BENEFICIAL ELECTRIFICATION LEAGUE

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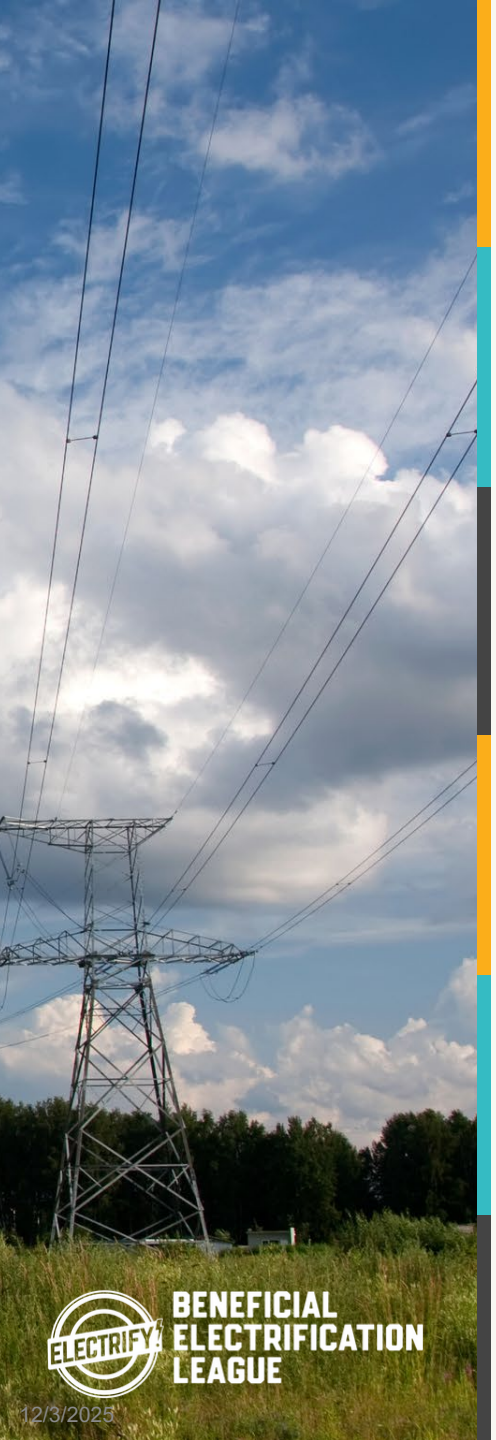
Environmentally Beneficial Electrification: Electricity as the End-Use Option

Keith Dennis

A Decade Of Beneficial Electrification



Theme and Viewpoint

The Value Proposition of Beneficial Electrification is Timeless

For over a century, people have chosen electricity when it improves their quality of life. At BEL, we articulate the four major value propositions of beneficial electrification as:

- **Saves consumers money over time;**
- **Benefits the environment and reduces greenhouse gas emissions;**
- **Improves product quality or consumer quality of life;**
- **Fosters a more robust and resilient grid.**

This report is organized around these pillars and is a first of its kind look back at benefits of Beneficial Electrification.

Key Takeaways – BEL Viewpoint

- **Progress can quickly become undermined when applications of electrification do not align with the four pillars of beneficial electrification.**

- **Affordable, reliable electricity is critical to sustaining the advancement of electrification.**

- **It is vital that beneficial electrification remains a bipartisan solution and a choice made by the consumer.**

BE-LEAGUE.ORG

A Decade of Beneficial Electrification: Progress and the Path Ahead

PRESENTED BY

Ryan Hledik
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BENEFICIAL ELECTRIFICATION LEAGUE WEBINAR
DECEMBER 3, 2025

Brattle

Introduction

Purpose of study

- BEL commissioned Brattle to look back over the past ten years and assess the extent to which electrification has delivered in four areas: cost savings, product quality and consumer experience, grid resilience, and emissions reductions.

Features of our approach

- Based on review of publicly available data and research studies on the impacts of electrification.
- Includes high-level analysis to illustrate the general magnitude of benefits that electrification has provided in the United States over the past decade.
- Concludes with a review of analyst projections regarding the future trajectory of beneficial electrification and emerging challenges.

