Greenbuild

ELECTRIFICATION IN EXISTING BUILDINGS: A SUSTAINABILITY IMPERATIVE

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INTRODUCTION

It's no secret that the way we heat, cool, and utilize energy overall in our buildings has a profound impact on the environment and climate change: In 2021, building operations accounted for 30% of global energy consumption and 27% of energy-related emissions.[1] While the COVID-19 pandemic spurred an unprecedented reduction in CO_2 emissions from this sector due to the shuttering of workplaces and shelter-in-place orders, emissions related to building operations have since reached an all-time high.[2]

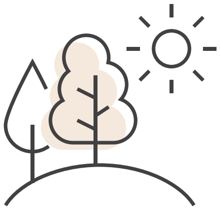
An essential approach to reducing the emissions that result from powering our global existing buildings is electrification, the process of transitioning to building technologies that operate with electricity instead of fossil fuels, thus reducing reliance on oil, gas and coal.[3] When the electricity used comes from renewable sources, this strategy represents a cornerstone effort for global decarbonization efforts.

KEY TERMS

Electrification in existing buildings refers to the process of transitioning from traditional fossil fuel-based systems to electric-powered systems for various energy-consuming applications. It involves replacing or retrofitting existing infrastructure, appliances, and equipment to operate on electricity instead of relying on fuels like oil, gas and coal.

Beneficial electrification reduces or maintains energy costs for consumers, contributes to a reliable electric grid, reduces harmful emissions and helps promote energy independence through reliance on domestic, renewable sources of energy.

Building decarbonization refers to the process of reducing or eliminating carbon dioxide (CO_2) and other greenhouse gas emissions from the buildings sector. Electrification is a key strategy for decarbonizing existing buildings.



AN URGENT CALL FOR ACTION

By electrifying existing buildings, it is possible to reduce reliance on fossil fuels, minimize the building sector's significant carbon footprint, and contribute to a more sustainable and clean energy future. Time is of the essence: in order to limit the global temperature rise to 1.5°C, which many scientists consider a dangerous threshold,[4] emissions from the buildings sector will need to be reduced by almost half by 2030.[5]

The time to educate, advocate and act is now. Building electrification is a foundational decarbonization strategy, one that can be implemented with a combination of corporate leadership, knowledge sharing, policy advancements and funding sources.

CHALLENGES TO WIDESPREAD IMPLEMENTATION

That said, it's not without its challenges. Electrification requires an upfront cost investment[6] and can be a complex operation requiring careful planning. Fortunately, technology advancements and growing implementation of electrification across the existing buildings sector is making it easier for projects to apply best practices and incorporate electrification strategies with fewer roadblocks. Further, state and federal policies are incentivizing electrification and helping to remove the cost barriers, with the goal of making electrification an achievable reality for most buildings. There is an increasing amount of funding and incentive programs geared toward replacing existing fossil fuel powered building equipment with electric alternatives.[7]

BENEFITS BEYOND SUSTAINABILITY

Electrification can act as a pillar of corporate ESG (environmental, social and governance) strategy, and help sustainability-oriented companies live their values through their portfolio of buildings, from corporate headquarters to storefronts. In addition, there are significant triple bottom line benefits to building electrification that are good for people, the planet and profits: Electrification can contribute to meaningful cost savings over time for building owners, as well as increase overall energy efficiency,[8] improve indoor air quality by eliminating potentially harmful emissions related to gas service,[9] support public health by reducing air pollution, and advance the creation of millions of jobs in the United States alone.[10]

STRATEGIES FOR ELECTRIFICATION IN EXISTING BUILDINGS

Successful implementation of electrification in existing buildings starts with careful planning, and extends to an array of tactics from transitioning heating and cooling systems, appliances and other building technologies to renewable energy sources. When paired with energy efficiency measures, electrification can be even more effective in decarbonizing buildings.

