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Reaching Zero with Renewables: Aluminium Industry

Presenters:
Linlin Wu, Manager – Environment, Statistics & Standards, IAI
James Walker, Team Lead – Renewable Gases, IRENA
Karan Kochhar, Associate Programme Officer – Innovation Networks, IRENA

TUESDAY, 29th July 2025 14:00-14:30 CEST

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SPEAKERS

Linlin Wu
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James Walker
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Karan Kochhar
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SPEAKER

Linlin Wu
IAI

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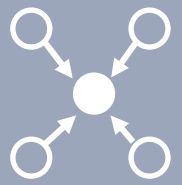
About the International Aluminium Institute

The International Aluminium Institute (IAI) is the only body representing the global primary aluminium industry.

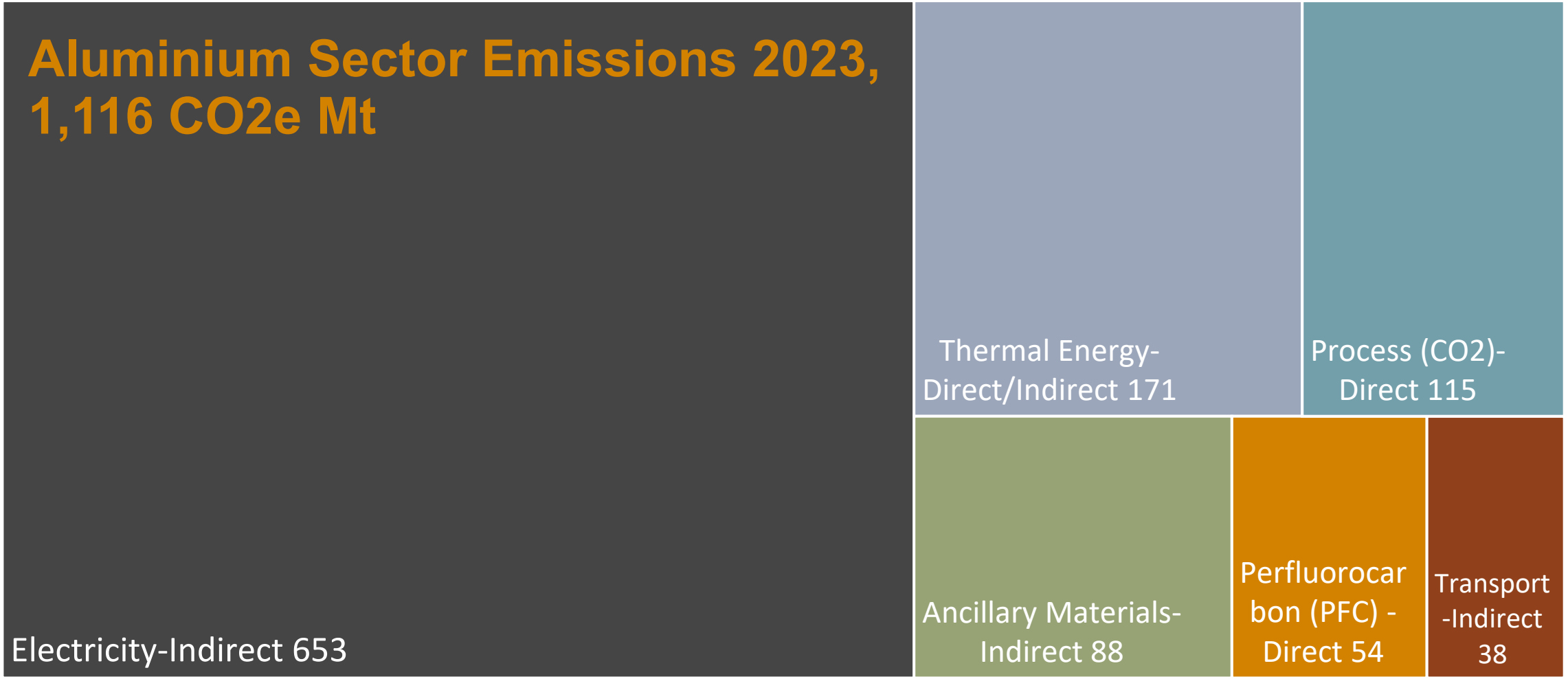
Since its foundation in 1972, members of the IAI have been companies engaged in the production of bauxite, alumina and aluminium, the recycling of aluminium and/or fabrication of aluminium, or as joint venture partners.

Current IAI membership represents all major regions of global bauxite, alumina and aluminium production.



The IAI has been key to bringing the industry together on shared purpose over the past 50 years.

Aluminium Sector Emissions



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IAI GHG emissions technology pathways…

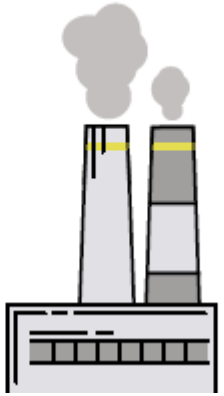
ALUMINIUM SECTOR GREENHOUSE GAS PATHWAYS TO 2050

Pathway 1

Electricity decarbonisation potential

Pathway 2

Direct emissions potential



Pathway 3

Recycling & resource efficiency potential

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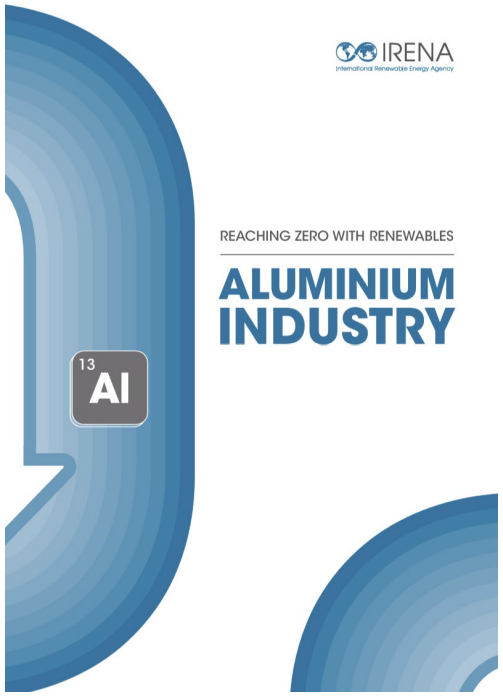
OBJECTIVES OF THE REPORT

- Discussing decarbonisation alternatives and best practices with a focus on renewable energy options.
- Defining actionable recommendations for a broader set of stakeholders to accelerate the transformation of the sector towards net zero.



