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Climate and Housing Crisis: A Research Agenda for Urban Communities

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Abstract

Housing unaffordability and climate change adversely affect the lives of Boston area residents. These crises are amplified by the ongoing COVID-19 pandemic and are especially salient for low- and moderate-income people and people of color. However, there is not currently an established body of academic research, municipal plans or an advocacy agenda that addresses these crises systematically and simultaneously. This paper proposes a research agenda that does so in a way that is equitable, centered on the needs of those who are most affected by the housing and climate crises, rooted in empirical and primary analysis, reflects a critical approach, and accommodates diverse analytic methods and disciplinary traditions. This transdisciplinary research agenda is based on four resources: key informant interviews, a review of the academic and practice literature, a resident-focused public event, and an expert-attended event. Our analysis of these resources has helped us better understand how the housing and climate crises intersect, what these intersecting crises mean to the experiences of diverse stakeholders, and how responses to specific research questions may support development of a range of policy and planning responses.

Research findings:

- Prominent themes: the need for affordable and sustainable housing development strategies that reflect the resources and values of vulnerable communities; the need to adapt analytic methods or develop new ones to assist practitioners in designing affordable and sustainable housing development strategies; and the need for academics, practitioners, advocates, and community members to better communicate among each other to develop common responses to the housing and climate crises.
- Key research questions: What community characteristics support successful implementation of residential development projects that are affordable and sustainable? How can a social cost-benefit analysis quantify social and environmental impacts so that projects that are not financially feasible using conventional metrics can be attractive? How can analytic methods be used to yield insights into designing policy instruments?

Keywords

Climate adaptation; climate resilience; climate mitigation; housing affordability; COVID-19; policy instruments; problem structuring; social cost-benefit analysis; community development; data and decision analytics; transdisciplinarity.

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Climate and Housing Crisis: A Research Agenda for Urban Communities

Introduction

The current housing market is not meeting the basic needs of a growing number of Americans. In 2018, 49.6% of renter households in Boston were cost-burdened (Salviati, 2019). Almost two-thirds of renters nationwide declare they cannot afford to buy a house (Goodman et al., 2018), while home prices continue to rise faster than wages in most urban areas of the country (ATTOM Data Solutions, 2019). This situation remains particularly severe for low-income people of color, who disproportionately struggle to achieve affordable and stable housing (Harvard Joint Center for Housing Studies, 2020).

Climate change has added another layer of complexity to the existing housing crisis. Because of projected sea-level rise and increased flood events, changes in precipitation patterns, and extreme temperature events, affordable housing availability and livability will likely decline. Floods and fires will destroy housing and units will become unlivable because of mold and heat. In addition, much of current climate adaptation policy is focused on protecting property and property owners and, as a result, favors wealthier communities (Anguelovski et al., 2019). We fear that those most impacted by the housing crisis will not only suffer from the effects of climate change but also from the consequences of adaptation policies that aim to maintain the status quo. We are also concerned that the crises associated with climate change and housing affordability may be seen as competing for attention and resources.

The COVID-19 pandemic has underscored the connection between housing, social equity, and overall well-being. As COVID-19 spread, cities ordered residents to retreat to their homes. This has elevated the importance of housing quality, stability, affordability, and location. COVID-19 is also intensifying the housing crisis for low-income communities. With the economic fallout, these communities are losing jobs at a higher rate, are increasingly unable to meet basic needs, and are falling behind on rent (Consumer Financial Protection Bureau, 2021). The National Low-Income Housing Coalition predicted in 2020 an increase of 1.5 million severely cost-burdened renters due to the pandemic (Aurand et al., 2020). Without effective policy interventions, there will be massive displacement.

The purpose of this working paper is to propose a research agenda on addressing the housing and climate crises in the Boston metropolitan area, accounting for the dramatic changes in all areas of public life due to the ongoing COVID-19 pandemic. We believe that our findings, grounded as they are in the characteristics of the Boston area, may be adapted to other metropolitan areas across the United States.

The election of President Joseph R. Biden Jr. in 2020 has resulted in a dramatic increase in the emphasis given to federal-level climate change response in the United States. Indeed, the Biden-Harris Administration has pledged to infuse climate change responses throughout policy areas such as housing, transportation, natural resource extraction, employment, national defense, and other areas. This policy emphasis is represented by two recent executive orders. Executive order

14008, “Tackling the Climate Crisis at Home and Abroad” (Federal Register, 2021a), has produced a White House Office of Domestic Climate Policy, led by a first-ever National Climate Advisor; a National Climate Task Force; a commitment to make environmental justice a part of the mission of every agency; the Justice40 initiative to deliver 40 percent of the benefits of federal environmental investments to disadvantaged communities; and a Climate and Environmental Justice Screening Tool to identify disadvantaged communities and inform equitable decision making across the federal government. Executive order 13990 (Federal Register, 2021b) reinstates the Social Cost of Carbon (SCC) Working Group and has directed it to develop measures to assess the social costs of carbon, nitrous oxide, and methane emissions.

In Massachusetts, Governor Charlie Baker has signed Bill S.9, “An Act Creating a Next-Generation Roadmap for Massachusetts Climate Policy” (Commonwealth of Massachusetts, 2021). This legislation introduces new policies to reduce greenhouse gas emissions and protect the environment, and enhance Massachusetts’ leadership within New England and across the U.S. in climate response. In the city of Boston, former mayor Martin J. Walsh initiated a range of programs related to climate adaptation and mitigation that are expected to continue under his successor, Acting Mayor Kim M. Janey. These include a Zero-Emission Vehicle Roadmap, the Climate Ready Boston Part II adaptation plan, climate resiliency plans in multiple Boston neighborhoods, and a citywide urban forestry master plan.

Eighteen months into the COVID-19 pandemic, the U.S. housing market is facing a crisis of affordability. Housing prices have increased by 13.2 percent in March 2021, a rate three times higher than the first quarter of 2020 and four times higher than in 2019. These increases are the result of high demand and limited supply. These price gains have greatly outpaced income growth, and large disparities in homeownership rates by race and ethnicity persist. While rents have moderated their historic growth, renter cost burdens remain high, an effect of pandemic-induced economic hardship (Harvard Joint Center for Housing Research 2021). Millions of renters face the prospect of eviction due to rent arrears, although the U.S. Centers for Disease Control have recently extended an eviction moratorium (Shepardson and Hunnicutt 2021). The Biden Administration has proposed $318 billion in housing investments as part of the American Jobs Plan, which includes increased spending on the national Housing Trust Fund, new investments to rehabilitate and preserve public housing, a new Community Revitalization Fund and a Community Development Block Grant Resiliency Program (National Low Income Housing Coalition 2021).

Housing in Massachusetts, and particularly in Boston reflects many of these national trends: high housing costs, especially in the Boston metropolitan area, large inequalities in income and wealth that produce housing insecurity and amplify racial and ethnic disparities in homeownership, and, particularly in Boston, excessive reliance on luxury housing (The Boston Foundation 2021, City of Boston 2018). Boston’s Housing A Changing City: Boston 2030 plan proposes increased housing production, preservation of existing housing and protecting households at risk for housing insecurity (City of Boston 2018). Massachusetts Governor Charlie Baker has recently announced $139 million in funding for affordable housing projects that will produce over 1,500 new rental units, the vast majority of which are affordable to low- and moderate-income households (Office of Governor Charlie Baker and Lt. Governor Karyn Polito 2021).

Despite these promising trends at the federal, state, and local levels, the climate and housing crises remain significant barriers to improved quality of life for low- and moderate-income residents and communities of color of Greater Boston. Sea level rise, extreme weather events, and residential mobility and redevelopment in coastal communities may increase the risk of displacement for low- and moderate-income households (Keenan et al., 2018). Sustained summer heat waves have amplified the "heat island effect" that makes residents of older housing vulnerable to health impacts of excessive heat and in need of public spaces and resources to cool down during heat events (Klein et al., 2014; Wong et al., 2016). Extreme winter events result in residents vulnerable to job loss and unable to access regular food sources due to transit inaccessibility. Adaptation and mitigation efforts may result in increased housing expenses that are passed on to renters, like increased cost of air conditioning (De Cian et al., 2019). These, among other challenges, have been amplified by the ongoing COVID-19 pandemic: more people, sometimes facing overcrowding at home, are prone to severe infections in their workplace or have lost income due to job loss (Jones et al., 2020; Rosenberg et al., 2020). This pandemic has highlighted the importance of affordable, safe, and livable housing, both for limiting the spread of COVID-19 and providing stability to residents as they experience the effects of climate change.

