IRENA

International Renewable Energy Agency

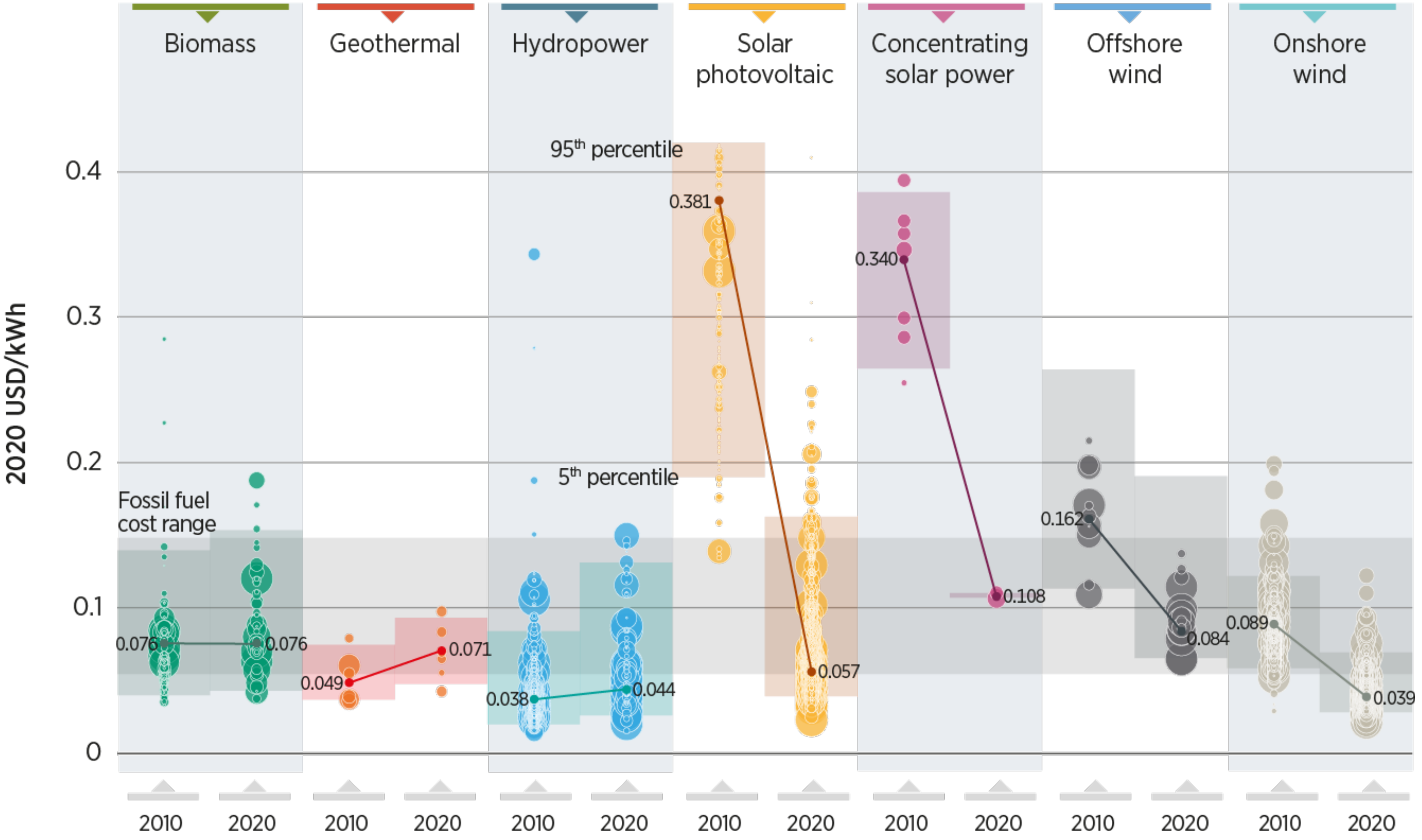
WORLD ENERGY TRANSITIONS OUTLOOK

1.5°C Pathway

OVERVIEW

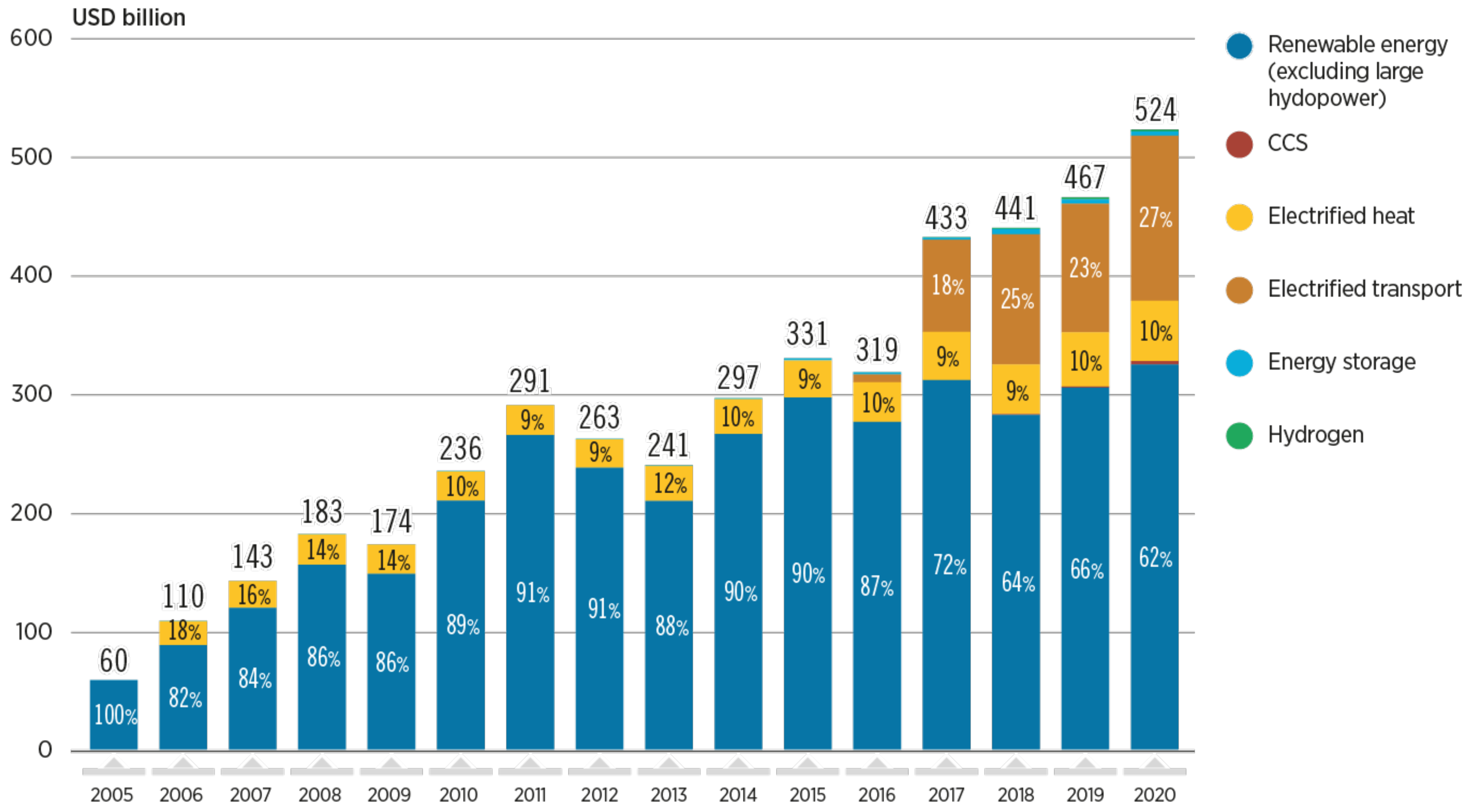
Global High-Level Forum on Energy Transition • Virtual • 30 June 2021 • Abu Dhabi

Renewables are increasingly the lowest-cost sources of electricity in many markets



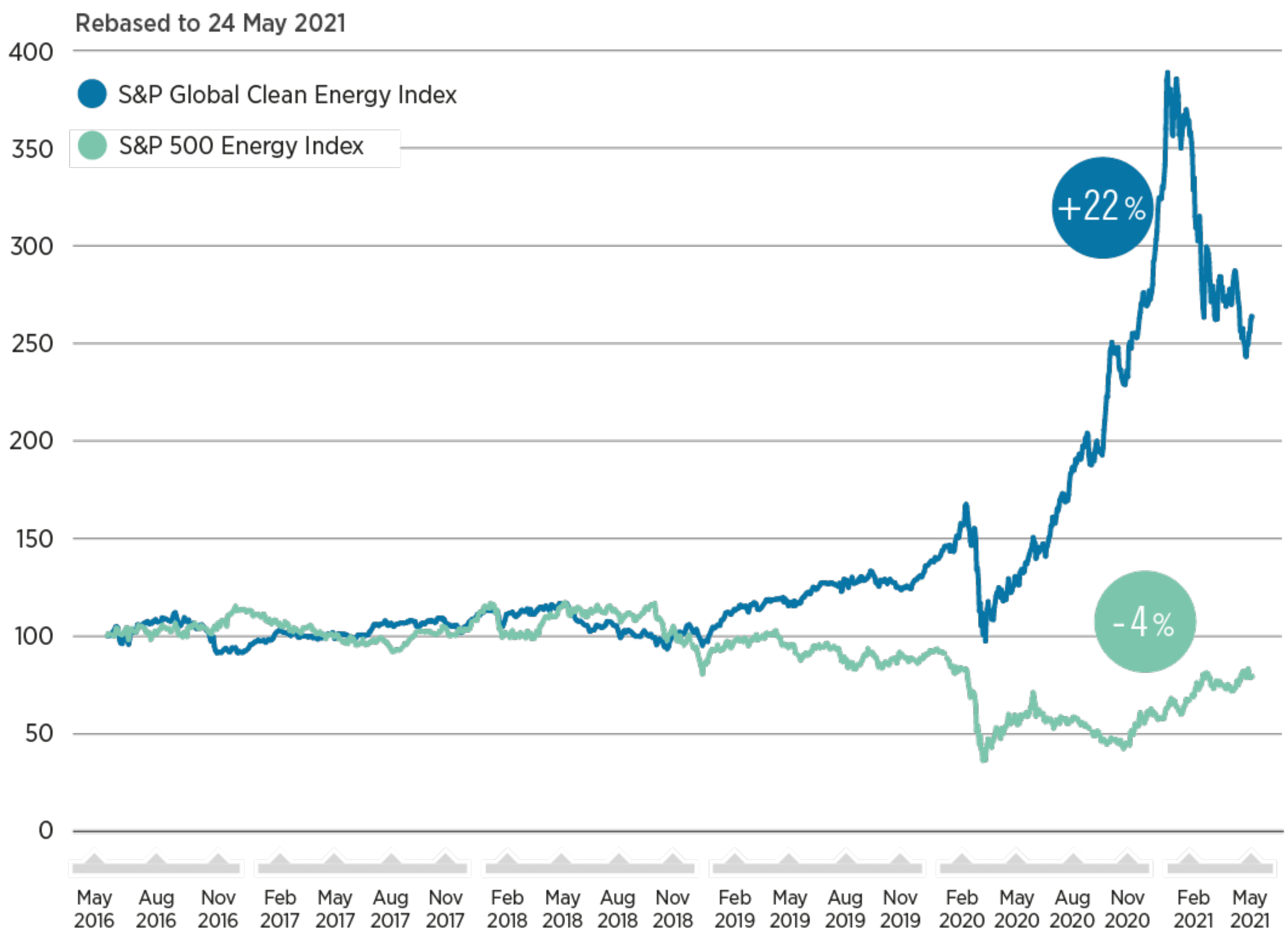
The costs of renewable energy have continued to decline. Solar PV and wind are increasingly the cheapest sources of electricity in many markets.

Investments in energy transition technologies continue to grow



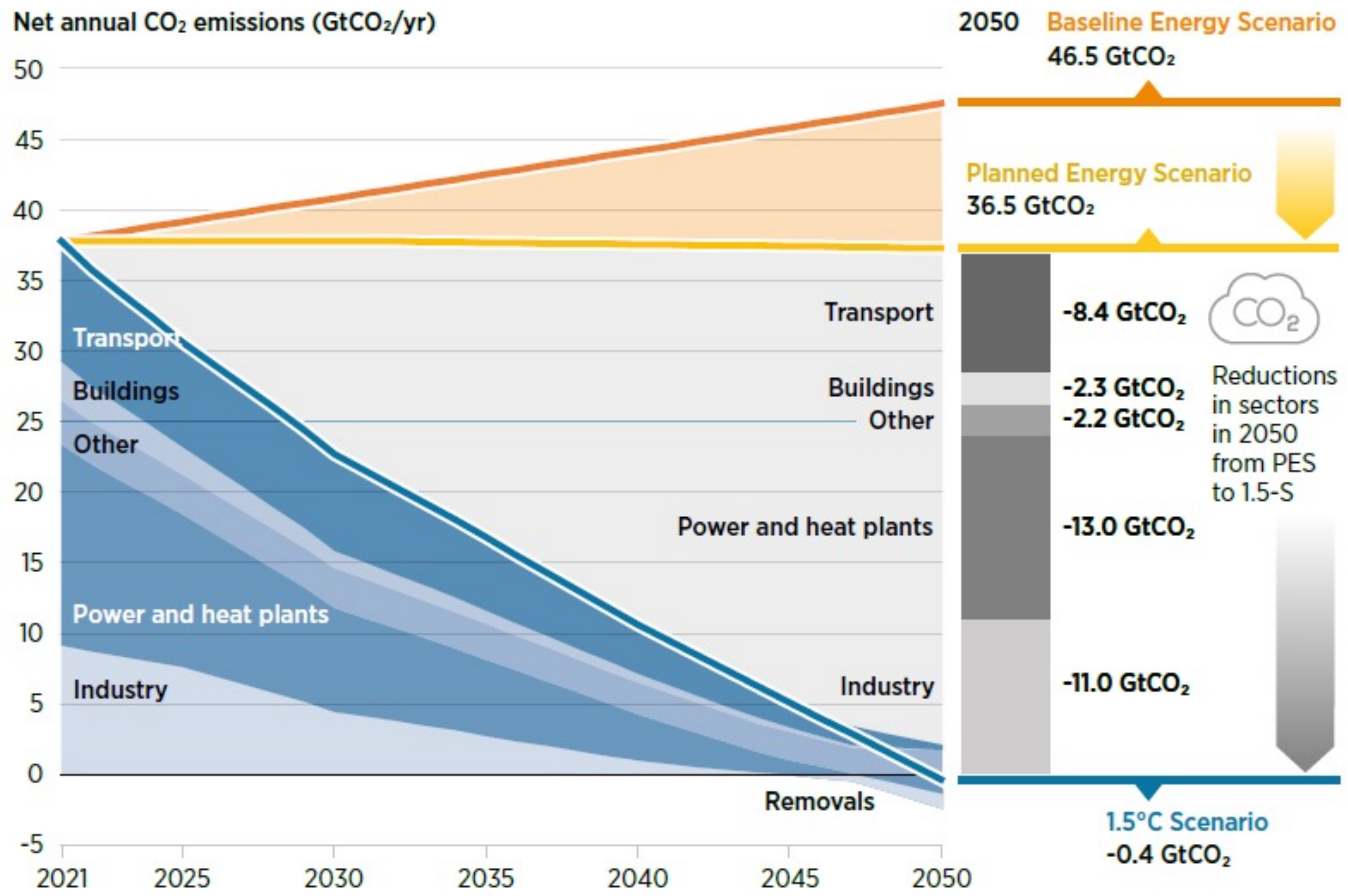
Notwithstanding the impacts of the COVID-19 pandemic, investment in energy transition technologies reached an all-time high of USD 524 billion in 2020 – and almost USD 800 billion if energy efficiency measures are considered

