28 AUGUST 2025

Pathways to efficient industrial electrification

Jay Mullin
Energy management coach

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6708 7293

When you hear the word electrification in an industrial context, what is the first thing that comes to mind?

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Mentimeter

When you hear the word *electrification* in an industrial context, what's the first thing that comes to mind?

0 / 1

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Pathway to Industrial El...

Choose a slide to present

By the end of this workshop, you will be able to:

- Understand the landscape of electrification opportunities across different applications
- Evaluate the feasibility of sector-specific electrification opportunities
- Identify next steps to support your electrification plan

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Follow along in the participant workbook!

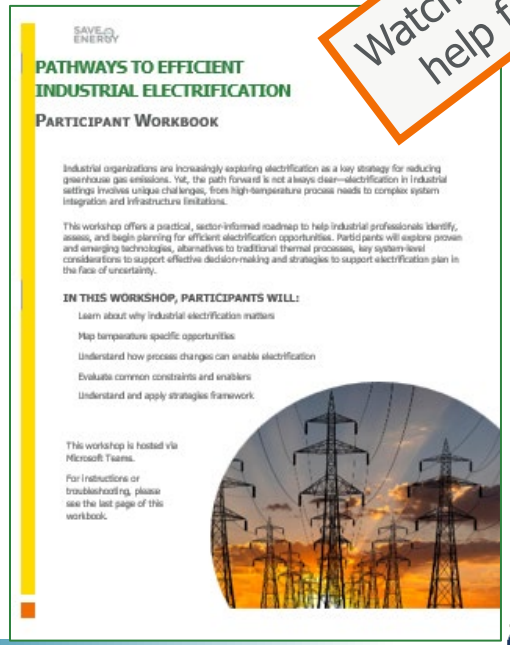
1

Watch for this icon to help follow along

Have the workbook open or printed out

Where to find the workbook:

- Click the link in the chat
- Download a copy to your computer
- Open and follow along



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What is driving decarbonization?

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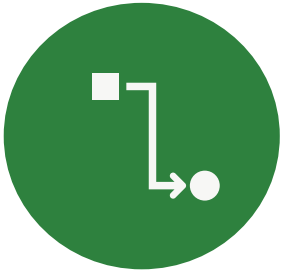
Policy momentum

- Canada's Net-Zero by 2050
- Clean electricity regulations
- Provincial mandates

Economic pressure



- Uncertain carbon pricing
- Energy cost stability
- Long-term resilience

Market mandates

- Environmental, social and governance (ESG) disclosure mandates
- Supply chain decarbonization demands
- Reputational risk

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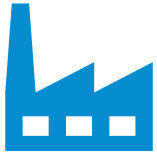
Department of Energy (DOE) pathways to net-zero road map

Energy efficiency

Material efficiency

Low-carbon fuels



Carbon capture

Electrification

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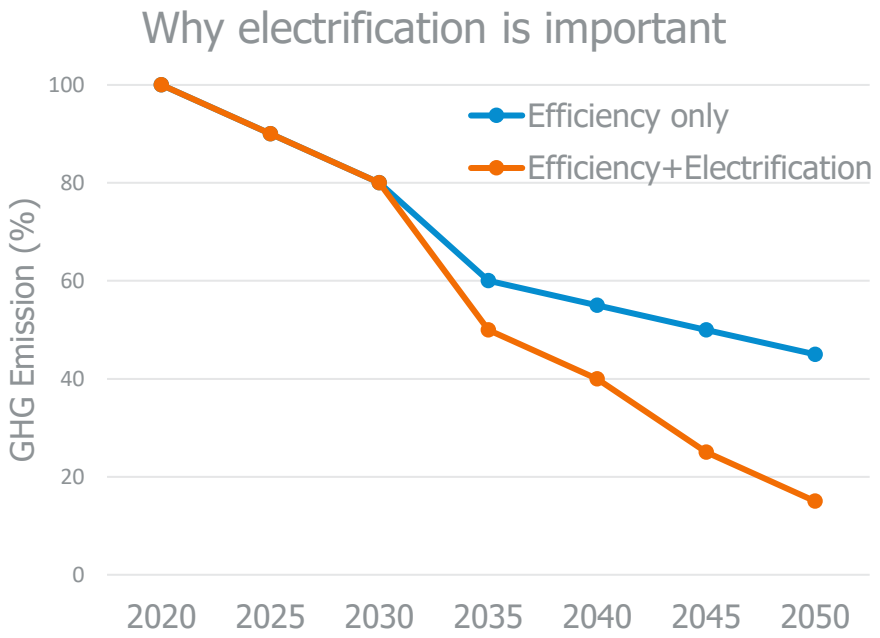
Why electrification is a key decarbonization pathway

