CHROMALOX

ACHIEVING DECARBONIZATION THROUGH ELECTRIFICATION:

Where & How to Start Your Journey

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EXECUTIVE SUMMARY

Decarbonization, while hugely important to the future of our world, is one of the most difficult challenges for global industry to overcome. And while there's no "plan B" for the planet, there's also no way to tackle decarbonization without making significant technology and process changes.

The good news is there are several viable technologies available that are direct replacements for fossil fuel-fired processes. But without the right strategy influencing technology choices or processes, something that's billed as positive change can prove to be an inefficient and costly exercise.

In this white paper, we'll take a close look at the biggest decarbonization challenges facing industrial organizations and the most popular electrification technologies available today.

We will also explore the critical role electric resistance technology (ERT) can play in industrial electrification and suggest a best practice strategy that's applicable wherever you are in your decarbonization journey.

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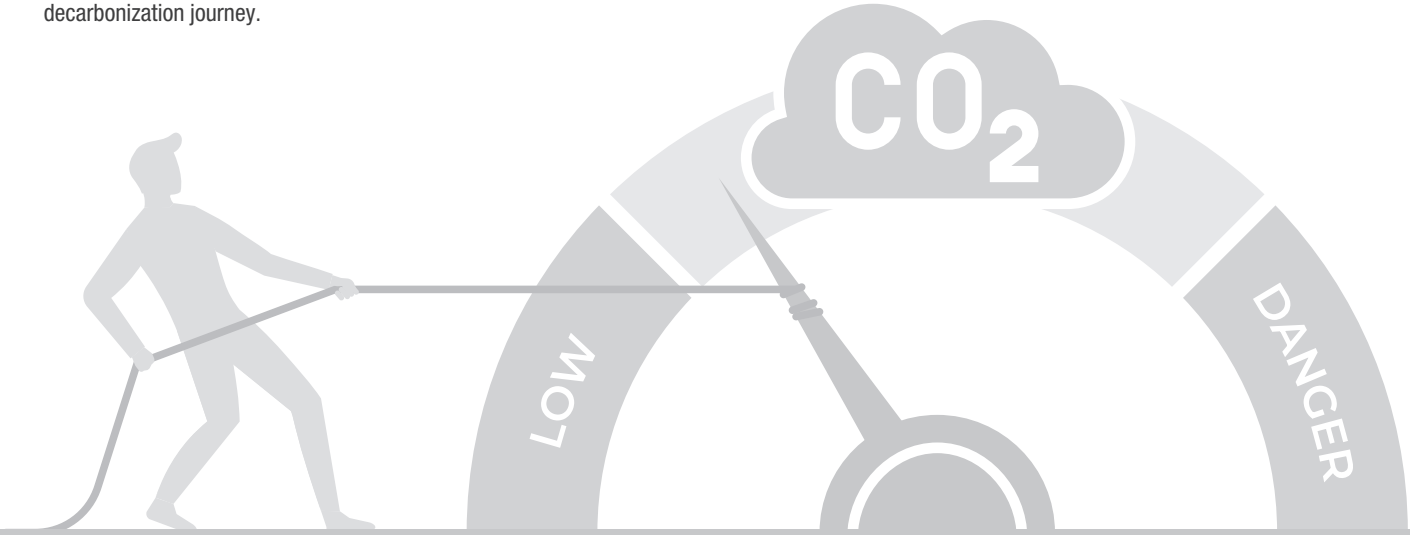


Decarbonization isn't a luxury— it's a necessity.

Decarbonization is a priority for most organizations now—not least in industry and large-scale manufacturing, where most processes are highly energy-intensive and operate at significant scale. This means that as global energy prices continue to rise, there's a clear need to reduce costs where possible for more healthy balance sheets and decarbonize to address the climate change emergency.

Increasing local and international legislation is also putting significant pressure on organizations to reduce and even eliminate their carbon emissions. For example, industry is now regulated by scope 1, 2, and 3 emissions designed to reduce the amount of carbon created, part of The Greenhouse Gas Protocol's greenhouse gas (GHG) accounting standards.

SUSTAINABILITY IS UNDER INCREASING SCRUTINY

Governments are also increasingly demanding that organizations report on their environmental, social, and governance (ESG) performance annually. And as the drive to achieve net zero by 2050 draws ever closer, heavy industry in particular needs to achieve a 93% reduction in carbon emissions. This is a substantial reduction from its current situation, where it accounts for a third of energy use and a quarter of GHG emissions globally.

