Conferencia:

World Energy Transition Outlook 2050: energías renovables, tecnologías y oportunidades

Ricardo Gorini, DSc. • 31 Agosto 2022

IRENA
International Renewable Energy Agency

International Renewable Energy Agency

- Established in 2011, by 2022 - 168 member states
- Headquarters in Masdar City, Abu Dhabi, UAE
- IRENA Innovation and Technology Centre – Bonn, Germany
- Permanent Observer to the United Nations – New York, USA

Mandate

To promote the widespread adoption and sustainable use of **all forms of renewable energy** worldwide

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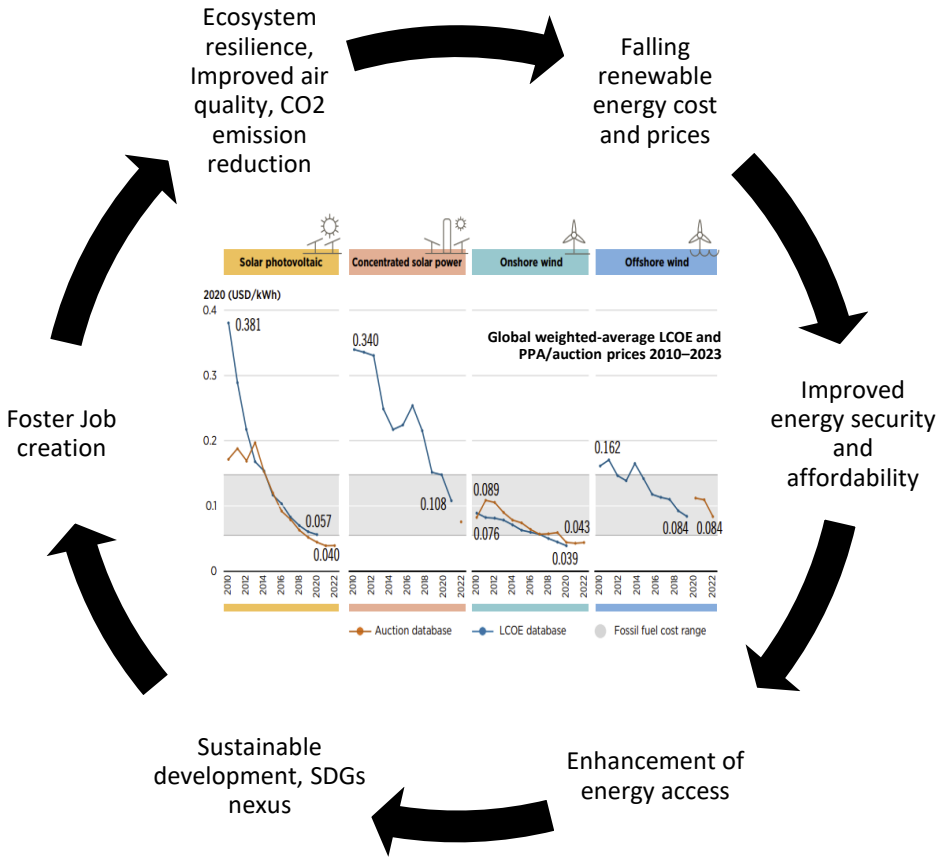
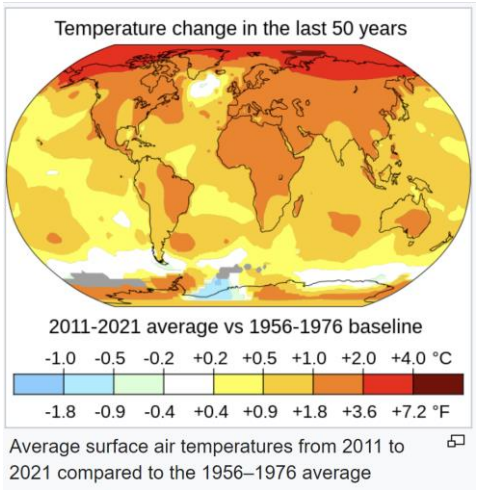
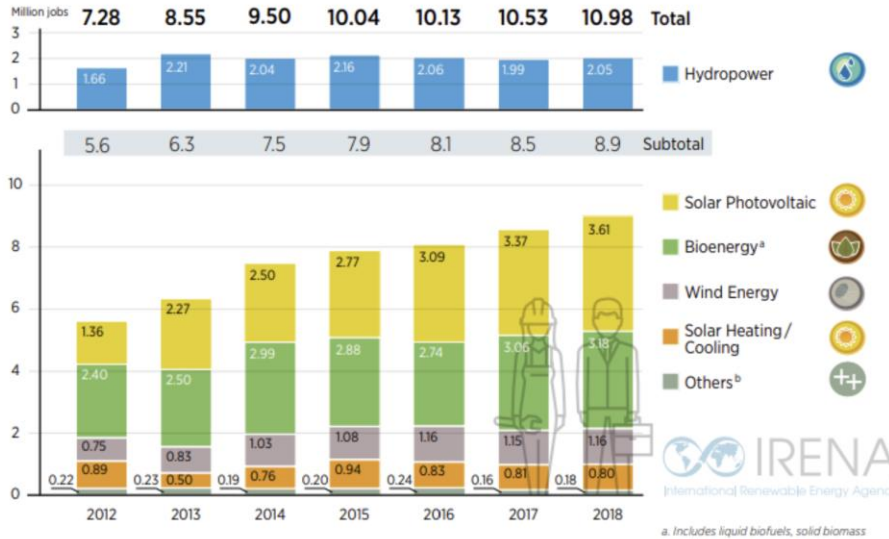
El porque de la *Energy Transition*?

Key drivers





Average surface air temperatures from 2011 to 2021 compared to the 1956–1976 average



a. Includes liquid biofuels, solid biomass and biogas.

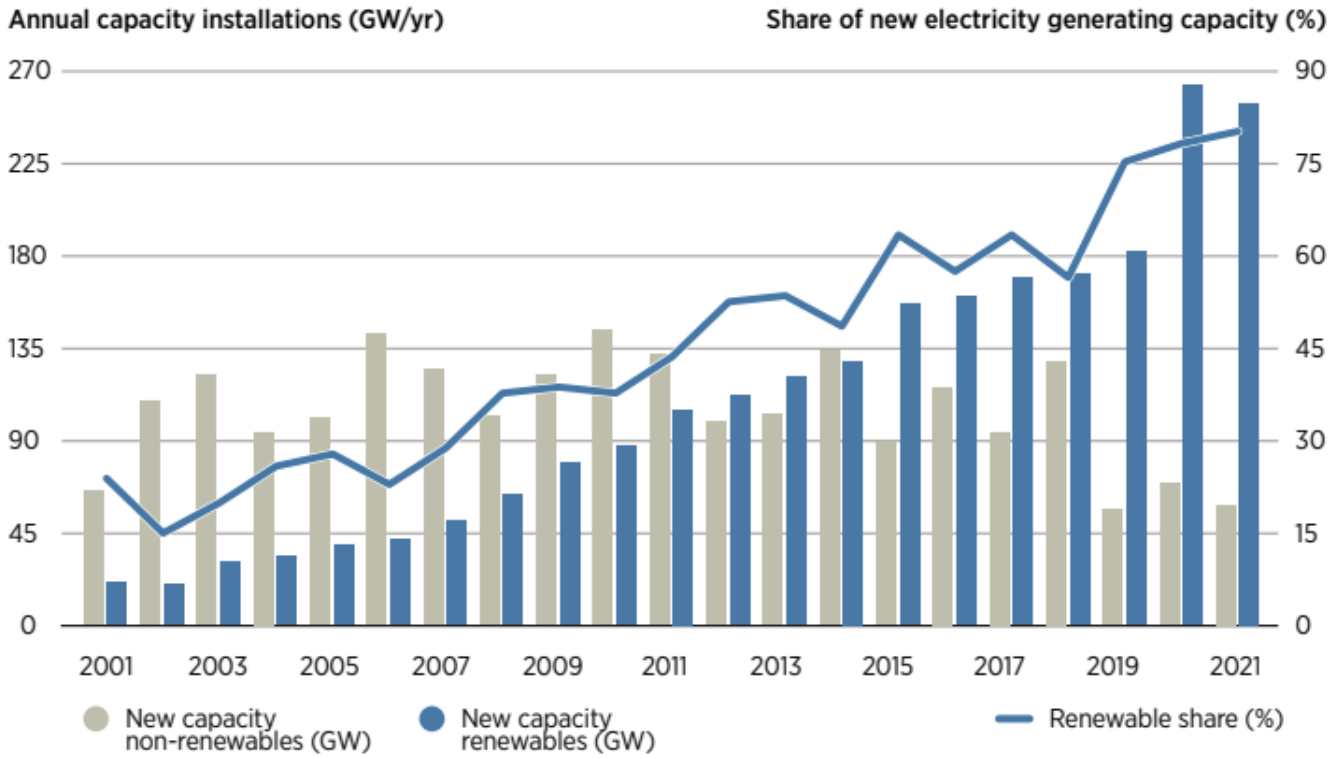
b. Other technologies include geothermal energy, concentrated solar power, heat pumps (ground-based), municipal and industrial waste, and ocean energy.

Source: IRENA jobs database.

Note: Except for hydropower where a revised methodology led to revisions of job estimates, numbers shown in this figure reflect those reported in past editions of the Annual Review.

Y, *de facto*, las renovables dominando la expansion

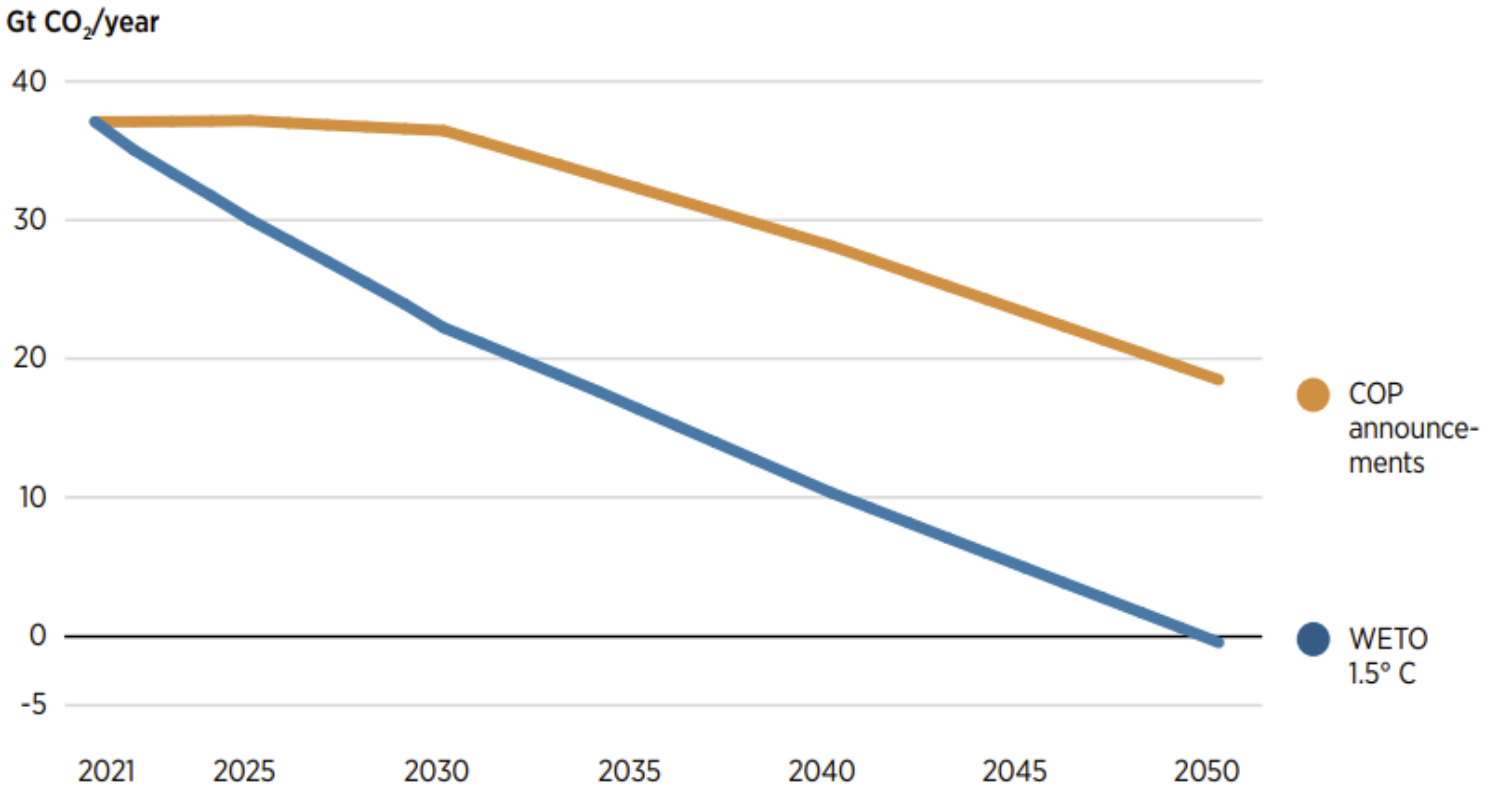
Share of new electricity capacity, 2001-2021



- Over the past decade, renewables capacity increased by 130%, while non-renewables only grew by 24%
- In 2021, the total installed capacity of renewable electricity reached 3 064 GW, generating around an estimated 8 000 terawatt-hours (TWh) of electricity
- Renewable electricity capacity additions have been outpacing those of non-renewables since 2014, with solar PV and onshore wind power dominating the growth

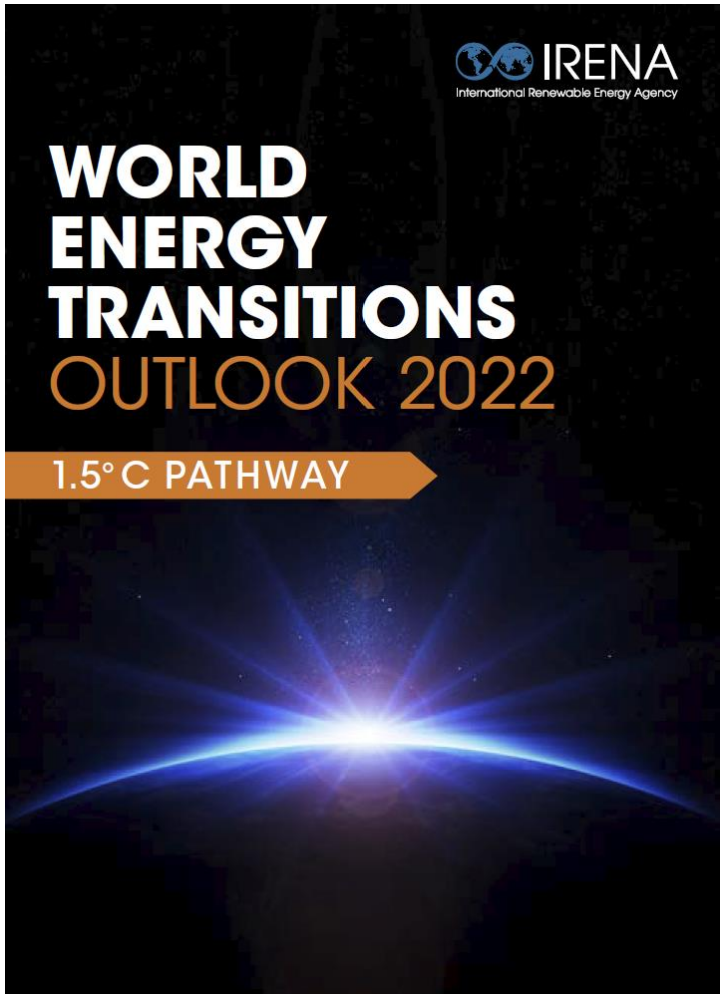
Pero, todavia no lo suficiente para el closing the gap: NDCs and net zero pledges

CO2 emission trajectories based on COP announcements and the WETO 1.5°C Scenario



- Despite the increased ambition expressed in COP26 announcements, current climate pledges are insufficient to reach net zero by mid-century
- Although the mitigation ambition level was clearly raised at COP26, substantial additional efforts are required to bridge the gap towards the 1.5°C target
- Emissions gap in 2050 between the COP26 announcements trajectory and the 1.5°C Scenario is still 20 Gt

Una vision estrategica: Que hay que hacer?

