



IChemE - Industrial Electrification

Safety implications and its opportunities



Govert van der Ploeg
Snr Electrification Technologist



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Shell’s net carbon intensity

Also, in this presentation we may refer to Shell’s “net carbon intensity” (NCI), which includes Shell’s carbon emissions from the production of our energy products, our suppliers’ carbon emissions in supplying energy for that production and our customers’ carbon emissions associated with their use of the energy products we sell. Shell’s NCI also includes the emissions associated with the production and use of energy products produced by others which Shell purchases for resale. Shell only controls its own emissions.

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The use of the terms Shell’s “net carbon intensity” or NCI is for convenience only and not intended to suggest these emissions are those of Shell plc or its subsidiaries.

Shell’s net-zero emissions target

Shell’s operating plan and outlook are forecasted for a three-year period and ten-year period, respectively, and are updated every year. They reflect the current economic environment and what we can reasonably expect to see over the next three and ten years. Accordingly, the outlook reflects our combined Scope 1 and 2 target, NCI target and our oil products ambition over the next ten years. However, Shell’s operating plan and outlook cannot reflect our 2050 net-zero emissions target, as this target is outside our planning period. Such future operating plans and outlooks could include changes to our portfolio, efficiency improvements and the use of carbon capture and storage and carbon credits. In the future, as society moves towards net-zero emissions, we expect Shell’s operating plans and outlooks to reflect this movement. However, if society is not net zero in 2050, as of today, there would be significant risk that Shell may not meet this target.

Non-GAAP measures

This presentation contains certain non-GAAP measures. For the most comparable GAAP measure and reconciliation of such non-GAAP measures to the most comparable GAAP measure, please see the “Non-GAAP measures reconciliations” of the 2025 Annual Report and Accounts.

Forward-Looking non-GAAP measures

This presentation may contain certain forward-looking non-GAAP measures such as [free cash flow] and [underlying operating expenses]. We are unable to provide a reconciliation of these forward-looking non-GAAP measures to the most comparable GAAP financial measures because certain information needed to reconcile those non-GAAP measures to the most comparable GAAP financial measures is dependent on future events some of which are outside the control of Shell, such as oil and gas prices, interest rates and exchange rates. Moreover, estimating such GAAP measures with the required precision necessary to provide a meaningful reconciliation is extremely difficult and could not be accomplished without unreasonable effort. Non-GAAP measures in respect of future periods which cannot be reconciled to the most comparable GAAP financial measure are calculated in a manner which is consistent with the accounting policies applied in Shell plc’s consolidated financial statements.

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Menti



<https://www.menti.com/>

Code: 2189 3134



Menti Question 1

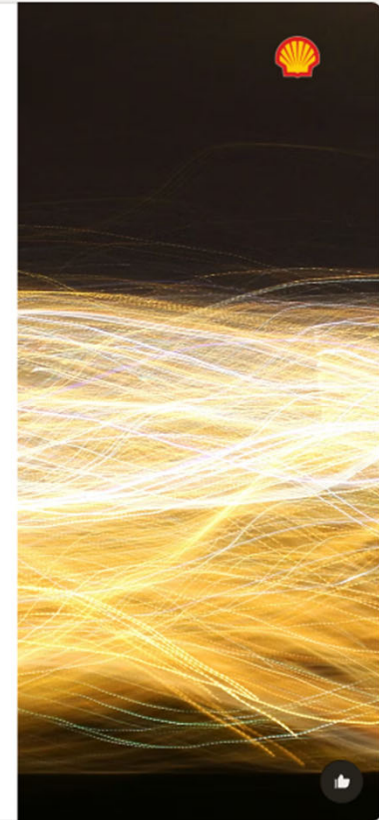
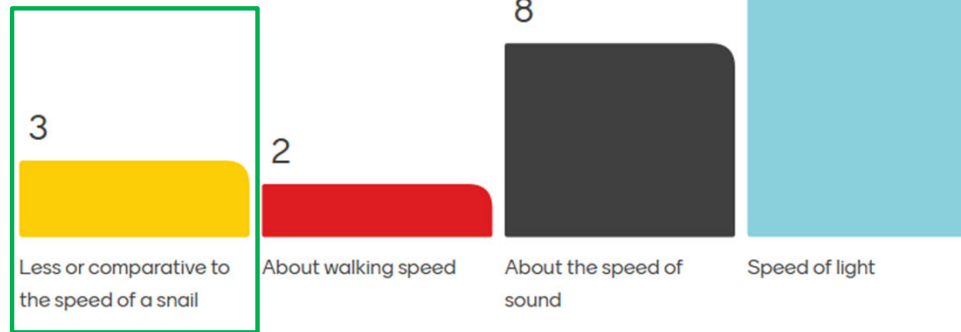
The drift velocity of electrons in a copper wire carrying DC current is remarkably slow: typically, only centimeters to meters per hour, depending on circumstances.

