

Catalyzing the Chemical Energy Transition

Electrification and Digitization

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Fastest Route to Net Zero

A more electric and digital world is key to a sustainable and resilient future.

Climate change is an energy challenge

> 80%

of the world's CO₂ emissions are linked to the production and consumption of energy

> 80%

of energy demand is still delivered by fossil fuels

Despite a dip during pandemic lockdowns, CO₂ emissions have rebounded to their **highest levels ever**

60%

of total energy is lost end-to-end, mostly due to continued reliance on burning fossil fuels to generate energy

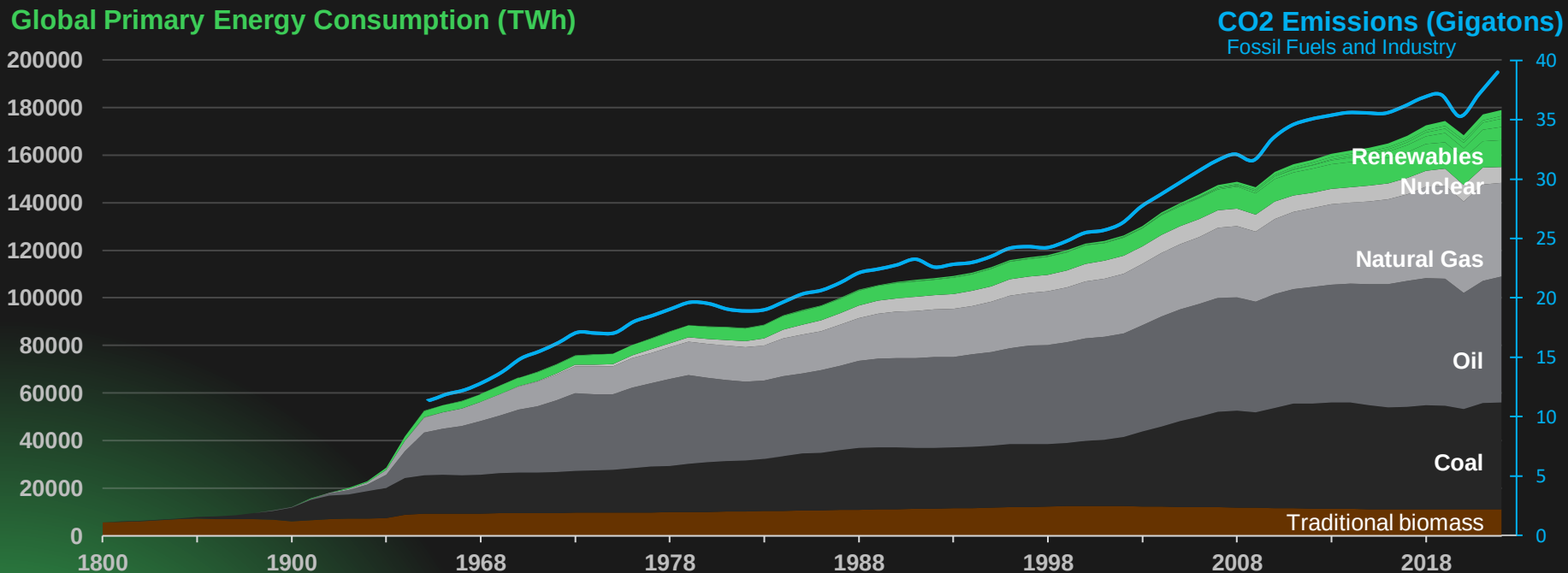


Global Energy Systems Are Coupled With Emissions

Energy Transitions

- Significant structural change in energy systems concerning supply and **consumption**
- Today: from fossil-based energy to renewable energy sources – decouple energy from emissions

Global Primary Energy Consumption (TWh)