The Four Pillars of Beneficial Electrification

Beneficial electrification delivers benefits under one or more of four pillars, without negatively impacting the others.

1

Cost Savings

Electrification has lowered energy bills for households and fuel costs for certain drivers. In sectors like agriculture and ports, strategic deployment of efficient electric technologies can reduce costs.

2

Product Quality

Electric options have improved comfort, safety, and performance, from quieter vehicles and cleaner indoor air to more consistent heating and cooling.

3

Grid Resilience

Flexible electric loads – such as EVs and smart appliances – have shown potential to ease grid stress and improve utilization of the grid by reducing peak demand.

4

Environmental Performance

Switching from fossil-fueled to electric appliances avoided locking users into decades of emissions, with benefits growing as the power sector decarbonizes.

Note: These four pillars were first defined by the Beneficial Electrification League (BEL). For further background, see the BEL website.

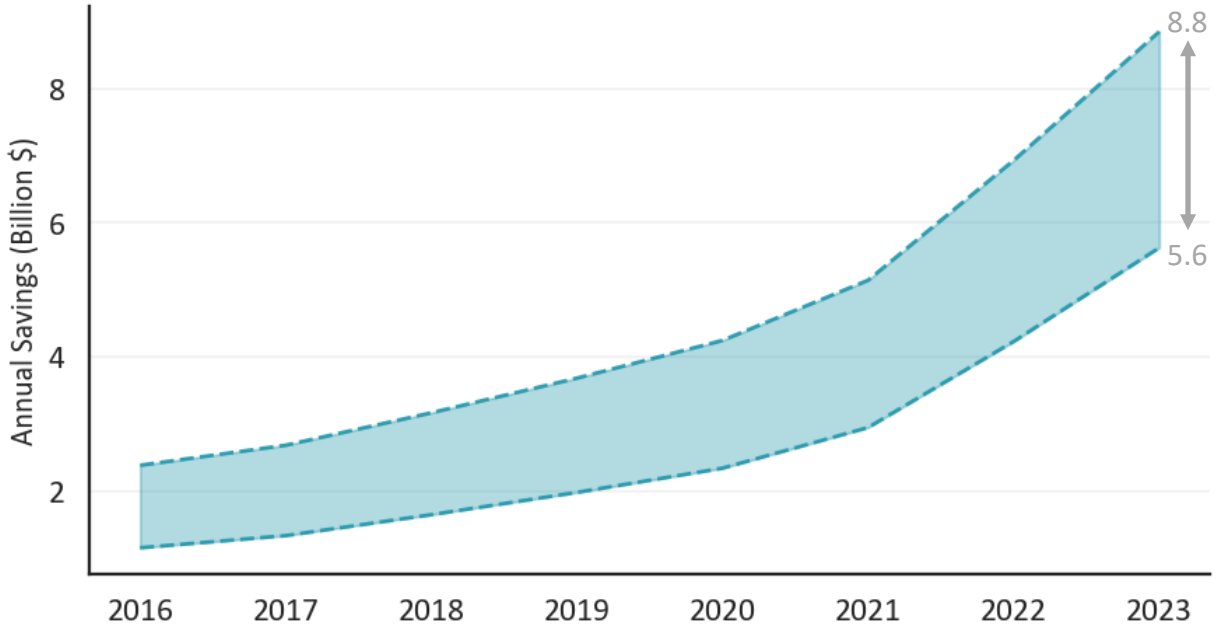
Cost Savings

1

Electrification has delivered billions of dollars in household cost savings over the past decade.

- Operational savings have helped offset the higher upfront costs of many electric technologies, which are often more sensitive to changes in incentives and policy support.
- Across technologies, households have saved billions in operational costs as adoption has increased.
- Heat pumps: We estimated $15–35B in cumulative household savings (2009–2024) among customers switching from non-gas fossil fuel heating. BEVs: We estimated $13–17B in cumulative owner savings (2016–2023) from lower fuel, maintenance, and operating costs.