These two drivers mean that those responsible for monitoring and helping accelerate their organization's sustainability efforts are under substantial scrutiny.

Board-level management and key stakeholders are under pressure to act on organizational sustainability commitments and demonstrate they're in control. They want to know there's a plan to optimize their organization's energy-intensive processes.

Organizations also need to consider their public perception. If the public—including pivotal shareholders—don't have evidence that an organization is taking action to reduce carbon emissions, brand reputation and even revenue can suffer.

What's holding organizations back from decarbonization?

One of the biggest challenges organizations have is replacing fossil fuel-powered processes without compromising their quality or the organization's top-line revenue. Ensuring replacement technology complies with the latest—and even future—standards and regulations while meeting sustainability targets is no mean feat. And that's not to mention completing the job at hand safely and efficiently at the right price.

For financial controllers, understanding detailed return on investment calculations is an absolute must. So, any replacement technology needs to be fully costed and bespoke to the organization's exact needs—something that can be challenging without the right systems and data.

PHYSICAL BARRIERS CAN RESTRICT TRANSFORMATION

Many organizations also simply don't understand their options. With so many other operational factors to manage, combined with the ease of keeping the status quo, this is no fault of their own.

Even for organizations that know how to make the switch, physical barriers can often get in the way. For example, switching from fossil fuels to electricity isn't necessarily straightforward for high-voltage processes, needing electricity grid suppliers to alter key transmission infrastructure, or even make changes to their generation regimes.

And with significant numbers of industrial organizations looking to electrify, electrical grid suppliers need to prioritize infrastructure changes and renewals, which means some organizations will lose out.

But the truth is, while these challenges have been enough to hold many organizations back, the consequences of failing to act are far more damaging. Senior leadership and key stakeholders will demand to see results—particularly where they've made sustainability and efficiency promises to the public and shareholders.

For critical roles responsible for a company's decarbonization focus, such as sustainability and facilities managers, the need to make good on their accountability and do the right thing has led to more organizations than ever taking action to decarbonize. That's why so many organizations are turning to electrification technologies to replace fossil fuel-powered processes.

What are electrification technologies?

Electrification technologies are the electrically-powered equivalents of fossil fuel-powered technologies. In the case of industrial processes, this primarily means natural gas steam and hot water boilers, thermic fluid heaters or hot air systems, but can also include petroleum-fueled equivalents.

From low to high-temperature heat applications, electrification can replace traditional fuels in almost any large-scale industry, including processes such as washing, food preparation, drying, evaporation, distillation, and even steam reforming and cracking in petrochemicals.

And, as we'll explore later, electric resistance technology in particular holds the key to replacing fossil fuel-powered boilers.

KEY ELECTRIFICATION TECHNOLOGIES

Heat Pumps

While heat pumps are a popular way to replace residential gas-fired boilers, they're being increasingly used for commercial and industrial applications, such as low-temperature processes, hydronic systems, and some low-pressure steam applications.

But while heat pumps are a viable alternative to fossil fuel-fired systems, they have moving parts like their older contemporaries, so installations can often be complex and expensive, requiring large footprints. And in colder climates, heat pumps can struggle to work efficiently, affecting their coefficient of performance (COP).

Heat pumps also rely on refrigerants that have global warming potential magnitudes higher than CO_2, are prone to leaks, and create significant end-of-life disposal challenges.

Electrodes

Electrode technology has served industry for decades, providing a solution for electrified steam and hot water production.

But as the demands on industrial technologies become more sophisticated, electrodes risk organizations being left behind.

For example, electrodes have large – and often vertical – footprints, but many industrial facilities simply don't have the head room. There are also costly chemical treatment and feedwater quality considerations.

What's more, maintenance can be wide-ranging, covering multiple moving parts and pumps. And with more complex systems comes greater safety considerations, particularly around arc overs, foaming, and insulators.

However, even if you ignore the disadvantages, these technologies alone can't help organizations shift to electrification and decarbonize.

