate reduction in emissions, although there are substantial immediate reductions, but rather the long-term goal of being able to reach net zero by 2050.

In terms of immediate reductions, the Applied Economics Clinic (and Arlington-based business) estimates that the lifetime emissions of a single-home three ton¹¹ heat pump system are about 49 tons of CO₂ or about 70% lower than the equivalent natural gas+A/C system.¹² These emissions are driven by the amount of fossil fuels, primarily natural gas, that are used to generate electricity.

When presented with heat pumps as a viable source of low-emission electric home heating many people initially wonder how electric heating can lower emissions when natural gas is used

⁹ "MA RLPNC 17-2: 2017 Massachusetts Single-Family New Construction Mini- Baseline/Compliance Study." NMR Group, Inc. January 3, 2018.

<https://drive.google.com/open?id=1xHgkYdxq7u5b8QOvlyx3i97uJ4SJyXdm>

¹⁰ <http://wepowr.com/heatsmartaw>

¹¹ Corresponding roughly to the heating load of a 3,000 sqft house, which is close to the average size of new single-family construction in Arlington.

¹² "Home Heat Pumps in Massachusetts." Applied Economics Clinic. July 2019.

<https://static1.squarespace.com/static/5936d98f6a4963bcd1ed94d3/t/5d24dd1ec22927000120e025/1562696991620/Updated+AEC+MA+Heat+Pump+9July2019.pdf>

to generate electricity. Firstly, natural gas is only used to generate about 50% of electricity in New England, while other fossil fuels like oil and coal generate less than 1% of electricity annually.¹³ The efficiency of natural gas fired power plants ranges from about 40-60%, meaning that roughly 1 unit of natural gas energy goes into generating 1 unit of electrical energy. The seasonal heating efficiency of a modern cold-climate heat pump is around 250%,¹⁴ meaning that averaged over the heating season 1 unit of electrical energy is converted to 2.5 units of heat energy in your home. In comparison, efficient gas heaters are about 90% efficient, converting 1 unit of gas energy to 0.9 units of heat energy in your home. Thus, even considering the gas used to produce electricity, the heat pumps results in less than half as much gas being burned, with correspondingly lower emissions.

The total effect on building emissions in Arlington between now and 2050 will be significant but not comprehensive. The planning department has estimated that at most 70 buildings on average would be affected by this bylaw each year, or about 0.4-0.5% of Arlington's total housing stock. Thus, by 2050 we estimate this would result in guaranteeing that about 12-15% of Arlington's buildings use efficient electric heat. In order to reach our net zero goal this number will need to be close to 100%, underscoring the need for additional policies and the importance of passing this bylaw now so as not to make our future problems more difficult than they already are.

Economics of Heat Pumps in New Construction

Heat pumps are both practical and economically feasible as the sole source of heat for new construction. It is a common misconception that heat pumps cannot be used as the sole source of heat in our climate and must have electric resistance or a fossil fuel backup for especially cold days. While this used to be true, the advent of cold-climate air-source heat pumps within the past seven years has completely flipped this, and now heat pumps as the sole source of heat is becoming standard practice in new construction across the state. In fact, Arlington's new high school will be heated entirely with heat pumps, large sections of it entirely with cold-climate air-source heat pumps. For residential construction a large selection of cold-climate air-source heat pumps are available.¹⁵ These are rated efficient to as low as -12 °F, temperatures that are simply not seen in Boston.¹⁶

¹³ Resource mix from ISO-NE information: <https://www.iso-ne.com/about/key-stats/resource-mix> Some people may point to the 77% of electricity generated in MA that is generated using natural gas (<https://www.eia.gov/state/print.php?sid=MA>). However, MA is part of a regional grid, ISO-NE, and we do not consume electricity only generated in MA. To use MA numbers would be akin to saying that because we live in Arlington we should consider the resource mix of electricity generated within Arlington, which is obviously a fallacy.