While the electrons barely move statistically in a specific direction, electrical energy is transported by the electromagnetic field surrounding the conductor, and when a circuit is switched on, that field is established at a large fraction of the speed of light.

[Link: How Electricity Actually Works](#)

At what speed do electrons travel through a copper wire carrying direct current (DC) ?

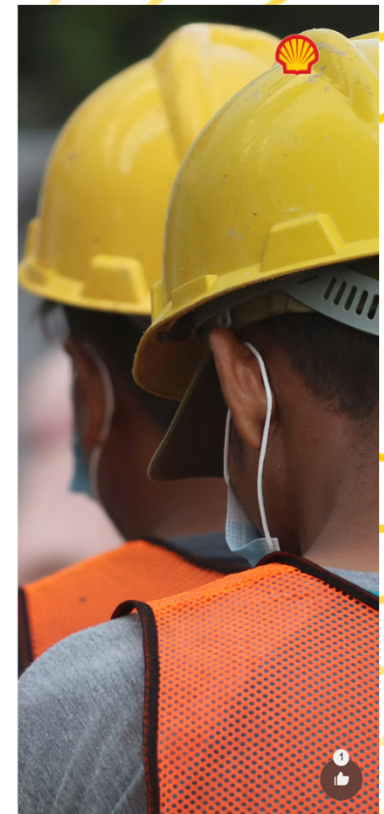
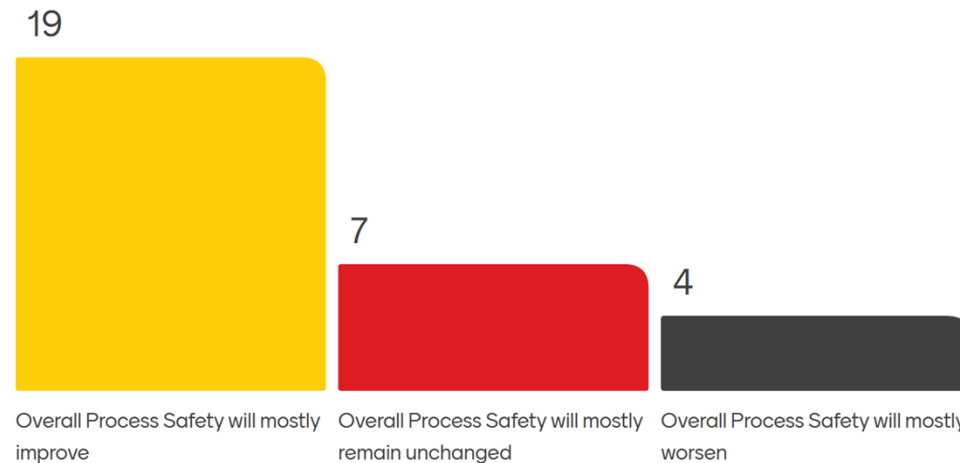
○ Correct answer



Menti Question 2

There is no right or wrong answer – Though the general believe is that Process Safety will mostly improve

How will the electrification of industrial processes affect overall process safety?