ESTIMATED TOTAL U.S. HOUSEHOLD OPERATIONAL SAVINGS FROM HEAT PUMP AND EV ADOPTION



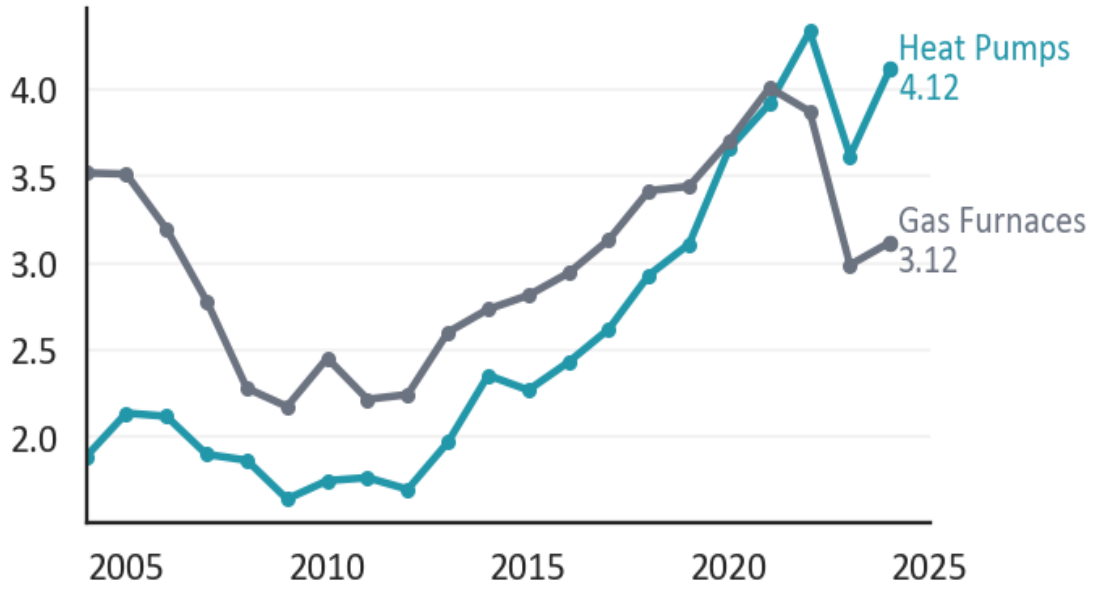
Sources and notes: 1) Heat pumps: savings estimated using RMI adoption data, assuming only households heating with fuel oil or propane experience savings, at a level of $550–$1328 per home (RMI, 2024, NREL, 2024). 2) Electric vehicles: savings estimated using vehicle registrations from Alternative Fuels Data Center, DOE and fill-up savings from Energy Innovation, 2023, assuming 45 fill-ups per year. See appendix for additional detail. All savings are expressed in real 2024 dollars.

Cost Savings (cont'd)

1

Since 2021, heat pump shipments have surpassed gas furnaces; in 2024 they were 32% higher.

AIR-SOURCE HEAT PUMPS AND GAS FURNACES SALES (MILLION)