¹⁴ The other term for this is the season Coefficient of Performance (COP). A seasonal COP of 2.5 is used based on "Northeast/Mid-Atlantic Air-Source Heat Pump Market Strategies Report 2016 Update." Northeast Energy Efficiency Partnerships (NEEP). January 2017. https://neep.org/sites/default/files/NEEP_ASHP_2016MTStrategy_Report_FINAL.pdf

¹⁵ "NEEP's Cold-Climate Air-Source Heat Pump List." <https://ashp.neep.org/#/>

¹⁶ "How Cold are Boston Winters?" The Boston Globe. January 7 2015. <https://www.bostonglobe.com/metro/2015/01/07/how-cold-are-boston-winters/8WLSz71EjGv72eUyHvGxL/story.html>

In addition to being feasible as the sole heating source for new construction in our climate, cold-climate air-source heat pumps are also currently financially practical. While each project will be unique, in 2018 consultants NMR Group Inc. issued a report for MassSave in which the costs for natural gas+A/C vs. a heat pump were modeled for a 2,500 SF single family Stretch Energy code compliant Massachusetts home.¹⁷ They found that, without any rebates or incentives, all electric equipment was about \$750 more to install. Compared to the hundreds of thousands of dollars that go into new construction this is a negligible cost difference of less than 1%. However, in all-electric new construction several thousand dollars and many hours of time can be saved by avoiding gas hookup costs, which more than makes up for the slightly higher initial costs of the heat pump system.

The operating cost difference between the gas and heat pump systems is also negligibly small. The NMR Group report finds that the electric system costs \$41/month more to use than the gas system. This should be compared to the monthly mortgage, insurance, and property taxes for a new \$1 million, 2,500 square foot home, which total about \$5,000/month. \$41/month represents less than a 1% increase in monthly costs. However, this is only one report. The Applied Economics Clinic finds that without any rebates or incentives the levelized cost of a residential heat pump system is only \$36/year, or \$3/month, more than the gas system.¹⁸

While these minor cost increases may not have an impact on those who are purchased new million dollar homes in Arlington, they could be significant for residents of affordable housing. However, it turns out that affordable housing and multi-family housing are already leading the way in terms of heat pump adoption. The reasons for this are detailed in testimony from the MassCEC,¹⁹ however the summary is that the higher density and higher efficiency of dense multi-family construction shifts the economics such that heat pumps are almost always the lowest cost option. This is true even in Arlington, where all of the Arlington Housing Authority's current projects are being planned or built with air-source heat pumps as the sole source of heat. The exception to this is in central hot water systems, which are not currently economical, although such systems are widespread in Europe and Asia. This is why such systems are specifically exempted in the proposed bylaw, as we describe later.

Finally, while space heating is the main focus of the proposed bylaw, other appliances such as clothes dryers are also affected. While electric resistance clothes dryers are common, there also exist options for heat pump powered clothes dryers, which are much more efficient and have the advantage of not needing any outside venting.

¹⁷ "RLPNC 17-14: Mini-Split Heat Pump Incremental Cost Assessment." NMR Group, Inc. November 27 2018. https://drive.google.com/file/d/1spNI84avw37u0UD9T0Esg7LYpo_Jv4eW/view?usp=sharing

¹⁸ "Home Heat Pumps in Massachusetts." Applied Economics Clinic. July 2019. <https://static1.squarespace.com/static/5936d98f6a4963bcd1ed94d3/t/5d24dd1ec22927000120e025/1562696991620/Updated+AEC+MA+Heat+Pump+9July2019.pdf>

¹⁹ <https://drive.google.com/file/d/0B3NX52pcQwJTV1dZLTc4MWtEbZliSzN4bC1UWlpZVjkxLVdV/view>

Exemptions and Waivers

While we have shown that going all-electric is almost always economical and has large and immediate emissions benefits, we recognize that it may not be feasible in all situations. It is for this reason that our proposal includes a number of practical and commonsense exemptions, as well as a waiver process in case of unforeseen circumstances.

We previously mentioned one practical exemption, which is central hot water for large buildings. In this case the technology is not currently available in the US to efficiently and cost-effectively provide a large, centralized source of hot water.²⁰ However, the exemption is set up to apply only if a cost-effective alternative is unavailable.

Another practical exemption is cooking equipment. Especially for commercial scale cooking there do not exist practical all-electric alternatives to gas. Thus all cooking equipment is exempted. Backup generators are also exempted for clear practical reasons as are medical and research facilities due to their more stringent requirements for temperature control and air flow. Finally, any repair of existing piping that is deemed unsafe is exempted.