Recent trends in financial markets



Investors and financial markets are anticipating the energy transition and already allocating capital away from fossil fuels and towards energy transition technologies, such as renewables

Net zero emissions by mid-century

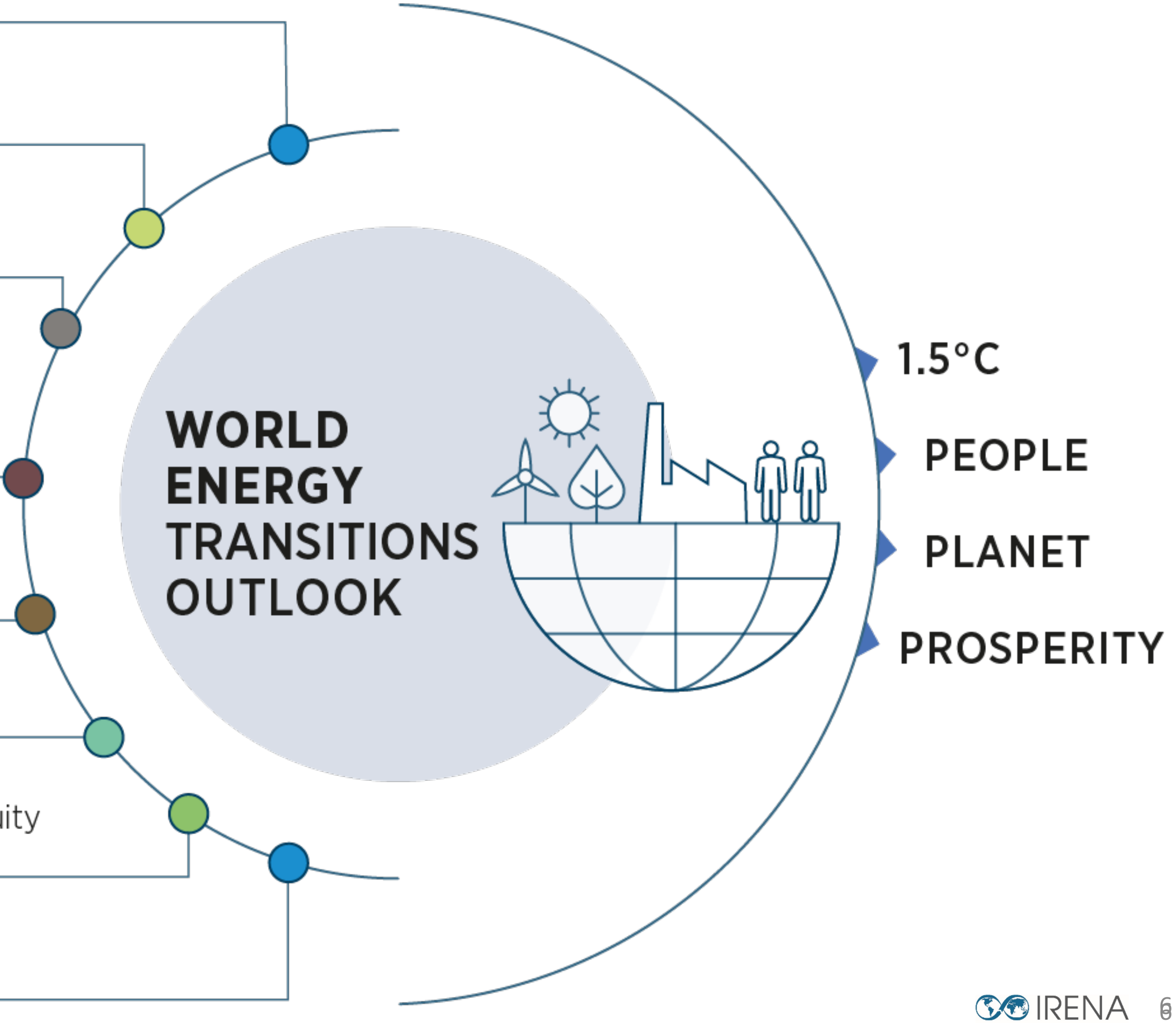


- Baseline emissions continue to rise, while the policies of governments (Planned Energy Scenario) result in flatlining of emissions
- For the 1.5°C climate target, global CO2 emissions need to drop to net zero by 2050
- Steepest decline necessary over the next 10 years – 2020 must be the decade of action

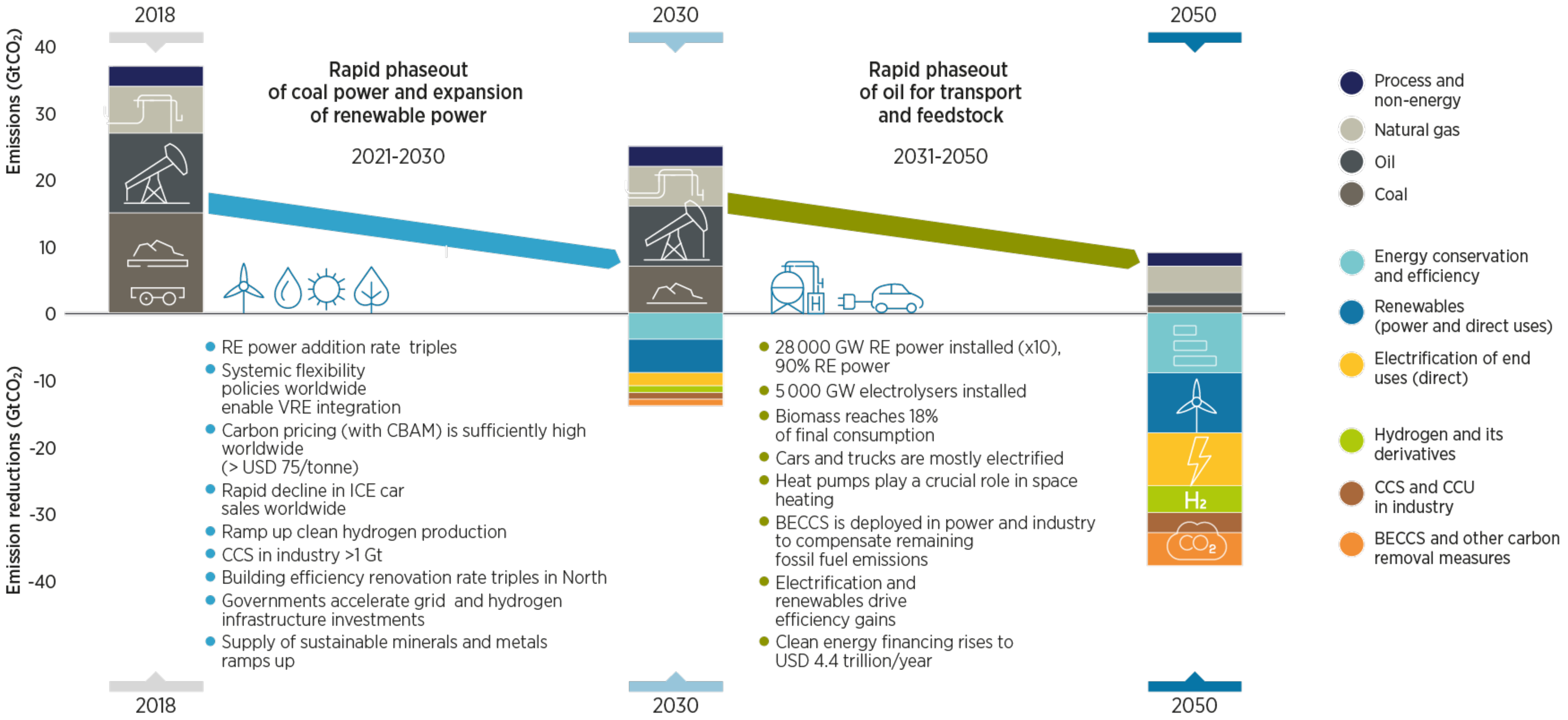
Investment and policy choices in the coming decade will define the pathway to 2050

Guiding framework of WETO theory of change

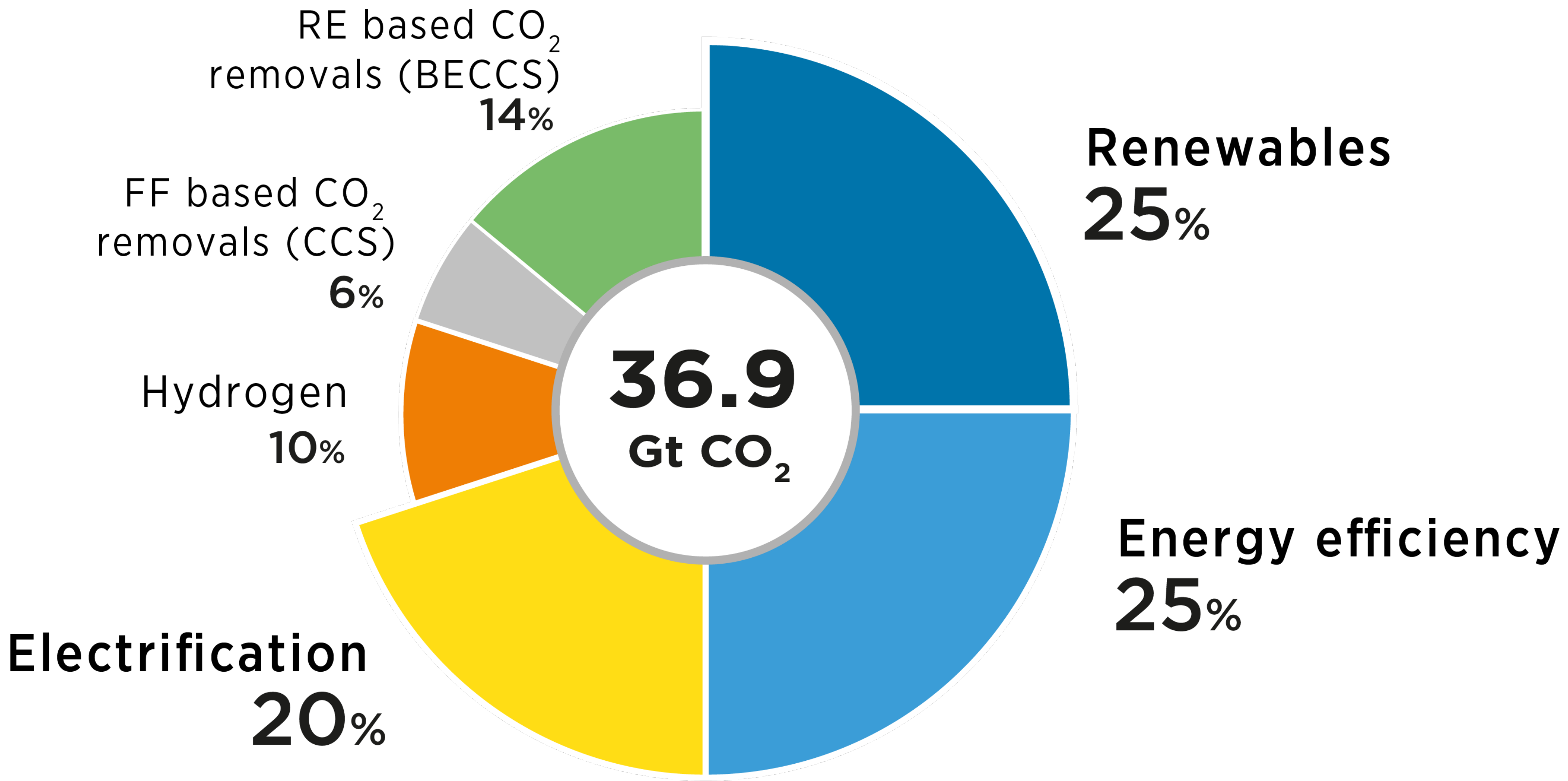
- **Pursue** the path that is most likely to drive down energy emissions in the coming decade.
- **Support** emerging technologies most likely to become competitive in the short-term and most effective in the long-term.
- **Limit** investments in oil and gas to facilitating a swift decline and a managed transition.
- **Phase out** coal and fossil fuel subsidies.
- **Reserve** CCS for economies heavily dependent on oil and gas and as a transitional solution.
- **Adapt** market structures for the new energy era.
- **Invest** in a set of policies for resilience, inclusion, and equity and protect workers and communities.
- **Ensure** all countries and regions have an opportunity to realise the benefits of the transition.