The Sustainable Solutions Lab (SSL) at the University of Massachusetts Boston, in collaboration with the Lincoln Institute for Land Policy, has begun an applied research effort to expand the knowledge base regarding the housing and climate crises in the Boston area. In particular, SSL has sought to develop a research program, using community-engaged problem structuring activities, to address the housing and climate crises. This effort is intended to generate knowledge that supports the development of policy and planning interventions to protect vulnerable urban communities from the impacts of climate change and to increase their ability to live in affordable and opportunity-rich communities, while addressing the short- and long-term impacts of the COVID-19 pandemic. This effort also seeks to identify climate change interventions, by which affordable, community-centered housing could help reduce greenhouse gas emissions. These interventions are primarily focused on mitigation, though we address adaptation as well.

Our research has generated insights from multiple stakeholders whose views and experiences are often in conflict:

- *Residents* express concerns and may mobilize for action, but traditionally do not play a central role in solutions design, implementation, and evaluation. We may further classify residents as transient residents (students and short-term visiting workers, e.g., who are insufficiently represented in resident actions), long-term organized residents (such as tenant unions, who are more engaged with practitioners through existing landlord-tenant structures), other residents without tenant union membership (who may mobilize for action but may not have existing formal structures for engaging directly with practitioners), and low-income homeowners and landlords.
- *Advocates and organizers* work with and represent the needs and concerns of residents, advocate for particular solutions, and take the lead in building community capacity for and interest in solutions, but traditionally do not have access to political power to

approve, fund and implement solutions, or to define a body of knowledge upon which solutions depend.
- *Researchers* provide foundational knowledge for solutions design, implementation, and evaluation, but may not be intimately familiar with the experiences and concerns of residents, advocates, and organizers or practitioners.
- *Practitioners* may represent nonprofit organizations, for-profit developers, or funders who produce affordable and climate-resilient housing and related physical infrastructure. They may also represent governmental bodies that set standards and prescribe interventions, as well as nonprofits that perform research and provide funding for academic researchers. They may have close ties to advocates and organizers and residents, but, by the nature of their work, may not routinely collaborate with researchers who can help enrich their practice with academic knowledge.

This research project bridges multiple academic perspectives. Through *social research*, we may explore what is known, and what can be learned, about communities and institutions that are affected by and respond to the housing and climate crises, and the efficacy of various interventions. Through *scientific research*, we may explore the design and evaluation of mechanisms, interventions and technologies associated with responses to the housing and climate crises.

Themes we identified from our data collection include: the need for affordable and sustainable housing development strategies that reflect the resources and values of communities of low- and moderate-income people and people of color; the need to adapt or develop new analytic methods to assist practitioners in designing affordable and sustainable housing development strategies; and the need for academics, practitioners, advocates, and community members to better communicate among each other to develop common responses to the housing and climate crises. Throughout this paper, we use 'sustainable housing' to denote 'climate-positive housing' and 'climate-friendly housing.'

Our research with these stakeholders has resulted in many findings. Race and funding issues are common elements of the housing and climate crises. Technologies and community engagement mechanisms to support construction of climate-friendly housing with some affordable elements do exist and have been used in multiple projects in the Boston area. However, the social, political, and economic characteristics of these projects, and the communities in which they are situated, call into question the ease by which similar projects might be financially and politically feasible in less advantaged communities. Mandates, local technical capacity, financial subsidies, and active local advocacy can generate genuinely affordable and climate-friendly housing – but it is rare to have all of these elements operating simultaneously and in a flexible manner. It is quite difficult to engage community residents in discussions about the housing and climate crises in language that is comfortable to them as distinct from the language that is natural to professionals and scholars. We have identified a wide range of policy instruments, under development and in practice across the country, related to analytics and decision support, collaboration and capacity building, funding and financing, and green building and retrofitting. However, we have not found many specific ways to upgrade climate adaptation and mitigation-oriented instruments to also address the housing crisis. We describe these and other findings in the body of the paper.

These findings have enabled us to identify two promising areas of research inquiry: identifying the characteristics of communities where policy instruments have been successfully developed; and developing tools and methods to design policy interventions. The first area is concerned with learning how to adapt emerging practices in climate-ready affordable housing development to initiatives in less-affluent and marginalized urban communities, and to determine which community characteristics (residents, organizations, and infrastructure) are most indicative of successful policy instrument development and modification. This work is rooted in principles of policy analysis and planning, where the primary focus is on identifying causal mechanisms, evaluating interventions, and generating insights for practice. The second area is motivated by the recognition that technical knowledge, beyond administrative mechanisms, is necessary to ensure that policy and planning interventions work as designed and can achieve defined social goals. In this domain, addressing the uncertain nature of the policy and planning environment, quantifying non-monetary social impacts, and supporting policy and planning design through improved decision-making is essential. This must be done in a way that recognizes the special challenges of addressing the needs of low- and moderate-income communities and communities of color. Therefore, the goal here is to learn how certain analytic methods can be adapted to support the work of practitioners by developing tools and methods to design and evaluate policy interventions related to climate-ready affordable housing development.

These specific areas of research inquiry inspire several promising extensions. Among these are: How can we maximize participation in efforts to address the housing and climate crises by those who are most affected? What are the perceptions of climate change by communities most at-risk for climate impacts? How can interventions, such as retrofitting and new development, be adapted to reduce displacement? What resources and institutions can enable residents to play a leading role in neighborhood development? How can we develop a cohesive, statewide policy for affordable housing and climate adaptation? We present these and other promising research extensions in the body of the paper as well. This paper is based on the final report of a project on the housing and climate crises conducted between June 2019 – March 2021 (Johnson et al., 2021a).

In Section 2, we use relevant research to develop a conceptual framework connecting processes, stakeholders, boundary setting and relationships between core concepts, and a theoretical framework linking multiple disciplinary and methodological traditions. In Section 3, we present our community-engaged problem structuring process and describe the tasks associated with data collection and analysis. In Section 4, we describe themes that arose from our primary data collection, findings associated with these themes, promising policy instruments, and the questions that form the basis for our research program. In Section 5, we discuss expected and unexpected findings across different sources of data, identify areas for future research, and propose ways to execute our research program. Section 6 provides a conclusion.

Literature and frameworks for inquiry

Climate Change, Housing Affordability, and COVID-19

There is agreement within the scientific community that climate change poses a great risk to societies, particularly those located in areas that are already vulnerable to environmental hazards, such as coastal zones, flooding areas, or heat islands, among others (IPCC, 2014). Responses to climate change consist of mitigation and adaptation strategies. Mitigation involves the management of climate change through endeavors to reduce its drivers, greenhouse gases (GHG), over the long-term, while adaptation involves the management of risk and vulnerability to climate change impacts in the short-term (Bierbaum et al., 2013; Landauer, Juhola, & Söderholm, 2015). While mitigation and adaptation are both essential responses, Susskind (2010) argues that adaptation planning is especially critical; cities will face many adverse climate impacts in the near term no matter how effective mitigation strategies may be.

The largest share of adaptation policies is taking place at the local level, as proximity to stakeholders and the general public provides authorities with place-based exposure and better understanding of climate risks, allowing policy makers to tailor responses that are, ideally, protecting communities (Corfee-Morlot et al., 2011). However, scholars are beginning to question if climate adaptation policy may be exacerbating unequal outcomes (Shi et al., 2016; Anguelovski et al., 2016).

Recent studies conducted at different sites have found that climate adaptation policies, and their resulting plans, can aggravate socio-spatial inequalities across populations, particularly low- and moderate-income communities of color. Where these populations are located in urbanized areas, and outcome measures of interest include housing markets, climate adaptation policies may lead to a sort of 'climate gentrification' (Keenan, 2018), that is, gentrification that is generated or exacerbated by climate adaptation policies. This concept highlights the dependent relationship between elements of the built environment – such as housing, transportation, or public facilities – that may worsen vulnerabilities related to climate impacts or are themselves exacerbated by those impacts (McNamara and Keeler, 2013; Räsänen et al., 2016; Walker et al., 2016; Treuer et al., 2018; Anguelovski et al., 2016). Besides gentrification, one outcome of climate adaptation planning can be reduced housing development due to the use of expensive building materials to produce climate resilient housing, which can limit housing options for excluded or marginalized communities. As an example, see the recent work of the Cambridge Climate Resilience Zoning Task Force (Cambridge Community Development Department, 2021).

There is growing evidence that urban economic actors may be employing the rhetoric of climate adaptation to establish speculative, exclusionary, or unsustainable practices-such as addressing sea-level rise by building coastal high-end housing that can pay for the elevation of the waterfront - thus exacerbating historic injustices associated with infrastructure and land use development (Sovacool et al., 2015). Focusing on climate resilience therefore hides tradeoffs associated with the uneven distribution of adaptation costs and benefits (Pelling et al., 2015).

