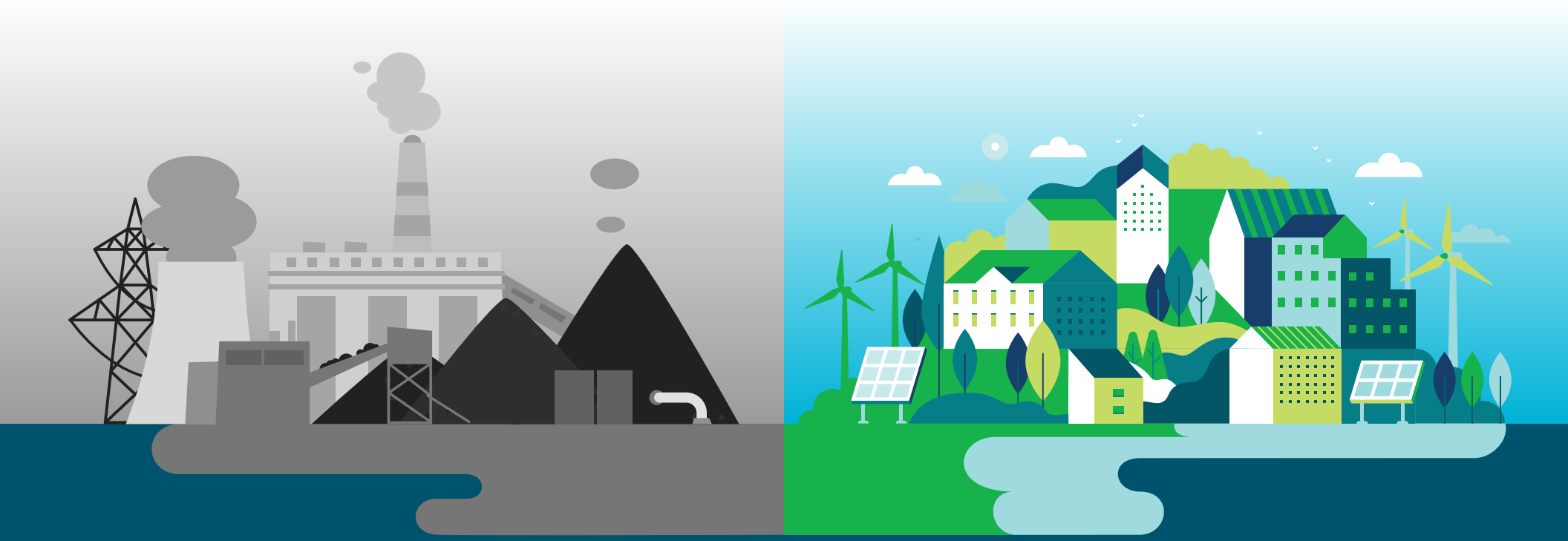

THE BUILDING DECARBONIZATION PRACTICE GUIDE

A Zero Carbon Future for the Built Environment

Google Microsoft ENERGY FOUNDATION UL AIA California WRNS STUDIO BUILDING DECARBONIZATION COALITION Guttmann & Blaevoet URBAN FABRICK WILLIAM J WORTHEN FOUNDATION

VOLUME 7:

Resources

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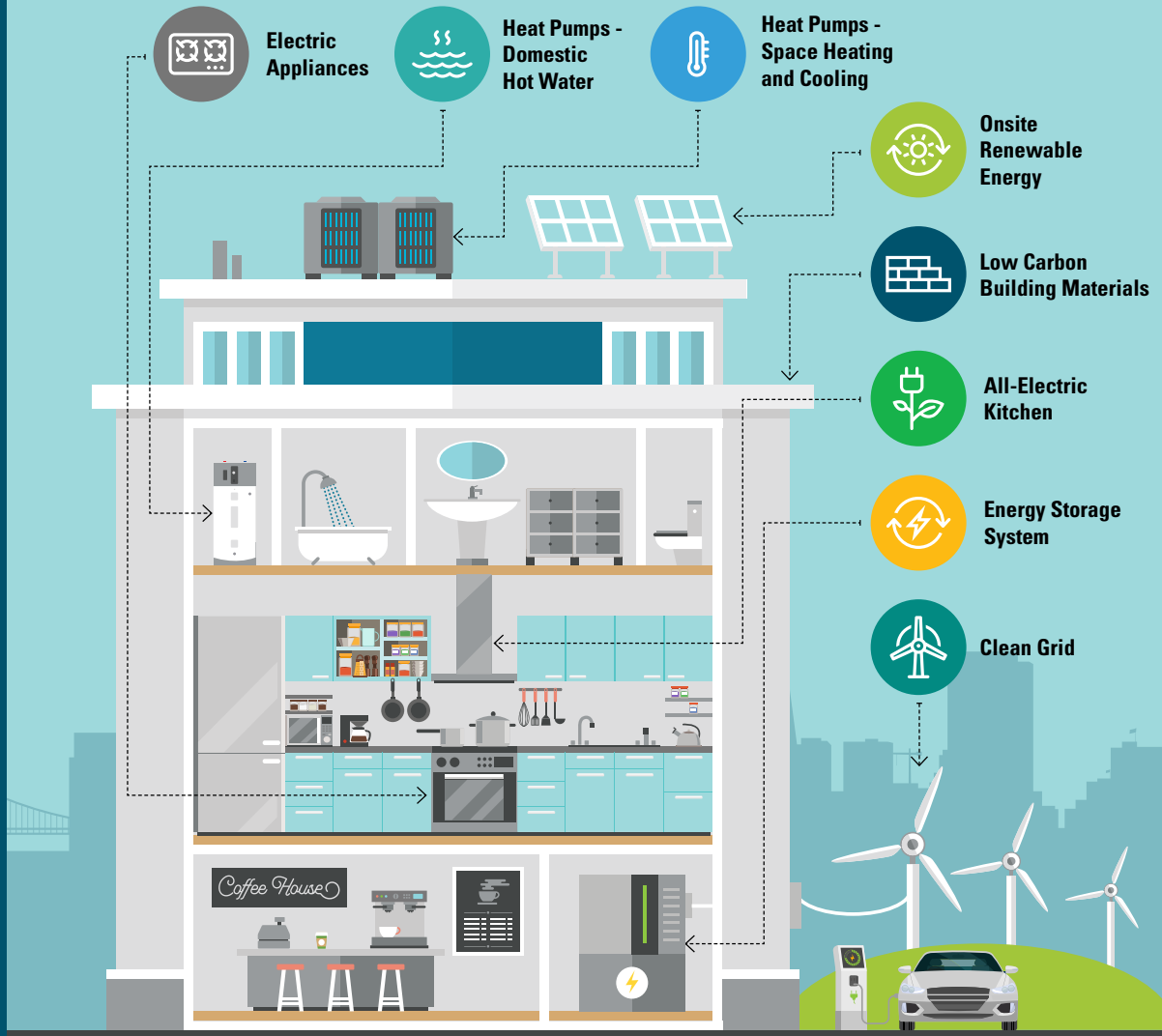

