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International Renewable Energy Agency

The International, Regional & Israeli Energy Sector and the Impact of the War in Gaza

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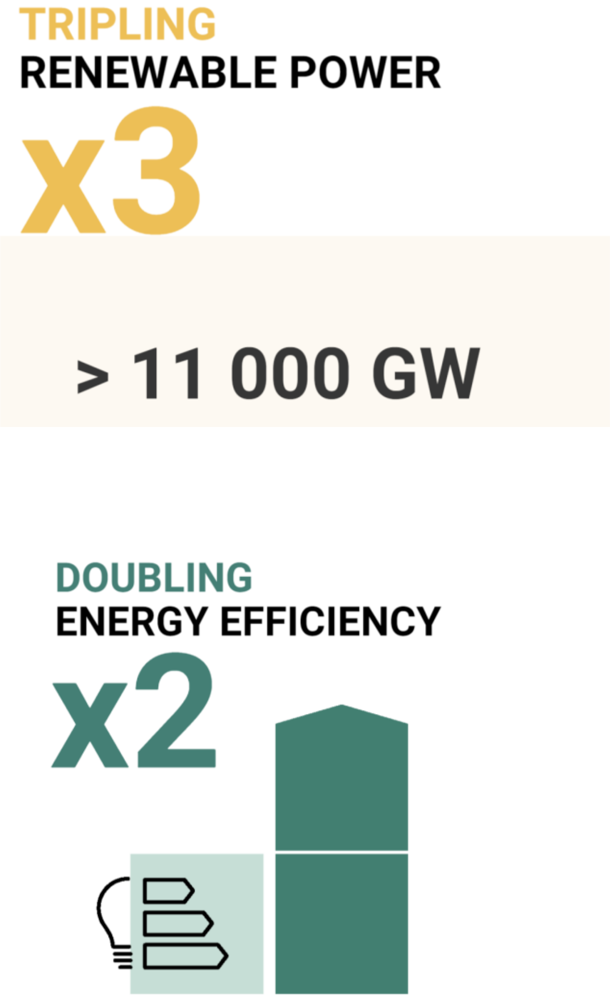
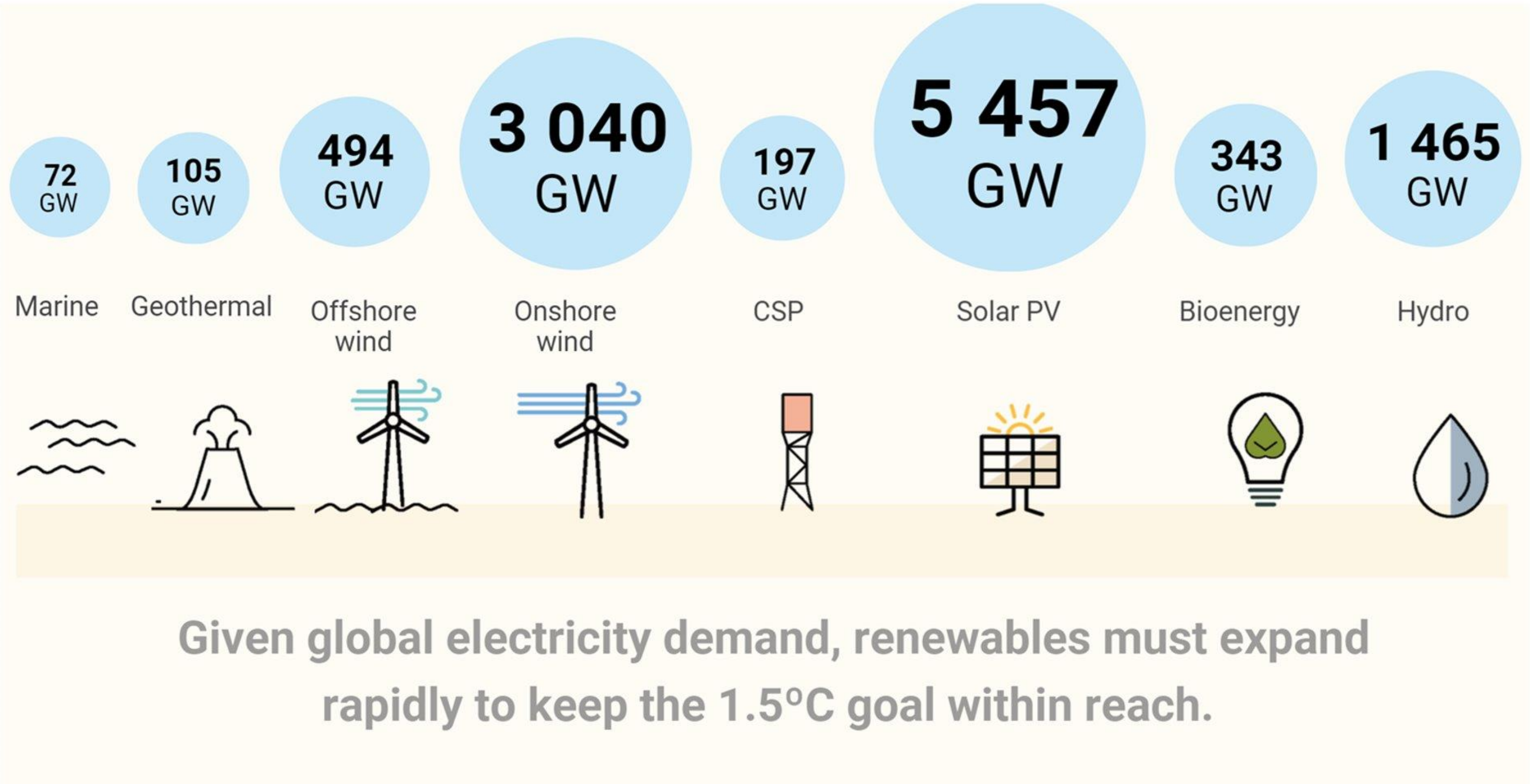
COP 28 Outcomes: Transitioning Away from Fossil Fuels





