BUILDING DECARBONIZATION ROADMAP: SUMMARY OF STRATEGIES

PRODUCED FOR THE UNITED STATES CLIMATE ALLIANCE

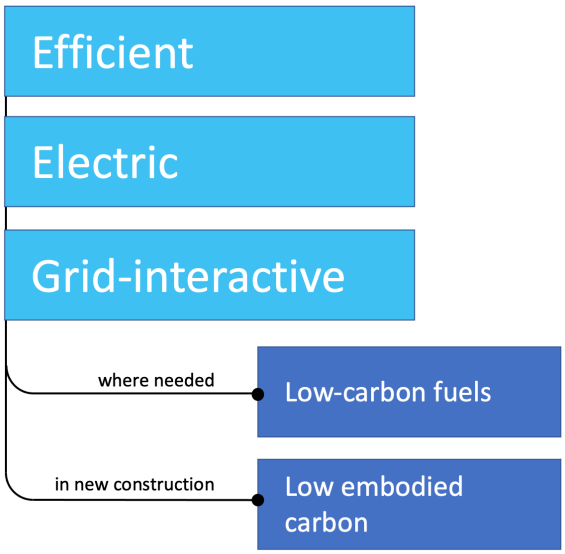
The United States Climate Alliance (USCA) commissioned RMI to produce the following Building Decarbonization Roadmap. It was prepared with guidance and significant contributions from the USCA Building Transformation Working Group, which includes staff from various state government agencies and offices. Not all states in the Alliance participated in this process. This Roadmap is not meant to represent a policy plan for the Alliance or any Alliance states but is rather a tool designed to summarize the highest-impact actions that states can take to decarbonize buildings.

OVERVIEW

Governors in the USCA have committed to implementing policies that advance the goals of the Paris Agreement, aiming to reduce greenhouse gas (GHG) emissions by at least 26%–28% below 2005 levels by 2025.[1] Representing more than 55% of the US population, 60% of the US gross domestic product, and just under 40% of US GHG emissions, these states and territories have the potential to drive substantial progress while helping lead the way for states and territories that are not USCA members.[2] This substantial impact necessitates attention and action, and it also brings with it a wide array of opportunities for decarbonization policy. Many of these policies are worth pursuing in their own right, emissions impacts aside, because of their benefits to human health, equity, economic development, resilience, and more.

This document summarizes the Building Decarbonization Roadmap produced for the United States Climate Alliance (USCA), aiming to provide policymakers with the key information needed to decarbonize the buildings sector, including an overview of the problem, the benefits of action, pathways to implementation, and key policy solutions. For additional information, see the Building Decarbonization Roadmap and the policy toolkit.

Exhibit 1: Key Principles of Building Decarbonization



Building sector decarbonization hinges on five core principles:

- **Efficient**: Ensure new buildings are designed and constructed to be highly efficient and that existing buildings realize deep efficiency benefits.
- **Electric**: Electrify fossil fuel-based end uses (e.g., space and water heating) where possible. Immediate opportunities in each state will differ based on available technology, economic feasibility, climate, and other context considerations. The benefits o electrification will continue to increase as the grid becomes cleaner.
- **Grid-interactive**: Enable grid-interactivity with appliances and energy management systems that can receive and respond to grid signals. Grid-interactive buildings can also serve as a distributed energy resource to minimize grid impacts, support variable renewable generation, and maximize consumer value.
- **Low-carbon fuels**: Determine the role of low-carbon fuels, which may support decarbonization of certain geographies or hard-to-electrify end uses.
- **Low embodied carbon:** Use low-carbon materials in new construction and major retrofits, and reuse carbon-intensive materials and structures where possible.

These strategies are high impact and applicable to any state interested in decarbonizing its building sector, with different variations possible for each strategy. In any case, by selecting policies customized to their needs, states can take advantage of the widespread opportunities for progress in the building sector to meet decarbonization goals and other policy objectives.

