

CHINA 2050: A FULLY DEVELOPED RICH ZERO-CARBON ECONOMY

DEMAND-SIDE DECARBONIZATION

DEMAND REDUCTION, ENERGY EFFICIENCY IMPROVEMENT, AND FUEL SWITCH

STEEL	CEMENT	CHEMICALS	SURFACE TRANSPORT	SHIPPING AND AVIATION	BUILDING
<ul style="list-style-type: none"> Scaling up secondary steel production with scrap and EAF; Promoting hydrogen direct reduced iron (DRI) and other technologies; Applying CCS to traditional steelmaking. 	<ul style="list-style-type: none"> Improving material efficiency; Using zero-carbon energy as heat input; Applying CCS for emissions from fossil fuel and production process. 	<ul style="list-style-type: none"> Promoting efficient use of fertilizers and plastics circularity; Applying CCS to fossil fuel-based production routes; Substituting conventional feedstocks with CO₂ and zero-carbon H₂, or biomass. 	<ul style="list-style-type: none"> Controlling travel growth with smart planning and development of subways and railways; Promoting electrification for light vehicles and heavy road transport with BEVs and FCEVs. 	<ul style="list-style-type: none"> Applying electric engines for short-distance travels; Promoting hydrogen and ammonia as shipping fuels; Supporting bio and synthetic jet fuel development and application. 	<ul style="list-style-type: none"> Stepping up electrification, including expanding use of heat pumps; Demanding higher building energy efficiency; Utilizing biomass, industrial waste heat, and solar thermal where applicable.

