USGBC Issue Brief #2:

Beneficial Electrification

What it is:

Electrification refers to using technologies such as electric vehicles or electric heat pumps that operate with electricity instead of burning fossil fuels such as oil, gas and coal. Electrification functions as a **decarbonization** strategy when the electricity used is - or is on a path to be – generated with clean resources such as wind and solar power.[i] According to the U.S. Energy Information Administration, the carbon intensity of U.S. electricity generation will decrease more than 26% from 2020 to 2050.[ii] Applying electrification to buildings means using electricity for core functions, such as heating, cooling, and cooking, and potentially industrial processes that have traditionally been provided by onsite combustion of gas, heating oil, propane, or other fossil fuels.

USGBC's Issue Briefs explain current trends in buildings policy and technology with a focus on decarbonization, sustainability, and health. This brief explains what beneficial electrification is about, how it supports decarbonization, and key policies deploying this strategy. Read Issue Brief #1 for an overview of Building Decarbonization.

Specific building technologies that are driving electrification as a viable solution include air source heat pumps, geothermal heat pumps, induction cooktops/stoves, high efficiency electric or heat pump water heaters, and other products. Incentives and funding programs to replace on-site fossil fuel equipment with electric equipment are growing rapidly. Some jurisdictions are adopting policies or codes to require new buildings to be all-electric and/or to restrict new on-site fossil fuel use ("gas bans") as a means to halt further expansion of fossil fuel infrastructure and avoid the future cost of replacement to all-electric.

Electrification represents a significant shift in the energy economy that will dramatically increase demand on the grid, with a variety of implications in different regions depending on resources and readiness. As a result, many NGOs, including USGBC, support **"beneficial electrification,"** which calls for electrification when it meets the following objectives:

- Reduces, or at least does not increase, energy costs for consumers, particularly low-income households
- Is coordinated with grid reliability and demand management investments
- Reduces harmful emissions (at buildings and/or from the energy supply)[iii]

In addition, beneficial electrification can help promote energy independence by relying on domestic renewable energy sources.

Why it matters:

In the latest Intergovernmental Panel on Climate Change (IPCC) report, the world's top climate scientists warned that we are running out of time to avoid the worst impacts of climate change, and that "without immediate and deep emissions reductions across all sectors," limiting global warming to the Paris agreement goal of 1.5°C is "beyond reach."

In the U.S., commercial and residential buildings account for more energy consumption (40%) and greenhouse gas emissions (GHG) (31%) than any other sector of the economy.[iv] [v] Specifically, onsite combustion of fossil fuels in buildings contributes **13% of U.S. emissions**.[vi] Further, while power utility emissions are dropping rapidly as the grid becomes cleaner, emissions from

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the use of fossil fuels onsite at buildings have *grown* 8% since 1990. There is a big opportunity for impact: For example, the 2018 CBECS found that half of commercial buildings and more than two-thirds of floorspace (70%) used natural gas.[vii] Where, and when, clean electricity is available, replacing fossil fuel-using equipment with electric equipment can reduce these emissions. An increasing number of studies have concluded that achieving carbon neutrality in the U.S. will require electrification of heating and cooling, with some organizations focused solely on electrification and others calling for a hybrid approach where electrification is supplemented with clean fuels.[viii]

Three things to know:

Beneficial electrification is a growing strategy for projects to achieve low operational carbon emissions.

USGBC supports beneficial electrification policies as a core strategy for government jurisdictions to achieve building decarbonization, where deep energy efficiency is an underlying strategy, where designed to account for equity impacts, and where grid issues are addressed.

USGBC plays a role in informing our members about electrification benefits and programs, as well as opportunities to engage in a jurisdiction's consideration of electrification policies.