Anguelovski et al. (2016) and Chu et al. (2017) suggest that there is a duty from the public sector to contextualize existing institutional parameters that define both the vulnerability and exposure

of sensitive populations. In line with the growing relevance of the climate gentrification subfield, there is a need for policy makers and relevant stakeholders shaping climate change adaptation to increase their awareness of the processes exacerbating socioeconomic vulnerabilities, besides the exposure to the physical environment (Fussel, 2007; O'Neill et al., 2014).

In relation to Boston, Anguelovski et al. (2016) pointed out that the city has incentivized adaptation interventions focused on property protection and economic development agendas. By favoring the privatization of responsibilities, the authors claim that the city is also prioritizing rent-seeking behavior over the improvement of the city's infrastructure and public services. The Boston case shows that the institutionalization of adaptation through public–private partnerships or private networks can sometimes produce exclusionary practices. These practices highlight how certain elected representatives, agencies and advocates have played a powerful role in perpetuating dominant discourses of vulnerability by tacitly excluding disadvantaged groups from both the policy discussion and the benefits of the adaptation plans.

The global COVID-19 pandemic has, as of late July 2021, resulted in more than 195 million cases of the novel coronavirus and over 4 million deaths worldwide (Coronavirus Resource Center at John Hopkins University, 2021). In the United States, there have been approximately 34.5 million cases of COVID-19 and more than 609,000 deaths as of July 28, 2021 (Centers for Disease Control and Prevention, 2021a). COVID-19 was the third leading cause of death in the U.S. in 2020, behind heart disease and cancer (Centers for Disease Control and Prevention, 2021b). Indigenous, Black, and Latino racial groups have much higher age-adjusted mortality rates from COVID-19 than white and Asian groups (APM Research Lab, 2021; CDC, 2021b). The disproportionate impact of COVID-19 among low-income communities and communities of color may be explained not only by the increased presence of comorbidities such as obesity or diabetes, but also by sociodemographic characteristics that put certain populations at higher risk for infection. These include overcrowded housing, inadequate healthcare, reliance on public transit, multigenerational households, and employment in front-line and health service professions. These factors are associated with racial and class inequality and structural racism (Oppel et al., 2020; CDC, 2021c). Moreover, there is growing evidence that exposure to the coronavirus is exacerbating existing inequalities (Maxwell, 2020). These national trends have been observed for the Boston metropolitan area: underserved communities such as East Boston and Chelsea, with high concentrations of immigrant, undocumented, and low-income residents of color, have been especially hard-hit (Massachusetts General Hospital, 2020). Recent research has indicated that Boston communities affected the most by COVID-19 are also those most at risk for adverse impacts of climate change (Colarossi, 2020).

Housing unaffordability has been well documented as a threat to family and community well-being. Over 80 percent of low-income renter households in the U.S. are moderately cost-burdened (pay more than 30 percent of their income in rent) or severely cost-burdened (pay more than 50 percent of their income in rent); and about 46 percent of all renters are cost-burdened. Housing unaffordability results in families deferring important spending on food, healthcare, and other necessities (Harvard Joint Center for Housing Studies, 2020). Using the metric of 'housing wage,' or the hourly wage that would be required to afford a two-bedroom rental home, Massachusetts has the third-highest housing wage in the U.S. at $35.52. The Boston metropolitan

area has by far the highest housing wage within the state, at $44.44 (National Low-Income Housing Coalition, 2020).

The connections between housing unaffordability, climate change impacts and COVID-19 for low- and moderate-income communities and communities of color can be visualized in a dramatic way (Figure 1). Climate change, represented by extreme weather events, can result in health impacts, such as psychological distress and allergies and asthma exacerbated by climate change, as well as lack of public spaces to cool down during heat events; these impacts can increase vulnerability to COVID-19 infection. In turn, the COVID-19 pandemic has resulted in extreme health impacts as well as job loss. This financial insecurity amplifies a variety of financial cost burdens, such as using air conditioning for heat relief, and introduces housing

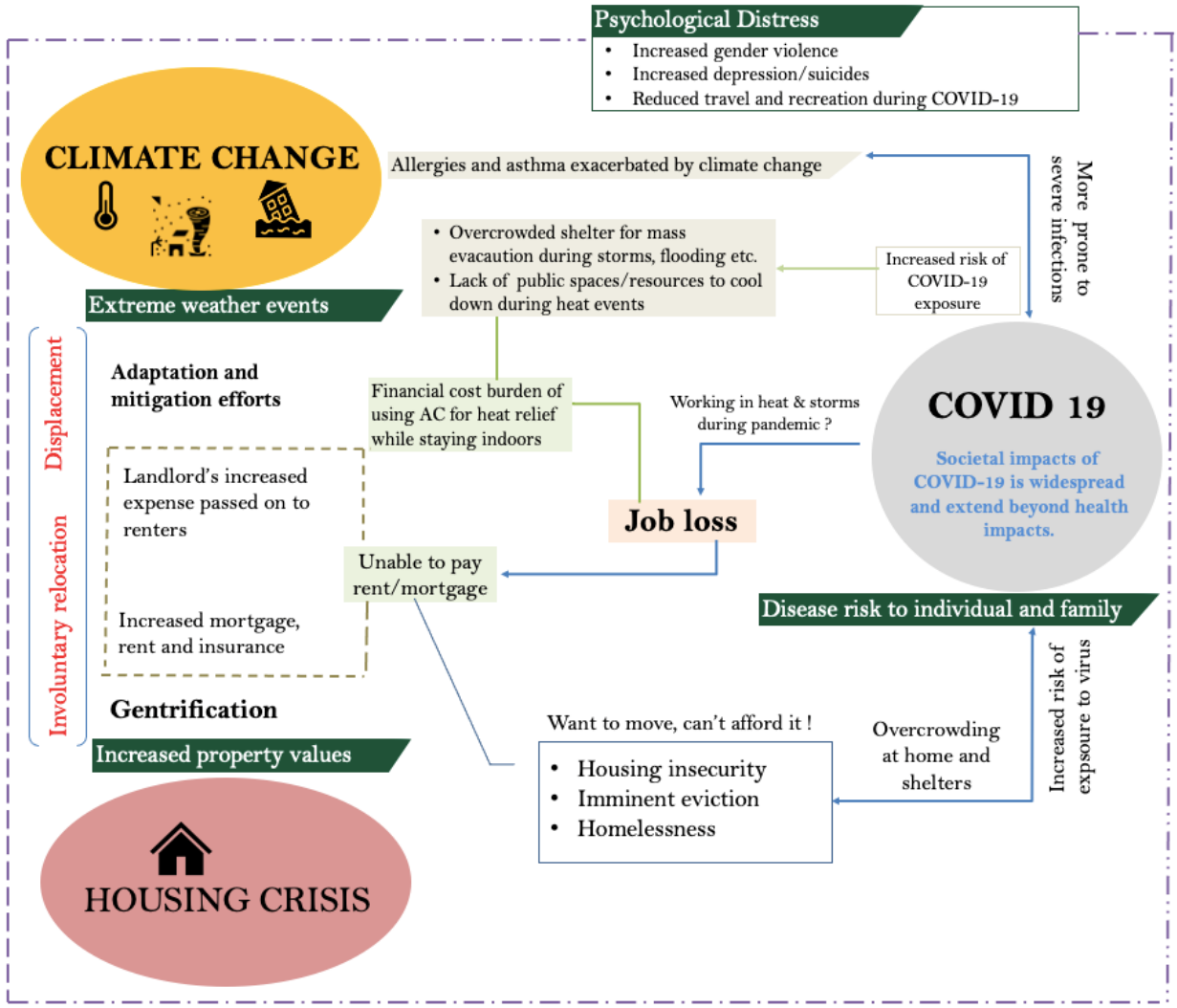


Figure 1: Connections between Housing Crisis, Climate Crisis and COVID-19 Pandemic