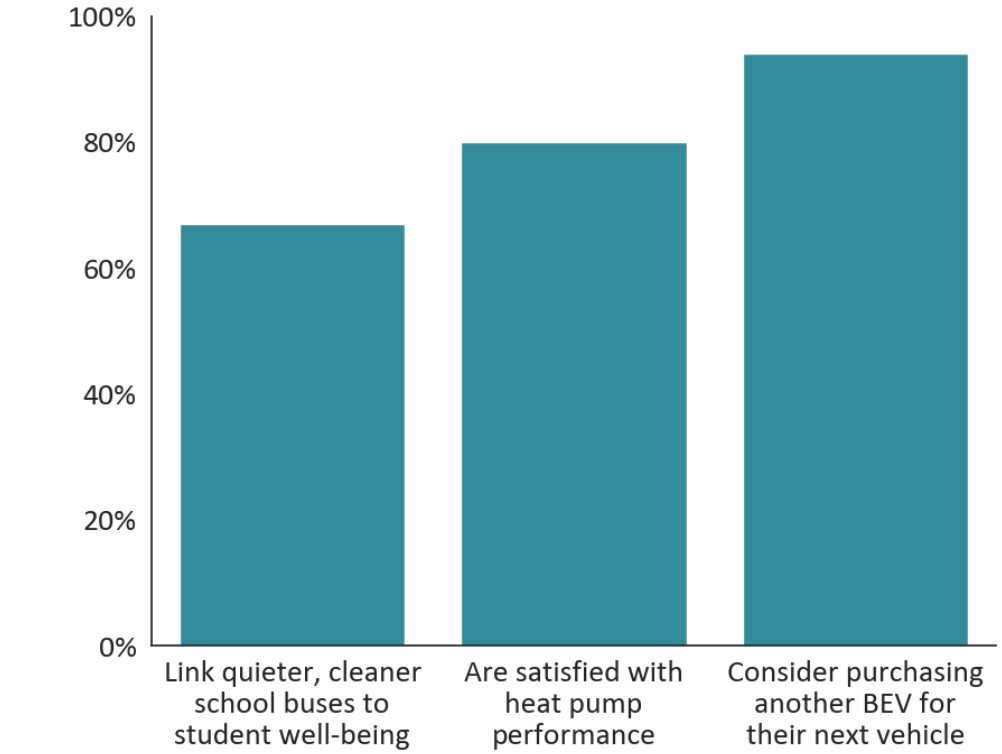
Source: Air Conditioning, Heating, & Refrigeration Institute, Monthly Shipments Report (Heat pumps vs Gas Furnaces).

Product Quality

2

Over the past decade, customers who have switched to electric technologies have reported high levels of satisfaction.

- Survey data indicates strong customer satisfaction and positive perceptions of electric technologies across multiple sectors.
- Compared to traditional fossil-fuel technologies, electric technologies offer thermal and physical comfort for users and reduce noise pollution in residential and commercial settings.
- Electrification of transportation, freight, and port operations helps reduce combustion-related local air pollution and deliver public health benefits.



Sources and notes: Survey of U.S. parents and voters on electric school buses (Forbes, 2025); Consumer survey of heat pump owners (Eunomia, 2023); EV Satisfaction survey (JD Power, 2025).

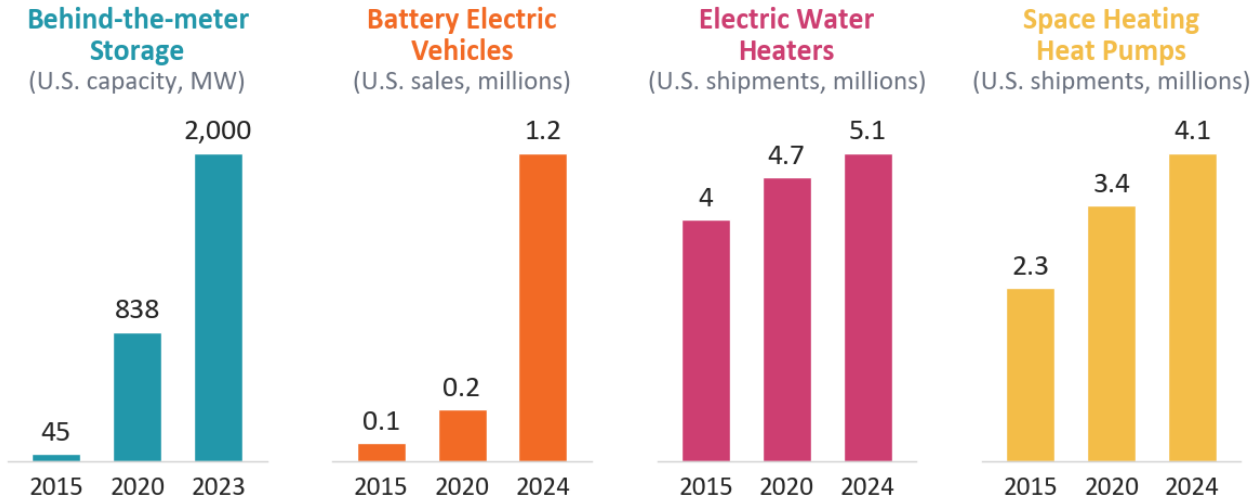
Grid Resilience

3

Flexible behind-the-meter (BTM) technologies have provided substantial grid benefits, primarily as capacity or an emergency resource.