Eliminates on-site combustion

Efficiency alone is not enough

Co-benefits beyond emissions



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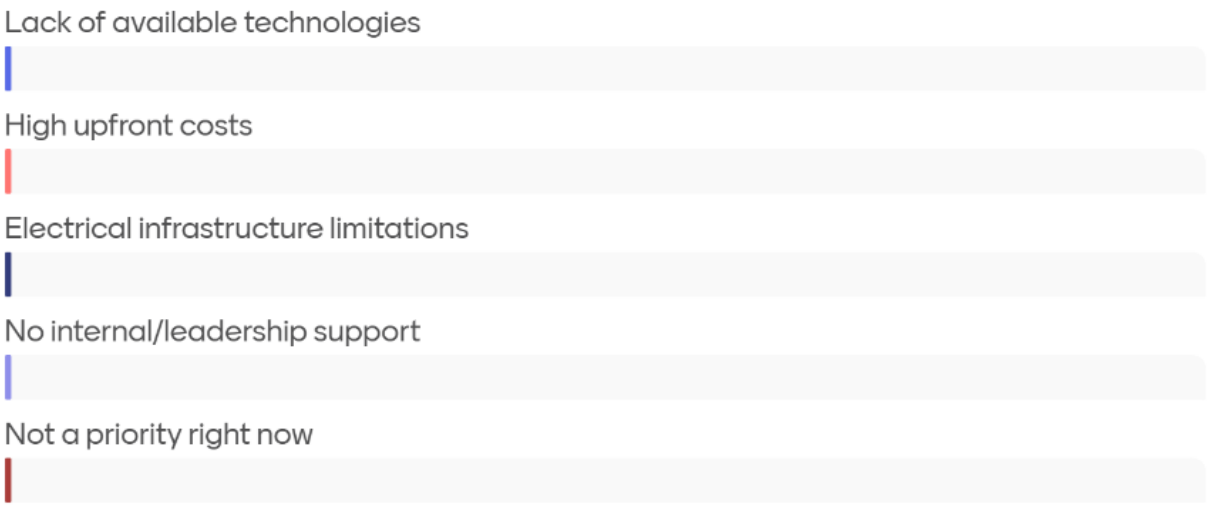
What do you believe is the biggest barrier to industrial electrification?



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Choose a slide to present

Why is industrial electrification not increasing faster?

Infrastructure constraints

Lack of available technology

Perceived high costs and low return on investment (ROI)

Misconceptions/ lack of awareness

Case study: 3M – advanced manufacturing*

Goal: net-zero greenhouse gas (GHG) emissions by 2050

Interim target: 50% reduction in Scope 1 and 2 emissions by 2030

Electrification actions: 3M's energy strategy includes mandating renewable electricity and embedding energy design requirements into capital investments, indicating a broader push toward electrification.

Drivers: carbon reduction goals, operational efficiency, safety improvements, and growing expectations from investors and ESG

*Source: https://www.3m.com/3M/en_US/sustainability-us/

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Case study: Cascades – pulp and paper (Canada)*

Goal: 38% reduction in Scope 1 and 2 GHG emissions by 2030

Actions: process redesign for thermal efficiency, electrification of dryers and heating systems in Quebec

Drivers: clean electricity supply and Quebec industrial electrification incentives

*Source: https://www.cascades.com/en/news/cascades-launches-its-fourth-sustainability-action-plan-driving-positive-change

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Case study: ArcelorMittal Dofasco – steel (Ontario)*

Goal: reduce GHG emissions by 60% by 2030

Action: transitioning from coal-based blast furnaces to electric arc furnaces (EAFs)

Impact: GHG reduction of up to 3 $MtCO_2e$ annually

Support: $400M in funding from the federal government (the Strategic Innovation Fund)

*Source: https://corporate.arcelormittal.com/media/press-releases/

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Understanding available technologies

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Temperature drives technology - 1

100°C to 300°C | 300°C to 800°C | 800°C to 2,000°C | >2,000°C

Low temperature: Common processes include space heating, washing, pasteurization, and other low-temperature applications.