AT A GLANCE: THE KEY BENEFITS OF ELECTRIFICATION

- ✓ Eliminate on-site Scope 1 emissions
- ✓ Eliminate Scope 2 emissions when powered by renewables
- ✓ Gain highly efficient energy to usable heat conversion
- ✓ Remove the complexity & cost of combustion-reliant energy sources
- ✓ Reduce maintenance costs & downtime

Electric Resistance Technology (ERT): A proven electrification tool for greater efficiency, cost-effectiveness, & safety

For more than a century, ERT has proven itself as a tried and tested technology in a wide range of industrial, commercial, and residential heating applications. It operates on the premise of Ohm's law, where a current is passed through a resistance coil, which generates heat. That heat is then transferred through dielectric material and emits from a metal sheath surface into the process.

The technology is highly versatile, serving countless hot water and oil, steam, and hydrocarbon gas applications, and even works in nitrogen and hydrogen processes.

But ERT's biggest application today is replacing fossil fuel-based heating use cases, offering greater efficiency, control, and simplicity while needing far less maintenance.

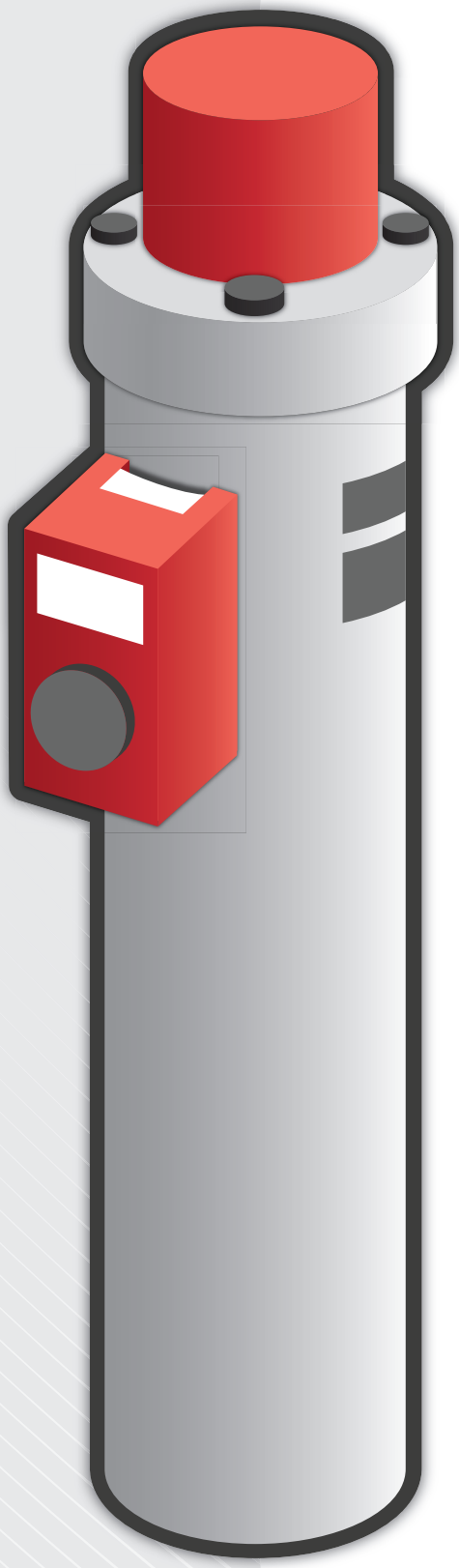
FEWER COMPONENTS MEANS GREATER RELIABILITY

ERT can also replace traditional electrodes as a way of producing hot water and steam. Unlike electrodes, ERT has no moving parts, reducing maintenance requirements. With no chemical dosing motors or hydraulic systems, ERT requires fewer components, reducing the risk of downtime and eliminating the substantial impact of chemical dosing.
ERT is also electrically isolated from water, making it a far safer alternative to electrodes.

In addition, ERT offers significant efficiency savings compared to an electrode, for example, eliminating the need for power-consuming pumps and motor systems.

And ERT is useful for far more than just straight replacement applications. It's increasingly common in cold-climate air-source heat pumps, where units can often struggle with efficiency and meeting required temperatures. ERT can be used to boost or pre-heat hydronic or air lines for heat pumps, bringing them in line with expected efficiency levels.

ERT is also used for heat tracing. For example, by managing temperature across a network of pipes in a cold climate, ERT can ensure pipes flow freely and don't freeze.



In focus: Utility company targets zero emissions

An electric utility company wanted to replace its oil-fired power plant boiler to achieve zero emissions, but the company was under strict time constraints and needed to replace a 2 MW application.