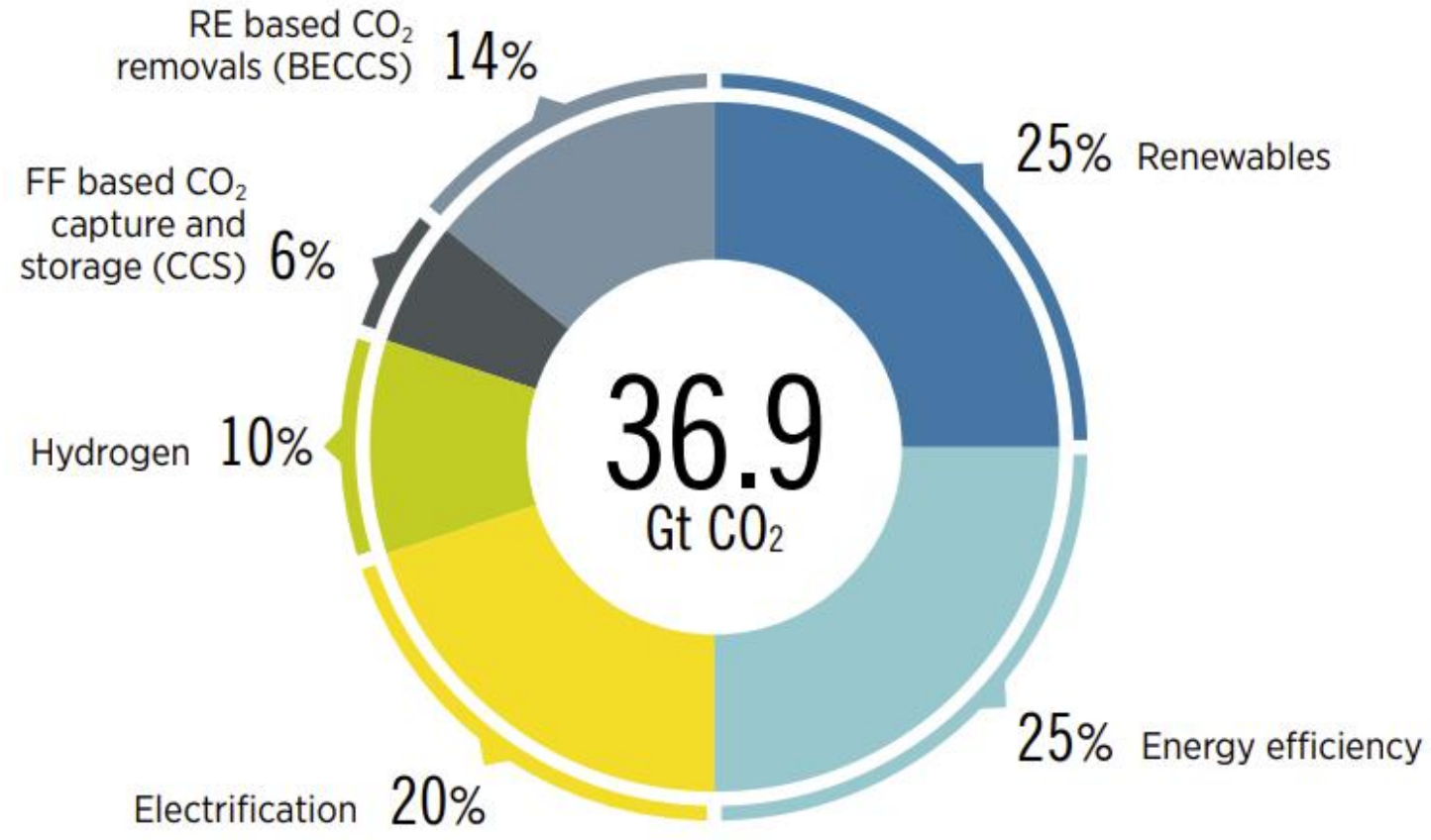


https://www.irena.org/publications/2022/Mar/World-Energy-Transitions-Outlook-2022

Perspectiva global: energia renovable y tecnologias

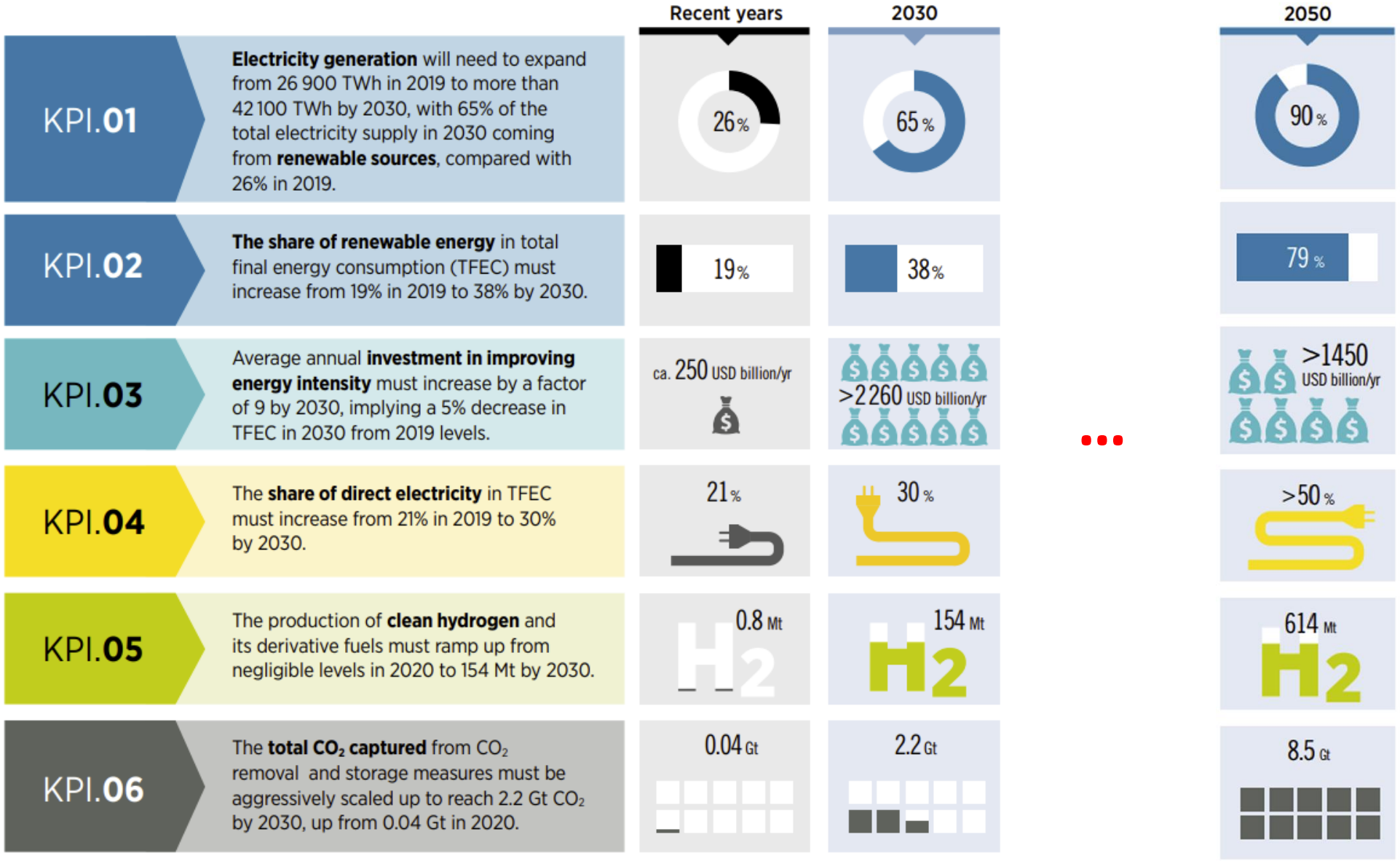
IRENA WETO: Renewables, efficiency and electrification dominate energy transitions

Reducing emissions by 2050 through six technological avenues

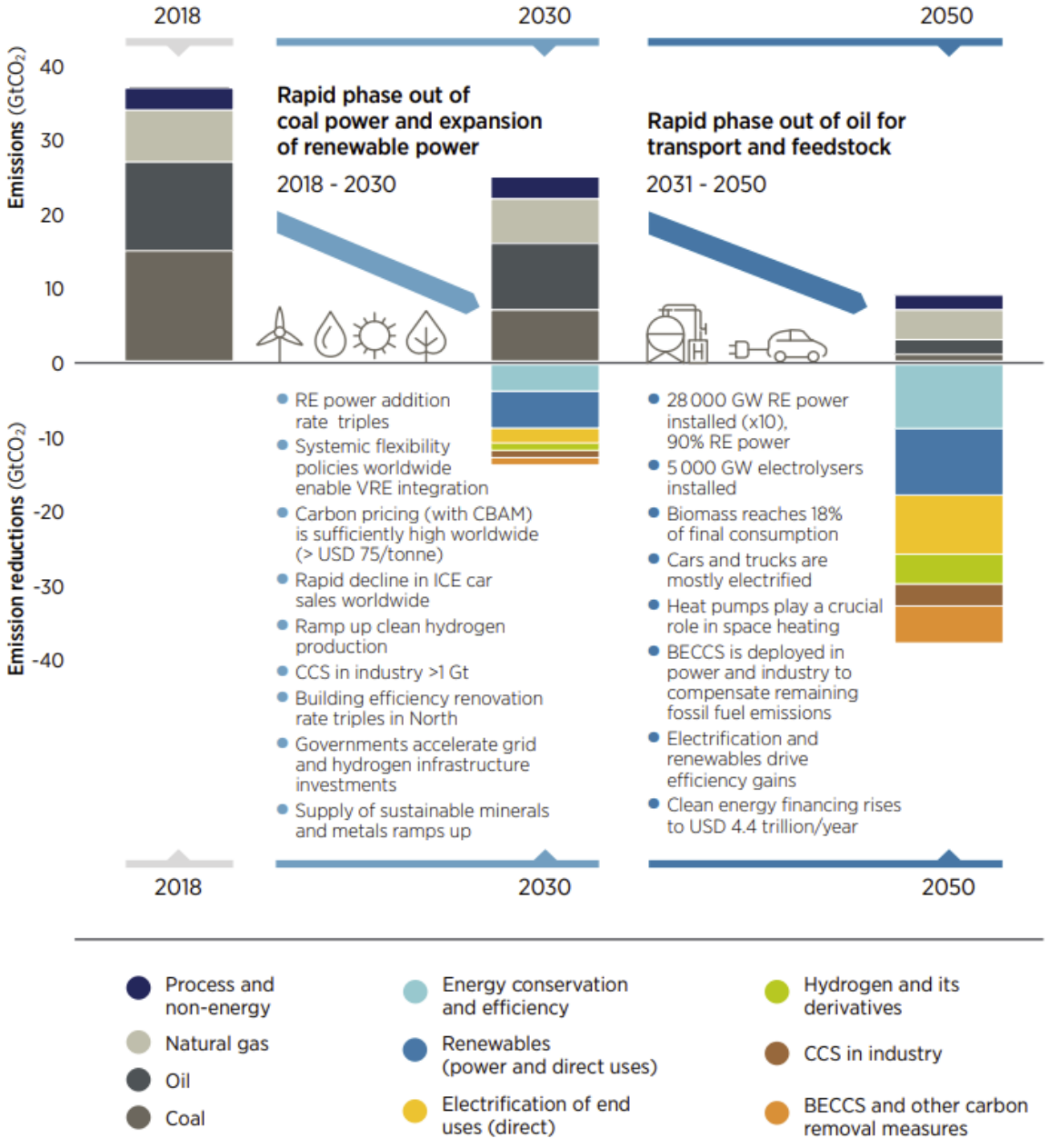


90% of all decarbonisation in 2050 will involve renewable energy through direct supply of low-cost power, efficiency, electrification, bioenergy with CCS and green hydrogen.

Key performance indicators for achieving the 1.5°C Scenario by 2030 and 2050



Evolution of emissions in accordance with the deployment of technological avenues, 2018–2050



- By 2030, renewable power should reach 10 700 GW globally, almost quadrupling the current capacity.
- The annual energy intensity improvement rate needs to rise to 2.9%, nearly two and a half times the historical trend.
- Infrastructure upgrade, modernisation and expansion is a high priority in the coming decade.
- By 2050, electricity will be the main energy carrier, increasing from a 21% share of total final energy consumption in 2018 to over 50% in 2050.

Key milestones and actions for rapid emission reductions, 2021-2030

Renewable energy share in electricity generation must increase to 65% by 2030.

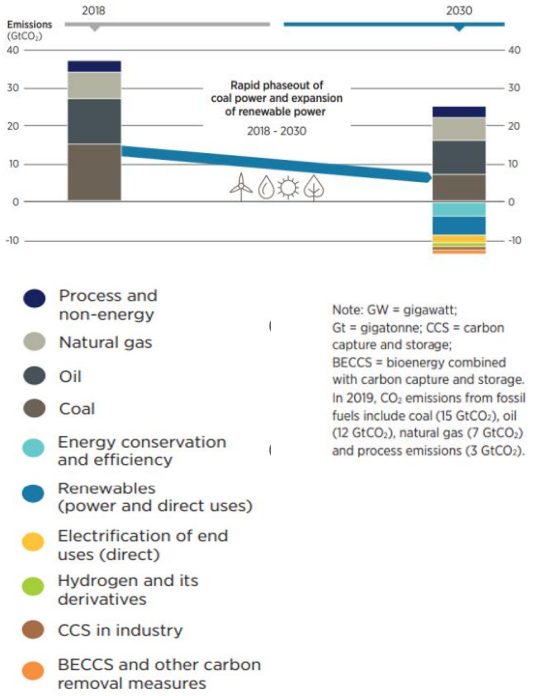
- An additional 8 000 GW of renewable capacity in this decade
- Installed capacity of on-shore wind of 3 000 GW, four times that of 2020
- Off-shore wind to scale-up to 380 GW, 11 times more than in 2020
- Installed capacity of solar PV to reach 5 200 GW, more than seven times that of 2020
- Hydropower capacity to increase to 1 500 GW, 30% more than in 2020
- Other renewable technologies to reach 750 GW, up six-fold from 2020.

The share of direct electricity in total final energy consumption (TFEC) must rise from 21% to 30%; deployment of energy efficiency measures must increase 2.5 times.

