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Emerging Technologies Review 2023: Beyond Efficiency to Electrification in California

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Cars and appliances are becoming increasingly efficient, using less energy to deliver the same results. But if they continue to run on fossil fuels, even the most efficient machines threaten public health, waste money, and warm the planet. In 2023, efficiency isn't enough to solve our greatest challenges. It's time to move beyond efficiency to electrification.

This is no small task in a fossil-fuel dominated world. In the U.S. there are currently 275 million vehicles, 132 million space and water heaters, 95 million cooking devices, and 19 million clothes dryers powered by polluting fossil fuels like fracked gas, propane, and gasoline. Mass electrification requires replacing each fossil-powered vehicle and appliance at the end of its life cycle — or earlier — with an electric alternative. Powering these electric machines with clean energy will require millions of additional electric devices such as rooftop solar panels, breaker boxes, battery storage, and vehicle chargers. According to Rewiring America, a total of approximately one billion machines across the U.S. need to be electrified. With the Inflation Reduction Act (IRA) injecting billions into the clean energy economy, there has never been a better time to electrify the country.

California is leading the charge. The state has set bold electrification targets, and is backing them up with well-crafted policy and meaningful investments. But even in California, we have a long way to go. Policymakers, businesses, and individuals should take immediate action to:

- Reduce consumption of fossil gas;
- Reduce electricity prices for consumers;
- Prepare the grid for full electrification;
- Electrify California's schools;
- Electrify industrial processes;
- Remove the obligation to serve for gas utilities;
- Adopt grid-interactive home technologies; and
- Train the next generation of electrification workers.

The 2035 Initiative's Emerging Technology Review brought together advocates, academics, government officials, and private sector leaders to discuss our electrified future and how to achieve it. To distill the workshop's key recommendations and lessons learned, the following memo discusses: 1) the benefits of electrification, 2) California's electrification successes, 3) the next steps that California should take to accelerate electrification, 4) how IRA investments will supercharge electrification, and 5) how electrification can advance equity and justice.

Emerging Technology Review 2023 Panelists

Ari Matusiak, Co-founder & CEO, Rewiring America
David Hochschild, Chair of the California Energy Commission
Sonia Aggarwal, CEO of Energy Innovation
Hannah Bascom, VP Regulated Business, SPAN
Samantha Ortega, Government Relations Manager, ChargerHelp
Vince Romanin, CEO, Gradient
DR Richardson, Co-Founder at Elephant Energy
Le-Quyen Nguyen, Deputy Secretary for Energy at CNRA
Merrian Borgeson, Director, California Policy, Climate & Clean Energy Program
Leah Stokes, Anton Vonk Associate Professor of Environmental Politics, UC Santa Barbara

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Why Electrify?

Our cars and appliances function as mini fossil fuel plants — spewing toxic chemicals and climate pollution directly into the air we breathe. Replacing these dirty and dangerous machines with electrified alternatives yields several benefits:

Electrification slashes climate pollution. Currently, 90 percent of U.S. carbon pollution is related to energy, and roughly half of that comes from our buildings and vehicles. By moving to a 100 percent clean electricity grid and electrifying all of our cars, home appliances, and industrial processes, we can cut 75 percent of current carbon pollution and take an important step toward securing a liveable future.

Electrification protects public health. Fossil-powered household appliances emit harmful air pollutants that seriously threaten human health, and can induce asthma, heart attacks, and even premature death. While most appliance pollution is vented outdoors, gas stoves release toxic chemicals directly into the home. One study found that gas cooking raises the risk of childhood asthma by 42 percent. Air pollution from gas-powered cars causes tens of thousands of premature deaths each year in the U.S. These harms are not distributed equally — people of color in the U.S. are much more likely to be exposed to toxic pollution from both dirty home appliances and vehicles. Electrification addresses these dangerous health impacts by eliminating toxic pollution from fossil-powered machines.