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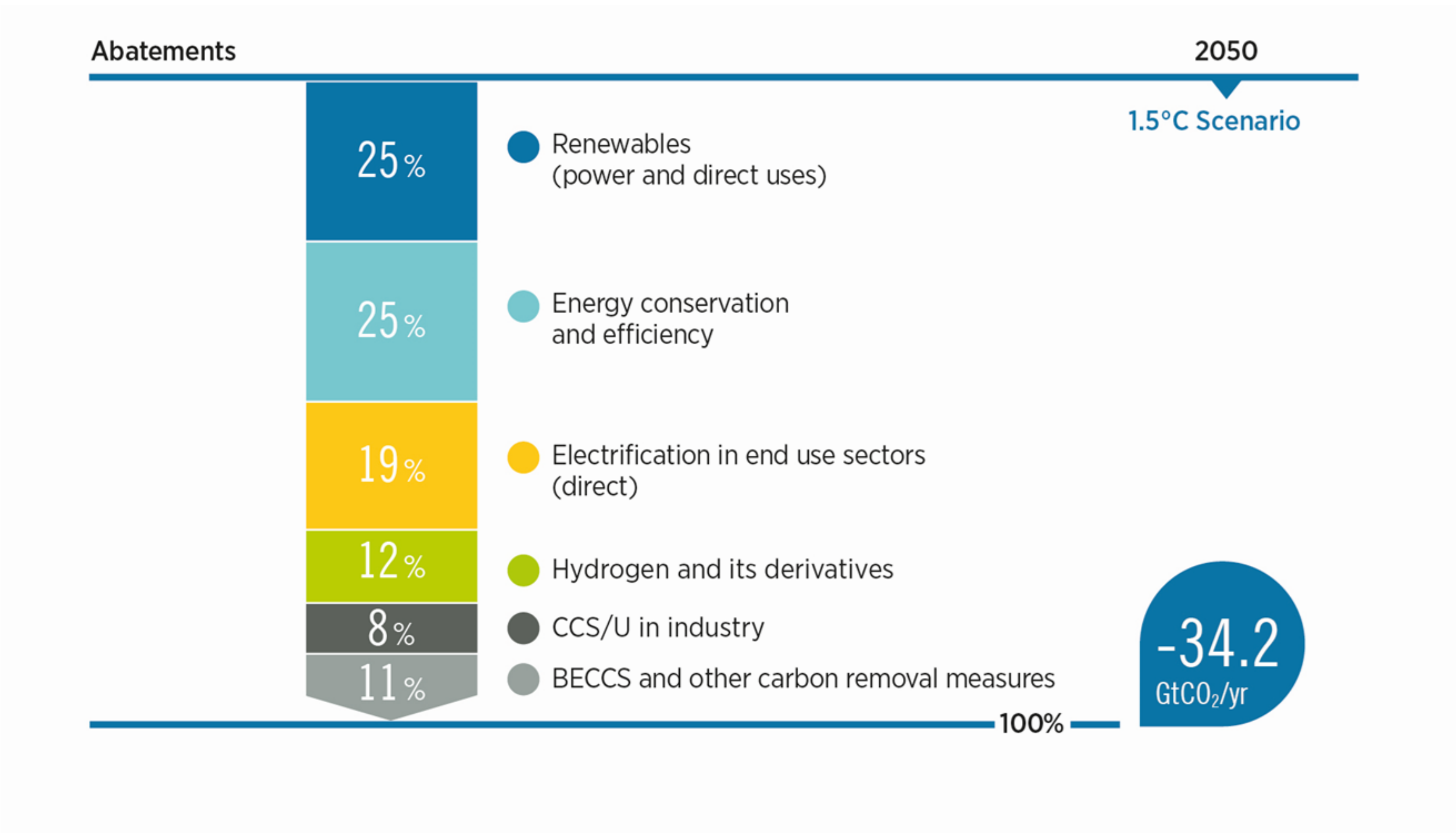
Renewables, efficiency and electrification dominate decarbonisation

Carbon dioxide emissions abatement under the 1.5C Scenario in 2050



- Renewable energy through direct supply of low-cost power, efficiency, electrification, bioenergy with CCS and clean hydrogen dominate the **decarbonisation** of the energy system

Source: IRENA, *World Energy Transitions Outlook 2023: 1.5°C Pathway, Vol.1*, 2023

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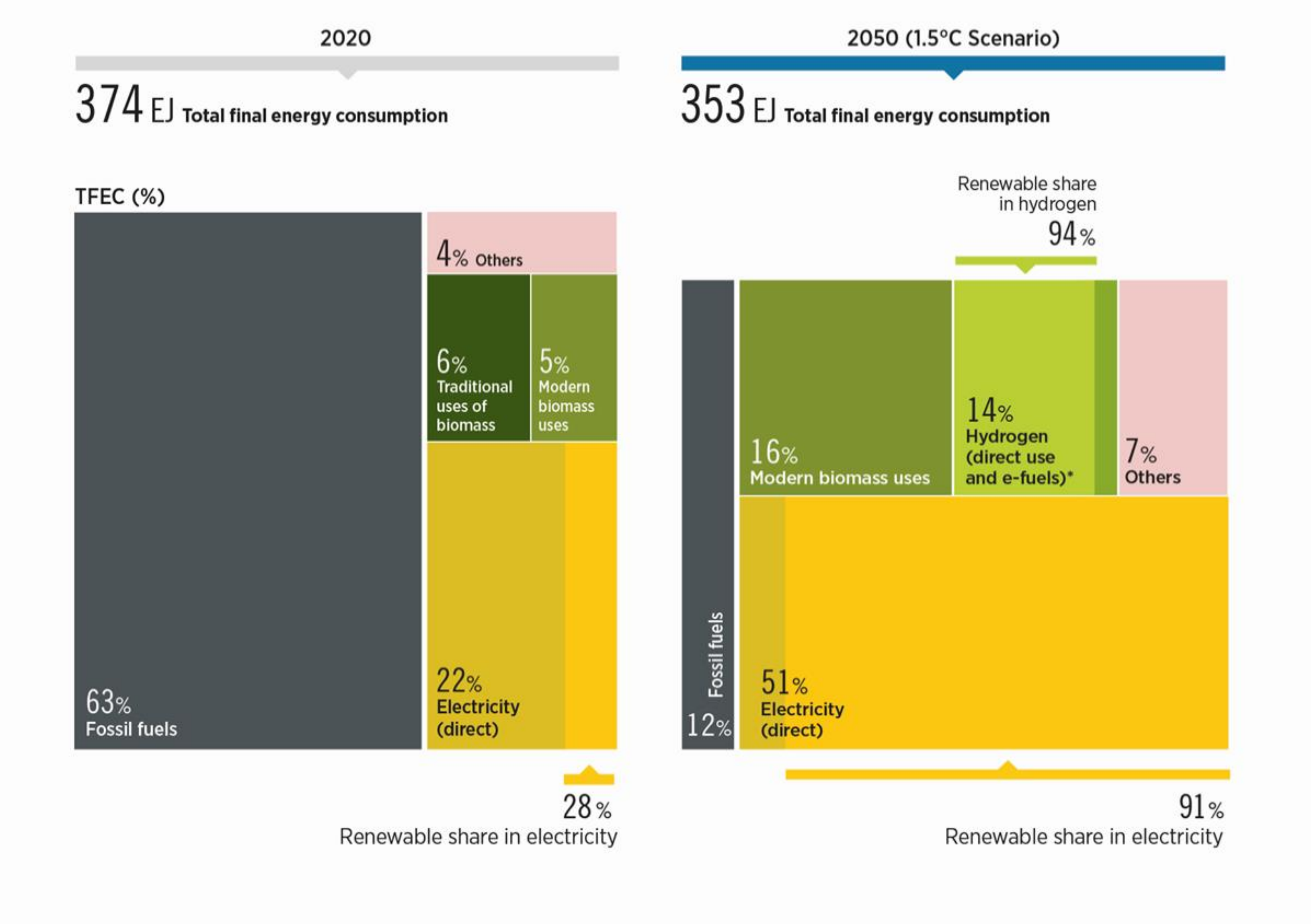
Electricity will become the main energy carrier in 2050