Evolution of emissions with phaseouts of coal and oil, 2021-2050

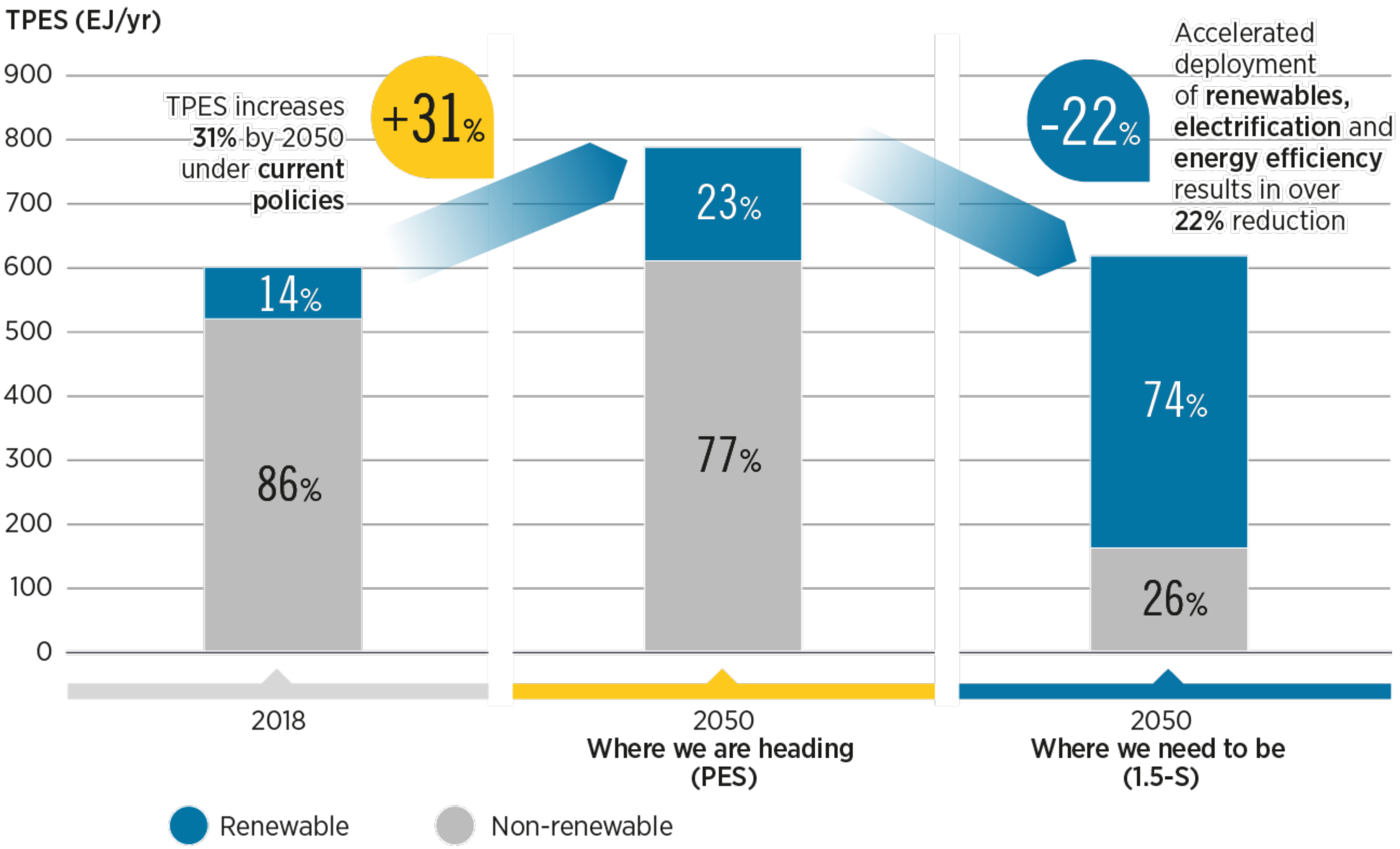


Renewables, efficiency and electrification dominate energy transition



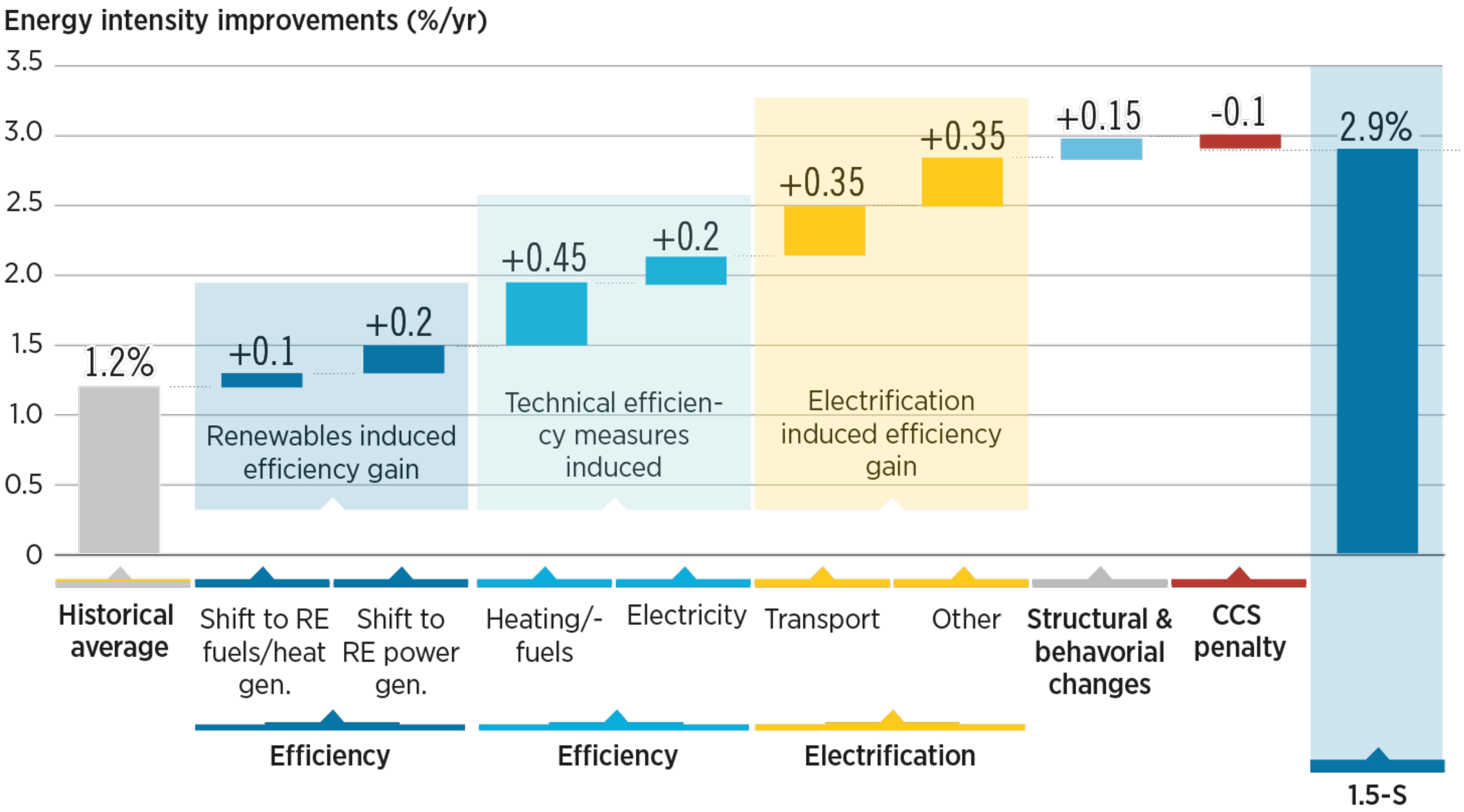
90% of all decarbonisation in 2050 will involve renewable energy through direct supply of low-cost power, efficiency, electrification, bioenergy with CCS and green hydrogen.

The global energy supply must become more efficient and more renewable



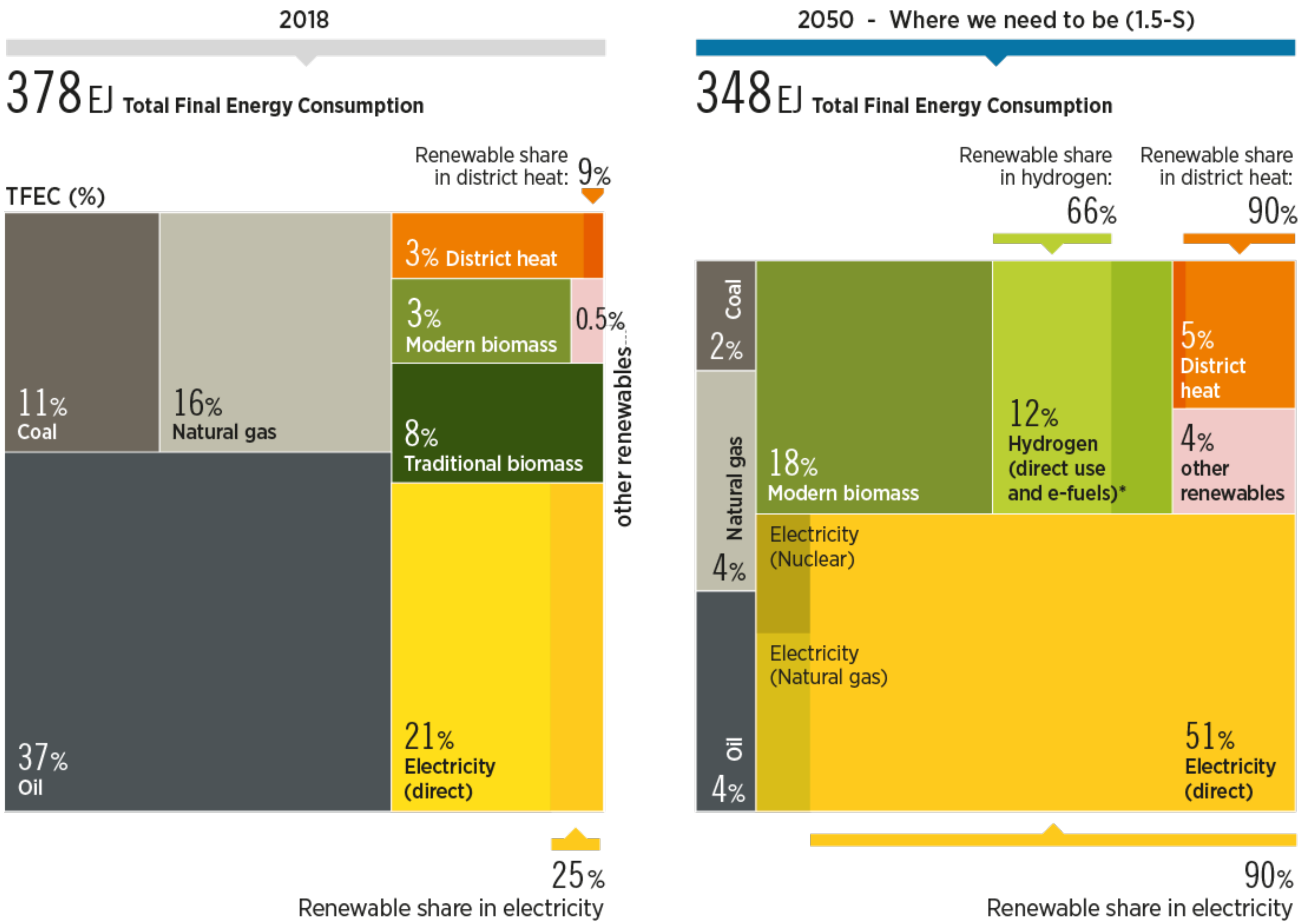
- The share of renewable energy in primary supply must grow from 14% in 2018 to 74% in 2050 in the 1.5°C Scenario.
- This entails an 8-fold growth in the pace of renewable share growth, and a 2.5-fold increase in the rate of energy intensity improvement.

Renewables combined with electrification deliver large energy intensity improvement



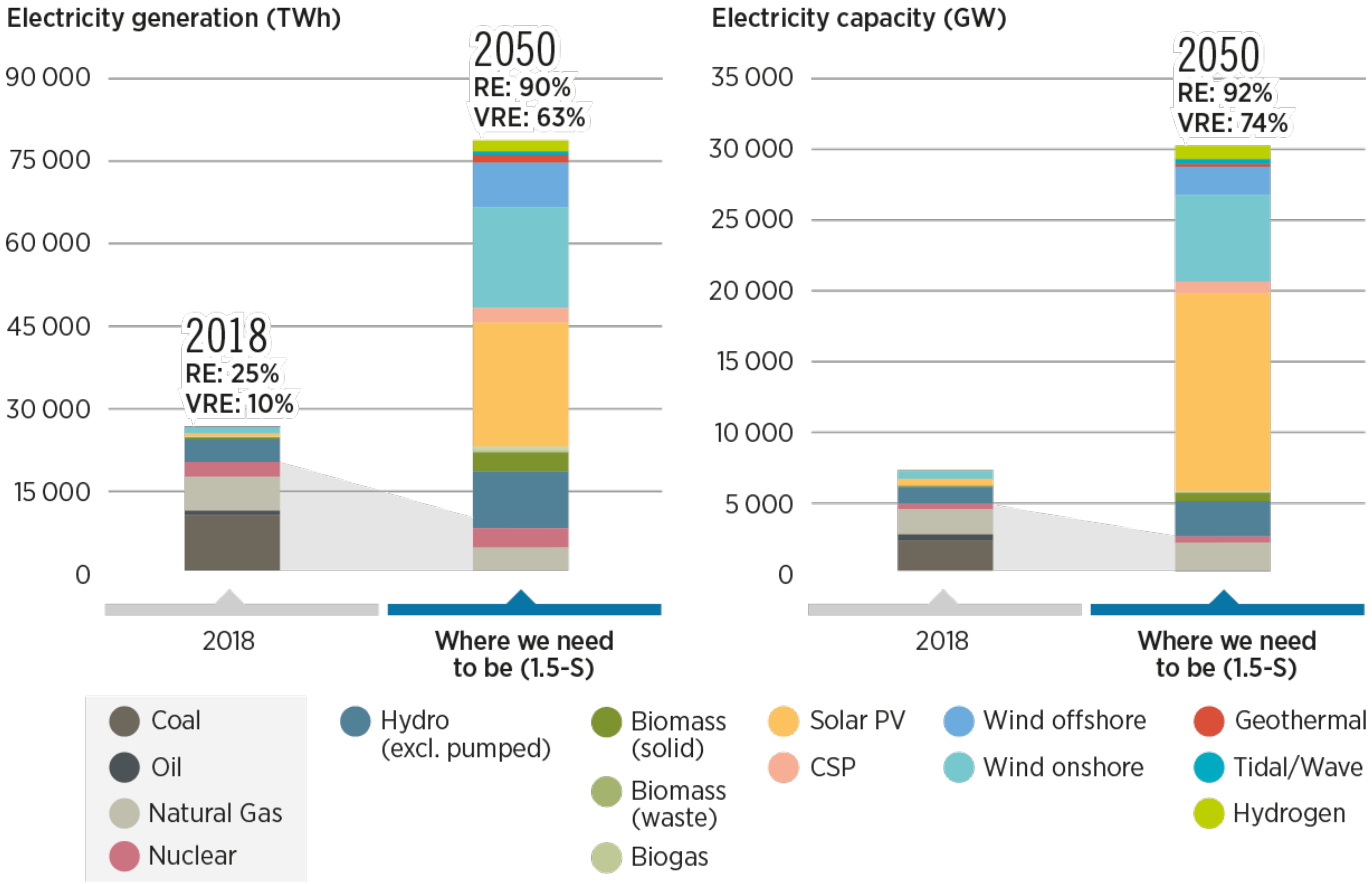
In the 1.5°C Scenario, the rate of energy intensity improvement needs to increase to 2.9% per year, nearly two and a half times the historical trend, causing the energy intensity of the global economy to fall over 60%.

Electricity is the central energy carrier in future energy systems



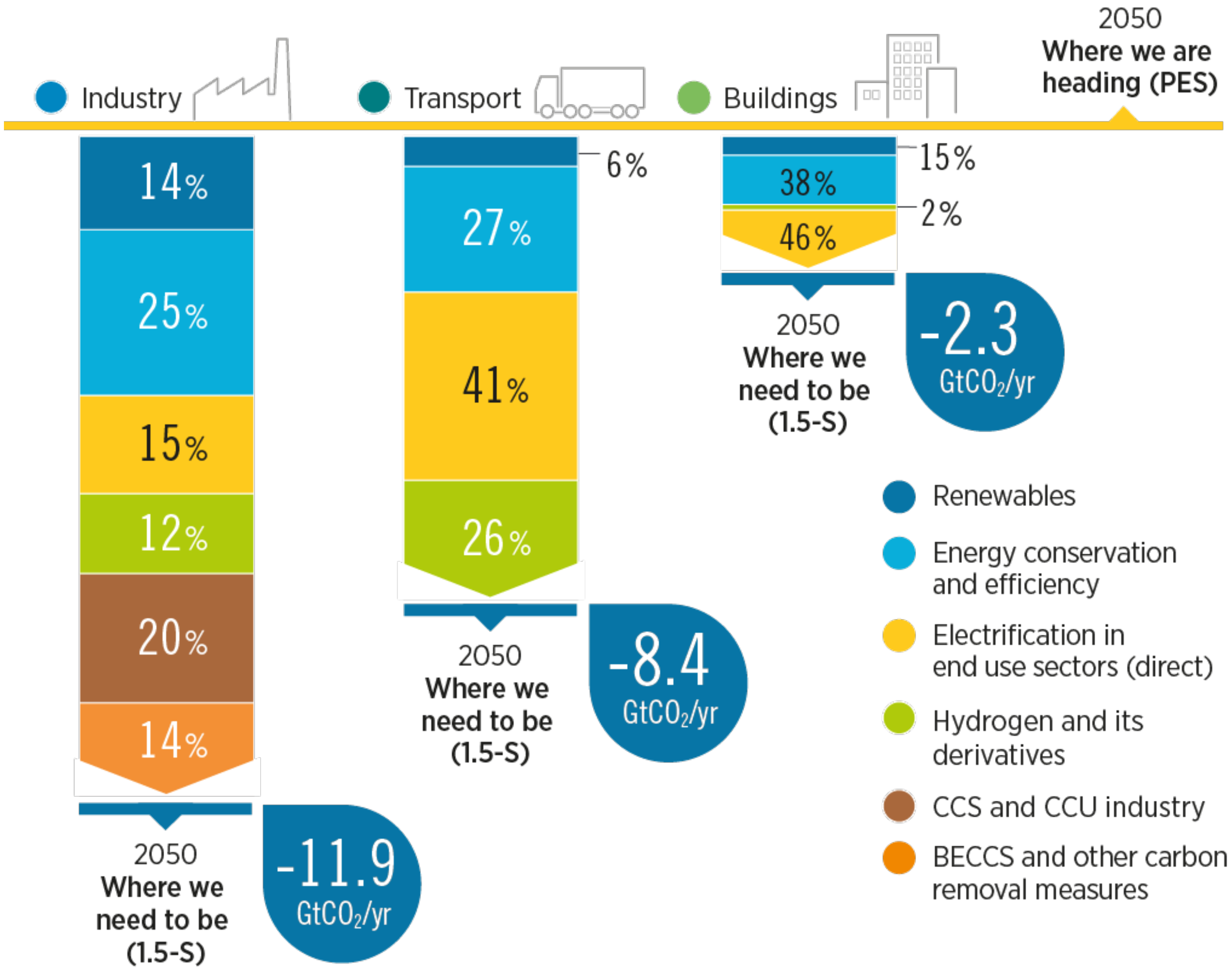
- By 2050, electricity would be the main energy carrier with more than a 50% direct share of total final energy consumption – up from 21% in 2018.
- By 2050, 90% of total electricity needs would be supplied by renewables followed by 6% from natural gas and the remainder from nuclear.
- Another 8% of final energy would come as indirect electricity in the form of e-fuels and hydrogen.