With support from International Aluminium Institute

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Aluminium production has grown steadily

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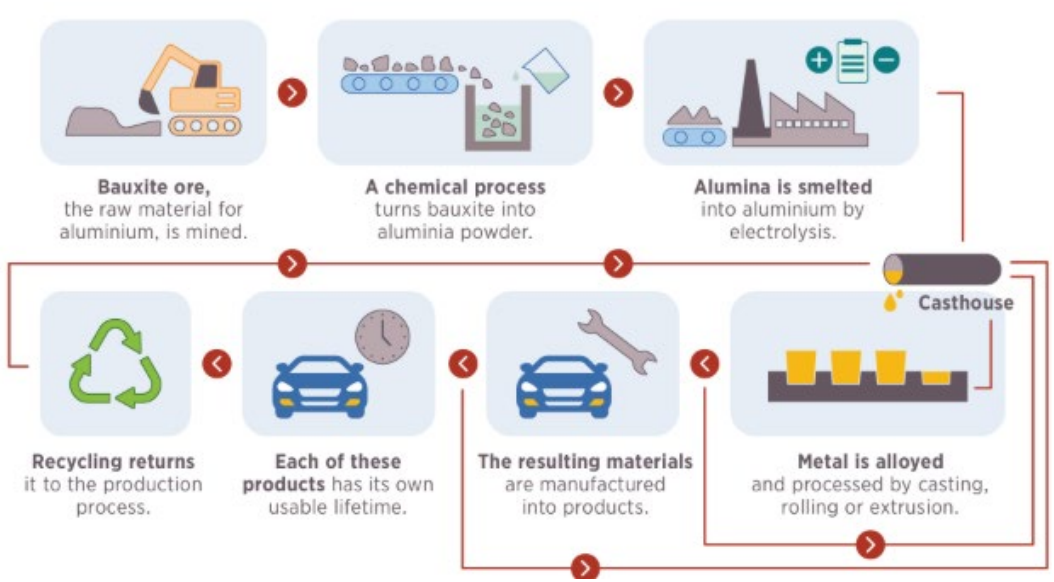
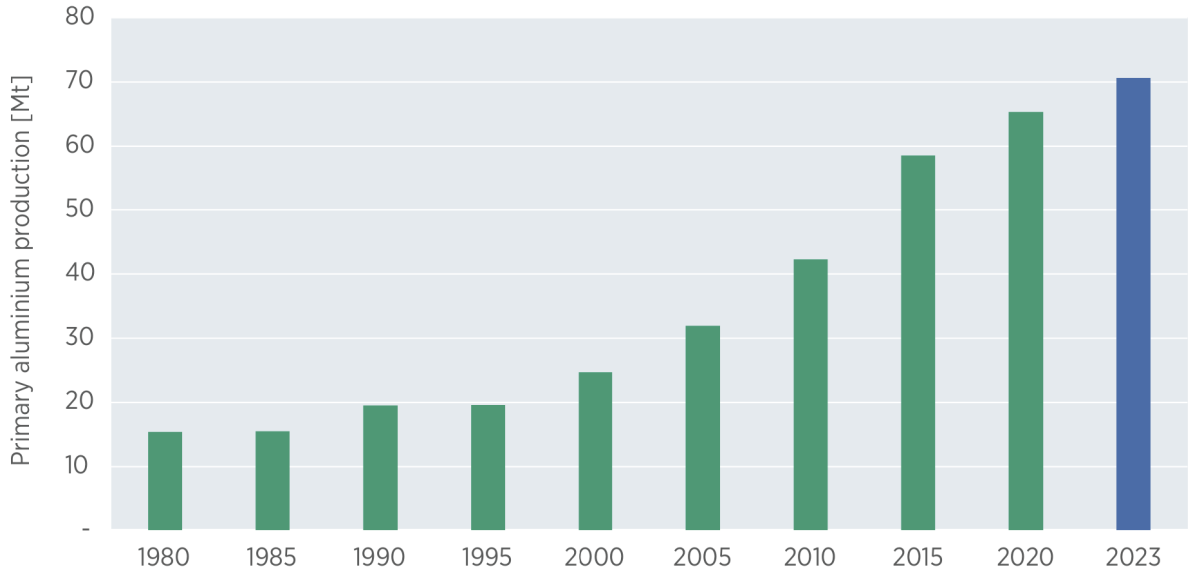
Figure 1 Aluminium production chain (left) and primary aluminium production (right)





Aluminium **production** has **risen** over time − **15 Mt/year** in 1980 to close to **70 Mt/year** in 2023.