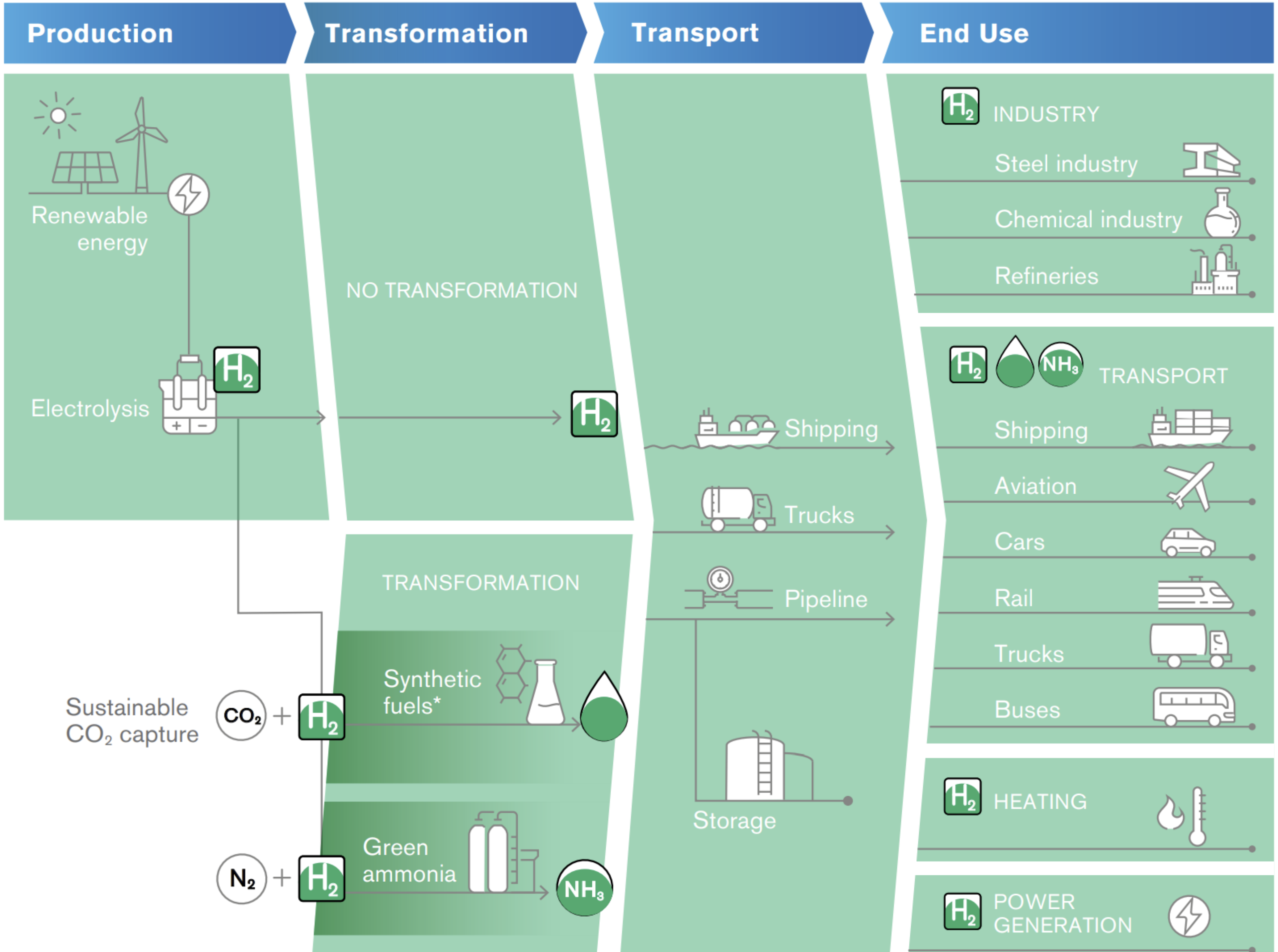
Breakdown of total final energy consumption by energy carrier between 2020 and 2050 under the 1.5C Scenario



- **Renewable energy** deployment, improvements in **energy efficiency** and the **electrification** of end-use sectors contribute to this shift
- More significant roles of **modern biomass** (16%) and **hydrogen** (14%) in 2050
- **94% of hydrogen** consumption in 2050 from **renewables**

Source: IRENA, *World Energy Transitions Outlook 2023: 1.5°C Pathway, Vol.1*, 2023

Clean hydrogen to play unique role in energy transition (especially for industry and transport)



Green hydrogen:

- Can be traded as a **gas** (in compressed tanks, or via pipelines) or as a **liquid** (in ships).
- Can also be traded in the **form of chemical derivatives** e.g., methanol, ammonia, methane and jet fuel.
- Can enable the trade of other low-carbon commodities, such as metallic iron.