- Uptake of flexible behind-the-meter (BTM) technologies has increased substantially in the past decade.
- These technologies are controllable and able to respond to real-time grid signals to help optimize grid operations and investments.
- U.S. demand response programs provide on the order of 60 GW of capacity, roughly equivalent to 270 combustion-based peaker plants.

UPTAKE IN FLEXIBLE BTM TECHNOLOGIES (2015–2024)



Source: NREL, 2021 and The Brattle Group, 2023

Source: Argonne National Lab., 2025

Source: Air-Conditioning, Heating, and Refrigeration Institute, 2025

Source: Air-Conditioning, Heating, and Refrigeration Institute, 2025

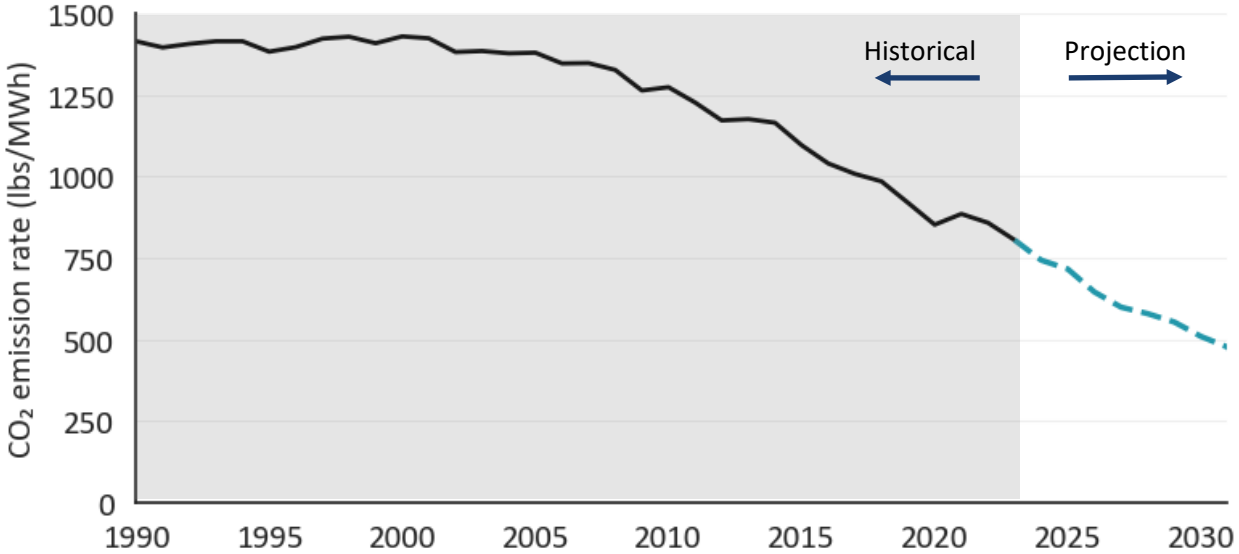
Environmental Performance

4

Power sector decarbonization and technology efficiency improvements have driven significant greenhouse gas emissions savings from electrification.

- From a CO_2 emissions perspective, U.S. electricity generation is significantly cleaner than a decade ago.
- As the grid decarbonizes, both existing and newly adopted electric appliances become cleaner over time.
- We estimate emission savings from heat pump and battery electric vehicle adoption in the order of 63 million tons of CO_2 during the eight-year period between 2016 and 2023.

