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FACT SHEET

FLIPPING THE SWITCH:
HOW THE TRANSITION TO EFFICIENT ALL-ELECTRIC BUILDINGS WILL HELP THE UNITED STATES MEET ITS CLIMATE GOALS

Buildings—from single-family homes to office high-rises—are fossil fuel guzzlers. In addition to burning heating oil and propane, buildings are responsible for about one-third of all the fossil gas (aka "natural" gas) consumed in the United States each year. These fossil fuels, used mostly for space and water heating, emit massive amounts of carbon and air pollutants.[1] Scientists agree that if we do not act quickly to phase down greenhouse gas (GHG) pollution, we are unlikely to meet our climate goals and avert the worst consequences of the climate crisis.[2] Buildings offer a crucial opportunity for GHG reductions: Switching to efficient electric heating systems and appliances powered by pollution-free electricity could cut U.S. carbon emissions by 1 billion tons annually.[3]

Transitioning buildings to efficient electric appliances could cut U.S. carbon emissions by 1 billion tons per year.

This switch—replacing gas furnaces, boilers, water heaters, stoves, and clothes dryers with highly efficient electric appliances that can run on 100 percent clean electricity—alongside efforts to continue reducing energy waste in buildings, is known as "building decarbonization" or "beneficial electrification." This must be done in a way that prioritizes America's most vulnerable communities (including people of color and those with lower incomes), supports local economies, and creates family-sustaining jobs.

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Currently, buildings create GHG emissions in two ways: 1) by consuming electricity generated from dirty fuels at power plants, and 2) by burning fossil fuels on site to run heating and cooling equipment, as well as gas appliances like stoves and dryers. Luckily, the first is steadily declining. Policies to increase the amount of clean, renewable power in our electricity system and improve energy efficiency are reducing the environmental impact from the electricity consumed by buildings. However, the share of GHG emissions from burning fossil fuels directly in buildings—such as when using a gas water heater or furnace—has grown in the last 15 years.[4]

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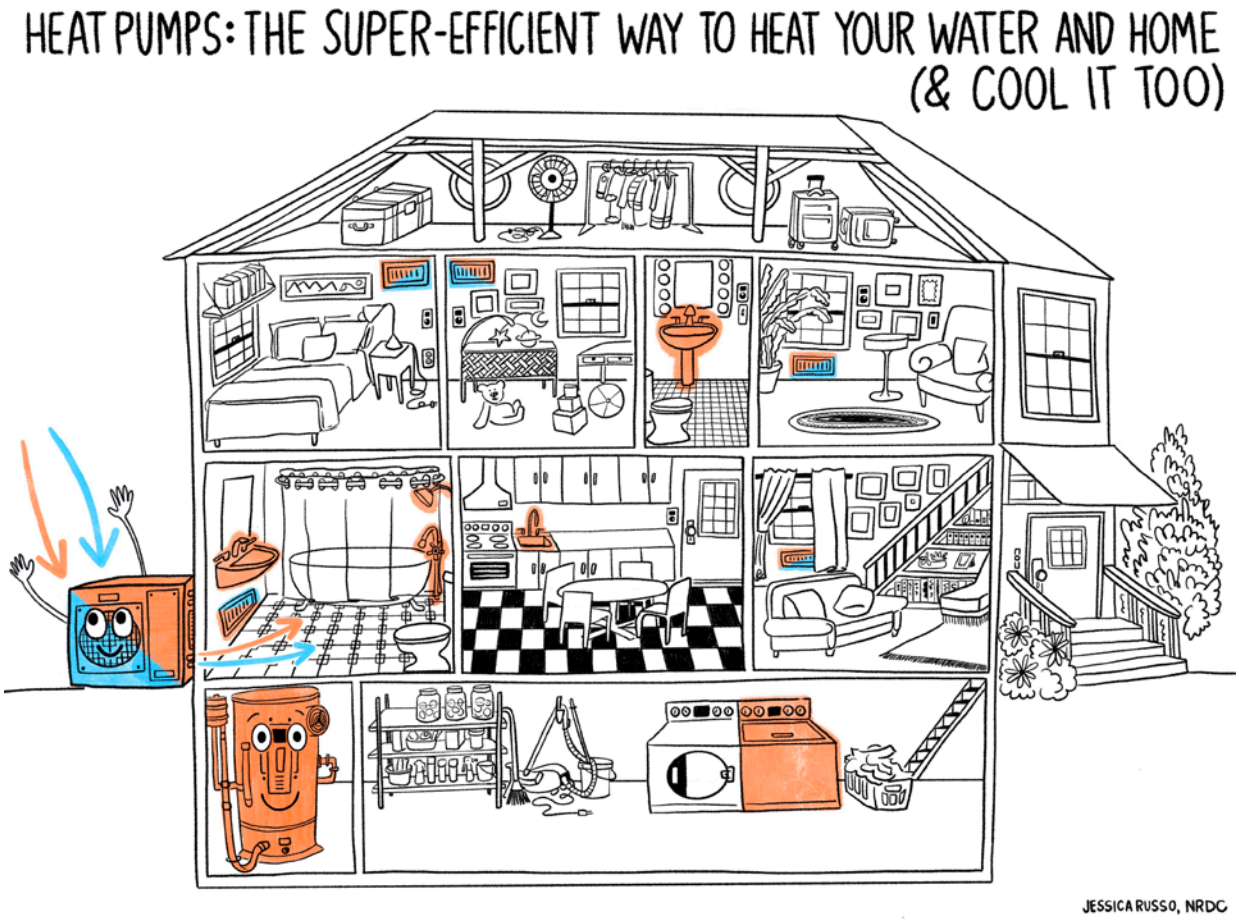