Renewables will dominate the power generation mix



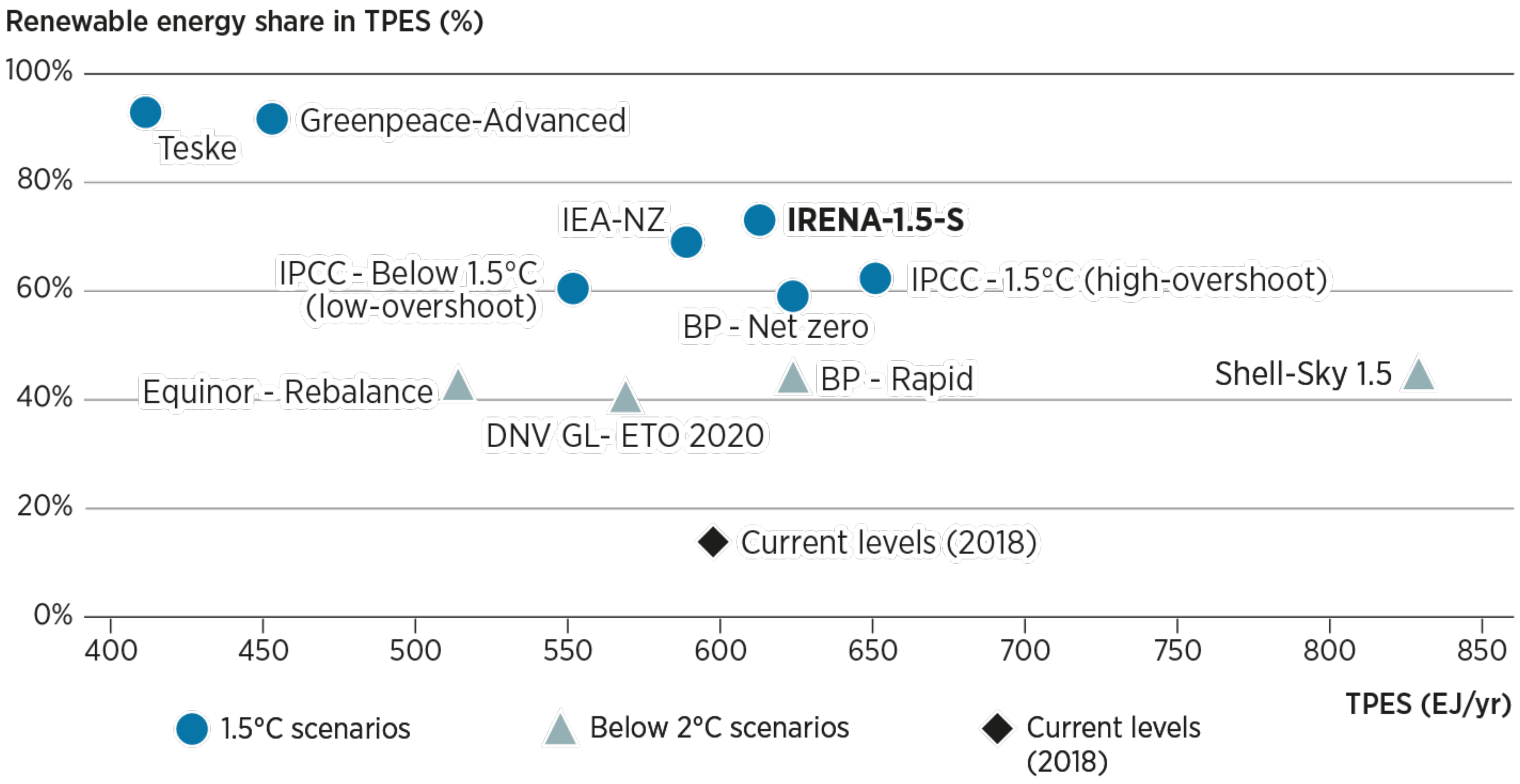
- By 2050, power generation triples compared to today's level, and renewables supply 90% of total electricity up from 25% in 2018.
- Limited role for nuclear as it is not least-cost zero carbon electricity.
- Fossil fuels in power will be greatly diminished, but natural gas will still exist.

All options are important in the mitigation effort



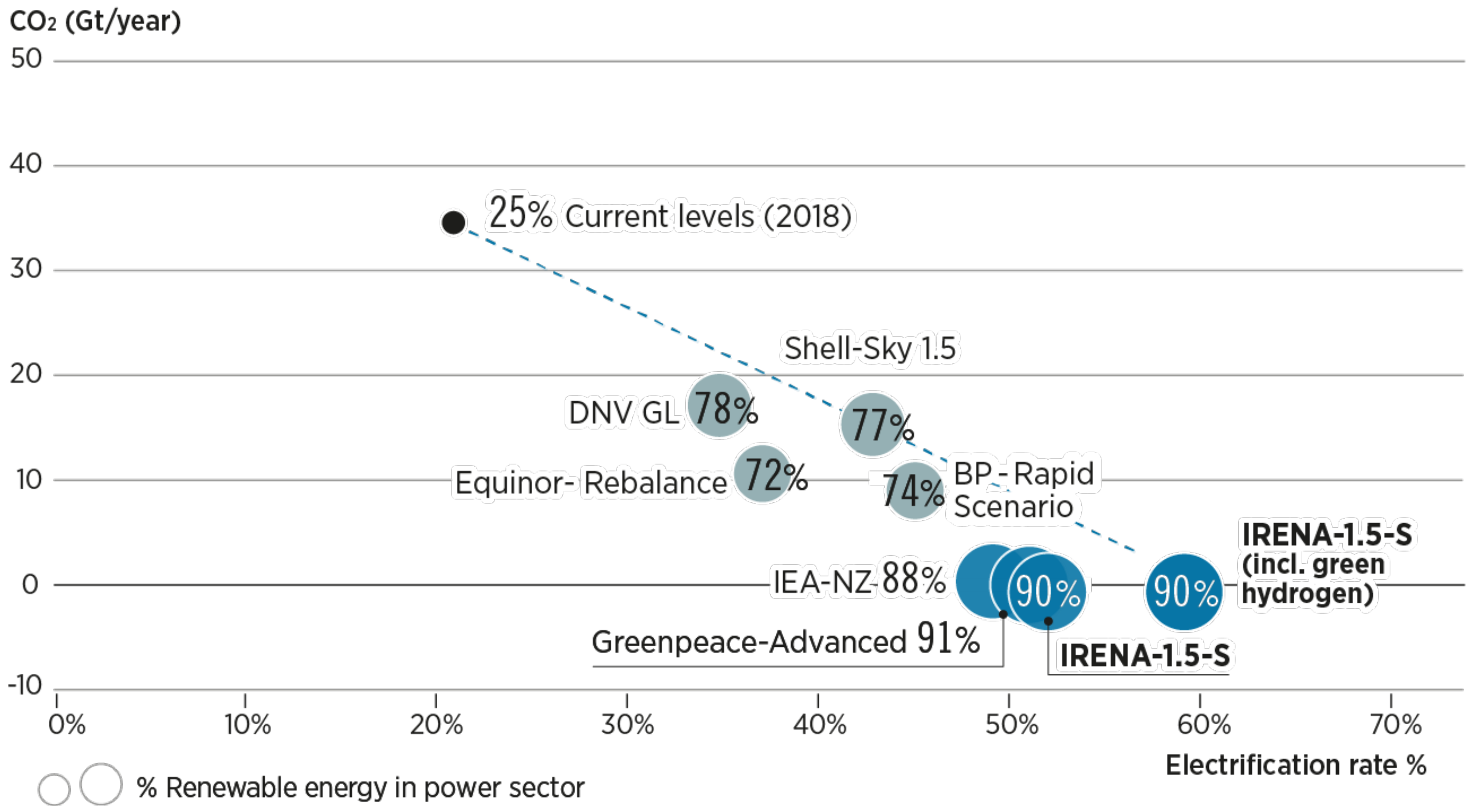
- In transport, 67% of emission reductions come from direct electrification and hydrogen.
- In industry, hydrogen and electrification combined contribute 27% of mitigation needs.
- In buildings, the key solutions are electrification, contributing close to half of the reduction needed, followed by energy efficiency.

Several other scenarios explore pathways for the energy transition



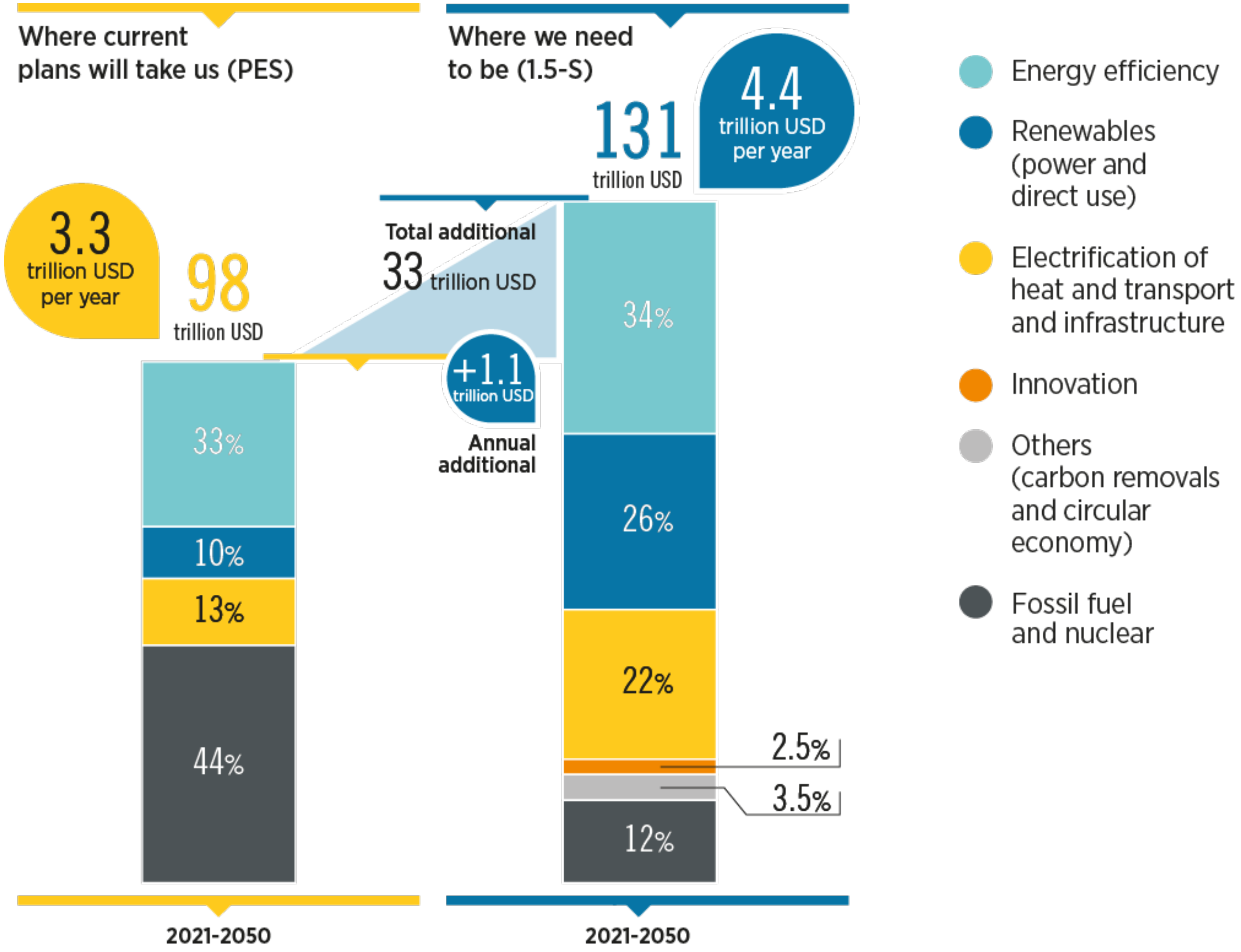
Several other scenarios have been published to explore pathways for the energy transition in the coming decades. Their variation reflects the complexity and uncertainties of the energy transition and different approaches and assumptions regarding the development of key components.

Emerging consensus on the role of renewables and electrification



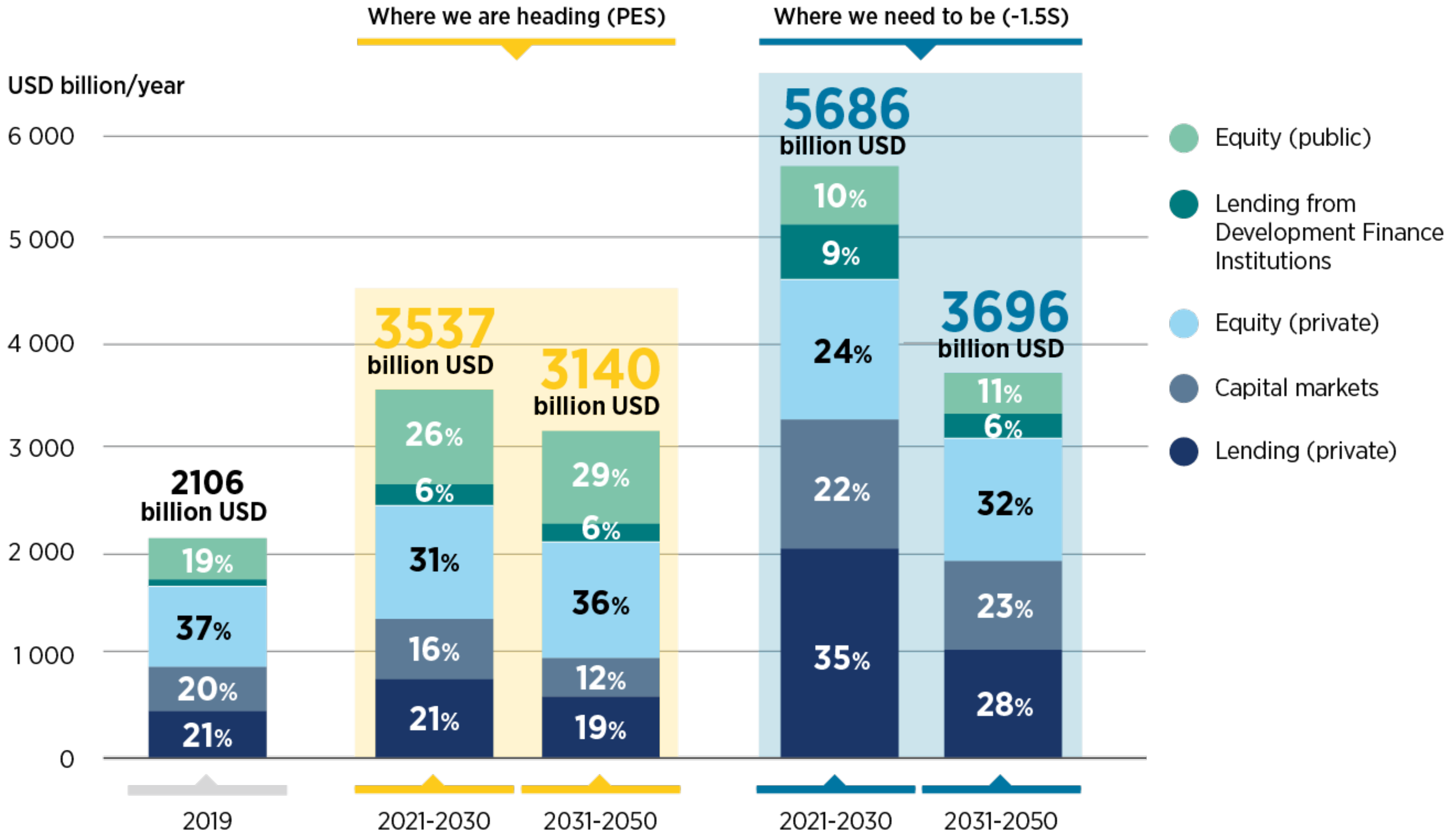
Despite the differences among the energy scenarios, there is a clear consensus on the important role that electrification powered by renewable energy sources has in the decarbonisation of the energy system.

