Energy
Transitions
Commission

The **Making Mission Possible** Series

Making Clean Electrification Possible: *30 Years to Electrify the Global Economy*

June, 2021

ENERGY

ACWA POWER
bp
CHINA HUANENG
CLP 中電
drax
ENVISION
IBERDROLA
LONGi Solar
nationalgrid
Ørsted
ReNew POWER
sse
Schneider Electric
Statnett
snam
VATTENFALL

INDUSTRY

ArcelorMittal
Dalmia Bharat Cement
EVgo
Heathrow
RioTinto
SAINT-GOBAIN
SSAB
TATA
TATA STEEL
VOLVO
Worley energy | chemicals | resources

Energy Transitions Commission

Energy Transitions Commission

Adair Turner

teri

Ajay Mathur

FINANCE

Allianz
BANK OF AMERICA
CREDIT SUISSE
European Bank for Reconstruction and Development
HSBC
IMPAX Asset Management
ipgroup
17 96 LOMBARD ODIER LOMBARD ODIER DARIER HENTSCH
MODERN ENERGY
春華 Primavera
中国石化 SINOPEC Capital
Willis Towers Watson

KNOWLEDGE PARTNERS

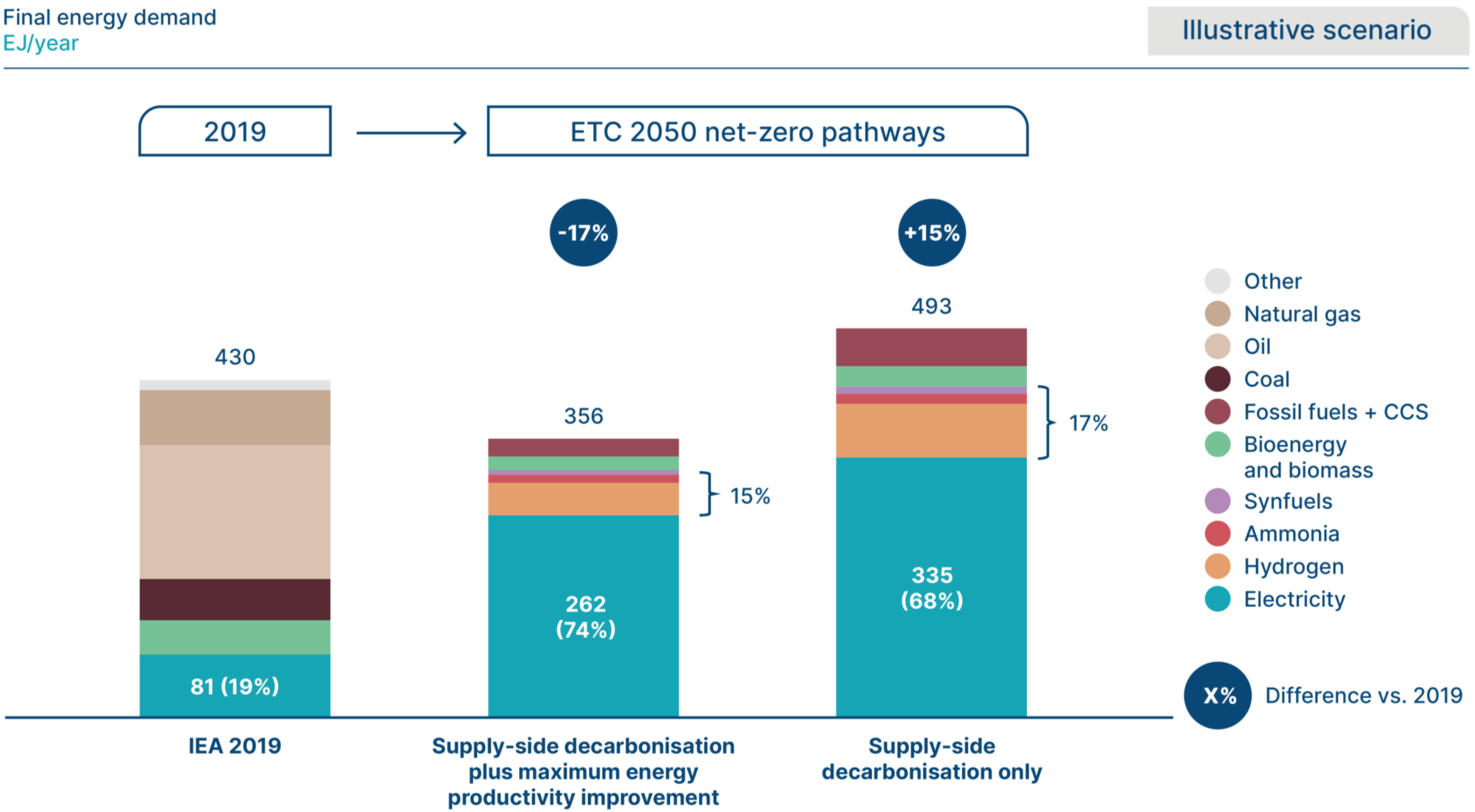
BloombergNEF
MATERIAL ECONOMICS
SYSTEMIQ

CIVIL SOCIETY

DRC
European Climate Foundation
TSINGHUA UNIVERSITY 1911
LSE
ROCKY MOUNTAIN INSTITUTE
SUSTAINABLE ENERGY FOR ALL
UNITED NATIONS FOUNDATION Connecting you with the United Nations
WE MEAN BUSINESS
WORLD RESOURCES INSTITUTE

A net-zero global economy is technically and economically possible by mid-century, but we need to act in the 2020s to put mid-century targets within reach.

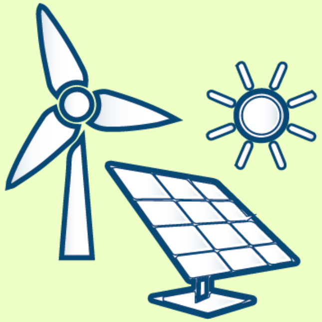
Final energy mix in a zero-carbon economy: electricity will become the dominant energy vector, complemented by hydrogen and fuels derived from it



Source: SYSTEMIQ analysis for the Energy Transitions Commission (2021); IEA (2020), *World Energy Outlook*

The Making Mission Possible Series

Scaling the underlying decarbonisation technologies to meet mid-century net-zero economy needs



Clean electrification

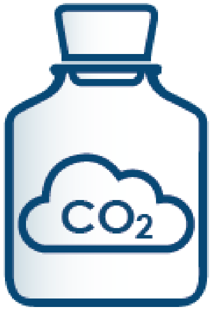
Massive clean electrification at the heart of a net zero emissions economy: global power system growing 3.5-5x and simultaneously decarbonising

Hydrogen

Major, complementary role for clean hydrogen alongside clean electrification, with 5-7x increase in global hydrogen production

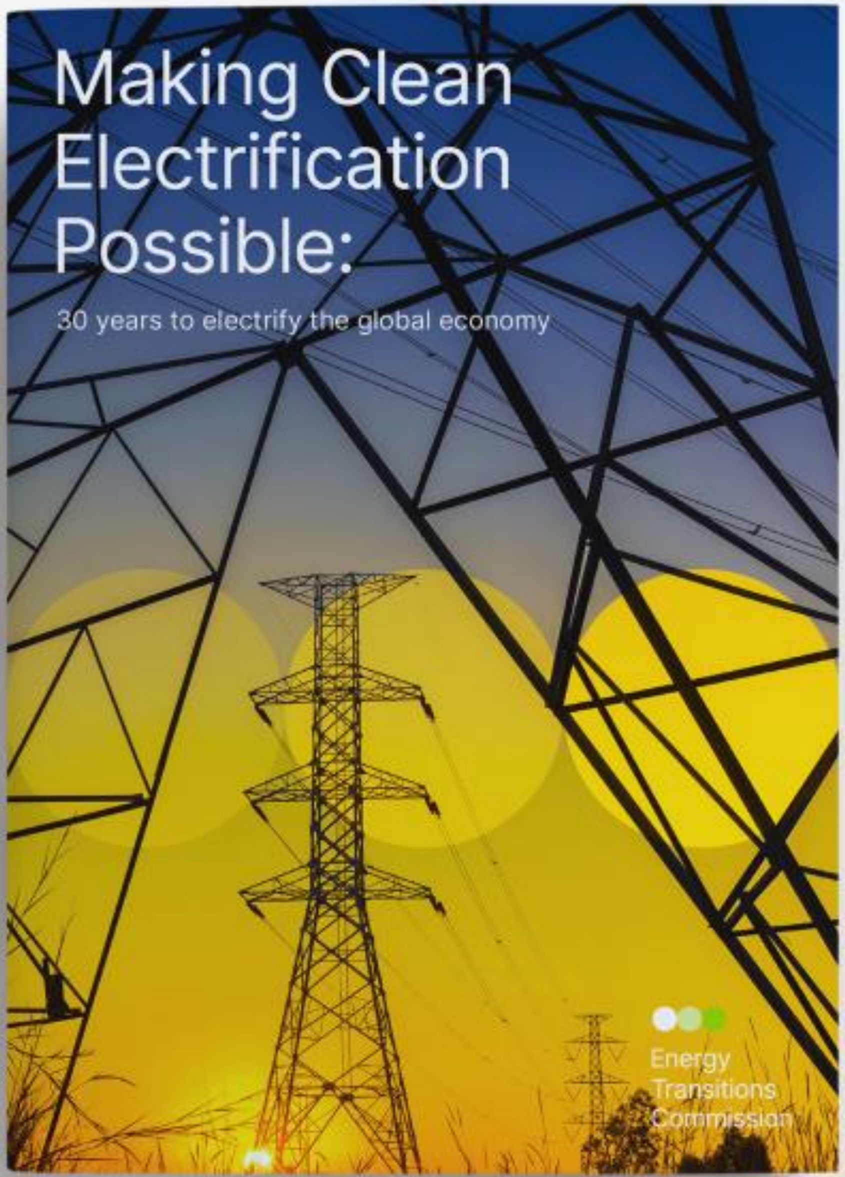
Bio-energy

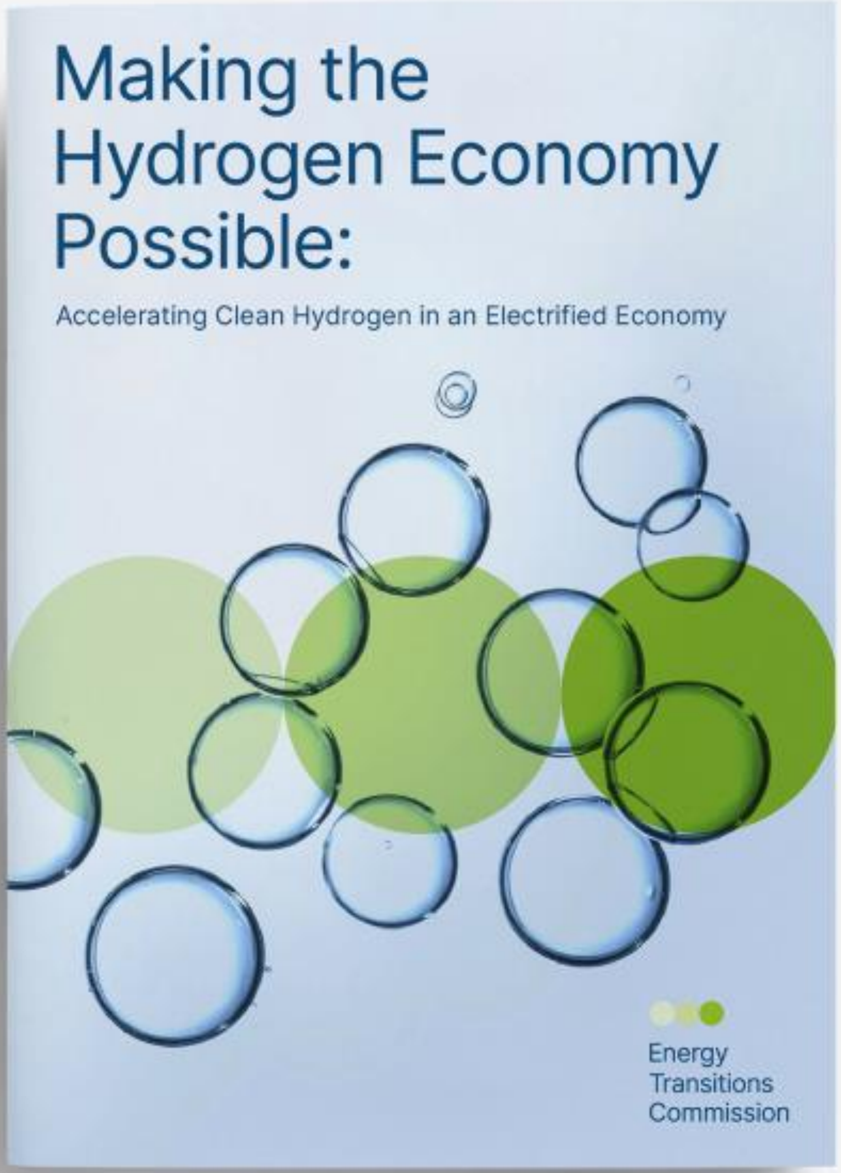
Prioritised, and tightly regulated use of constrained supply of sustainable, low-carbon bio resources



Fossil + CCU/S

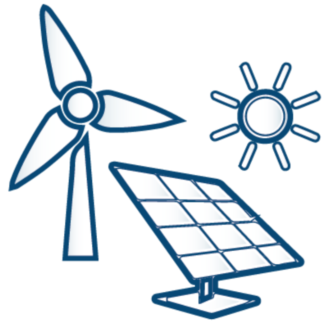
Essential but limited role for fossil energy combined with carbon capture and storage (c.5-8 $GtCO_2$ p.a.)