The proposed bylaw also explicitly includes several important clarifications on scope. Firstly, the bylaw only applies to piping on the customer side of the meter, which is important in order not to conflict with state regulation. In addition, since the bylaw only applies to piping, there is no effect on outdoor portable cooking appliances, such as grills. In addition, since it only applies to fossil fuel piping, the non-fossil fuel components of a heating system are not affected and can be extended or modified freely.

In the case of a practical or economic burden not covered by the existing exemptions, the bylaw includes a waiver process. We propose that the waiver process be handled by the Building Inspector with the support of other Town staff. Since the waiver requests may be quite technical in nature we empower the Building Inspector to see outside expertise as necessary.

Conclusions

Overall we believe that the proposed bylaw is a significant, important, and necessary first step towards meeting our long-term emissions goals. The proposal is practical and commonsense, and once common misconceptions are dispelled it tends to be entirely noncontroversial.

Additional Questions and Concerns

1. Can the grid handle this?

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

²⁰ Ibid.

demand, and these declines are expected to continue. The proposed bylaw affects too few buildings, too slowly (1% or fewer per year), to impact the electrical grid, which already has year-on-year variation exceeding 1%, significantly.²¹ Meanwhile 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.

2. Is a ban really an appropriate response?

We believe that the answer is yes, for a variety of reasons. First, generous incentives already exist to help spur the adoption of heat pumps, so the carrot is already there. Second, every new building built today that uses fossil fuels is a building that will need to be retrofitted in the next few decades, likely at a much higher cost than just building all-electric from the start. Due to the large-scale need to retrofit our buildings, these costs will likely be paid at least in part by the government, meaning all of us, rather than by the people who put in the fossil fuel system. It is thus prudent policy for us to want to avoid these future costs. Third, our understanding is that one of the contributing reasons for why gas systems are still used despite the economic feasibility of all-electric buildings is that developers will use a fairly standard building design with only minor changes from one project to another. This policy will thus provide a needed push to change this standard design.

3. How many other municipalities are considering similar proposals?

Arlington is not alone in considering a prohibition on fossil fuel infrastructure in new construction. We don't have up-to-date information from every municipality, but our current tally is 18 municipalities that are considering it, and of that seven, including neighboring Belmont, are currently moving forward with a proposal (including Brookline).

²¹ <https://www.iso-ne.com/about/key-stats/electricity-use/>

WELCOME!



TONIGHT'S AGENDA

- Welcome and Agenda Review (5) *Anne Wright*
- Overview of Warrant Article (5) *Amos Meeks*
- The Need (5) *Coralie Cooper*
- How does electric heat work? and
Affordability: costs of heat vs. gas/oil (10) *Jeremy Koo*
- Will heat pumps work for affordable housing? (5) *Bev Craig and Bob
Fitzpatrick, CEC*
- Proposed exemptions and waivers (5) *Anne Wright*
- Brookline's experience (5) *Jesse Grey*
- Questions and Answers (75) *Amos Meeks, MC*
- Closing (5)



PROPOSED BYLAW OVERVIEW



THE PROPOSED BYLAW PROHIBITS NEW FOSSIL FUEL PIPING IN:

New Construction



Gut Renovations



**Existing buildings, kitchen renovations, additions, etc.
will be entirely unaffected**



THE PROPOSED BYLAW INCLUDES A VARIETY OF PRACTICAL AND COMMONSENSE EXEMPTIONS:

Customer side only



Backup generators are **exempted**



Portable propane appliances **unaffected**



All gas cooking appliances **exempted**



THE PROPOSED BYLAW INCLUDES A VARIETY OF PRACTICAL AND COMMONSENSE EXEMPTIONS:



Hot water for large buildings **exempted**

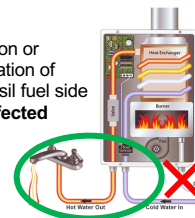


Repair of existing unsafe piping is **exempted**



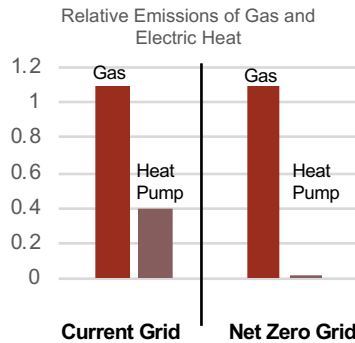
Research and medical facilities are **exempted**