Brief Introduction



Govert van der Ploeg
Snr Electrification Technologist

- 27 Years of experience in the industry
- Delivering high impact innovation
- Deep engineering expertise, industrial decarbonization, R&D, strategy and project delivery
- Responsible for the development of integrated electrification solutions
- Electrical Steam Cracker Development Lead
- Electrical Steam Methane Reformer (eSMR) Development Lead
- Inventor of electrical process furnaces
- 11 Patents

Shell Global Solutions

2019 – Present Senior Electrification Technologist
2013 – 2019 Technologist Gas to Liquids (GTL)
2006 – 2013 Process Engineer Gasification and Hydrogen Manufacturing

Aker Kvaerner

2000 – 2005 Process Engineer

Process Management & Control

1998 – 2000 Application Engineer

Education

Master of Science (MSc) in Chemical Engineering
Technical University of Eindhoven (TU/e), The Netherlands

Presentation content



Managing electrical safety risks in industrial electrification

Risks



Electrification: An Opportunity for the Industry

Opportunities



Applications: A practical Shell example

Example

Key messages

Risks

- Electricity is inherently hazardous, posing risks of electrocution and energy release.
- Today's high levels of electrical safety are founded on more than 140 years of standardization, engineering, and operational experience.
- Increase training & education to expand electrical eng. competencies

Opportunities

- Many industrial energy demands can technically be directly electrified to reduce CO₂ emissions.
- Electrification may significantly improve the integrated energy efficiency through smart utilization



Source: Marshelec, via Wikimedia Commons, licensed under CC BY-SA 3.0. ABB equipment shown. May 2026

Electricity is invisible, until it comes out...

Electricity Kills: Three key electrical safety risks

Arc Flash

Sudden energy release through gas → extreme heat, pressure, and molten metal → injury or death



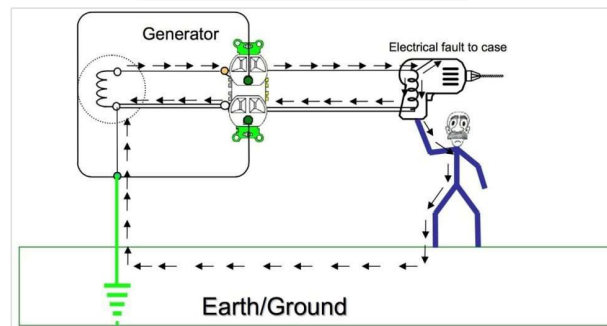
Source: Electrical Engineering Portal, 'Be extremely careful when racking in and racking out of circuit breaker', accessed 27 Aug 2026.

Electrocution

Even 30 mA is not a safe current
– It can still be fatal



Hand to Opposite Foot



Electrical Shorts

Release of the full potential of electrical power → heat → equipment failure → uncontrolled circumstances



Electrical Energy is Dangerous & Powerful

Electricity is invisible, until it comes out...



Electricity is the highest-grade energy and is powerful

- This is an internal arc test of switchgear – low voltage 25000 Amps
- The test failed (here the fault is NOT contained within the equipment)
- This energy level is small compared to large industrial power systems

Electrical Safety Through 145 Years of Standardization

Electrical safety is built on more than 140 years of accumulated engineering experience.

1881 – International Electrical Congress (Paris): alignment on electrical units such as the volt, ampere, and ohm

1904 – International Electrical Congress (St. Louis): call for standardization of electrical equipment ratings and terminology.

1906 – Establishment of the International Electrotechnical Commission (IEC): the start of global electrical standards.