Source: **IRENA (2025),** Reaching Zero with Renewables: Aluminium Industry

Electricity is a large source of emissions in aluminium production

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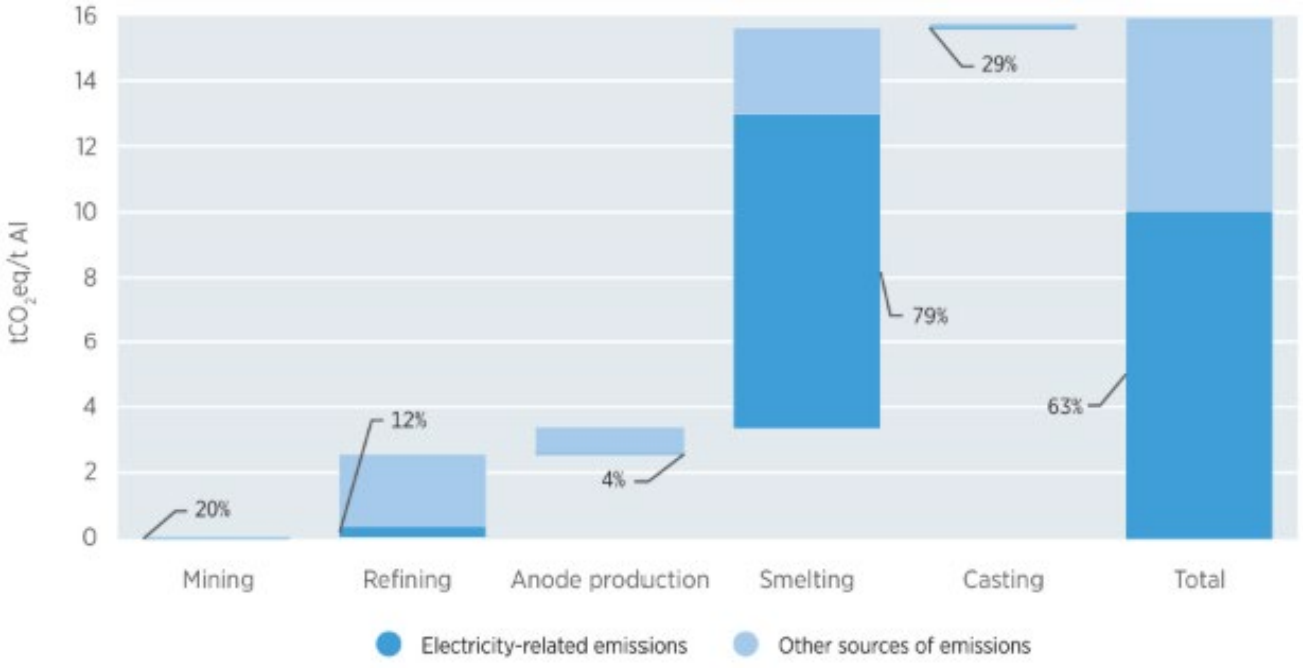
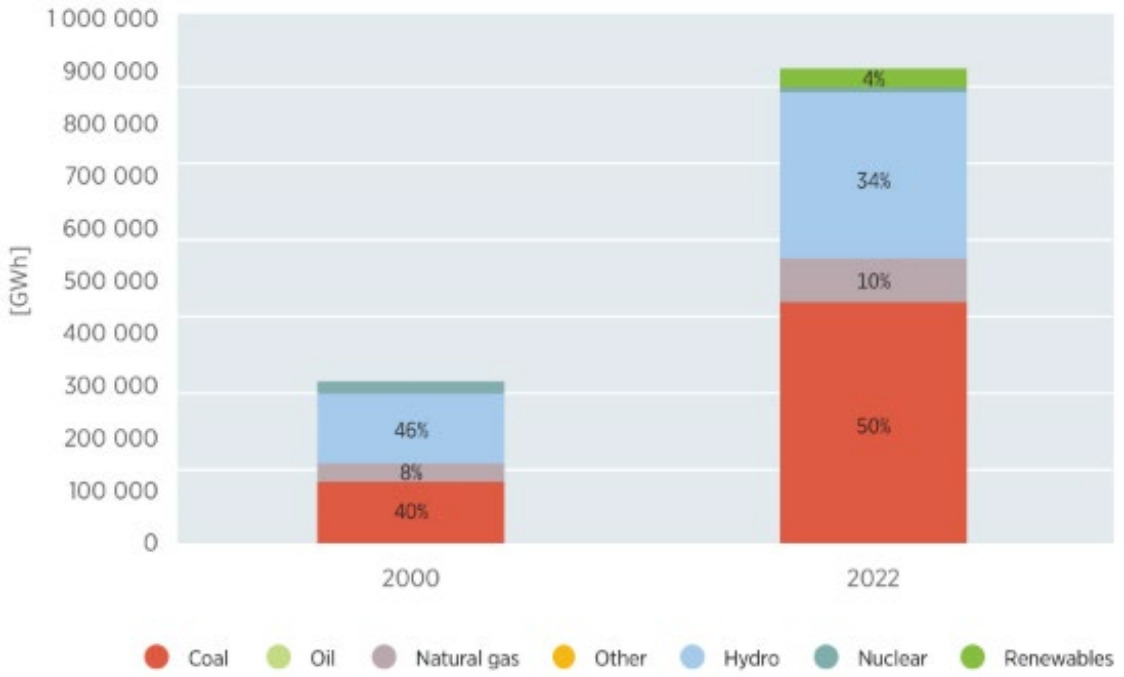
Figure 2 Electricity-related emissions in primary aluminium production (left) and evolution of power mix in aluminium smelting (right)





The increased reliance on fossil fuels for electricity contributes to a **significant share of emissions** to produce aluminium.