Extension or modification of non-fossil fuel side is **unaffected**



QUICK ANSWERS TO SOME COMMON CONCERNS:

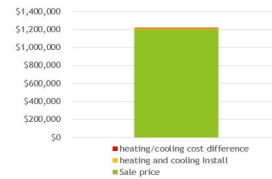
Heat pumps immediately lower emissions, even with electricity from gas



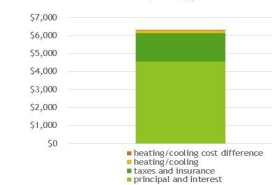
Calculated assuming a 90% efficient gas furnace, heat pump seasonal COP of 2.5, and 50% of electricity generated with natural gas

Cost differences for residential buildings are extremely small

Approximate price for a new 3,000 sq' home



Approximate monthly costs for a new 3,000 sq' home



Assuming \$1.50/therm; \$0.2063/kWh; 20% down payment, 4% interest rate on 30yr mortgage



QUICK ANSWERS TO SOME COMMON CONCERNS:

Affordable housing is already leading the way



Finch Cambridge, 98 affordable housing units, passive house standard with VRF heat pumps

Maximum average annual number of building affected: **~70**
0.4-0.5%



O'Shea house, Brookline Housing Authority property, 100 units of affordable housing. VRF heat pumps.

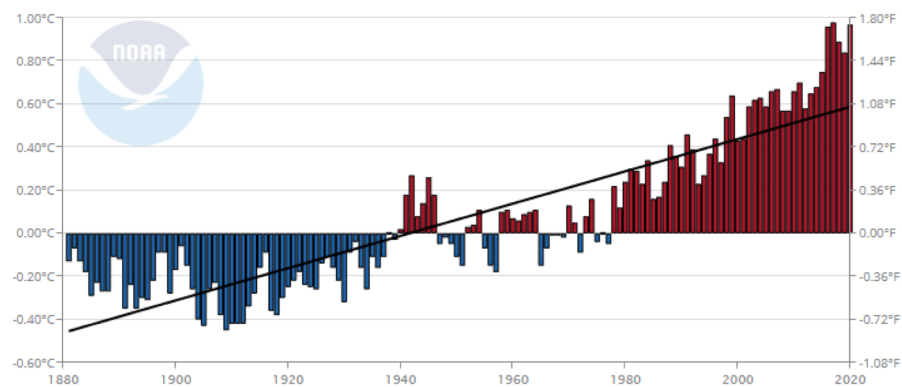


The need

To reach Arlington's
Net-Zero goal by
2050, we will need to
decarbonize our
buildings



Global Land and Ocean
February-January Temperature Anomalies



Source: National Oceanic and Atmospheric Administration (NOAA)



Environment ► Climate change Wildlife Energy Pollution


Climate change

JP Morgan economists warn climate crisis is threat to human race

Leaked report for world's major fossil fuel financier says Earth is on unsustainable trajectory