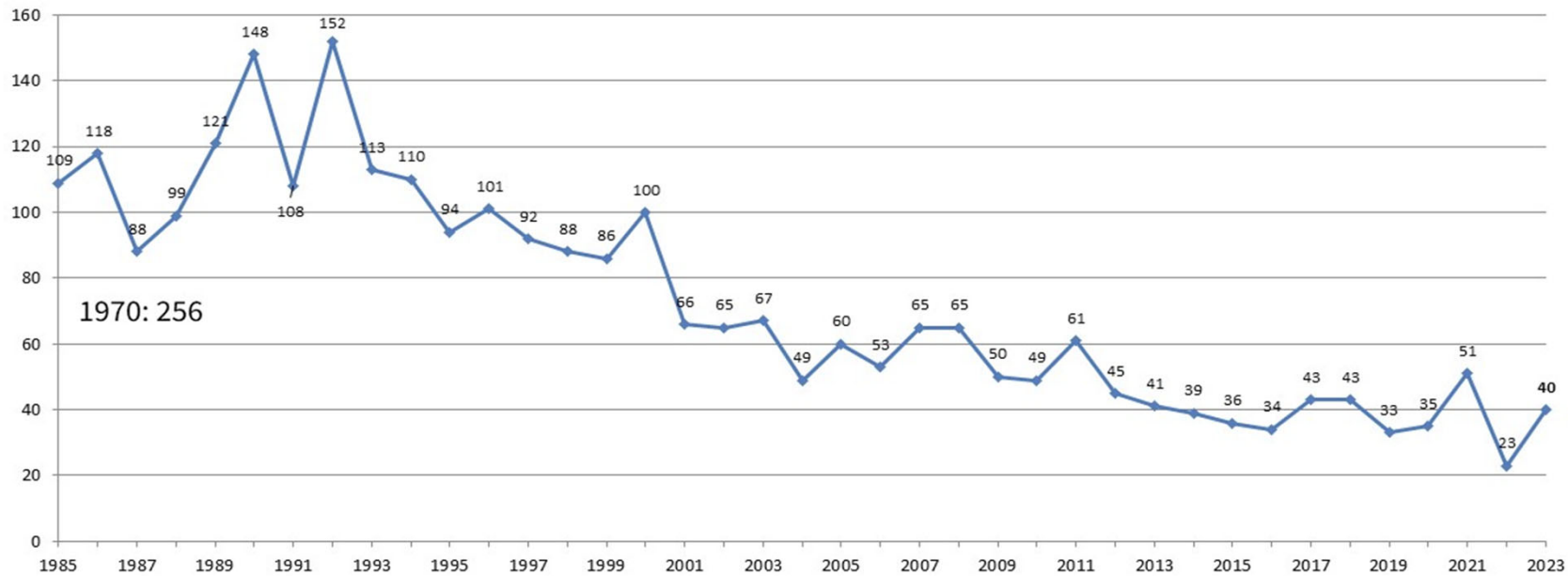
1914 – First IEC technical committees established.

1950s–Present – Expansion into thousands of detailed standards covering electrical equipment, system design, and safety.