Key Strategies. Successful pathways to substantive building decarbonization require action around these first two strategies:

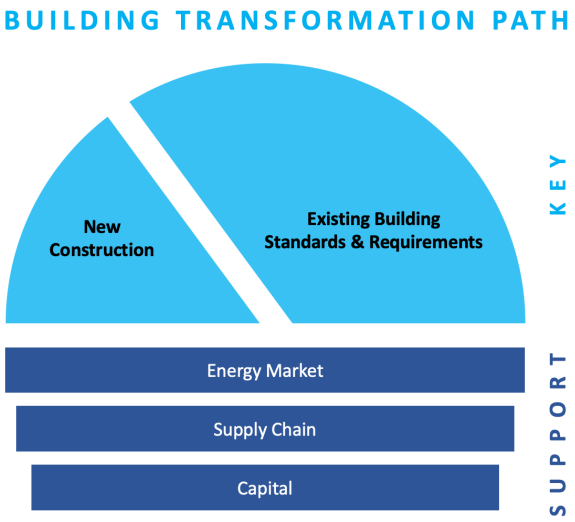
- **Fostering zero-carbon new construction** to ensure that new buildings support, rather than hinder, decarbonization efforts
- **Establishing building or equipment requirements** to decarbonize the existing building stock and building equipment

Supporting Strategies. These strategies include supporting, market-building policies that help accelerate decarbonization, and their implementation can be more varied and context-specific:

- **Transforming the energy market** to scale decarbonization
- **Strengthening the supply chain** to support low-carbon approaches
- **Expanding access to capital** to help remove barriers to low-carbon solutions

Exhibit 2 below summarizes these strategies in a hierarchy of implementation—the two key strategies are in light blue, and the three supporting strategies are below in dark blue.

Exhibit 2: Strategies for Building Decarbonization



These strategies are designed to be high impact and applicable to any state interested in decarbonizing its building sector, with variations possible for each strategy. In any case, by selecting policies customized to their needs, states can take advantage of the widespread opportunities for progress in the building sector to meet decarbonization goals and other policy objectives.

DECARBONIZING THE BUILDING SECTOR

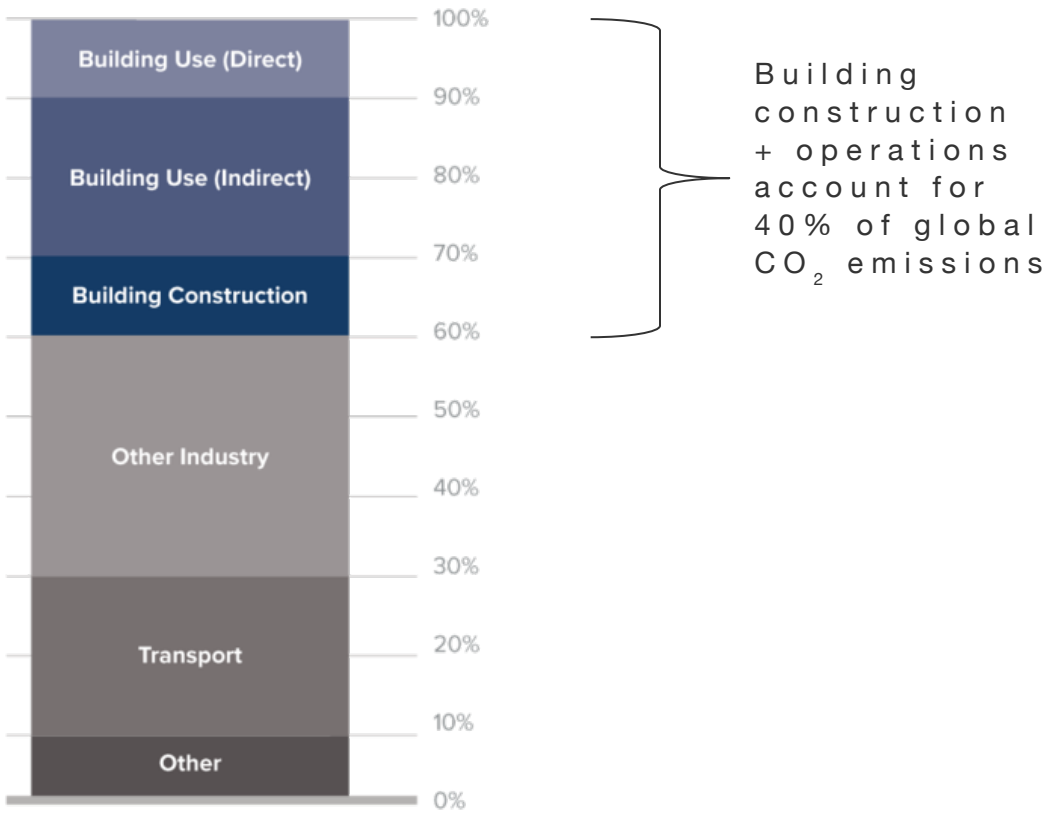
Greenhouse gas (GHG) emissions from buildings fall into several categories:

- **Operating emissions,** which come from building energy consumption and include:
  - **Direct (on-site) emissions**, which come from the burning of fossil fuels in buildings (e.g., emissions from gas water heating and propane space heating equipment).
  - **Indirect emissions**, which come from electricity consumed in buildings and include emissions from energy losses during electricity generation, transmission, and distribution.
- **Embodied emissions,** which represent the life cycle emissions associated with building materials—such as concrete, iron, and steel—from resource extraction to end-of-life
- **Refrigerant emissions**, attributable to commonly used refrigerants in refrigeration equipment; heating, ventilation, and air conditioning (HVAC) appliances; and heat pump water heaters (HPWHs) are potent GHGs and contribute to global warming when leaked into the atmosphere. Refrigerant emissions can be categorized as either direct or embodied emissions.

In the United States, indirect emissions represent roughly 60% of total annual building sector emissions, direct emissions represent about one quarter, and embodied emissions represent about one eighth.[3]

Buildings represent the largest single contributor to global carbon dioxide (CO_2) emissions: about 40%.
Exhibit 3 on the following page shows this contribution in detail. A dramatic reduction in global emissions will be difficult without a strong focus on reducing emissions from the building sector.

Exhibit 3: Global CO_2 Emissions by Source



SOURCE: IEA 2019

THE PROCESS OF DECARBONIZATION

Decarbonization of the built environment also means taking action to address emissions from both new construction and existing buildings.

New buildings: All new structures and equipment must be built to align with emissions targets and should be highly efficient and all-electric to the extent possible. About one-third of the building area that will exist globally in 2050 will be built between now and then.[4] Building carbon-intensive structures today is incompatible with the aggressive timeline required to limit warming to 1.5°C. Building inefficient buildings today would effectively "lock in" emissions far into the future. In other words, we should avoid constructing new buildings that will immediately require retrofits to meet climate goals.

All-electric construction can save money by avoiding the cost of gas infrastructure in buildings, and in some instances avoiding the costs of distribution lines in new developments, whereas existing dual-fueled buildings have already incurred the costs of gas pipelines and appliances. Some states may pursue a building sector decarbonization pathway that also includes low-carbon fuels, such as hydrogen or biomethane (i.e., purified biogas). As these fuel sources are likely to be expensive and limited in supply at the scale required to decarbonize the building sector, their use should most often be prioritized for hard-to-electrify sectors, such as industry and manufacturing.

Existing buildings: Minimizing emissions requires retrofitting the existing building stock. Given capital improvement cycles, most buildings will have only one opportunity for major retrofits before 2030, and policies should be designed to ensure that significant retrofits are aligned with climate goals.

THE BENEFITS OF ACTION

Fortunately, decarbonizing buildings is a strong investment, offering tremendous benefits that make it attractive independent of the need to avoid the climate crisis and its impacts. Other benefits include:

- **Supporting job creation and economic recovery and development**. Energy efficiency, renewable energy, and electrification all help create jobs. Investing in energy efficiency, for example, creates nearly three times more jobs per dollar than investing in the fossil fuel sector.[5] Decarbonizing the building stock will also require local labor; construction jobs cannot be outsourced in the same way that manufacturing or other sectors' jobs may be.
- **Improving health and safety**. Low-carbon buildings can help improve indoor environmental quality. For example, electrification can improve indoor air quality and reduce asthma, especially important during the COVID-19 pandemic and an issue that may disproportionately affect low- to moderate-income households.[6] All-electric buildings also eliminate the risk of carbon monoxide poisoning and reduce the risk of fires from combustion.
- **Enhancing equity.**
    - *Increasing energy affordability*. Efficiency and electrification programs can provide targeted support specifically for LMI households. LMI households face higher energy burdens and higher rates of energy insecurity than higher-income households.
    - *Investing in underserved housing*. Building sector transformations offer an opportunity to correct for historic institutional disinvestment in specific communities.
    - *Equitable workforce development*. States can provide accessible training and certifications to support a transition of the building sector. States can also create specific job opportunities for marginalized communities.
    - *Neighborhood stabilization*. By reducing energy burdens and health threats, building transformations can help stabilize existing neighborhoods and decrease mortgage foreclosures. [7]
    - *Addressing additional building issues*. Other building issues and remediation needs can be addressed alongside decarbonization efforts, including lead, mold, and structural or electrical issues. Some buildings may require these upgrades before other decarbonization solutions can be implemented.
- **Increasing resilience and security**. Energy efficiency upgrades such as insulation and other envelope improvements can help keep homeowners safe during extreme heat or cold weather and associated power outages.
- **Improving the condition and value of the building stock**. Upgrades improve the building stock as essential infrastructure for families and businesses. These upgrades act as investments in the future of the communities that they are in and create a foundation for other continued improvements.

PATHWAYS FOR IMPLEMENTATION

States can take action in the building sector through a number of pathways, each with different challenges and opportunities for impact. No type of action is necessarily better than another, but some have more resilience or more directly drive tangible emissions reductions than others. Some actions may fit into more than one category (e.g., an institutionalized action that establishes a plan). These five pathways are outlined in more detail below, with icons showing the typical level of impact of each pathway.

Institutionalized actions are legally enforceable steps that come through three main avenues:

- **Legislative action**: State legislatures can pass laws that establish commitments or require specific actions, codifying the actions beyond a single administration.
- **Regulatory action**:
    - **PUCs** can reform utility business models and require utilities to meet efficiency standards, offering penalties for noncompliance and rewards for strong performance.
    - **Energy codes** are adopted by states and local jurisdictions and are part of a package of codes that address the built environment (including fire, electrical, and structural codes). In some cases, state law automatically adopts the latest energy code, such as IECC. In others, states review options and determine a path forward.

- **Executive order**: Governors can set targets, establish programs, and create a number of other changes through an executive order though subsequent administrations could reverse orders if desired.

L M H ☐ **Programs** are administrative frameworks with dedicated staff and funding. Well-designed programs can provide a powerful leadership role to move the market, drive local government or utility action, and prompt larger-scale federal or regional change. Because funding sources and administrations change, programs may not be permanent.

L M ☐ ☐ **Internal operations** offer an opportunity to drive change within a state's own sizable portfolio of buildings. Often called "leading by example," this opportunity can involve demonstrating new solutions, showcasing best practices, developing local contractor experience regarding decarbonization solutions, or anchoring aggregate purchasing benefits that can enhance private sector action.

L ☐ ☐ ☐ **Planning** can take commitments toward more tangible action through, for example, a climate action plan or a decarbonization roadmap. Developing such a plan takes a target or a goal one step closer to impact, but it may still not result in near-term action.

L M ☐ ☐ **Commitments** can send a market signal and may require less effort to achieve than other pathways to action. However, a commitment without funding, planning, or legal enforcement may not result in tangible impact.

Considering the urgency of climate change, it is important to not view these policy options as sequential—moving, for example, from a commitment to a plan to a program. Whenever possible, these components should move forward in parallel to ensure expedient action and change. Plans and commitments should serve to lay the foundation for action rather than to delay it.

POLICY MENU

The many benefits of building decarbonization provide reason enough to take swift action, and states have a wide variety of policy options to achieve that decarbonization. Now is the time for state policy to pave the way to progress. The extensive menu of policy options shown below provides states with a variety of paths to suit each specific context and helps states realize these opportunities.