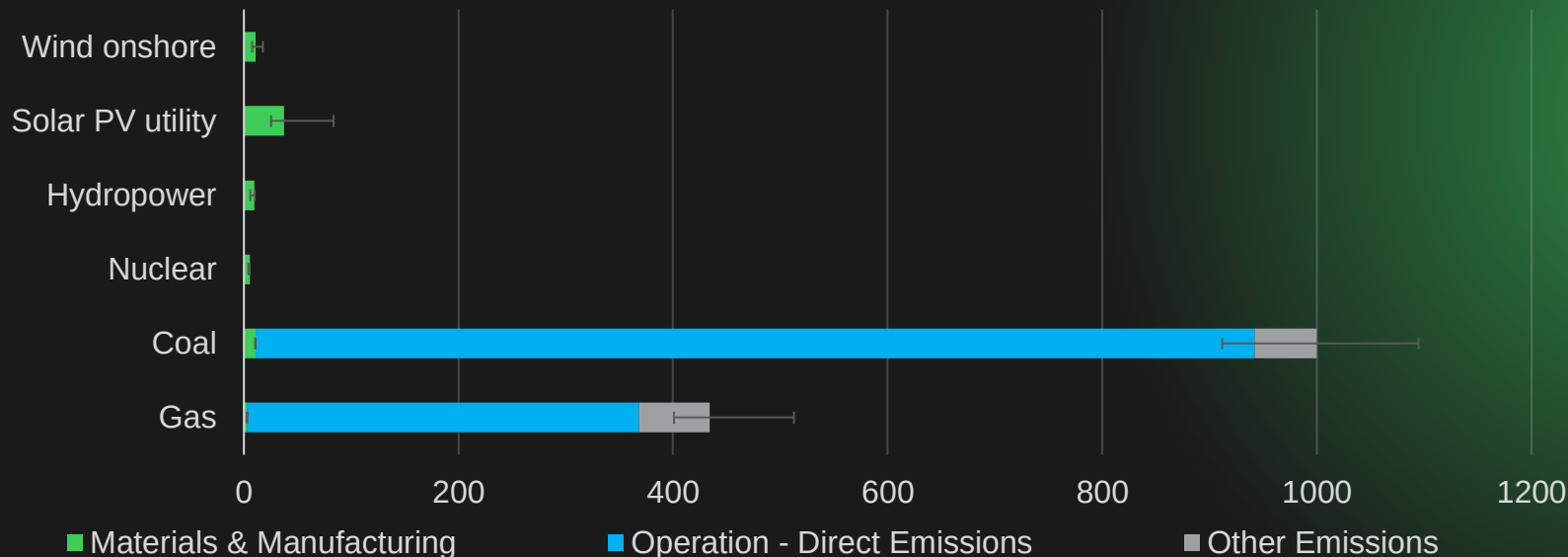


Life Cycle Carbon is Low For Renewable vs Fossil Energy

Global average life-cycle greenhouse gas emissions intensity

- Upstream steps of clean energy technology supply chains tend to be more energy and emissions intensive than those for fossil energy
- Clean energy technologies emit far less in operation

Power Generation (kg CO₂-eq/MWh)



From the Age of Fire to the Age of Electric and Digital

Annual Gigatons CO₂

50

25

1750

Industry 1.0

The first industrial revolution began with the rise of technology and the mechanization of steam and waterpower.



Electricity 1.0

Early pioneers, Volta and Faraday, made advances in the practical use of electricity.



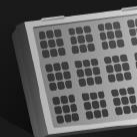
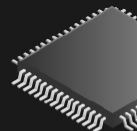
1870

Industry 2.0

The world learned how to scale these technologies and entered the age of mass deployment, with mass production and manufacturing.

Electricity 2.0

Mass electrification came through the introduction of early power plants.



1950

Industry 3.0

The development of silicon resulted in the production of integrated circuit chips and software, which led to the creation of fully automated machines.

Electricity 3.0

Silicon development supported the birth of renewable energy through solar cells and also facilitated the path for digital technology.

Today



Industry 4.0

The rapid evolution of the Internet, IoT, and other digital technologies such as artificial intelligence, robotics and cloud computing ushered in the fourth industrial revolution.

Electricity 4.0

The convergence of digital and electric combined with software is driving efficiency and sustainability.