Paris Electrical Exhibition 1881

Fatal electrical accidents in Germany

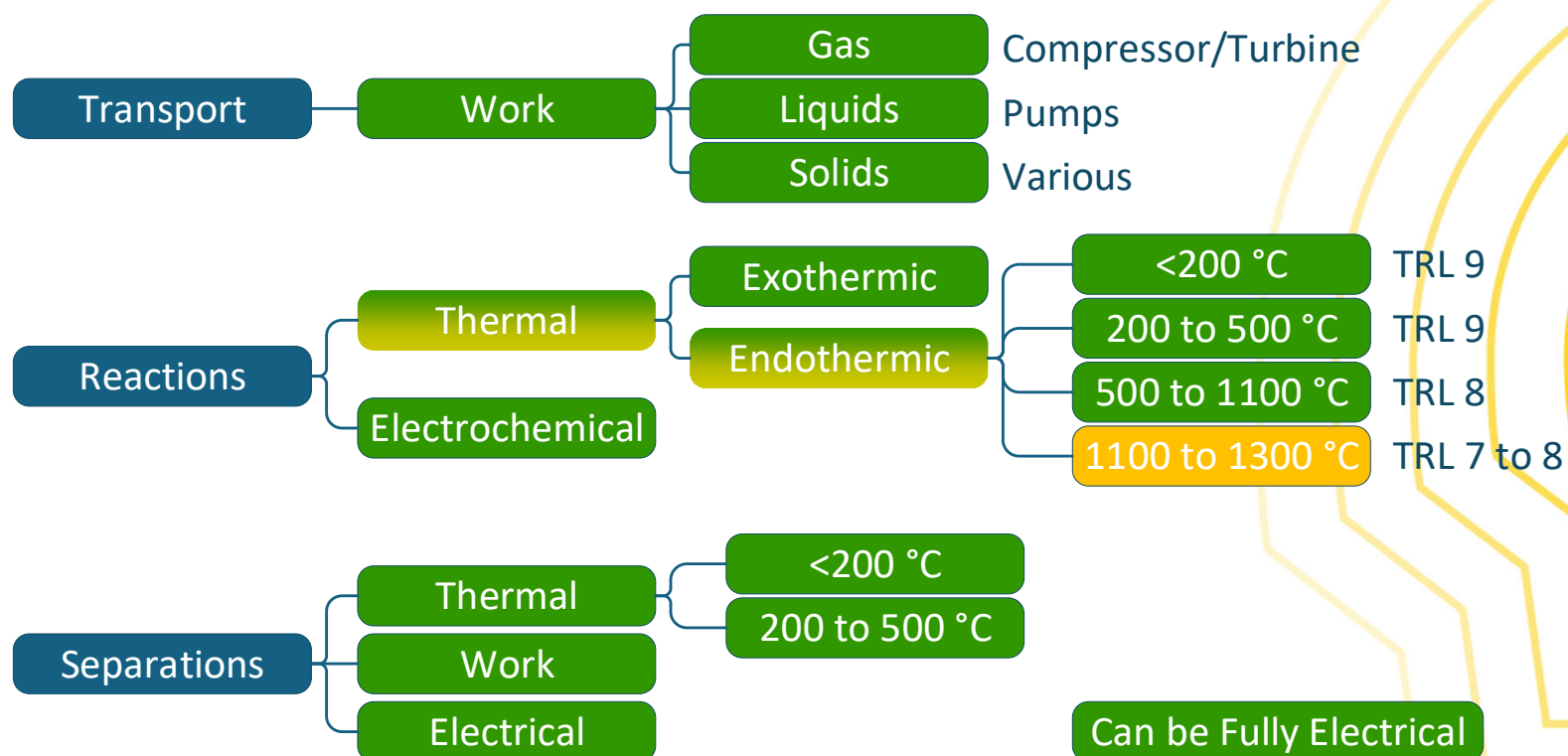


Quelle: Statistisches Bundesamt: Sterbefälle nach äußeren Ursachen und ihren Folgen (Deutschland 2022), ICD-10



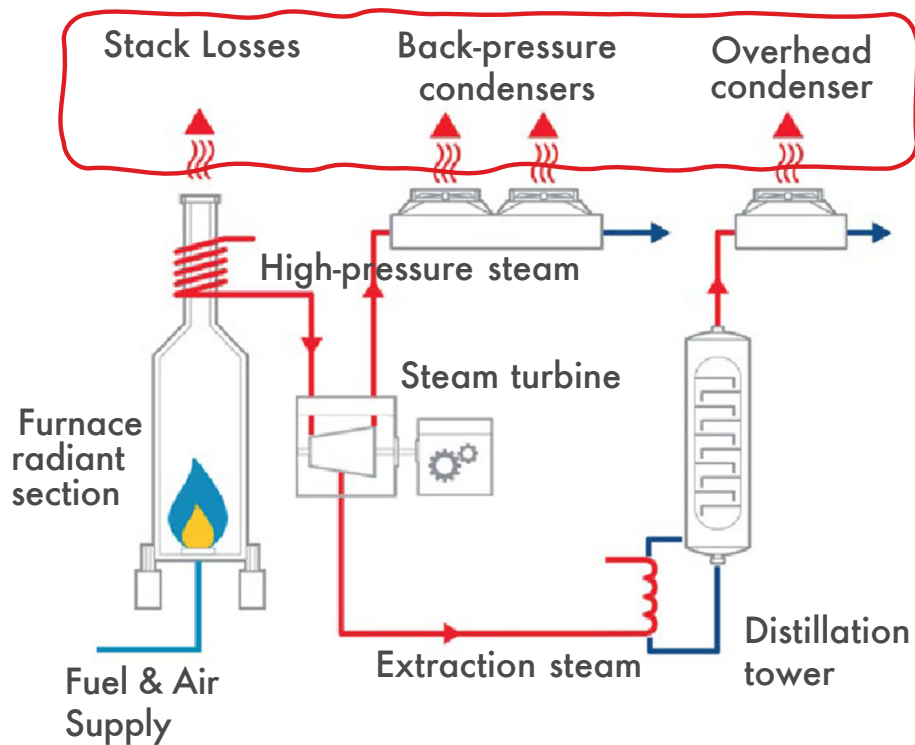
The Netherlands records ~4800 workplace accidents of which ~60 ended fatally annually; electrical and arc-flash incidents are not reported separately and are typically embedded within broader workplace accident statistics despite their high severity.