Note: The term "synthetic fuels" refers here to a range of hydrogen-based fuels produced through chemical processes with a carbon source (carbon monoxide (CO) and CO_2 captured from emission streams, biogenic sources or directly from the air). They include methanol, jet fuels, methane and other hydrocarbons. The main advantage of these fuels is that they can be used to replace their fossil fuel-based counterparts and can, in many cases, be used as direct replacements – that is, as drop-in fuels. Synthetic fuels produce carbon emissions when combusted, but if their production process consumes the same amount of carbon, in principle this allows them to have net-zero carbon emissions.

Source: IRENA, *International trade and green hydrogen: Supporting the global transition to a low-carbon economy*, 2023.

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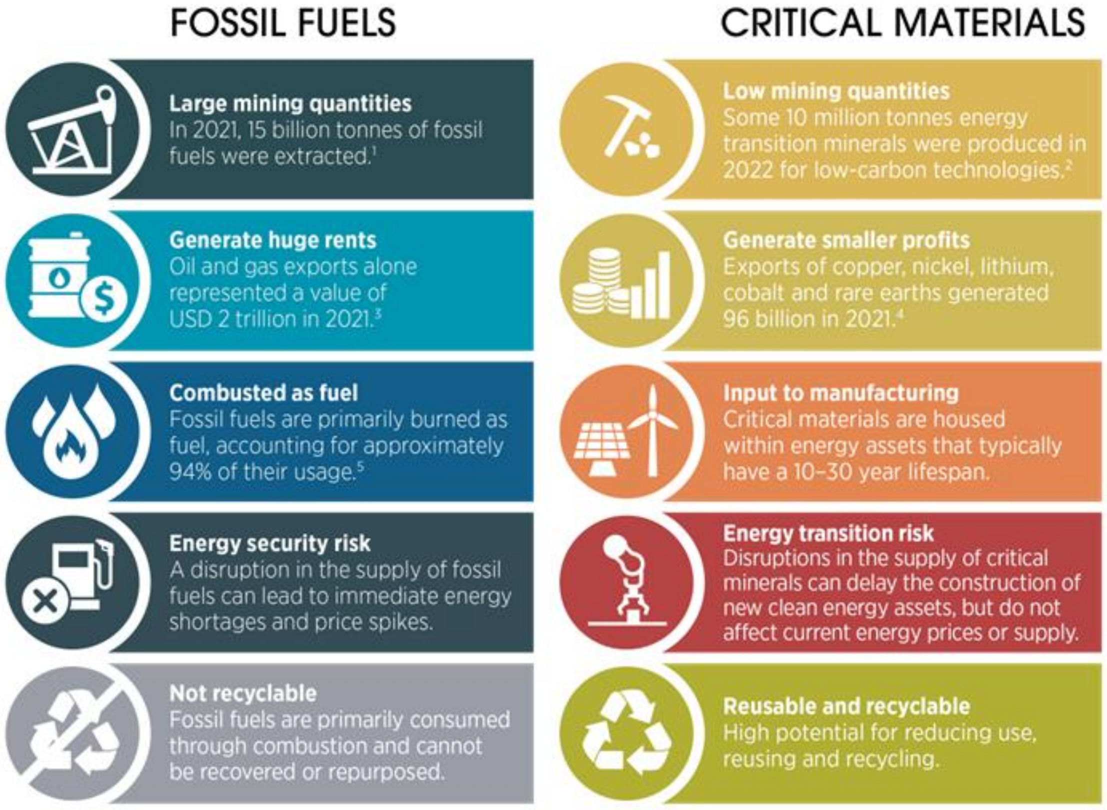
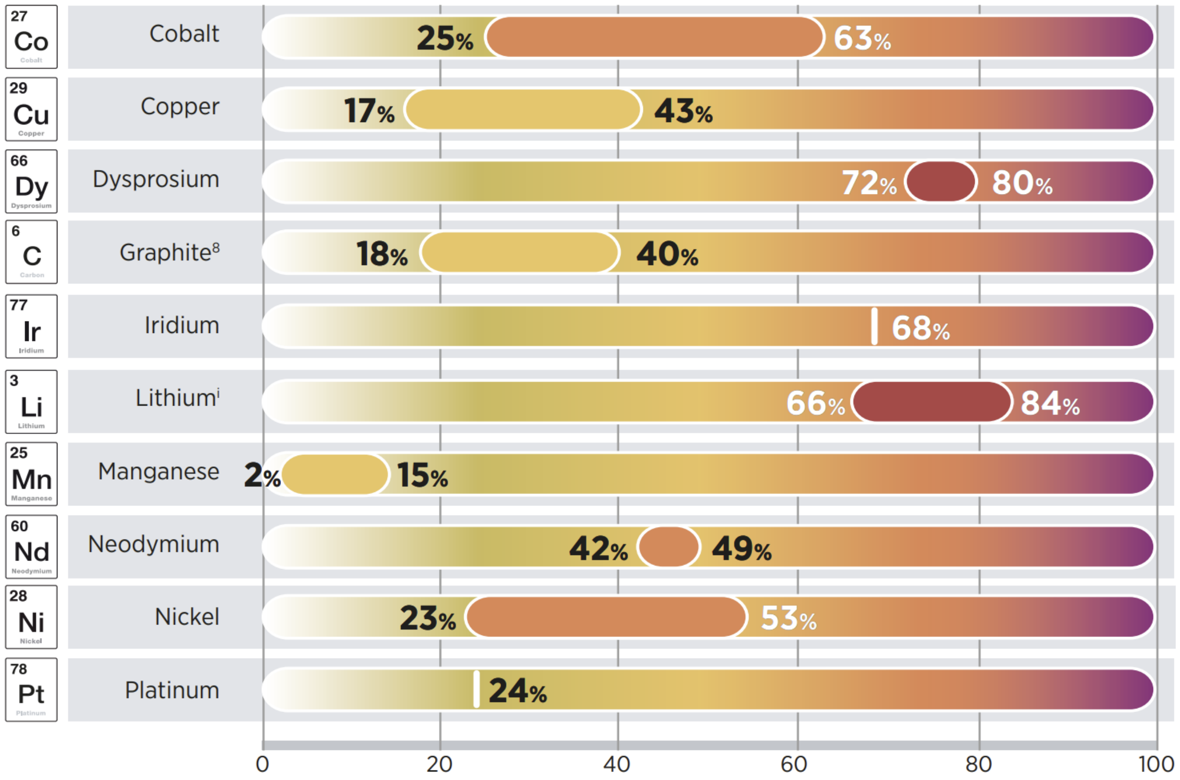
Critical Materials