Energy Transitions Commission

Making Clean Electrification Possible:
30 Years to Electrify the Global Economy

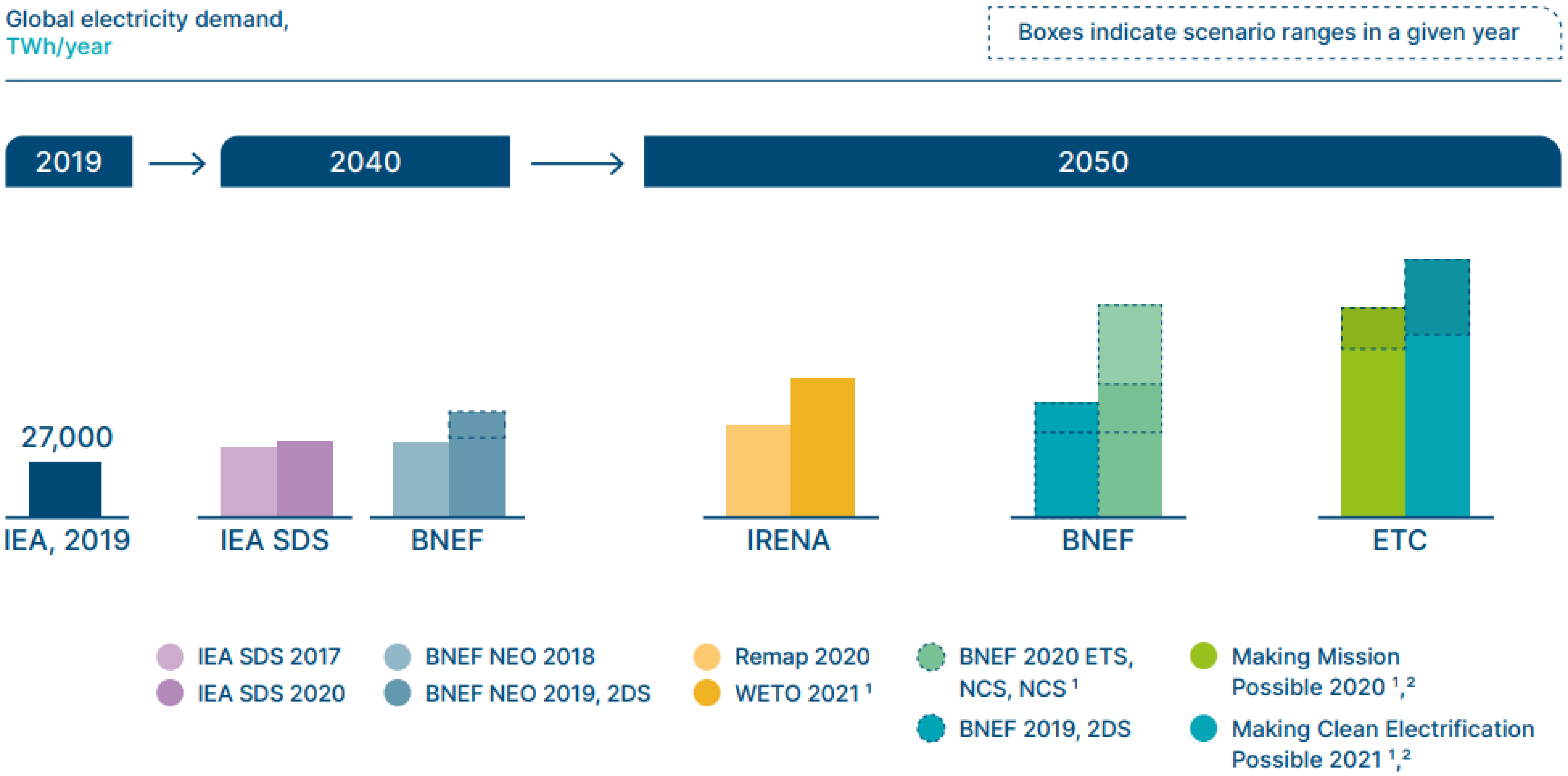


Clean electrification

Massive clean electrification at the heart of a net zero emissions economy: global power system growing 3.5-5x and simultaneously decarbonising

1. **Massive electrification to deliver a zero-carbon economy**
2. **Generating low-cost, zero-carbon power**
3. **Building and financing zero-carbon power systems**
4. **Critical priorities for the 2020s**

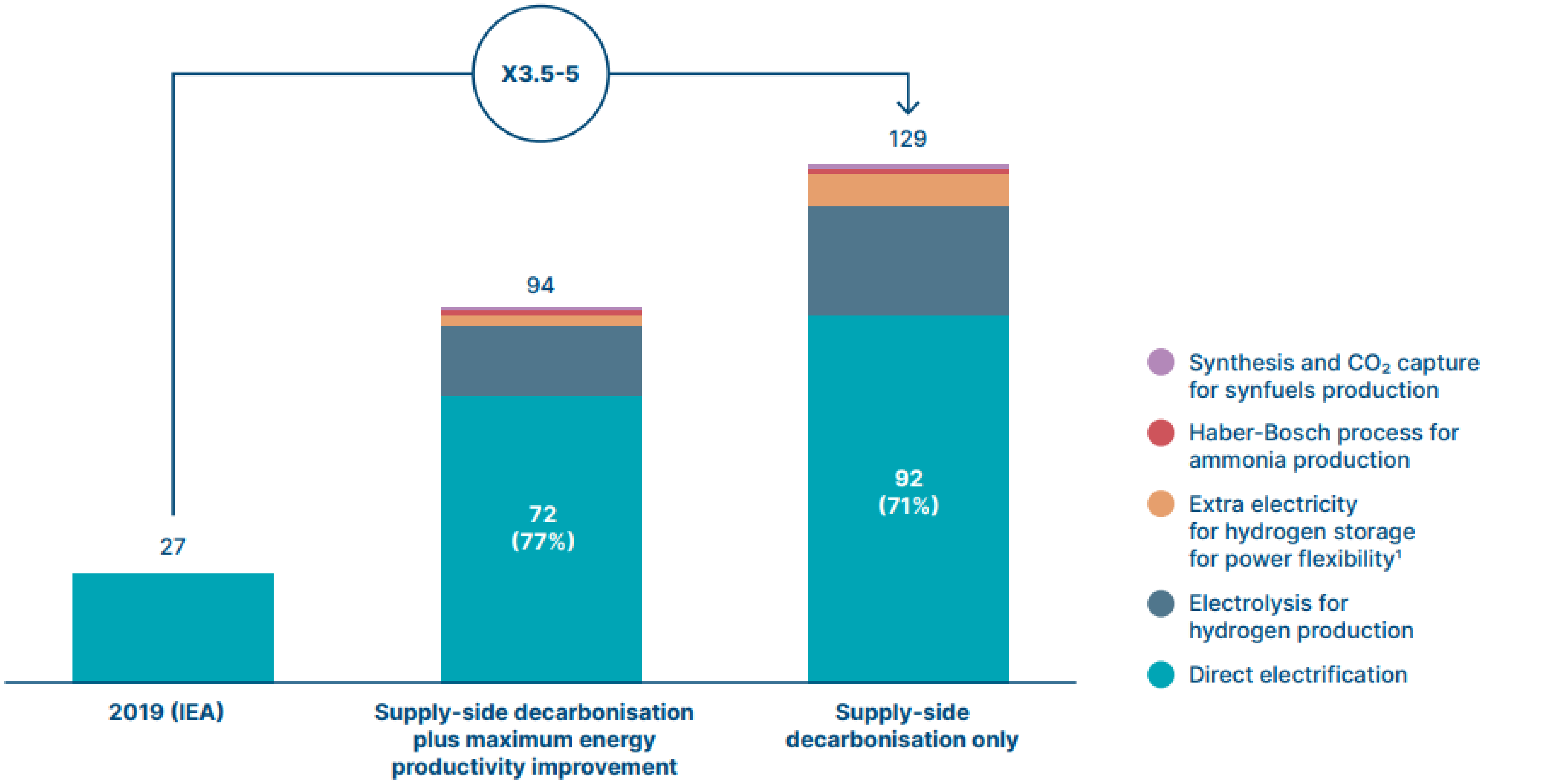
External outlooks increasingly aligned to high electrification vision



[1] Includes electricity demand from green hydrogen production. [2] Denotes range across supply-side decarbonization plus maximum energy productivity improvement and supply-side decarbonization only scenarios. Notes: IEA SDS is IEA Sustainable Development Scenario; BloombergNEF's NEO is *New Energy Outlook*, with the 2020 base case as the Economic Transitions Scenario (ETS) and the alternative, deep decarbonization scenario as the NEO-Climate Scenario (NCS). IRENA Remap is the Energy Transformation outlook to 2050, WETO is the 1.5DS in the World Energy Transitions Outlook. Source: IEA, IRENA, BloombergNEF, ETC.

By 2050, global electricity demand expected to grow 3.5-5x to 90-130,000 TWh

Total electricity generated by 2050 in the ETC indicative pathways
000 TWh/year

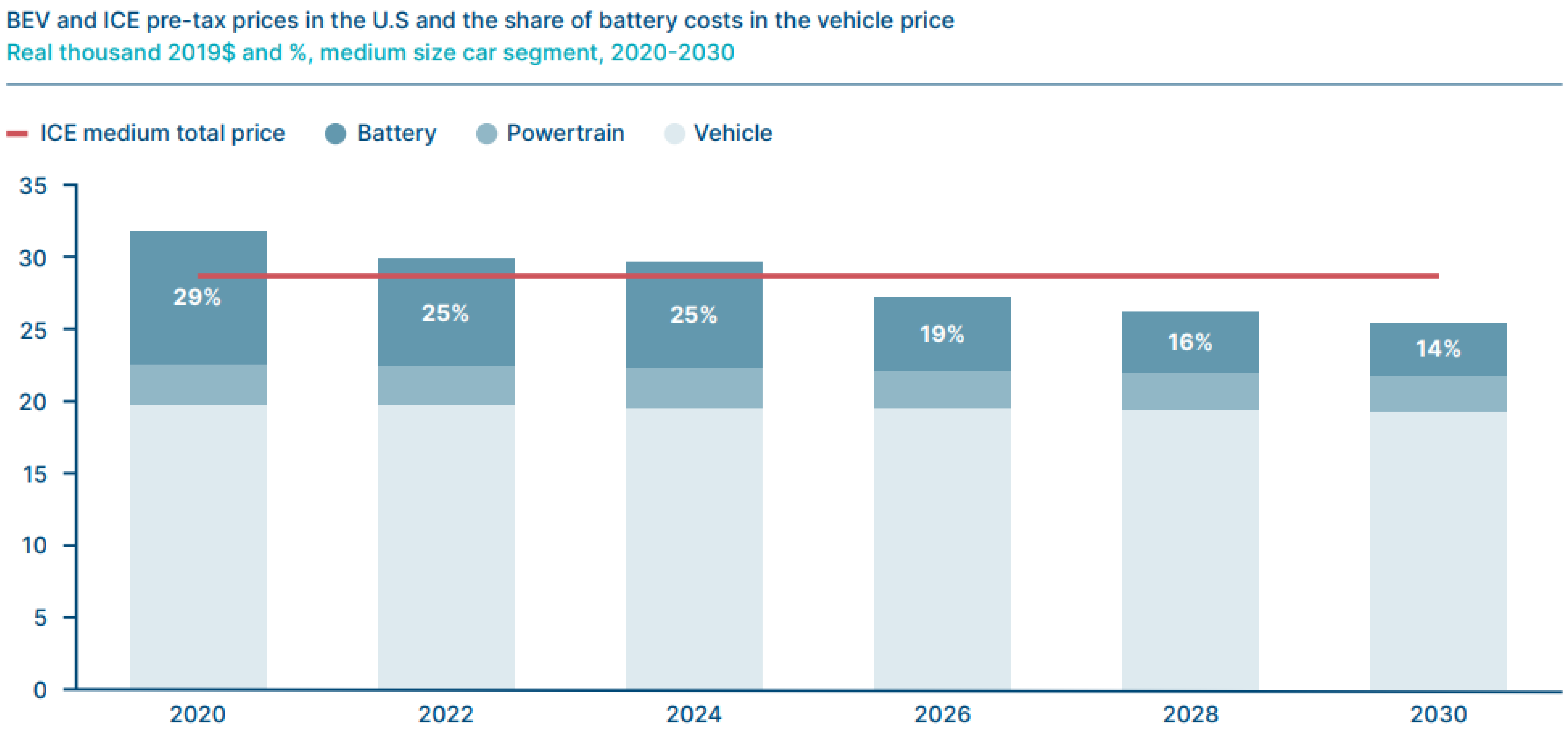


Note: Assumes 85% green hydrogen production in 2050. 1: Extra electricity for hydrogen storage for power flexibility only covers the electricity loss due to the transformation into hydrogen and back to electricity. Source: SYSTEMIQ analysis for the Energy Transitions Commission (2021), IEA (2020), *World Energy Outlook*