Patrick Greenfield and Jonathan Watts
Fri 21 Feb 2020 11.27 EST

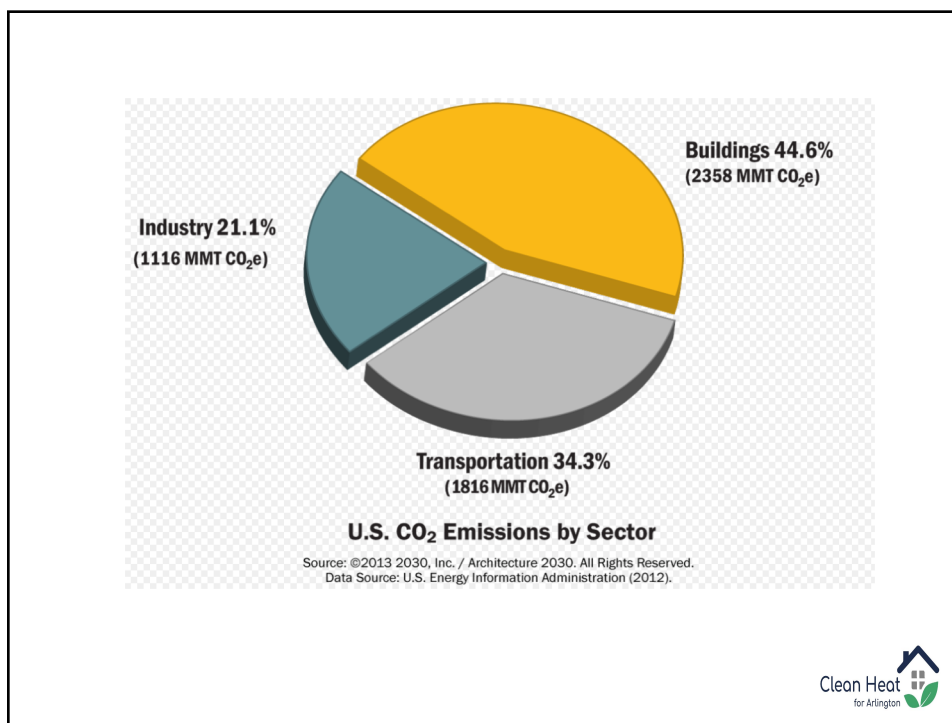
12,328

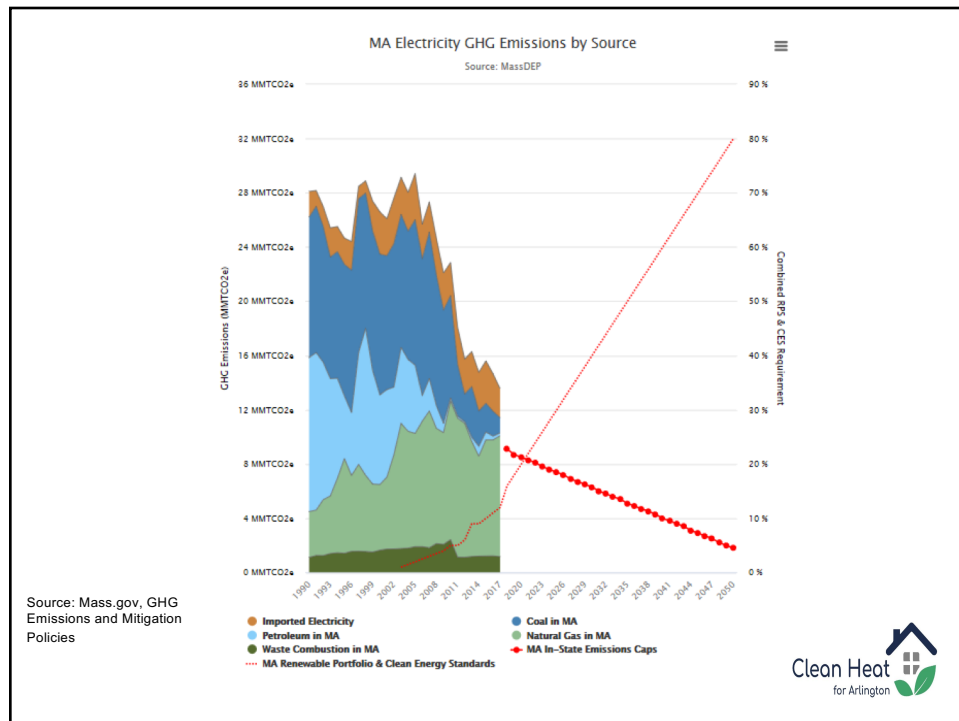


▲ The JP Morgan paper said 'catastrophic outcomes' could not be ruled out. Photograph: Dimitar Dilkoff/AFP via Getty Images

Source: The Guardian

Clean Heat for Arlington





What is a heat pump?

Heat pumps in the Northeast

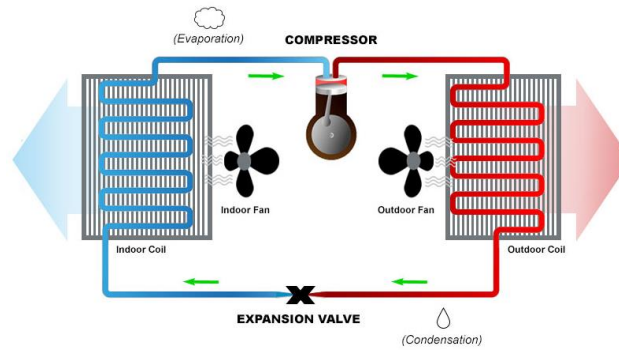
Costs vs. gas in new construction

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WHAT IS A HEAT PUMP?