Electrification saves people money. Electrification cuts household costs without sacrificing comfort. Reducing consumption of expensive fuels like gasoline and replacing dirty appliances with ultra-efficient electric alternatives like heat pumps pays dividends for consumers. An analysis from Rewiring America found that the average American household would save $1,800 annually on their energy bills if they fully electrified their homes and vehicles. Additionally, consumer rebates and incentives in the IRA will put more money in people's pockets who electrify their lives. These savings are especially significant for low-income residents, who spend a disproportionate amount of their income on energy bills each month.

California: An Electrification Leader

California is on the cutting edge of electrification in the U.S. In 2018, California enacted a binding law that requires 100 percent clean electricity generation statewide by 2045. Governor Newsom has also set several important electrification targets, including deploying six million heat pumps in the state by 2030 and equipping seven million climate ready homes by 2035. To support these goals, the state has implemented regulations that ban the sale of new gas furnaces and water heaters by 2030 and outlaw the sale of gas-powered passenger vehicles by 2035. Regulators in the Bay Area have opted to move even faster on building electrification, banning the sale of gas water heaters and furnaces starting in 2027 and 2029, respectively. Additionally, dozens of municipalities across the state have passed restrictions on gas infrastructure in new buildings.[1] Last year, California updated their building code, which effectively made all-electric construction the least expensive option for the first time ever. In 2023, California has the budget to support major action on electrification, including $922 million for building decarbonization, $145 million for heat pump incentives, $2.9 billion for zero-emission transportation, and $192 million for school electrification.

But even in California, we have a long way to go to electrify at the scale needed to protect public health, slash climate pollution, and save money for consumers. The state still relies heavily on polluting fossil gas for electricity generation, home heating, and energy for industrial processes. Of the 25 million space and water heaters in California, less than one million are electric heat pumps. Only 560,000 of the 14 million cars on the road are electric vehicles. California's nation-leading targets, laws, and budget have set the stage for transformative action on electrification. As California Energy Commission (CEC) Chair David Hochschild puts it: *"We're done setting goals, now it's time to build things. Now is the great implementation."*

Next Steps for Electrification in California

Reduce consumer electricity prices. Lowering electricity prices is crucial to encouraging electrification across the state. On average, Californians pay $212 per month on electricity bills, which is 19 percent higher than consumers nationally. The average electricity rate within the state is 30 cents per kilowatt-hour (kWh), compared to 20 cents nationally. California electricity is expensive. This poses a challenge to electrification efforts; as Californians electrify their homes and vehicles they will purchase more power from the grid to replace fossil energy. While electrification is still cost-effective, the state's elevated electricity rates means Californians have less incentive to electrify compared to other states. This is especially important for lower income households, who are disproportionately impacted by higher rates.

To address this, the California legislature enacted Assembly Bill 205, which requires fixed rates for basic electricity services and generally simpler energy bills. In response, California's three largest utilities proposed a fixed rate structure that adjusts for income: if you make more

[1] In April of 2023, a federal appeals court overturned the city of Berkeley's restrictions on gas in new building construction. The ramifications for other municipal gas bans remains uncertain.

money, you pay a higher base rate. The proposal has yet to be officially adopted, but ultimately stands to reduce per-kWh electricity rates while advancing energy equity.

Electrify industrial processes. On the road to decarbonization, the industrial sector is falling behind. California has the third most energy-intensive and climate-polluting industrial sector in the nation, behind only Texas and Louisiana. One of the greatest opportunities to reduce climate pollution in the near term is to slash emissions from low-temperature industrial heat applications. For example, in California, the food and beverage industry is one of the largest consumers of fossil gas, mostly for thermal processes. However, most of these processes require temperatures of less than 200 °C, making them well positioned to move away from fossil fuels toward industrial-scale electric heat pumps. Deploying heat pumps to replace fossil fuels in low-temperature industrial processes is technically feasible, and would cut pollution while lowering operating costs for industrial firms.