New investment priorities: renewables, efficiency and electrification



- A climate-safe future calls for the scale-up and redirection of investments towards energy transition technologies, away from fossil fuels.
- Accelerating the pace of the energy transition and scaling up investments in energy transition technologies in all sectors hinges on what the world does between 2021 and 2030. Setting the right investment priorities is key.

New investment priorities: renewables, efficiency and electrification



The additional capital needed for the 1.5°C Pathway would be largely covered by the private sector, while public resources would continue to be key to lower the risk perception for investors and ensure a just and inclusive energy transition

Energy transition investment needs to be scaled up significantly in the coming decades

Power

Annual average investments (USD billion/yr)

		Historical 2017-19	1.5°C Scenario 2021-50
Power generation capacity	Hydro - all (excl. pumped)	22	85
	Biomass (total)	13	69
	Solar PV (utility and rooftop)	115	237
	CSP	3	84
	Wind onshore	80	212
	Wind offshore	18	177
	Geothermal	3	24
	Marine	0	59
Grids and flexibility	Electricity network	271	600
	Flexibility measures (*e.g.* storage)	4	133

- In the power sector, accelerated investment of USD 1.7 billion per year would account for 44% of the total required energy transition investment over the period to 2050.
- Key generation technologies, such as solar PV (rooftop and utility scale) would draw annual average investment of USD 237 billion per year; onshore wind, USD 212 billion per year;
- Power grids, including energy flexibility measures, close to USD 733 billion per year.

Energy transition investment needs to be scaled up significantly in the coming decades

End uses and district heat

Annual average investments (USD billion/yr)

Category	Technology	Historical 2017-19	1.5-S 2021-50
Renewables end uses and district heat	Biofuels - supply	2	87
	Renewables direct uses and district heat	31	84
Energy efficiency	Buildings	139	963
	Industry	45	354
	Transport	65	157
Electrification	Charging infrastructure for electric vehicles	2	131
	Heat pumps	12	102
Innovation	Hydrogen - electrolysers and infrastructure	0	116
	Hydrogen-based ammonia and methanol	0	45
	Bio-based ammonia	0	22
	Bio-based methanol	0	12
Carbon removals	Carbon removals (CCS, BECCS)	0	65
Circular economy	Recycling and biobased products	0	25

Total average investments (excluding fossil fuel and nuclear) **2017-2019**

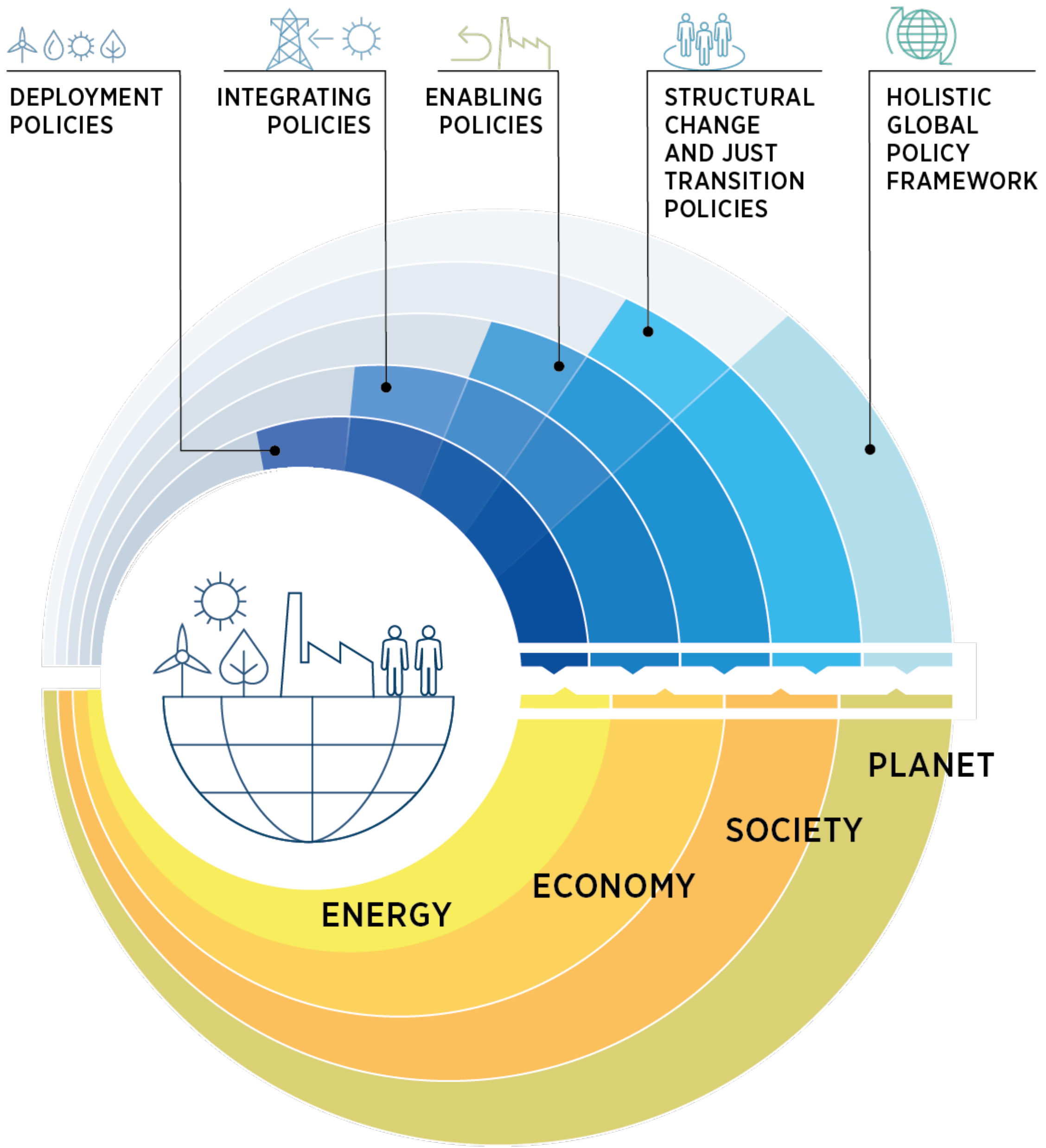
824 USD billion/year

Total average investments (excluding fossil fuel and nuclear) **2021-2050**

3 843 USD billion/year

- Buildings would require investment in a wide range of renewable and energy efficiency technologies: LED lamps, more efficient appliances, efficiency-oriented retrofits of building shells, heat pumps and smart home systems.
- Transport investments include energy efficiency measures, biofuel supply and electric vehicle charging stations.
- An increasingly large amount of new investment is needed in smart meters, energy storage, hydrogen electrolyser and networks, carbon capture and storage, bioenergy with carbon capture and storage (BECCS), and others (materials recycling, bioplastics, etc.).

Comprehensive policy framework for a just energy transition



A policy framework for a just energy transition includes:

- A host of **cross-cutting enabling policies,** including policies that set ambitions and issue clear signals to stakeholders, eliminate distortions, incentivise the uptake of solutions and facilitate access to affordable financing, among others.
- **Deployment policies** to support all the essential technological avenues supporting market creation, thus facilitating deployment, reducing technology costs and increasing adoption at levels aligned with energy transition needs.
- **Integrating policies** enable the integration of energy transition related technologies into the energy system, the economy, society and planet.
- The energy transition will bring benefits, as well as challenges in the form of potential misalignments in finance, labour markets, power systems and the energy sector itself. A set of **structural and just transition policies** is required to manage potential misalignments.
- A **holistic global policy framework** brings countries together to commit to a just transition that leaves no one behind and strengthens the international flow of finance, capacity and technologies in an equitable manner.

Cross-cutting enabling policies

Raise ambition in commitments to the energy transition	Targets should go beyond the power sector to include heating and cooling and transport, and specific solutions such as green hydrogen
Phase out fossil fuels	A holistic policy framework is necessary to address fossil fuels as a stranded asset and its socio-economic implications
Eliminate distortions and incentivise energy transition solutions	Policies (e.g., carbon pricing) should be implemented with careful consideration of social and equity issues, particularly for low-income populations
Foster innovation	Enabling policies further innovation in technology, infrastructure, finance, business models, market design, regulations, governance, etc.
Raise awareness among consumers and citizens	Consumers and citizens influence governments and corporations to move faster and make proactive choices regarding energy consumption and sources

Deployment policies

	Abatements	Overview of policies to support energy transition by technological avenue	
Renewables (power and direct uses)	25%	Deploy renewables in power and direct uses	• Regulatory measures that create a market for solutions • Fiscal and financial incentives that make them more affordable • The choice of instrument and its design should be context specific and consider broader policy objectives
Energy conservation and efficiency	25%	Increase energy conservation and efficiency	• Energy efficiency policies (e.g. strict building codes, appliance standards) in buildings and industrial processes. • Shift from energy-intensive modes to low-carbon modes in transport
Electrification in end use sectors (direct)	20%	Electrify end uses	• Targets for renewable power should consider rising demand from electrification • Policies and power system design to support electrification in achieving its potential for providing system flexibility
Hydrogen and its derivatives	10%	Support green hydrogen	• Enabling policy framework with four key pillars: a national green hydrogen strategy, priority setting, guarantees of origin and enabling policies
CCS and CCU industry	6%	Ensure the sustainable use of bioenergy	• Policies to address sustainability concerns
BECCS and other carbon removal measures	14%		

Challenges and policies for a just and inclusive transition

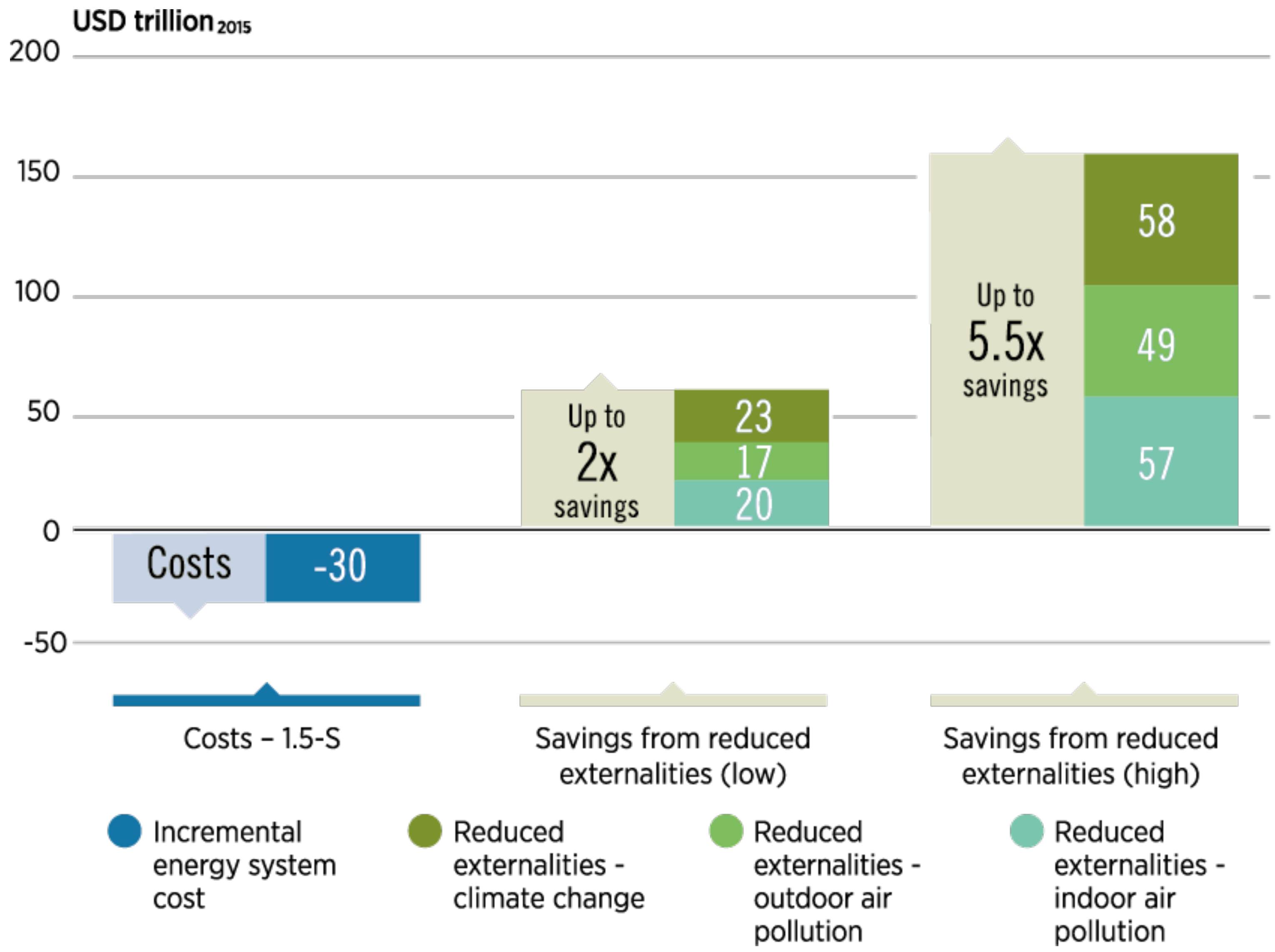
Challenges and potential misalignments

- Finance
- Power system structures
- Structural dependencies
  - Fossil fuels and commodities
  - Technology
  - Supply chains
  - Trade
- Labour markets
  - Job misalignments
  - Decent jobs agenda
  - Diversity needs