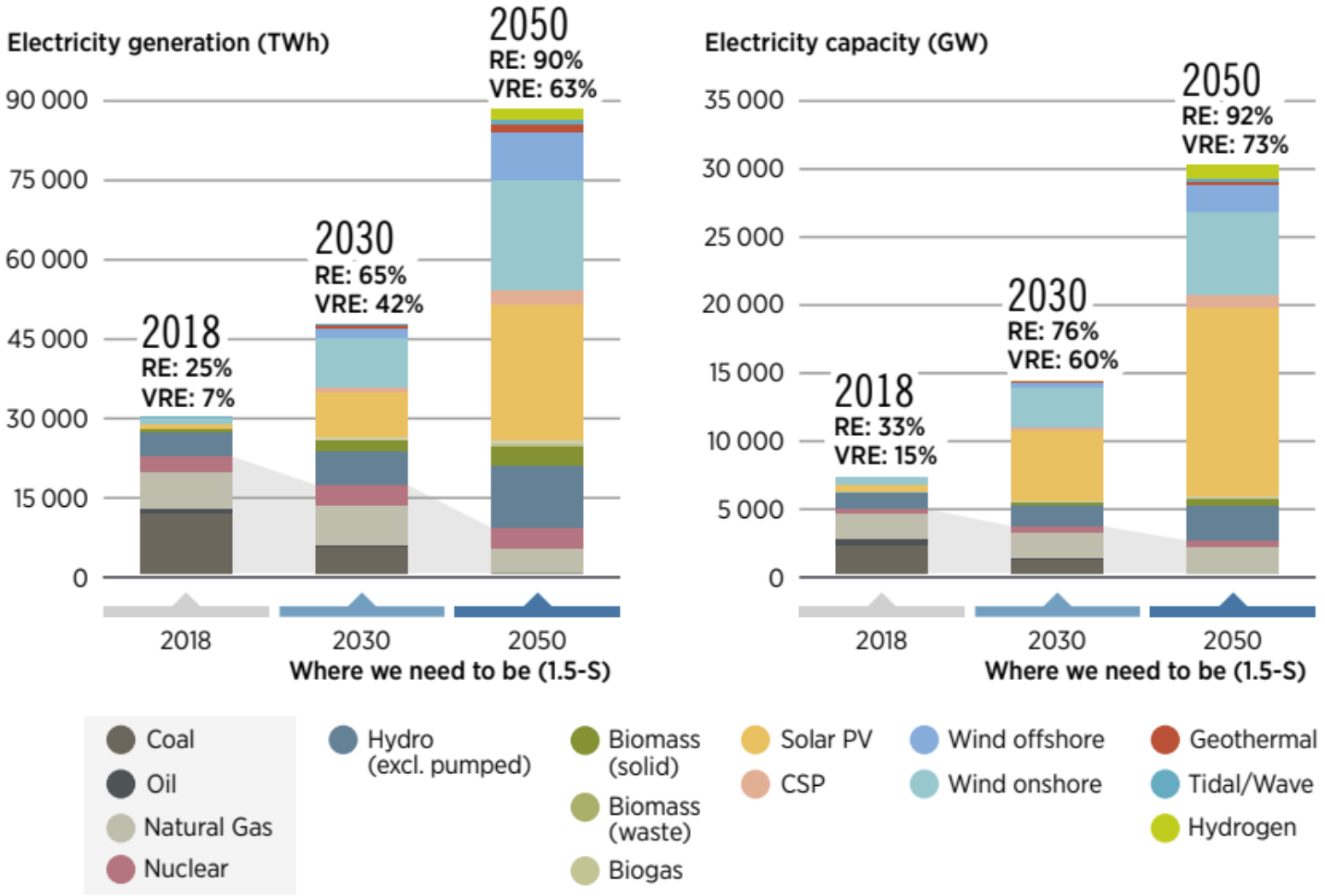
- A drop in TFEC from ca. 390 EJ today to 370 EJ
- Expanded electrification of energy services, especially in transport sector
- Improved energy efficiency standards and retrofitting of existing buildings
- Process changes in industry, relocation of industries, and circular economy practices.

Direct renewables in end-use sectors must grow from 12% in 2019 to 19% by 2030.

- Hydrogen consumption to reach a minimum of 19 EJ by 2030
- Total consumption of bioenergy and feedstock in industry to increase to 25 EJ, 2.5 times more than in 2019
- Solar thermal, geothermal and district heating solutions to be scaled up to 60 EJ, 1.3 times the 2019 levels.
- Biofuel's share for energy consumption in transport to increase from 3% in 2019 to 13%
- Increase ambition on biojet to reach 20% of total fuel consumption by 2030.

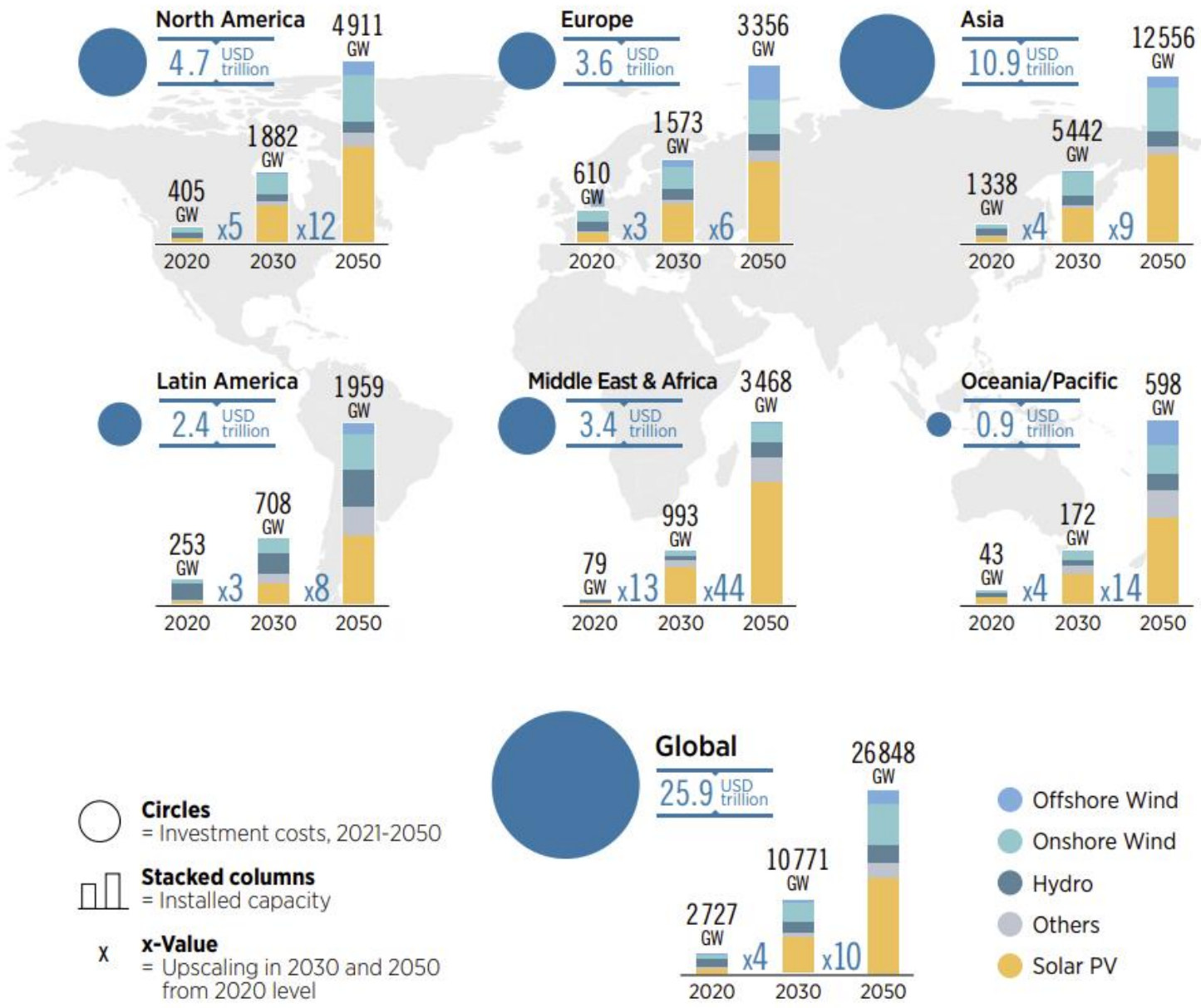


Renewables could decarbonize 90% of the power sector by 2050

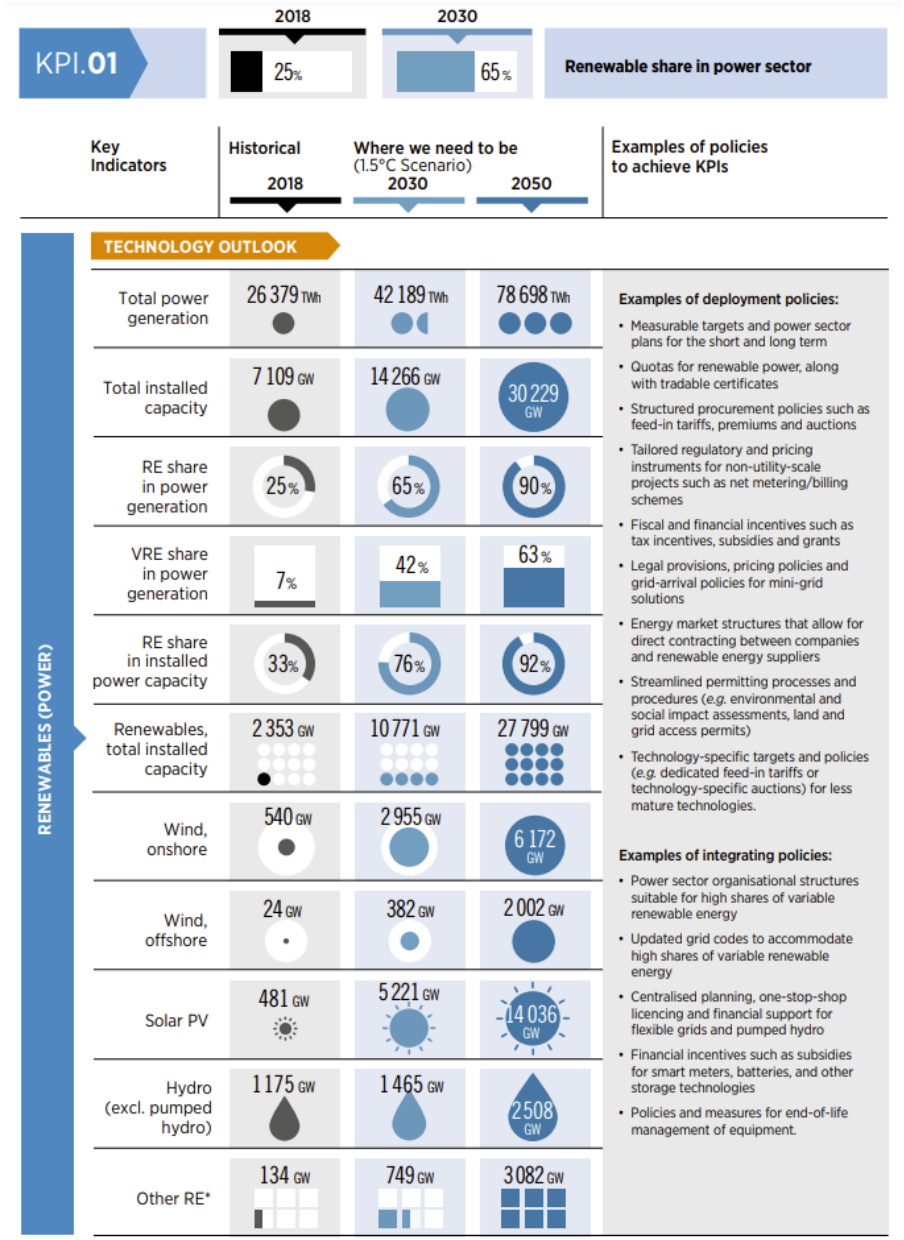


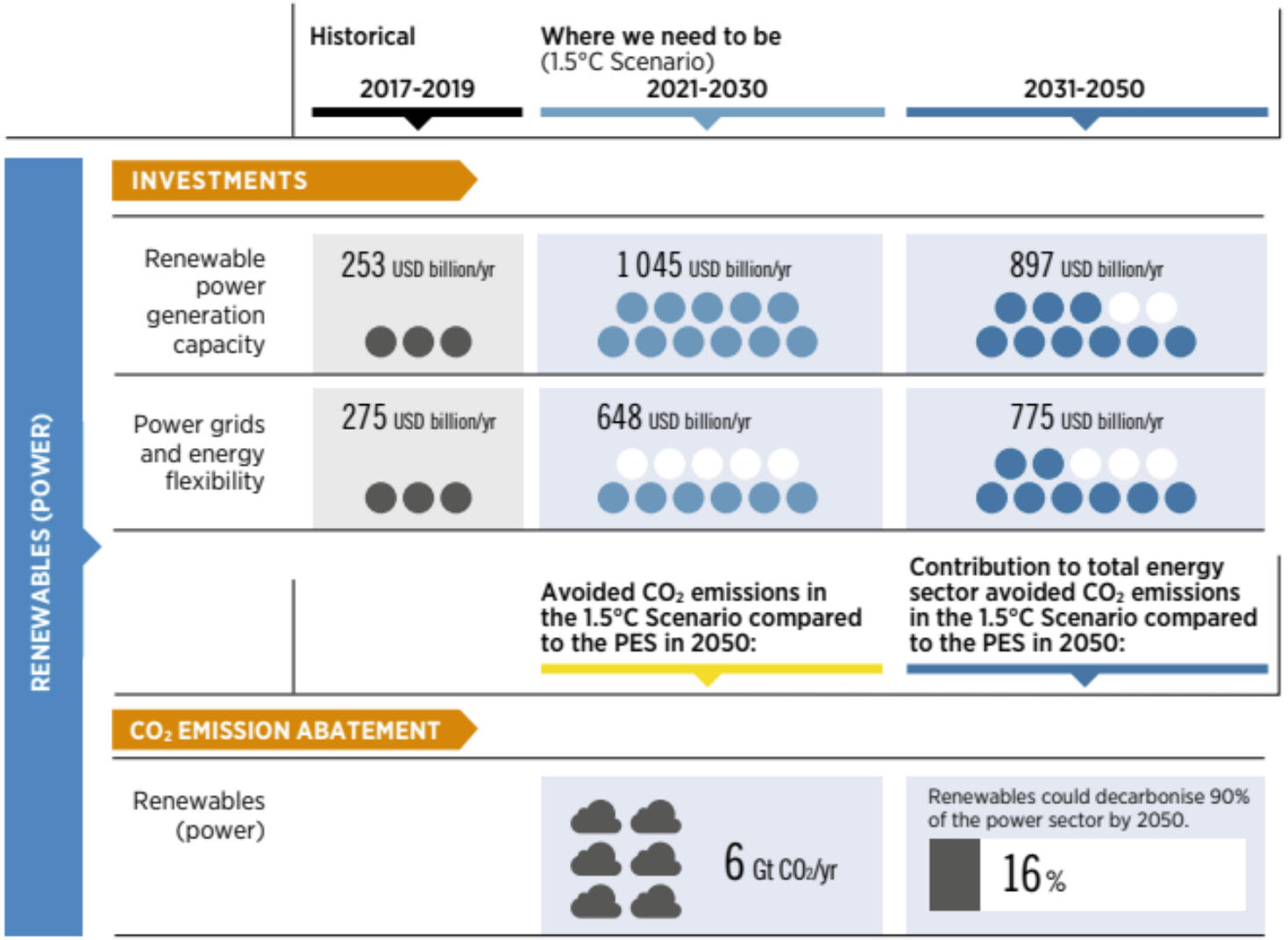
Note: 1.5-S = 1.5°C Scenario; CSP = concentrated solar power; GW = gigawatts; PV = photovoltaic; RE = renewable energy; TWh/yr = terawatt hours per year; VRE = variable renewable energy.