How an air conditioner works



Heat Pump: Run it in reverse!

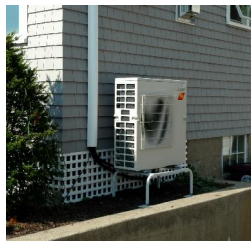
Image Source: Carrier (<https://www.carrier.com/residential/en/us/products/heat-pumps/how-does-a-heat-pump-work>)

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WHAT IS A HEAT PUMP?

Air Source



Ground Source (Geothermal)



Water Heater



Images courtesy of: Boucher Energy Systems, New England Ductless, EnergySmart Alternatives, and Hot Water Solutions Northwest



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WHAT IS A HEAT PUMP?

Common misconceptions

- **Electric heat is inefficient**
- Heat pumps don't work in Massachusetts climate
- Heat pumps cannot serve as the only source of heat in a home



Air Source:
220-350+% efficient

Ground Source:
350-480+% efficient

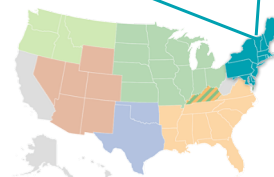
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WHAT IS A HEAT PUMP?

Common misconceptions

- Electric heat is inefficient
- **Heat pumps don't work in Massachusetts climate**
- Heat pumps cannot serve as the only source of heat in a home



Cold-Climate Air Source Heat Pump Specification requires high-efficiency at 5°F, many systems perform to -13 to -22°F

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WHAT IS A HEAT PUMP?

Common misconceptions

- Electric heat is inefficient
- Heat pumps don't work in Massachusetts climate
- **Heat pumps cannot serve as the only source of heat in a home**

- In 2017, approx. **10%** of new homes in MA used a heat pump as the **only source of heating/cooling**
- Ground source heat pumps **do not lose output and efficiency** significantly on the coldest days of the year
- Dozens of systems installed through HeatSmart 2019 in retrofits had **no backup heat**

Sources: MA RLPNC 17-2: 2017 Massachusetts Single-Family New Construction Mini-Baseline/Compliance Study; 2019 HeatSmart Mass program data

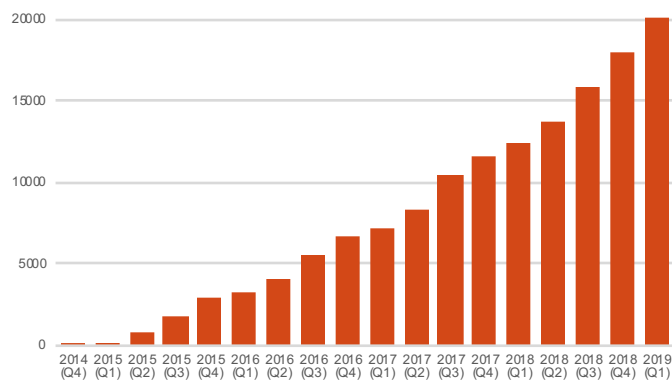
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HEAT PUMP MARKET IN THE NORTHEAST

MassCEC Rebate Data

Cumulative Cold Climate Air Source Heat Pump Rebates (MassCEC), 2014-2019



Rebate amounts were reduced twice during the life of the program!







Source: MassCEC

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HEAT PUMP MARKET IN THE NORTHEAST

The Rest of the Region

State	Program	# of Rebated Installations
		~30,000 systems (2013-2018)
		8,200+ systems (Q1 2015-Q4 2017)
		11,000+ sites (9/2017-12/2019)

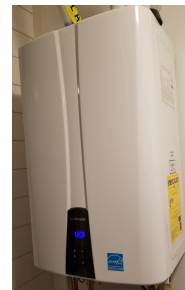
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HEAT PUMP COST COMPARISON