Source: **IRENA (2025),** Reaching Zero with Renewables: Aluminium Industry

Solar and wind are in the center of a decarbonised power supply

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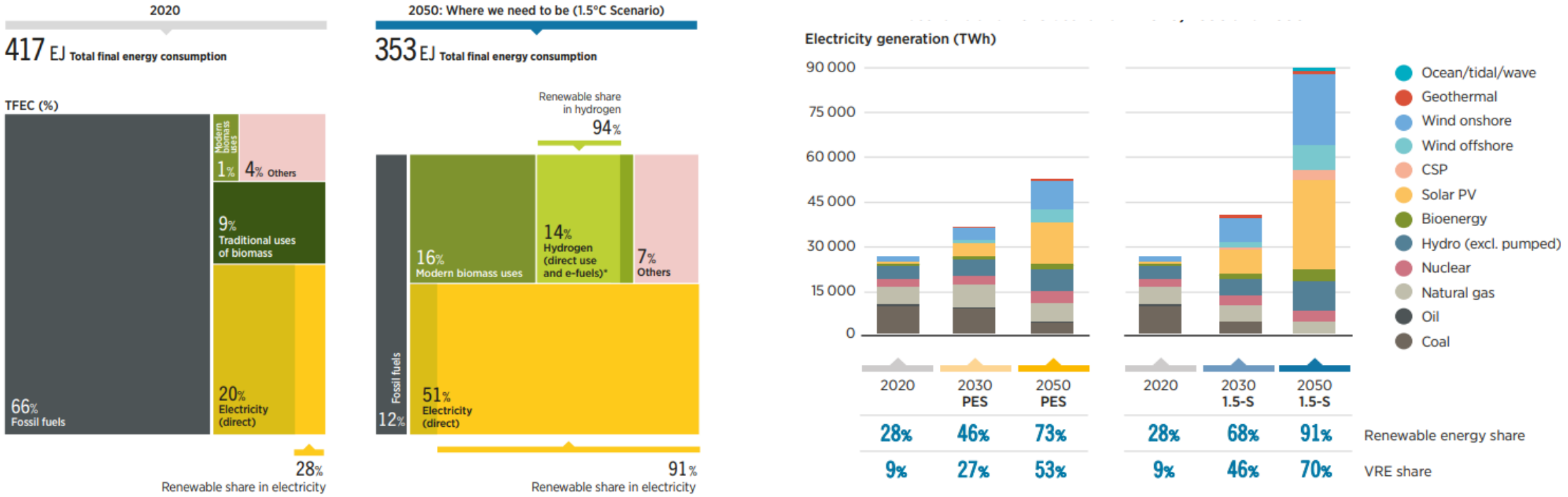
Figure 3 Breakdown of total final energy consumption by energy carrier under IRENA's 1.5°C Scenario (left) and global power generation mix by energy source: PES and 1.5°C Scenario (right)



Notes: 1.5-S = 1.5°C Scenario; CSP = concentrated solar power; GW = gigawatt; PES = Planned Energy Scenario; PV = photovoltaic; TWh = terawatt hour.

Electricity becomes the main energy carrier by 2050 accounting for **over 50% of TFEC** by 2050. This is driven largely by renewables, owing to their cost competitiveness.

Source: **IRENA (2023),** World Energy Transitions Outlook

We are transitioning to a world of abundant, cheap renewables

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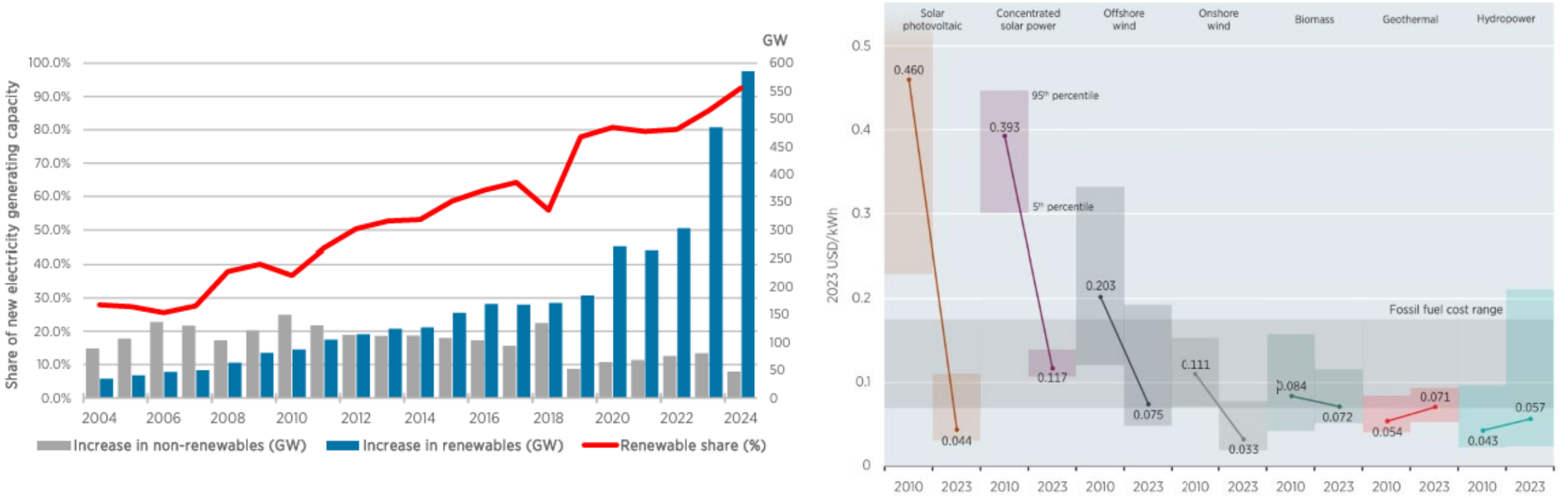
Figure 4 Renewable share of annual power capacity expansion (left) and global LCOE from newly commissioned utility-scale renewable power technologies, 2010 and 2022 (right)



The share of renewables in total capacity expansion has reached over **90% in 2024**. At the same time, we see that new solar and wind are the **cheapest options** to produce power in most markets around the world.