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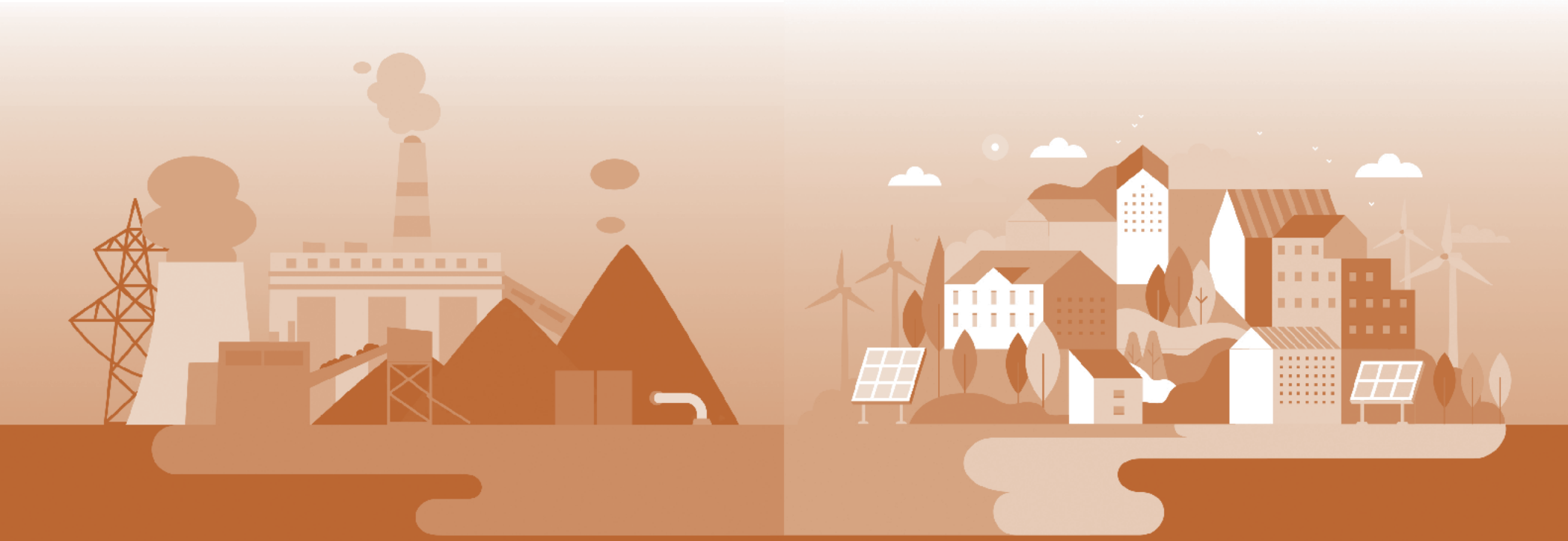

VOLUME 7

Resources

Resources in this Volume are organized by the topic areas covered in each Volume of the Building Decarbonization Practice Guide. Some are referenced in the footnotes, and others are simply resources that informed the content developed by the various working groups that contributed to this Guide. A few resources are referenced in multiple topic sections below, which allows readers to focus on their areas of interest without missing relevant resources.

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        i. SMUD Multifamily Retrofit (https://www.smud.org/en/Business-Solutions-and-Rebates/Business-Rebates/Multi-Family-go-electric-incentives)

        ii. SMUD All-Electric Smart Homes (New) (https://www.smud.org/en/Going-Green/Smart-Homes)

        iii. SMUD Appliance Rebates (https://www.smud.org/en/Rebates-and-Savings-Tips/Rebates-for-My-Home/Home-Appliances-and-Electronics-Rebates)

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    a. Culinary and maker spaces dedicated to sharing the excitement of electric kitchens with online events, chef experiences, videos and content:

        i. The Electric Kitchen Workshop, Monark Premium Appliance, San Francisco, CA (https://monarkhome.com/)

        ii. Other Monark Premium Appliance locations:

            - Santa Clara, San Rafael, Concord, and Rancho Cordova, CA
            - Reno, NV
            - Miami, Bonita Springs, Palm Beach, and Pompano, FL
            - Yale Appliance Dorchester, Framingham and Hanover MA (www.yaleappliance.com)

        iv. Miele USA Experience Centers:

            - San Francisco and Beverly Hills, CA
            - Boca Raton and Coral Gables, FL
            - Chicago, IL
            - Manhattan, NY
            - Princeton, NJ
            - Scottsdale, AZ
            - Seattle, WA
            - Tyson's Corner, VA

        v. Pirch Appliances (www.pirch.com)

            - Costa Mesa, Glendale, Palm Springs, La Jolla, and Solana Beach, CA

        vi. BSH Appliances Experience and Design Center (https://www.bosch-home.com/us/kitchen-planning-resources/showrooms)

            - Irvine, CA
            - Chicago, IL
            - New York, NY

        vii. Monogram Design Centers (www.monogram.com)

            - Chicago, IL
            - Denver, CO
            - Philadelphia, PA
            - Norwalk, CT

        viii. Fisher & Paykel Experience Center (https://www.fisherpaykel.com/ca/inspiration/experience-centres)

            - Costa Mesa, CA and New York, NY

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› Vallejo, CA

x. Purcell-Murray (www.purcellmurray.com)

› San Francisco, CA

xi. Riggs Distributing, Burlingame, CA (https://www.riggsdistributing.com/events/)

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7.6_Decarbonization Codes and Policies

As we attempted to develop a volume of content around codes and policy innovations in the decarbonization space, it became clear that the landscape is changing rapidly, and much of what we were writing became outdated before we were done. So, in an effort to make a meaningful contribution to the discussion of code and policy development, we are sharing the resources and some of the narrative that we developed to help governmental and non-governmental organizations make progress towards codifying their commitments to decarbonization.

We have also included resources developed by other organizations that outline the strategies they adopted as well as the justifications for their course of action. We hope these resources support your journey toward meeting the decarbonization responsibilities applicable to your organization's role in the built environment,

While this section of the Resources Volume does not have a corresponding volume in the Guide, we would like to give special thanks to Ted Tiffany from the Building Decarbonization Coalition for his diligent effort to develop enduring content for this volume of the Guide.