Regional distribution of total installed capacity (GW) in 2020, 2030, 2050

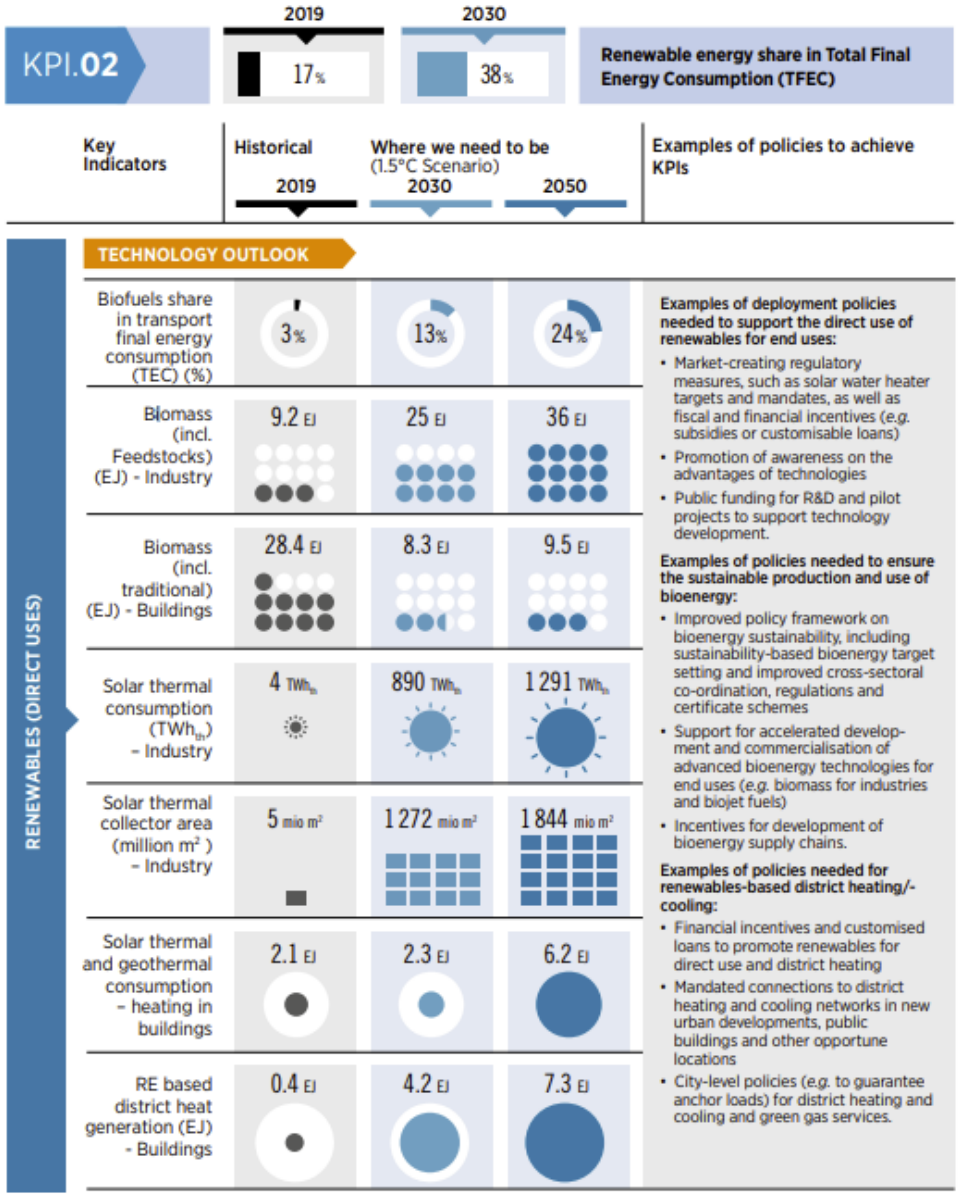


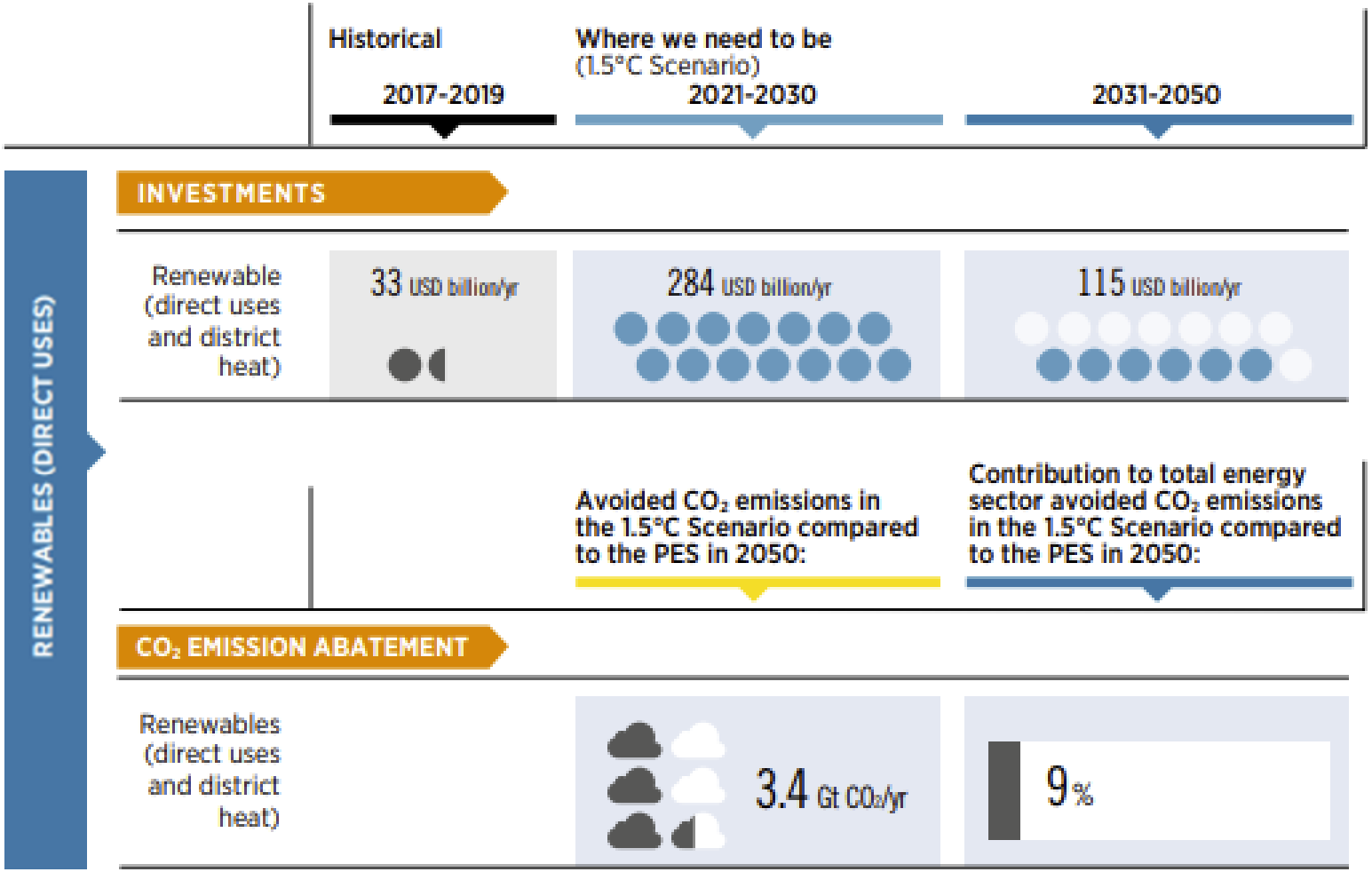
Key indicators of performance on renewables in the power sector



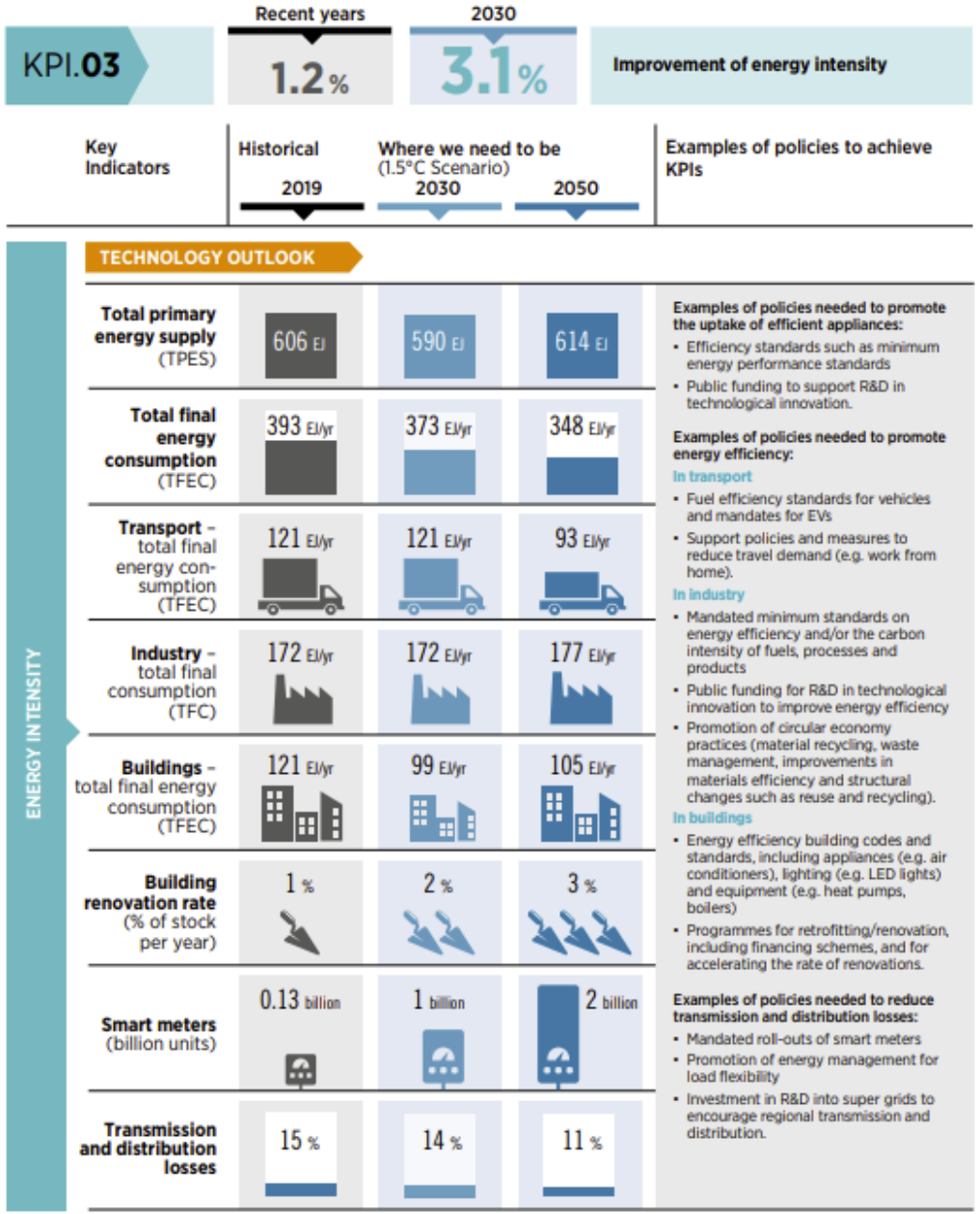


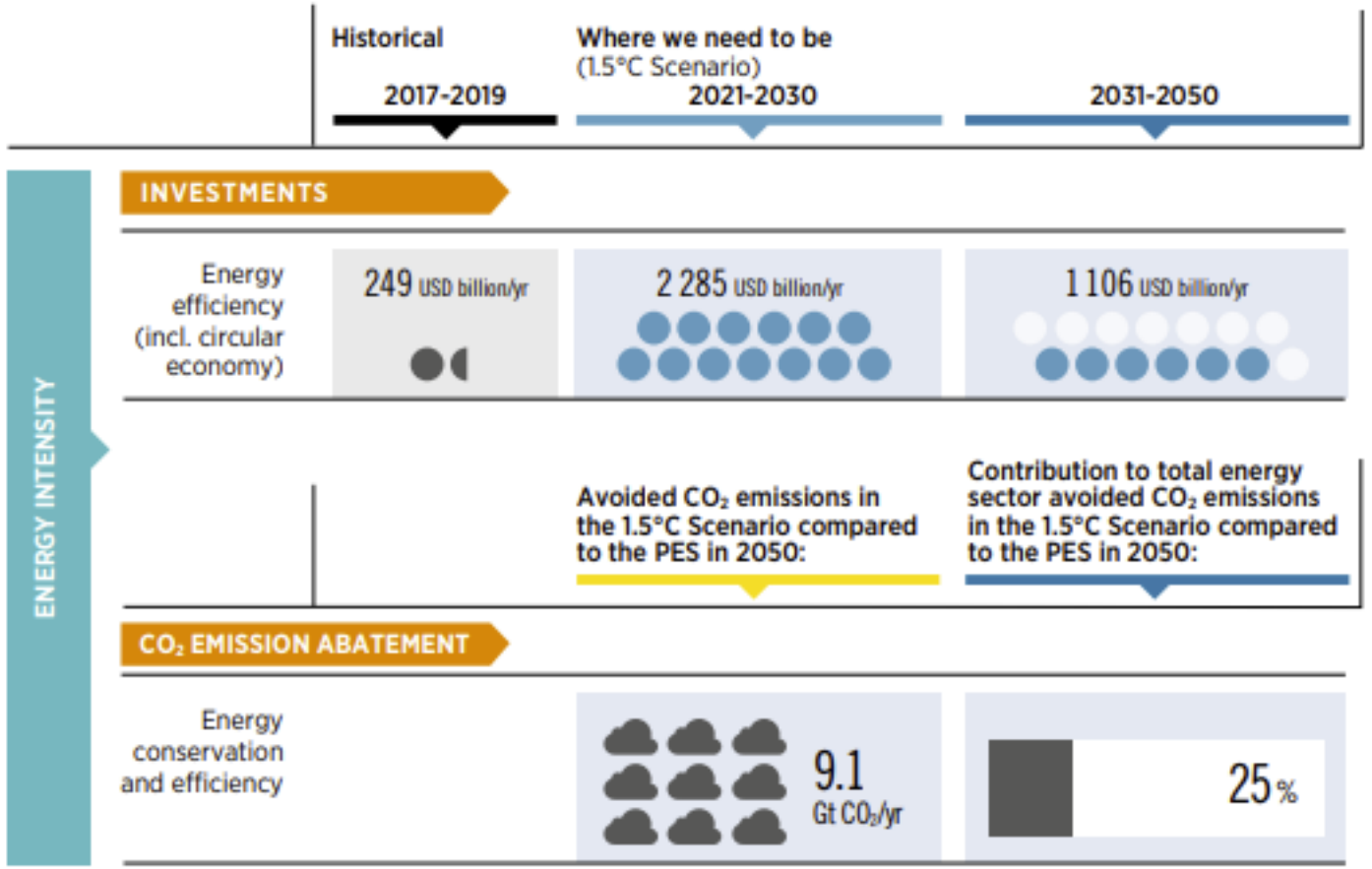
Key indicators of performance on direct uses of renewables [bioenergy and other]





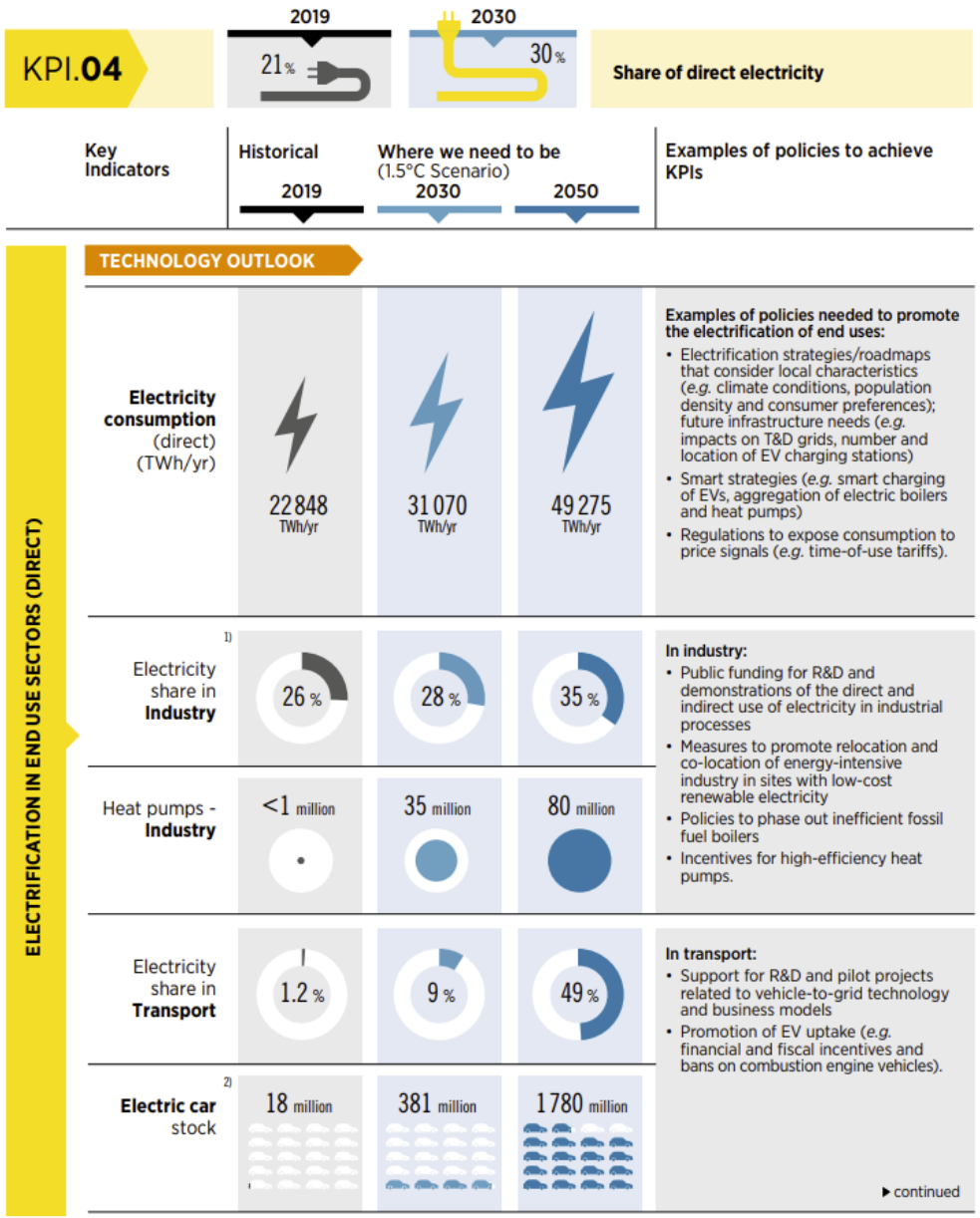
Key indicators of performance on energy conservation and efficiency