Because America's electricity supply is cleaner than ever and is expected to become even less polluting in the coming years, replacing fossil fuel-powered appliances and equipment with versions that run on electricity is the most effective and economic way to eliminate the remaining GHG emissions from buildings.[5] Many U.S. homes already run entirely on electricity; almost 40 percent rely on electricity for heat.[6] Recent game-changing technologies, such as heat pump water heaters and induction stoves, now make it possible to power the remaining homes and many other buildings with America's increasingly clean electricity.

Building decarbonization can be especially transformative for low-income communities and communities of color, which are already disproportionately experiencing the damaging effects of climate change and high utility bills; shifting to highly efficient and cleaner energy sources will reduce their overall energy needs while improving the indoor air they breathe. However, these communities do not often benefit from such advances in technology unless policies are designed intentionally to prioritize their needs. To ensure that communities of color and low-income communities partake of the benefits of building decarbonization, policies must be coupled with real efforts to partner with affected communities to address energy insecurity and close America's clean energy affordability gap. Without such efforts, there is a risk that policy decisions will perpetuate existing systemic inequities or not be responsive to community needs, leading to missed opportunities to improve the quality of buildings where people live and to cut dangerous climate pollution.[7] Prioritizing Black, brown, Indigenous, and low-income households will ensure that historically underserved communities can reap the most benefits from building decarbonization and the new clean energy economy.

The transition away from using fossil fuels in buildings will take many years, but because buildings and the equipment within them can last for decades, we must begin making the right policy decisions now.

HEAT PUMPS: A GAME CHANGER FOR SWITCHING HOME ENERGY USE TO CLEAN ELECTRICITY

Policies supporting the installation of electric heat pump equipment in homes and businesses are a key element of any building decarbonization plan. Most electric heating today is provided by a technology that has been around for many decades called electric resistance, which is inexpensive to install and maintain but more expensive to operate than fossil gas heating. However, advances in heat pump equipment over the past decade are changing the game in terms of efficiency, comfort, and cost, making the switch away from fossil fuel heating and cooling appliances more attractive. Today's advanced electric heat pumps are three to five times more efficient than typical gas equipment for heating water and indoor spaces.[8]

FOSSIL GAS ALTERNATIVES ARE NOT A SUBSTITUTE FOR BUILDING ELECTRIFICATION

Some states and utilities are exploring alternative types of gas, such as biogas or synthetic gas. Biogas, sometimes called renewable gas, is primarily methane produced from organic sources such as food scraps or animal waste, and synthetic gas is methane or hydrogen created using electrical power. However, these alternatives are limited in availability and extremely high in cost, and many sources of biogas raise environmental concerns.[9] In fact, only about 3 to 7 percent of U.S. gas consumption could be displaced by options from ecologically sound sources that do not significantly increase emissions.[10] They should be reserved for applications that are the most challenging to electrify, such as aviation, heavy industry, and shipping.

In addition to reducing GHG emissions compared with fossil gas heating, super-efficient electric heat pumps can provide both space and water heating without emitting harmful pollution into the home and atmosphere. They operate like air conditioners in reverse—using refrigerant fluids to collect and concentrate heat from the surrounding outside air and then releasing that heat into the air or water inside a home. The same heat pump can also provide cool air during the summer months by working in reverse. In contrast, traditional fossil gas heating releases GHGs that damage our climate, carbon monoxide, nitrogen compounds, formaldehyde, and other harmful air pollutants.