2030

45% reduction in CO₂ by 2030 (from 2010 levels)

2050

Reaching net zero CO₂ emissions globally around 2050.

+ 1.5 °C



Electricity Makes Energy Efficient

■ Fossil fuels ■ Other energy forms ■ Renewables (wind, solar, other renewables)



Direct fossil fuel uses incur almost **2/3** of efficiency losses from primary to useful energy

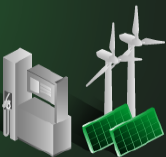
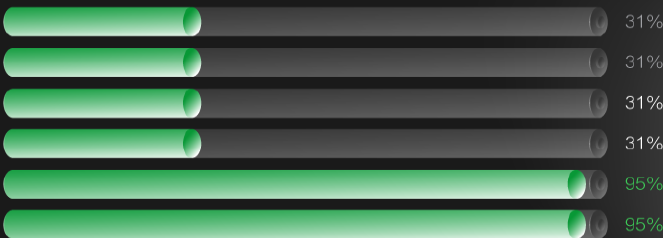
FOSSIL FUEL (DIRECT USE)	Primary energy	Final energy	Useful energy
Oil	1	0.94	0.19
Natural gas	1	0.82	0.70
Coal	1	0.72	0.50

ROUND-TRIP EFFICIENCY

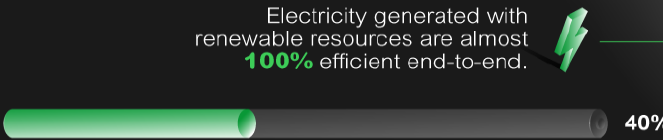


Once generated, Electricity incurs only around **5%** of losses in transmission and distribution

ELECTRICITY	Primary energy	Final energy	Useful energy
Natural gas	1	0.33	0.31
Coal	1	0.33	0.31
Bioenergy	1	0.33	0.31
Nuclear	1	0.33	0.31
Hydro	1	1	0.95
Solar, wind & other renewables	1	1	0.95



All energy forms	1	0.70	0.40
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Electricity generated with renewable resources are almost **100%** efficient end-to-end.