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Temperature drives technology - 2

100°C to 300°C	300°C to 800°C	800°C to 2,000°C	>2,000°C

Medium temperature: Common processes include food processing and paint curing.

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Temperature drives technology - 3

100°C to 300°C

300°C to 800°C

800°C to 2,000°C

>2,000°C

High temperature: Common processes include metal treatment as well as glass and ceramic production.

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Temperature drives technology - 4

100°C to 300°C	300°C to 800°C	800°C to 2,000°C	>2,000°C

Very-high temperature:
Niche applications only

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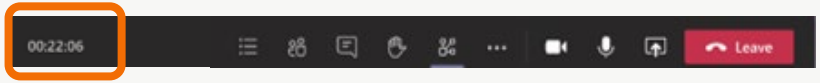
Breakout room activity

In your breakout room:

1. Discuss what fossil fuel-based heat sources are at your facility
2. Classify each process by heat source and temperature range
3. Estimate the % of total fossil fuel consumption for each

Keep an eye on the countdown timer in the top-left corner:



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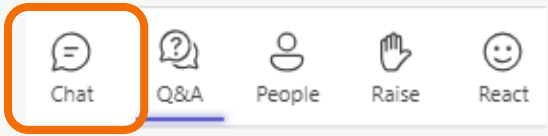

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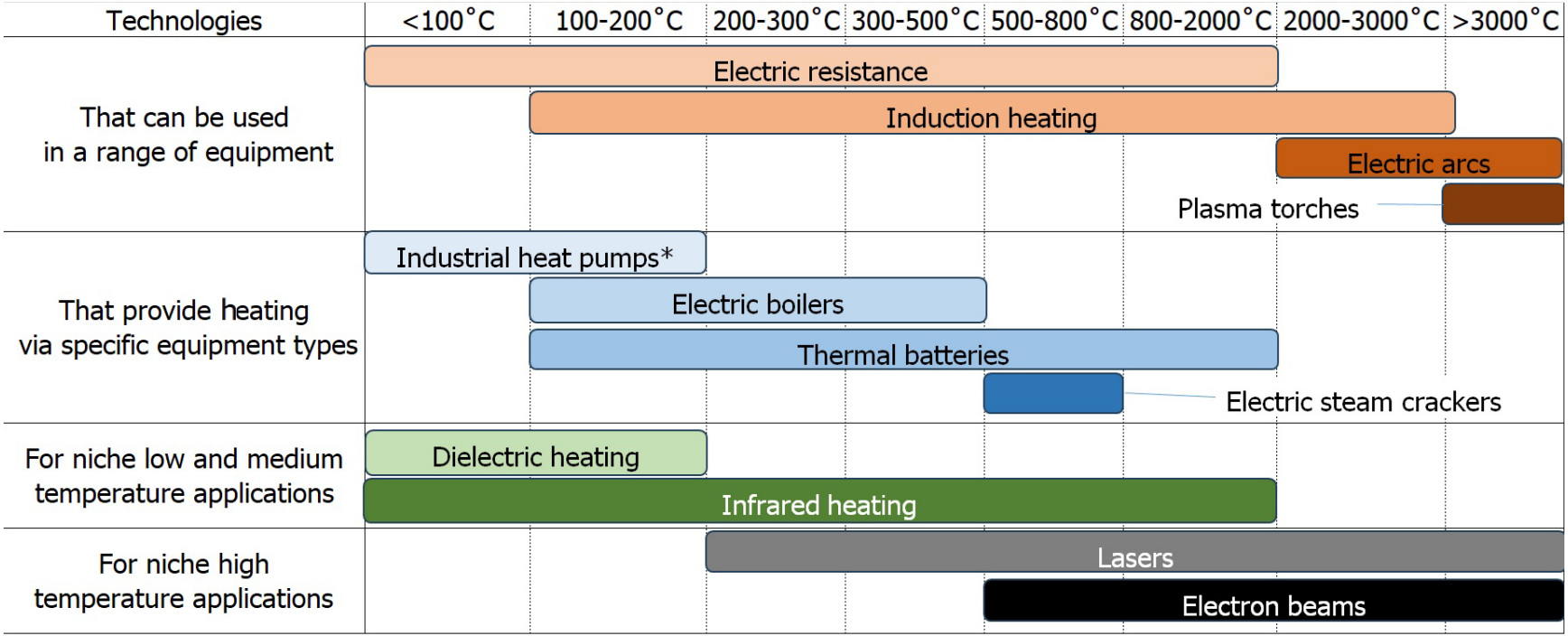
Electric technologies by process temperatures