Policies for structural change and a just and inclusive energy transition

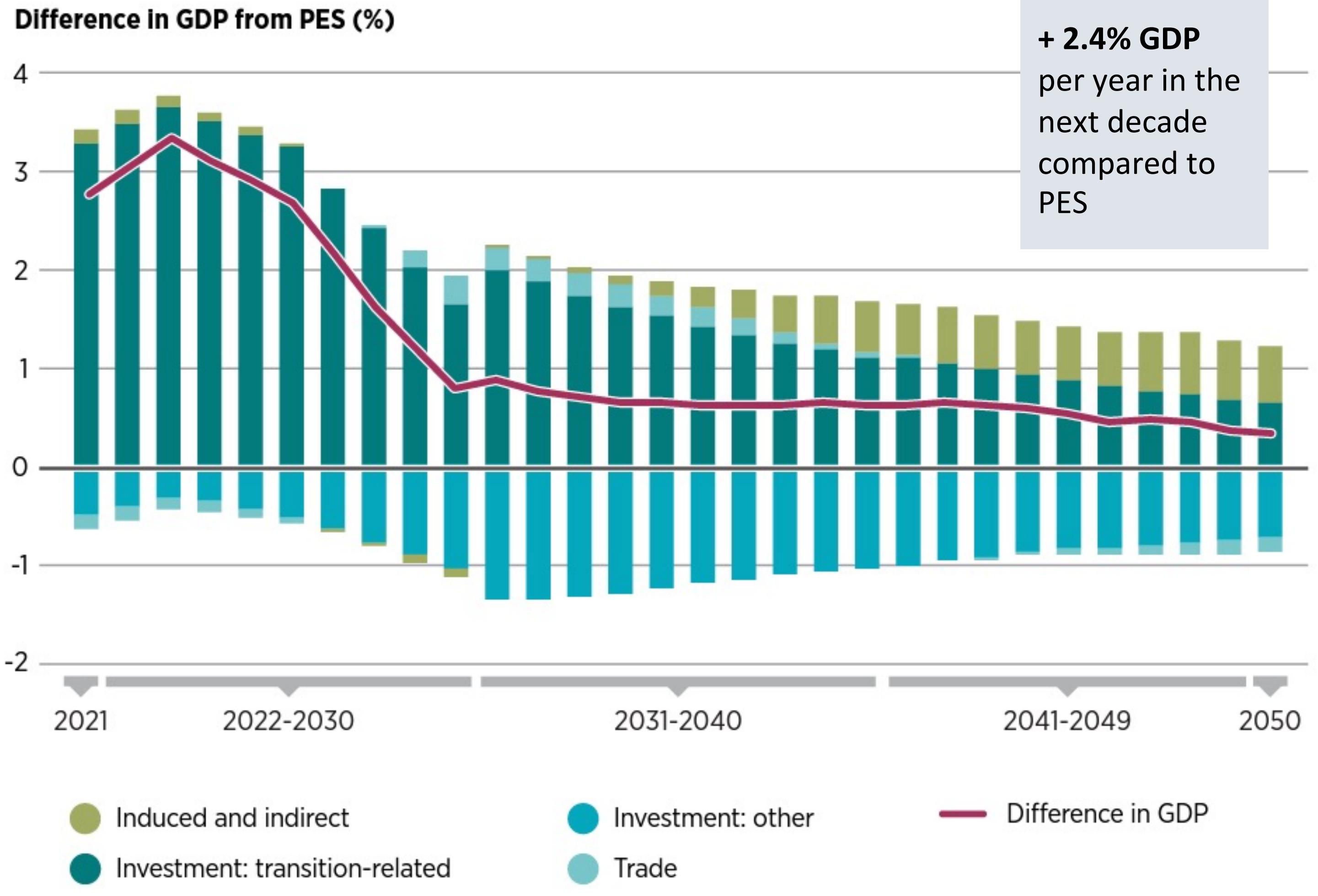
Objective	Recommendations
Address potential misalignments in labour markets	Ensuring a just and fair transition will require measures to overcome temporal, geographic and skills-related imbalances.
Develop local value chains	Enhancing and leveraging domestic capabilities requires carefully crafted incentives and rules, business incubation initiatives, supplier-development programmes, support for small and medium enterprises and promotion of key industrial clusters.
Provide education and build capacity	Early exposure to renewable-energy-related topics and careers is vital for sparking young people's interests in pursuing a career in the sector, and also to increase social acceptance by a knowledgeable citizenry.
Support a circular economy	Policies and measures are needed to ensure the sustainability of energy-transition-related solutions and their smooth integration in existing ecosystems in terms of sustainability, circular economy principles and reduced environmental impacts.
Support community and citizen engagement	Community energy can play an important role in accelerating renewables' deployment while generating local socio-economic benefits and increasing public support for local energy transitions.

Every USD 1 spent on the energy transition yields between USD 2 and USD 5.5

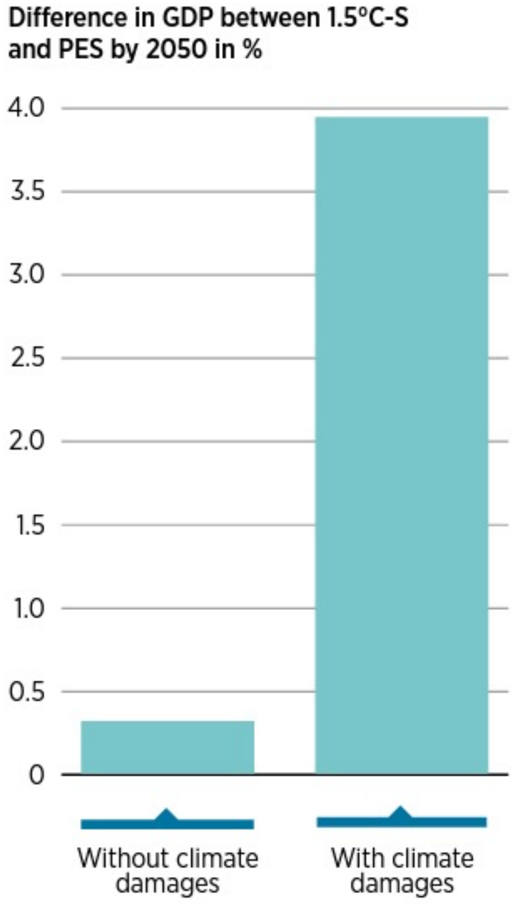


- The overall balance of the energy transition is positive, with benefits greatly exceeding costs. IRENA estimates that in the 1.5°C Scenario every USD 1 spent on the energy transition would yield benefits valued at between USD 2 and USD 5.5.
- In cumulative terms, the 1.5°C Scenario would have an additional energy-system cost (net effect of increased investment and reduced operation costs) of USD 30 trillion over the period to 2050 but would result in a payback through reduced externalities on human health and the environment of between USD 61 trillion and USD 164 trillion.

The energy transition boosts global GDP

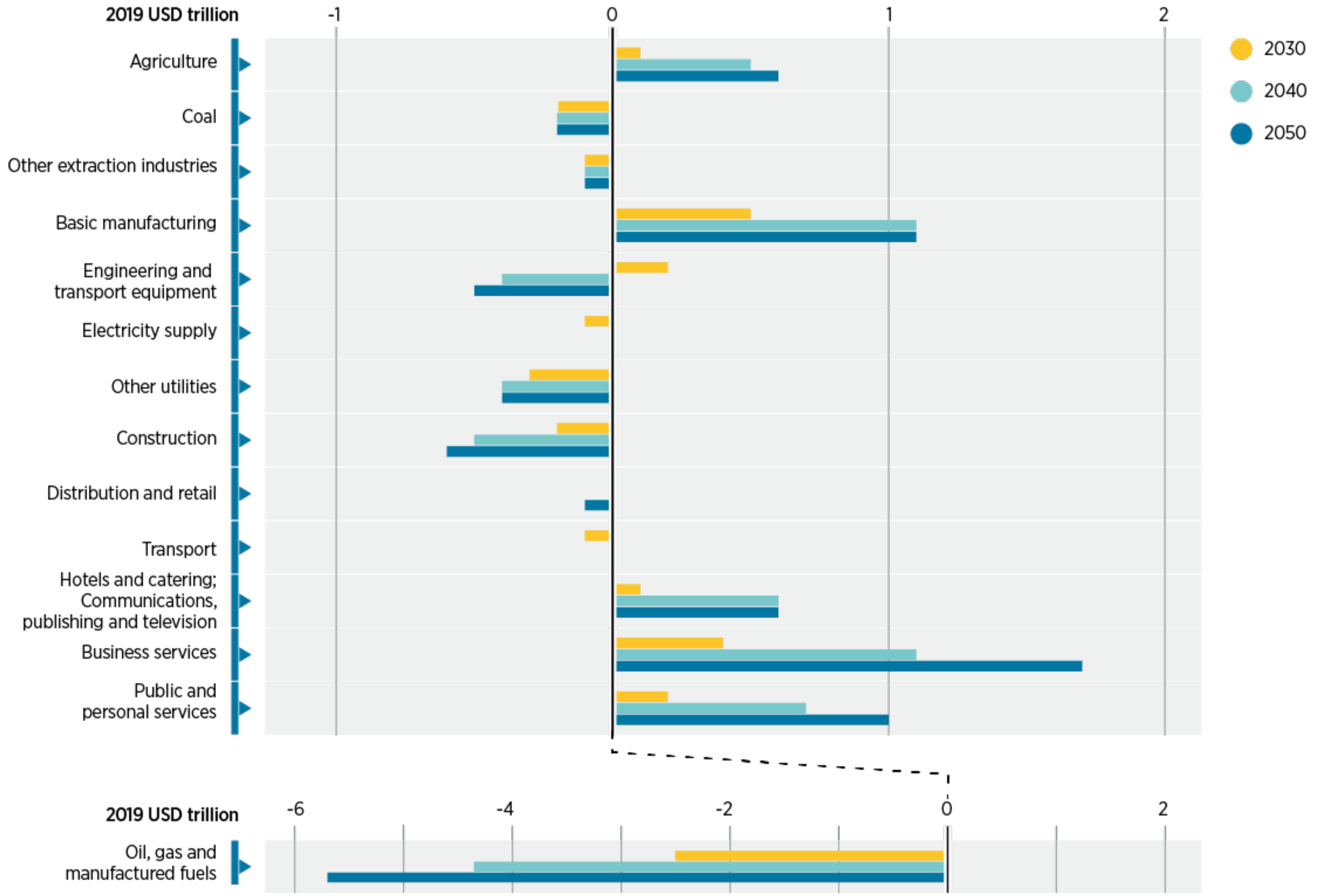


+ 2.4% GDP per year in the next decade compared to PES



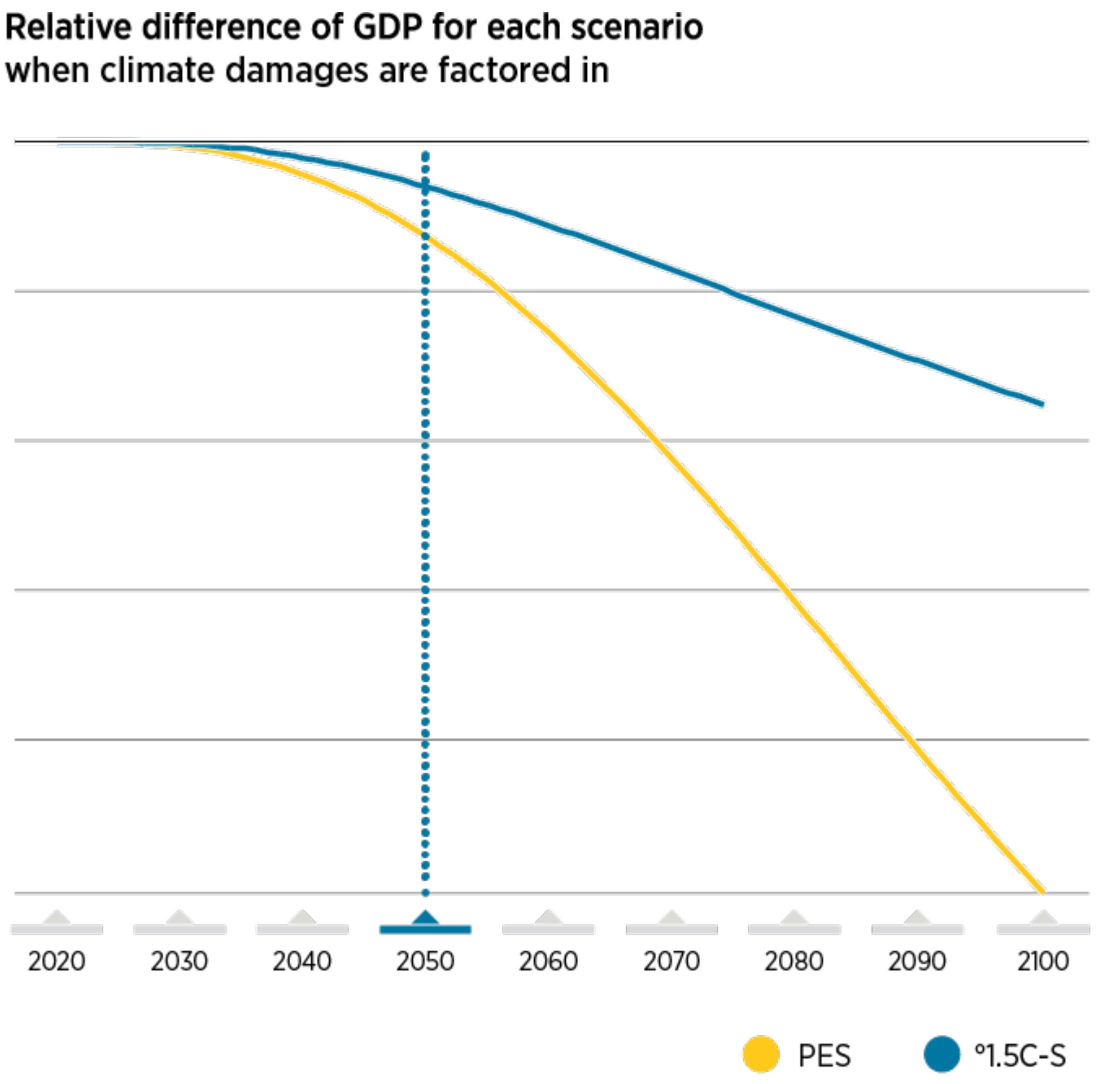
- The 1.5°C Pathway provides a boost in GDP that is 2.4% greater (on average) than that of the PES over the next decade, aligned with the needs of a post-COVID recovery. Over the transition period to 2050, the average improvement of GDP is estimated at 1.2% over the PES.
- 1.5°C Scenario implies lower impact of climate damages on GDP.

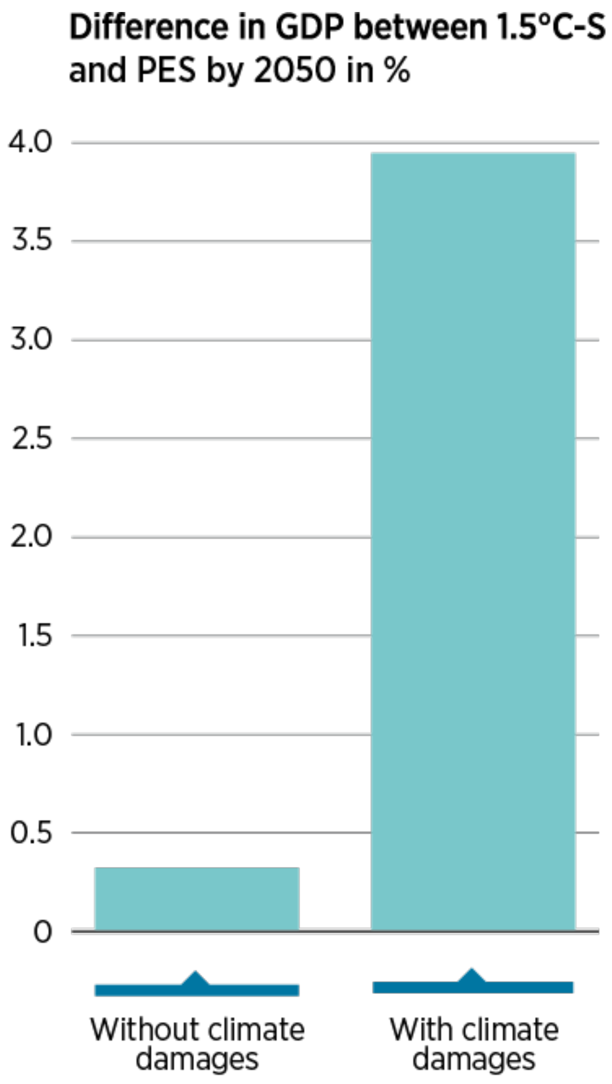
Sectoral differences in economic output between the baseline and 1.5C



- The oil and gas and manufactured fuels sector experiences the most negative impacts.
- The largest benefits accrue in the three aggregated categories of services.