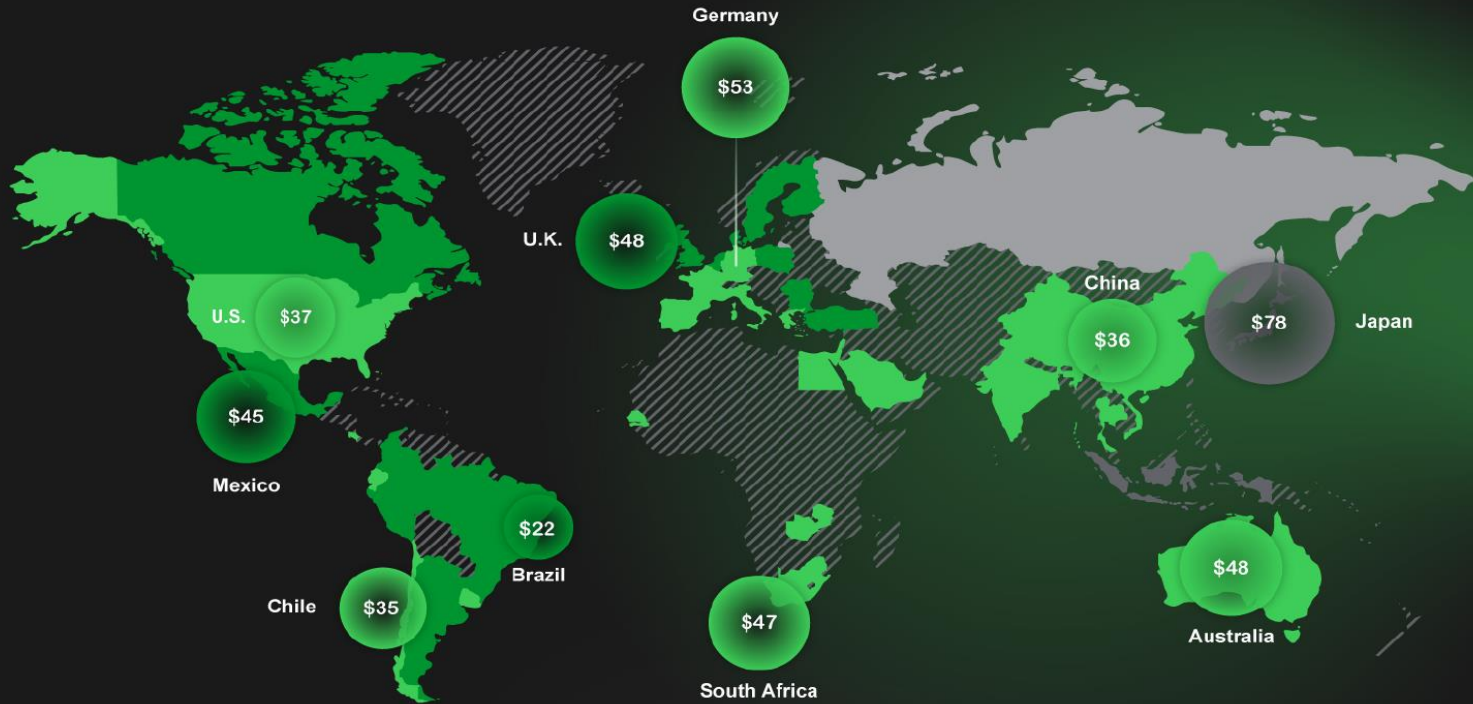


Primary energy: available in the raw resource. Final energy: remaining after conversion and delivery to end-use. Useful energy: actual units of motion or heat effectively used | Petit, V. 'Age of Fire'

Renewables Least Expensive New Electricity Source for 2/3 of the World

Cheapest source of Bulk Generation. Current LCOEs of New build solar, wind, coal and gas (2021)

■ Coal ■ Natural Gas ■ Wind ■ Solar ▨ Not covered

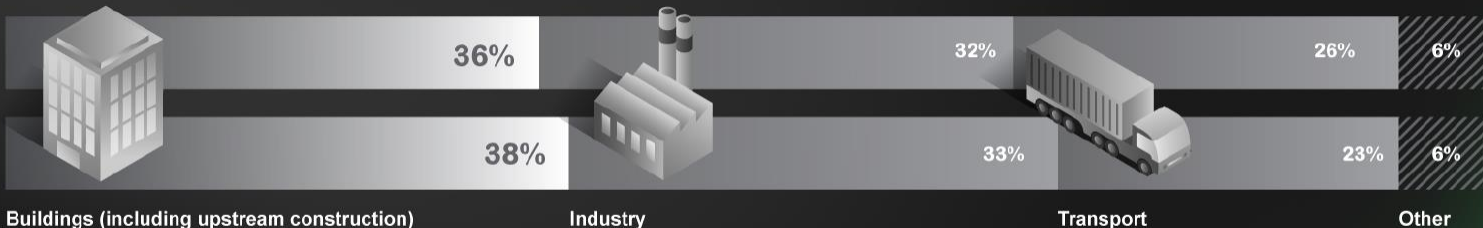


Source: BloombergNEF. Note: The map shows the technology with the lowest LCOE for new-build plants in each country where BNEF has data (H1, 2021). The dollar numbers denote the per-MWh benchmark levelized cost of the cheapest technology. All LCOEs are in nominal terms. Calculations exclude subsidies, tax-credit or grid connection costs. CCGT is combined-cycle gas turbine.