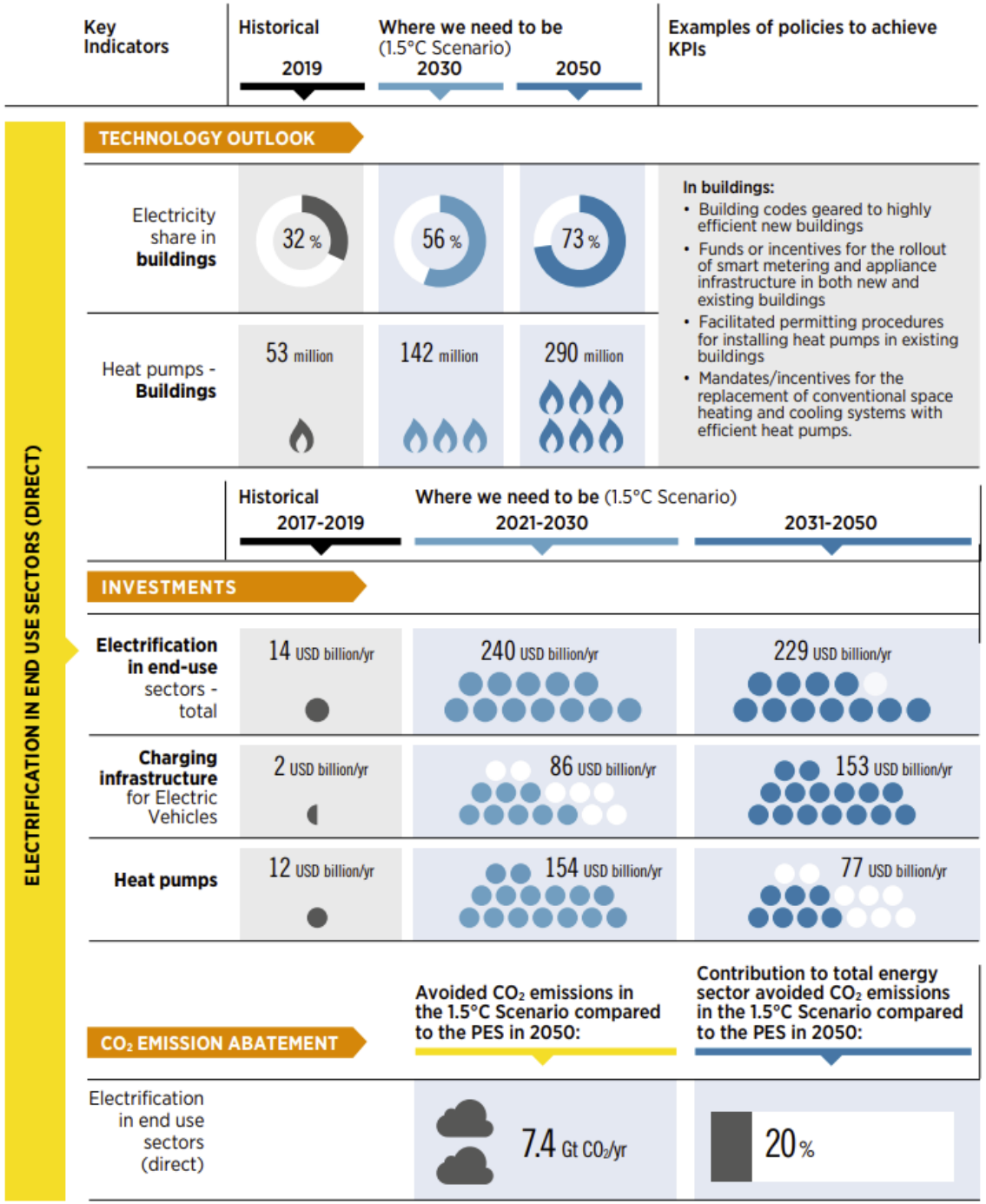




Note: Recent years represents the average energy intensity improvements from 2018 (1.2%), 2019 (2.0%), and 2020 (0.5%).

Energy transition components: Electrification of end-use sectors (direct)





Energy transition component: Hydrogen and its derivatives (e-fuels)

KPI.05 — Production of clean hydrogen and derivatives

2020: H_2 0.8 Mt | 2030: H_2 154 Mt

HYDROGEN AND DERIVATES

TECHNOLOGY OUTLOOK

Key Indicators	Historical 2020	Where we need to be (1.5°C Scenario) 2030	2050
Clean hydrogen production	>0 EJ/yr	19 EJ/yr	74 EJ/yr
Clean hydrogen share in total final energy consumption (TFEC)	<0.1%	3%	12%
Clean hydrogen share **in transport** total final energy consumption (TFEC) (%)	<0.1%	0.7%	12%
Ammonia, methanol, **synthetic fuels share in transport** total final energy consumption (TFEC) (%)	<0.1%	0.4%	8%
Clean hydrogen consumption - **Industry** (EJ)	>0 EJ	16 EJ	38 EJ
Clean hydrogen consumption – **Buildings** (EJ)	0 EJ	2 EJ	3.2 EJ

Examples of policies to achieve KPIs

Examples of policies needed to promote the use of hydrogen and its derivatives:

- National green hydrogen strategies that define the level of ambition for hydrogen across end-use sectors and the support required for attracting private investments
- Establishment of sectoral priorities for the use of green hydrogen
- Certification systems - guarantee of origin (GO) - to track the origin and to account for the lifecycle emissions of hydrogen
- Industrial policies to maintain competitiveness and create export opportunities
- Mechanisms to enable the shift from grey to green and clean hydrogen (*e.g.* incentivising demand for low-carbon commodities like green steel, green ammonia)
- Promotion if hydrogen-based steel and chemical production in industry including through pilot projects.

▸ continued

HYDROGEN AND DERIVATES

	Historical 2017-2019	Where we need to be (1.5°C Scenario) 2021-2030	2031-2050
INVESTMENTS			
Hydrogen and its derivatives (incl. electrolysers, feedstocks and infrastructure)	0 USD billion/yr	133 USD billion/yr	176 USD billion/yr
		Avoided CO_2 emissions in the 1.5°C Scenario compared to the PES in 2050:	**Contribution to total energy sector avoided CO_2 emissions in the 1.5°C Scenario compared to the PES in 2050:**
CO_2 EMISSION ABATEMENT			
Hydrogen and its derivatives		3.7 Gt CO_2/yr	10%

Energy transition component: CCS, BECCS and other

KPI.06 — Emissions captured through CCS, BECCS and others

	2020	2030
	0.04 Gt	2.2 Gt

Key Indicators	Historical 2020	Where we need to be (1.5°C Scenario) 2030	2050	Examples of policies to achieve KPIs

CCS, BECCS AND OTHERS

TECHNOLOGY OUTLOOK

	2020	2030	2050
Carbon capture and storage (CCS) for process and fossil fuel emissions in industry - total	0.04 $GtCO_2$ captured/yr	1.3 $GtCO_2$ captured/yr	3.4 $GtCO_2$ captured/yr
CCS - **Industry**	0.005 $GtCO_2$ captured/yr	1.1 $GtCO_2$ captured/yr	2.3 $GtCO_2$ captured/yr
CCS - **Blue hydrogen**	0.03 $GtCO_2$ captured/yr	0.3 $GtCO_2$ captured/yr	1.1 $GtCO_2$ captured/yr
BECCS and others - total	0.001 $GtCO_2$ captured/yr	0.9 $GtCO_2$ captured/yr	5 $GtCO_2$ captured/yr
BECCS and others - **Industry**	0.001 $GtCO_2$ captured/yr	0.8 $GtCO_2$ captured/yr	1.7 $GtCO_2$ captured/yr
BECCS and others - **Power and District heat**	0 $GtCO_2$ captured/yr	0.1 $GtCO_2$ captured/yr	3.4 $GtCO_2$ captured/yr

Examples of policies needed to promote CO_2 removal, capture and storage measures:

- Inclusion of CCS/BECCS in national energy plans
- Financial incentives such as tax credits, grants, direct equity investment or concessional loans
- Carbon pricing with a clear long-term trajectory
- Public funding for pilot projects for BECCs and for the selective use of CCS, mainly to capture process emissions in energy-intensive industries.

▶ continued

	Historical 2017-2019	Where we need to be (1.5°C Scenario) 2021-2030	2031-2050

CCS, BECCS AND OTHERS

INVESTMENTS

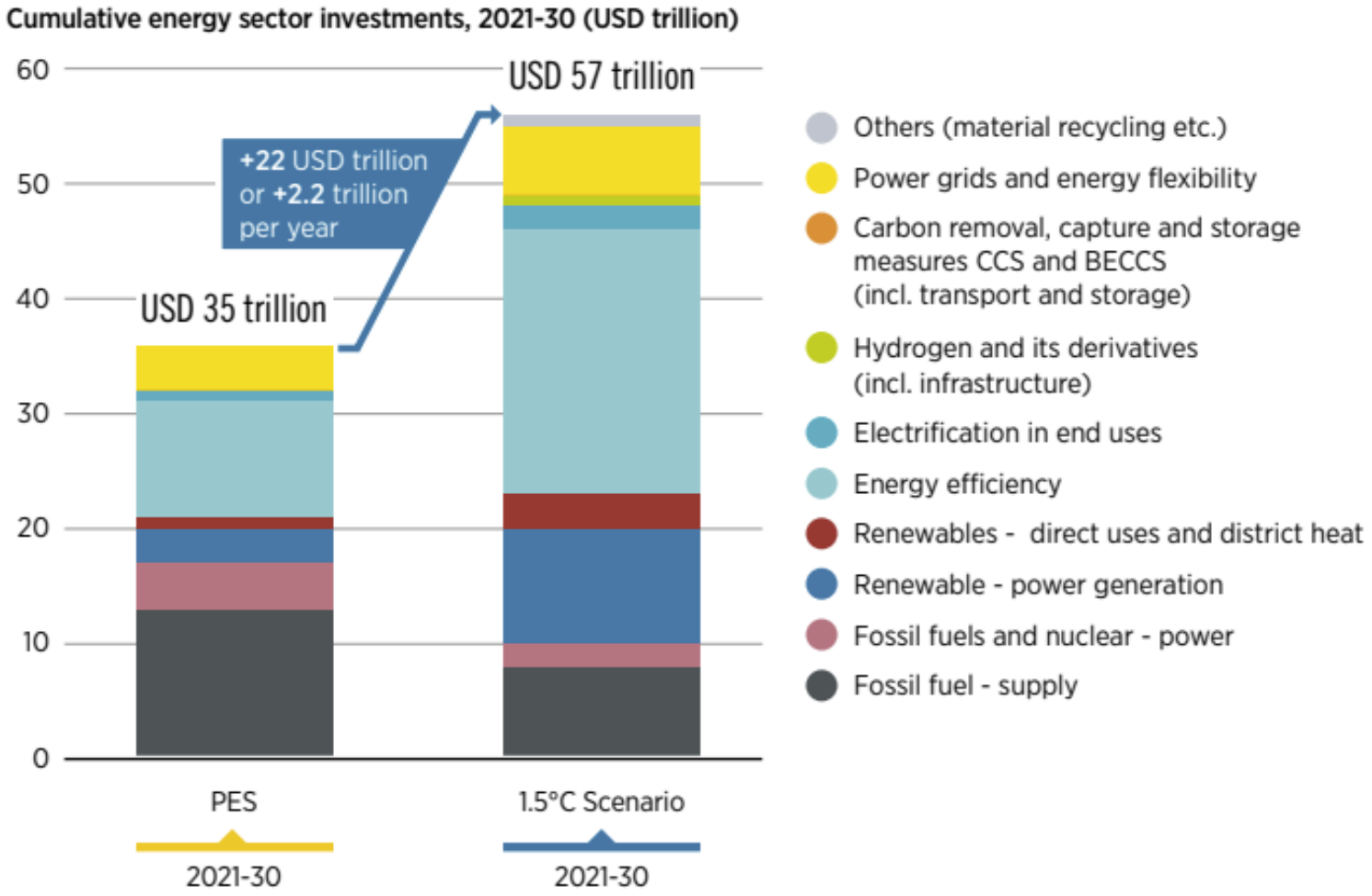
CCS and BECCS	0 USD billion/yr	41 USD billion/yr	77 USD billion/yr

	Avoided CO_2 emissions in the 1.5°C Scenario compared to the PES in 2050:	Contribution to total energy sector avoided CO_2 emissions in the 1.5°C Scenario compared to the PES in 2050:

CO_2 EMISSION ABATEMENT

CCS and BECCS	7.4 Gt CO_2/yr	20%

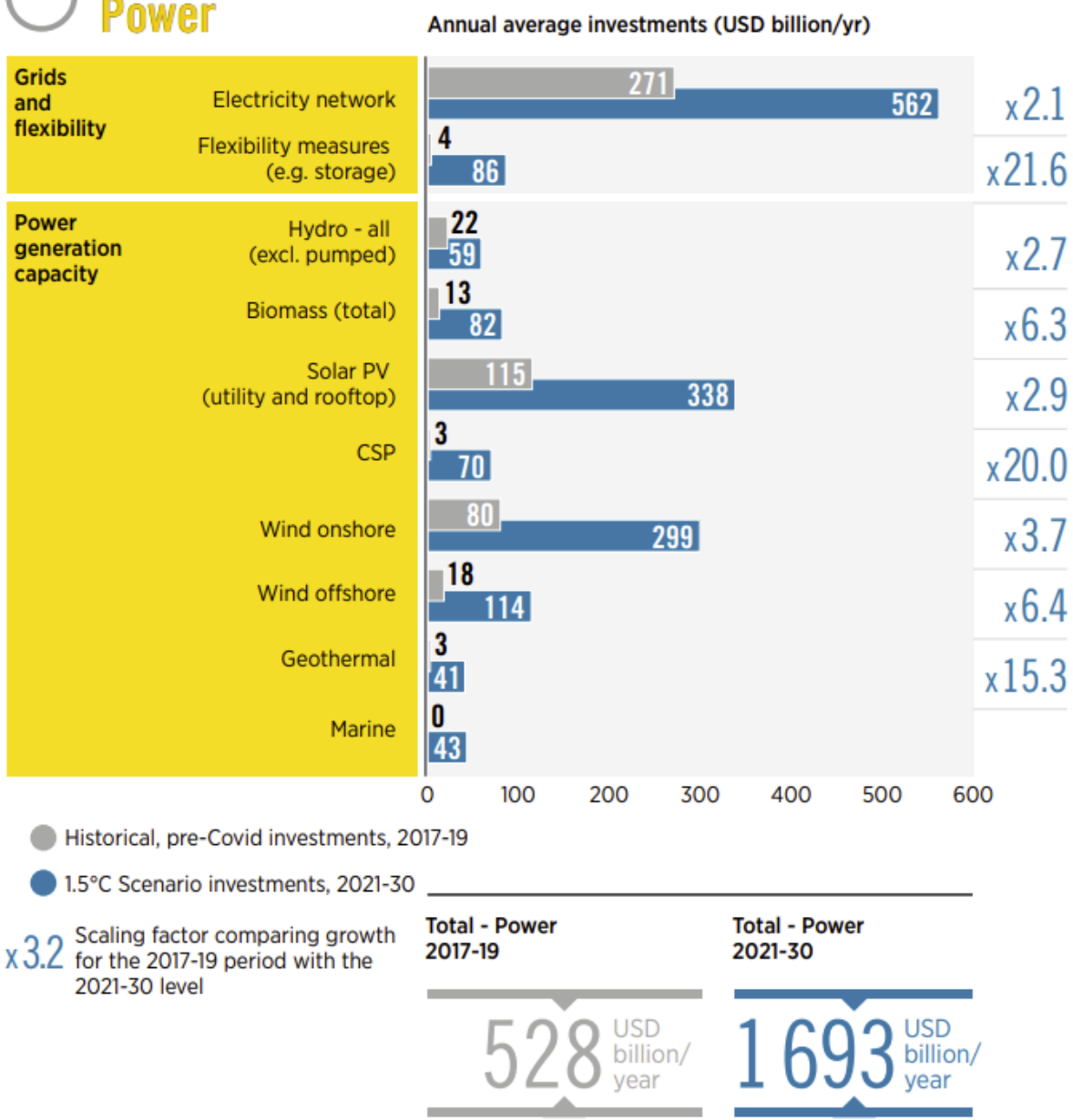
Total investment by technological avenue: PES and 1.5°C Scenario, 2021-2030