Electrification will be driven by growth in existing and new applications

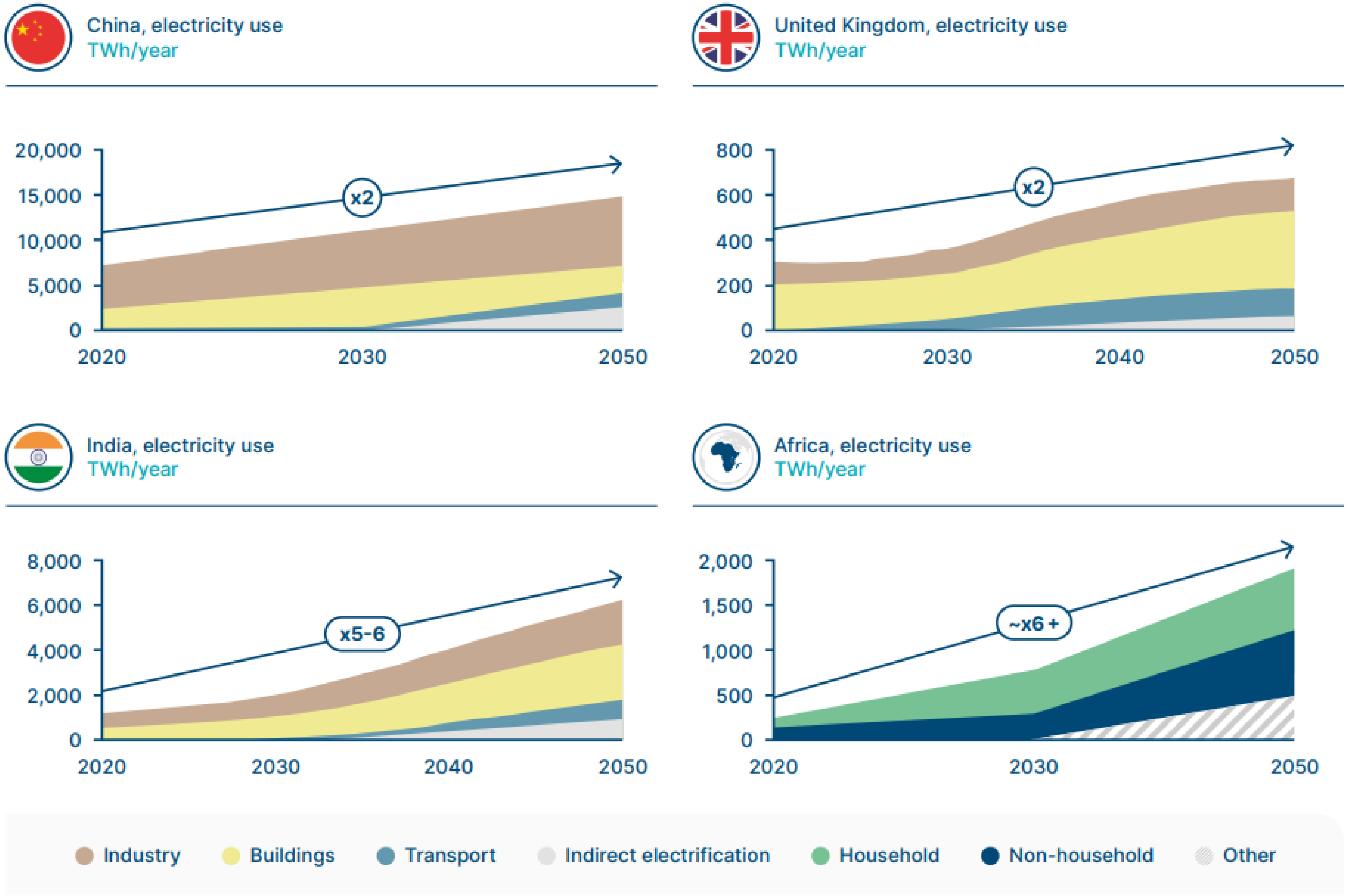
	Primarily existing or new applications?
Road Transport • Light duty battery electric vehicles (BEVs) costs to fall below internal combustion engine (ICE) • In medium and heavy duty trucking, role for BEVs alongside hydrogen fuel cell vehicles (FCEVs)	**New**
Shipping and Aviation • In short-haul segments, direct electrification to play significant role • In long-haul, primarily indirect electrification via hydrogen-based fuels (ammonia, synfuels)	**New**
Buildings • Building heating to be increasingly electrified, including via heat pumps • Air conditioning and other already electrified uses growth driven by rise in living standards	**New and existing**
Industry • Light industry which is already electrified to grow driven by rise in living standards • Harder-to-abate industry to be decarbonised via mix of CCU/S and direct/indirect electrification	**New and existing**

Light duty vehicles will be one of the first sectors to electrify - “tipping point” of upfront price parity across BEVs and ICE expected in the mid-2020s



Source: BloombergNEF (2020), *When Will EVs Be Cheaper Than Conventional Vehicles?*

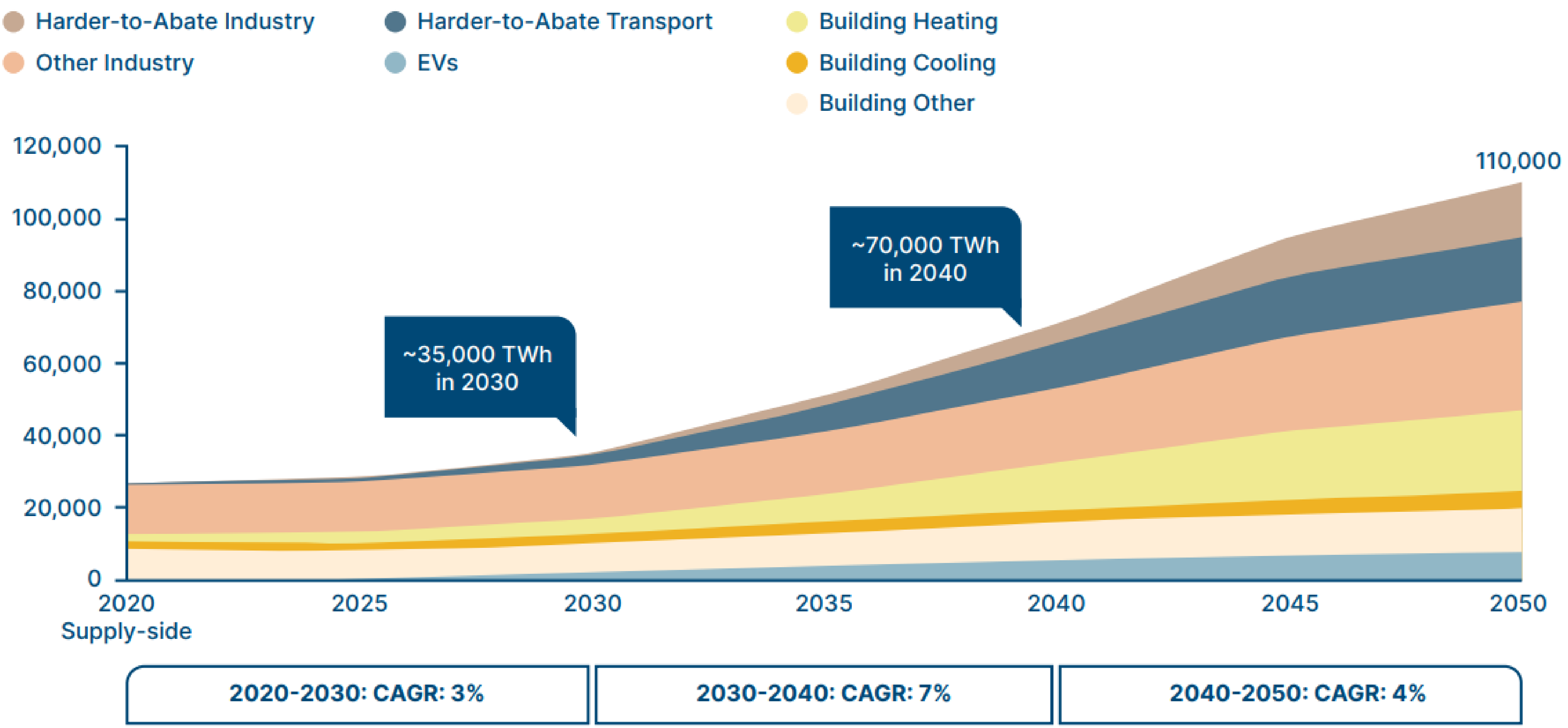
The pace and scale of electricity use growth will vary by region



Source: RMI/ETC China, TERI/ETC India, UK Climate Change Committee, IEA (2019) *World Energy Outlook* Africa case

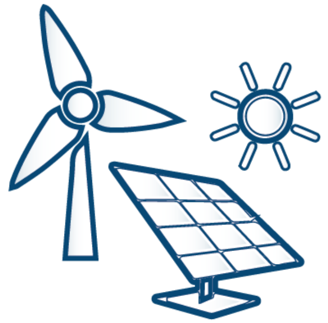
Global ramp-up of electricity use could see fastest growth in 2030s, highest absolute additions in 2040s as green hydrogen production rises

Illustrative global scenario for electricity use, TWh



Note: Other industry includes Aluminium, Pulp& Paper, Other (incl. Mining, FMCG, Textiles, Metals, Electronics, Equipment, Construction).
Source: SYSTEMIQ analysis for the Energy Transitions Commission (2021).

Making Clean Electrification Possible: 30 Years to Electrify the Global Economy



Clean electrification

Massive clean electrification at the heart of a net zero emissions economy: global power system growing 3.5-5x and simultaneously decarbonising

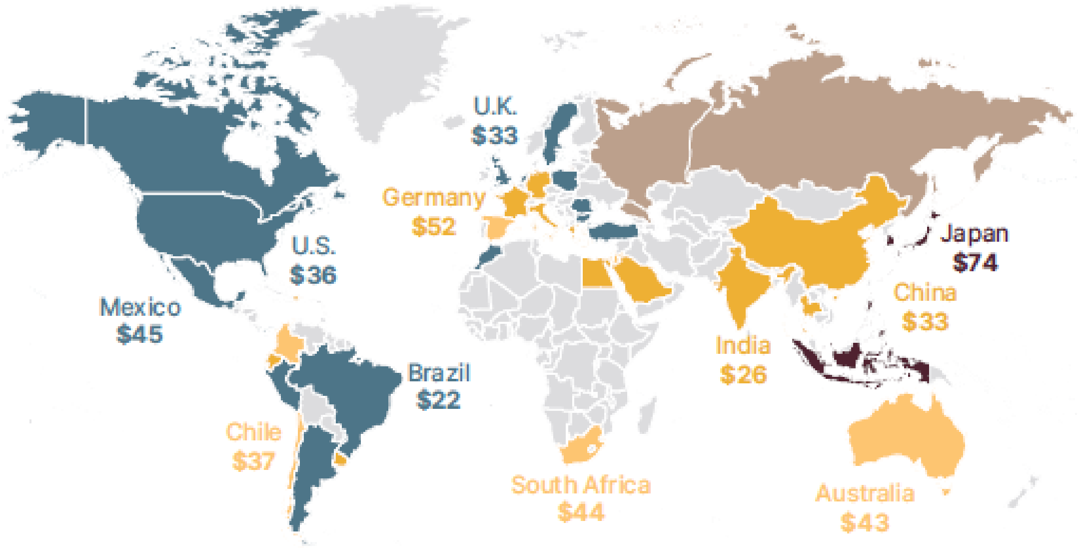
1. **Massive electrification to deliver a zero-carbon economy**
2. **Generating low-cost, zero-carbon power**
3. **Building and financing zero-carbon power systems**
4. **Critical priorities for the 2020s**