Technically many energy demands can be directly electrified

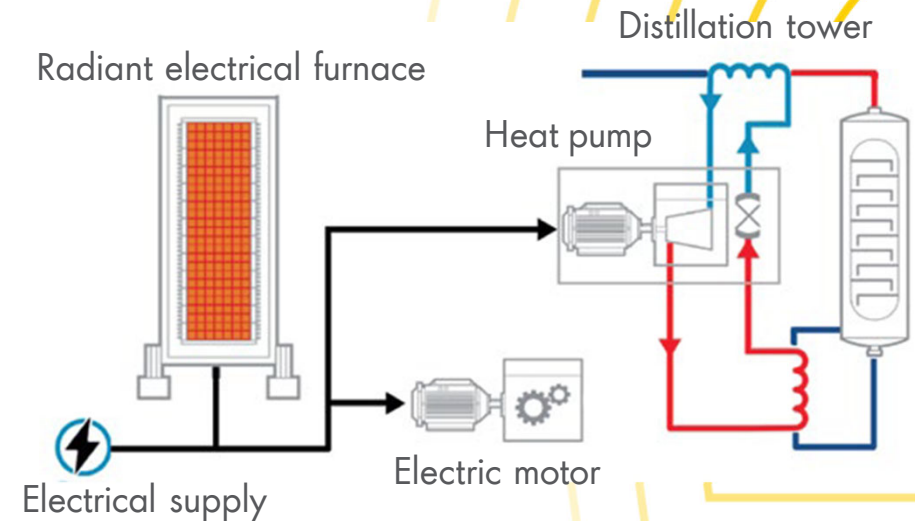


Technically there are limited barriers to electrify all energy demands, either directly or indirectly

Electrification reduces emissions and can potentially result in large efficiency improvements