Source: **IRENA (2025),** Renewable Capacity Highlights; **IRENA (2024),** Renewable Power Generation Costs in 2024

The cost for solar and wind power is attractive for regions with aluminium smelters

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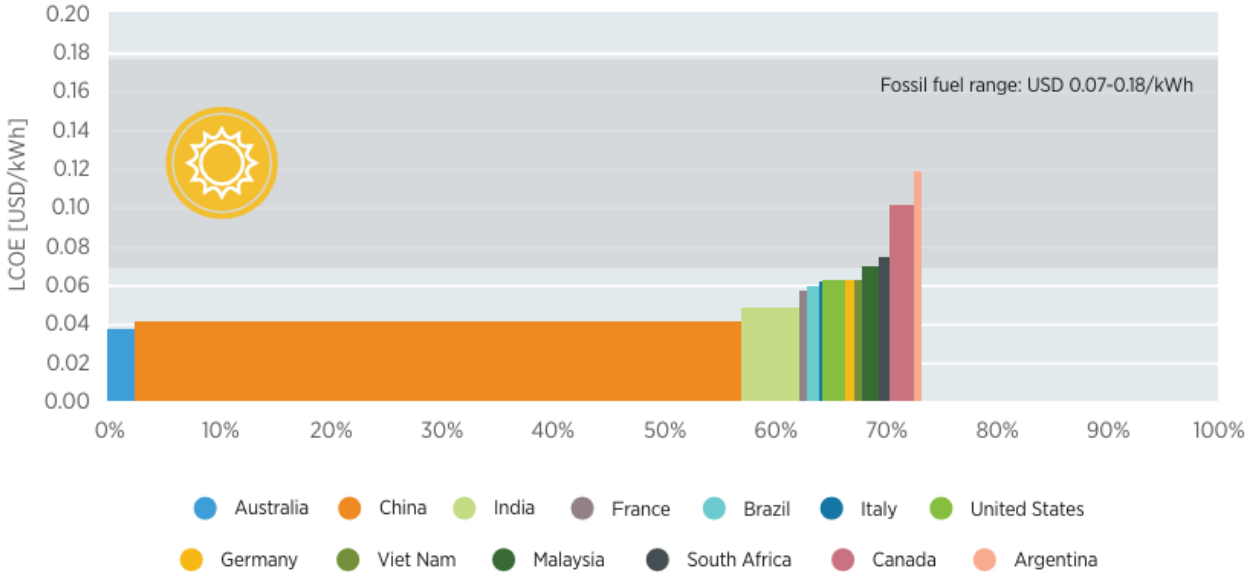
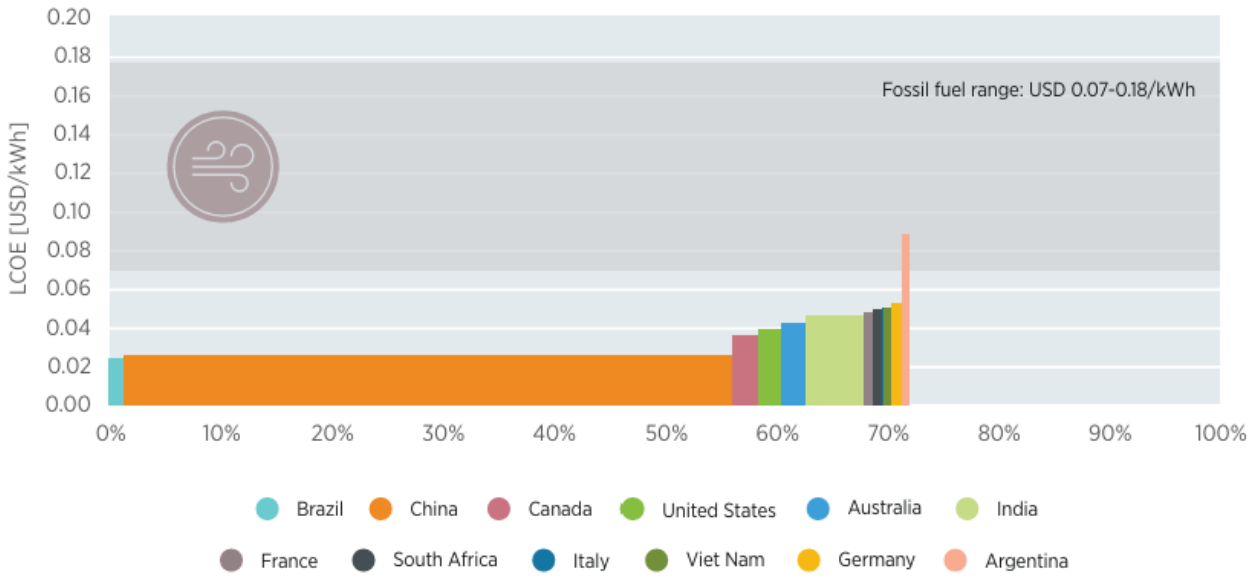
Figure 5 LCOE of utility-scale solar PV (left) and onshore wind (right) compared with fossil fuel generation in regions with aluminium smelting capacity. respectively





Notes: Country-specific cost data are available for regions comprising about roughly three-quarters of the world's total smelting capacity. The annual smelting capacity excludes smelters with hydroelectric power supply.

About **two-thirds** of the global smelter capacity is already located in the regions where new utility-scale solar is cheaper than cheapest fossil-fuel power. And little less than **three-quarters** when comparing costs with onshore wind.