Exhibit 4: Policies for Building Decarbonization

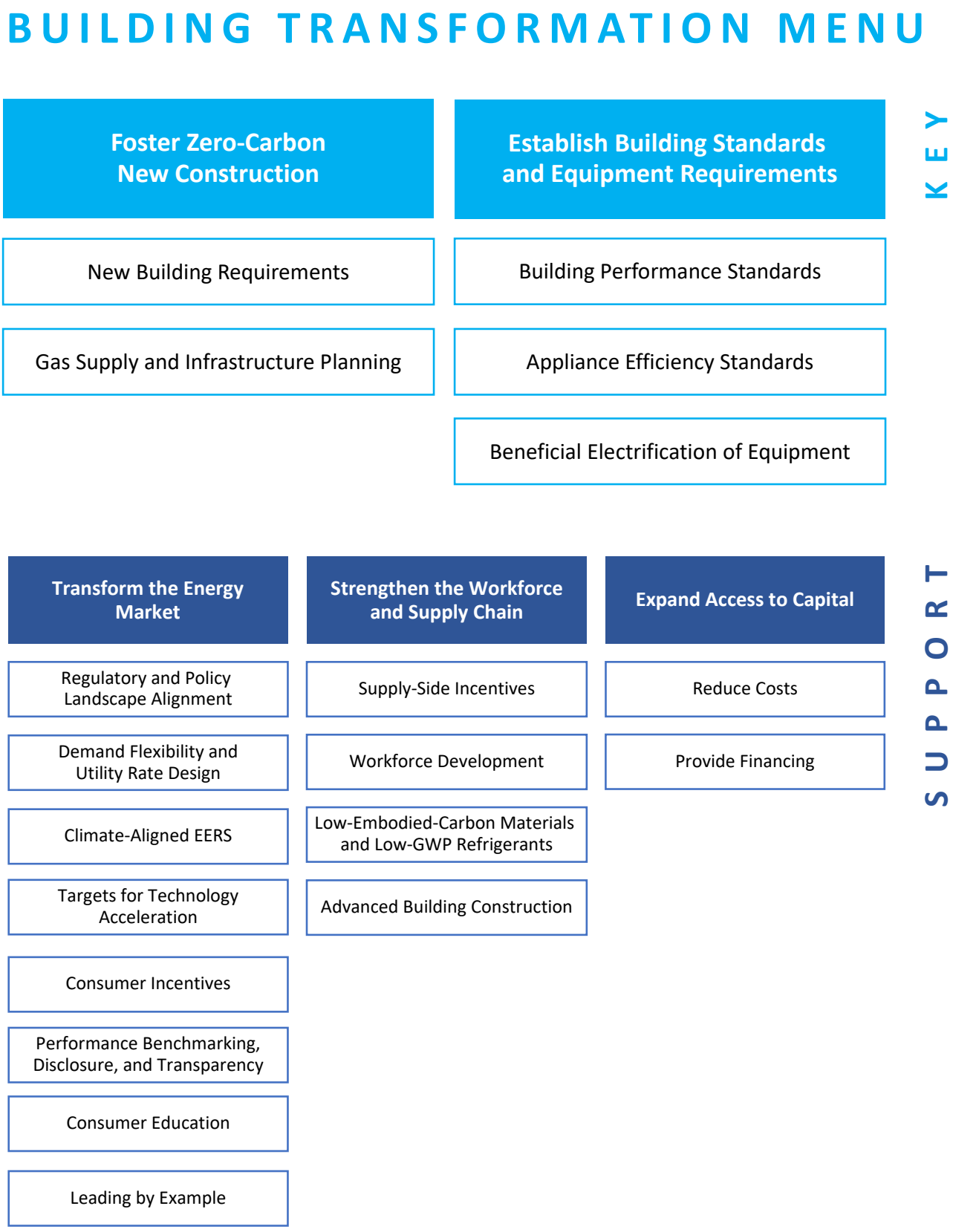


Exhibit 5: Policy Menu Options

Strategy	Action Options	Details
Foster Zero-Carbon New Construction	New Building Requirements	Ensure that all new residential and commercial construction, as well as major renovations and building additions, are built to a low-carbon standard.
	Gas Supply and Infrastructure Planning	Supports all-electric construction where appropriate and disincentivizes or limits the further buildout of the gas distribution system, avoiding costs down the line, while considering the role for alternative fuels where electrification is not possible.
Establish Building Standards and Equipment Requirements	Building Performance Standards	Set limits on energy or GHG emissions intensity for certain building types.
	Appliance Efficiency Standards	Reduce energy consumption in technologies such as furnaces, air conditioners, water heaters, and lighting.
	Beneficial Electrification of Equipment	Supports all-electric and efficient sales or installations of new equipment, with a particular focus on space and water heating equipment.
Transform the Energy Market	Regulatory and Policy Landscape Alignment	Encompasses removing barriers to fuel switching and rethinking efficiency incentives for fossil fuel devices.
	Utility Rate Design and Demand Flexibility	Helps to incent efficiency—capturing the full value of electrification, reducing negative grid impacts, and supporting variable renewables.
	Climate-Aligned Energy Efficiency Resource Standards (EERS)	Involves establishing EERS on the basis of total energy or avoided GHG emissions, rather than separately for gas and electric consumption, helping to align utility incentives.
	Targets for the Acceleration of Beneficial Technology	Send a powerful market signal and spur adoption of key technologies.
	Consumer Incentives	Speed uptake of technologies and practices, helping to transform the market by lowering effective costs and increasing consumer awareness.
	Building Performance Benchmarking, Disclosure, and Transparency	Involves measuring energy-related emissions and making that information accessible to arm key decision makers with the knowledge needed to reduce emissions.
	Consumer Education	Increases awareness of clean, efficient options and incentives available in the market.
	Leading by Example	Drives modest decarbonization by reducing emissions within state government buildings.
Strengthen the Supply Chain	Supply-Side Incentives	Provide financial mechanisms that motivate market actors; such as manufacturers, distributors, and contractors; to develop the market for low-carbon building technologies.
	Workforce Development	Ensures that everyone upstream of consumers understands the benefits of, and has the skills to deploy, low-carbon technologies and can effectively accelerate sector decarbonization.