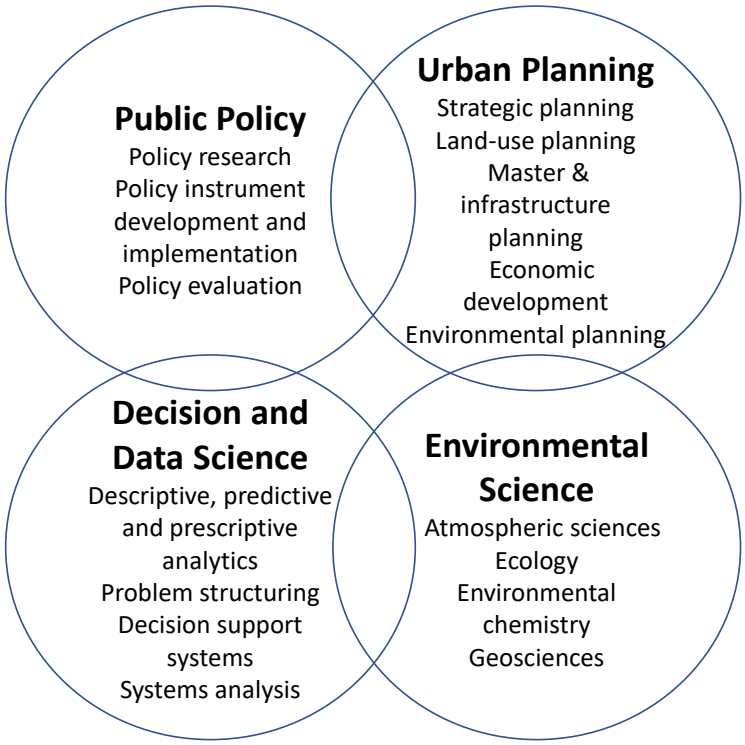
Source: Authors

insecurity that amplifies the effects of the ongoing housing crisis. This housing insecurity can take the form of reduced ability to pay housing costs and overcrowding resulting from COVID-19-related job losses, as well as adaptation and mitigation activities and gentrification-related activities by property owners that can increase housing costs and result in displacement.

These connections have been made clear to us during our field research, as we will describe below.

Transdisciplinarity

This research project brings together knowledge from multiple disciplines (Figure 2). From public policy, we apply tools of policy design, policy instrument development and implementation, and policy evaluation. Urban planning contributes methods from land-use planning, housing and real estate planning, infrastructure planning, and environmental planning.



[Figure 2: Connections between Disciplines]

Sources: ClearPoint Strategy (2020); Mackay and Shelton (undated)

Environmental science provides the basis for describing current and anticipated levels of impacts on the natural, built, and social environments of climate change, and the environmental effects of policy instruments and planning interventions. Decision and data science enable us to represent the values and priorities of stakeholders and to formulate problems whose solutions may address the housing and climate crises; to generate responses to the housing and climate crises that are feasible and Pareto-improving; to develop decision support systems to visualize and implement

solutions; and to use systems thinking to capture dynamic relationships between stakeholders, organizations, and phenomena.

Just as the climate, affordable housing, and COVID-19 crises are closely connected and reinforcing, the four disciplinary approaches listed above are as well. Urban planning initiatives and interventions to address the climate crisis and the housing crisis rely on evidence drawn from environmental science and public policy, respectively. Analytic methods from public policy benefit from the know-how of the decision sciences to provide specific, evidence-based guidance and operational prescriptions and systems by which to translate guidance and prescriptions into on-the-ground action. Insights from environmental science rely on public policy and urban planning to quantify impacts on various systems, organizations, and institutions.

In fact, our project to build a research agenda to address the housing and climate crises, as amplified by the COVID-19 crisis, can be described as a transdisciplinary endeavor. As characterized by Negron (2021), transdisciplinarity addresses complex questions of broad social concern through the integration of multiple disciplines and the development of new models and methods, where experiences and knowledge of non-experts is central to problem formulation and solution. One framework for transdisciplinarity is represented by a pyramid of inquiry and types of knowledge (Max-Neef, 2005; Spreng, 2014; Gaziulusoy and Boyle, 2013) that might be useful for our purposes.

Max-Neef (2005) suggested that knowledge should be organized around a hierarchical system composed by four disciplinary levels: the value, normative, pragmatic, and empirical levels (see Figure 3 below). The lowest level of this pyramid is represented by the empirical question of "what exists?" It is at this level where different disciplines such as physics, chemistry, sociology, or economics, among other disciplines, can be used to describe and understand a system itself or the behavior of any processes in the system. For example, we use physics to understand the basis behind climate systems regulation or chemistry to understand how greenhouse gasses are emitted and how to increase their abatement. We can also use sociology to understand how the distribution of social groups across residential locations is affected by social structures and processes.

The next level is represented by the pragmatic question of "what are we capable of doing?", which relates to technological disciplines and helps us understand the feasibility of potential interventions by using or combining the disciplines of the first level, or what we have learned from the empirical level. At this level, we see disciplines like engineering or architecture that can be used by policy instruments enabling initiatives such as retrofitting houses, designing solutions for flooding and heat events, implementing site improvements, switching to renewable energy sources, etc. The knowledge acquired at the bottom two levels (empirical and pragmatic) provides the empirical information necessary to understand the phenomenon and situations, known as *System Knowledge* (Hirsch Hadorn et al., 2006; Gaziulusoy and Boyle, 2013).

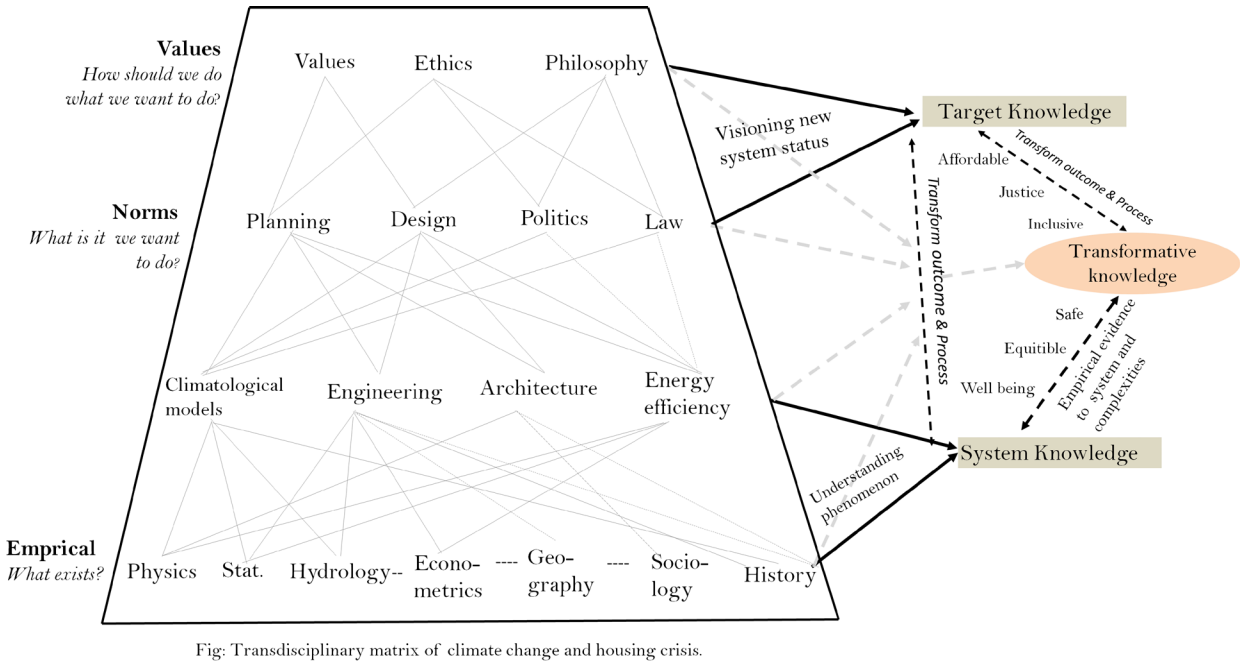


Fig: Transdisciplinary matrix of climate change and housing crisis.

Figure 3: Transdisciplinary Pyramid of Inquiry

Sources: Max-Neef (2005); Gaziulusoy and Boyle (2012); authors.
Note: Not all the disciplines across climate change and housing study domains are presented in the transdisciplinary matrix.

The next disciplinary level answers the normative question of "what is that which we want to do?" Disciplines at this level are generally validated by different stakeholders. For this research, the actions or interventions that are the subject of study consist of policies, plans, or laws demanding mitigation or adaptation actions to address climate change. The higher level of the pyramid answers the question "how should we do what we want to do?" and must be in line with the values or ethics we acknowledge as a society. The knowledge obtained from these normative and value levels involves visioning a new system status termed as *Target Knowledge* (Hirsch Hadorn et al., 2006; Gaziulusoy and Boyle, 2013). For our purposes, we seek insights at this highest level: if the leading value of policies and plans becomes addressing the impacts of climate change to also improve the wellbeing of those who are at the intersection of and being affected by different impacts of the housing and climate crises, then that would really mean that our actions are putting the excluded or marginalized communities at the center, and the resulting interventions should not promote more inequality and displacement.