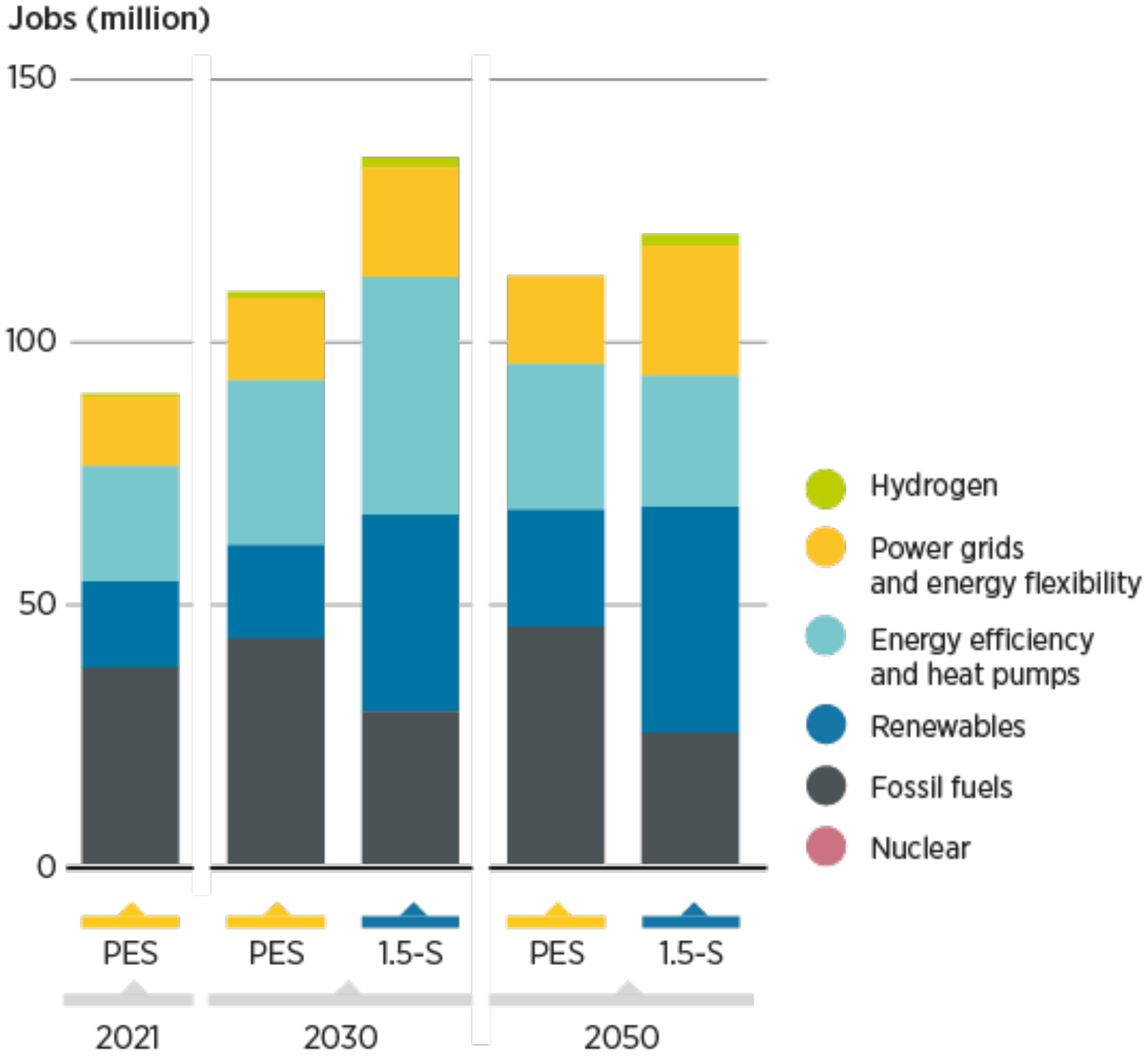
Impact of climate change on GDP between the baseline and 1.5C

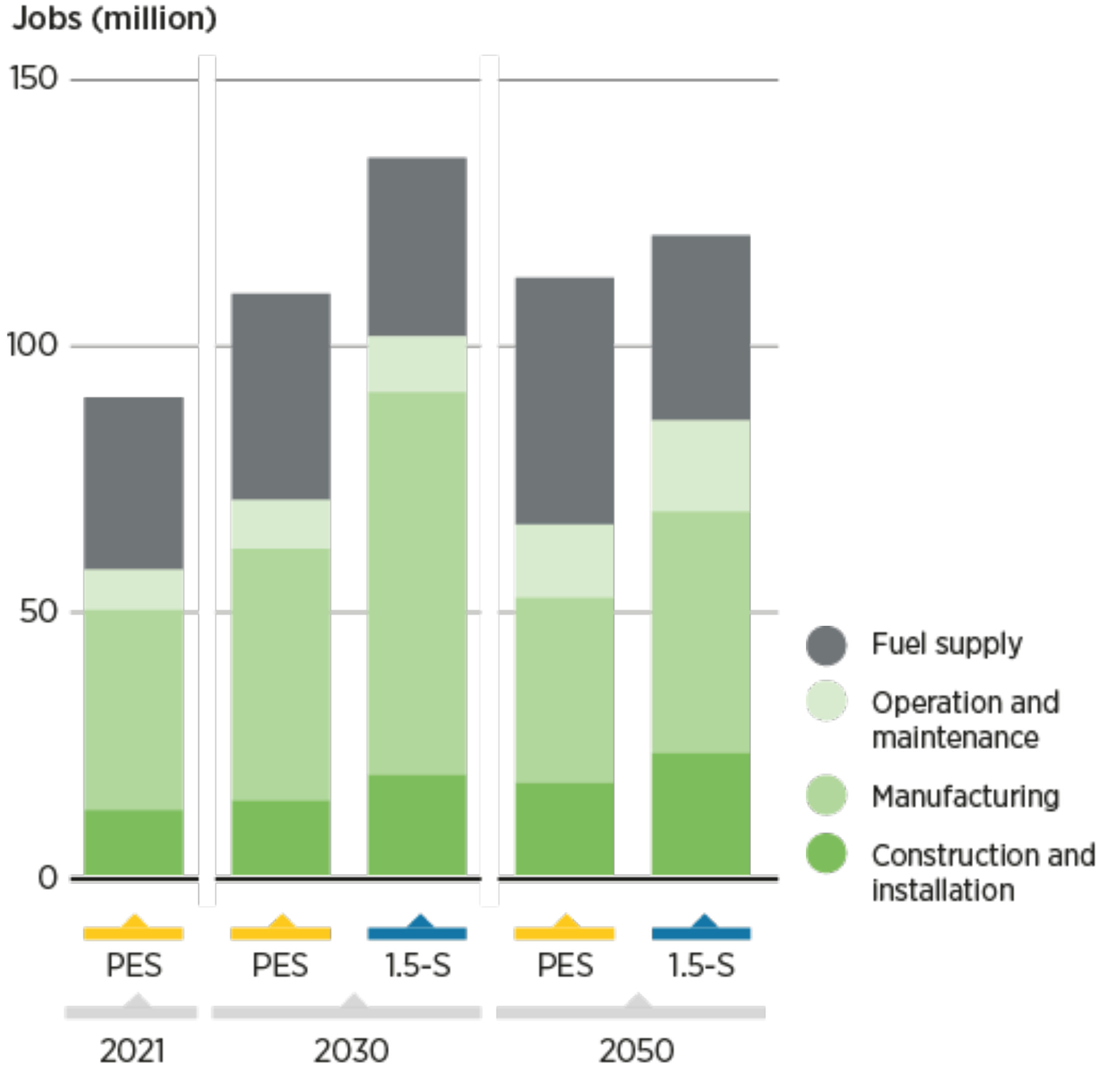




1.5°C Scenario implies a lower impact of climate damages on GDP, supporting the benefits of transitioning swiftly to a clean energy future

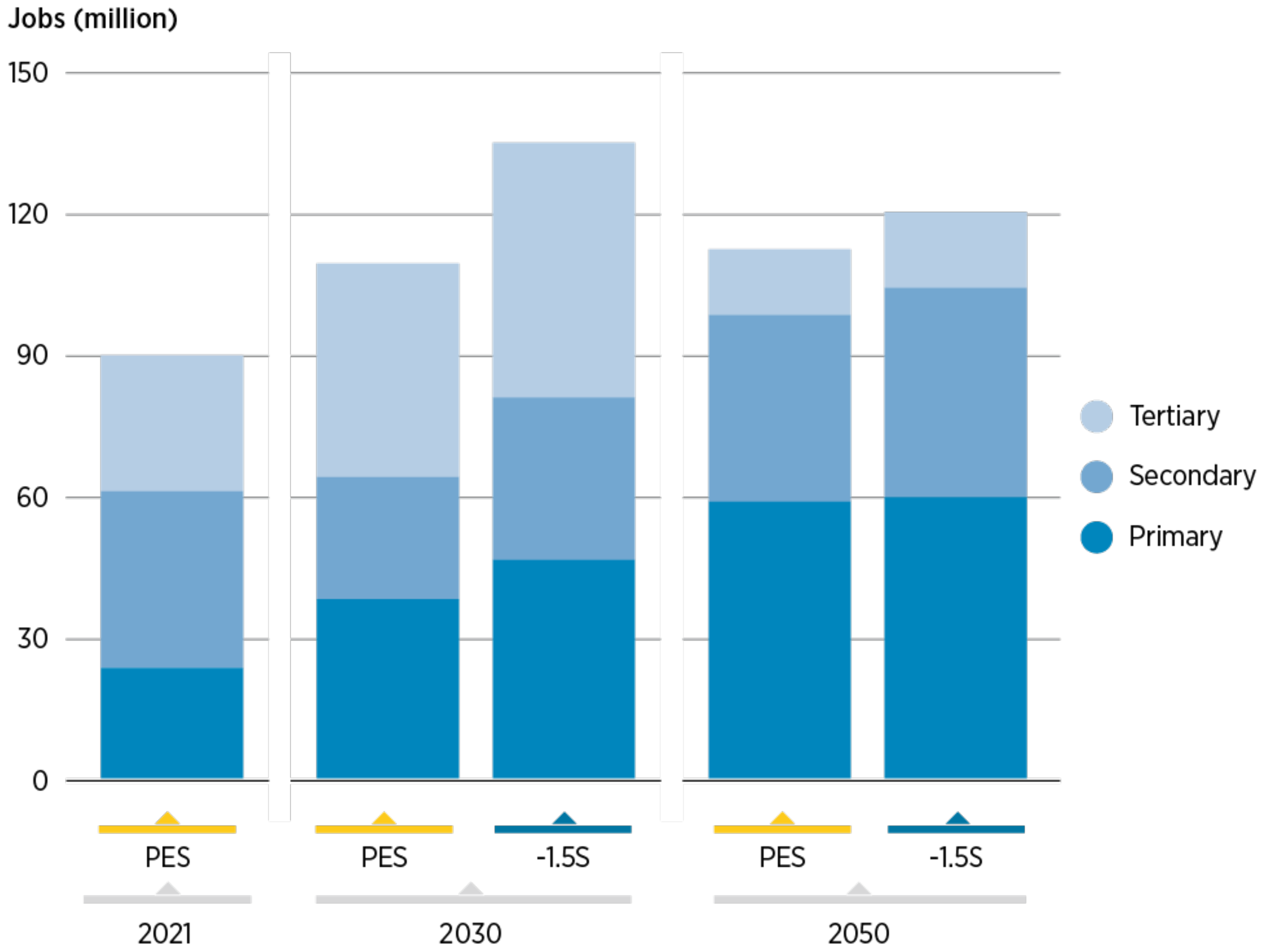
Energy Sector jobs by technology and segments of the value chain



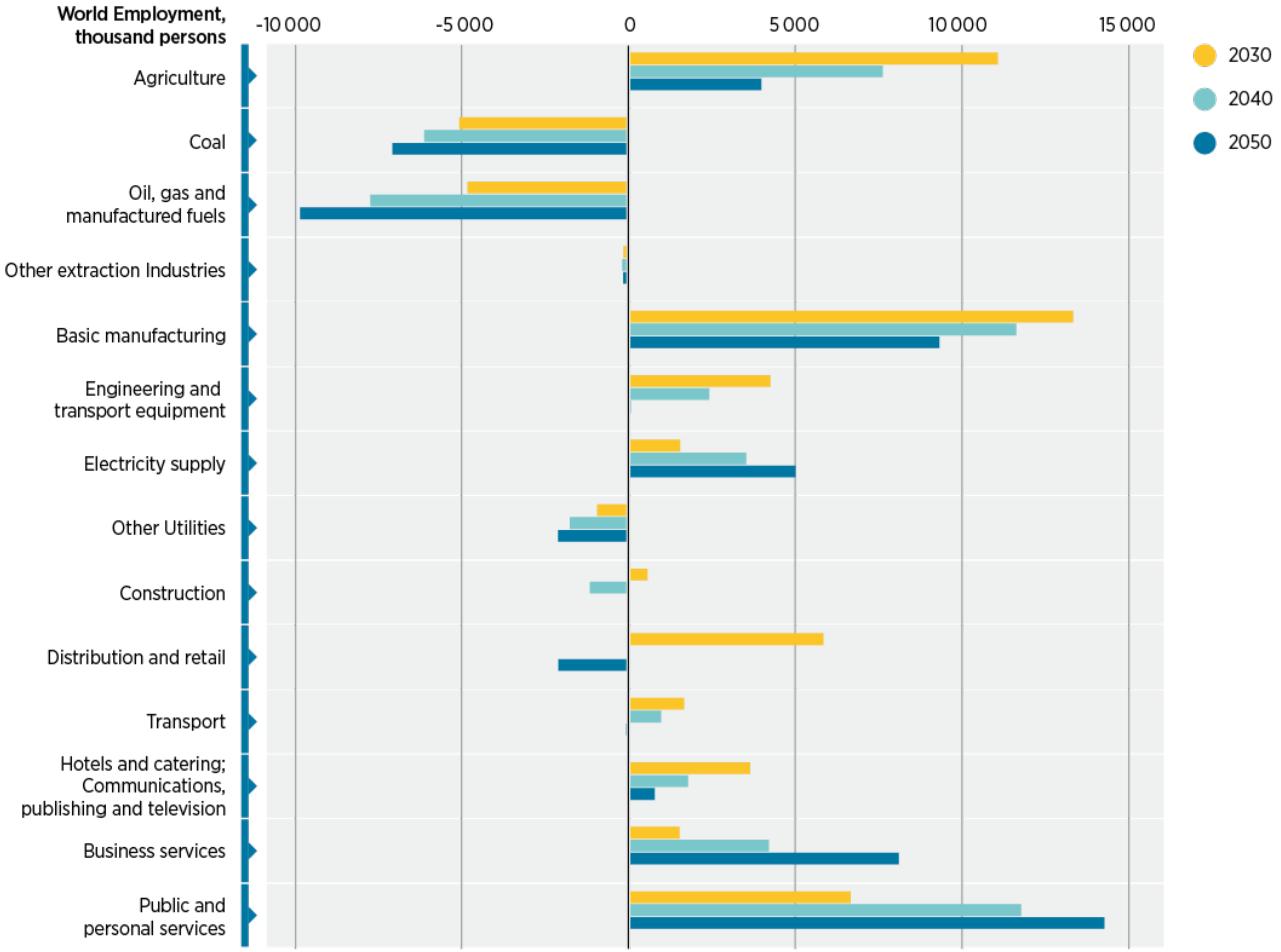


- Throughout the transition period, economy-wide employment is 0.9% higher on average under the 1.5°C Scenario than under the PES.
- A transformed energy sector will have 122 million jobs in 2050. Qualifications, skills and occupations under the ambitious 1.5°C Scenario are increasingly concentrated in manufacturing, followed by fuel supply.