Zero-carbon power systems are low-cost and feasible

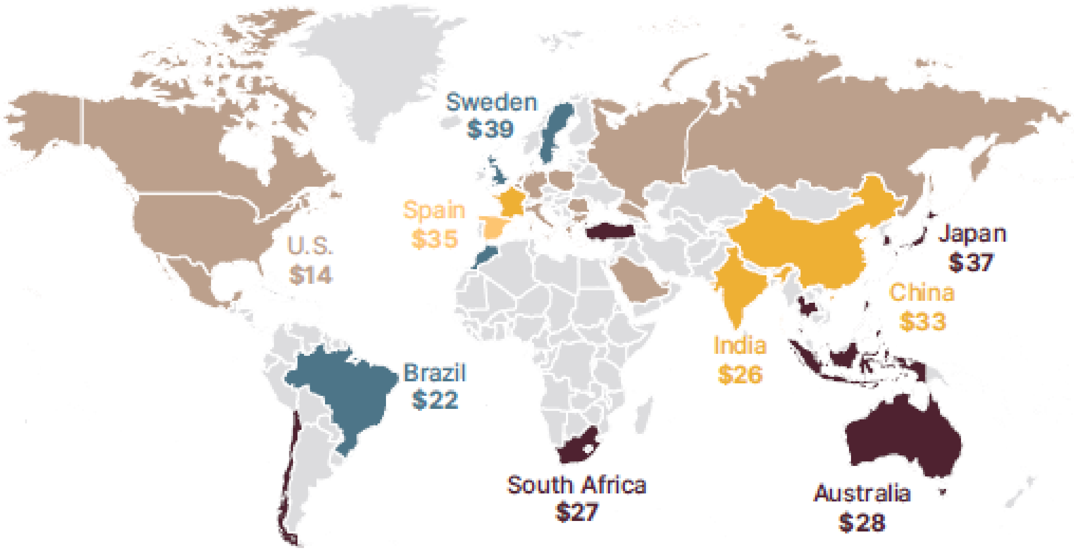
1. VRE is or will soon be lowest-cost generation
2. Variety of options to solve the balancing challenge in high-VRE systems
3. Total system generation costs in zero-carbon power systems likely to be the same as or below those of fossil-based power systems
4. Power network reinforcement, expansion and digitalisation can support zero-carbon systems
5. Steady phase out of unabated fossil generation can be achieved
6. Sufficient VRE resources available globally, though some regions will face higher constraints

Falling costs of renewables means VRE increasingly cost-competitive against both new and existing fossil generation

New-build VRE vs. new-build fossil
Cheapest source of bulk generation globally, 2020



New-build VRE vs. existing fossil
Cheapest source of bulk generation globally, 2020



Onshore wind · Offshore wind · Utility PV - fixed axis · Utility PV - tracking · Natural gas - CCGT · Coal · Not covered

VRE cheaper than new fossil in countries representing 2/3 of global population.

VRE cheaper than existing fossil in countries representing almost 1/2 of global population.

Source: BloombergNEF (2020), *2H 2020 LCOE Update*

As a result, the key power system issue is how to balance supply and demand across hours, days, weeks and seasons

Balancing needs are dependent on the shape of VRE supply and of demand, and vary by market:

Within day balancing

- **Hour-by-hour balancing:** forecastable hour-by-hour supply variations (e.g. cloud cover), and very short-term fluctuations in precise supply (e.g. change in wind levels)
- **Day-to-night balancing:** Predictable diurnal cycle (e.g. solar generation during the day, but demand to run AC at night)

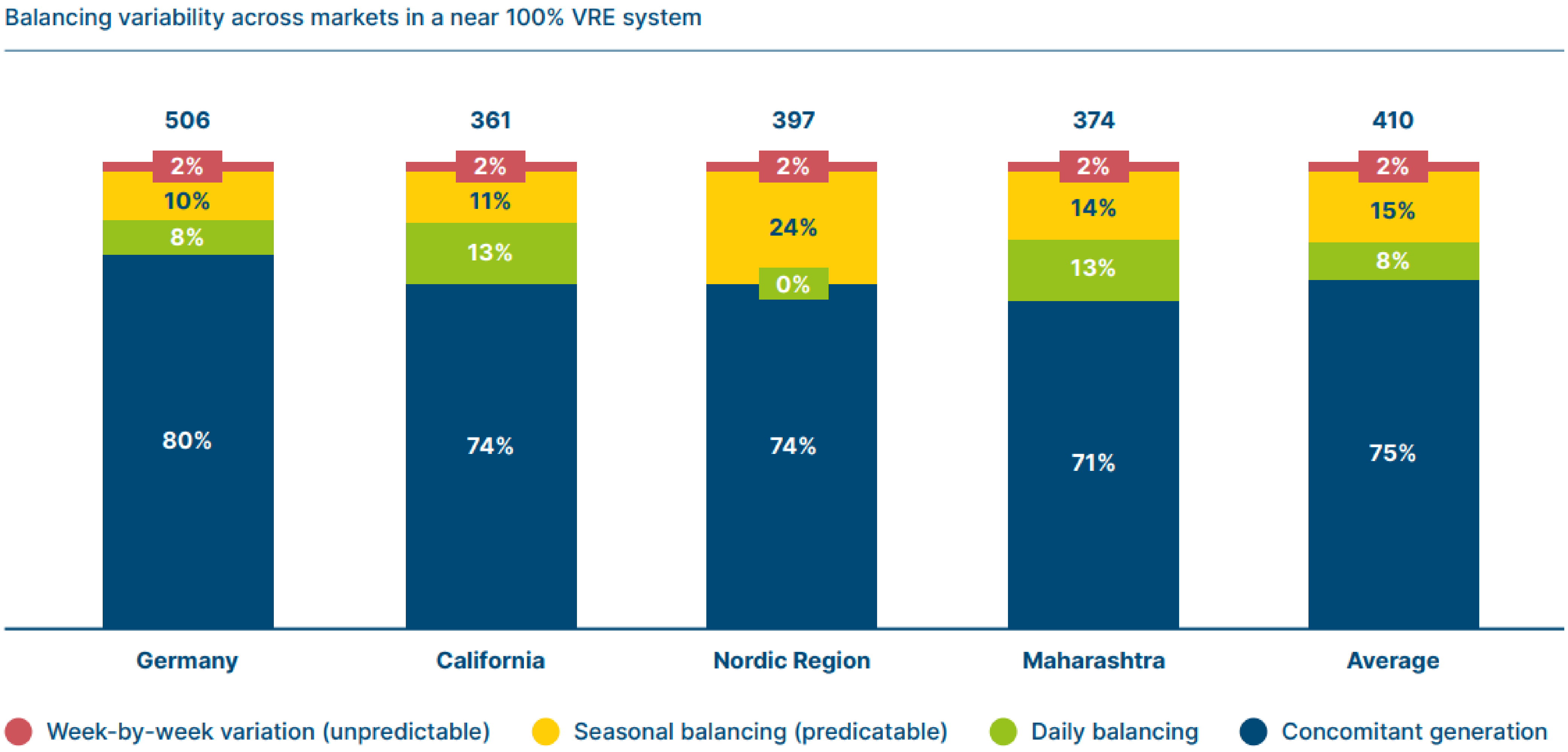
Seasonal energy differential

- **Balance across seasons**: Predictable seasonal month by month cycle in demand or supply (e.g. winter demand peak for building heating in Northern latitude economies; wind generation peak in India during the monsoon season)

Security of supply

- **Week-by-week variations:** Unpredictable months in advance, and varying in importance each year (e.g. extended weeks of 'wind droughts'/anticyclones)

Scale of seasonal balancing needs differs across regions



Note: 2% of generation for security of supply represents an approximation, and will vary by region. Generation scaled up to meet 100% demand based on current VRE ratio: Wind (64%), solar (34%) and run of river hydro (2%) Source: Source: Climate Policy Initiative for the Energy Transitions Commission (2017).

Daily, seasonal and weekly balancing challenge for zero-carbon power systems can be met with different options

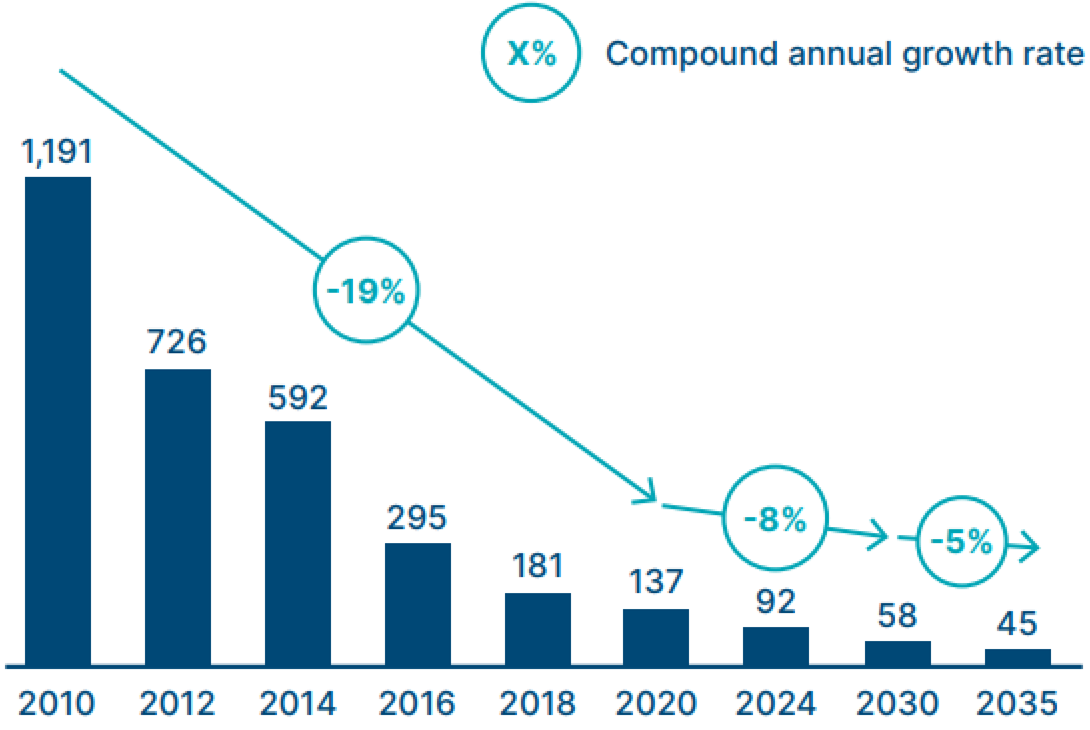
Range of dispatchable generation, energy storage, demand-side flexibility options

			Daily	Seasonal (predictable)	Week-by-week (unpredictable)
Dispatchable generation	Other zero carbon	Hydro, nuclear[1]	✓	✓	✓
	Fossil	Fossil (or bioenergy) + CCS	✓	✓	✓
		Fossil – very low utilisation	✓	✓	✓
Energy storage		Pumped hydro	✓	✓	✓
		Lithium ion battery[2]	✓		
		Emerging technologies	✓		
		Power-to-X-Power[3]	✓	✓	✓
Demand side flexibility		EV (smart charging, V2G)	✓		
		Heating load	✓		
		Industrial load[4]	✓	✓	

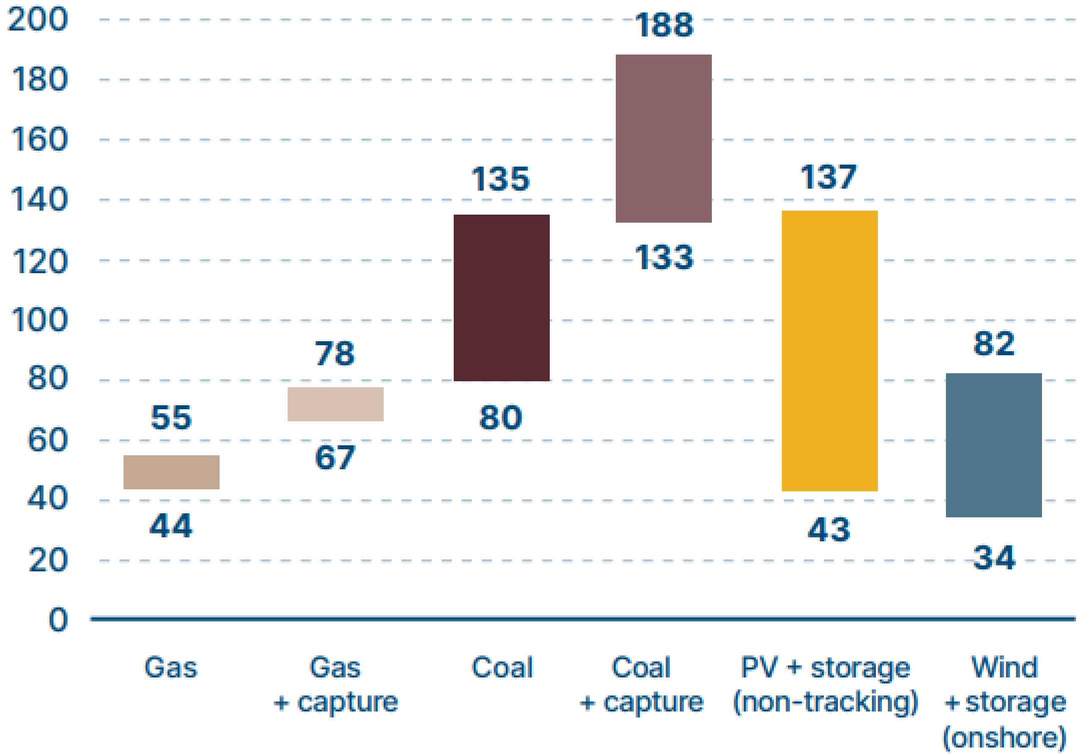
Notes: [1] Limited nuclear capacity for flexible ramping. [2] Li-ion storage is utility scale and behind-the-meter. [3] Examples of Power-to-X-Power include hydrogen from electrolysis and hydrogen re-conversion into power via gas turbines or fuel cells. This also has elements of demand-side flexibility as production (e.g. hydrogen via electrolysis) can be aligned to optimal times for the system.[4] Including hydrogen electrolysis. Source: Adapted from Climate Policy Initiative for the Energy Transitions Commission (2017), *Low-cost, low-carbon power systems*

