

A BETTER LIFE WITH A HEALTHY PLANET

PATHWAYS TO NET-ZERO EMISSIONS



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WARNING: uncertainties ahead

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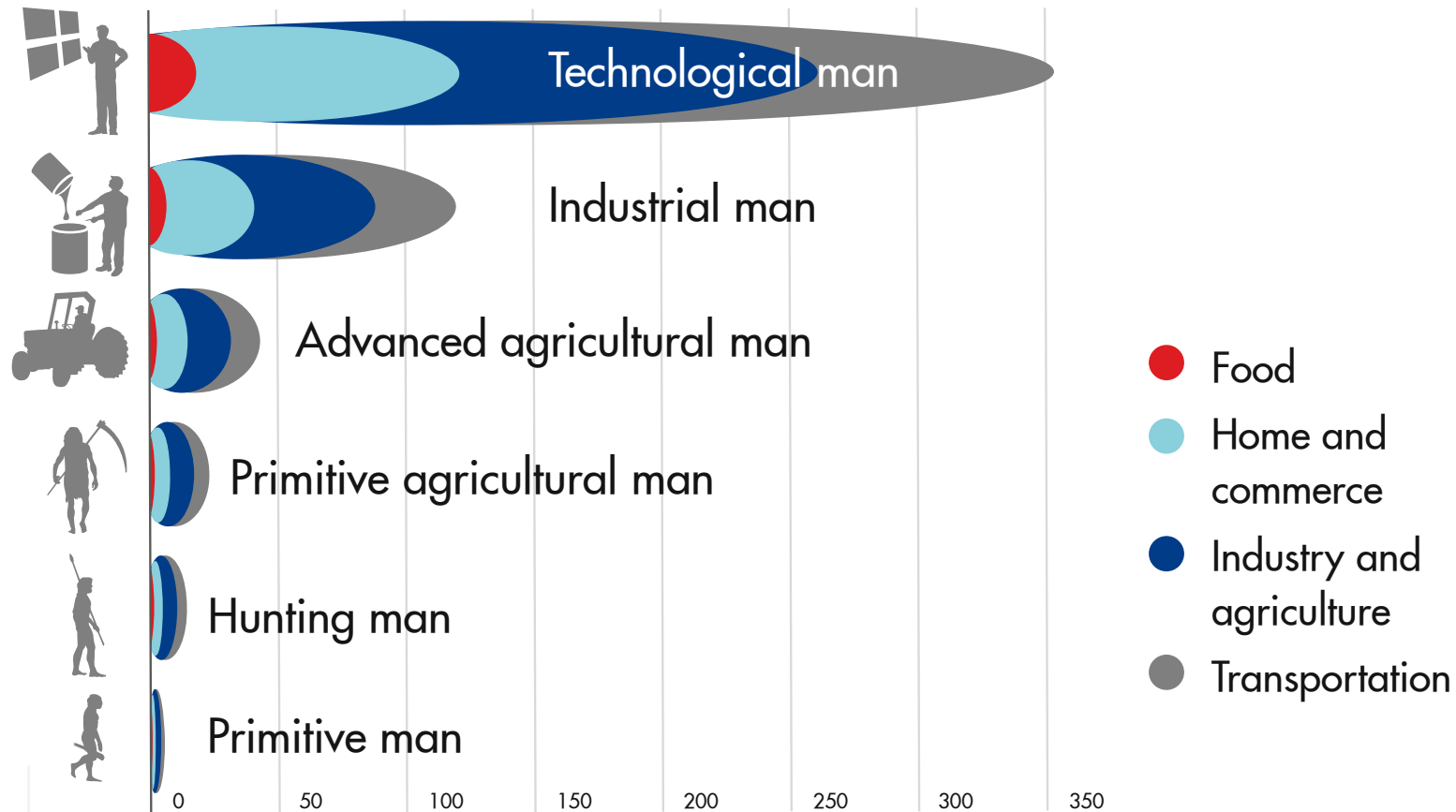
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A view on evolution of primary energy consumption by individuals