Source: **IRENA (2024),** Renewable Power Generation Costs in 2024, **MPP (2023),** Making Net-Zero Aluminium Possible

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Progress towards Renewables in aluminum sector

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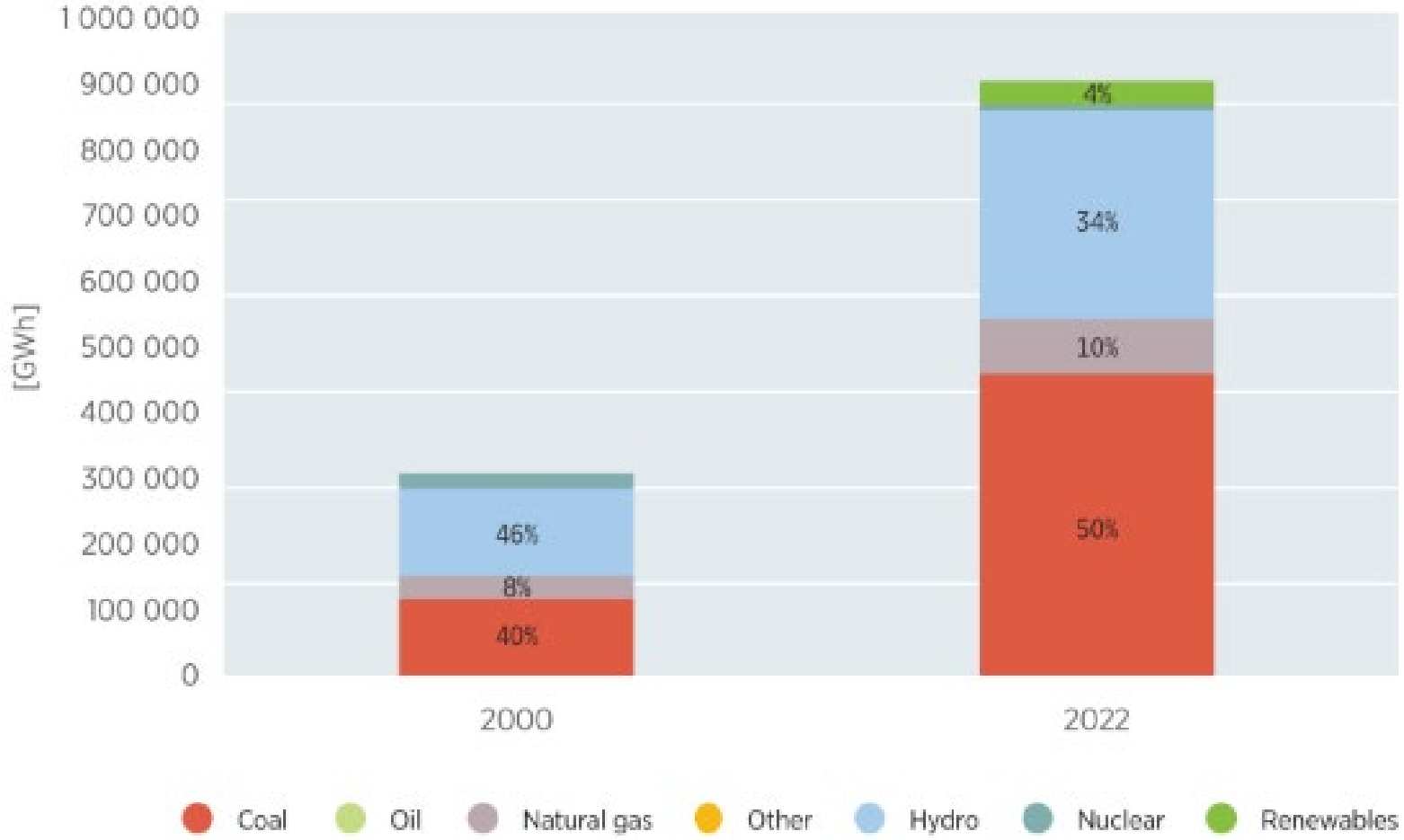
Figure 6 The evolution of power mix in aluminium smelting



Source: : **IRENA (2025),** Reaching Zero with Renewables: Aluminium Industry

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A holistic perspective of the energy system will be required

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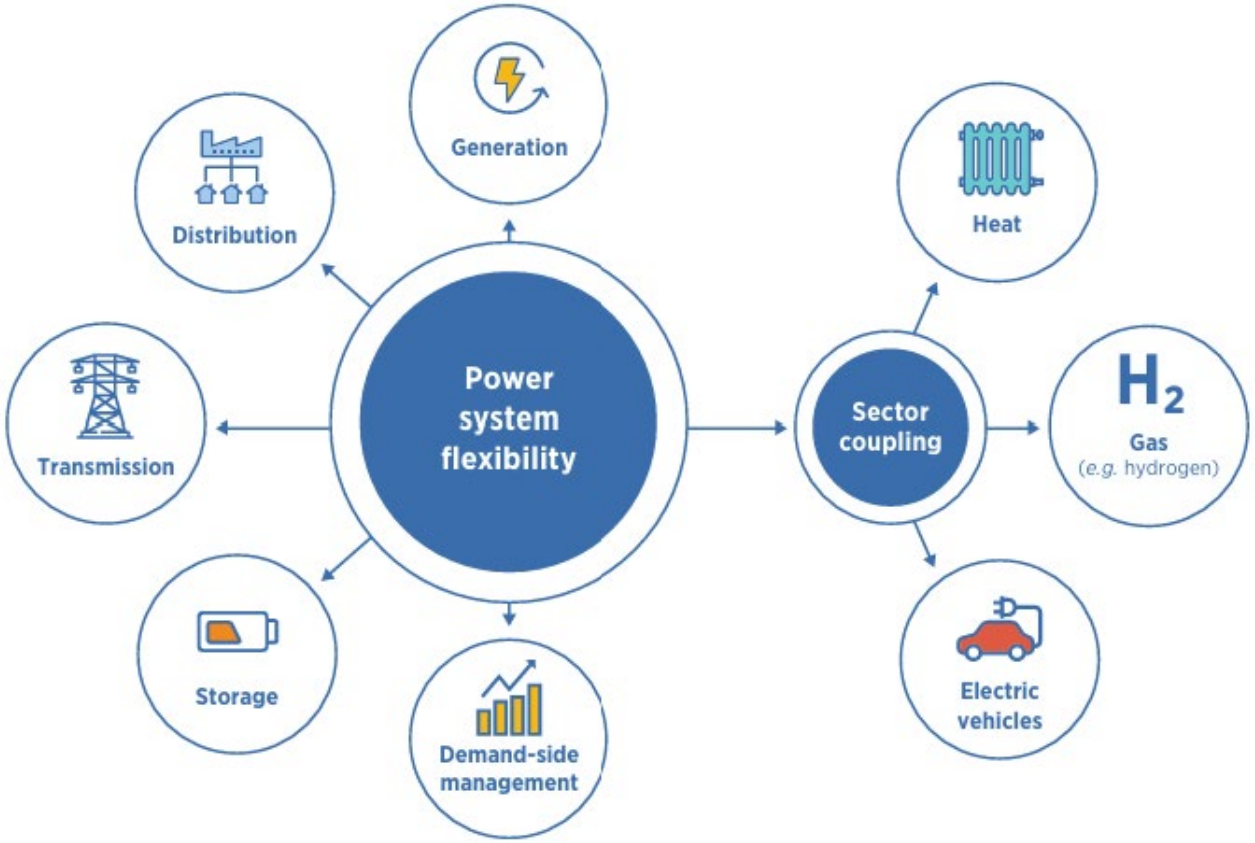
Figure 7 Power system flexibility enablers