Research project design

The mission of the larger research project that has inspired this paper is to build a collection of policy responses to the twin crises of climate change and housing insecurity, especially as they affect urbanized low-income communities and communities of color. Core priorities include: community-level interventions and localized impact; sustained and meaningful engagement with

stakeholders who are disproportionately harmed by the climate and housing crises; visualization and communication of tradeoffs across time scales, geography, and affected groups; and recognition of imbalances of power, influence, and resources. Planned project activities include problem structuring at all problem stages and inclusive policy analysis. Proposed policy responses would address the current COVID-19 pandemic that amplifies historical inequities and requires a re-thinking of traditional social investment priorities. The project uses scientific knowledge about the climate and housing crises to ensure that proposed responses are meaningful and feasible. The first phase of this project that this paper documents is *problem structuring*, that is, data collection, analysis, and reflection to articulate a research agenda that will support inquiry over multiple years. This research agenda is based on findings identified from a literature review and field research; these findings correspond to a wide range of themes and observations and inspire many promising areas of future inquiry. These findings and future research areas have motivated the formulation of a select set of research questions that provide a frame for inquiry that crosses disciplinary boundaries, embraces qualitative and quantitative data and analytic methods, and are of interest to scholars and practitioners.

We have performed three types of problem structuring activities. We conducted key informant interviews between November 2019 – February 2020 and November – December 2020 with practitioners, scholars, and advocates. We reviewed the literature on urban impacts of climate change, particularly on housing. Finally, we conducted public-facing activities: a 'town hall' to learn from community members their experiences with the housing and climate crisis and a 'convening' of scholars and practitioners to better understand best practices and cutting-edge research on the twin crises of climate change and housing unaffordability.

The initial set of key informant interviews were done to better situate our research project in the wider community of climate adaptation research, to identify local experts, and to frame our literature review. The July 2020 town hall, conceived earlier that year as an in-person event but conducted virtually due to the COVID-19 pandemic, attracted 54 participants. It opened our eyes to the experiences of residents of Boston's low-income and communities of color who face persistent risks to housing stability and health from housing unaffordability and gentrification. In addition, it revealed to us the challenges of engaging residents whose lived experiences do not always align with the priorities of advocates and researchers in the climate space who may convey a sense of longer-term and more-strategic thinking and technocratic terms in their communication. Table 1 shows a list of activities performed at the town hall.

Introduction, Director, Sustainable Solutions Lab
Introduction from Michael Johnson
Introduction to Residents' Stories, Director, City Life/Vida Urbana
Resident Story – Fair Lawn Apartments
Organization description, Work of Alternatives for Community and Environment (ACE)
Resident Story – Vine Street Community Center Board Member
Introduction to Breakout Groups, Director, City of Boston Housing Innovation Lab
Breakout groups
Facilitated report back from breakout groups, Associate Executive Director, GreenRoots
Closing

Table 1: Town Hall Activities

The August 2020 convening brought together 33 experts from advocacy, planning, community, government, academic and funding organizations to discuss policy responses to the climate change and housing crises. This one-day event was intended to identify new ways of framing and asking questions, discover dimensions that we had not explored and learn how policy instruments were applied. Table 2 is the list of organizational affiliations of convening participants.

Alternatives for Community and Environment	Goulston & Storrs
Barr Foundation	GreenRoots
Boston Green Ribbon Commission	Groundwork USA
Boston Housing Authority	Housing Innovation Lab
Boston Planning and Development Agency	Innovation Network for Communities
Boston University	Lincoln Institute of Land Policy
Cambridge Public Schools	Mass Climate Action Network
Chinatown Community Land Trust	MDS/Miller Dyer Spears Inc.
Chinese Progressive Association	Natural Resources Defense Council
City Life/Vida Urbana	New Ecology, Inc.
City of Boston Environment Department	Sasaki
Climate Ready Boston	The Boston Foundation
Codman Square Neighborhood Development Corporation	The Greenlining Institute
Department of Urban Studies and Planning, Massachusetts Institute of Technology	The Herman and Frieda L. Miller Foundation
Enterprise Community Partners, Inc.	The Hyams Foundation
Fairmount/Indigo Collaborative	Urban Land Institute

Table 2: Convening Participant Organizations

After the convening, we conducted six more key informant interviews with a range of community advocates and practitioners in the Boston area. These interviews were intended to help the research team learn more about specific projects intended to address the housing and

climate crisis, such as the Newton Northland and Cambridge Finch multifamily passive housing developments. They were also intended to reveal what, specifically, can make projects, programs and initiatives intended to address the housing and climate crises work, and what practical challenges practitioners face who implement housing projects intended to be affordable and climate resilient. Table 3 contains a list of second-round key informant interview participants.

Role & Organization	**Reason Interviewed**
Newton Resident, Environmental Advocate	Chair of an environmental advocacy organization involved in a large passive house residential development.
Director of Development, Affordable Housing Developer	Passive house developers that look to improve availability and quality of housing for low- and moderate-income residents.
Senior Vice President of Development, Affordable Housing Developer	Represents a developer of affordable housing.
Senior Program Officer, Community Development Financial Institutions (CDFI)	Manages a green retrofit program and resilient affordable housing grants.
Founding Principal, Green Building Consulting Firm	Consultant working in a large passive house residential development.
Project Manager, Green Building Consulting Firm	Spoke with during first round of interviews; expert who first mentioned to us the advantages of new mixes of policy instruments.

Table 3: Second-Phase Interview Participants

From September 2019 through January 2021, we revisited the research literature that underlies our project. This work has reinforced our understanding of the scholarly consensus on climate change, climate change impacts, definitions of climate change mitigation and adaptation, and best practices and current knowledge about the processes and impacts associated with climate change mitigation and adaptation.

Results

We will present the research insights that have emerged from our conversations with key informants, the town hall, the convening, and literature review in three phases. First, we identify findings that we have extracted from our data collection, grouped into categories, and amplified by recurring themes. Second, we discuss specific policy instruments that appear promising as building blocks for interventions in the communities of special interest to us. Last, we synthesize our learnings into three research questions that we believe provide substantial potential for academic findings and contributions to practice.

Findings

How to think about the housing and climate crisis

We found that **framing the housing and climate crisis, using language that captured the needs and interests of all stakeholders, and thinking about root causes was of significant interest to all stakeholders**. For example, we found that race and funding issues are common elements of the housing and climate crisis. This issue came up during the convening and was associated with themes of who is impacted / needs to be at the table, framing, and availability of resources and navigating institutions. One participant said about this, "Black and brown people, low-income people, undocumented folks, unhoused people, outdoor farm workers, people that are the most vulnerable need to be at the center." Said another, "So if we're not thinking about the root cause [systemic racism] and how we're trying to address root causes, then we're really going to just keep addressing symptoms that will continue to be exacerbated and persist."

Also from the convening, we observed **a lack of mutual understanding among advocates and practitioners, on the one hand, and researchers, on the other, regarding the nature and potential efficacy of policy instruments**. This was associated with themes of "framing" and "what is valued" and arose from our observations that conversations around the question of how to upgrade climate adaptation and mitigation-oriented instruments to also address the housing crisis resulted in more general discussions on the need for climate policy to serve both social and housing needs. While this social policy issue goes beyond the scope of this study, we believe it merits further attention. We also observed **limited attention paid to developing arguments that interventions that were justified on social policy or equity grounds might also be justified on cost-benefit grounds as well – an issue that also arose during key informant interviews.**

Conversations at the convening revealed **a lack of specific suggestions about how housing and climate crises are amplified by the COVID-19 crisis.** Convening participants did agree that equity and representation should be put at the center of housing and climate policy. One participant observed, "We have in this state, in this Commonwealth, a real lack of representation at the state legislature level in terms of the number of women, the number of people of color and the number of people who have lived experience in some of these housing and environmental issues."

During portions of the convening devoted to discussions of politics, we observed **an interest in education, collaboration, and political negotiation to create change**. One observer said, "So when you limit things to just Boston and you forget about not even inside the 128 belt but the Berkshires and the entire Commonwealth, then you don't share the burden and you don't share the responsibility. Boston can and should lead on some of these policies, but it has to be a bit more of a statewide approach as well." Finally, we learned from convening participants that **political organizing can change the discussion regarding which populations are 'deserving' of benefits associated with novel responses to the housing and climate crises.** This reflected the themes of community engagement and participation, who is impacted / needs to be at the table, political organizing, framing and what is valued.