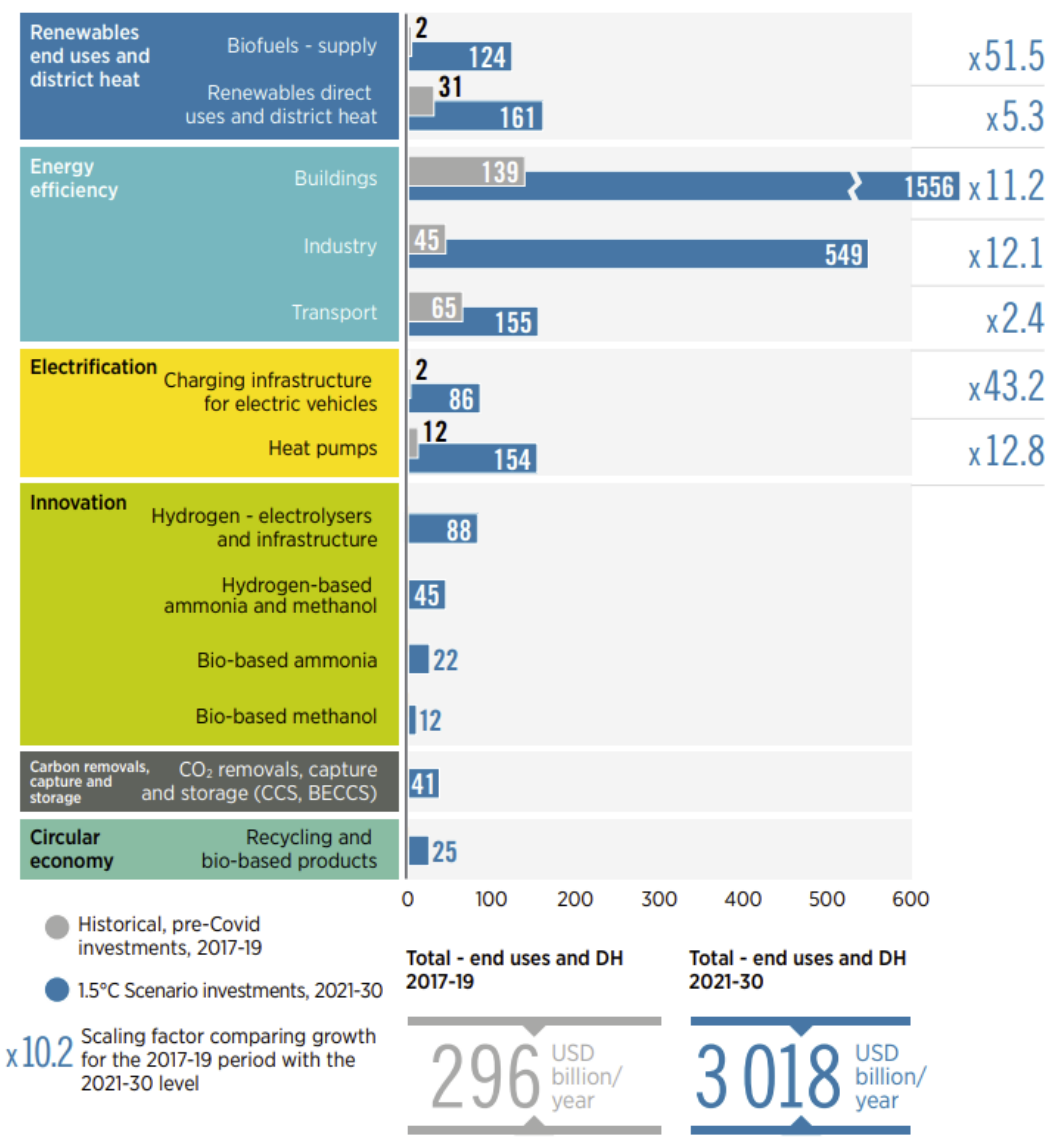
- A significant scale up of investments will be required in this decade, in all sectors and regions, to reach USD 5.7 trillion a year
- The 1.5°C Scenario requires additional investments of almost USD 2.2 trillion per year over the PES until 2030
- The 1.5°C Scenario demands spreading out the remaining required investment for 2021 across the decade

Average annual investments in USD billion per year by technology and measure, 2021-2030

Power



End uses and district heat

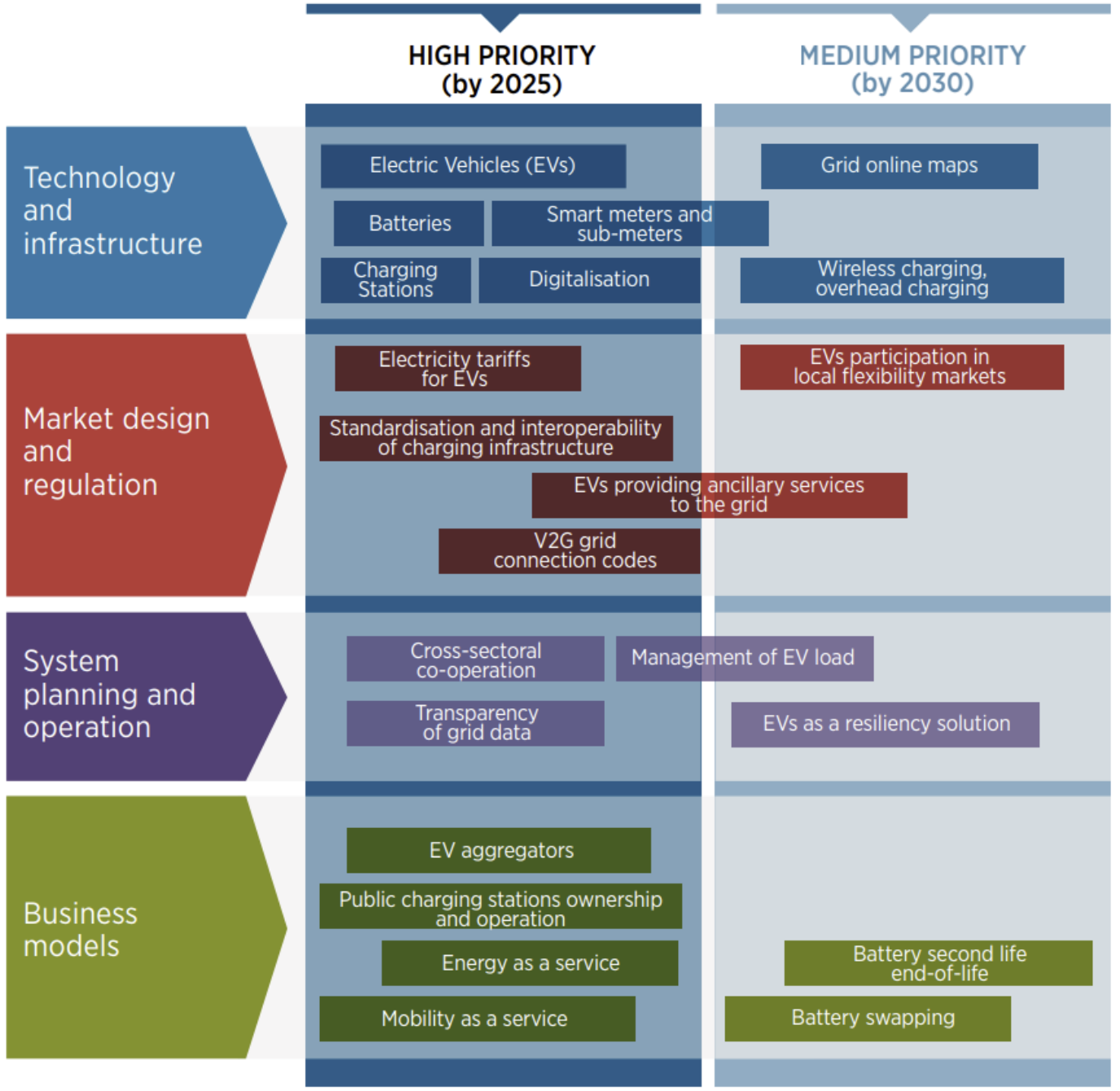


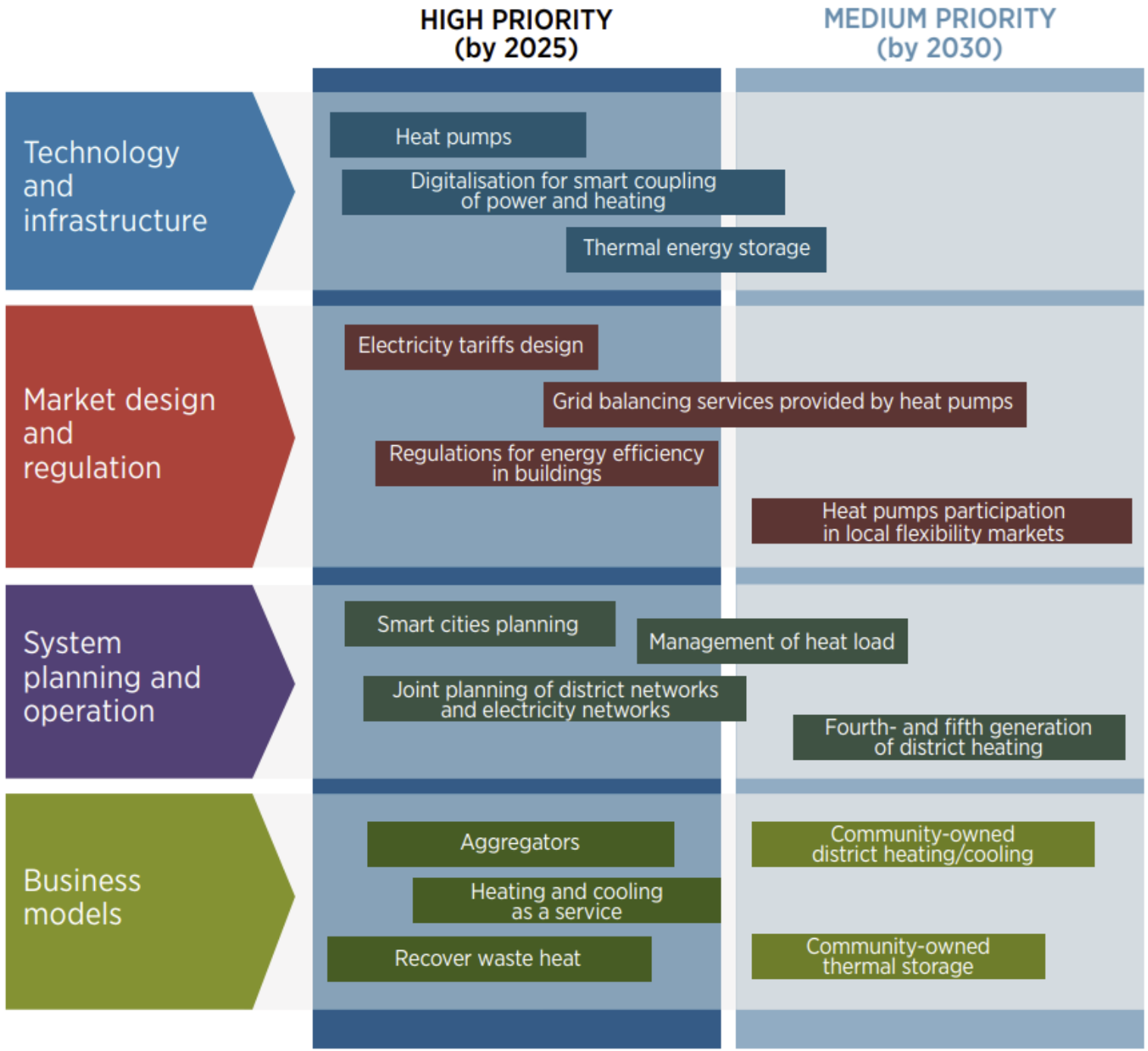
Business opportunity

IRENA's innovation landscape for integrating variable renewable energy

ENABLING TECHNOLOGIES	BUSINESS MODELS	MARKET DESIGN	SYSTEM OPERATION
1 Utility-scale batteries **2** Behind-the-meter batteries	**12** Aggregators **13** Peer-to-peer electricity trading **14** Energy-as-a-service	**17** Increasing time granularity in electricity markets **18** Increasing space granularity in electricity markets **19** Innovative ancillary services **20** Re-designing capacity markets **21** Regional markets	**25** Future role of distribution system operators **26** Co-operation between transmission and distribution system operators
3 Electric-vehicle smart charging **4** Renewable power-to-heat **5** Renewable power-to-hydrogen	**15** Community-ownership models **16** Pay-as-you-go models	**22** Time-of-use tariffs **23** Market integration of distributed energy resources **24** Net billing schemes	**27** Advanced forecasting of variable renewable power generation **28** Innovative operation of pumped hydropower storage
6 Internet of things **7** Artificial intelligence and big data **8** Blockchain			**29** Virtual power lines **30** Dynamic line rating
9 Renewable mini-grids **10** Supergrids			
11 Flexibility in conventional power plants			

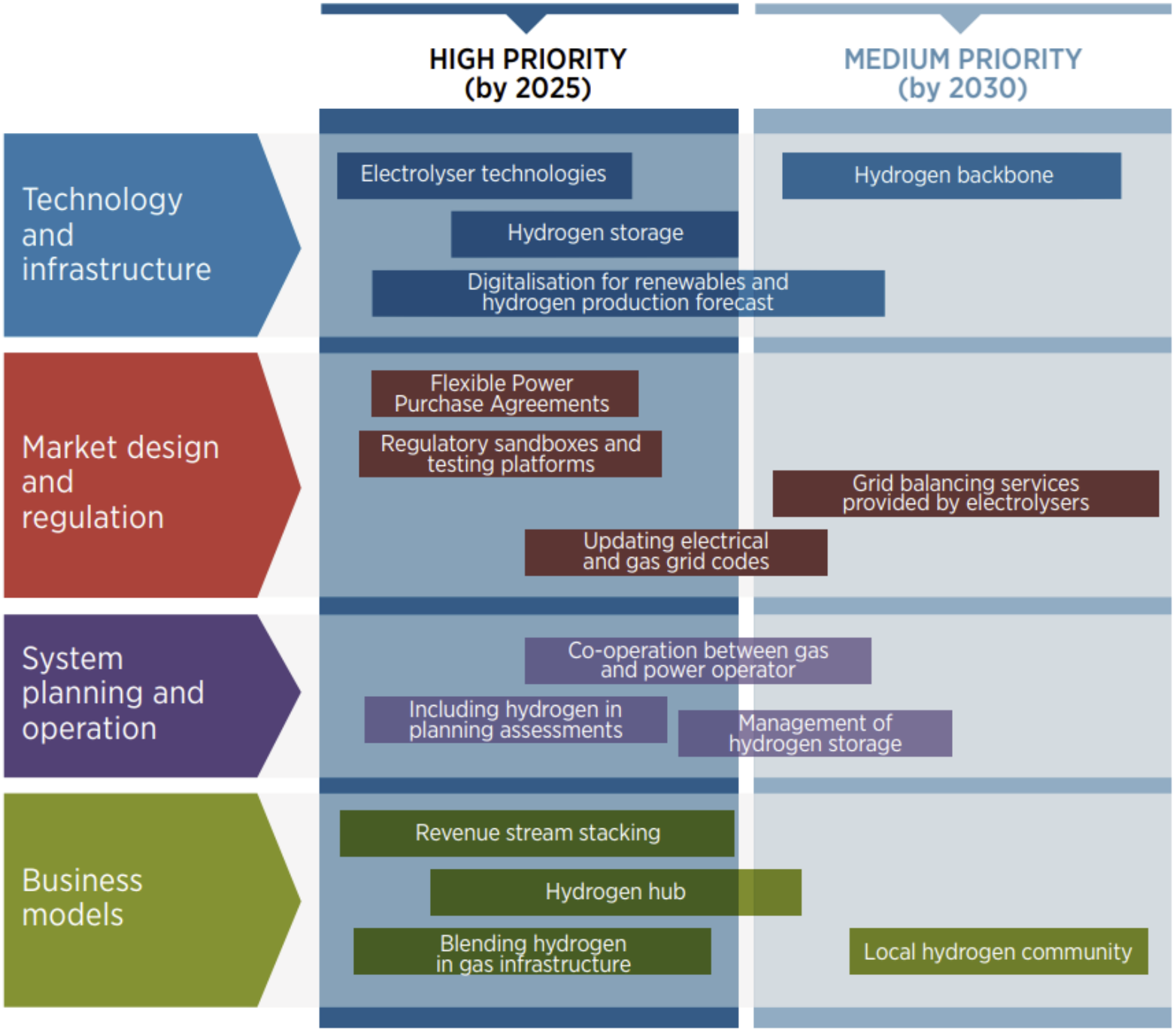
Priorities for the smart electrification of the mobility sector for 2025 and 2030