For daily balancing, lithium-ion batteries will be an increasingly cost-effective solution

Battery prices – Observed and Outlook
Real 2020 $/kWh (historical, predicted)



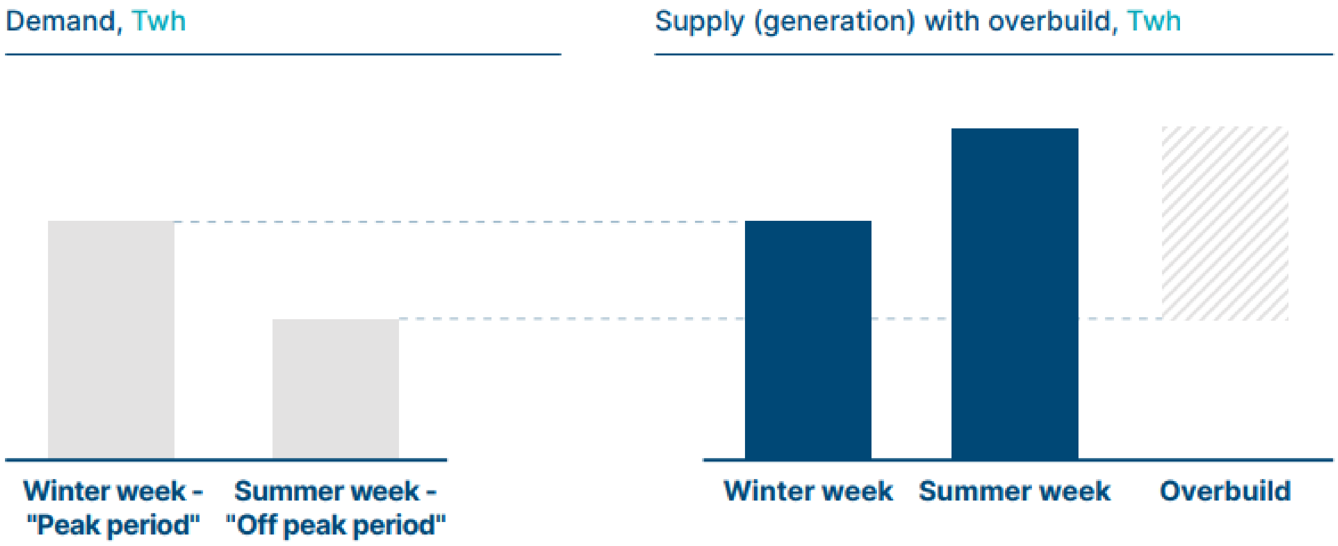
Comparison of US LCOEs in 2023
$/MWh, (2018 real)



Note: on RHS, capture refers to post-combustion, liquid absorption of CO_2. LCOE forecasts use 4hr battery storage. LCOEs exclude subsidies, tax credits, and CO_2 transport and storage costs. Source: BloombergNEF (2020)

VRE 'overbuild' could provide low-cost option to meet seasonal balancing

Illustrative northern latitude archetype



Overbuild of solar or wind to meet winter peak demand, creates surplus generation in summer

This "surplus" electricity can either by curtailed – or provide very cheap/free electricity for e.g. seasonal green hydrogen production

Cost of procuring kWh of energy in winter period:

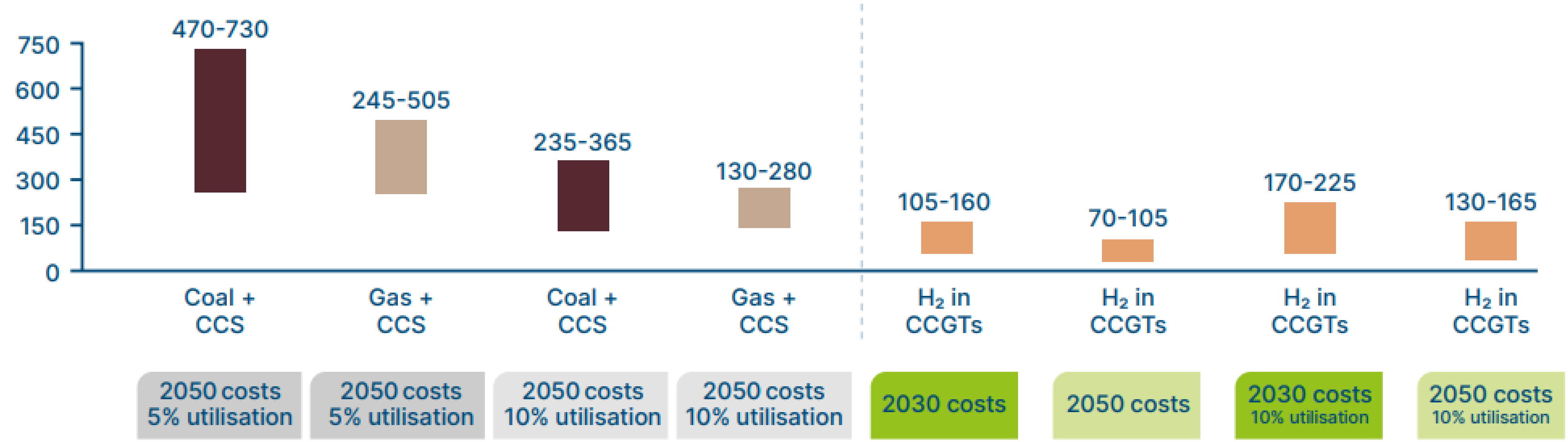
		China 2040	USA 2040
Solar	Projected Solar PV LCOE	$0.024/kWh	$0.015/kWh
	x2 ("oversizing" to ensure winter period production)	**$0.048/kWh**	**$0.030/kWh**
Gas	Projected marginal cost of gas CCGT	**$0.055/kWh**	**$0.032/kWh**

Installing additional renewables to meet seasonal demand peak cheaper than operating existing gas plants, rationale for VRE "overbuild" – where curtailment in the "low season" is the least-cost option to meet demand in the "high season"

Note: LCOE 2040 projection is based on BloombergNEF, and is the mid-range China and low-end for the United States. Source: BloombergNEF (2020)

H2 in CCGTs could be most cost effective zero-carbon way to meet unpredictable week-by-week variations

Indicative levelised cost of electricity (LCOE), $/MWh

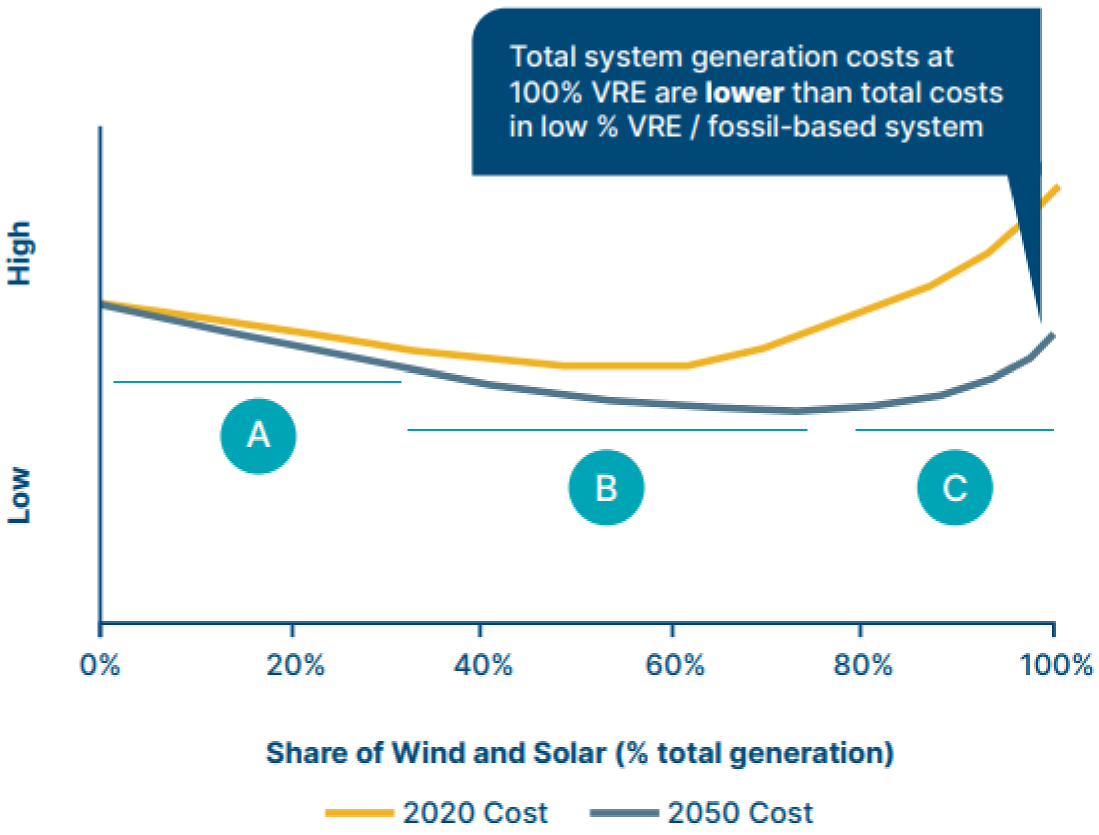


CCS Capex	Yes (new asset)	n/a	
Generation Plant Capex	No (existing asset)	No (existing asset with no retrofit cost, assumes H_2-compatible gas turbine)	Yes (new asset, H_2-compatible gas turbine)

Notes: High/Low ranges determined by CCS capex cost ($2490-4770/KW for coal CCS and $1620-3560/KW for gas), fuel costs ($2-7/MMBtu for gas, coal fuel costs assumed to be negligible in 2050), and costs of hydrogen production ($1.5-2.5/kg in 2030, and $0.9-1.5/kg in 2050). Hydrogen T&S cost assumed to be $0.2/kg. Assuming 50% conversion efficiency in CCGTs for hydrogen. Hydrogen-ready CCGT capex is assumed to be $1000/KW in 2050 and $1080/KW in 2030. Assumed 20-year asset lifetimes. Source: S. Budinis, S. Krevor et al, (2018), *Energy Strategy Reviews*, "An assessment of CCS costs, barriers and potential." BloombergNEF(2020), *Hydrogen: The Economics of Power Generation*, SYSTEMIQ analysis for the Energy Transitions Commission (2021).