Heat pump technology has been available for decades, but modern heat pump appliances are much more efficient and reliable than earlier generations.[11] A wide variety of heat pump systems can now meet the heating and cooling needs of virtually every U.S. region, including cold-climate heat pumps that perform efficiently even when it's very cold outside.[12] Maine, one of the coldest states in the country, is already leading in U.S. installations of high-performance heat pumps and aims to install another 100,000 units by 2025.[13]

Heat pumps and other electric appliances can also leverage advanced controls and communications technology that makes it easier to maximize use of electricity from renewable sources by responding to electric grid conditions in real time. Such "demand flexible" equipment improves electric reliability and reduces customer costs by using clean energy when it is most plentiful and cheapest, such as by preheating water when the sun is shining midday and storing it for later use.[14]

If we retire all coal plants by 2030 so that no electricity is generated from coal—as climate scientists say we must—replacing fossil fuel appliances with heat pumps will lead to a significant decrease in emissions nationwide.[15] The majority of the country is already well on its way to this coal-free goal, meaning that a heat pump installed today in all but two states will emit fewer GHGs across the appliance's life than the fossil gas appliance it replaces.[16]

ELECTRIFICATION CAN REDUCE COST IN NEW *AND* EXISTING BUILDINGS

In most cases, it already is less expensive and faster to build new homes exclusively with electric appliances instead of fossil gas appliances, because it avoids gas infrastructure costs such as connecting distribution lines, installing meters, and outfitting the building with gas pipes.[17] Studies have found that buyers of new homes can save $3,000 or more in construction costs by going all-electric.[18]

Going all-electric in existing buildings can also reduce customer energy bills, especially when paired with additional energy efficiency improvements and onsite rooftop solar generation or when the equipment being replaced uses expensive propane or heating oil.[19,20] Utility bills can be further reduced if customers have access to electric rates that reflect the varying cost of supplying electricity at different times of day.[21] Most electric rates average the cost of energy across all hours of the day; more advanced rate plans allow people to save by using electricity when it is cheapest, most plentiful, and likely to be from the cleanest resources. Additionally, converting buildings to all-electric will become increasingly cost-effective as more homes and businesses adopt the technologies, bringing down appliance and installation prices. Policies to encourage building electrification should be paired with key equity provisions, such as language ensuring that renters are not displaced due to increased value of their home post-retrofit.

1 BILLION TONS

Building decarbonization can cut U.S. carbon emissions by 1 billion tons per year.

3-5X

Heat pumps are 3-5X more efficient than gas space and water heating equipment.

42%

Cooking with gas can increase by up to 42% the risk that children will experience asthma symptoms.

HEALTHIER INDOOR AND OUTDOOR AIR

Eliminating emissions from burning fossil fuels inside homes provides major public health benefits. Gas and propane stoves release carbon monoxide, nitrogen compounds, formaldehyde, and other air pollutants that can exacerbate existing respiratory and health conditions, including asthma.[22] If stoves are not properly vented, studies have found, cooking with gas can lead to kitchen concentrations of nitrogen oxides considered unhealthy under outside air pollution standards and can increase by as much as 42 percent the risk that children living in the home will experience asthma symptoms.[23] Properly vented appliances can help protect individual households, but they increase outdoor air pollution.

Occupants of efficient homes with electric appliances, as well as their neighbors, breathe healthier air by avoiding toxic fumes from gas stoves, furnaces, and water heaters.[24] In California alone, replacing gas with electric appliances would prevent more than 350 premature deaths each year and produce $3.5 billion in annual health benefits from cleaner air.[25] In areas with heavy pollution burdens, particularly in low-income communities that disproportionately experience poor air quality, these indoor and outdoor air quality improvements are sorely needed.

WE NEED POLICY ACTION TODAY

Replacing fossil fuel equipment with highly efficient appliances and running them in efficient homes with clean, renewable electricity are key and necessary parts of the strategy to fight the climate crisis. Also critically important is ensuring that clean electric appliances are accessible to all—including low-income homeowners and renters, many of whom can't afford to replace equipment or don't have a say in equipment purchase decisions. All of this will require timely, decisive action at all levels of government.