Critical materials are fundamentally different from fossil fuels



Assessing disparity between current supply and anticipated demand in 2030 for selected materials*



Sources: (USGS, 2023a; Eurometaux, 2022; IRENA, forthcoming; McKinsey, 2023; WSJ, 2023; Mining.com, 2021; Mitchell and Deady, 2021; NVM, 2021; QYResearch, 2023; Garvey, 2021; Minerals Council of Australia, 2022; Nickel Asia, 2022; Systemiq, 2023; Cobalt Blue Holdings, 2022; Darbar, 2022; Fu, 2020; Albemarle, 2023; Lazzaro, 2022; McKinsey, 2022; S&P Global IQ, 2022).

Note: *A short-term scarcity ratio compares the mine production of selected material in 2022 with the demand expected in 2030; see Annex for calculation methodology.

Source: IRENA, *Geopolitics of the Energy Transition: Critical Materials*, 2023

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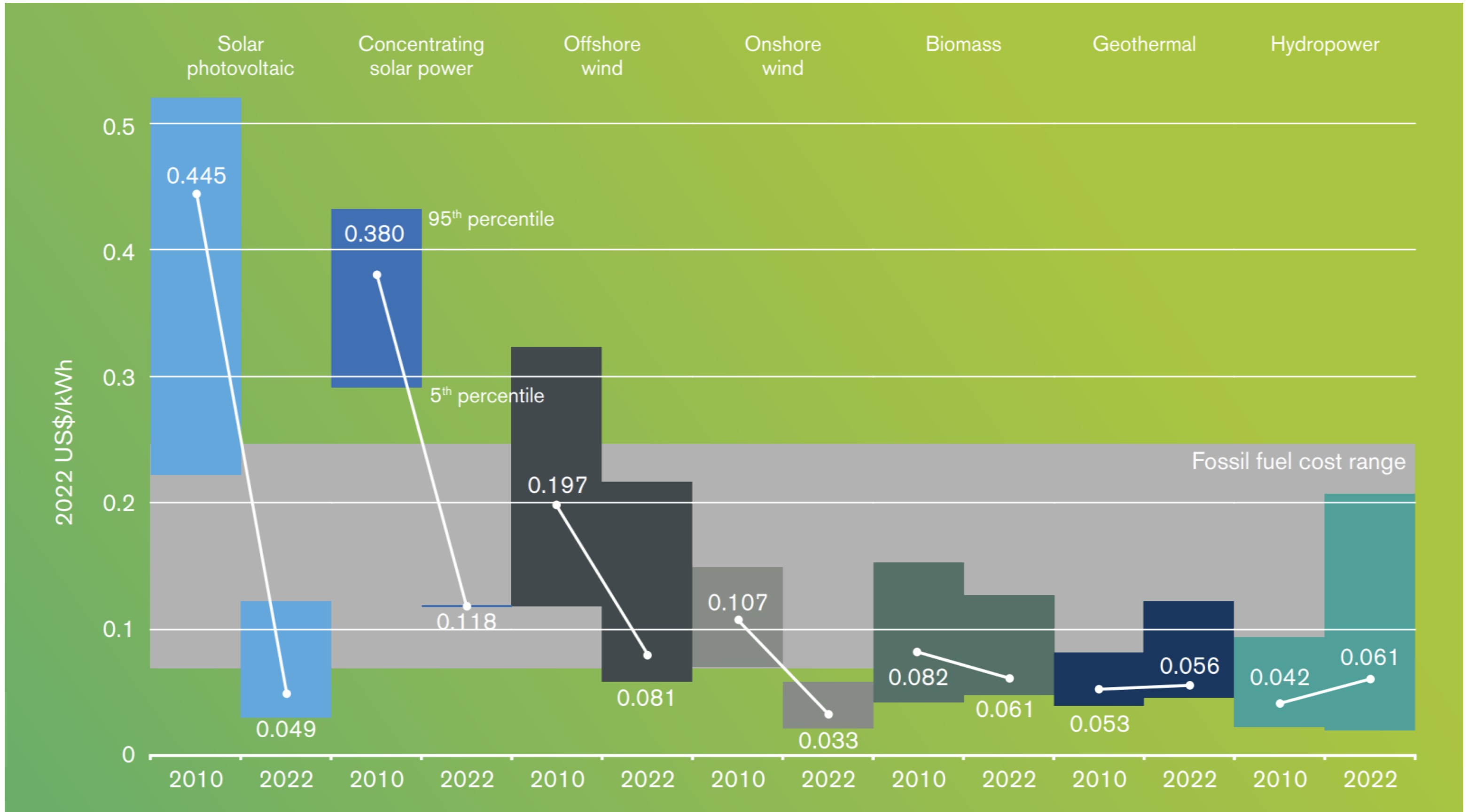
Costs, energy prices and the energy transition