US POWER SECTOR CO_2 INTENSITY



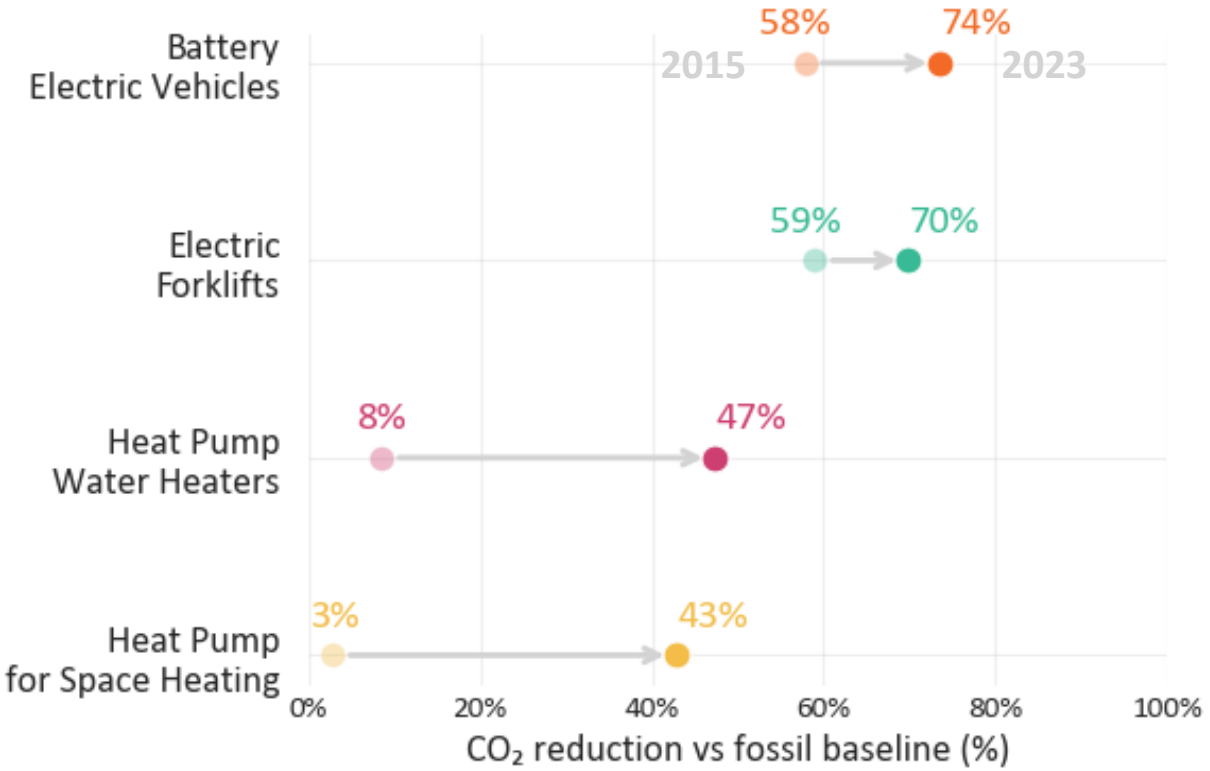
Sources: Historical emission intensities are from the EIA State Electricity Profiles, Table 7. Forward-looking projections are derived from EIA Annual Energy Outlook (AEO 2025), Reference Case, Table 18 and Table 8.

Environmental Performance (cont'd)

4

The emissions savings from individual electric technologies relative to fossil-fueled technologies has increased significantly. In addition to a cleaner power system, this is driven by improved efficiency of the electric technologies.

EMISSIONS SAVINGS OF ELECTRIC VS FOSSIL-FUELED TECHNOLOGIES



Sources and notes: EIA (2015, 2023 CO_2 national-average grid intensity); EPA (natural gas emissions factor of 53.06 kg/MMBtu); NREL (ASHP COP and HPWH COP ranges); EPA (400g CO_2 /mile for gasoline cars); NREL & Fueleconomy.gov (0.29–0.34kWh/mi for BEV); DNV (forklift duty cycle: diesel 495 MMBtu/yr; electric 103 MMBtu/yr). Emissions are use-phase only. See appendix for additional detail.