Total system generation costs in zero-carbon power systems likely to be the same as or below those of fossil-based power systems

Total system generation costs as function of VRE penetration,
$/MWh, 2020 and 2050 cost scenarios



A

0-30% VRE penetration

Declining system generation costs as cheaper renewables replace fossil in baseload generation; no balancing needs

B

30-80% VRE penetration

Further cost declines as renewables + storage increasingly cheaper than fossil for dispatchable generation

C

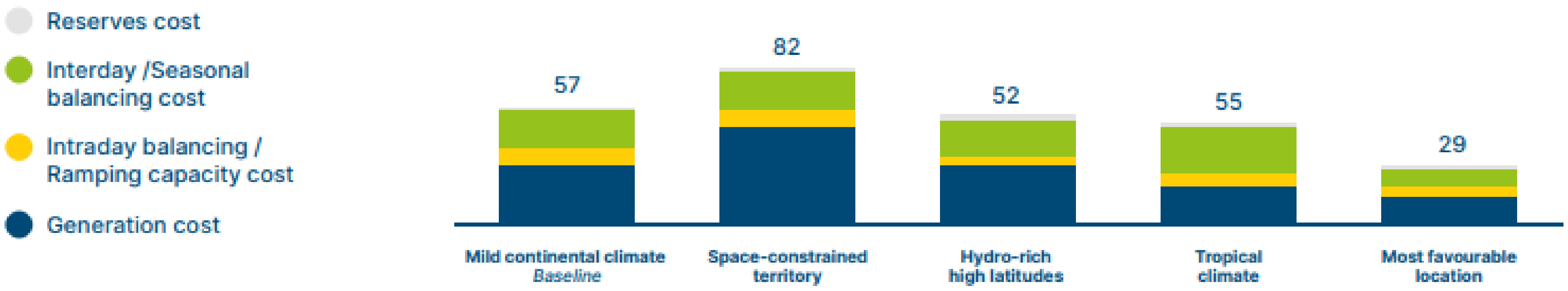
80-100% VRE penetration

Increase in total system generation costs as significant costs required to provide zero carbon answers to the "last 10%-20%" of generation

Source: Adapted from TERI/ETC India (2020) *The Potential Role of Hydrogen in India*

Local cost of near-total-variable renewable power systems will vary depending on climate patterns, natural resources and existing power flexibility infra

Maximum all-in cost of power generation in a near-total-variable-renewable power system by 2035
$/MWh, breakdown by flexibility services

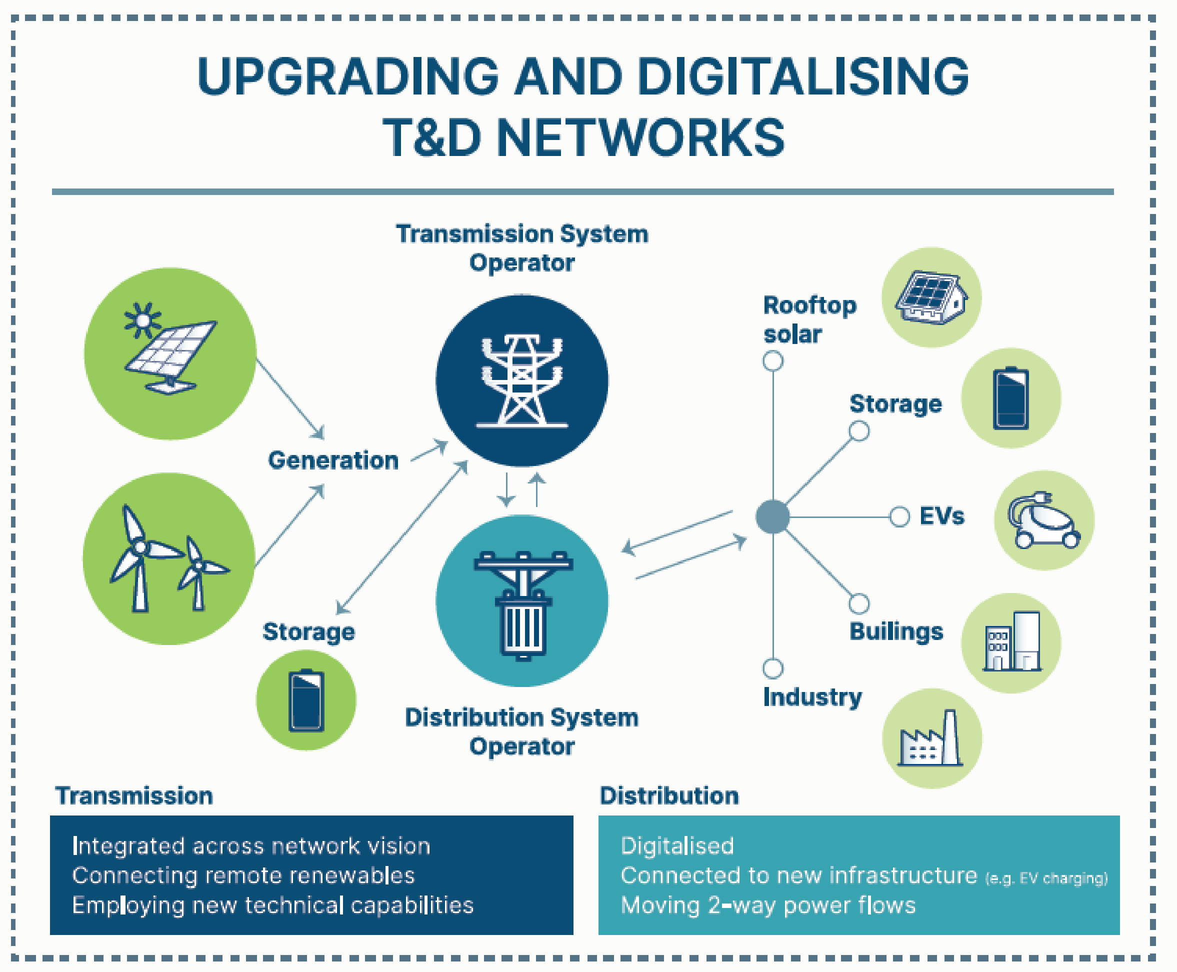


All archetypes are based on same power demand and have identical reserves costs

	Mild continental climate (Baseline)	Space-constrained territory	Hydro-rich high latitudes	Tropical climate	Most favourable location
Seasonal needs	Strong winter peak Long winter	*Identical to baseline*	*-5% vs. baseline* Generation capacity partially covered by existing hydro	*-25% vs. baseline* Limited seasonality (low latitudes)	*-50% vs. baseline* Limited seasonality (low latitudes)
Daily needs	Medium: heating needs but complementary wind and sun	*Identical to baseline*	*- 41% vs. baseline* 80% covered by cheap existing hydro	*+20% vs. baseline* *Long periods with no sun/wind + high air conditioning*	*-50% vs. baseline* Low: mild evenings
Bulk RE generation	Complementary wind and solar	*+ 67% vs. baseline* Space availability challenge	*Identical to baseline*	*-33% vs. baseline* Abundant wind and solar	*-50% vs. baseline* Very abundant wind and solar

SOURCE: Adapted from Climate Policy Initiative for the Energy Transitions Commission (2017), *Low-cost, low-carbon power systems*

Power network reinforcement, expansion and digitalisation can support zero-carbon systems



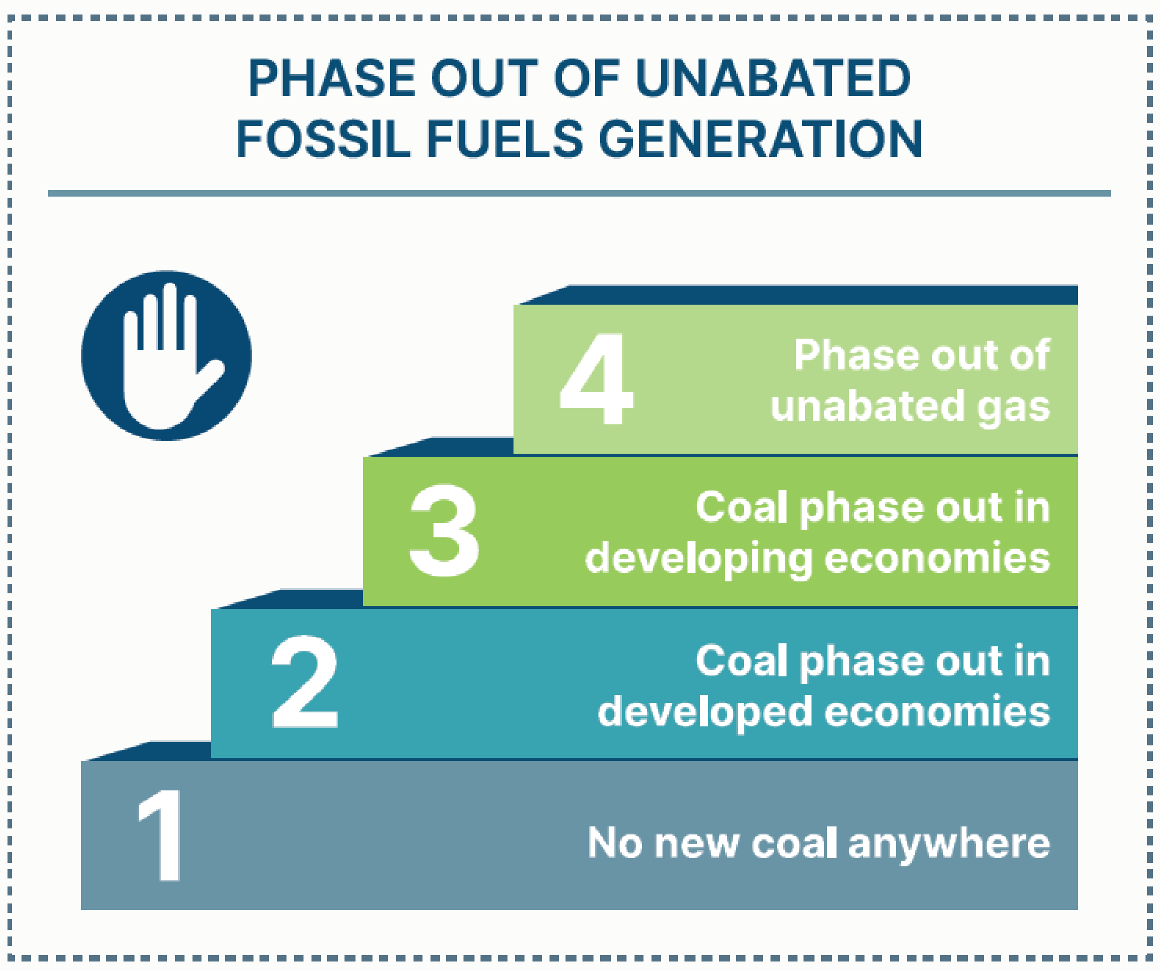
Factors that increase T&D spending needs relative to power system size (2020-2050)

- Digitalisation
- Increase in peak demand load and capacity needs, infrastructure upgrades for mass electrification (*can be offset by enabling network optimisation in the future)*
- Interconnectors
- Higher undergrounding

Factors that decrease T&D spending needs relative to power system size (2020-2050)

- Optimised line capacity (*enabled by digitalisation)*
- Load shifting (*enabled by digitalisation and infrastructure upgrades)*
- Increase in distributed energy resources

Steady phase out of unabated fossil generation can be achieved



- All countries should commit to **near totality of new growth of electricity as zero-carbon. No new coal** capacity should be added, and the **role of new gas should be limited** to very specific circumstances.
- New **VRE generation is now fully competitive** with new fossil power generation in many locations, and this cost advantage will spread wider and grow larger over time.
- While **existing thermal plants** will need to play a flexible **role in balancing systems** in many geographies, almost all countries have **sufficient capacity in place** to play this role even in hugely expanded electricity systems.

Sufficient VRE resources available globally, though some regions will face higher constraints

Solar

- Global solar resources **massively exceed** needs; 100,000 TWh electricity production would require only **1-1.2% of total land area**
- Important **national constraints** in high population density countries

Wind

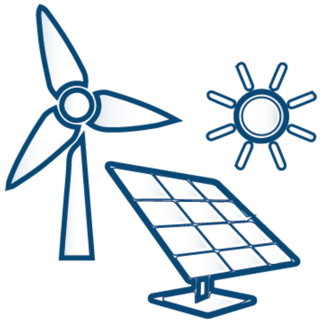
- Global wind resources show **massive potential**
- IEA estimates technical potential to generate more than **420,000 TWh/year** from offshore wind alone – 4x ETC high case of future demand

Minerals

- **Sufficient resources of lithium, nickel, cobalt** to meet demand from EV and grid batteries
- Opportunity to push **circularity in value chain,** including via materials recycling
- Concerns about cobalt supplies have unleashed **technological progress** which makes possible zero-cobalt batteries

Source: IEA (2019), *World Energy Outlook*, US Geological Survey (2020).