7.6.1_POLICY AND CODE CONTEXT

Climate change impacts are pushing local, state, and national governments, international organizations, and other governmental and non-governmental entities to drive action through policy and code adoption for decarbonization. In this section of the Resources Volume, we lay out some of the current efforts to decarbonize the built environment through codes, ordinances, corporate policies, and other levers that will shape the landscape of climate-responsible construction for years to come. Many of these levers are being used to shift the marketplace towards decarbonization, helped along by some innovative and transformational policies, including:

- Building codes
- Local energy/decarbonization ordinances
- GHG emissions targets
- Climate action plans
- Renewable portfolio standards and clean energy goals for utility providers
- Bans on new natural gas connections
- Air quality district standards
- Health & safety standards
- Fossil fuel system transition planning
- Transportation policies, including low carbon and alternative fuel standards
- Incentives, regulations, and standards for equipment and appliances
- Transition to low GWP refrigerants
- Reductions of embodied carbon in construction
- Carbon neutrality commitments
- Carbon pricing

The Center for Climate and Energy Solutions maintains a state-by-state database of governmental policy actions that are leading the effort to decarbonize the built environment.[1]

1 https://www.c2es.org/content/state-climate-policy/

7.6.2_ENERGY CODE COMPLIANCE AND THE CHALLENGES FOR ALL-ELECTRIC BUILDINGS

The primary goal of building electrification is to directly reduce operational carbon emissions. However, typical energy codes that govern new construction have focused on reductions in annual energy use. Most energy codes combine electricity and gas use into a baseline annual energy consumption target. For codes that use cost as a metric for compliance (e.g. any local or state Energy Code based on ASHRAE 90.1), this mixed-fuel baseline penalizes all-electric building designs.[2]

The traditional focus of Energy Codes on reducing energy cost will need to shift to metrics that are directly proportional to, or composed of, carbon emissions. And, as Codes and Standards evolve towards the inclusion of carbon metrics, the baselines used for comparison must also change to a low carbon building scenario, reflecting the carbon content of fuels — as well as time of use — in order to drive design decisions that support operational carbon emissions reduction goals. For example, The Zero Code™[3] has created a Time Dependent Source (TDS) energy metric that attempts to align with hourly grid carbon emissions. This kind of approach would allow energy use regulators to stay within their mandate of regulating energy, while still promoting operational carbon emission reductions.

Most states in the U.S. use some form of ASHRAE 90.1 as their Energy Code (often through adoption of the International Energy Conservation Code — the IECC — which references the ASHRAE Standard). The U.S. Department of Energy provides a good map for determining which model Energy Code each State has adopted as their State Energy Code.[4] While many states are using antiquated Energy Codes (there are at least six states still using the 2009 IECC, which references an even older version of ASHRAE 90.1), the State of Washington has adopted one of the most advanced codes with respect to the utilization of carbon emissions metrics. Their 2021 State Energy Code (effective July 1, 2023) utilizes an "HVAC Total System Performance Ratio," which is the ratio of the sum of a building's annual heating and cooling load in thousands of BTUs to the sum of annual carbon emissions in pounds from energy consumption of the building HVAC systems. This metric allows the State to evaluate the emissions "efficiency" of proposed building designs.

California has taken a different approach. The adoption of Time Dependent Valuation (TDV) metrics was established in 2005 in order to incentivize preferred times of use as a way of managing peak load. In 2022, the state adopted a dual compliance approach using both the TDV and the TDS metric which, like Washington State, will begin to measure carbon emissions reduction performance. At the same time, the California Energy Commission is working to enable building electrification technologies in the software used for compliance calculations as well as to establish changes to baselines to better evaluate all-electric building designs with respect to carbon emissions reductions.

Energy Codes are typically updated on a three-year cycle, which is not rapid enough to keep pace with the urgent timeline for significant decarbonization of the built environment. Further complicating matters, many jurisdictions do not keep their local or state Codes up to date with current model code revision cycles. Thus, owners and design teams that want to meet their project needs through all-electric building designs, as well as governmental entities that want to meet their decarbonization goals, must be aware that these designs are highly likely to encounter compliance challenges under existing energy codes. To avoid the overwhelming need for local jurisdictions to invent their own Code compliance pathways, national model codes — and the metrics and tools used to verify compliance — need to catch up to this new design paradigm. Meanwhile, organizations that are just beginning to make efforts to encourage decarbonization of the built environment through local ordinances and codes can take advantage of the policies and code changes already made by over 100 jurisdictions in the U.S. — many of them available in the resources listed below.

2 For further discussion of this, see Volume 2, section 2.5, "Using Building Performance Modeling as a Design Guidance Tool."

3 www.zero-code.org

4 https://www.energycodes.gov/state-portal

7.6.3_FOSSIL FUEL TRANSITION PLANNING

Any discussion of building decarbonization at scale needs to take into consideration the impacts of a declining ratepayer base on existing natural gas infrastructure.

Some local jurisdictions have implemented natural gas connection bans on new construction, while other states have pre-emptively restricted any local jurisdiction's ability to implement such policies: as of June 2023, twenty-four states, including Arizona, Texas, Oklahoma, Florida, Tennessee, and Kansas have adopted "preemption laws" that prohibit municipalities from banning natural gas.

None of these efforts address the critical need to plan transition strategies for funding the maintenance, replacement, and decommissioning costs of methane distribution systems. Without significant change, current rate structures will cause an ever dwindling number of users to carry an ever greater burden of the cost of new and existing methane infrastructure assets. This raises a large equity concern: the last users to electrify, which is likely to be the poorest ratepayers, will be unfairly burdened with the highest gas rates.

Utility rate design is a complex matter, best covered by other experts in this field. However, policy planners need to recognize that this is a critical area to address so that efforts to fully decarbonize the built environment can be both successful and equitable.

7.6.4_TRANSITION TO LOW GLOBAL WARMING POTENTIAL (GWP) REFRIGERANTS

The refrigerants that electrified equipment, such as heat pumps, use will be an important topic of discussion as regulators address the carbon emissions impact of our collective electrification and decarbonization efforts. The attractiveness of transitioning to low GWP refrigerants is complicated by the complexity of competing performance factors, such as flammability and reduced energy efficiency.[5] The unintentional leakage from field-constructed refrigerant piping systems is not currently regulated nor widely studied. Many state air quality regulators and other governmental stakeholder agencies are debating how to regulate the quantities of high GWP refrigerants that are presently being used, as well as methods to encourage, if not mandate, the use of low GWP refrigerants.

The Enhanced Refrigerant Management credit of LEED version 4[6] provides an incentive for reducing the quantities of refrigerant used, as well as promoting the use of refrigerants with low GWPs. However, this credit alone does not send a large enough market signal to deter the use of relatively energy efficient systems with large quantities of high GWP refrigerants — for example, Variable Refrigerant Variable Refrigerant Volume (VRV) or Variable Refrigerant Flow (VRF) systems that typically use large amounts of R410A refrigerant that has a GWP of over 2,088. One study completed in 2017 showed that almost 50% of LEED certified buildings did not earn the Enhanced Refrigerant Management credit.[7]

Who regulates these emissions, as well as the best way to balance the operational carbon and embodied carbon impacts of the building, needs attention.