Nexus with LEED:

LEED supports building decarbonization in a myriad of ways – from rewarding reduced energy and water consumption, to using lower impact materials and reducing whole building life cycle effects. Electrification of heating, cooling, and other building systems can help achieve **energy optimization** when high efficiency equipment is selected and sized properly, in conjunction with a well-insulated envelope. With the v4.1 Energy Optimization credit, LEED adds the metric of GHG emission improvement with the intent to push all projects towards decarbonization.[ix] This additional metric essentially means that a project can max out the points only by having zero carbon energy sources, which means electrification in certain regions of the grid. This points the way forward for LEED, where GHG emissions as well as energy use are integral for maximizing points.

Other credits also reward electrification. Smart electric equipment with demand management technologies, for example, can be used to reduce contribution to peak demands and associated peak carbon intensity of grid power, under the **grid harmonization** credit.[x] And, we are seeing many **all-electric buildings** represented in the growing number of certified LEED Zero Energy and LEED Zero Carbon projects.[xi] To learn more about how LEED drives projects to use additional decarbonization strategies, see Issue Brief #1.

USGBC Policy Position:

USGBC supports beneficial electrification, particularly when done in conjunction with deep energy efficiency and peak management, as a core strategy to achieve building decarbonization. We support jurisdictions developing tailored approaches to beneficial electrification that reflects such factors as the equitable impact on consumers, the characteristics of local building stock, the regional power portfolio and pace of clean power development, and availability of funding.

As jurisdictions develop electrification policies, we urge strong energy efficiency policies as a precursor or companion. **Pairing efficiency with electrification** is critical for ensuring that the goals of "beneficial" electrification are met.[xii] Even with a fully decarbonized economy, energy efficiency will remain a foundational component of the energy system to reduce costs and protect

consumers, conserve critical mineral resources, and help stabilize and manage increasingly strained power grids. We advocate for clear goals and targets, backed by specific policies which may include regulatory and non-regulatory approaches, with transparent tracking and accountability.

Opportunities and Challenges:

Equity – Several concerns have emerged related to equity. First, in some areas, electricity is much more costly for heating than natural gas, and while technology is advancing rapidly, electric heat pumps may be expensive to operate in cold climates,[xiii] particularly without updated building envelopes. Secondly, if relatively higher income households have a greater ability to transition from gas service to all-electric homes, the low income customers could be left behind in a shrinking customer pool to support the fixed costs of the gas utility. Jurisdictions need to account for these scenarios in design of their electrification policies.

Cost – Recent cost-benefit studies indicate that electrification of residential heating and cooling is already lifecycle cost effective in some locations/sectors;[xiv] however retrofitting some building types such as tall urban structures may require more extensive changes to HVAC space and electric service upgrades which may add complexity and cost.[xv] For new construction, avoiding the need to install gas service lines can be a significant cost offset. Costs of purchasing and installing electric equipment such as heat pumps have generally been higher than their gas counterparts but have been declining and will continue to go down as market uptake rises. The federal government is also investing to help increase efficiency and reduce cost of some key electric equipment. In sum, costs and benefits are changing rapidly and over time will move towards favoring electrification.

Health benefits – Several recent reports point to the health benefits from all-electric buildings as compared to buildings using natural gas or other on site fossil fuels; and the monetized value of such benefits. These health benefits are essentially avoided health impacts from eliminating methane and other emissions occurring in buildings with gas service and gas cooking.[xvi]

Availability of clean power - Achieving the carbon reduction benefits of electrification relies on clean electricity, which may be provided by on-site renewable energy generation and/or clean power from a grid or a community scale project. The pace at which grids in the United States are becoming clean varies widely.[xvii] Some grids are inherently low-emission through traditional reliance on hydropower or nuclear energy, while others, particularly in the Midwest, may continue to utilize low-cost natural gas or coal plants for several decades. Importantly, the time and magnitude of buildings' peak power demands also matters as a grid that's relatively clean may still use a fossil fuel peaker plant during times of highest demand -- so a building drawing on the grid during those periods will be adding carbon emissions at least in the near term. Another complexity is spillover impacts, referring to how adding new demand to a clean grid can cumulatively have an overall effect of requiring more energy be produced which again may lead to fossil fuel based power.