The reliability and security of the energy system is **not the responsibility of a single technology** such as solar and wind but rather depends on how the whole system works together.

Source: **IRENA (2018),** Power system flexibility for the energy transition – Part I: Overview for policy-makers

Integrating renewables requires systemic innovation

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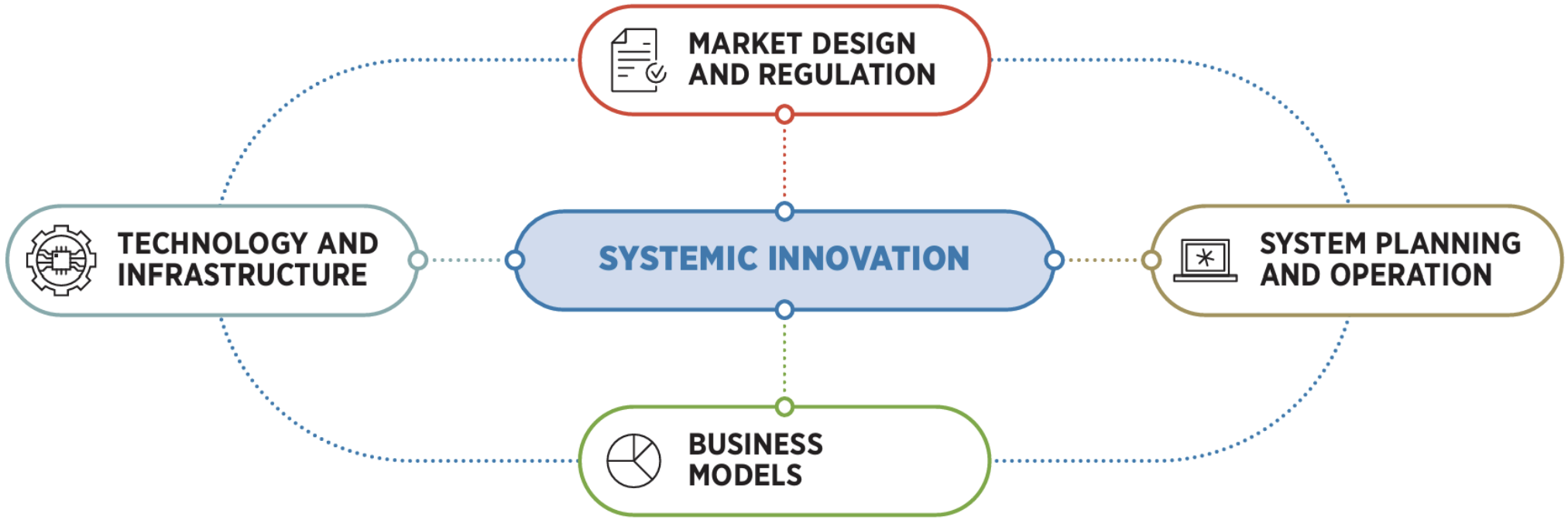
Figure 8 Systemic innovation approaches



Increasing the share of variable renewable energy (VRE) in the power supply to the aluminium sector requires **innovative solutions** that go beyond technology.

Source: **IRENA (2023d)**, Innovation landscape for smart electrification: Decarbonising end-uses with renewable power