Keeping in mind the organization's time constraints, we worked closely with the company to recommend a previously designed 2,280 KW @ 480V 3PH steam generator, helping save precious engineering and manufacturing time.

The new system has far fewer moving parts to reduce maintenance costs and system complexity compared to a fossil fuel-fired boiler. It also features an auxiliary heat recovery steam generator for greater efficiency when the power plant is idle.

The auxiliary steam also provides a saturated steam source which is then superheated by a Chromalox model GCHIS circulation heater to pre-heat the seal glands on the steam turbine.

By eliminating its backup fuel oil storage tanks and gaining fast generator start-up capabilities, the company has achieved its zero emission sustainability requirements.

Other benefits include:

- A precise power control that provides efficient and effective use of available electricity— even with fluctuating steam flow demands.
- A bundled steam generator and superheater— for design uniformity and single source responsibility.
- Fully insulated steam generator vessel and interconnecting piping shipping— to reduce field installation cost and energy loss.
- High heating element corrosion resistance— with long life Incoloy sheathed electric heating elements.

Taking your 1st step: Conducting a decarbonization assessment & designing a roadmap

While it's tempting to tackle your biggest challenge first when embarking on an electrification journey, this is rarely the most effective approach. For example, replacing a large gas-fired boiler with an electric alternative will decarbonize the heating process. But if the infrastructure around it —such as pipework and supply— is old and inefficient, you can risk making the wrong decisions, such as installing an overpowered electric system.

So, having an experienced partner to help guide the assessment and implementation processes, like Chromalox, can pay dividends. But when it comes to electrification strategy and planning, what does good look like?

1. DECENTRALIZATION

At the decentralization stage, it's important to think about a wide range of solutions that can place heat directly where it's needed, such as point-of-use steam generators, tank heaters, heat transfer systems, process air heaters, and comfort heaters.

Looking at decentralized process heating methods can help reduce combustion equipment demand to lower emissions and increase efficiency by minimizing transfer losses from the source to the user.

TOP TIPS:
- Take a broad approach to what you need.
- Decide what you're trying to achieve.
- Look at the thermal load and the overall system.
- Apply scalable electric heaters in point-of-use applications to remove the burden from central systems, which cuts emissions, improves efficiency, and offers better process control.

2. OPTIMIZATION

Optimization is about minimizing losses and improving the system. It can help you reduce unnecessary heat loss (heat trace) and improve process media quality with booster heaters, reducing inefficiencies, waste, and excess maintenance costs while boosting overall performance.

For example, steam superheaters and heat tracing systems can help you mitigate heat loss or boost your steam quality to keep your process running effectively and efficiently. It's something Chromalox specializes in, working with our colleagues in Spirax Sarco to optimize steam systems.

TOP TIPS:
- Identify opportunities to improve system function.
- Look for quick wins to enact faster change.
- See how complexity can be more effectively managed.
- Identify CapEx investment for more accurate planning.

3. DECARBONIZATION

Once you've identified point-of-use opportunities and optimized your system, it's time to decarbonize your remaining fossil fuel systems based on true demand.

One solution is to use Chromalox DirectConnect™ medium voltage technology to address large central combustion systems where conventional electric systems may not have been viable. This can reduce infrastructure and wiring losses, and simplify your installation.

TOP TIPS:
- Now you've reviewed your overall infrastructure, decide what you need from your key system.
- Following the optimization stage, determine whether there's an opportunity to make your key system smaller & more efficient.
- Link your system selection to your decarbonization goals & roadmap.