*up to 160°C, some up to 200°C

Industrial electrified heating technologies and their ranges. (Image credit: Energy Innovation)

TRL = Technology Readiness Level

7

Technology	Application	Maximum temperature	TRL
Electric boilers	Conventional boiler replacements	500°C	11
Resistance heating	Ovens, melting metals or plastics, heating liquids or gases	1,850°C – 2,000°C	7-11
Induction heating	Metal processing	2,000°C	7-11
Plasma torches	Metal working, cement sintering	5,000°C	5-11
Electric arc furnace	Steel and metal processing	1,850°C	11
Thermal batteries	Ovens, melting metals or plastics, heating liquids or gases	1,000°C – 1,500°C	7-9
Dielectric heating	Curing, drying, pasteurization	100°C – 2,200°C	6-11
Infrared heating	Drying, curing, heat forming, laminating	1,370°C	11
Laser heating	Cutting, welding, sintering, engraving	Millions	7-11
Electron beams	Welding, machining, refining	5,930°C	2-5

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Industrial heat pump technology readiness level by temperature range

Temperature Range	1	2	3	4	5	6	7	8	9	10	11
<80°C											
80°C to 100°C											
100°C to 140°C											
140°C to 160°C											
160°C to 200°C								*			
>200°C											

Source: IEA. World Energy Report Special Report. *The Future of Heat Pumps.* 2022

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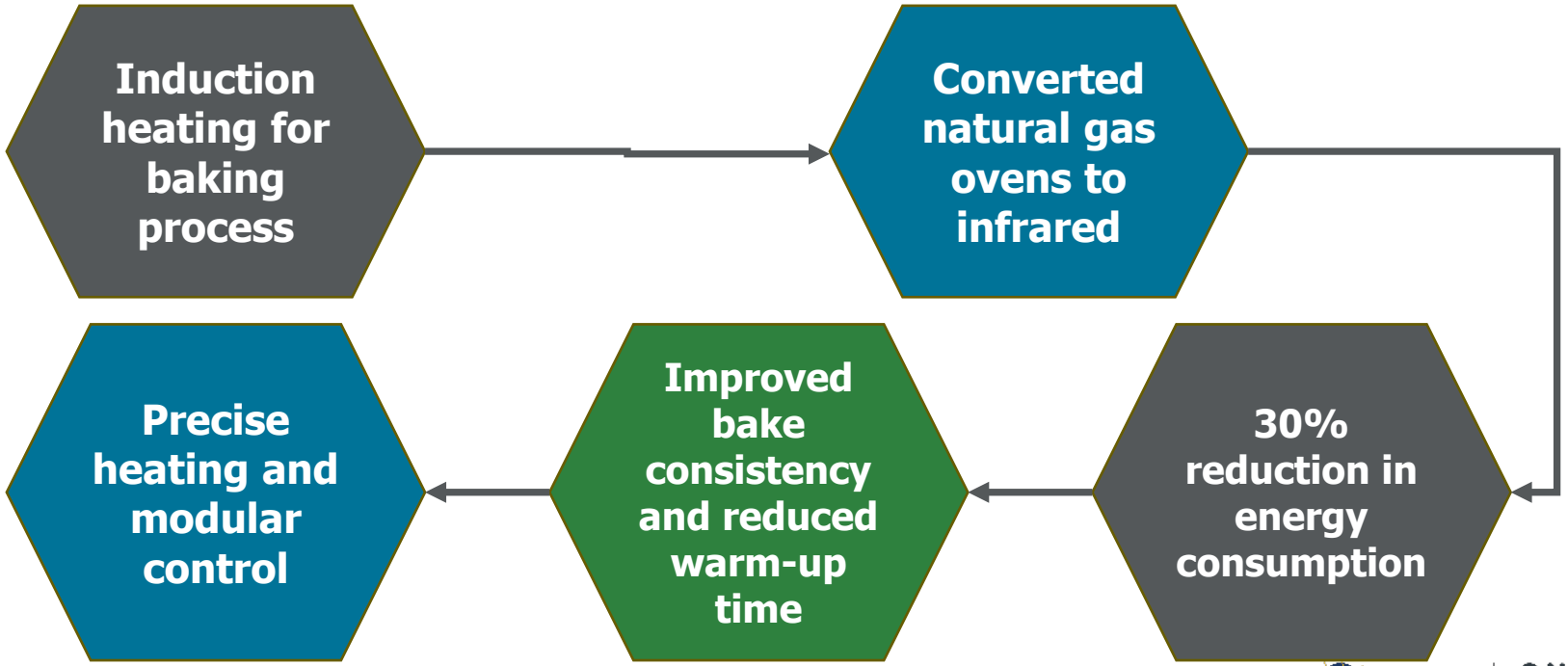
Sector-specific success stories - *La Brea Bakery*