How to work with and learn from vulnerable communities and build knowledge and capacity for change

Another set of findings, primarily from the town hall, placed focus on the importance of understanding the lived experiences of persons most affected by the climate and housing crisis and who we believe ought to take a leading role in building solutions to this crisis. For example, the words of community residents made clear to us **the distress that low- and moderate-income residents feel in living through a health pandemic and facing severe and chronic financial, housing and personal insecurity**. Residents spoke about having their rent increased, and how the stress caused by those increases, as well as increased utility bills from running air conditioners, was amplified by the stress associated with COVID-related confinement, especially for those with pre-existing conditions, such as chronic illnesses and depression. We also learned that **it is challenging to engage community residents in discussions about the housing and climate crises in language that is comfortable to them as distinct from the language that is natural to professionals and scholars**. We understood that there were more connections to be made between housing, climate, and COVID-19. However, we and the other participants were unsure of how to frame our questions to help residents make these connections. One option is to use other methods, such as community resource mapping,[1] ethnographic adaptations of photographic expression[2] and examinations of one's own body, known as 'body mapping' (e.g., Coetzee et al., 2019), that draw on lived experience and creativity to create "data." Related to this, we found that **authentic community engagement will require a mix of collaborations, co-learning, and technology that may support learning for action regarding the climate and housing crises**. This reflected themes of community engagement and participation, connectivity and social networks, capacity of community-based organizations, and what is valued.

Opportunities for designing novel interventions

Our last category of theme-motivated findings addressed primarily technical issues associated with developing policies, programs, and initiatives to jointly address the climate and housing crisis. Our primary finding in this respect, derived mostly from interviews, is that **technologies and community engagement mechanisms to support construction of climate-friendly housing with some affordable elements exist and have been used in multiple projects in the Boston area.** However, the social, political, and economic characteristics of these projects, and the communities in which they are situated, call into question the ease by which similar projects might be financially and politically feasible in less advantaged communities in the Boston area. Evidence for this comes from our extensive engagement with key informants involved with the Newton Northland mixed-use housing project. This project is distinguished for its passive housing and environmental remediation technologies; the creativity by which its supporters from the environmental sustainability and housing affordability camps joined forces; and supporters' determination to build evidence for the potential positive impacts of the project, and to gain support not only at City Council but also through a referendum. However, Newton, a highly educated and affluent suburban Boston community, has assets that may have ensured the

[1] http://www.ncset.org/publications/essentialtools/mapping/overview.asp
[2] https://photovoice.org

project's success that are not present in other, less advantaged Boston communities that are at greatest risk of impacts from the housing and climate crises.

We also found from our interviews that **the administrative, political, and financial hurdles to developing affordable and sustainable are substantial, and require complex coordination between communities, municipalities, and nonprofit organizations.** While the focus in our key informant interviews was on passive housing, there are many other types of sustainable housing strategies to be considered, such as proximity to transit and green infrastructure. One executive at an affordable housing developer said, "…I think we're just focused on housing and so I think we can spend a little bit more time on the resiliency stuff, but those groups have lots of other components in their community that they're trying to work on. Maybe that's why they're not as far ahead but I know they're as committed to try to get it done." Our key informants also emphasized that **mandates, local technical capacity, financial subsidies, and active local advocacy can generate genuinely affordable and climate-friendly housing – but it is rare to have all of these elements operating simultaneously and in a flexible manner**. This insight reflected many emerging themes, including tradeoffs between affordable and subsidized housing development; financial resources for housing that meets dual goals simultaneously; timing of funding acquisition; and technical and financial skills of housing developers.

From the convening, we observed **a lack of specific ways proposed by participants that climate policy might be influenced so that it puts housing stability for low- and moderate-income population of color at the center**. As stated by a nonprofit director, "So if the intention is to create a city where working class people are more than welcome but actually where there's support to stay in the city of Boston, then questions about retrofitting buildings becomes what can we do to create habitable, living standards that are more than just the bare minimum? Situating that inside an anti-displacement conversation, I think should be the thing that guides us." A discussion of policy instruments indicated **limited ideas on specific ways to upgrade climate adaptation and mitigation-oriented instruments to address the housing crisis, as well as few specific ideas on how to reach tenants as well as homeowners when developing programs for renovations and retrofits**. One staffer from an environmental advocacy organization stated, "So the things that we're trying to look at is what kind of tenant protections can be in place either within the energy programs themselves or just within the space of like looking at all of the various tenant protection tools from inclusionary zoning to just cause evictions."

Policy instruments

We discussed during the convening, but also during key informant interviews, particular policy instruments that appeared to be quite promising for addressing the housing and climate crises. A full list of policy instruments discussed is available in Johnson et al. 2021a, A.1.42 – A.1.46. In the category of analytics and decision support, we identified the CalEnviroScreen Mapping Tool[3] to recognize disadvantaged communities based on 20 indicators, representing categories of exposure, environmental effect, sensitive population, and socioeconomic status. In the category

[3] https://oehha.ca.gov/calenviroscreen

of regional climate and capacity-building, California's Regional Climate Collaborative Program[4] and the Washington State Office of Equity Task Force[5] were particularly promising.

There is also a wide range of funding and financing instruments. We discussed eight policy instruments related to funding and financing. Among these are California's Cap and Trade Program[6] that sets a statewide limit on greenhouse gas emissions and devotes 35% of funds derived from purchased allowances to vulnerable communities; Massachusetts's Community Preservation Act, in which communities tax themselves to make investments in housing;[7] and the Vancouver (Canada) Speculation Vacancy Tax,[8] in which properties lived in less than six months per year by the owner receive a special assessment. Finally, the convening discussed a range of policy interventions related to green building and retrofitting. These include the Triple-Decker Design Challenge,[9] a competition to generate replicable and scalable approaches for all-electric retrofits of the Boston region's iconic three-story multifamily buildings; and the Center for Smart Building Technology at Roxbury Community College,[10] a program launched in 2020 to train students to be certified technicians for smart building technology.

Research questions

As the goal of this project was to develop a research agenda to address the housing and climate crisis, we considered the themes, primary findings and details of existing policy instruments arising from our key informant interviews, town hall, convening and literature review in order to distill some directions for inquiry that hold promise for future study and real-world impact. The first set of questions arose from our realization that there might be substantial barriers to replicating or adapting successful efforts for affordable and sustainable multi-family developments in affluent and politically influential communities like Newton and Cambridge to meet the needs and resources of less affluent and politically influential communities in the Greater Boston area. In particular, we wondered if there might be indicators, or characteristics, of the communities of special interest to us – low- and moderate-income communities and communities of color, especially those in or close to the urban core – that could indicate if and how affordable and sustainable housing might be successfully built.

Research question 1:

What are the physical, social, and economic characteristics of communities that support successful implementation of climate-preparedness measures and investments in new developments? How might climate-preparedness measures and investments be designed to maximize the likelihood of adaptation across diverse communities? Are there distinctions between city of Boston neighborhoods and municipalities outside of Boston with respect to

[4] https://www.adaptationclearinghouse.org/resources/ca-sb-1072-regional-climate-collaborative-program-technicalassistance.html
[5] https://healthequity.wa.gov/TheCouncilsWork/OfficeofEquityTaskForceInformation
[6] https://www.c2es.org/content/california-cap-and-trade/
[7] https://www.communitypreservation.org
[8] https://www2.gov.bc.ca/gov/content/taxes/speculation-vacancytax/faq-speculation-and-vacancy-tax
[9] https://www.masscec.com/triple-decker-design-challenge
[10] https://www.rcc.mass.edu/banner/1140-enroll-today-in-our-smart-building-technology-program

receptiveness to affordable and climate-ready residential developments and housing-related infrastructure?

As shown in Table 4, these questions are perhaps most central to our problem structuring project, as it reflects themes that emerged across all of our data gathering activities and reflects potential for robust academic findings and practitioner impact. In this and the tables to follow describing our research questions, we distinguish between 'academic perspective', 'practitioner perspective' and 'associated themes' that put our research questions into context. Academic perspective refers to the methodology, or world-view that guides the inquiry, as well as analytic methods that may be used in specific studies. Practitioner perspective highlights viewpoints about specific research endeavors that are especially important to practitioners who seek tangible impact in communities. Associated themes refers to ideas and concepts that we identified as particularly salient in our key informant interviews, community town hall and climate convening. These are best understood as motivations for research, as opposed to settled fact.