Electrify California's schools. There are almost 10,000 K-12 schools in California covering 730 million square feet of buildings, making the school system one of the state's largest public infrastructure systems. Most schools still rely on outdated heating, ventilation, and air conditioning (HVAC) systems that emit climate pollution and are costly to maintain. Some schools do not even have modern HVACs. Moreover, these systems are typically not capable of filtering wildfire smoke, air pollution, and viruses from the air inside schools, putting student health at risk. Upgrading to all-electric HVAC systems with advanced filtration provides a safer and healthier environment for California's students and school staff. California spends $15 billion annually on its school facilities. The average school wastes $110,000 on energy inefficiencies, largely due to outdated systems. California should align school infrastructure investments with its climate and public health goals. This would mean replacing outdated HVAC systems with ultra-efficient electric technologies like heat pumps, thereby protecting student health, slashing climate pollution, and lowering operating costs. For more on California school electrification, see this report from The 2035 Initiative, Rewiring America, and UndauntedK12.

Prepare the grid for full electrification. Replacing fossil energy with electricity means that more of our energy will be drawn from the electrical grid. To electrify everything in the U.S. economy, the grid will need to deliver 2 to 3 times more electricity than it does today. Meeting this demand with clean electricity will require a steep rise in carbon-free energy generation and a massive buildout of transmission infrastructure nationwide. We will also need to invest in reliability, ensuring that we can maintain a safe and dependable grid as electrification accelerates.

Adopt grid-interactive home technologies. Electrical panels are the single point where a household draws energy from the grid, through a set of wires that connect to power lines. Electrical panels have varying capacity, and currently, 60-70 percent of U.S. households have a panel that is too small for whole-home electrification. Upgrading to a larger panel requires running new wires into a home and can cost thousands of dollars. However, households can install a smart panel that interactively manages demand in an electrified home, automatically

switching circuits on and off in response to increased load demand. The CEC can support smart appliances like these by adopting standards that promote grid-interactive home technologies.

Train the next generation of electrification workers. Mass electrification will depend on electricians to replace fossil-fueled appliances with electric ones, upgrade panels, and maintain existing systems. The problem is, there simply aren't enough workers. In California, there is 1 certified electrician for every 478 housing units, and building contractors are struggling to fill open positions. The shortage extends to other important trades as well – HVAC technicians, plumbers, and other workers crucial for electrification are in short supply. California will get some help from federal funds — the IRA provides $200 million to states to train contractors involved in home efficiency and electrification installations. Beyond taking advantage of this program, the state should develop pathways to retrain fossil fuel workers to enter electrification-related trades. California should scale up training programs for electricians and related trades through community colleges and technical schools.

Reduce consumption of fossil gas. Right now, California's power sector is dominated by gas. Fossil gas contributes the largest portion of electricity generation, comprising 38 percent of the state's fuel mix in 2021. Gas is also the primary fuel for space heating and industrial processes. Electrification threatens the profits of powerful gas utilities, and the industry isn't going down without a fight. Utilities in California have been caught running astroturfing campaigns to oppose electrification, using ratepayer money to spread public misinformation. To fight back, we need education to get out the truth on the many benefits of electrification. The state also continues to invest heavily in gas infrastructure, a pattern inconsistent with California's climate and public health goals. These investments should be redirected to electrification projects that will save Californians money, protect their health, and combat climate change.

Remove the obligation to serve. Outdated state law also stands in the way of California's electrification goals. Under California law, utilities have an "obligation to serve" customers. Currently, this language is being interpreted as a requirement for gas utilities to provide gas to customers even when there are clean and affordable electric alternatives. For example, if the majority of a neighborhood wanted to fully electrify, but a single household wanted to keep using gas appliances, the utility must continue providing gas to that neighborhood. This could even mean maintaining a gas pipeline that services a single home. The California legislature should clarify the language to allow utilities to meet this statutory obligation with either clean electricity or gas. This would give neighborhoods the choice to discontinue their gas service, and instead meet their energy needs for heating and cooking with electricity.