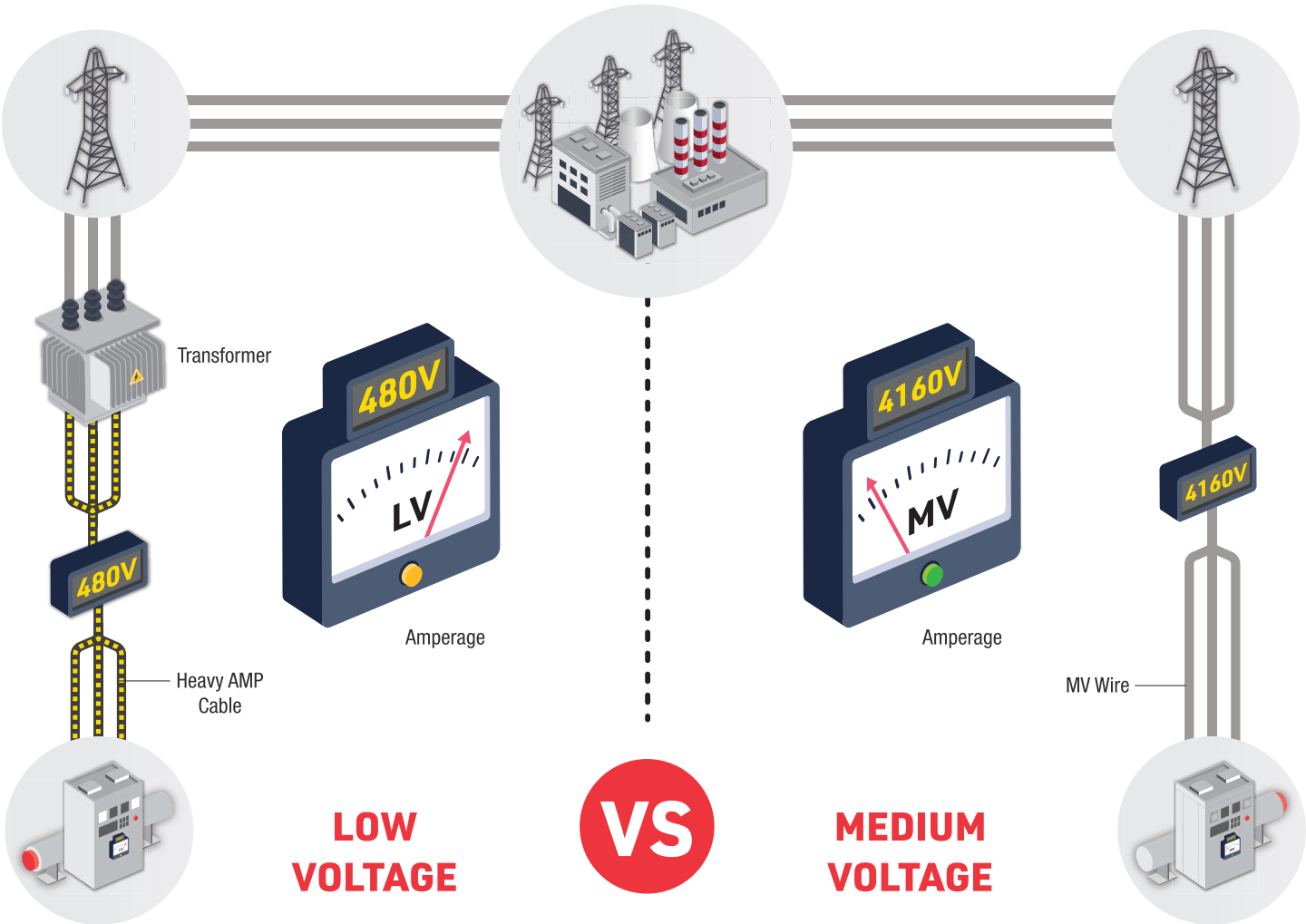
Chromalox DirectConnect™: Setting the new standard for industrial heating solutions

For electric heating projects, installation costs can quickly outweigh the costs of the equipment and start-up. The need for transformers, wiring, terminations, conduit runs, hangers, wire pulls, and inspections significantly increases the project costs.

DirectConnect™ medium-voltage electric solutions offer an answer to industries with large heating demands. Already at work in the power generation, oil and gas, and chemical sectors, these systems not only significantly reduce installation and lifecycle costs but also deliver emissions-free operations.

The technology reduces amperage, requires fewer, smaller wires, and is a fraction of the installation costs.
Also, taking advantage of medium voltages improves power distribution efficiency.

Our customers typically see:
- Reduced costs—through installation costs and total cost of ownership
- Greater energy efficiency—approximately 99% compared to rated efficiencies of fossil fuel-based systems



Take advantage of electrification and make decarbonization your strategic priority

While organizations must decarbonize their operations, they can and should take a strategic approach to how this transition happens, particularly around electrification.

From our decarbonization assessment to our products based on the industry's most advanced materials, we can help you navigate your electrification journey to decarbonize efficiently and cost-effectively.

To find out more about what we offer and how we can help your organization, get in touch with our team of experts today.

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