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What about applications where an appropriate technology is not currently available or feasible?

Process redesign

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How can process changes enable electrification?

Lower temperature alternatives

Mechanical substitution

Non-thermal or chemical alternatives

Modular or batch operation

Hybrid or transitional system

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Lower temperature alternatives

What it means: adjust the process so it works effectively at a lower temperature

Example: extend pasteurization time at 70°C instead of 90°C

Benefit: enables the use of heat pumps, electric resistance or induction, which are more feasible at lower temps

Considerations: may increase cycle time or require quality verification studies

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Mechanical substitution

What it means: replace thermal processes with mechanical ones that use less energy or no heat at all

Example: use mechanical pressing or centrifuge instead of thermal drying

Benefit: dramatically reduces energy demand and can be electrified with motors and drives

Considerations: may require equipment redesign or handling modifications

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Non-thermal and chemical alternatives

What it means: use UV, microwave, radio frequency (RF) or chemical process instead of thermal ones

Example: UV curing of coatings instead of curing in an oven

Benefit: high efficiency, fast throughput, lower temperature and often better-quality control

Considerations: process compatibility, safety and worker exposure may need to be addressed

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Modular or batch operation

What it means: replace large centralized systems with multiple smaller electric units or transition from continuous to batch

Example: replace one large boiler with multiple point-of-use electric units or tankless heaters

Benefit: enables scalable electrification, more control and easier integration with renewable or off-peak power

Considerations: space, controls integration and maintenance coordination

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Hybrid or transitional system

What it means: implement a phased or blended approach to allow partial electrification or future conversion

Example: install a dual-fuel system or electric preheater or oversize electrical infrastructure during upgrades

Benefit: flexibility to decarbonize gradually while avoiding stranded assets

Considerations: may require forward planning and additional upfront investment

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Group discussion – rethinking your process

Think of your heat sources that may be challenging to electrify and write them in your workbook:

- Can the process operate at a lower temperature?
- Can the function be replaced with a mechanical process?
- Can the function be replaced with a chemical or other non-thermal process?
- Can the process be broken into smaller units or shifted to batch?
- Could the heat source be hybridized as a transitional step?

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Prioritizing and planning electrification - 1

Short term

- Low-cost optimization
- Cost-effective efficiency upgrades
- Cost-effective electrification, for example:
  - Steam tracing
  - Applications with production benefits

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Prioritizing and planning electrification - 2

Short term	Medium term

	• End-of-life upgrades
	• Avoid locking in high-emission systems
	• Plan for deeper retrofits, for example:
	  •High-temperature systems
	  •Process changes
	  •Infrastructure upgrades

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Prioritizing and planning electrification - 3

Short term	Medium term	Long term

		• Change processes
		• Integrate new technologies for high-temperature applications, for example:
		  • High-temperature heat pumps
		  • Other technologies