Chemical Sector Uses Energy for Motion and Heat

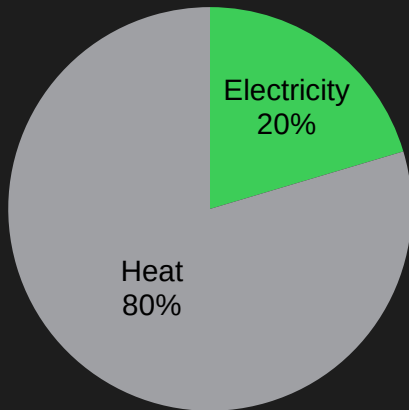
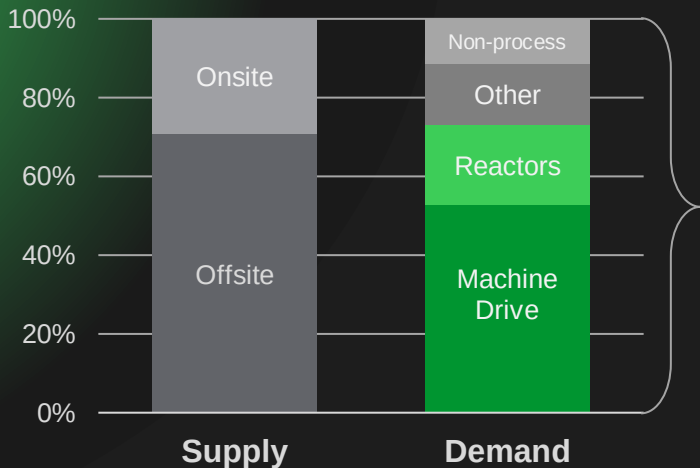
Share of global energy use

Share of global CO₂ emissions

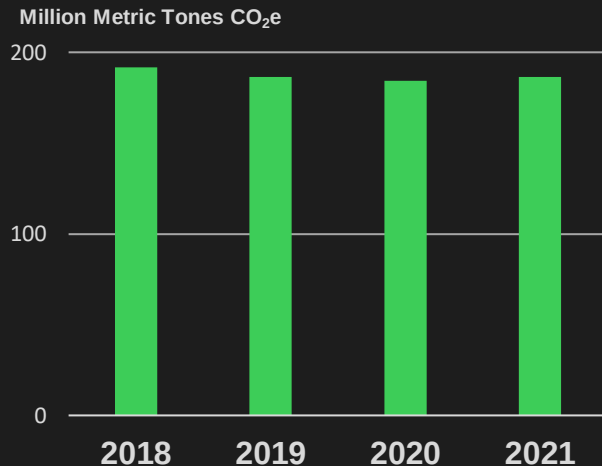


U.S. Chemical Sector

Energy Consumption and Supply



Greenhouse Gas Emissions



Many Industrial Processes Can be Electrified Today

Some can be deployed faster than others.

1

Electrification of machine drive
(compressors, pumps, etc.)

O&G Downstream

O&G Upstream

O&G Midstream

Iron & Steel

Aluminium

Cement

Mining

Glass

Pulp & Paper
F&B

Steam crackers

Fracking fleet

Oil pump stations

EAF + DRI

Electrolysis of Al

Kiln in cement

Fleet haulage

Elect. furnace for glass

Heat pumps

2

Electrification of heat
(furnace, steam boiler, gas-fired heaters, electrolyzers, etc.)

Small heaters

Offshore topside

Gas compressor stations

Molten oxide elect.