Building-grid optimization – As electrification of buildings and transportation adds demand, optimizing buildings for grid interaction is critical to dampen peak grid demand – and peak carbon emissions.[xviii] While metrics are available to specify optimized building characteristics, this

area is a current gap in policy. USGBC is advocating for the use of GridOptimal metrics, as included in LEED pilot ACP[xix] for Grid Optimization, in policies and incentives.[xx]

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Additional Resources

"Accelerating Electrification," recorded webinar. 2022. Available at https://www.buildingaction.org/events. Featuring Sen. Martin Heinrich and Rep. Paul Tonko, two of the co-founders of the Congressional Electrification Caucus, discussing how Congress can accelerate building electrification, followed by a panel of experts including ACEEE, Carrier, NEEP, and USGBC.

Alliance to Save Energy. Beneficial Electrification and Grid Opportunities. 2020. Available at https://activeefficiency.org/focus-areas/beneficial-electrification/. This report suggests considerations for deploying beneficial electrification focusing on impacts in the built environment as well as opportunities to achieve a more dynamic, efficient, and clean grid.

American Council for an Energy-Efficient Economy (ACEEE). State Policies and Rules to Enable Beneficial Electrification in Buildings through Fuel Switching. 2020. Available at: https://www.aceee.org/policy-brief/2020/04/state-policies-and-rules-enable-beneficial-electrification-buildings-through. This policy brief provides a snapshot of the existing state policy landscape for regulators and program administrators seeking to design and deliver effective programs that enable fuel switching.

Electricity Map, online resource, available at https://app.electricitymap.org/map. Displaying carbon intensity of U.S. grids in near real-time.

Hannah Ritchie, Max Roser and Pablo Rosado. "Electricity Mix" (2020) Published online at OurWorldInData.org, available at https://ourworldindata.org/electricity-mix.

Lawrence Berkeley National Laboratory. Electrification of buildings and industry in the United States: Drivers, barriers, prospects, and policy approaches. 2018. Available at: https://emp.lbl.gov/publications/electrification-buildings-and. This study reviews the possible benefits and barriers to greater electrification in U.S. buildings and industry, the technical and economic potential for electrification, and policy and programmatic approaches.

New Buildings Institute. Building Electrification Technology Roadmap. 2021. Available at: https://newbuildings.org/resource/building-electrification-technology-roadmap/. The Building Electrification Technology Roadmap (BETR) is a guide for utilities and other organizations developing, implementing, and supporting electrification technology programs as a way to advance high efficiency technologies, reduce GHG emissions, and improve public health.

Regulatory Assistance Project. Beneficial Electrification: Principles for the Public Interest. 2018. Available at: https://www.raponline.org/event/beneficial-electrification-principles-for-public-interest/. This webinar (and related report at the same link) outline conditions under which electrification can produce benefits for consumers, utilities, and society, plus policy considerations to help regulators evaluate and strengthen proposals to increase electrification in their states.

RMI. The Economics of Electrifying Buildings. 2018. Available at: https://rmi.org/insight/the-economics-of-electrifying-buildings/. This study analyzes the economics and carbon impacts of the electrification of residential space and water heating both with and without demand flexibility.

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Resources for the Future. Electrification 101. 2022. Available at https://www.rff.org/publications/explainers/electrification-101/. Explainer with economic focus.

Slipstream, Commercial building electrification: Accelerating decarbonization in cold climates (2021), course on USGBC.org, available at https://www.usgbc.org/education/sessions/commercial-building-electrification-accelerating-decarbonization-cold-climates.

U.S. Environmental Protection Agency (EPA). Webinar - Whole Building Approaches to Efficiency and Electrification (recorded). 2021. Available at https://www.epa.gov/statelocalenergy/webinar-whole-building-approaches-efficiency-and-electrification. Webinar from ENERGY STAR aimed at residential decarbonization.