We note that the Newton and Cambridge examples discussed earlier can be regarded as at least partially about reducing GHG emissions (mitigation), not just about housing better equipped to withstand climate change (adaptation). We emphasize adaptation here and have done so throughout this paper because our primary motivation is to develop interventions that address more immediate needs of excluded or marginalized communities to withstand negative impacts of climate change. Addressing this research question can use lessons drawn from the Capital Absorption Framework, by which cities and regions attract investment for affordable housing through a systems change approach that spans multiple communities, multiple financing plans and multiple sectors besides housing, such as healthy environments and quality education (Berlin 2017)

Research question (brief)	Academic perspective	Practitioner perspective
What community characteristics support successful implementation of residential development projects that are affordable and sustainable?	Causal explanation Multi-case study Mixed-methods study Transdisciplinary study	Guidance for community organizing, local organization capacity-building, project design and implementation
Associated Themes		
Affordable housing regulations Funding mechanisms Community engagement and participation Connectivity and social networks Who is impacted / needs to be at the table Government agencies Policy design and implementation strategies Zoning Presence and knowledge of community resources Digital divide Practitioners and advocates Capacity (of community-based organizations) Political organizing Climate preparedness interventions Framing What is valued		Policy instruments Housing insecurity Financial and emotional stress Climate and housing crises simultaneously Financial resources for housing that meets dual goals simultaneously Differences across municipalities Permitting process of Newton Northland development Incentivizing use of passive house technology Affordable housing is more climate efficient and also more expensive than market-rate housing Technical and financial skills of housing developers Big changes will require mandates, not only incentives LEED is not enough

Table 4: Research Question 1: Domain Perspectives and Associated Themes

The second research question arose from our awareness of the managerial, technical, and financial challenges associated with development of affordable and sustainable housing, and the ability of for-profit and nonprofit developers to use cutting-edge technologies and first-rate financing knowledge to enable new construction and renovation projects incorporating affordability and sustainability principles to succeed. However, we were struck by the notion that certain projects that might not be feasible according to the balance sheet – construction costs offset by loans, grants and rental revenues, and the like – did not reflect long-term and non-

monetary impacts accruing to residents and communities associated with affordable and sustainable housing. As explained by a practitioner who reviewed our preliminary findings, there is ambiguity in available methods to quantify benefits, which makes the benefit side of the equation less robust or more easily questioned and refuted, versus the relative simplicity of establishing the cost side of the equation. In place of cost-benefit arguments, there appears to be a trend towards determining best technically feasible outcomes, and then asking whether project, program or government budgets can sustain the cost of those outcomes or could be expanded to do so. It seemed to us that there might be an opportunity to adapt principles of social cost-benefit analysis to quantify important components of climate adaptation projects, especially benefits. This could enable developers, advocates, and government managers to develop a social policy rationale for projects that are innovative based on affordability and sustainability, especially in vulnerable communities.

Research question 2:

Can social benefit-cost analysis be used to quantify certain social and environmental impacts, especially over the longer term, in such a way that these projects might be more economically and politically attractive?

As shown in Table 5, this research question brings together concerns related to fundamental values (who is impacted / needs to be at the table), quantifying important considerations of the housing and climate crisis, and identifying tradeoffs between conflicting objectives that are associated with basic notions of social cost-benefit analysis, such as standing, shadow prices and distributional equity. These concerns have tangible impacts for practitioners, both builders and funders (who need to formally justify their proposals) and advocates and public servants (who need to justify public investments).

Research question (brief)	Academic perspective	Practitioner perspective
How can a social cost-benefit analysis quantify social and environmental impacts so that projects that are not financially feasible using conventional metrics can be attractive?	Interesting application of well-known analytic methods Empirical calculations using shadow prices could generate novel estimates of benefits and costs Use simulation for sensitivity analysis	Draw connections between academic theory (CBA), practice (business models and balance sheets), and politics (arguments that are persuasive to funders and policy makers)
Associated Themes		
Who is impacted / needs to be at the table Climate preparedness interventions Framing What is valued Housing insecurity Climate and housing crisis simultaneously	Tradeoffs between affordable and subsidized housing development Affordable housing is more climate efficient and also more expensive than market-rate housing Worthwhile projects may not be financially feasible or pass the benefit-cost test	

Table 5: Research Question 2: Domain Perspectives and Associated Themes

We note that the associated theme that affordable housing is more climate-efficient and also more expensive than market-rate housing reflects a current trend that we found from the convening and key informant interviews that may be the case when comparing new affordable housing to market-rate housing under current regulations.

The last research question arises from our realization that the problems that developers, planners and community developers solve daily to produce affordable and sustainable housing are technically quite demanding. They need to navigate a thicket of policies, procedures, regulations, and best practices in the field to decide how a certain project might be designed, sited, financed, and constructed. Since developments take a long time, it is possible that technologies for physical construction and construction management in use now, such as those for estimating construction costs or performing retrofitting, might be obsolete in a few years' time, while other technologies not feasible at present might enter common use in the future. Developers routinely manage a portfolio of projects, and they are likely to understand that different type of developments, of different sizes, technologies and affordability goals, might be more appropriate for some communities and particular locations within communities than others. Decision science, an applied engineering field dedicated to improving the theory and practice of decision-making, can assist practitioners to design, implement, and evaluate interventions that are intended to balance multiple technical and social objectives and which represent measurable improvements over the status quo (see e.g. INFORMS, 2021). Thus, new decision science applications could

enable stakeholders to jointly solve problems associated with urban affordable and sustainable housing. Indeed, Johnson et al. (2016) explored these issues in the context of the 2008 – 2012 foreclosure housing crisis as experienced across the Boston metropolitan area; Johnson et al. (2021b) explores similar issues in the context of shrinking cities and distressed communities.

Research question 3:

Problems associated with designing and implementing policy instruments to address the housing affordability and climate change crises have a number of common characteristics: technical complexity, competing priorities, uncertainty in social, economic and institutional environments, and long planning horizons, among others. How can analytic methods in decision science and spatial analysis that have successfully addressed problems such as these in different contexts yield insights relevant to community members, advocates and community-focused practitioners?

Table 6 indicates that research into the design and implementation of policy instruments involves multiple disciplines (urban planning, public policy, operations research and analytics), technical domains (decision science, data science, geographic information systems, policy analysis), addresses different tasks (data collection and analysis, decision modeling and decision support, community-engaged and data-informed problem structuring) and has importance for academic researchers and practitioners.

Research question (brief)	**Academic perspective**	**Practitioner perspective**
How can analytic methods be used to yield insights into designing policy instruments?	Tech domains (GIS and spatial analysis; analytics and data science; community-engaged operations research; policy analysis) can yield new models and methods	Tech domains can yield user-focused applications that generate actual time & cost savings and social benefits
Associated Themes		
Policy design and implementation strategies Policy instruments Tradeoffs between affordable and subsidized housing development	Financial resources for housing that meets dual goals simultaneously Timing of funding acquisition Differences across municipalities Technical and financial skills of housing developers	

Table 6: Research Question 3: Domain Perspectives and Associated Themes

We note that FHLBank Boston Affordable Housing Design Competition[11] and the MassCEC Passive House Design Challenge[12] represent ways to expand technical capacity and sharing knowledge to address this research question.

Discussion

Our study revealed some challenges in data collection and engagement with community collaborators. While our first set of key informant interviews were done in-person, due to the COVID-19 pandemic, all human subjects' data collection from March 2020 onwards was performed remotely, either online via videoconference or by cellphone. During the convening, we engaged participants to consider how we might influence climate policy so that it puts housing stability for low- and moderate-income populations of color at the center. While participants emphasized the need for impacted residents to be at the table, and the danger of climate adaptation strategies causing displacement, they provided few details of how climate policy discussions might be specifically influenced. We also did not learn as much as we wanted from participants regarding substantive differences that would make addressing the housing and climate crises simultaneously especially difficult. There appeared to be few specific suggestions on how we might upgrade climate adaptation and mitigation-oriented instruments to address the housing crisis as well. Finally, while participants agreed that equity should be at the center of ways to better align the priorities of housing and climate advocates, few examples were provided about how this might be done.[13]

The town hall event allowed us to hear and reflect on the voices of community members and community-based organizations who are on the front lines of the affordable housing and climate change crises. However, we suspect that the virtual format of this event prevented us from connecting as deeply as we would have liked with the lived experiences of community members, nor to understand how community capacity and expertise might be enhanced to provide essential local support for affordable and sustainable housing. We observed that some participants were very interested, but chose not to share, perhaps because they had the means to face challenges associated with the housing and climate crisis and the pandemic. Others who had first-hand experiences with the effects of the housing and climate crisis, as complicated by the pandemic, did not make as many connections between these phenomena as we had expected – even as the event took place on one of the hottest days of the year.[14] In choosing participants for future community-focused events, we will strive to connect those with a knowledge of systems and policy, who may also have privilege, with those that have a first-hand, lived experience but may not bring a systems-level understanding.

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[11] https://www.fhlbboston.com/fhlbank-boston/affordable-housing-competition#/

[12] https://www.masscec.com/emerging-initiatives/passive-house

[13] An informant notes an increasing awareness of the need for work at the intersection of climate, housing and jobs.