5 For further discussion of this topic, see Volume 2, section 2.5.1.3.2, "Carbon Emissions Equivalent."

6 "Enhanced Refrigerant Management and LEED-NC V4 EA Credit 6," John M. Rattenbury, 2020 (https://pdhonline.com/courses/m496/m496content.pdf)

7 "Assessment of Energy Credits in LEED-Certified Buildings Based on Certification Levels and Project Ownership," Asli Pelin Gurgun et al., Buildings 2018, February 9, 2018 (https://www.mdpi.com/2075-5309/8/2/29)

7.6.5_EMBODIED CARBON

Outlined below are just a few examples of current governmental and non-governmental policy actions addressing the challenge of embodied carbon. The list is rapidly expanding as a result of growing recognition concerning the significant impacts of embodied carbon on total carbon emissions.

7.6.5.1_Embodied Carbon in Codes

The first building code focused on low embodied carbon was passed in Marin County, California in 2019. The code language adopted by Marin was developed by a stakeholder working group composed of manufacturers, structural engineers, architects, and others, working in collaboration with Bay Area city and county agencies, and with the support from the Bay Area Air Quality Management District. The limits proposed by the group used data from local manufacturers and local built projects to ensure that the limits are achievable and specific to Marin County.

The Marin County Code[8] includes two compliance pathways. The first pathway is prescriptive and sets limits on the total amount of Portland cement (measured in pounds) allowed per cubic yard of concrete. The second pathway is performance-based and requires either a concrete mix to meet embodied carbon quantity thresholds (kg CO_2e/m3) as verified by a product-specific Type III Environmental Product Declaration (EPD) or requires the total embodied carbon of all concrete mix designs within the same project to not exceed a project limit.

In August of 2023, the California Building Standards Commission adopted the first statewide embodied carbon requirements through Part 11 of the State's Building Codes, known as CALGreen. These new requirements will be enforced starting in July of 2024, and apply to new construction, remodels, and adaptations of existing commercial buildings over 100,000 square feet (or 50,000 square feet for schools). This action will impact some of the largest construction projects in California, and encourages the adaptive reuse of existing buildings.

Chapter 9 of the International Green Construction Code (based on the ANSI/ASHRAE/ICC/USGBC/IES Standard 189.1-2017, "Standard for the Design of High-Performance Green Buildings Except Low-Rise Residential Buildings") includes language for several requirements related to embodied carbon, including industry-wide or product-specific EPDs and the performance of a whole building life cycle assessment (LCA) during design.

Broadly speaking, certification and policy requirements address embodied carbon at the material/product level or at the building/project level. At the material/product level, the use of low carbon products are prioritized, reductions in the overall amount of products of concern are encouraged, or both. At the project level, the entirety of the project is considered with the goal of reducing embodied carbon as a whole. While both approaches are important, focusing on the material/product level may limit the amount of reduction achieved on a project. Broadening the focus to the entire project typically assures a greater amount of carbon reduction is achieved.

7.6.5.1.1_PROCUREMENT POLICIES

"Buy Clean" policies are a way to guarantee that products and materials used for public projects are spent responsibly, on materials that are manufactured in a cleaner, more efficient, environmentally-friendly manner. "Buy Clean" procurement policies have been adopted at the Federal Level, in at least four States thus far (California, Colorado, Oregon, and Minnesota), and at the municipal level (e.g., Portland and Los Angeles).

Buy Clean Colorado, which was signed into law in July 2021, will phase in EPD requirements and GWP limits for asphalt, cement, concrete, glass, steel, and wood on public building and transportation projects.

At the federal level, President Biden charged his Administration — through his December 2021 Federal Sustainability Plan and Executive Order 14057 — to launch a Federal Buy Clean Initiative to promote use of low-carbon, Made-in-America construction materials.

8 https://library.municode.com/ca/marin_county/codes/municipal_code?nodeId=TIT19MACOBUCO_CH19.07CACORE_19.07.020DE

A wide range of countries around the world practice some form of Green Public Procurement (GPP) to promote products and materials that are more environmentally friendly and have a lower energy or carbon footprint. The report "Curbing Carbon from Consumption: The Role of Green Public Procurement" looks at 30 such programs, 22 of which are from countries in Asia, Europe, North and South America, Africa, and Oceania.

7.6.5.1.2_ZONING AND LAND USE REGULATIONS

Zoning laws in the U.S. have a long, sordid history of doing more social harm than good. These laws have been misused to implement everything from racist, exclusionary red-lining policies to restrictions that create unreasonable barriers to residential development (and thus driving up housing prices).

However, when done well, zoning laws can make it easier for a community to implement its vision for a more sustainable future. For example, in order to receive a rezoning permit under the City of Vancouver's Green Buildings Policy for Rezoning,[9] design teams must submit an Embodied Carbon Design Report to demonstrate that the project is on track to meet the *Vancouver Building By-law's* life-cycle equivalent carbon dioxide emissions limits (i.e. global potential impact, or 'embodied carbon'). These limits are expected to be in force at the time of the project's first Building Permit application. Embodied carbon for each building, in $kgCO_2e/m2$, is calculated by a whole-building life-cycle assessment using standard assumptions according to the City of Vancouver Embodied Carbon Guidelines.

7.6.5.1.3_WASTE AND REUSE

Government policies also support the reuse of buildings and materials through construction waste management, deconstruction policies, or supporting local reuse centers and programs. Examples include:

- Los Angeles Adaptive Reuse Ordinance (https://www.ladbs.org/services/core-services/plan-check-permit/plan-check-permit-special-assistance/adaptive-reuse-projects)
- Houston Building Materials Reuse Warehouse (https://www.houstontx.gov/solidwaste/reuse.html)
- Portland Deconstruction Requirements for residential projects (https://www.portland.gov/bps/climate-action/decon/deconstruction-requirements)

For more information, see the C40 Cities Climate Leadership Group, C40 Knowledge Hub Implementation Guides, "How to start deconstructing and stop demolishing your city's buildings."[10]

7.6.5.2_Embodied Carbon Reduction Voluntary Standards and Commitments

There are multiple examples of green building rating systems that promote the reduction of embodied carbon. "The Embodied Carbon Review"[11] by One Click LCA identifies over 100 green building certifications that also include voluntary embodied carbon reporting and reduction requirements.

Under the U.S. Green Building Council's (USGBC) Leadership in Energy and Environmental Design (LEED) rating system, project teams can earn points for building reuse and for quantifying the embodied carbon of a project, as well as accruing additional points if the embodied carbon of a new building is reduced from a baseline. Project teams can also earn points for using products with EPDs or if products have demonstrated embodied carbon reductions relative to a baseline.