Making Clean Electrification Possible:
30 Years to Electrify the Global Economy



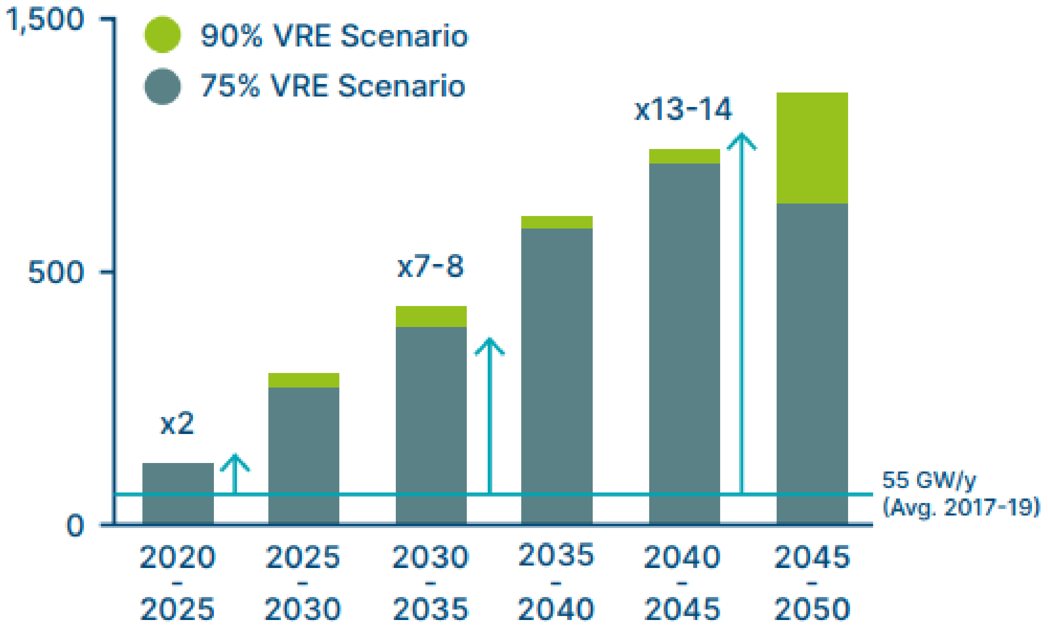
Clean electrification

Massive clean electrification at the heart of a net zero emissions economy: global power system growing 3.5-5x and simultaneously decarbonising

1. **Massive electrification to deliver a zero-carbon economy**
2. **Generating low-cost, zero-carbon power**
3. **Building and financing zero-carbon power systems**
4. **Critical priorities for the 2020s**

Annual wind and solar installations must grow dramatically

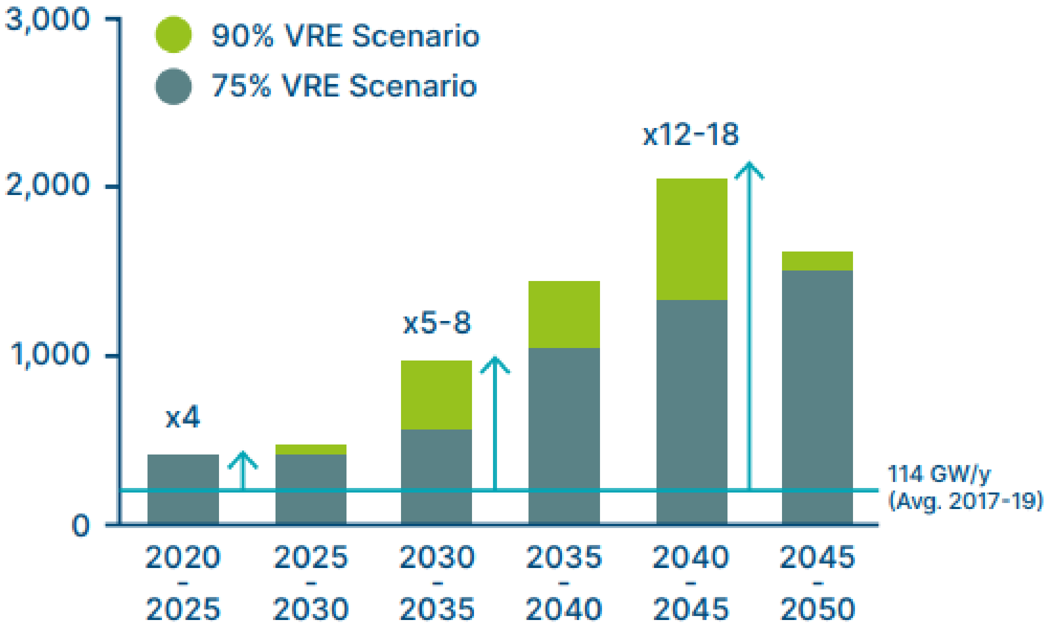
Wind - annual installed capacity additions
GW / year (annual average over 5-year period)



Average annual additions over total period (2020-50)

~3460 GW / year	~510 GW / year

Solar - annual installed capacity additions
GW / year (annual average over 5-year period)



Average annual additions over total period (2020-50)

~870 GW / year	~1,110 GW / year

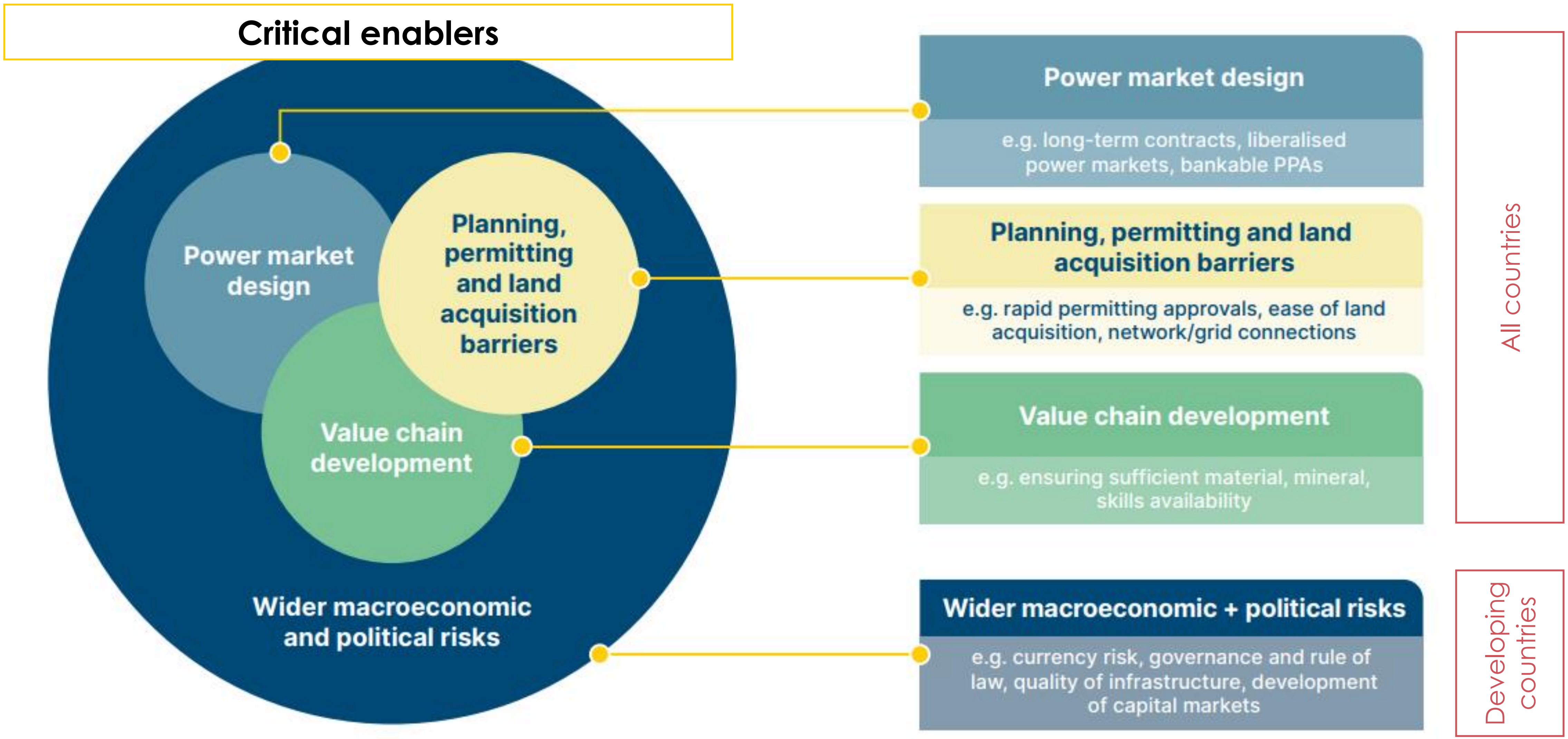
Note: 75% VRE scenario assumes 32% solar and 43% wind generation in 2050. 90% VRE scenario assumes 42% solar generation and 48% wind generation in 2050.
Source: BloombergNEF (2020) *New Energy Outlook*, SYSTEMIQ analysis for the Energy Transitions Commission (2021).

Power sector investments represent vast majority (~80%) of total investments to reach net-zero, but represent less than 1.5% of global GDP

	2050 vision		Key investment needs	Total investment 2020-2050, US$bn	Total annualised investment, US$bn pa	Share of GDP %
Power	**Total power generation** 110,000 TWh / year **Total capacity required** 27-35 TW solar 14-16 TW wind 2-4 TW of hydro, nuclear, other zero-carbon	**Renewables & other zero-carbon**	26-34 TW solar 14-15 TW wind 3.5 TW other zero carbon	~46,000-47,000	~1,500-~1,600	~0.8%
		Transmission & Distribution	~50% of generation, front-weighted	~36,000	~1,100	~0.6%
		Battery storage	14 TWh per day (5% of daily generation)	~1,500	~50	~0.03%
		Seasonal storage: H_2 storage and/or CCS on thermal plants	4 TW thermal capacity equipped with CCS (5% of generation)	~3,800	~130	~0.07%
			1.5 TW electrolysis (2% power shifted)	~430	~15	~0.05%
Hydrogen in final use	800 Mt/year for final sectoral energy use	**Production**	7.6 TW electrolysis 0.7 TW blue hydrogen capacity	~1,200	~40	~0.02%
		Transport and storage	Salt caverns and other storage Gas pipeline retrofit	~1,100	~40	~0.03%
Industry	Steel, cement and petrochemicals industries achieve zero-carbon		CCS application to cement Hydrogen DRI or CCS for steel Multiple forms of changed chemical production process	~1,600	~50	~0.03%
Transport	**Road charging infrastructure**	Total decarbonisation road transport ~2bn electric cars and~200m electric trucks & buses	~1000bn slow residential, 200m moderate speed public and 10million superfast chargers, + truck and bus chargers	~2,000	~70	~0.04%
	Aviation and shipping	All long haul routes running with zero carbon fuels	Aviation and green shipping R&D, SAF plant investment and ship / fuel supply retrofit	~900	~30	~0.02%
Buildings Energy efficiency	IEA estimate of additional required investment in better insulation and more efficient lighting and HVAC systems			~12,000-15,000	~400-500	~0.2%
Total				**~106-110,000**	**~3,600-3,700**	**~1.8%**

Note: Wind and solar capacity for hydrogen production is included in renewables generation.
Source: SYSTEMIQ analysis for the Energy Transitions Commission (2021).

Achieving the build and investment at the pace and scale required will necessitate critical enablers



Source: Industry interviews, SYSTEMIQ analysis for the Energy Transitions Commission (2021).

Appropriate power market design will require a continued role for long-term contracts, as well as reforms to other markets and market enablers

1 LONG TERM ENERGY CONTRACTS/ PPAs: Auction-based, 2-way, production-based, tied to the energy market

- **Careful contract design critical to minimise market distortions**
- **Corporate PPAs should be encouraged**, though will not be sufficient
- **Optimum structures will vary by country and over time** as technologies develop

LT energy contracts complemented by other adaptions to ensure system benefits from new technologies available

2 SHORT TERM MARKETS	3 LONG TERM PEAK CAPACITY MECHANISMS	4 FLEXIBILITY LEVERS	5 MARKET ENABLERS
Ensure system balances in short term, while **integrating new technologies** (e.g. <15 min wholesale market windows)	Ensure security of supply, while **avoiding weighting solutions towards fossil** (e.g. carbon intensity restrictions or fossil bans)	Enable **flexibility solutions to come online**, reducing size of peak capacity challenge (e.g. time of use pricing for EV charging, mandate DSO capability)	Enable **VREs and storage technologies to participate on even footing** to fossil (e.g. carbon pricing, transparent government & SO decision making processes)

Optimal long-term energy contract structures to ensure sufficient revenue certainty

Power market design focus

When organised at the market level, long-term energy contracts must balance

- Attracting **low-cost capital/WACC** by ensuring sufficient **revenue certainty** for investors
- Incentivising **supply aligned to market needs, minimising distortion of short-term markets**