Looking Ahead: Overcoming near-term challenges

A new set of challenges has emerged. Sustained momentum with beneficial electrification will depend on technological progress, improvements in customer engagement, and policy action, among other factors.

Rising electricity prices

Retail rates are increasing in parts of the U.S., which can erode electrification cost savings.

Continued technology improvements can offset higher prices and keep lifecycle costs favorable.

Grid strain from new loads

AI/data centers and transportation electrification are creating resource adequacy and network challenges.

Load flexibility and improved grid planning/operations can provide the needed capacity.

Consumer cost pressures

Higher electricity bills may slow adoption.

But long-term fuel and O&M savings, improving efficiency, and strong consumer preferences for cleaner/convenient technologies can sustain momentum.

Uncertain policy environment

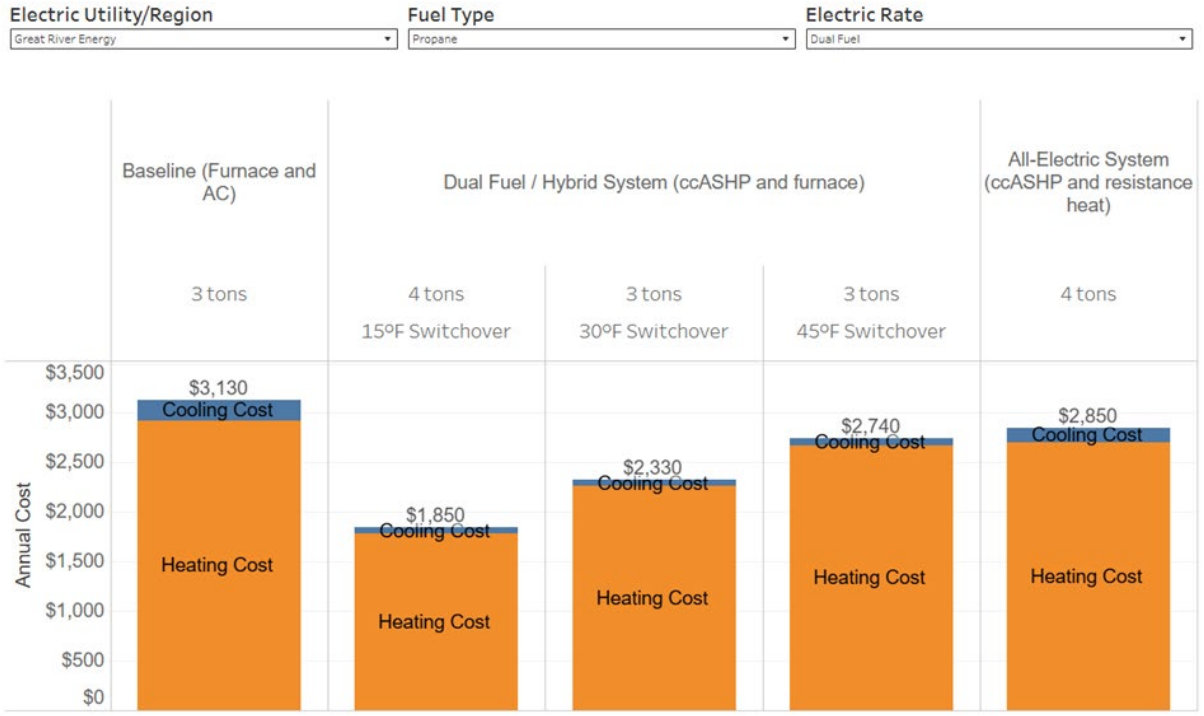
Shifting policies, changing incentives, and infrastructure bottlenecks create risks for utilities, investors, and customers.

Stable, predictable policy is essential to capture electrification’s full benefits.