[14] This insight inspires yet another research question: how climate risks can be better communicated, for example, through public engagement strategies. This is a focus of current research sponsored by the Lincoln Institute of Land Policy (https://www.lincolninst.edu/research-data/toolkits/scenario-planning).

Our post-convening interviews generated valuable knowledge about affordable and sustainable housing development that we felt was not as well-known across the communities of developers, advocates, regulators, scholars and community-based organizations and residents as it should be. They confirmed our intuition from the convening that these stakeholder groups could benefit from a common storehouse of data, policy and planning findings and examples of interventions and instruments regarding what has worked, in what context – for example, the Newton Northland project in combining housing affordability and environmental sustainability in a particularly wealthy and politically-progressive community – and consequently what we don't know about what might work in other communities. One finding from the interviews is that a prominent source of opposition to the Newton Northland project came from less-affluent community members who felt put-upon by more privileged residents and who feared property value losses from the development. We infer from this that a deep understanding of community residents and social dynamics will be essential to respond to unexpected local sources of opposition to policy and planning interventions to address the housing and climate crisis.

Since most of our human subjects' data collection was done remotely, some nuance and a sense of personal connection may have been lost. However, we found our community partners unfailingly courteous, generous, and engaged during a trying time and one in which many of our partners may have faced great personal distress. We thank them for their commitment to and cooperation with our research effort.

Our study results identified multiple areas of future inquiry. These include:

- Defining what is meant by adaptation and mitigation solutions in housing, including in market-rate or private household contexts;
- Understanding how impacted groups think about and experience climate change and its interactions with housing unaffordability and health insecurity;
- The tension between community control and input over housing and climate programs that may reflect specific mandates or requirements;
- Best practices in other states regarding state-wide policies for affordable and sustainable housing that could be adapted for Massachusetts;
- Adapting procedures and technologies associated with rapid building retrofits to Boston;
- Building and maintaining social networks to protect excluded or marginalized populations from the adverse effects of the climate and housing crises;
- Resources that could enable community members to reduce the financial strain from the climate crisis and the pandemic;
- Identify cases of affordable housing developments or policies and how they specifically are not climate resilient;
- Green technology training programs as a way to support specific projects and broader social justice goals;
- Understanding how the issues of approving and building climate-friendly affordable housing different from the challenges of building affordable housing that may not necessarily climate-friendly;
- Power mapping to support community advocacy and coalition-building; and

- Extensions to widely-used analytic methods in cost-benefit analysis, data analytics, decision science and spatial decision support to devise new and adapt existing policy instruments to guide localized and community-engaged interventions.

Our research questions bridge social research and technological perspectives. The social perspective focuses on what is known, and what can be learned, about communities and institutions that are affected by and respond to the housing and climate crises, and the efficacy of various interventions. The technological perspective focuses on how to design and evaluate mechanisms, interventions and technologies associated with responses to the housing and climate crises. The first research question, addressing the community characteristics that might support successful implementation of residential development projects that are affordable and sustainable, will require an environmental scan, key informant and community interviews, and analysis of primary (field) as well as secondary (administrative) quantitative data on community characteristics, all using primarily conventional social science-based analytic methods. It will require experts in housing and community development, urban and environmental planning, and non-academic practitioners as well as researchers. It may accommodate a multi-case study, mixed-methods approach in which the cases could represent communities in the Boston area and outside Boston, as well as a multi-method, primarily quantitative approach using a diversity of data sources.

The second research question, addressing the design of a social cost-benefit analysis (Weimer and Vining, 2017) approach to residential development that is affordable and sustainable, would rely primarily on secondary quantitative analysis and analytic methods from the social and decision sciences. In particular, policy simulation (Desai, 2012) could generate insights into a range of net impact measures that reflect many different assumptions about uncertain futures and priorities placed on impacts upon various stakeholder groups. The perspectives of practitioners would be especially important to understand how analytic model results could influence a primarily political process by which social investments are determined. The last research question, addressing analytic methods that might yield insights into designing policy instruments, while also requiring methods from the social and decision sciences, is likely to lean somewhat more on technological domains that produce end-user focused applications such as spatial decision support systems (Jankowski and Nyerges, 2001) and public participatory geographic information systems (Brown and Kyttä, 2014; Ghose, 2017), and technologies such as scenario planning (Goodspeed, 2020) as well as expert-focused applications such as decision models to generate policy suggestions that address multiple decision periods, multiple objectives and uncertainty regarding key problem parameters (see e.g. Johnson et al., 2016). Simultaneously, this question will require authentic engagement with communities to ensure that the problems to be modeled and solved align with local priorities. This will require use of approaches associated with community-based operations research (Johnson, 2012) and community operational research (Johnson, Midgley & Chichirau, 2018).

Conclusion

Over the course of nearly two years, we have interviewed key informants and collected primary field data via one public-facing town hall event and another convening event directed at researchers and practitioners. Many interviews and both public-facing events were performed remotely due to the COVID-19 pandemic. We have conducted these activities in order to better understand the state-of-the-art, best practices and opportunities for new research in the space defined by the affordable housing crisis, the climate change crisis, and the COVID-19 pandemic, with a particular focus on policy and planning interventions intended to benefit low- and moderate-income communities and communities of color in urban neighborhoods and communities in the Boston metropolitan area.

Among our many findings are the following:

- We recognize a tension between 'sustainable housing' that is adapted/resilient to climate change and that which emphasizes contributions to climate mitigation. Our focus is on housing that leads with adaptation, with elements of mitigation as appropriate and feasible for the vulnerable communities that are the focus of this project.
- Technologies and community engagement mechanisms to support construction of climate-friendly housing with some affordable elements exist and have been used in multiple projects in the Boston area.
- However, the social, political and economic characteristics of these projects, and the communities in which they are situated, call into question the ease by which similar projects might be financially and politically feasible in less-advantaged communities in the Boston area.
- Administrative, political, and financial hurdles to developing affordable passive housing are substantial and require complex coordination between communities, municipalities and nonprofit organizations.
- Government mandates, local technical capacity, financial subsidies, and active local advocacy can generate genuinely affordable and climate-friendly housing – but it is rare to have all of these elements operating simultaneously and in a flexible manner.
- Low- and moderate-income residents feel intense distress from severe and chronic financial, housing, and personal insecurity, which has been amplified by the current pandemic.
- Understanding the extent and lived experiences of this distress requires engaging community residents in language that is comfortable to them as distinct from the language that is natural to professionals and scholars, is quite difficult. Authentic community engagement will require a mix of collaborations, analytic methods, co-learning and technology that may support learning for action regarding the climate and housing crises.
- There appears to be a lack of mutual understanding among advocates and practitioners, on the one hand, and researchers, on the other, regarding the nature and potential efficacy of policy instruments, and specific ways that climate policy can be influenced so that it puts housing stability for low- and moderate-income population of color at the center. A data or policy instruments repository might facilitate collaborations.

- Participant discussions about the framing of the twin problems of housing affordability and climate change have revealed that while racism and funding issues are common to these problems, there are not as many suggestions as to how to influence climate policy so that it puts housing stability for low- and moderate-income populations and people of color at the center, and how the two crises are amplified by the COVID-19 crisis.

These findings have resulted in a number of research questions that we believe may form the foundation for a research agenda that is *transdisciplinary* (bridging urban planning, public policy, environmental science and decision science), *mixed-methods* (qualitative and quantitative data collection and analysis), *critical*, *community-engaged* and *high-impact*. Three of these that appear to be of highest priority are:

1. What community characteristics support successful implementation of residential development projects that are affordable and sustainable?
2. How can a social cost-benefit analysis quantify social and environmental impacts so that projects that are not financially feasible using conventional metrics can be attractive?
3. How can analytic methods be used to yield insights into designing policy instruments?

We believe that an applied, community-engaged, transdisciplinary research agenda that is based on the findings in this report and inspired by these research questions can have several beneficial impacts. First, it can generate practitioner-focused knowledge that can improve how affordable and sustainable housing is built, where it is built, and which communities benefit from it. Second, it can generate scholarly knowledge that can expand our capability to do research in housing, community development and climate change, focused especially on marginalized populations in urban areas, that can enrich multiple disciplinary traditions. Third, it can enhance teaching and university-community partnerships by infusing real-life practice into the classroom and providing local institutions with a leadership role in community development and climate response in urban communities. We hope that this research program, which is quite preliminary, will involve academic and practitioner investigators from multiple disciplinary traditions; may serve as a bridge between primarily scientific and technological research that may benefit from a stronger connection to community perspectives; and may support community-facing advocacy and practice that may benefit from cutting-edge research and data.

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