HEAT PUMPS: THE FOUNDATION OF BUILDING ELECTRIFICATION

GreenTechMedia called heat pumps “the enabling technology of widespread building electrification,”[11] which isn’t an overstatement, as space heating accounts for about one third of the total energy consumption in the average commercial building.[12] This existing technology is a viable electric substitute for conventional furnaces or boilers, which run on natural gas, propane or heating oil. A McKinsey analysis found that heat pumps could constitute about 90% of new heating unit sales by the year 2050.[13]

Heat pumps use both refrigerant and electricity to transfer heat from the outdoor air (air-source heat pumps) or the ground (geothermal heat pumps) to the inside of a building, even in colder climates, and provide both heating and cooling functions. In general, geothermal heat pumps may present a better option for buildings in extremely cold climates, though they have a higher upfront price tag.[14]

They’re also highly efficient compared to their fossil fuel-burning counterparts: A 2020 report by the American Council for an Energy-Efficient Economy (ACEEE) found that replacing gas-burning heating systems in commercial buildings with high-efficiency heat pumps could reduce a building’s total greenhouse gas emissions by 44%.[15]

OPTIMAL IMPLEMENTATION

While this technology is incredibly effective in supporting electrification efforts across global buildings, heat pumps aren't universally suited for every building retrofit, depending on a given building's current heat distribution system—which is why assessment and planning is a vital step before incorporating electrification technologies into an existing building. Heat pumps are an excellent option for buildings that use forced air, electric resistance, or low-temperature hot water systems,[12] but may not be the right choice for replacement in other distribution systems.

Timing also plays a role in when and how heat pumps can be optimally integrated: replacement of HVAC equipment is frequently reactionary and urgent, since heating and cooling are necessary functions of a building for occupant comfort. With some in-demand heat pumps requiring a long lead time, it's ideal to prepare building infrastructure for electrification in advance of an event like an emergency boiler failure.[16]

PREPARING FOR HEAT PUMP RETROFITS

In addition to these considerations, the U.S. Department of Energy's Better Buildings Initiative recommends a variety of site assessment actions to prepare for heat pump conversion, including:

Placement: All-electric systems, including heat pumps, may require both larger hot water storage tanks and take up more space than existing boilers and fossil-fuel powered technology.

Panels and wiring: The electric conversion process may require upgrades or redesign to a building's panels and wiring.

Thermal distribution: For buildings that rely on high temperature steam or hot water distribution, it's important to assess whether there is enough capacity to accommodate heat pumps that require lower supply temperatures.

Central vs. distributed solutions: Buildings that utilize centralized space and water heating systems may create challenges for electrification, and could require transitioning to a decentralized approach with smaller systems placed throughout the building.

Auxiliary and back-up systems: Heating performance and efficiency decreases for air-source heat pumps operating at colder temperatures, and may require thermal storage for backup.[17]

Proper planning can ensure a more cost-effective, seamless, and higher efficiency heat pump conversion process for existing buildings.

SUPPORTING TECHNOLOGIES: WATER HEATERS AND ELECTRIC APPLIANCES

The same heat pump technology used for heating and cooling indoor air can also be used to heat water, a strategy that, if applied universally, could mitigate 17 billion pounds of annual greenhouse gas emissions and result in $890 million in energy savings.[18]

For existing commercial buildings, replacing gas-powered appliances, like stoves, with electric alternatives, is another means of transitioning away from fossil fuels. Just like heat pumps, induction stoves powered by electricity are more efficient than their gas-powered counterparts: ENERGY STAR found that these appliances are about three times more efficient than gas stoves.[19] They also provide a clear human health benefit: many studies have indicated that gas stoves emit pollutants that irritate human airways, causing respiratory problems.[20] A December 2022 study linked 12.7% of childhood asthma cases in the U.S. to gas stove use,[21] and long-term nitrogen dioxide exposure, an invisible by-product, is linked to lung disease[22] and increased mortality.[23]

Retrofitting a building to incorporate electric appliances may involve upgrading the electrical circuit to support the power requirements of induction appliances. It’s essential to ensure the electrical system can accommodate the load and to address any necessary modifications.

RENEWABLE ENERGY SOURCES AND ENERGY EFFICIENCY

Electrification in and of itself reduces reliance on fossil fuels, but in order for the maximum benefit to be achieved, it must be paired with proactive shifts to electricity powered by solar, wind and other sources of zero-carbon energy—which is already underway. The share of renewables in global electricity generation reached 28.7% in 2021. Promising initial reports suggest that 2022 was a record year for increasing the capacity of renewable energy, and policies like REPowerEU and the U.S. Inflation Reduction Act will further accelerate the transition to electricity powered by renewables.[24] As it stands now, the carbon intensity of U.S. electricity generation is expected to decrease by more than 26% by 2050.[25]