Great River Energy's beneficial electrification journey

Jeff Haase
Director, Member Services

Minnesota ASHP Collaborative



ASHP
air source heat pump collaborative

The Minnesota Air Source Heat Pump (MN ASHP) Collaborative is a **statewide initiative** dedicated to advancing the **adoption of energy-efficient air source heat pumps**.

We work alongside market actors, from contractors to utilities, to homeowners and local governments, the Collaborative **provides resources, training, and up-to-date technology data** to accelerate the market for ASHPs.

Xcel Energy
CenterPoint Energy
minnesota power
Great River Energy
Otter Tail Power Company
Minnesota Energy Resources
Southern Minnesota Municipal Power Agency
Missouri River Energy Services

ASHP

Projects and partnerships

EPRI GridFAST

MINNESOTA TRUCKING ASSOCIATION MTA

GREAT RIVER ENERGY

Electric fleet fueling partnership

Site Host Application

The electrification of commercial fleets is taking place in different parts of the country, which is presenting new challenges to electric utilities and fleet operators. Great River Energy is proactively addressing these challenges by seeking to partner with a local fleet operator with plans to electrify all or a portion of their vehicle fleet.

The objective of this pilot is to work with an electric vehicle fleet fueling site to deploy, test and document new utility processes, equipment and interim power solutions. The goal of the initiative is to provide the electrical capacity and power needs reliably and safely in a timely and cost-effective manner.

In return, the site host partner is eligible to receive project contributions from Great River Energy. The details of what will be committed to the selected project site will vary based on its location, project scope and timeline. These identified solutions will be mutually agreed upon once a suitable site and project scope is determined.

General details and site host requirements

- The primary electric fueling site must be located within the service territory of a Great River Energy member-owner cooperative. If multiple sites are needed for the fleet, it is preferred all fueling sites be served by one of our member utilities. A map of our service territories can be found at https://greatriverenergy.com/cooperative-benefits/#member-owner-cooperatives
- Single depot location fueling (return to base) sites are preferred; however, hub and spoke and short haul end-to-end operations that require two or more fueling locations will be considered.
- "Behind the fence" fleet fueling depot-style sites that will require several direct-current fast chargers (DCFCs) are preferred, as opposed to public DCFC sites for light-duty electric vehicle fueling of non-fleet vehicles. Non-typical fleet fueling locations will still be considered.
- A site host with a need for electric infrastructure to serve a large electric fueling load (>0.5 megwatt nameplate connected load) is preferred.
- Sites with plans to break ground within the next 24 months for at least phase 1 of their electric vehicle deployment are desired.
- Partner is expected to bring their own electric vehicles. Our intent is to assist with the charging infrastructure, grid and associated equipment only.

ELECTRIFY AND SAVE

Beneficial Electrification:

Tri-State Generation and Transmission Perspective

Peter Rusin
Senior Electrification Manager

Progress: Beneficial Electrification as a Jumping Point

Quick Tri-State Facts:

- 40% of households served by members have propane heating
- 56-70% of average home utility spend is for space conditioning and water heating
- Since 2020 Tri-State has focused the residential program (marketing, incentives, training) around Beneficial Electrification

What has happened on the ground?

- In 2020 only 2% of members would consider an air source heat pump for space conditioning compared to over 60% in 2025.
- Most electric utilities within Colorado have voluntarily worked together to set heat pump specifications for incentives in 2023 and in 2025 unified contractor requirements
  - BEL National instrumental in setting up the framework and continued success
- Dual fuel heat pumps changed the equation on cost effectiveness with more kWh sales - Reduced summer capacity and avoiding the winter peak

Potential: Where are We Going with BE

Maximizing Value at the Household Level:

- EV chargers, air source heat pumps, and heat pump water heaters can all be controlled
- Utilizing load flexibility to reduce capacity needs and utilize lower cost power
- Supporting member-utilities battery program development to compliment the electrification measures

The Great Frontier of Commercial / Industrial:

- 50% electrification is better than 0%
  - Dual fuel roof top units are becoming a program focus
- Minimizing large industrial electrification with efficiency
  - Find ways to incorporate demand response
- Support creativity