How the IRA Supports Electrification

The Inflation Reduction Act (IRA), signed into law in August 2022, invests $370 billion to grow a just, thriving, and inclusive clean economy. Many of the IRA's programs will directly support electrification, including:

Home electrification rebates: Through its host of consumer rebate programs, the IRA gives every American household an "electric bank account." Two IRA programs send nearly $9 billion to states to create home efficiency and electrification rebate programs. Households are eligible to receive up to $14,000 to purchase and install electric heat pumps, water heaters, cooktops, and more. Additionally, households can receive up to $4,000 for home efficiency upgrades. California has been allocated $582 million through these programs, and anticipates supporting electrification in 65,000 homes across the state. These limited programs should be targeted to low income Californians, helping them to electrify their homes while also reducing energy demand through weatherization.

Electrification tax credits: Households can claim up to $8,200 annually to make their homes more efficient, including through electrification. The IRA also provides up to a $7,500 credit directly to consumers to offset the cost of a new electric vehicle, and up to $4,000 for used electric vehicles. Commercial vehicle owners can claim a credit of up to 30 percent of the cost of electrifying fossil-powered vehicle fleets.

Green finance: The IRA's $27 billion Greenhouse Gas Reduction Fund (GGRF) aims to build an ecosystem of equitable, green finance throughout the U.S. that can support all phases of electrification projects. This flexible funding from GGRF is designed to leverage billions more in private capital to invest in decarbonization and climate resilience. The majority of financing will flow to disadvantaged communities, supporting cost-saving electrification and clean energy projects for those who need it most.

Now that the IRA has passed, we turn to the hard work of implementation. Many IRA investments will be implemented by state and local governments, who must design programs that ensure money actually reaches the people who need it most, especially in disadvantaged communities. The $370 billion in IRA investments is just an estimate. IRA credits are uncapped, and if we activate around electrification we can blow projections out of the water. The IRA's investments have near limitless potential to transform our economy to one that is clean, safe, and electric — but only if we implement them effectively, rapidly, and equitably.

Electrification and Equity

Electrification allows financial and health benefits to be delivered directly into the homes of disadvantaged, low-income, and historically marginalized communities. Cost-savings are especially significant for low-income households, who spend three times more of their income on energy bills than the average consumer. Moreover, on average people of color are exposed to twice as much harmful air pollution from residential fossil appliances than white people. Electrification can help energy-burdened residents better meet their needs while balancing the scales of air pollution inequality.

To grant disadvantaged communities access to the far-reaching benefits of electrification, we must make clean, electric machines the most convenient and affordable option for everyone. If

disadvantaged communities are left out, electrification elsewhere could drive up energy costs for those still reliant on outdated fossil-powered machines. In many cases, disadvantaged communities will need access to technical assistance to ensure that they are ready to electrify. Aggregating demand at the community level is key. Electrification can be challenging to navigate, but if we cluster purchases of electric technologies across multiple households, we can make them more affordable while supporting people through the process.

Crucially, communities must be engaged throughout the transition to electric technologies. Education is paramount. We must ensure that people understand the electrification process and are given the authority and tools to guide changes in their own homes and communities. Electrification can be a powerful driver of equity and justice, but only if we do it right.

Our Electric Future

Electrification protects public health, saves money for everyday Americans, advances equity, and fights climate change. A world where we trade gas-powered cars for electric vehicles and our homes run on fossil-free electric appliances is safer, healthier, and more prosperous. With billions of federal dollars raining in to support electrification, now is the time to make the transition.

California will play a key role. By scaling electrification technology and delivering a blueprint for a fossil-free society, California can pave the way for nationwide electrification. Plenty of work remains, including lowering electricity prices, upgrading schools, training workers, electrifying industry, and moving away from fossil gas. As recently as 2018, California's energy efficiency programs were not permitted to focus on electrification. In 2023, we know that efficiency is not enough to meet the moment, and a better future is within our grasp. Direct electrification *is* efficiency, and so much more.