Steam boilers

Heat tracing

LNG train

Green H₂

Benefits Beyond Carbon Emissions Reduction

Electric

makes energy green



Electricity is the most efficient energy
and the best vector of decarbonization

&

Digital

makes energy smart



Digital makes the invisible visible,
measurable, and actionable



Lifetime savings on
energy efficiency of
electrified process



Better control, driving
higher efficiency



Lower
maintenance costs



Enablement of
remote operations



Participation in grid
flexibility mechanisms

Digital Technology Key Enabler for Smart Energy Consumption



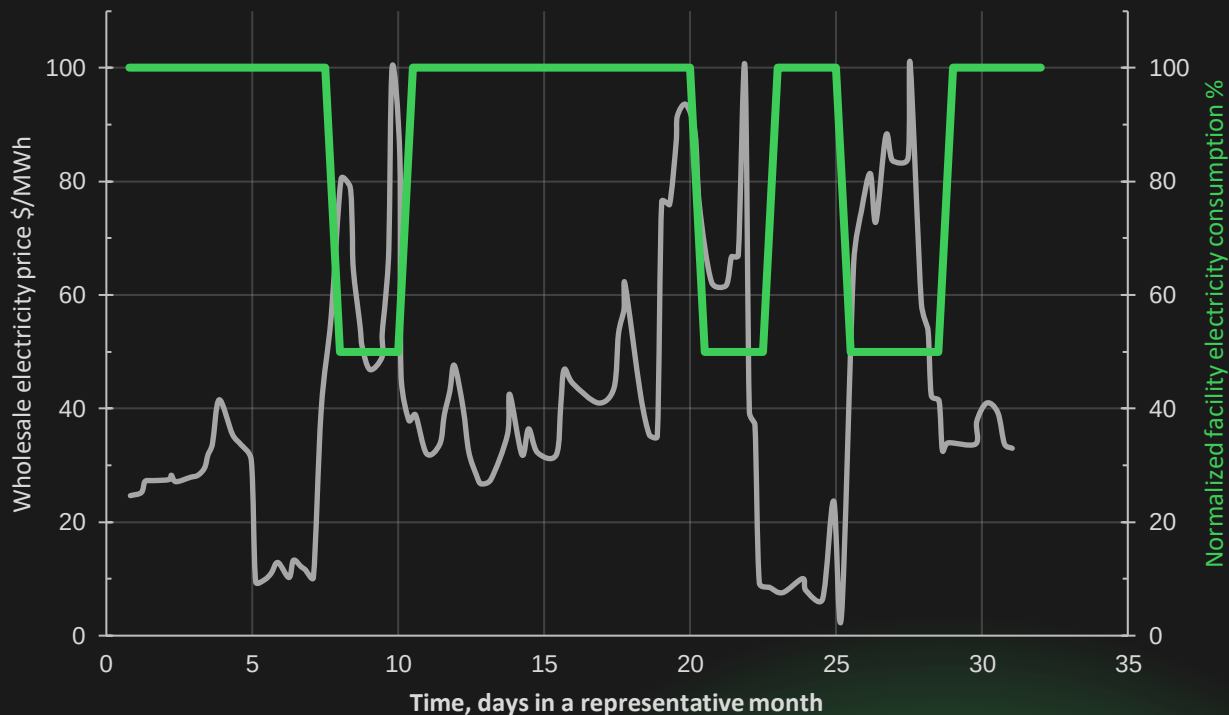
Participation in grid flexibility mechanisms



Demand side management/flexibility mechanism potential

Power and process integration leads to new flexibility paradigms for cost, carbon, and scheduling optimization

Example of flexible operation in response to variable electricity prices



What a Net Zero Future Looks Like in 2050

Grids of future

~100% reduction in CO2 emissions

Solar energy is captured on every suitable rooftop.

Power is generated with ~90% renewable energies.

Buildings of the future*

93% reduction in CO2 emissions

70% of buildings use heat pumps.

~100% Digital

Infrastructure of the future

83% reduction in CO2 emissions

70% of BEVs on the road.

2x more rail
2x less air transport

Industries of the future

84% reduction in CO2 emissions

70% recycling rates

Electrification of industry rises to 40-65% of final energy demand.

The 1.5° scenario is within reach when we **embrace sustainability** as a business imperative

Best in class companies follow a **3-step** approach:

1 Strategize

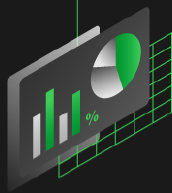
Define climate strategy to meet customer's ambition aligned with Science-Based Targets initiative



- measure enterprise baseline
- create decarbonization roadmap
- structure program and governance
- communicate commitment

2 Digitize

Create a single source of truth for energy and sustainability data



- monitor resource usage and emissions
- identify saving opportunities
- report and benchmark progress

3 Decarbonize

Execute decarbonization strategy



- ELECTRIFY operations
- REDUCE energy use
- REPLACE energy source
- ENGAGE value chain



Life Is On



Schneider
Electric

Our purpose is to empower all to **make the most of our energy and resources, bridging progress and sustainability for all.**

At Schneider, we call this **Life Is On.**

Our mission is to be **your digital partner for Sustainability and Efficiency.**

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