Under the International Living Future Institute's (ILFI) Living Building Challenge (LBC) and Zero Carbon certification, teams are required to quantify their project's embodied carbon and prove a reduction was achieved.

9 https://guidelines.vancouver.ca/policy-green-buildings-for-rezonings.pdf

10 https://www.c40knowledgehub.org/s/article/How-to-start-deconstructing-and-stop-demolishing-your-citys-buildings?language=en_US

11 https://buildingtransparency-live-87c7ea3ad4714-809eeaa.divio-media.com/filer_public/a6/60/a6600a77-4255-4549-bbb7-09c7a7069c54/wc_am-embodiedcarbonreview2018pdf.pdf

In addition to voluntary green building rating systems, there are a growing number of voluntary commitments targeting different stakeholder groups, such as the 2030 Challenge for Embodied Carbon, the C40 Clean Construction Declaration, the SE2050 Commitment Program for structural engineering firms, and the AIA Materials Pledge. For more information, see:

- The Carbon Leadership Forum's Embodied Carbon Policy Toolkit (https://carbonleadershipforum.org/clf-policy-toolkit/)
- SE 2050's document on Embodied Carbon in Green Rating Systems (https://se2050.org/resources-overview/embodied-carbon-in-green-rating-systems/)
- C40 Cities Clean Construction Forum (https://www.c40.org/what-we-do/scaling-up-climate-action/energy-and-buildings/clean-construction-forum/)
- C40 Cities Clean Construction Policy Explorer, where you can see policies pursued/adopted by cities in the network (https://www.c40knowledgehub.org/s/article/Clean-Construction-Policy-Explorer?language=en_US#:~:text=The%20Clean%20Construction%20Policy%20Explorer,as%20new%20policies%20are%20developed)
- Carbon Neutral Cities Alliance's Embodied Carbon Working Group, including their report, "City Policy Framework for Dramatically Reducing Embodied Carbon," published spring 2020 in partnership with Architecture 2030 and One Click LCA (https://www.embodiedcarbonpolicies.com/)
- The Pacific Coast Collaborative's initiatives, including the Low Carbon Construction Task Force (https://pacificcoastcollaborative.org/initiatives/)
- The AIA Materials Pledge (https://www.aia.org/pages/6351155-materials-pledge)
- The 2030 Challenge for Embodied Carbon (https://architecture2030.org/2030_challenges/embodied/)
- C40 Cities Net Zero Carbon Buildings Declaration (https://www.c40.org/accelerators/net-zero-carbon-buildings/)
- C40 Cities Clean Construction Declaration (https://www.c40.org/accelerators/clean-construction/), the signatories of which include Los Angeles and San Francisco in California, and international cities like Budapest, London, Mexico City, Milan, and Oslo. The following is included among the goals of the declaration:
  - "To ensure that our cities develop the net zero emission buildings and infrastructure of the future, we pledge to bring together and inspire stakeholders to take action, and enact policies and regulations where we have the powers to:
    - Reduce embodied emissions by at least 50% for all new buildings and major retrofits by 2030, striving for at least 30% by 2025;
    - Reduce embodied emissions by at least 50% of all infrastructure projects by 2030, striving for at least 30% by 2025;
    - Require zero emission construction machinery in municipal projects from 2025 and zero emission construction sites city-wide by 2030, where available."

7.6.5.3_Climate Action Plans

A growing number of climate action plans address embodied carbon. Every climate action plan is different, but embodied carbon typically falls into Buildings and/or Waste and Material Recovery. Examples of climate action plans that address embodied carbon include:

- **City of Austin Climate Equity Action Plan,** which includes a goal to reduce the embodied carbon of building materials used in local construction by 40% by 2030 from a 2020 baseline
- **Oakland 2030 Equitable Climate Action Plan (ECAP)**
- **The City of San Francisco's Climate Action Plan,** which has a Responsible Product & Consumption (RPC) strategy that aims to "achieve total carbon balance across the buildings and infrastructure sectors" and includes seven strategies for reducing embodied carbon, under a broader goal of reaching net zero GHG by 2050.
- **Eugene Community Climate Action Plan**
- **King County 2020 Strategic Climate Action Plan**

7.6.6_CORPORATE POLICIES

Globally, many corporations have recognized the need to reduce their climate change impacts. Some have established internal standards that set deep decarbonization goals for their emissions related to embodied carbon and operational carbon (including emissions from both building operations and business-related transportation).

Corporate commitments related to embodied carbon are typically focused on supply chain or Scope 3 GHG emissions. For an overview of corporate policies and commitments related to embodied carbon, see the Carbon Leadership Forum's "Embodied Carbon Toolkit for Building Owners"[12] or the World Business Council for Sustainable Development's report "Decarbonizing construction: Guidance for investors and developers to reduce embodied carbon."[13]

A few corporate policies are highlighted below.

Google[14]

In 2012, Google committed to a goal of purchasing enough renewable energy to match 100% of their operations. They achieved this goal in 2017. They reached this milestone through a combination of direct purchases from renewable developers and through partnerships with their utility providers to purchase renewable energy. This policy led the discussion past "annual net zero carbon" to ensuring that each hour of energy use was satisfied by carbon free power. As a result, Google is now working to achieve the much more challenging long-term goal of powering their operations on a region-specific, 24-7 basis with clean, zero-carbon energy. This long-term goal is being approached using three key strategies:

- Taking more of a regional strategy to renewable energy procurement and working to maximize the amount of renewable energy they buy in regions where they operate;
- Widening the technology lens to undertake projects and services that address the challenge of obtaining cost-effective clean energy on an hour-by-hour basis every day of the year;
- Working to promote policies that empower energy consumers and accelerate the transition to 100% clean energy–powered electricity grids in a way that makes sense for all energy customers.

12 https://carbonleadershipforum.org/clf-owner-toolkit/

13 https://www.wbcsd.org/Programs/Cities-and-Mobility/Sustainable-Cities/Transforming-the-Built-Environment/Decarbonization/Resources/Decarbonizing-construction-Guidance-for-investors-and-developers-to-reduce-embodied-carbon

14 https://static.googleusercontent.com/media/www.google.com/en//green/pdf/achieving-100-renewable-energy-purchasing-goal.pdf

Microsoft[15]

In 2020, Microsoft committed to being carbon negative by 2030 across all of its emissions categories (including Scope 3 emissions). Furthermore, by 2050 Microsoft has committed to removing from the environment all the carbon the company has emitted either directly or by electrical consumption since it was founded in 1975. It has already begun investing in carbon removal, a crucial step toward being carbon negative by 2030. They are focusing on four strategies to reach their 2030 commitment:

- **Reducing direct emissions:**
  - They will reduce Scope 1 and 2 emissions[16] to near zero by increasing energy efficiency, decarbonization, and reaching 100 percent renewable energy by 2025. Strategies to achieve these reductions include:
    - Building data centers for optimum power usage effectiveness,
    - Promoting grid stability via energy storage solutions,
    - Investing in one of the largest geoexchange fields in the United States as part of their Redmond Campus Modernization project,
    - Designing energy efficiency into their campuses:
      - All major projects will achieve LEED Gold or Platinum certification, ensuring high energy efficiency design, with additional energy efficiency improvement projects planned each year to drive down energy usage.
    - Developing hydrogen fuel cells for data centers:
      - Microsoft is demonstrating the application of green hydrogen at industrial scales with a first of its kind, zero emission, 3 MW hydrogen polymer electrolyte membrane (PEM) fuel cell back-up power generator piloted in July 2022.
    - Implementing all-electric kitchens in their dining operations,
    - Electrifying their global campus operations vehicle fleet of over 1,800 vehicles by 2030.
- **Reducing value chain emissions:**
  - By 2030, Microsoft aims to reduce their Scope 3 emissions by more than half from a 2020 baseline, by:
    - Increasing data quality from their supply chain,
    - Improving accounting methodologies,
    - Advancing lifecycle assessments for cloud providers,
    - Optimizing devices based on real-world data,
    - Improving efficiency to reduce the number of data centers,
    - Reducing embodied carbon in buildings and interiors,
    - Reimagining the circularity of cloud hardware,
    - Engineering carbon out of their cloud operations and hardware supply chain,
    - Boosting efficiency of device usage,

15 https://news.microsoft.com/2020/01/16/microsoft-announces-it-will-be-carbon-negative-by-2030/

16 https://ghgprotocol.org/sites/default/files/2022-12/FAQ.pdf

- Roadmapping their supply chain,
- Reducing emissions in their devices supply chain,
- Decarbonizing transportation,
- Advancing sustainable aviation.

» **Using only carbon-free energy:**

- Matching 100 percent of their electricity consumption with zero carbon energy purchases 100 percent of the time by 2030.
- Committing to environmental justice in carbon-free energy procurement:
  - Microsoft is in its third year of modeling approaches that link their carbon-free energy commitments with community-led clean energy and resiliency projects.
- Contributing to collective action to decarbonize the electric grid:
  - Through their involvement with Sustainable Energy for All (SE For All), an organization that works in partnership with the United Nations, Microsoft has committed to taking actions that drive toward decarbonization of electricity grids around the world to combat climate change.

» **Removing the rest of their emissions:**

- By 2030, Microsoft will remove more carbon than it emits. By 2050, the company intends to remove an amount of carbon equivalent to all their historical emissions.
- 2022 projects and results:
  - In FY22, Microsoft contracted 1,443,981 metric tons of carbon removal. They also made multi-year commitments to carbon removal. These projects will provide around 300,000 metric tons towards their greater than five million metric ton goal in 2030.[17] Projects include:
    - **CarbonFuture:** Together with Pacific Biochar, CarbonFuture is retooling lumber mills' bioenergy plants to produce more biochar compared to energy — a process which can be scaled across the mill's bioenergy fleet.
    - **Neustark:** Neustark is removing carbon within the Swiss concrete recycling industry by carbonating demolished concrete with carbon dioxide from biogas production.
    - **Acorn:** This program from Cooperative Rabobank UA assists in the transition to agroforestry systems in the tropics — including in Colombia, Ivory Coast, Nicaragua, and Peru — and is replicating that financing model in additional areas.

17 While the large-scale development and deployment of carbon removal technologies are considered critical to meeting ambitious international climate change targets, these technologies still largely remain in the research and development phase, or are not yet scaled up. Facilities built so far remove just a tiny fraction of the carbon dioxide that scientists say is necessary to make a difference. (https://time.com/6213489/remove-carbon-emissions-from-air/)

Kaiser Permanente Health Care[18]

Healthcare is one of the most carbon-intensive and climate-change-impacted sectors of the built environment. "Climate change and people's health are inextricably linked. As a health care organization we see the negative impacts and know we need to lead and act quickly," said Greg A. Adams, chair and chief executive officer of Kaiser Permanente. In 2022, Kaiser Permanente joined the U.S. Health and Human Services climate pledge,[19] which seeks to mobilize the health care sector to reduce greenhouse gas emissions. Kaiser aims to reach net-zero emissions by 2050.

The work toward reaching net-zero emissions requires Kaiser to go beyond removing carbon from their energy use and eliminating direct greenhouse gas emissions through both decarbonization retrofits and carbon offset purchases. Kaiser Permanente will also aim to address greenhouse gas emissions from purchased goods and services, investments, business-related travel and transportation, waste, and employee commuting. This net-zero commitment builds on Kaiser Permanente's partnership with the National Academy of Medicine's Action Collaborative on Decarbonizing the U.S. Health Sector[20] since its inception in 2021, as well as its support of Health Care Without Harm,[21] a nonprofit dedicated to building a low-carbon, resilient health care system.

University of California[22]

The University of California has long been a leader in sustainability policy development that many other institutions of higher education have followed. Since June 2019, new construction projects within the UC system have to be designed without natural gas connections for space and water heating. In addition, UC has set a target of 100% renewable electricity by 2025. Finally, while working to reduce the use of natural gas, they have also set an industry-leading target of 40% renewable natural gas by 2025 for remaining uses.

Georgia Tech[23]

Since 2020, Georgia Tech's Design & Construction standards require embodied carbon on all new ground-up projects as well as renovations that include exterior changes to be quantified and reduction opportunities evaluated throughout the design process. Since their standards seek to balance the desire to reduce embodied carbon with the goal to use materials that do not contain known environmental toxins (i.e., "healthy materials"), their standards do not set a specific embodied carbon reduction target.

18 https://about.kaiserpermanente.org/commitments-and-impact/healthy-communities/news/first-carbon-neutral-health-system-in-us

19 https://www.hhs.gov/about/news/2022/04/22/hhs-launches-pledge-initiative-mobilize-health-care-sector-reduce-emissions.html

20 https://nam.edu/programs/climate-change-and-human-health/action-collaborative-on-decarbonizing-the-u-s-health-sector/

21 https://noharm.org/

22 https://policy.ucop.edu/doc/3100155/SustainablePractices

23 http://facilities.gatech.edu/system/files/forms_files/yellowbook-2021-01-29-final_mmc.pdf

University of Michigan[24]

In 2021, the University of Michigan set the following carbon neutrality goals:

» By 2025

- Reduce Scope 1 and 2 greenhouse gas emissions by 50 percent;
- Reduce emissions from purchased power (Scope 2) to net zero;
- Establish reduction goals for a wide range of indirect emission sources (Scope 3).