Urban Land Institute. Electrify: The Movement to All-Electric Real Estate. 2021. Available at https://knowledge.uli.org/reports/research-reports/2021/electrify-the-movement-to-all-electric-real-estate. Providing outlook and perspectives for commercial real estate and electrification.

USGBC's Issue Brief Series is a resource developed by the Advocacy & Policy Team to help inform the green building community on trending built environment topics. Each Issue Brief will provide an explanation of the topic, the relevance to USGBC and green building policy, the nexus with LEED, and curated resources to learn more.

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References:

[i] Clean electricity focuses on low carbon sources but may be defined differently, such as whether nuclear power is included.

[ii] EIA, Energy Outlook 2022, Table 18.

[iii] See BlocPower, "Consumers Need to Know: Electrified Homes are Better Homes," USGBC.org.

[iv] EPA, Sources of Greenhouse Gas Emissions. See "Total U.S. Greenhouse Gas Emissions by Sector with Electricity Distributed." Note that for Commercial and Residential, 31% accounts for onsite energy use and offsite electricity generation used.

[v] EIA, Use of Energy Explained.

[vi] EPA, Sources of Greenhouse Gas Emissions. See "Overview." Note that for "Commercial and Residential" 13% accounts only for onsite energy use.

[vii] See EIA, Commercial Building Energy Consumption Survey (CBECS) 2018 Building Characteristics Flipbook, page 26.

[viii] See, e.g., Karl Hausker, WRI, "Decarbonization Pathways to Meet Our Climate Imperative," presented at NASEO Energy Policy Outlook Conference (2022), available at https://energyoutlook.naseo.org/data/energymeetings/presentations/Hausker-Karl.pdf.

[ix] LEED BD+C v4.1 Optimize Energy Performance credit.

[x] LEED BD+C v4.1 Grid Harmonization credit; see also v4 Demand Response credit.

[xi] See LEED Zero Directory.

[xii] See Urban Green, Grid Ready (2021), finding that "Heat pump upgrades need to be combined with other building improvements to lower electricity demand... These upgrades to building envelopes and other systems are critical."

[xiii] See, e.g., Rocheleau, J. (2021), Heat pumps can lower home emissions, but not everywhere, Eos, 102 (reporting an NREL study).

[xiv] See Billimoria, Sherri, Mike Henchen, Leia Guccione, and Leah Louis-Prescott. The Economics of Electrifying Buildings: How Electric Space and Water Heating Supports Decarbonization of Residential Buildings. Rocky Mountain Institute (2018), http://www.rmi.org/insights/reports/economics-electrifying-buildings/ (finding, for various scenarios in four U.S. cities, "electrification of space and water heating and air conditioning reduces the homeowner's costs over the lifetime of the appliances when compared with performing the same functions with fossil fuels.").

[xv] See Brett Bridgeland, RMI, Decarbonizing Tall Buildings with a New York State of Mind (2022).

[xvi] Dr. Yifang Zhu, Rachel Connolly, Dr. Yan Lin, Timothy Mathews, and Zemin Wang, UCLA, prepared for the Sierra Club, Effects of Residential gas Appliances on Indoor and Outdoor Air Quality and Public Health in California (2020).

[xvii] See, e.g., S&P Global, US States Face Uneven Paths in Movement for 100% Clean Energy (2019).

[xviii] See Val Jensen, Duncan Rotherham, ICF, Building Electrification: Steps to Start Now Amid an Uncertain Future (2021), available at https://www.icf.com/insights/energy/building-electrification-steps-start-now.

[xix] Alexi Miller, "GridOptimal LEED pilot credit encourages designers to help solve grid issues," (2021) available at https://www.usgbc.org/articles/gridoptimal-leed-pilot-credit-encourages-designers-help-solve-grid-issues.

[xx] See https://www.usgbc.org/articles/gridoptimal-leed-pilot-credit-encourages-designers-help-solve-grid-issues.