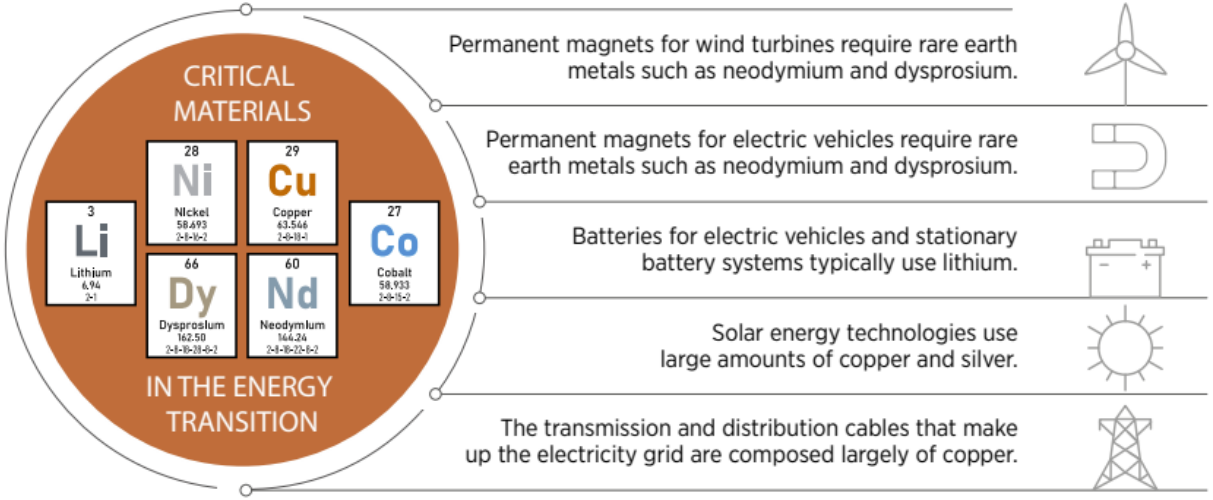


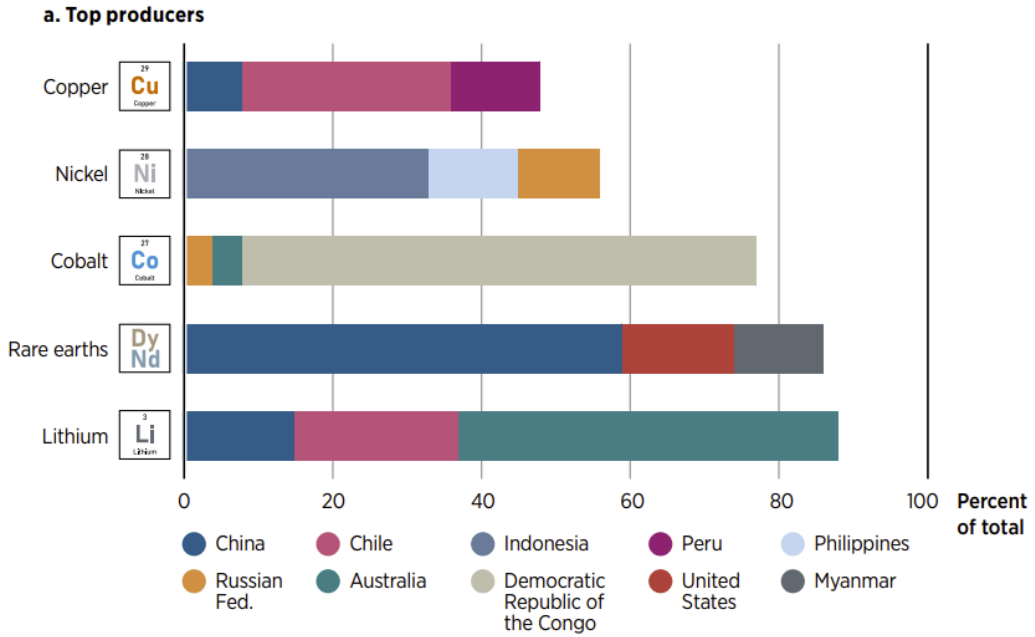
Priorities for the smart electrification of the heating and cooling sectors for 2025 and 2030

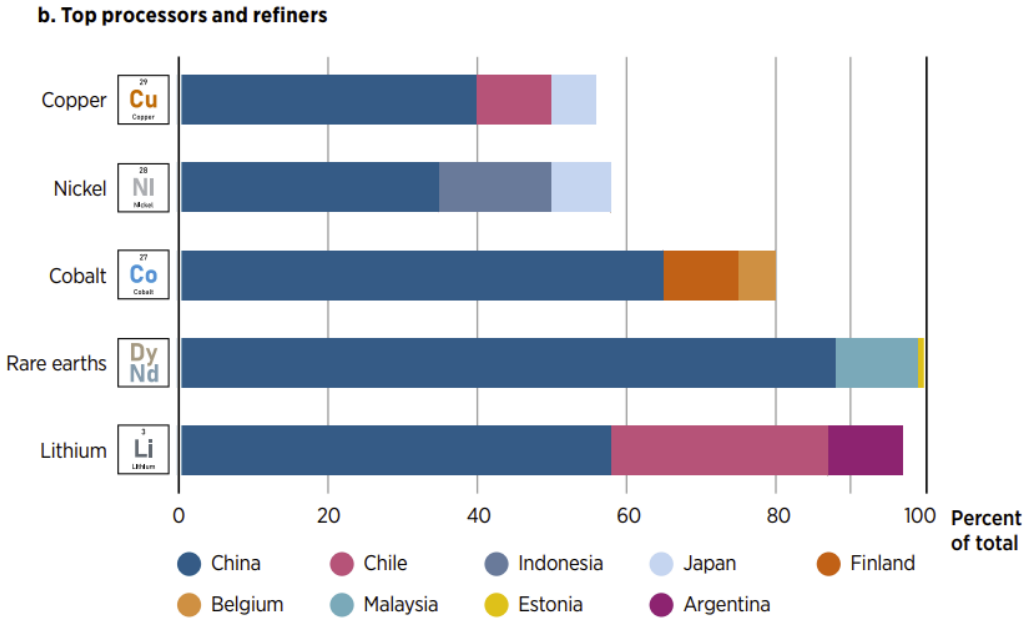
Priorities for the smart electrification of hydrogen production for 2025 and 2030



Main technologies increasing demand for critical materials







Biomass sources for the bioeconomy

Agricultural residues

- Crop residues such as straw, corn stover and sugarcane bagasse
- Other agricultural residues/wastes such as manures
- Other process residues such as food processing wastes, palm kernel shell and mill effluents

Forestry products

- Wood processing residue
- Harvesting residue
- Thinnings and other products from forestry operations
- Wood grown as part of land remediation projects or other afforestation

Energy crops

- Conventional energy crops such as sugar, corn, cereals and oil crops
- Perennial energy crops including short rotation forestry, miscanthus, switch grass
- Energy catch and break crops

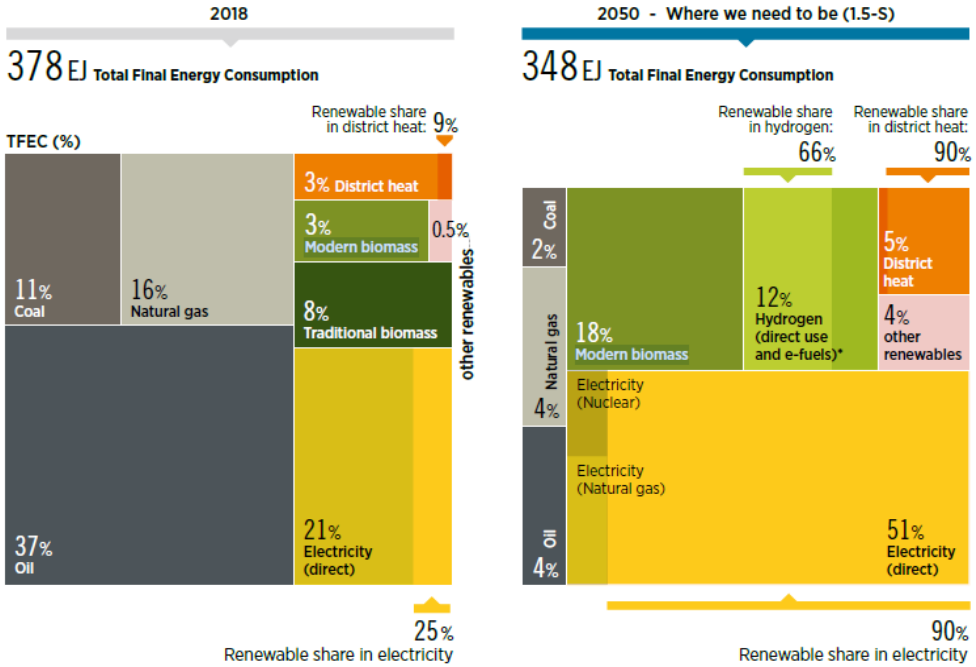
Post-consumer waste

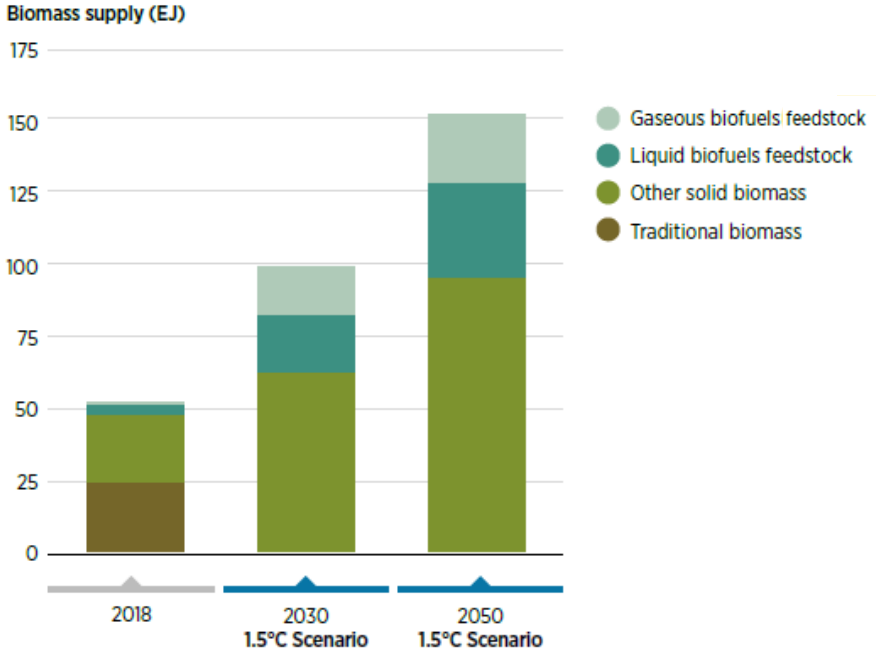
- Municipal solid waste
- Food wastes including used cooking oil
- Other industrial waste
- Sewage and other waste water

WETO Pathway:

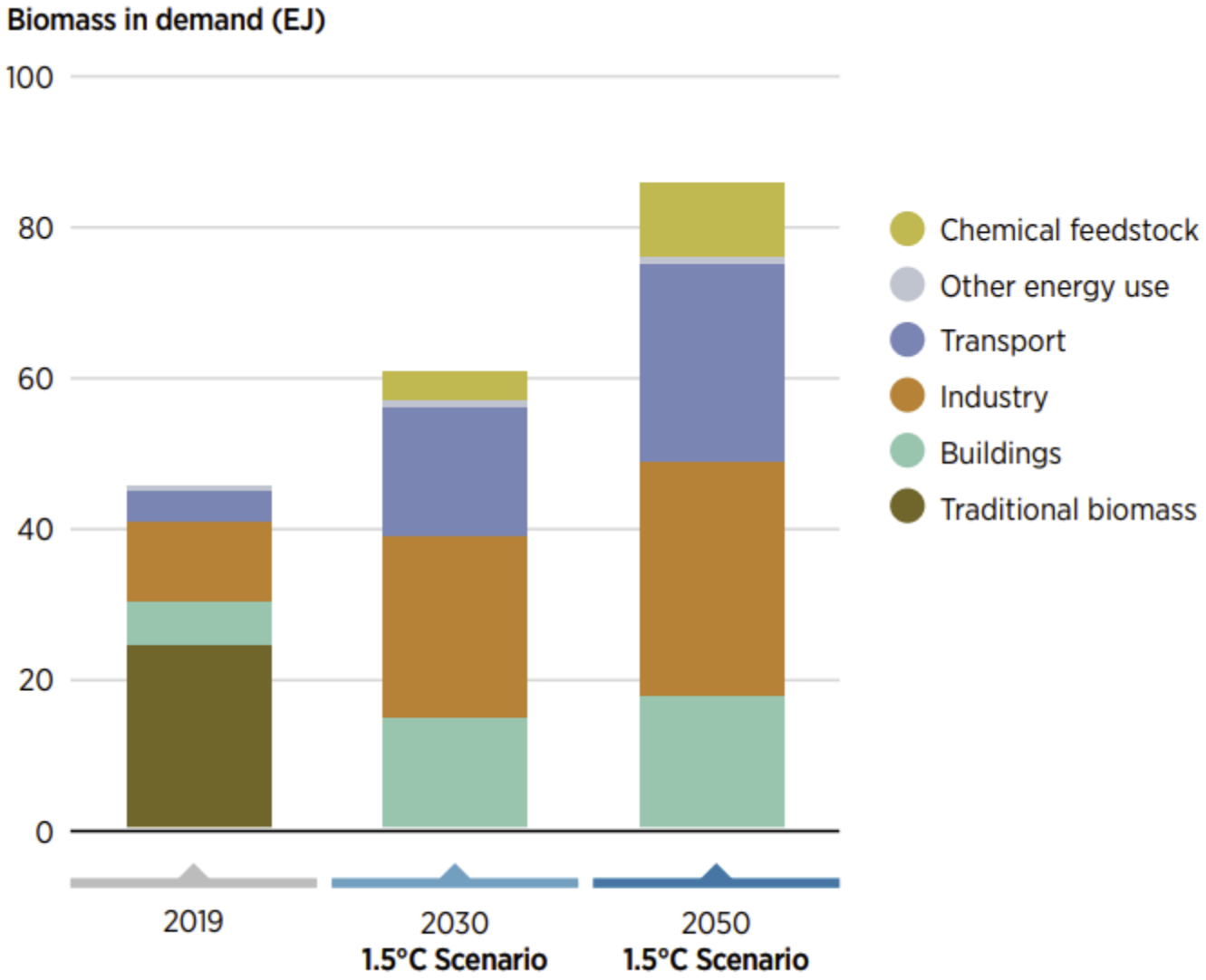
Biomass is key to deliver the 1.5C Paris compatible scenario

- Bioenergy makes up around 50% of renewable energy use today
- Biomass supply will need to rise to ~150 EJ by 2050
- Biomass supplied from sustainable sources will need to rise from current levels of 30 EJ by a factor of five-fold by 2050