» By 2040

- Eliminate direct, on-campus greenhouse gas emissions (Scope 1), which includes:
- Installing geothermal heating and cooling for some new construction projects (the first step in a phased transition of heating and cooling systems);
- Electrifying their bus fleet;
- Launching a revolving fund for energy efficiency projects, starting with $25 million over five years.

» Foster a university-wide culture of sustainability, with justice as a core principle.

7.6.7_INCENTIVES AND CARBON PRICING

As indicated at the beginning of this Volume, model energy codes are continually advancing in a national and international effort to drive down maximum allowable energy use. In order to move beyond Code (at least until zero GHG emissions is a code requirement), utility incentive programs will be necessary in order to continue to encourage owners to invest in technology and systems that lead the way towards decarbonization of the built environment. As we evolve from a "Zero Net Energy" mindset to a "Zero Net Carbon" one, incentive structures will need to change, evolving to develop market penetration for electrification technologies, grid harmonization approaches, and energy storage systems. Current incentives that encourage deep energy efficiency — often structured as performance "beyond code minimum" — will need to be restructured to address "Zero Net Carbon" goals.

Heat Pump Water Heaters (HPWHs) are an example of an electrification technology that has enormous potential for achieving the decarbonization of service water heating systems. Incentives for this technology should be prioritized for two key outcomes: 1) the fuel switching benefits (i.e., replacing a gas-fired water heater with an efficient electric-powered water heater), and 2) its grid harmonization benefits (i.e., reducing emissions by controlling the HPWH to operate when excess solar is available on the grid and then coasting when sources with high carbon emissions are supplying electricity).

A good resource for tracking incentives by State is provided by the Database of State Incentives for Renewables & Efficiency (DSIRE), hosted by North Carolina State University's NC Clean Energy Technology Center.[25] This site lists over 2,300 policies and programs throughout all 50 States. However, many policies and programs are still focused on energy efficiency rather than decarbonization. Programs that specifically promote decarbonization include:

24 https://president.umich.edu/initiatives-and-focus-areas/environment-sustainability-and-carbon-neutrality/

25 https://www.dsireusa.org/

» **TECH Clean California,** a statewide initiative to accelerate the adoption of clean space and water heating technology across California homes in order to help California meet its goal of being carbon-neutral by 2045. TECH incentives are now available for single-family HVAC projects and multi-family HVAC and HPWH projects throughout the state of California. Single-family HPWH incentives are still available in Southern California Gas territory.[26]

» **The California Building Initiative for Low-Emissions Development (BUILD) Program,** a residential building decarbonization program that provides incentives and technical assistance to support the adoption of advanced building design and all-electric technologies in new, low-income all-electric homes and multifamily buildings.[27]

And yet, the DSIRE database is incomplete and does not allow policies and programs to be filtered for a focus on decarbonization. For example, the programs administered by the Bay Area Regional Energy Network (BayREN) are not listed. BayREN is a coalition of the nine counties in the San Francisco Bay Area, partnering as a network of local governments to promote resource efficiency at the regional level, focusing on energy, water and greenhouse gas reduction.[28] So, for now, consumers and advocates need to work hard to tap all available resources for incentives focused on decarbonization.

The landmark Inflation Recovery Act of 2022 (IRA) is also an evolving source of funds for state and local governments to distribute in support of decarbonization. The IRA provides billions of dollars in incentives, grants and loans to support new infrastructure investments in the areas of clean energy, transportation and the environment.

26 https://switchison.org/contractors/incentive-resources/

27 https://www.energy.ca.gov/programs-and-topics/programs/building-initiative-low-emissions-development-program-build

28 https://www.bayren.org/hpwh

29 https://crsreports.congress.gov/product/pdf/R/R47262

30 https://www.nga.org/ira-resources/#:~:text=The%20Inflation%20Reduction%20Act%20(IRA,energy%2C%20transportation%20and%20the%20environment

31 https://www.ucsusa.org/resources/carbon-pricing-101

According to the Congressional Research Service:

> " The funding and financial incentives of [the] IRA could promote deployment of low- and no-GHG emission technologies beyond what would otherwise occur (i.e., in a "business-as-usual" baseline). This deployment would likely reduce or avoid some quantity of GHG emissions compared to baseline projections. A number of recent analyses by researchers generally estimate that under baseline conditions (i.e., without [the] IRA), U.S. GHG emissions would decrease by 24% to 35% by 2030 compared to 2005 levels. The same analyses estimated that [the] IRA could reduce U.S. GHG emissions by 32% to 40% by 2030 compared to 2005 levels."[29]

The National Governors Association has a website that provides a one-stop-shop for Governors' infrastructure, energy and environment advisors as they look to leverage infrastructure provisions in the IRA.[30]

Incentives for electrification technology should be paired with carbon pricing strategies that put financial pressure on the use of fossil fuels. As the Union of Concerned Scientists describes, "The aim is to put a price on carbon emissions — an actual monetary value — so that the costs of climate impacts and the opportunities for low-carbon energy options are better reflected in our production and consumption choices."[31]

Funds raised at the local, state, or national level can be used to invest in the transition to a fossil-fuel-free economy, including everything from infrastructure upgrades for our electricity distribution systems to transition assistance for workers displaced by the disinvestment in fossil-fuel production. Other transition funds can be found by repurposing dollars currently spent on subsidizing fossil-fuel extraction.

7.6.8_CONCLUSIONS

All of the available policy levers need to be used to address the total carbon impacts of our buildings. Codes, ordinances, standards and other policy actions need to influence reductions in embodied carbon, the allowable GWP of refrigerants used in building systems, and operational energy use. Individuals and organizations with direct influence over the built environment need to prioritize the use of building materials and systems that achieve true carbon neutrality by 2050 for all new and existing buildings as well as advocate for a grid that is supplied 100% by electricity from renewable sources. This is currently the only viable path towards a zero-carbon future for the built environment.

What are leading States doing?