DECARBONIZATION MUST LEAD WITH EQUITY

The transition to healthier and more climate-friendly all-electric buildings creates an invaluable opportunity to prioritize investments in our country's most under-resourced communities. However, if building electrification is not implemented equitably, the burden on those communities will be exacerbated. Twenty percent of the country's multifamily housing units are occupied by households earning less than $35,000 a year, which means there are at least 3.6 million households that can ill afford any detrimental changes to their housing situations, such as rent increases that might result from building efficiency improvements.[26] Building decarbonization policy must leverage the appropriate technologies *and* affordability protections to ensure those households can continue to live in their homes after they switch to clean electric appliances. Building decarbonization will benefit everyone only if it also preserves affordability and stability for historically underserved communities.

To shift buildings off fossil fuels, the federal government should make investments and set standards to accelerate the deployment and further development of highly efficient clean heating technologies.

State and local policymakers should:

- Adopt building energy codes that reflect the health and cost advantages of all-electric new construction.
- Implement tools such as building energy auditing, benchmarking, and minimum performance requirements that make it easier to understand and reduce a building's pollution and climate impact.
- Ensure Black, brown, and Indigenous communities are part of the decision-making process and receive sustained and sufficient direct support, so that historically underserved communities are prioritized and benefit from the transition.
- Design electrification policies for subsidized and unsubsidized affordable housing, coupled with anti-displacement policies and bill assistance programs, to preserve communities and prevent the risk of eviction.
- Provide workforce development opportunities that support fossil fuel workers and traditionally underrepresented populations, creating good, family-sustaining careers.

Utility regulators should:

- Establish sustained direct support for upgrading homes in historically underserved communities so that renters and homeowners benefit from the transition.
- Realign energy efficiency policies to focus on longer-term emissions-reduction goals in addition to energy savings, so that existing efficiency funding can support adoption of highly efficient electric equipment, development of the workforce to install it, and consumer education campaigns that promote efficient electrification of buildings.
- Reconsider electric rate designs to encourage electricity use at times when it is very low in cost and sourced from clean, renewable sources like wind and solar.
- Avoid wasting resources on new fossil fuel infrastructure that will become uneconomic before the end of its life as customers opt out of the gas system due to health, cost, and environmental concerns, leaving remaining customers and taxpayers holding the bag.

Transitioning America's buildings from gas to advanced electric appliances for space and water heating, cooking, and other uses will greatly reduce GHG pollution and benefit communities living with unhealthy air quality and high energy bills. Coupled with energy efficiency and clean electricity, moving away from fossil fuels provides a path toward pollution-free homes and places of work. Investing in cleaner, healthier buildings will also reduce the country's long-term energy costs and offer new ways to create family-sustaining jobs.[27] Now is the time to act.

ENDNOTES

1 U.S. Energy Information Administration (hereinafter EIA), "Frequently Asked Questions (FAQs): How Much Natural Gas Is Consumed in the United States?," https://www.eia.gov/tools/faqs/faq.php?id=50&t=8 (accessed June 30, 2020).

2 Vignesh Gowrishankar and Amanda Levin, *America's Clean Energy Frontier: The Pathways to a Safer Climate Future*, NRDC, September 2017, https://www.nrdc.org/sites/default/files/americas-clean-energy-frontier-report.pdf.

3 NRDC calculation based on *EIA Annual Energy Outlook 2018*. This total does not include the impact of continuing to move away from using fossil gas to generate electricity to keep the lights on and run building appliances. If current emissions from electricity are included, buildings represent one-third of U.S. GHG emissions.

4 U.S. Environmental Protection Agency, *Inventory of U.S. Greenhouse Gas Emissions 1990–2018*, April 2020, https://www.epa.gov/sites/production/files/2020-04/documents/us-ghg-inventory-2020-main-text.pdf.

5 Sophia Ptacek and Amanda Levin, "Race to 100% Clean," NRDC, December 2, 2020, https://www.nrdc.org/resources/race-100-clean. Gowrishankar and Levin, *America's Clean Energy Frontier*.

6 EIA, "Household Heating Fuels Vary Across the Country," *Today in Energy*, October 28, 2011, https://www.eia.gov/todayinenergy/detail.php?id=3690.

7 Greenlining Institute and Energy Efficiency for All, *Equitable Building Electrification: A Framework for Powering Resilient Communities*, September 2019, https://greenlining.org/publications/reports/2019/equitable-building-electrification-a-framework-for-powering-resilient-communities.

8 Pierre Delforge and Christina Swanson, "Very Cool: Heat Pump Water Heaters Save Energy and Money," NRDC, November 30, 2016, https://www.nrdc.org/experts/pierre-delforge/very-cool-heat-pump-water-heaters-save-energy-and-money.