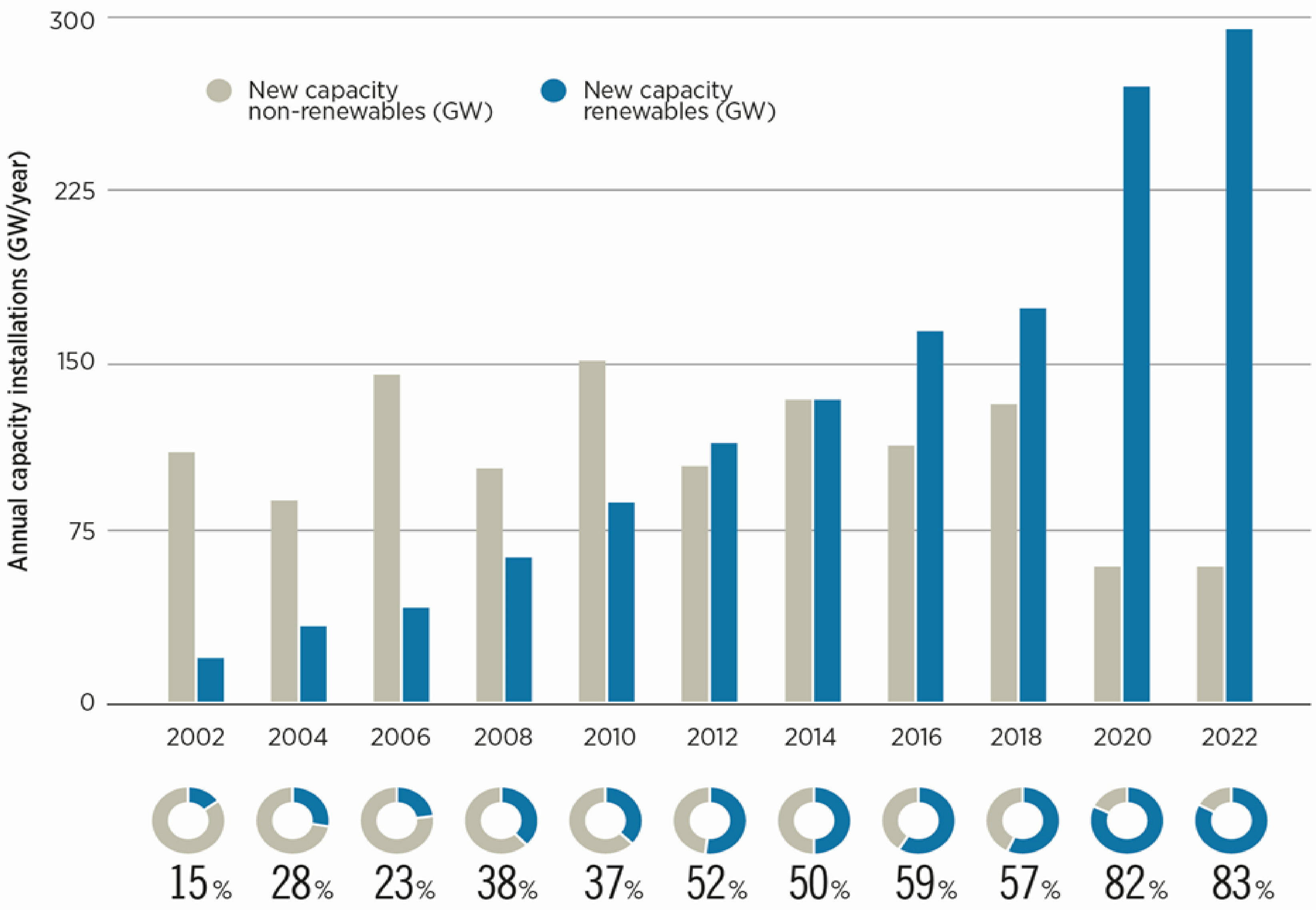


Note: kWh = Kilowatt-hour, i.e., a measure of the quantity of energy delivered by one kilowatt of power for a duration of one hour.
* The levelized cost of electricity is the ratio of lifetime costs to lifetime electricity production of a power generator, both of which are discounted back to a common year using a discount rate that reflects the cost of capital.

- Renewable electricity costs continued their historic **downward trend**.
- The global weighted average levelised cost of electricity (LCOE) of newly commissioned utility-scale **solar PV** projects **fell by 89%** between 2010 and 2022.
- The LCOE of **CSP** fell by **69%,** and **onshore** and **offshore wind** by **69%** and **59%,** respectively.

Source: IRENA, *International trade and green hydrogen: Supporting the global transition to a low-carbon economy*, 2023.

Renewable Capacity Additions 2010 -2022



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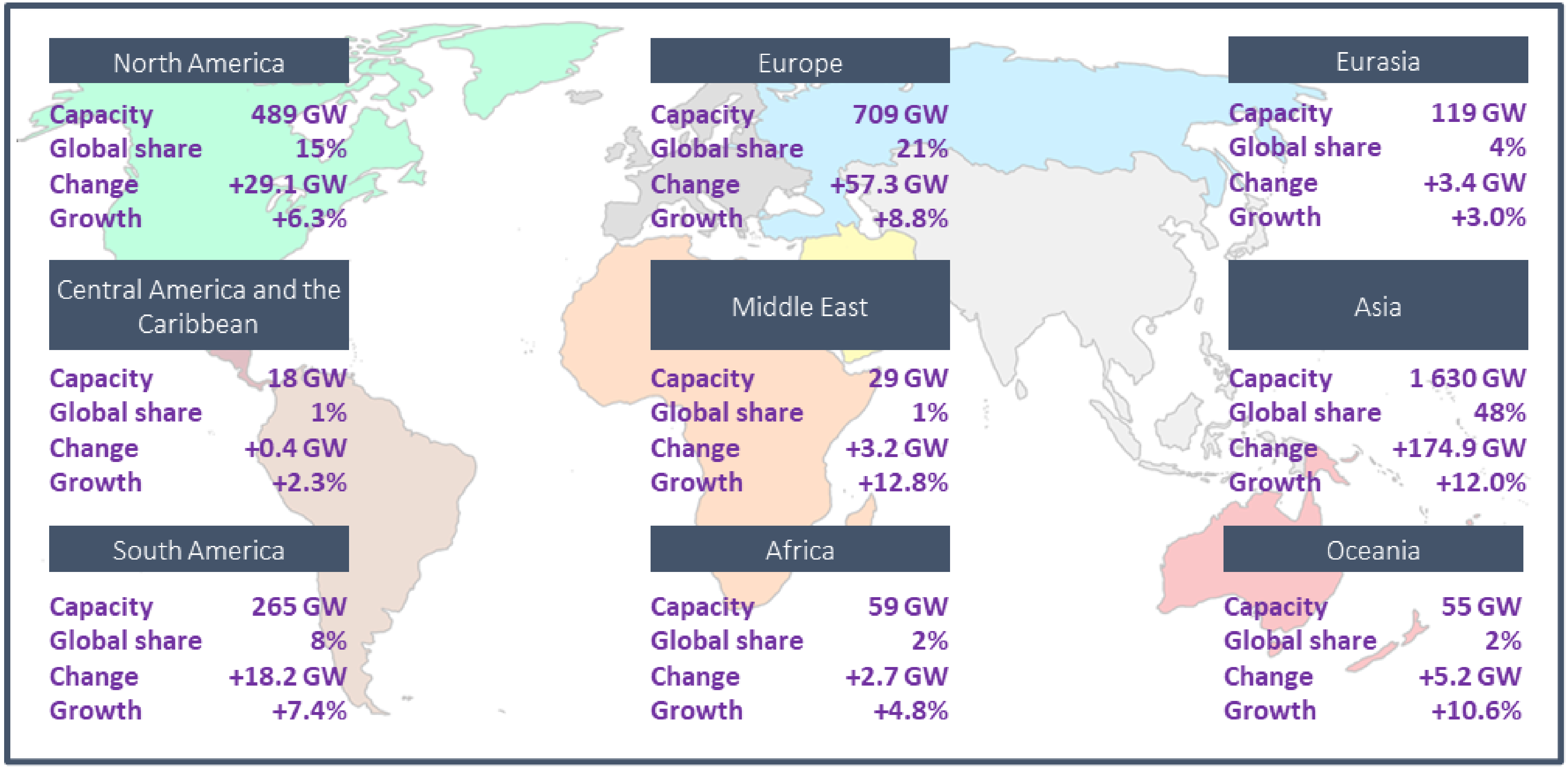
Source: IRENA, *World Energy Transitions Outlook 2023: 1.5°C Pathway, Vol.1*, 2023