Looking at deep decarbonisation of the aluminium industry

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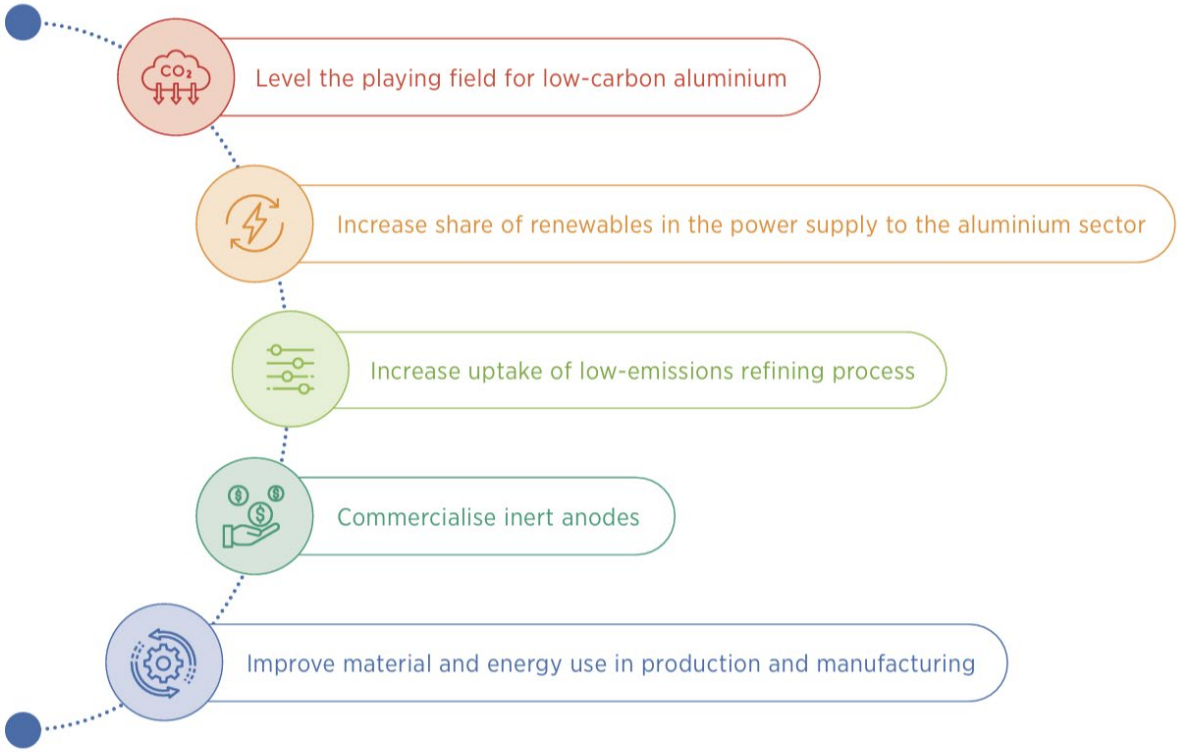
Figure 9 Key areas of action to decarbonise the aluminium sector



A **deep decarbonisation** of the aluminium sector would involve widescale adoption of low-carbon refining processes, reducing process emissions, increasing material and process efficiency within the industry.

Source: Source: **IRENA (2025),** Reaching Zero with Renewables: Aluminium Industry

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Further readings

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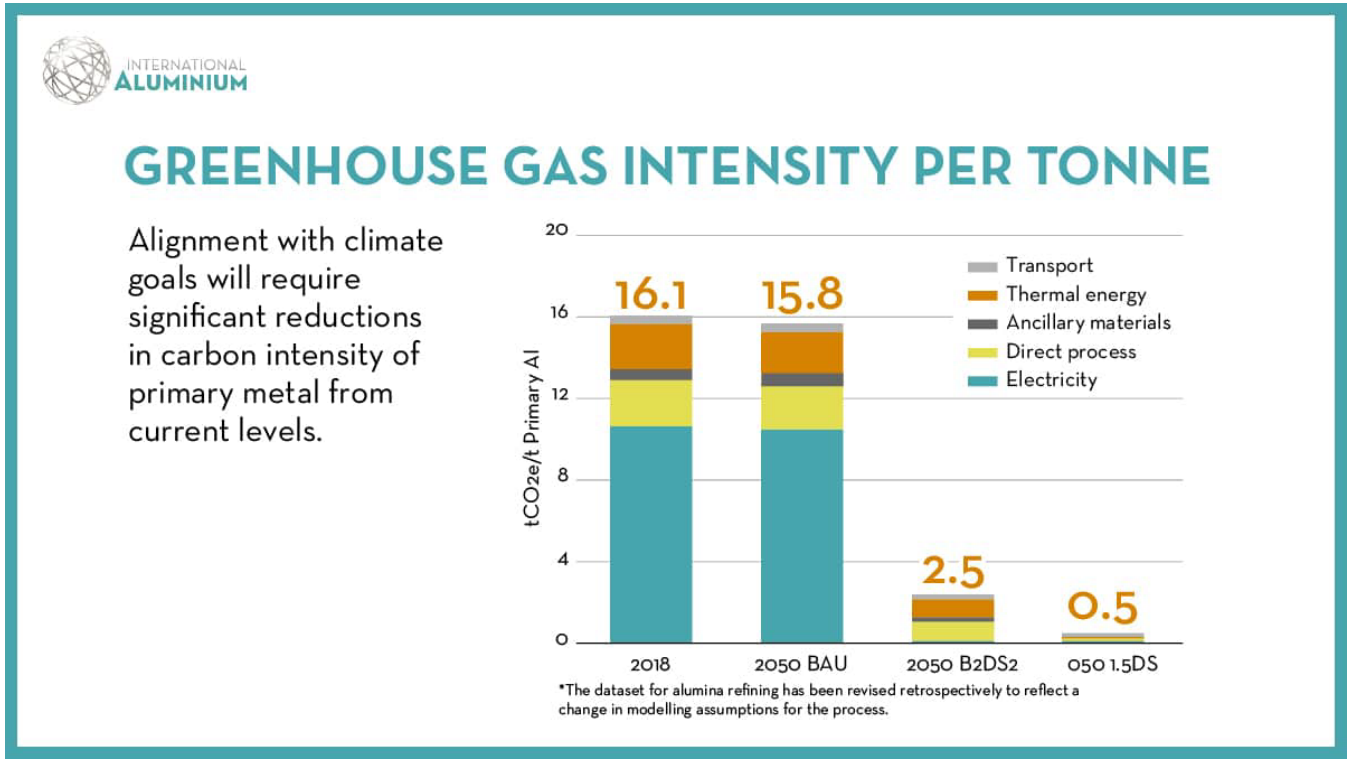

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