Education level requirements in energy sector evolve as transition progresses



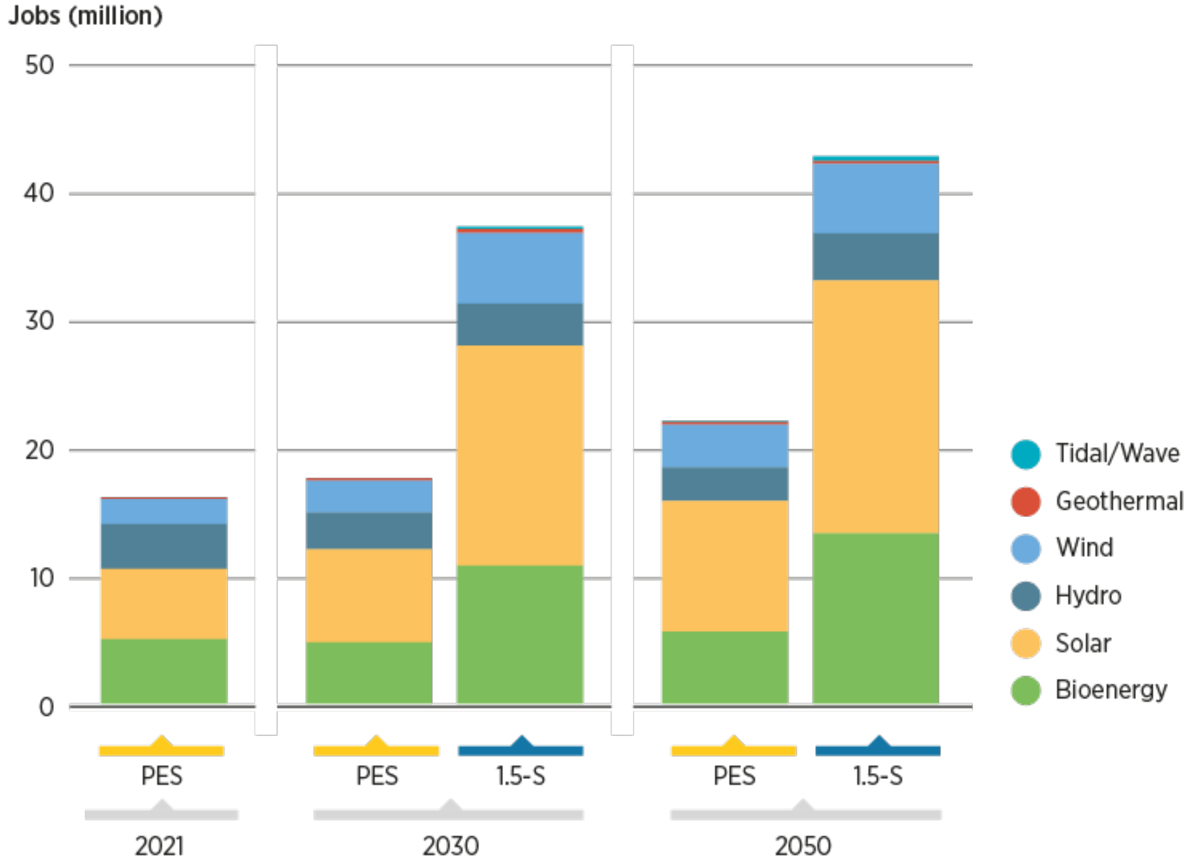
Sectoral differences in employment between the baseline and 1.5C



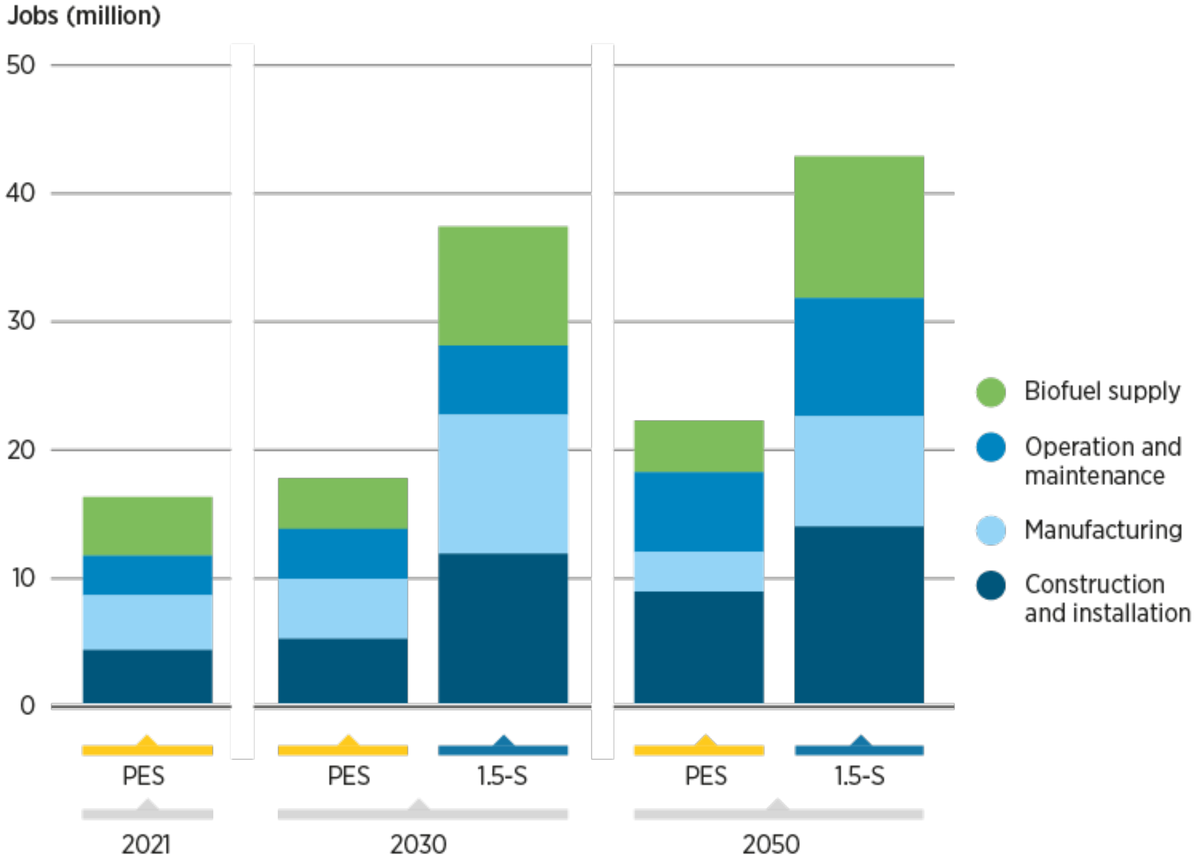
Sectoral employment shifts away from mining and manufactured fuels towards services, manufacturing and agriculture

Renewable energy jobs by technology and along the segments of the value chain

Jobs in renewable energy, by technology, in the 1.5°C Scenario and PES

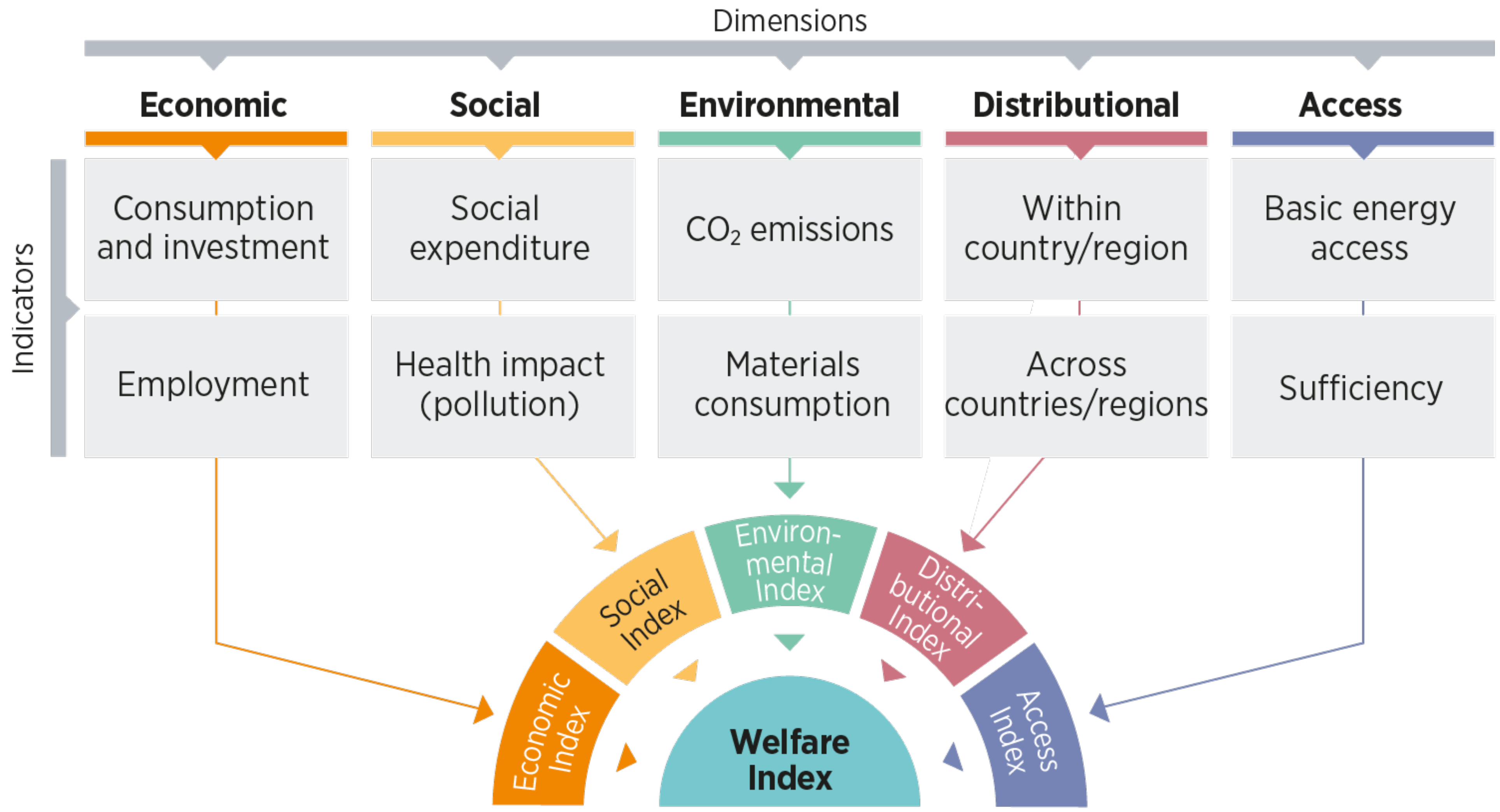


Renewable energy jobs, by segment of value chain, in the 1.5°C Scenario and PES



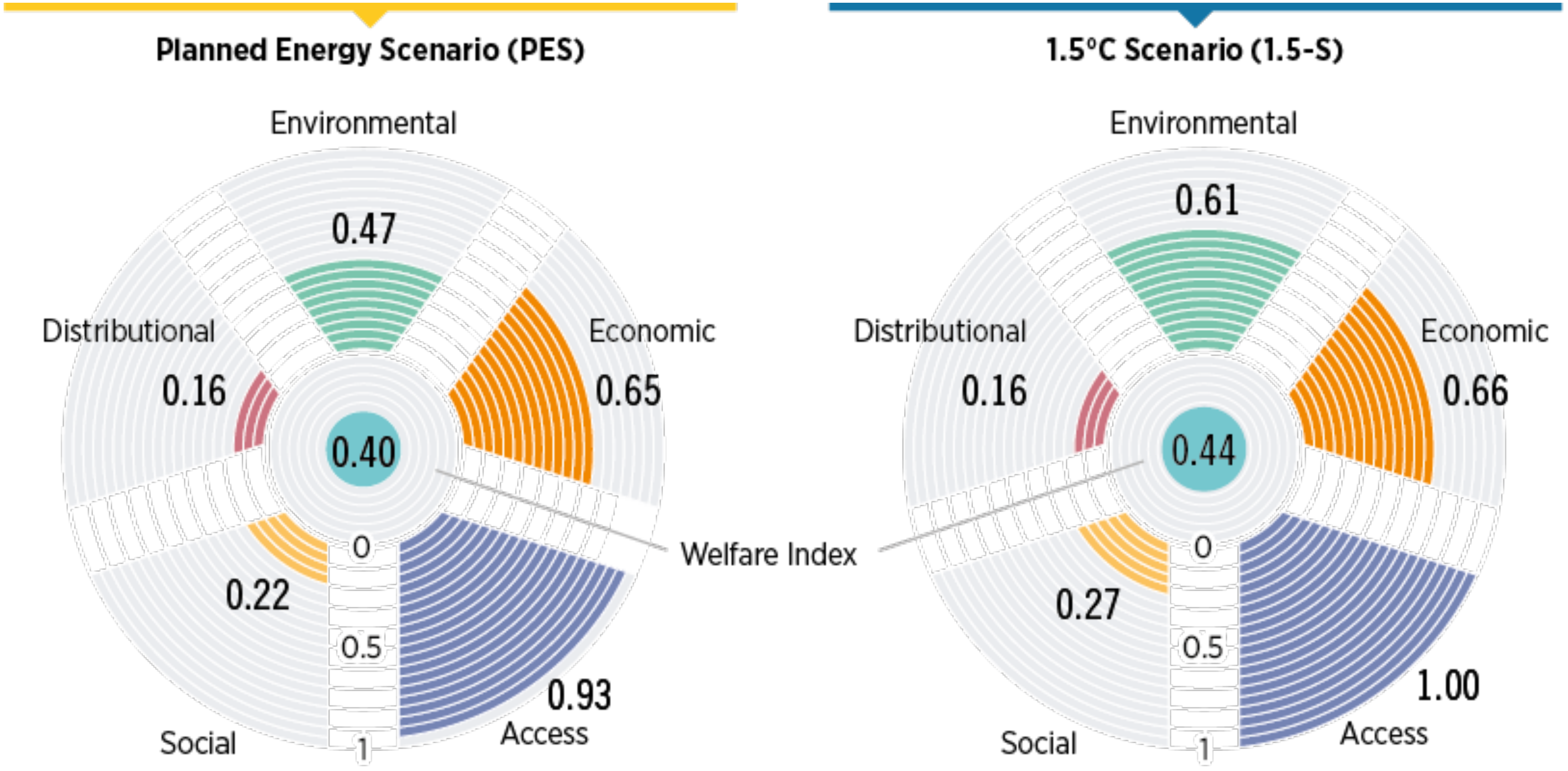
- Renewable energy jobs will increase from 11.5 million today to 43 million in 2050. Solar photovoltaic (PV) accounts for the largest share, followed by bioenergy, wind and hydropower.
- Construction, installation and manufacturing boost renewable jobs during the following decade, with operation and maintenance gaining relative weight as the transition advances under the 1.5°C Scenario.

IRENA's Energy Transition Welfare Index



IRENA's Energy Transition Welfare Index captures economic, social, environmental, distributional and energy access dimensions. For the first time, the Index reports distributional and energy access dimensions that are often overlooked in other analyses.

Socio-economic footprint of the energy transition



The 1.5°C Scenario performs better than the PES along all welfare dimensions, yielding an 11% improvement over the PES by 2050.

- The *environmental dimension* sees a 30% improvement over PES with significantly lower emissions under the 1.5°C
- The *social dimension* improves 23% under the 1.5°C Scenario largely due to improved health outcomes from lower outdoor and indoor air pollution.
- The *distributional dimension* improves 37% over PES; however, the index remains low in an absolute sense, indicating potential equity barriers.
- The *energy access dimension* grows 7% under the 1.5°C Scenario compared to PES as universal energy access and sufficiently levels are reached.

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Thank you!