9 Ibid.

10 Merrian Borgeson, "A Pipe Dream or Climate Solution? The Opportunities and Limits of Biogas and Synthetic Gas to Replace Fossil Gas," NRDC, June 2020, https://www.nrdc.org/sites/default/files/pipe-dream-climate-solution-bio-synthetic-gas-ib.pdf.

11 Katy McSurdy, "So Hot Right Now: Innovations in Heat Pump Technology," Nexant, February 7, 2019, https://www.nexant.com/resources/so-hot-right-now-innovations-heat-pump-technology.

12 Northeast Energy Efficiency Partnerships, "Cold Climate ASHP Specification and Product List," https://neep.org/ASHP-Specification (accessed January 4, 2020).

13 Acadia Center, "Clean Heating Pathways," https://acadiacenter.org/wp-content/uploads/2020/03/Acadia-Center-Clean-Heating-Pathways.pdf (accessed January 4, 2020).

14 Ryan Hledik, Judy Chang, and Roger Lueken, *The Hidden Battery: Opportunities for Electric Water Heating*, The Brattle Group, January 2016, https://www.electric.coop/wp-content/uploads/2016/07/The-Hidden-Battery-01-25-2016.pdf.

15 Rachel Golden and Cara Bottorff, "New Analysis: Heat Pumps Slow Climate Change in Every Corner of the Country," Sierra Club, April 23, 2020, https://www.sierraclub.org/articles/2020/04/new-analysis-heat-pumps-slow-climate-change-every-corner-country.

16 Claire McKenna, Amar Shah, and Mark Silberg, "It's Time to Incentivize Residential Heat Pumps," Rocky Mountain Institute, June 8, 2020, https://rmi.org/its-time-to-incentivize-residential-heat-pumps/. This analysis assumes continued renewable penetration as determined by binding policies already in place, but no further grid mix changes.

17 Asa S. Hopkins et al., *Decarbonization of Heating Energy Use in California Buildings: Technology, Markets, Impacts, and Policy Solutions*, Synapse Energy Economics, October 2018, https://www.synapse-energy.com/sites/default/files/Decarbonization-Heating-CA-Buildings-17-092-1.pdf.

18 Amber Mahone et al., *Residential Building Electrification in California: Consumer Economics, Greenhouse Gases, and Consumer Impacts*, Energy and Environmental Economics, April 2019, https://www.ethree.com/wp-content/uploads/2019/04/E3_Residential_Building_Electrification_in_California_April_2019.pdf.

19 Ibid.

20 Jeff Deason et al., *Electrification of Buildings and Industry in the United States: Drivers, Barriers, Prospects, and Policy Approaches*, Lawrence Berkeley National Laboratory, March 2018, http://ipu.msu.edu/wp-content/uploads/2018/04/LBNL-Electrification-of-Buildings-2018.pdf.

21 Alejandra Mejia Cunningham, Michelle Vigen Ralston, and Katie Wu, *Rate Design for Building Electrification*, Building Decarbonization Coalition, January 2019, http://www.buildingdecarb.org/uploads/3/0/7/3/30734489/bdc_report_2_rate_design.pdf.

22 Weiwei Lin, Bert Brunekreef, and Ulrike Gehring, "Meta-analysis of the Effects of Indoor Nitrogen Dioxide and Gas Cooking on Asthma and Wheeze in Children," *International Journal of Epidemiology* 42, no. 6 (December 2013): 1724-37, https://doi.org/10.1093/ije/dyt150.

23 Ibid.; Brett C. Singer et al., "Pollutant Concentrations and Emission Rates From Natural Gas Cooking Burners Without and With Range Hood Exhaust in Nine California Homes," *Building and Environment* 122 (September 2017): 215–29, https://doi.org/10.1016/j.buildenv.2017.06.021.

24 Pierre Delforge, "Gas Appliances Pollute Indoor and Outdoor Air, Study Shows," NRDC, April 29, 2020, https://www.nrdc.org/experts/pierre-delforge/gas-appliances-pollute-indoor-and-outdoor-air-study-shows.

25 Zhu et al., *Effects of Residential Gas Appliances*.

26 Joint Center for Housing Studies of Harvard University, *America's Rental Housing 2017*, 2017, https://www.jchs.harvard.edu/sites/default/files/harvard_jchs_americas_rental_housing_2017_0.pdf.

27 Betony Jones et al., *California Building Decarbonization: Workforce Needs and Recommendations*, UCLA Luskin Center for Innovation, November 2019, https://innovation.luskin.ucla.edu/wp-content/uploads/2019/11/California_Building_Decarbonization.pdf.