Renewable Generation Capacity by Region



Despite Progress, the Energy Transition is far from Being on Track

Tracking progress of key energy system components to achieve the 1.5C Scenario

Indicators	Recent years	2030 [1]	2050 [1]	Progress (off / on track)
RENEWABLES				
ELECTRIFICATION WITH RENEWABLES				
Share of renewables in electricity generation [2]	28 %	68 %	91 %	
Renewable power capacity additions [3]	295 GW/yr [4]	975 GW/yr	1 066 GW/yr	
Annual solar PV additions [3]	191 GW/yr [5]	551 GW/yr	615 GW/yr	
Annual wind energy additions [3]	75 GW/yr [6]	329 GW/yr	335 GW/yr	
Investment needs for RE generation	486 USD billion/yr [7]	1 300 USD billion/yr	1 380 USD billion/yr	
Investment needs for power grids and flexibility	274 USD billion/yr [8]	605 USD billion/yr	800 USD billion/yr	
DIRECT RENEWABLES IN END-USES AND DISTRICT HEAT				
Share of renewables in final energy consumption	17 % [9]	35 %	82 %	
Solar thermal collector area	585 million m²/yr [10]	1 552 million m²/yr	3 882 million m²/yr	
Modern use of bioenergy (direct use)	21 EJ [11]	46 EJ	53 EJ	
Geothermal consumption (direct use)	0.9 EJ [12]	1.4 EJ	2.2 EJ	
Renewables based district heat generation	0.9 EJ [13]	4.3 EJ	13 EJ	
Investment needs for renewables end uses and district heat [14]	13 USD billion/yr [15]	290 USD billion/yr	210 USD billion/yr	

Indicators	Recent years	2030 [1]	2050 [1]	Progress (off / on track)
ENERGY EFFICIENCY				
Energy intensity improvement rate	1.7 %/yr [16]	3.3 %/yr	2.8 %/yr	
Investment needs for energy conservation and efficiency [17]	295 USD billion/yr [18]	1780 USD billion/yr	1525 USD billion/yr	
ELECTRIFICATION				
Share of direct electricity in final energy consumption	22 % [19]	29 %	51 %	
Passenger electric cars on the road	10.5 million [20]	360 million	2 180 million	
Investments needs for charging infrastructure of EV's and EV adoption support	30 USD billion/yr [21]	137 USD billion/yr	364 USD billion/yr	
Investment needs for heat pumps	64 USD billion/yr [22]	237 USD billion/yr	230 USD billion/yr	
HYDROGEN				
Clean hydrogen production	0.7 Mt/yr [23]	125 Mt/yr [24]	523 Mt/yr [25]	
Electrolyser capacity	0.5 GW [26]	428 GW	5 722 GW	
Investment needs for clean hydrogen and derivatives infrastructure [27]	1.1 USD billion/yr [28]	100 USD billion/yr	170 USD billion/yr	
CCS AND BECCS				
CCS/U - emissions abated	0.04 $GtCO_2$ captured/yr [29]	1.4 $GtCO_2$ captured/yr	3.2 $GtCO_2$ captured/yr	
BECCS and others to abate total emissions	0.002 $GtCO_2$ captured/yr [30]	0.8 $GtCO_2$ captured/yr	3.8 $GtCO_2$ captured/yr	
Investment needs for carbon removal and infrastructure	6.4 USD billion/yr [31]	38 USD billion/yr	107 USD billion/yr	