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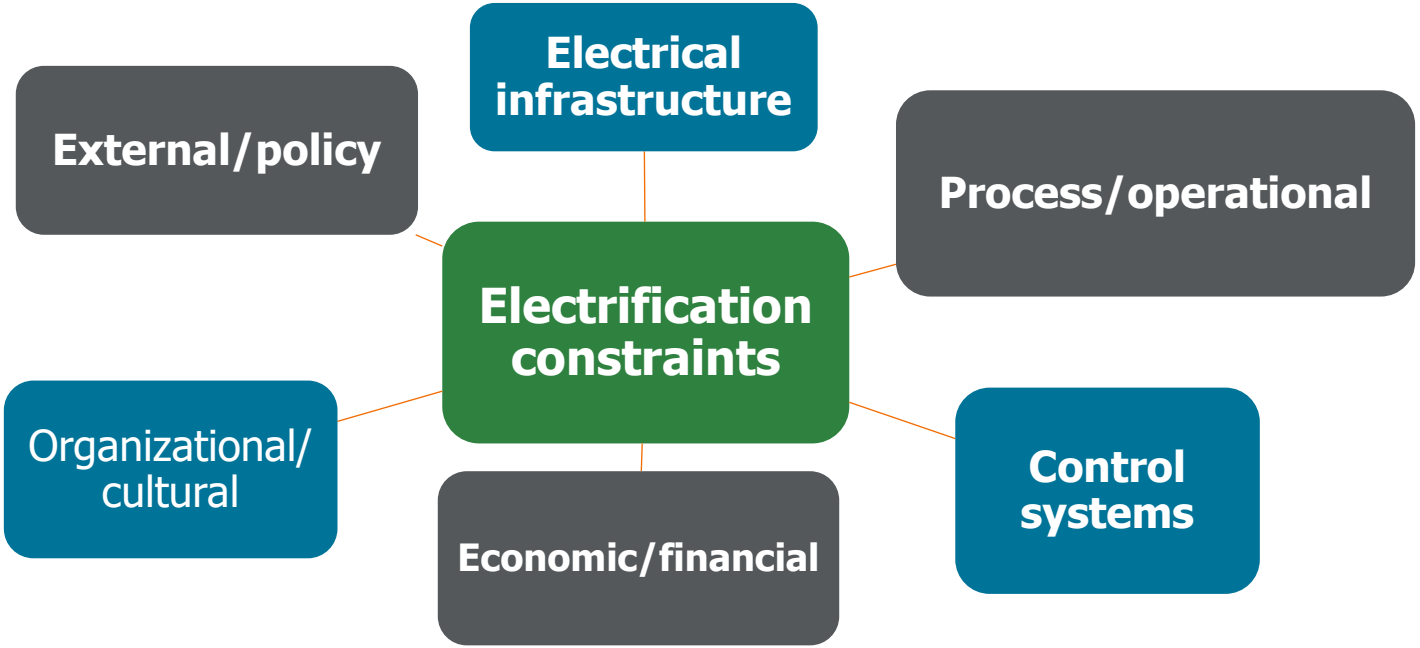
What is standing in the way — or pushing you forward?

Six common constraints to electrification readiness



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One Constraint that needs to be addressed at your facility that could be a barrier for electrification?

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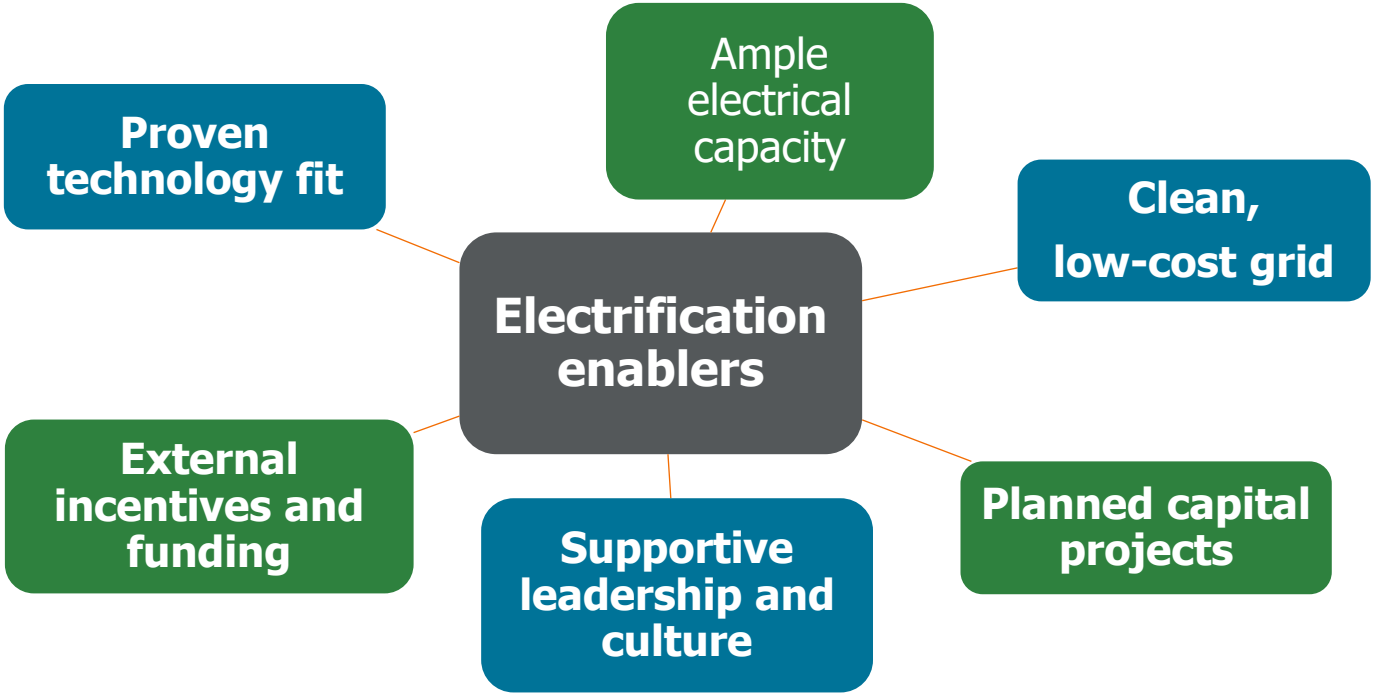
Six common enablers to electrification readiness