An example new single-family home

Traditional
Gas Furnace
Central AC
Tankless Gas HW



All-Electric
Minisplit Air Source Heat Pump
Heat Pump Water Heater



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HEAT PUMP COST COMPARISON

An example new single-family home

	Installed Cost	Annual Operating Cost
Traditional Gas Furnace Central AC Tankless Gas HW	\$11,724	\$1,511
All-Electric Minisplit Air Source Heat Pump Heat Pump Water Heater	\$12,478	\$2,007 (\$1,362 powered with solar)

Source: RLPNC 171-4: Mini-Split Heat Pump Incremental Cost Assessment;
 Estimate of Solar PPA/cost with financing price from Solarize MA Data

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Thank You / Q&A

Jeremy Koo

Associate

Strategic Electrification & Distributed Energy Resources

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**MASSACHUSETTS
CLEAN ENERGY
CENTER®**

**HEAT PUMPS: WHAT CAN AND
CAN'T BE DONE**

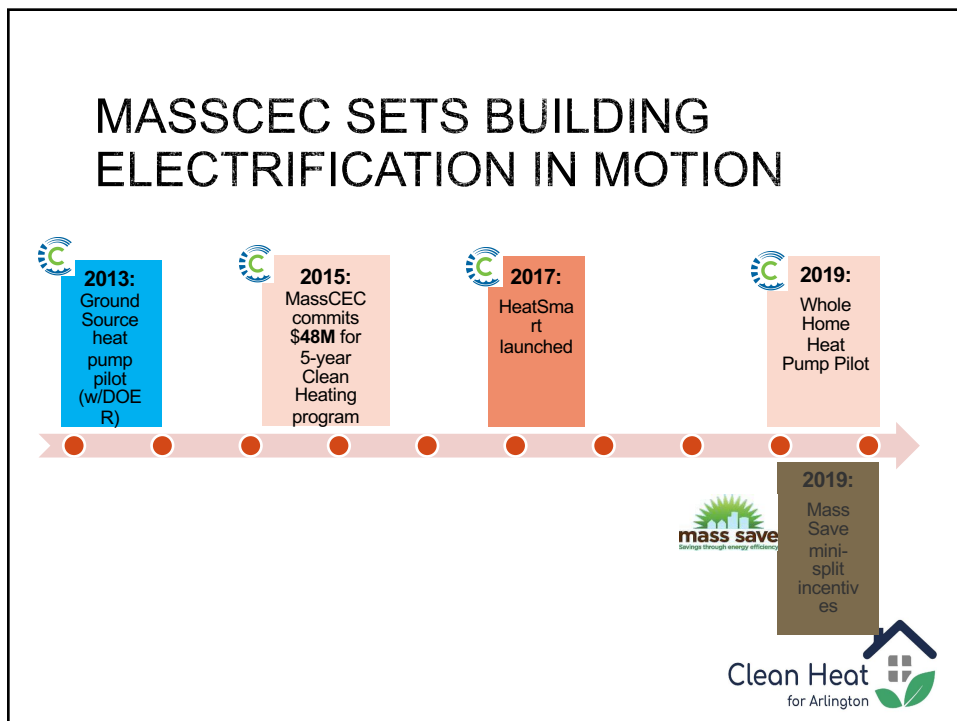
**ELECTRIFICATION AND
AFFORDABLE HOUSING**

Presented By

MassCEC

OUR MISSION

Grow the economy and help meet the state's ambitious clean energy and climate goals.



HEAT PUMPS ARE BECOMING INDUSTRY STANDARD IN NEW CONSTRUCTION

- Today's new buildings regularly use cold-climate air source heat pumps
- Air source heat pumps use electricity but are 3x as efficient electric resistance heat
- Used in climates colder than ours: upper Canada, Alaska, and Maine
- First costs are often lower than separate heating and cooling systems in new construction
- Operating costs in new construction multi-family are comparable to gas heated with cooling