Furthermore, electrification combined with overall energy efficiency strategies reduces energy needs and usage for existing buildings, further supporting progress to decarbonization. Energy audits or retro-commissioning for existing buildings can illuminate energy-saving opportunities, as well as inexpensive adjustments that can be made to address operational inefficiencies. Lighting, for example, accounts for 17% of the electricity consumed by commercial buildings in the U.S.[26] Switching to LED lighting systems can not only reduce operating expenses and energy usage, but provide utility rebates and other incentives. In some cases, seeking deeper energy efficiency improvements at the building envelope level, which extends to wall and roof insulation, assembly, penetrations and openings including windows, can provide meaningful improvements to operational efficiency.[27]

DRIVERS, CHALLENGES AND OPPORTUNITIES TO ELECTRIFICATION

Momentum around electrification in existing buildings is growing, driven by investors, lenders, tenants, and property managers striving to meet decarbonization commitments. A combination of these factors will impact how quickly buildings that are reliant on fossil fuels can transition to electric systems powered by renewables.

COST: PROMISING PAYOFFS WITH UPFRONT CHALLENGES

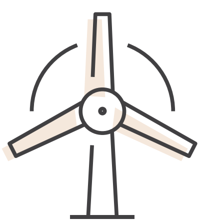
The cost and ROI surrounding electrification strategies is a critical piece of the puzzle. According to recent cost-benefit analyses, the electrification of residential heating and cooling has already proven to be cost-effective over the entire lifecycle in certain locations and sectors. Nevertheless, retrofitting certain building types, like high-rise commercial properties, may necessitate more extensive modifications to HVAC systems and electric service upgrades, which could increase complexity and expenses.[28] Further, to support equitable electrification and remove barriers in areas where electricity is more costly than natural gas, jurisdictions need to incorporate funding and policy support that aids this transition.

INCENTIVES AND FUNDING

Incentives can remove cost barriers that would otherwise prevent proactive electrification in existing buildings. Incentive programs are expanding across the U.S.: ACEEE identified 42 programs spanning $166 million in funding, primarily focusing on the transition to air source heat pumps.[8] The most common incentive programs involve a direct rebate to utility customers when they purchase qualifying electric equipment. In other cases, jurisdictions gain access to government funds to support the clean energy transition: The city of Menlo Park received $4.5 million in funding from the California state budget to convert fossil fuel-powered appliances in low- and middle-incoming housing.[29] Finally, long-standing tax deduction opportunities for energy-efficient upgrades in commercial buildings can save up to $1.80 per square foot.[8]

POLICIES DRIVING ELECTRIFICATION

Policy and building codes that support electrification in existing buildings, and push the market to adopt electrification, are a powerful means of advancing decarbonization. 104 U.S. jurisdictions have some form of building decarbonization ordinance in place, many of them focusing on banning gas stoves or gas hookups in new buildings,[30] with fewer policies specifically addressing retrofits. However, trailblazing locations like San Mateo, CA, which was among the first cities in the U.S. to adopt building codes that require the installation of electric appliances when equipment is replaced or renovations begin, will hopefully provide a model for other locales to follow suit. On a national scale, President Biden's Executive Order: Catalyzing Clean Energy Industries and Jobs Through Federal Sustainability and the accompanying Federal Sustainability Plan include directives for federal buildings and facilities to achieve net zero emissions by 2045 with electrification specified.[31]



BENEFICIAL ELECTRIFICATION

Electrification becomes even more appealing when it provides wins for utilities, the environment, and electricity users, which is exactly what beneficial electrification, widely supported by many non-profit groups and electrification advocates, achieves. In addition to a positive environmental impact, beneficial electrification means reduced or equivalent energy costs for consumers, which is critical for implementing electrification strategies in low-income areas. It's also synonymous with grid reliability and demand management investments, as well as promoting energy independence through the shift to domestic renewable energy sources.

CONCLUSION

While there are fewer barriers than ever to implementing electrification in existing buildings, there's still a long way to go in order to reach the emissions reduction targets that will support urgent climate change mitigation efforts. Currently, heat pumps, the highest impact electrification technology, only account for about 10% of the global heating need in buildings.[32] The building sector is at a critical juncture: a commitment to electrify existing buildings across the corporate and policy landscape could quite literally transform the future, and we need all hands on deck to deploy this high impact strategy.

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