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One Enabler that you can leverage in your facility that could support electrification?

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From insight to action: building your electrification strategy

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Uncertainty as a planning factor

Uncertainty is inevitable

Manage, do not avoid

Scenario thinking

Risk of inaction

Start with what can be done now:

- Identify low-risk, high-impact opportunities
- Focus on quick wins that are aligned with current maintenance and operations budgets
- Bundle with ongoing energy or ESG initiatives
- Leverage co-benefits like maintenance reduction, process control, safety and efficiency

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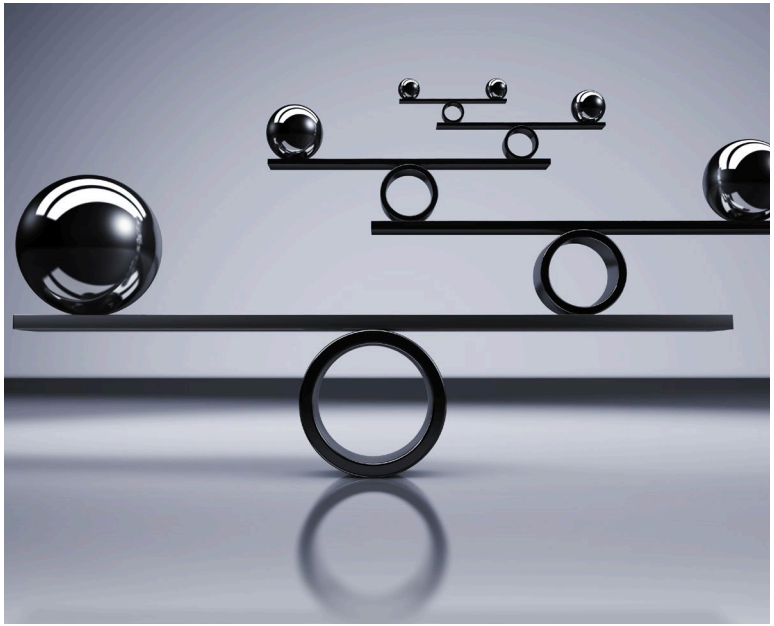
Identify knowledge or technology gaps:

- List processes suitable for electrification but not feasible today
- Determine whether a limitation is due to:
    - Technology maturity
    - Lack of internal expertise
    - Product/process validation requirements
- Plan to address through research, pilots, vendor trials or site-specific studies to close gaps



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Build in decision gates and triggers:

- Connect electrification opportunities to capital asset timelines:
  - Equipment nearing end-of-life
  - Facility expansion or renovation
  - Scheduled CAPEX planning windows
- Define triggers: incentives, tech readiness, carbon pricing, spark gap, equipment failure or retrofit opportunity
- Use structured decision frameworks to assess readiness (e.g. go, no-go checkpoints)