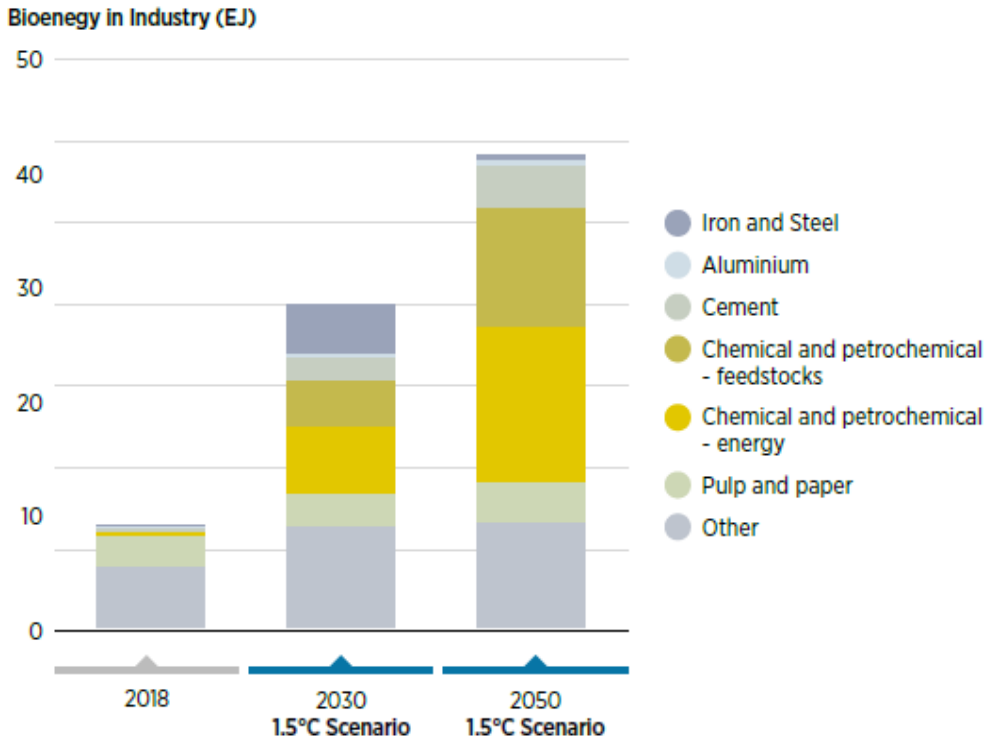
Role of biomass for energy and feedstock by end-use sector in the 1.5°C Scenario



- Contribution to the demand for modern energy and for feedstocks increases by a factor of three by 2030, and over four by 2050, providing 17% of all final energy consumption by 2050

WETO pathway: Bioenergy in industry

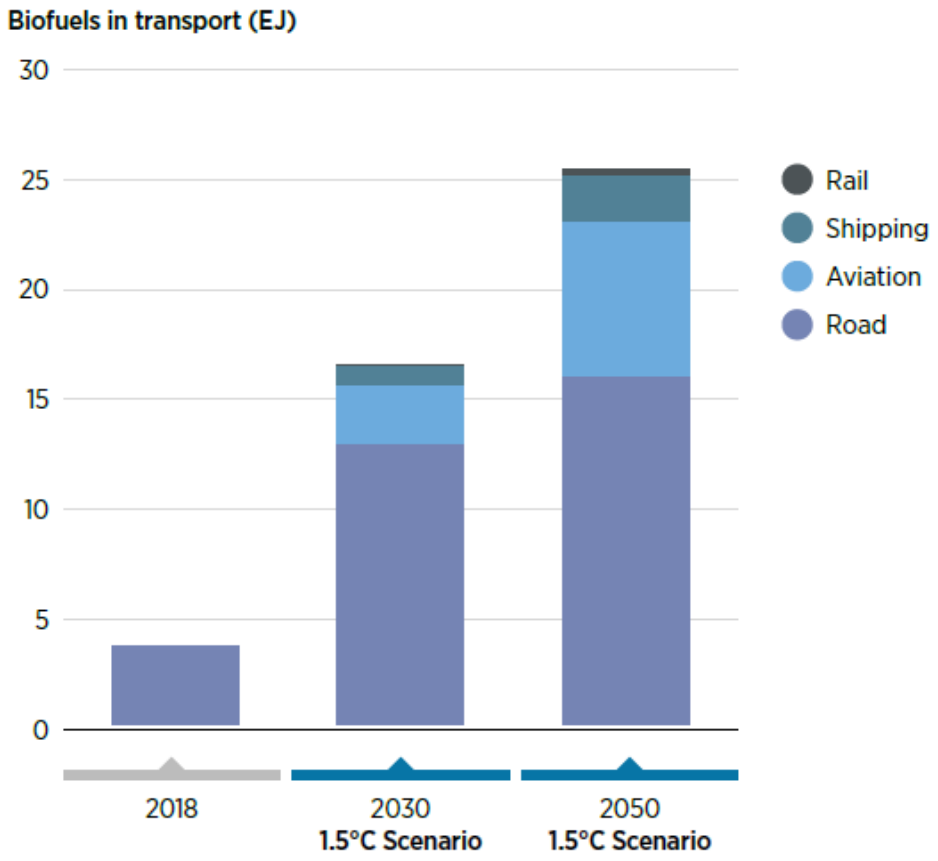
- The use of biomass in the industry sector needs to rise ca. four-fold from today to 2050
- Bioenergy mainly provides process heat for industry



- **Cement sector**
  - The role of biomass rises from ~0.5 to ~3-4 EJ by 2050
  - Often couples with CCS (BECCS)
- **Metal sector (aluminum and iron and steel production)**
  - a rapid rise in biobased carbon as a readily available short-term measure
  - longer-term increasingly rising the use of hydrogen as eletrification strategy
- **Chemical sector**
  - bioenergy provides both process energy and feedstock for chemical
  - biomass use increases to ~20 EJ in 2050, from very small levels today
  - bioenergy feedstocks for chemical production rises strongly to ~10 EJ by 2050

WETO pathway: Bioenergy in transport

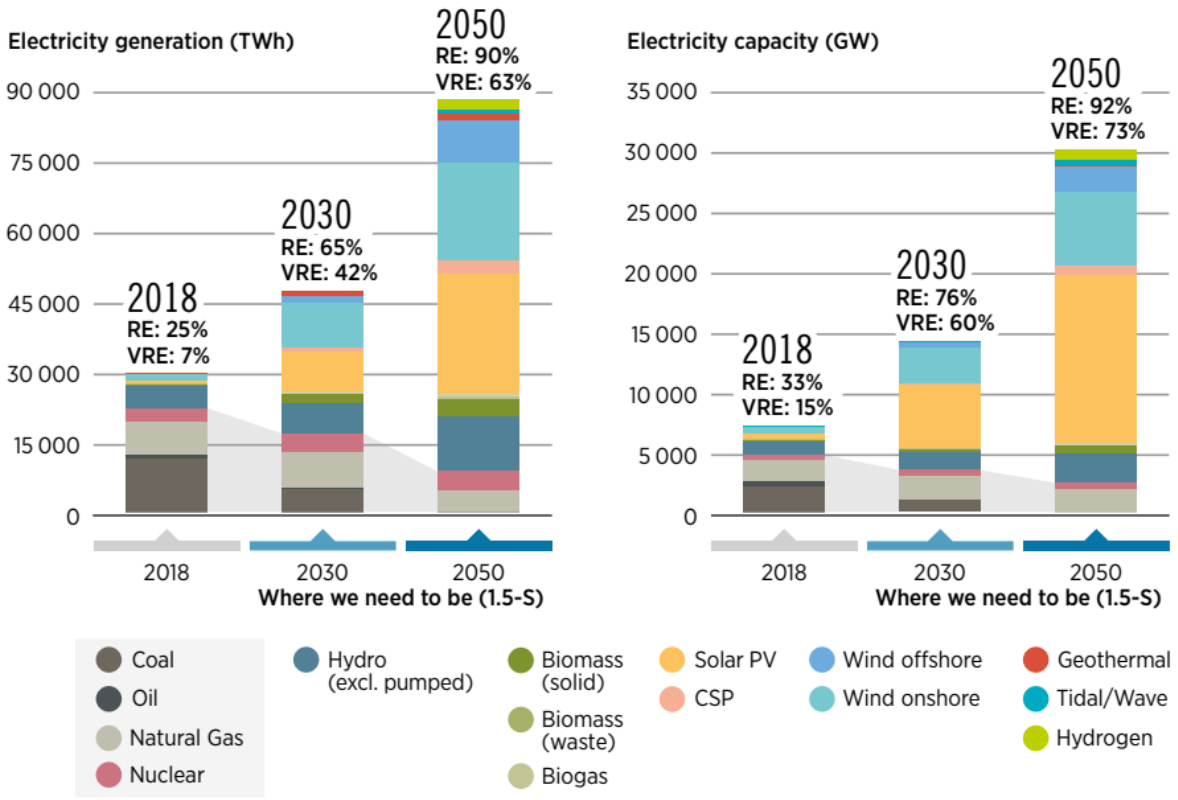
- Biofuels in transport grows more than four-fold between 2019 and 2030, and to more than six-fold by 2050



- **Biofuels for road transport**
  - Complement a strong rise in the electrification
  - Useful for long-haul road transport where biodiesel, hydrogenated vegetable oil (HVO) and biomethane
  - More than **470 billion liters per year** of biodiesel and bioethanol is needed for road transport by 2050
- **Biofuels for aviation**
  - About **200 billion litres per year** of biojet fuel will be required
  - 2019 production – 140 Million L (HEFA/HVO dominated): dramatic increase from 7 Million L in 2018
- **Biofuels for shipping**
  - Biodiesel-based fuels used for domestic navigation, and other fuels such as biomethanol playing important roles in international shipping
  - Around **60 billion litres per year** of biofuels is needed by 2050

WETO pathway: Bioenergy in power sector

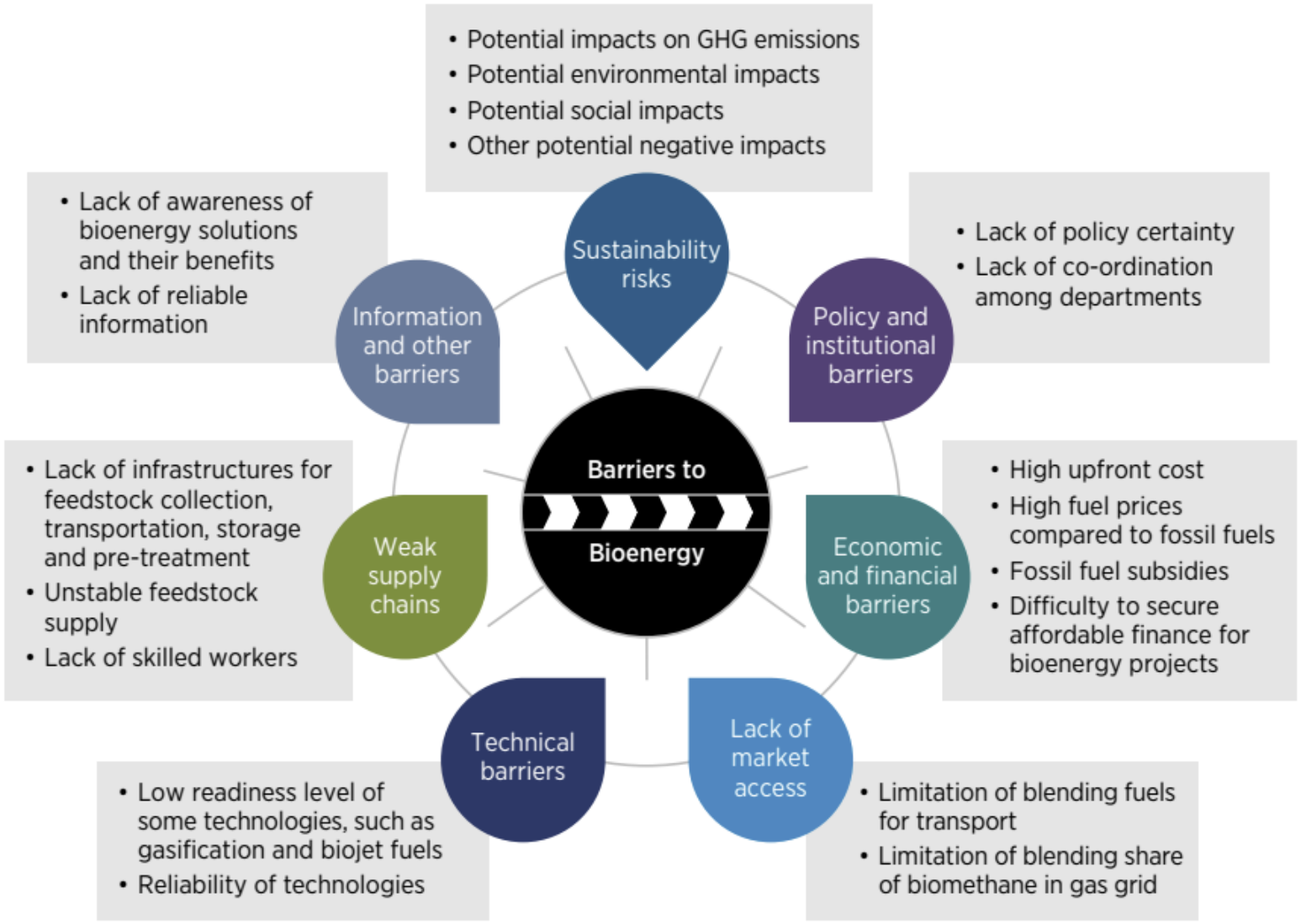
- Bioenergy in electricity generation grows around four-fold between 2019 and 2030, and to ca. eight-fold by 2050



Note: 1.5-S = 1.5°C Scenario; CSP = concentrated solar power; GW = gigawatts; PV = photovoltaic; RE = renewable energy; TWh/yr = terawatt hours per year; VRE = variable renewable energy.

- Share of solid biomass including waste in the electricity generation to reach 5% by 2050, up from 2% in 2019
- The installed capacity of Solid biomass should rise to 571 GW to generate more than 3 500 TWh of electricity by 2050 from around 100 GW in 2019
- Electricity generation through waste should scale by 5 times to reach 355 TWh by 2050 from current levels
- Electricity generation through biogas should scale by 12 times to reach 700 TWh by 2050 from current levels

Generic barriers to bioenergy deployment



- A policy framework to ensure bioenergy plays its role in achieving the 1.5°C target effectively
- A clear strategy with long-term targets for bioenergy development
- Coordinated bioenergy policy making involving ministries such as energy, forestry, agriculture, environmental protection and those relevant to end-use sectors
- Financial and fiscal measures to ensure that production and use of appropriate bioenergy sources are cost-effective for producers and users
- Mandates and obligations to ensure market access for bioenergy
- Adoption of a policy framework on sustainability to promote sustainable practices and incentivises improved performance
- Support for innovation through technical research, development and demonstration, and commercialization
- Further measures to tackle specific barriers including a clear set of permitting regulations, restrictions on fossil fuel use (e.g. cars or boilers), measures to support development of necessary infrastructure, training and skill development, quality control and standardisation and clear and reliable information on bioenergy to consumers and potential investors

Concluding remarks

- El mercado global de energía renovable es muy promisor
- Hay oportunidades en toda la cadena de valor de las energías renovables
- América del Sur y Colombia están en condiciones de estar a frente de la transición energética global

- Necesidad de expandir la producción y uso sostenible de biomasa
- La bioenergía desarrolla un rol muy importante en los sectores de transporte e industria
- No hay electricidad vs *biofuels*, sino que ambos son necesarios
- Mayor eficiencia en el uso de la biomasa, aumento de cogeneración, mayor producción de biogás y biocombustibles líquidos son importantes oportunidades de negocio

- Aumento de generación renovable competitiva, biomasa, solar, eólica, hidráulica, etc es *low hanging fruit*. Aumento de seguridad energética, empleos y desarrollo local, y *affordability*. No depende de la volatilidad de precios del mercado de fósiles
- Oportunidades de negocios con la necesidad de electrificación del uso final. EVs y toda su cadena de valor. Eficiencia energética en los edificios y la generación distribuida

- Hidrógeno como un mercado potencial

- Em mirar hacia la cadena de valor de la energía renovable, como a las oportunidades de negocio con la digitalización, o en la producción de los materiales necesarios a la producción de baterías, paneles y generadores, etc.

Acciones de panificación, coordinación entre niveles de gobierno, nuevas políticas y ajustes en la regulación, y planes de acción para nuevas inversiones

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