SUPPLY-SIDE DECARBONIZATION

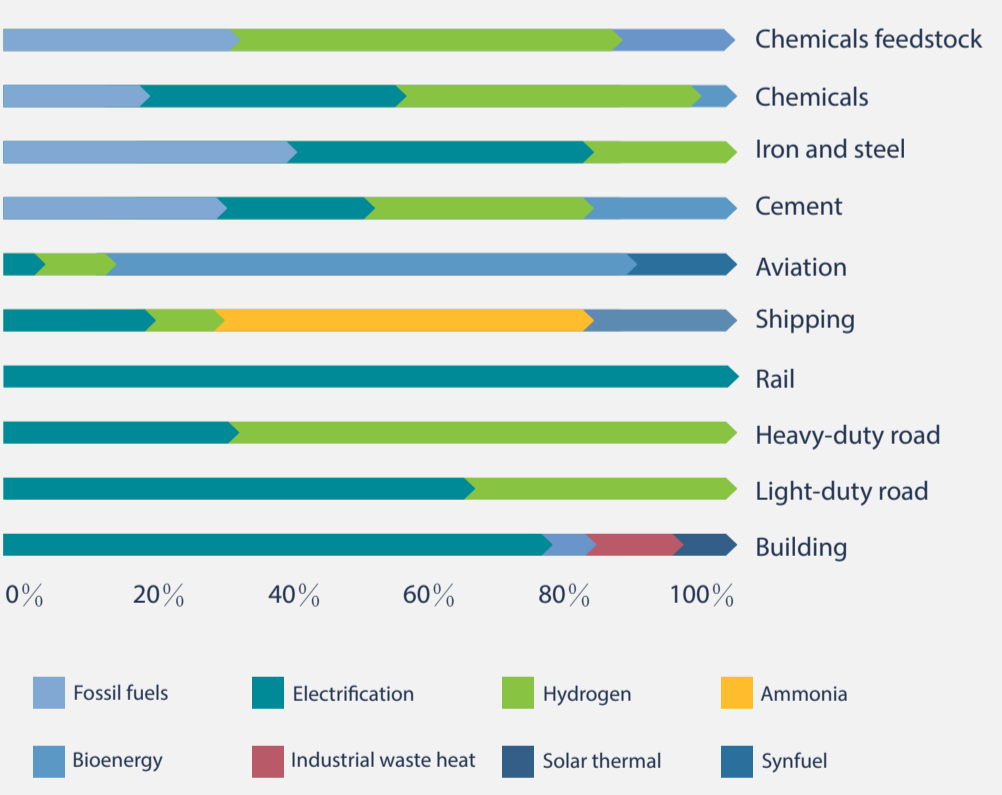
TECHNICALLY AND ECONOMICALLY FEASIBLE

ELECTRICITY	H ₂ HYDROGEN
<ul style="list-style-type: none"> 0.8%: China's land for 2,500 GW solar PV 70%: onshore wind resource to utilize 660 GW+230 GW: hydro + nuclear power standing by Energy storage, flexible generation, and demand response: to address flexibility >60%: LCOE reduction for renewables and batteries by 2050 <p>Installed power capacity in 2050 100% = 7,100 GW</p>	<ul style="list-style-type: none"> \$20/MWh, \$370/kW: max electricity price and electrolyzer capital cost for electrolysis to achieve cost parity with coal gasification without CCS 2600 TWh: electricity use to produce 58 Mt hydrogen <p>Hydrogen supply by source 100% = 81 Mt</p>
BIOMASS	CO ₂ CARBON CAPTURE & STORAGE
<ul style="list-style-type: none"> 17 EJ/a: max potential biomass resource, considering loss and land use 13 EJ/a: prioritized demand for aviation, chemical, and power generation Supply uncertainties: resource limitation, land use competition, collection costs and technology improvement <p>Bioenergy potential supply by source 100% = 17 EJ</p>	<ul style="list-style-type: none"> 1,500 Gt: practical storage capacity \$55/tonne CO₂: average total costs of capture, transportation and storage now with likely further cost reduction in future 1.1 Gt CO₂: total CCS capacity required per annum, with 90% capture efficiency to leave only 110 Mt residual emission <p>Residual CO₂ emissions by sector 100% = 110 Mt</p>

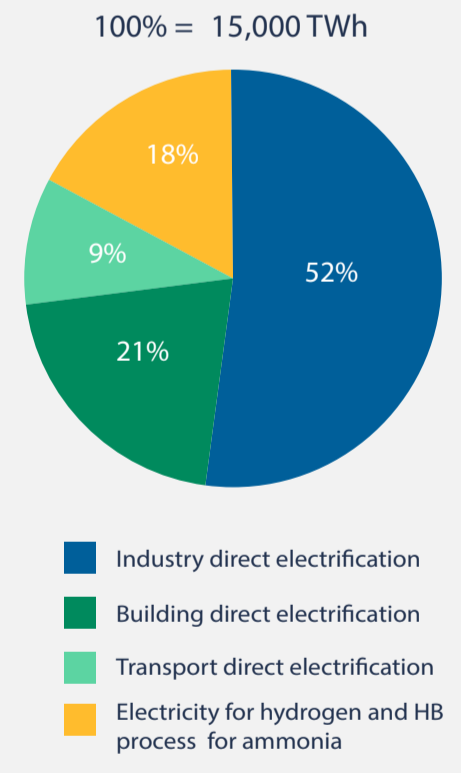
Meeting these energy demands in a zero-carbon fashion will require a major change in the mix of energy supply, with massive direct or indirect electrification, use of biomass and CCS, and significant reduction of fossil fuels.



Final energy mix in a zero-carbon scenario



Electricity demand by sector



TOTAL COST TO DECARBONIZE < 1% CHINA'S GDP
With minimal cost to end-users

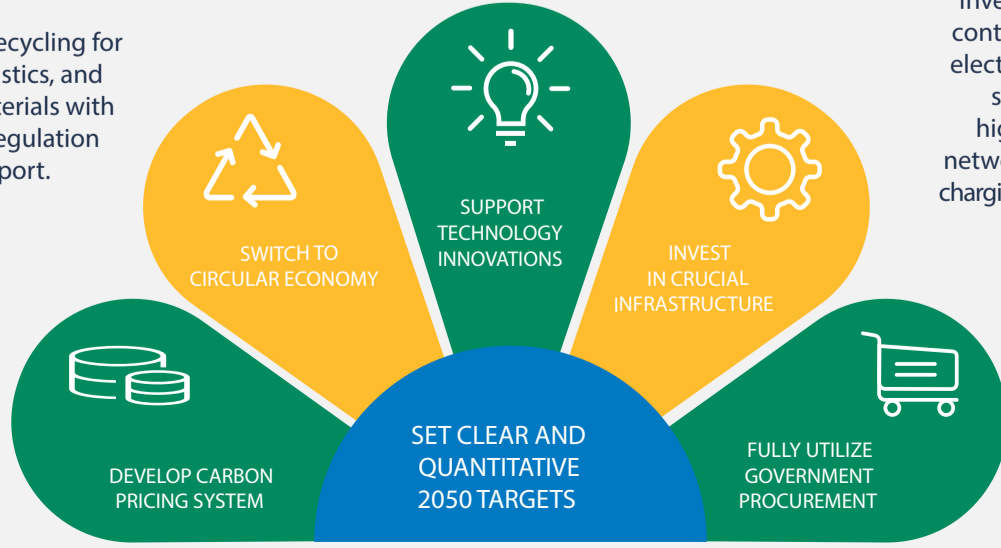
POLICY INSTRUMENTS

Support R&D and early-stage deep decarbonization technologies in energy storage, hydrogen production and storage, biofuels, Power-to-X, etc.

Promote recycling for steel, plastics, and other materials with strong regulation support.

Invest heavily and continuously in the electricity transmission system, high-speed rail network, and vehicle charging infrastructure.

Accelerate the development of the national carbon market to drive search for least-cost decarbonization solution.



Guide and incentivize procurement of central and local governments and also SOEs to stimulate demand for low-carbon products.