While each state has its own priorities, the main strategies fall into the following categories:

- **Removing regulatory barriers that hinder electrification ("fuel switching"):** Rules that prevent or penalize incentive programs for replacing gas equipment with electric alternatives as well as metrics that penalize electrification — such as outdated source energy factors from when there was little or no renewables on the grid), need to be removed. These changes may require legislation or regulatory action by state public utilities and energy commissions. Other policy barriers include utility rate structures, subsidies for fossil fuel infrastructure, and rules requiring utilities to provide fossil gas services even when not needed. The requirement to provide both gas and power (aka "Obligation to Serve" requirements), which exist in a lot of regulated utility markets, prevents a utility from only providing electrical service even in cases where that service alone can meet all project requirements.
- **Developing markets for heat pump technologies:** In many areas where space heating and domestic hot water are dominated by gas appliances, electric alternatives are hard to find or cost more because there is a lack of designers and contractors who are familiar with the available products. Bids for installing heat pump systems often come in higher due to risk pricing, which happens when contractors face unfamiliar requirements. As such, incentive programs, pilots, and requirements for public buildings to lead the transition are necessary to build market capacity. Mandatory standards such as building codes can accelerate the building of market capacity and make electrification more cost-effective. Market development incentives are often easier to adopt but do not generally meet the speed at which decarbonization efforts need to scale up.
- **Establishing all-electric building codes:** Model building codes that remove barriers to all-electric building design, as well as those that prioritize decarbonization strategies, are readily available and can be adopted now. In most applications, the life cycle cost of all-electric new construction is cost-effective even without accounting for the social cost of carbon.[32] A study by the New Buildings Institute concludes that it is less expensive to construct an all-electric single family home than either a minimally code-compliant home or an electric-ready single family home.[33] There are no technical barriers to all-electric residential construction, and even in extremely cold climates (i.e., where winter design temperatures are below 0 deg. F) cost increases are relatively small for the implementation of appropriate cold climate strategies. Also, in areas where the residential market is dominated by relatively few, large firms, and production builders, it is easier to train the workforce on new construction practices.

32 "UC Carbon Neutral Buildings Cost Study," Point Energy Innovations, June 23, 2017.

33 "Cost Study of the Building Decarbonization Code," New Building Institute, April 2022. (https://newbuildings.org/resource/cost-study-of-the-building-decarbonization-code/)

» **Gas transition planning:** As sales of fossil gas decline due to the electrification of building systems, energy efficiency policies, and a warming climate, gas prices for remaining customers will escalate (see Figure 2.11 in Volume 2, "Universal Design, Construction, and Operational Phase Considerations"). Thoughtful and proactive planning to ensure that the gas transition is equitable and just is not only a moral imperative, it is also a political necessity for building the broad coalition required to transition at the pace and scale necessary to achieve science-based climate change mitigation goals.

> " If not addressed proactively, 'stranded' gas assets can complicate the effort to transition the state away from excessive reliance on gas and its incompatibility with California climate goals. At the core of these complications are potential reductions in overall utility investment, rate increases for remaining gas customers, which could unduly burden lower-income and other vulnerable communities and threaten equitable access to energy and the notion of equitable distribution of responsibility and burden amongst a variety of potentially competing stakeholders including current vs. future ratepayers, utility shareholders vs. ratepayers, high income vs. low income customers, and gas vs. electric utility ratepayers."[34]
>
> — **Environmental Defense Fund, *Managing the Transition — Proactive Solutions for Stranded Gas Asset Risk in California***

In addition, the pipefitters and other workers who build and maintain the gas network will need to be considered as they see declining employment opportunities. For example, policies and incentives that expand district thermal energy networks can help replace lost jobs for some of the existing gas distribution pipeline workforce.

34 https://www.edf.org/sites/default/files/documents/Managing_the_Transition_new.pdf

The various policy tools to achieve a fully decarbonized outcome for the built environment are evolving quickly, but they are all aligned towards the same imperatives: to deliver a world where every building is all-electric powered by 100% renewable energy on the grid, and construction practices reduce — if not entirely eliminate — embodied carbon.

It is time for all governmental and non-governmental organizations to align policy actions with these imperatives so that we meet the distinct challenge of delivering a decarbonized society within a single generation.

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The Building Decarbonization Coalition unites building industry stakeholders with energy providers, environmental organizations and local governments to help electrify California's homes and work spaces with clean energy. Through research, policy development, and consumer inspiration, the BDC is pursuing fast, fair action to accelerate the development of zero-emission homes and buildings that will help California cut one of its largest sources of climate pollution, while creating safe, healthy and affordable communities. The Project Team gives special thanks to the BDC for its leadership in this endeavor and for the generous support of its Membership.

Contributors

Building Decarbonization Practice Guide Content Leadership

- **Panama Bartholomy,** Building Decarbonization Coalition
- **Rachelle Boucher,** Kitchens to Life
- **Glenn Friedman,** PE, FASHRAE, Taylor Engineers
- **Christopher Galarza,** Forward Dining Solutions
- **Miranda Gardiner,** AIA, iMasons Climate Accord
- **Steven Guttmann,** PE, BCxP, LEED Fellow, Guttmann & Blaevoet
- **Teresa Jan,** AIA, LEED AP, WELL AP, Multistudio
- **Heidi Lubin,** eSix Development
- **Kyle Pickett,** William J. Worthen Foundation
- **Katie Ross,** Microsoft
- **Pauline Souza,** FAIA, LEED Fellow, WELL AP, LEED AP BD+C, LFA, WRNS Studio
- **Alice Sung,** AIA, LEED AP BD+C, SEA, Greenbank Associates
- **Ted Tiffany,** LEED AP BD+C, Building Decarbonization Coalition

Project Manager

- **Brett Rosenberg**, LEED AP, Cushman & Wakefield

WJWF Intern

- **Laura Barbosa,** Construction Industry Workforce Initiative

Graphic Design

- **Stoller Design Group**

Copy Editor

- **Geoff Martin,** Wheelhouse Writing Services

Working Group Members and Content Contributors

- **Katie Ackerly,** AIA, David Baker Architects
- **Sean Armstrong,** Redwood Energy
- **Heather Burpee,** University of Washington Integrated Design Lab
- **Don Davies,** PE, SE, Magnusson Klemenic Associates
- **Pierre Delforge,** Natural Resources Defense Council
- **Patrick Doss-Smith,** HGA
- **Susan Freed,** County of San Diego
- **Andreas Gyr,** Google
- **Ryan Hamilton,** Consortium for Energy Efficiency
- **Barry Hooper,** SF Environment
- **Josh Jacobs,** LEED AP+ BD&C, UL
- **Dirk Kestner,** PE, LEED AP BD+C, ENV SP, Walter P Moore
- **Bruce King,** Ecological Building Network
- **Candice Kollar,** Kollar EcoCreative and William J. Worthen Foundation
- **Meghan Lewis,** Carbon Leadership Forum
- **Lisa Fay Matthiesen,** FAIA, LEED Fellow, Amazon
- **Maurya McClintock,** McClintock Facades Consulting, LLC
- **Hilary Noll,** AIA, LEED AP BD+C, Mithun
- **Kelsey Rose Price,** PE, Hines
- **Cole Roberts,** PE, LEED AP, WELL AP, Arup
- **Henry Siegel,** FAIA, LEED AP, Siegel + Strain Architects
- **Stacy Smedley,** Skanska
- **Larry Strain,** Siegel + Strain
- **Mark Webster,** PE, LEED AP BD+C, Simpson Gumpertz & Heger
- **Wolfgang Werner,** AIA, LEED AP BD+C, CPHD, Urban Fabrick, Inc.
- **Breana Wheeler,** BRE (BREEAM USA)
- **Tamim Younos,** Green Water-Infrastructure Academy

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