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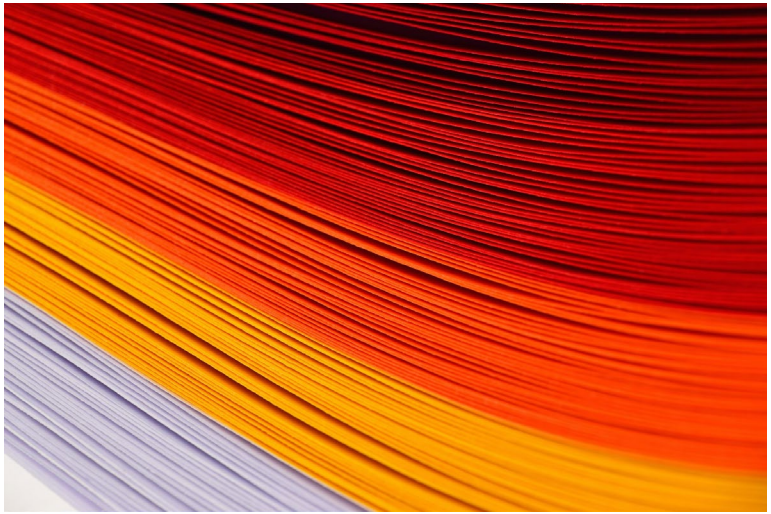
Design for flexibility and avoid lock-in:

- When replacements with electrified systems are not feasible now:
  - Choose modular or hybrid systems that can evolve
  - Oversize electrical panels for future electrification
  - Design pipe chases, ducting or spaces for future equipment
- Avoid long-life fossil investments unless adaptable



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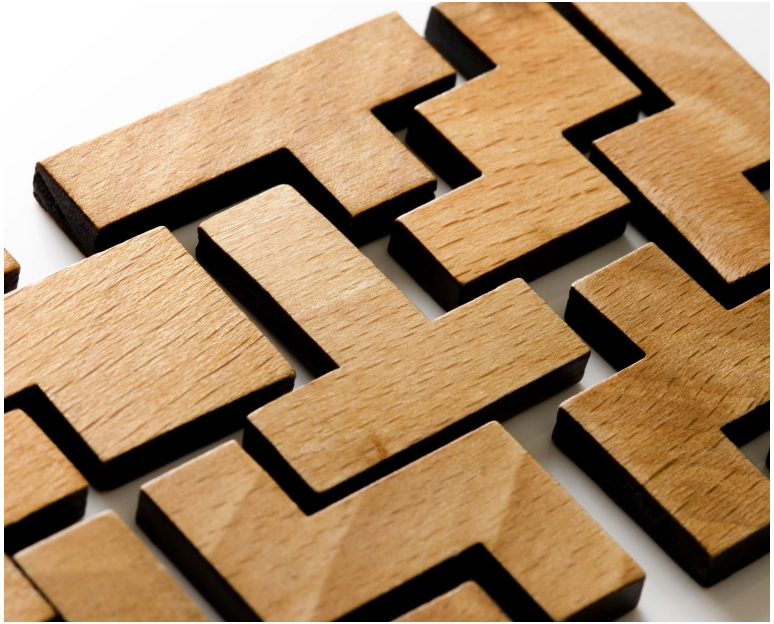
Integrate with broader business planning:

- Align electrification with:
  - 5 or 10-year capital planning
  - ESG or compliance milestones
  - Facility lifecycle assessments
- Budget for enabling infrastructure (e.g. transformers, control systems)
- Communicate internally to ensure electrification is part of strategic conversations early on



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Breakout room activity - 1

In your breakout room:

Think about the heat processes in your facility and discuss:

1. What could be electrified in the next few years?
2. For which key decision points do you need to plan?
3. How will you avoid locking in GHG emissions?

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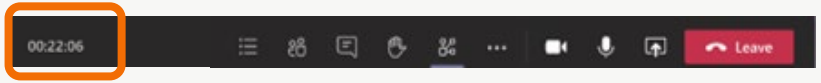

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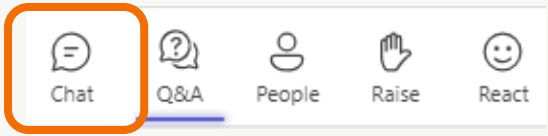

Call for action

What are you going to do in the next few weeks to start planning your pathway to industrial electrification?

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-Allison

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