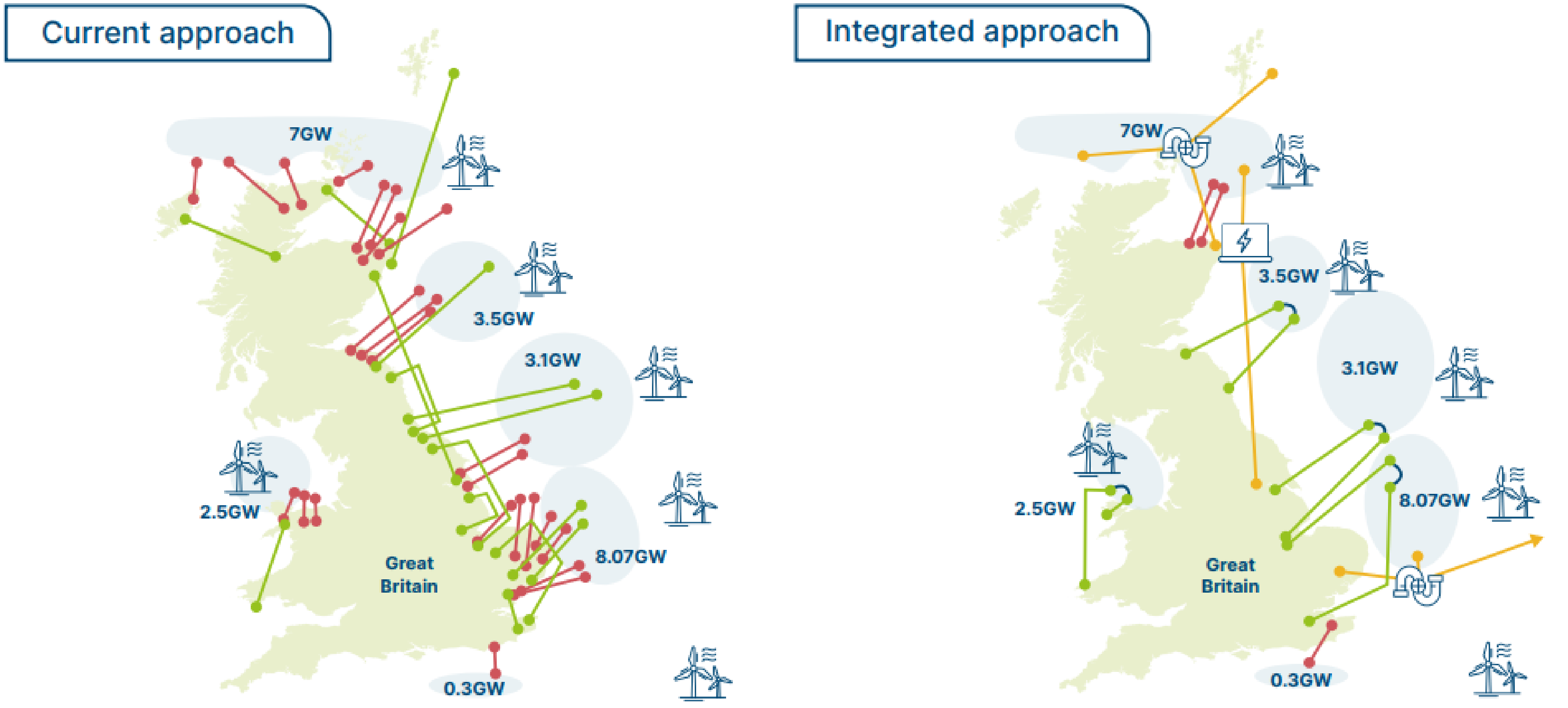
Production-based energy long-term contracts should include the following features

1 Competitive price-setting mechanisms	• Strike price set competitively via **auction, pay-as-bid** • **2- way contracts**. sharing risk across counterparties (i.e. generators reimburse any positive difference between strike price and wholesale reference price), or **1-way contracts** to optimise locational signals and drive lower auction bids
2 Ensure sufficient revenue certainty	• **Long term** contract (e.g. 15 years) • **Reference price based on technology-specific price** to minimise exposure to specifically low prices during times of VRE generation
3 Expose generators to wholesale market signals	• **Sliding premium with 'medium' settlement time**, e.g. daily, weekly or monthly, to incentivise producers to align generation with system needs based on wholesale pricing, and encourage the deployment of storage • Clause **against producing during negative wholesale prices**
4 Time of day / year / locational components	• **Multiple auctions with different time components (time of day, year) and / or locational components** - based on 4-6 year forecasts to reflect where / when energy shortages occur
5 Incentivise long-term use of existing assets	• **Market-wide contracts**, with existing and repowered generation able to bid into long-term production-based auctions once initial long-term energy contracts expires (e.g. after 15 years) for next auction period (esp. important for offshore wind)

Source: Industry interviews, IRENA, BloombergNEF, SYSTEMIQ analysis for the Energy Transitions Commission (2021).

Planning, permitting and land acquisition systems must support large-scale and rapid development, including for transmission and distribution networks

UK offshore wind network development models



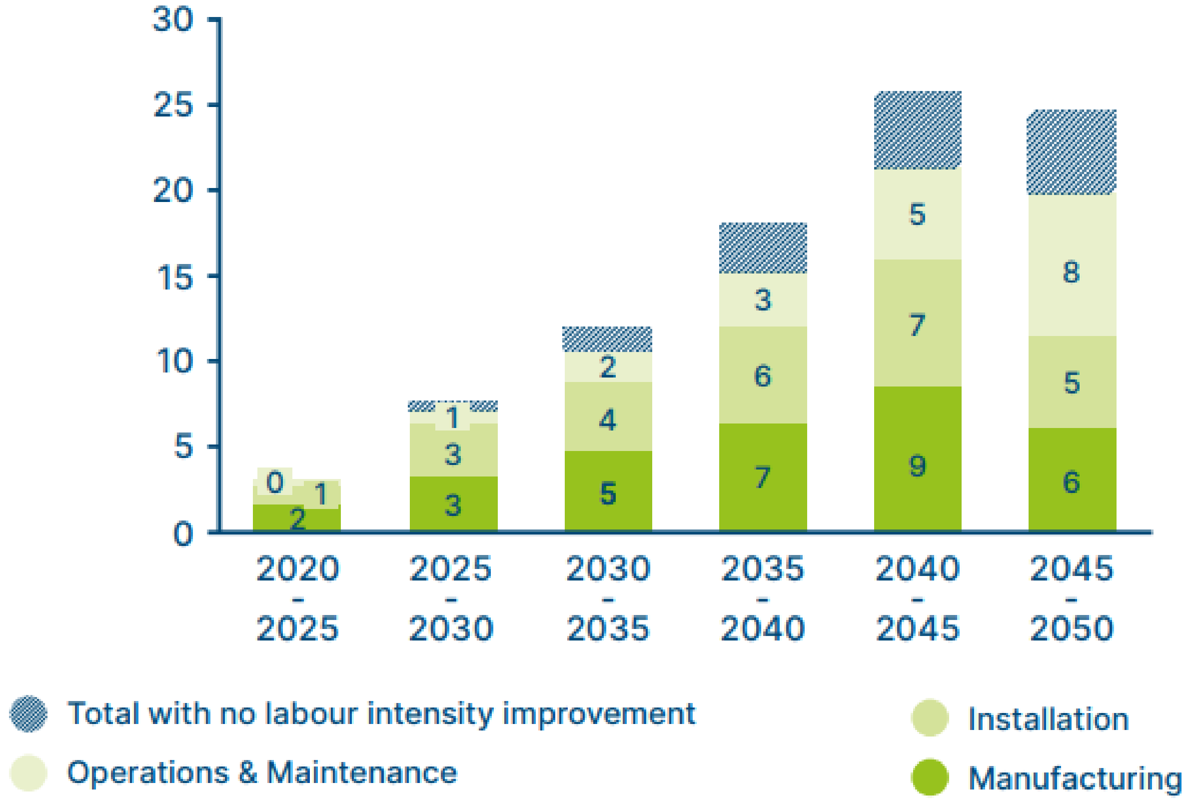
Critical enablers

- Simplifying and streamlining permitting and land acquisition processes
- Strategic approach to planning the siting of generation projects in conjunction with network design
- Anticipatory investment framework for T&D
- Further development of distributed generation and community-ownership models for renewable power

Source: National Grid ESO

Careful assessment of the ability of local and international value chains required to deliver the necessary pace of investment

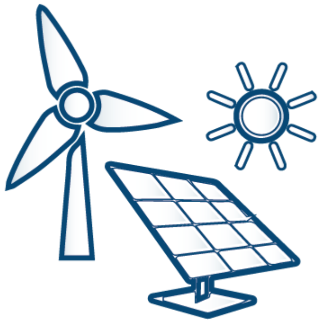
Annual VRE jobs split by type based on 90% VRE Scenario (2020 – 2050), Millions/year



Critical enablers

- A strategic vision and clear targets far in advance
- Collaboration between governments and industry to identify key capabilities and workforce skills
- Collaboration between governments and industry to identify components, materials and circularity strategies required to meet these targets
- In some cases, developing national strategies to grow local supply chain capabilities

Making Clean Electrification Possible:
30 Years to Electrify the Global Economy



Clean electrification

Massive clean electrification at the heart of a net zero emissions economy: global power system growing 3.5-5x and simultaneously decarbonising

1. **Massive electrification to deliver a zero-carbon economy**
2. **Generating low-cost, zero-carbon power**
3. **Building and financing zero-carbon power systems**
4. **Critical priorities for the 2020s**

Clean electrification

2030 TARGETS:

ELECTRIFICATION

Global electricity use up 1.5 times

- EVs near 100% of new car sales in developed countries, 50%+ in developing countries
- Heating increasingly electrified, building retrofits under way

WIND AND SOLAR DEPLOYMENT

Wind and solar ~40% global generation

- 5-7x increase in annual wind + solar installations
- Scaling storage and flexibility deployment

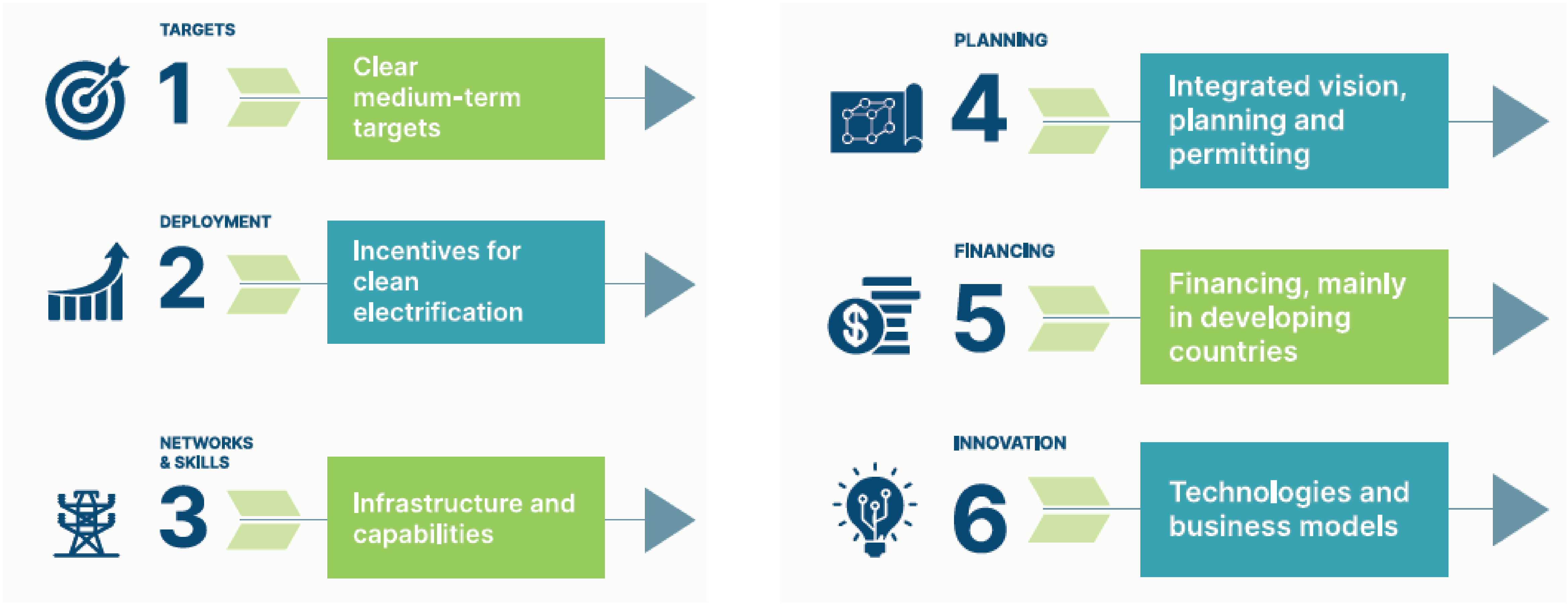
FOSSIL PHASE OUT

Grid emissions intensity

Developed countries	Developing countries
<80 gCO_2/kWh	<180 gCO2/kWh

- Immediate stop to new coal
- Meet all new electricity growth with wind and solar

Six critical actions for the 2020s to put mid-century targets in reach



Energy Transitions Commission

The Energy Transitions Commission is hosted by SYSTEMIQ Ltd.

© 2020 SYSTEMIQ Ltd. All rights reserved.

This is an internal document which provides confidential advice and guidance to partners and staff of SYSTEMIQ Ltd. and its subsidiaries. It is not to be copied or made available to any other party without prior written approval.