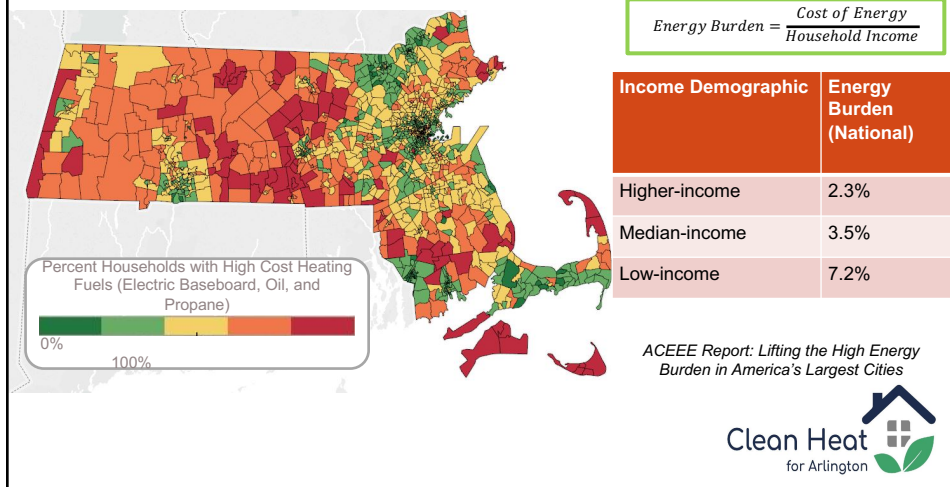


CENTRAL HOT WATER HEAT PUMP TECHNOLOGY NOT AVAILABLE

- Individual heat pump water heaters work great
- At 8+ units rental, developer will want to install central hot water system
- While some central technologies in Europe and Canada, not available in US
- Other difficult part of high performance building is heat recovery ventilation without any gas preheat



HEATING COSTS ARE DISPROPORTIONATELY HIGH IN COMMUNITIES WITH NO GAS



BUT NEW CONSTRUCTION ELECTRIC HEATING AND COOLING IS AFFORDABLE

- In new construction, there will not be increase in operating costs
- When cooling is included, operating may be much lower in future years as climate warms
- If electrify existing building with no envelope improvements= higher operating cost
- Masonry/brick buildings will be the most difficult to retrofit



QUESTIONS



- Robert Fitzpatrick
- Director, Gov't Relations
- rfitzpatrick@masscec.com
-



- Beverly Craig
Sr. Manager, Low-Income
bcraig@masscec.com



WHAT THE BYLAW DOESN'T COVER

Exemptions:

- Residential and commercial cooking;
- Hot water heaters for structures over 10,000 sq. feet;
- Emergency generators
- Scientific labs & medical offices and more.

Bylaw will not affect:

- Gas pipelines in the street
- Gas meters and hookups (piping (connections to the street))
- Removal of any existing infrastructure, piping, equipment or appliances
- Building insulation
- Energy efficiency of equipment
- Specific equipment or technologies to be installed



WAIVERS AND APPEALS

- If electrification causes undue expense or practical challenges, a waiver can be sought via appeal
- Method of appeal: Building Inspector grants waivers; may consult with town staff and local energy experts
- Special consideration given to projects sponsored by the Arlington Housing Authority, given its limited sources of capital funds



Jesse Grey

Brookline Town Meeting Member and

Architect of Brookline's Warrant Article 21

which passed in Brookline Town Meeting in November



Q & A'S



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THANK YOU!

- For more information, to submit questions, or to contact the Working Group, go to:
- www.cleanheatforarlingtonma.org



ADDITIONAL INFORMATIONAL SLIDES FOLLOW



MASSCEC'S APPROACH GETS RESULTS



Accelerate Market Adoption

Enable homeowners, businesses, government agencies, and non-profits to install clean energy systems



Build The Workforce

Connect job seekers and employers through internships, job and resume boards, and training programs



Supercharge Innovation

Support innovation at research institutions, startup companies, incubators and business accelerator programs



BUILDINGS: ENERGY, CARBON, AND MONEY



\$2,500

Annual household
energy spending

27%

MA GHG emissions from
fossil fuels used in buildings

0% (net)

Proposed 2050 MA
emissions target

2 million

Number of buildings in MA



\$229M awarded
to residents, businesses
and communities



Over **45,000**
Systems Supported



\$60M awarded to
low-moderate
income residents

**SINCE 2010, INNOVATIVE MASSCEC PROGRAMS HAVE
INCREASED THE DEPLOYMENT OF RENEWABLE ENERGY
TECHNOLOGIES**



157 MW
Solar



5,100 solar loans
supported
\$164M in loan value



\$1B in private
capital leveraged



240 MW
clean heating +
cooling