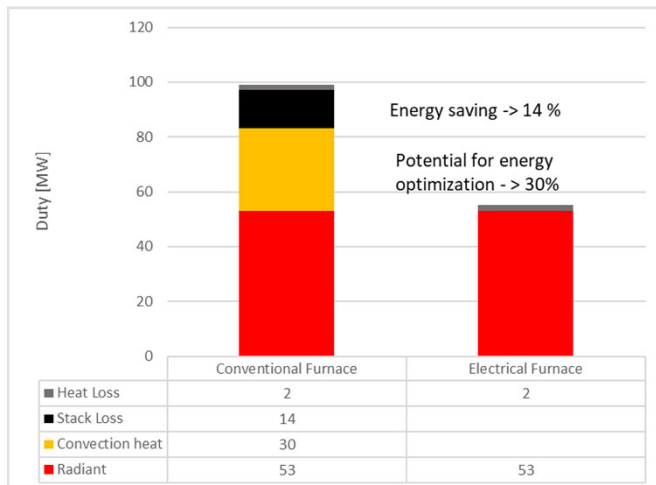


Eliminate energy rejection to the environment

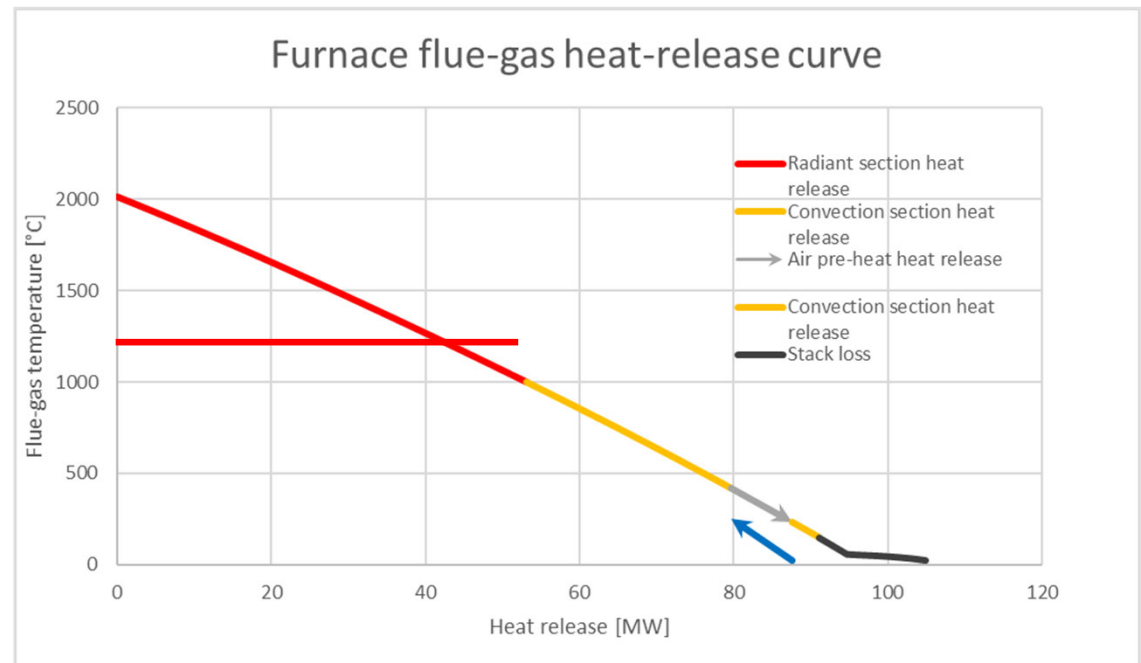


Example: Electrical Furnaces can conserve heat production

- Combustion produces flue gas which cannot be avoided
- Electrical furnaces do not
- Stack losses are eliminated
- Opportunity for integrated energy optimization



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Data shows the HHV heat-release curve

Example: Moerdijk Driver Electrification

- Several steam turbines were converted to Electrical Drives
- Reduction of condensing tail of the steam network
- Eliminated one Gas-fired Boiler operation → Can increase overall safety
- Less fuel & CO₂ emissions
- Higher integrated heat efficiency

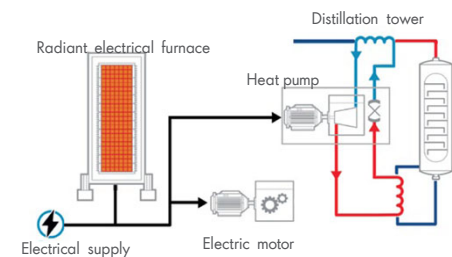
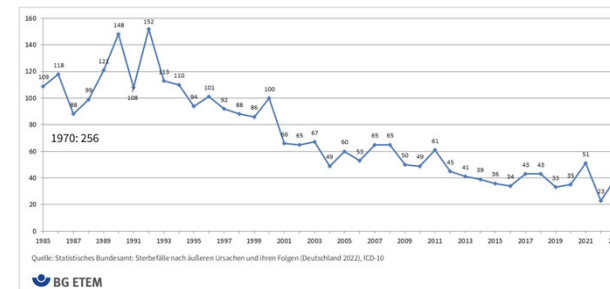


Concluding

- Electricity presents significant hazards and requires competent personnel to work with it safely → **Training & Education**
- The development of standards, regulations, and industry practices has greatly improved electrical safety → **Existing solid framework**
- Direct electrification potentially offers significant opportunities to reduce emissions while delivering economic value → **Assess opportunities**



Source: Electrical Engineering Portal, 'Be extremely careful when racking in and racking out of circuit breaker', accessed 27 Aug 2026.



Q&A