	Low-Embodied Carbon Materials and Low-GWP Refrigerants	Complement declines in operational emissions by pursuing decarbonization through these two less-discussed avenues.
	Advanced Building Construction	Uses off-site manufacturing and other supply chain innovations to make building construction faster and cheaper.
Expand Access to Capital	Reducing Cost	Can occur through, for example, aggregate purchasing or by leveraging other funding sources.
	Providing Financing	Can occur through, for example, public investment, inclusive financing, or green banks.

ENDNOTES

[1] "Governors," United States Climate Alliance, accessed September 7, 2020, http://www.usclimatealliance.org/governors-1; "State Population Totals and Components of Change: 2010-2019," United States Census Bureau, December 30, 2019, https://www.census.gov/data/tables/time-series/demo/popest/2010s-state-total.html#par_textimage.

[2] "Governors," United States Climate Alliance, accessed September 7, 2020, http://www.usclimatealliance.org/governors-1; "State Population Totals and Components of Change: 2010-2019," United States Census Bureau, December 30, 2019, https://www.census.gov/data/tables/time-series/demo/popest/2010s-state-total.html#par_textimage.

[3] Preliminary RMI analysis. Direct and indirect emissions data come from the International Energy Agency, and embodied emissions data come from an Architecture 2030 internal analysis.

[4] "Why the Building Sector?" Architecture 2030, accessed September 3, 2020, https://architecture2030.org/buildings_problem_why/.

[5] Heidi Garrett-Peltier, "Green versus Brown: Comparing the Employment Impacts of Energy Efficiency, Renewable Energy, and Fossil Fuels Using an Input-Output Model," *Economic Modelling* 61 (Feb. 2017): 439–447, https://doi.org/10.1016/j.econmod.2016.11.012.

[6] "Income Before Taxes: Annual Expenditure Means, Shares, Standard Errors, and Coefficients of Variation, Consumer Expenditure Survey, 2018," Bureau of Labor Statistics, accessed September 3, 2020, https://www.bls.gov/cex/2018/combined/income.pdf; "Household Energy Insecurity, 2015," US Energy Information Agency, accessed September 3, 2020, https://www.eia.gov/consumption/residential/data/2015/hc/php/hc11.1.php; Brady Seals and Andee Krasner, "Health Effects from Gas Stove Pollution," Rocky Mountain Institute, Physicians for Social Responsibility, Mothers Out Front, and Sierra Club, 2020, https://rmi.org/insight/gas-stoves-pollution-health.

[7] Emily McLaughin, "Foster Green Investment: The Virtues of Energy-Efficient Building Upgrades," Institute for Market Transformation, July 30, 2018, accessed March 23, 2021, https://www.imt.org/foster-green-investments-the-virtues-of-energy-efficient-building-upgrades/.