▸ Notes: see next page

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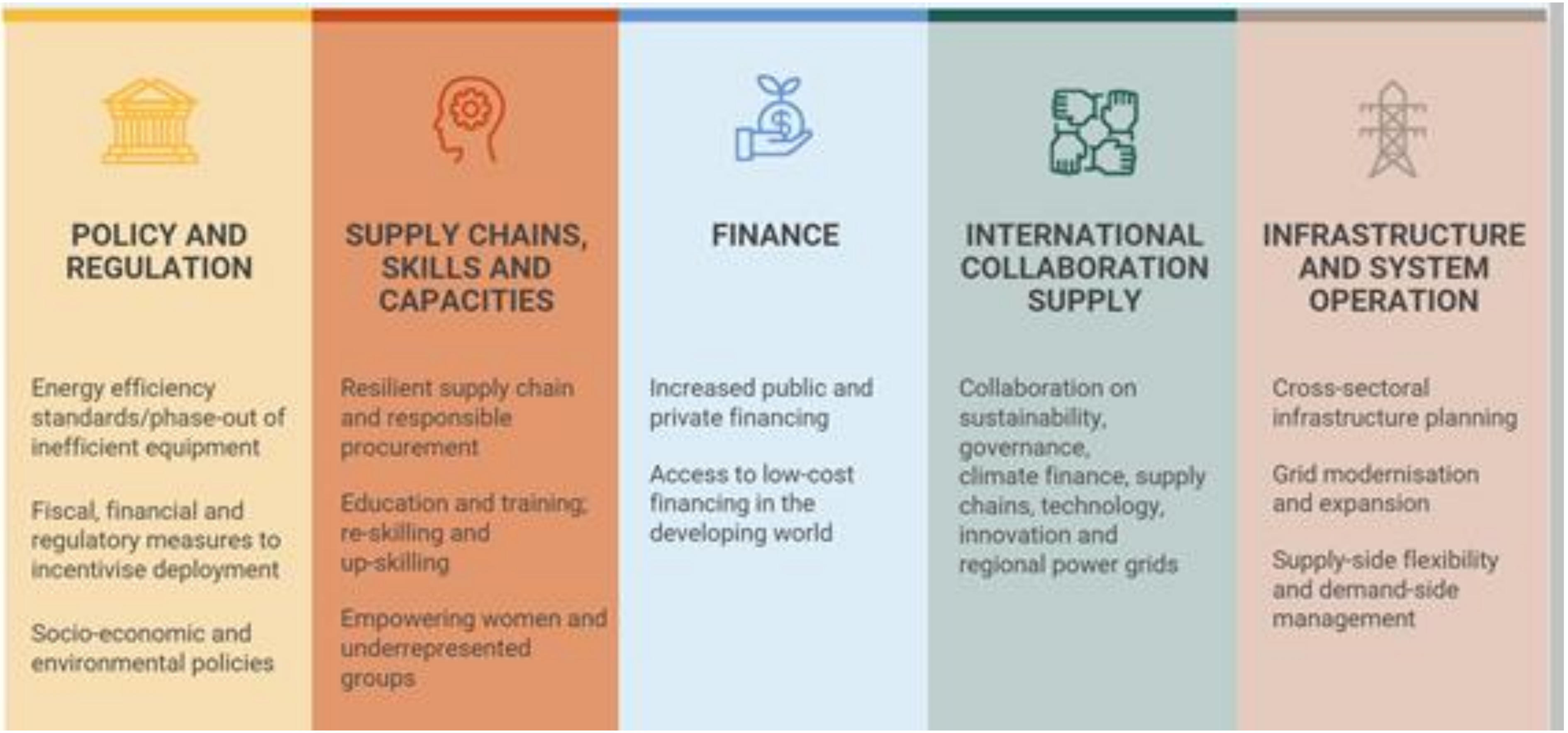
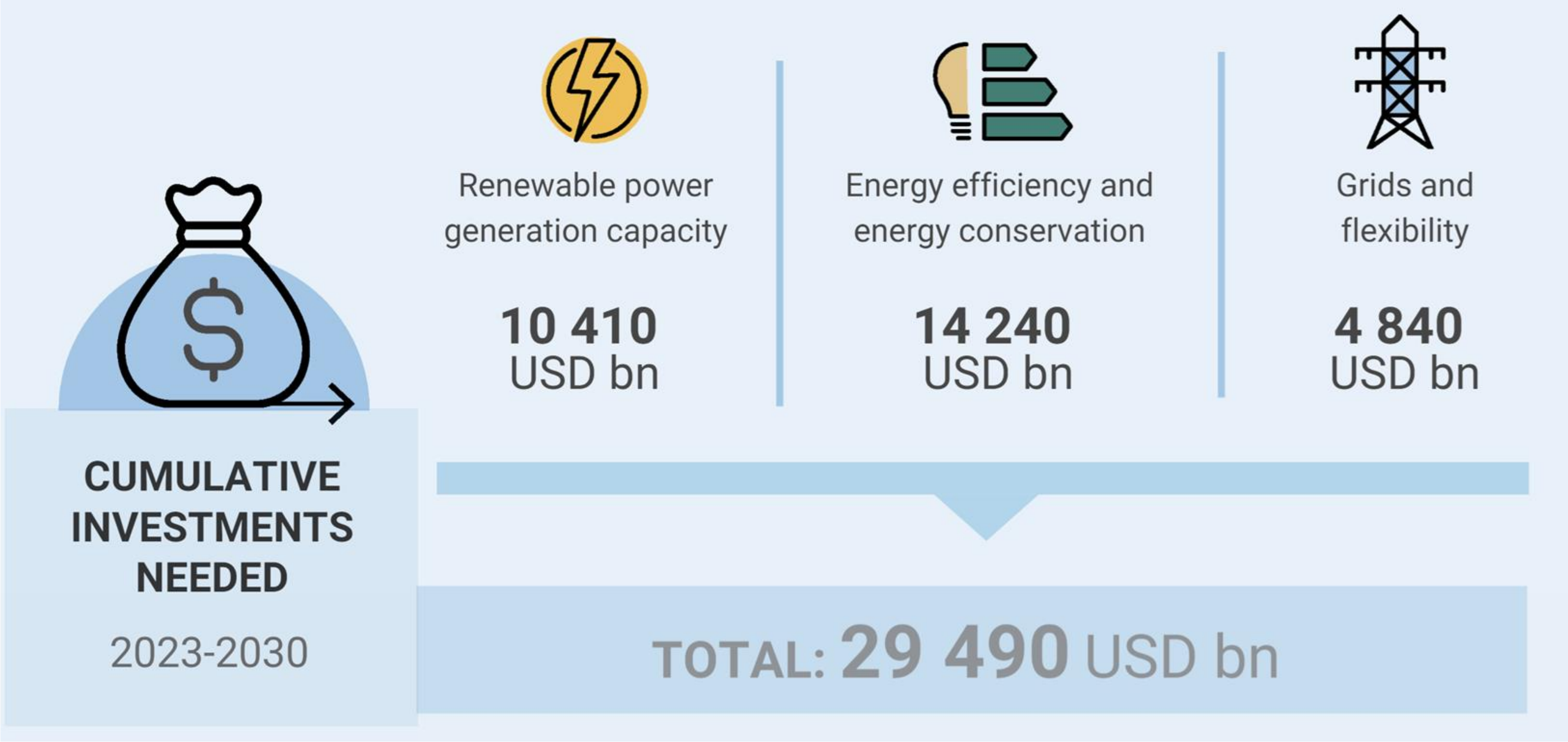
Source: IRENA, *World Energy Transitions Outlook 2023: 1.5°C Pathway, Vol.1*, 2023

Key Enablers: Tripling Renewables and Doubling Efficiency



Investment needs for a successful energy transition



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Thank you!

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