Primary Energy Use – GJ per Capita per annum

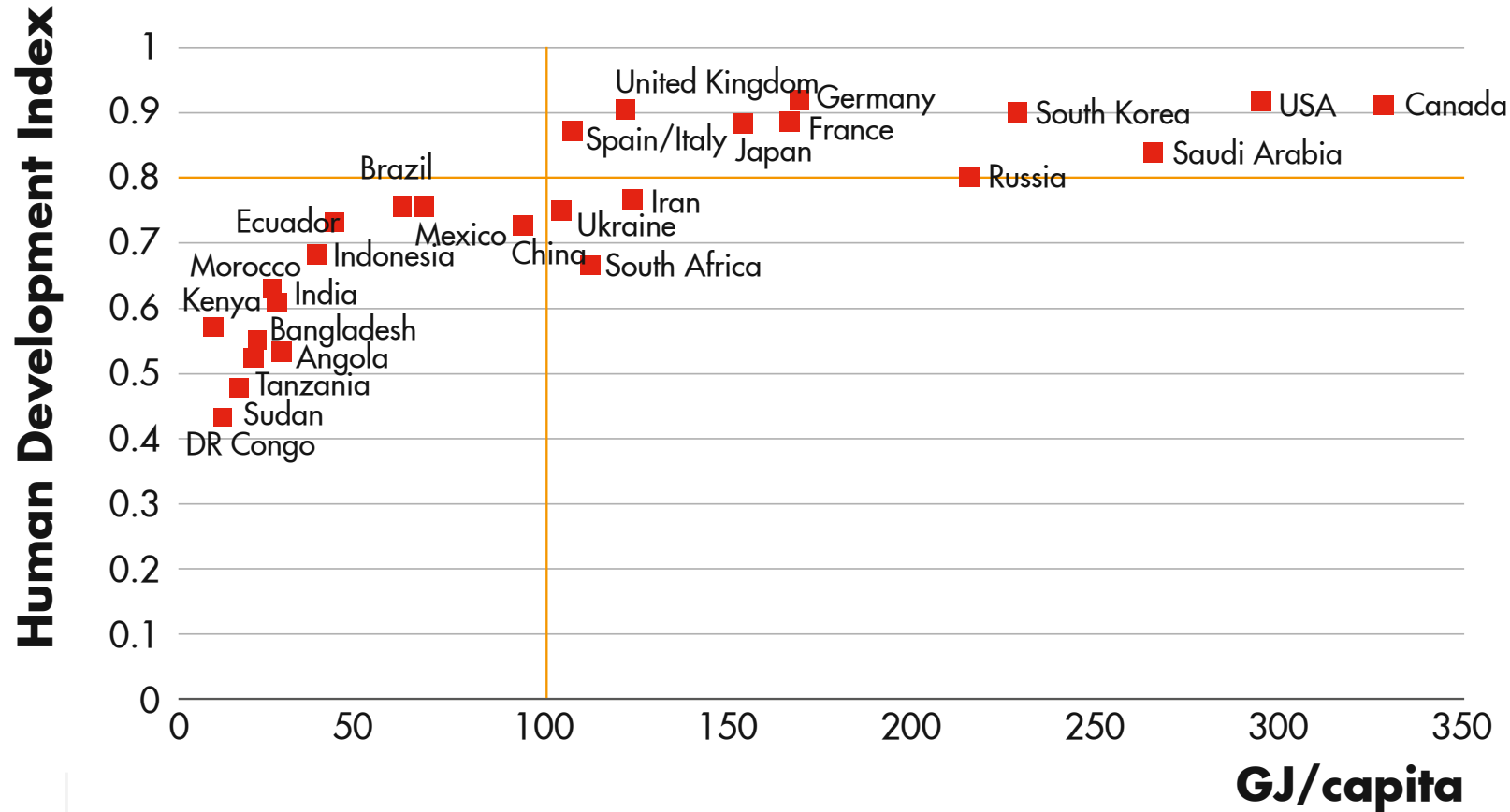


Where are we now?



Energy is an enabler for a decent quality of life

Per capita primary energy demand in 2014 vs UN human development index



Source: Shell analysis – UN Human Development Index

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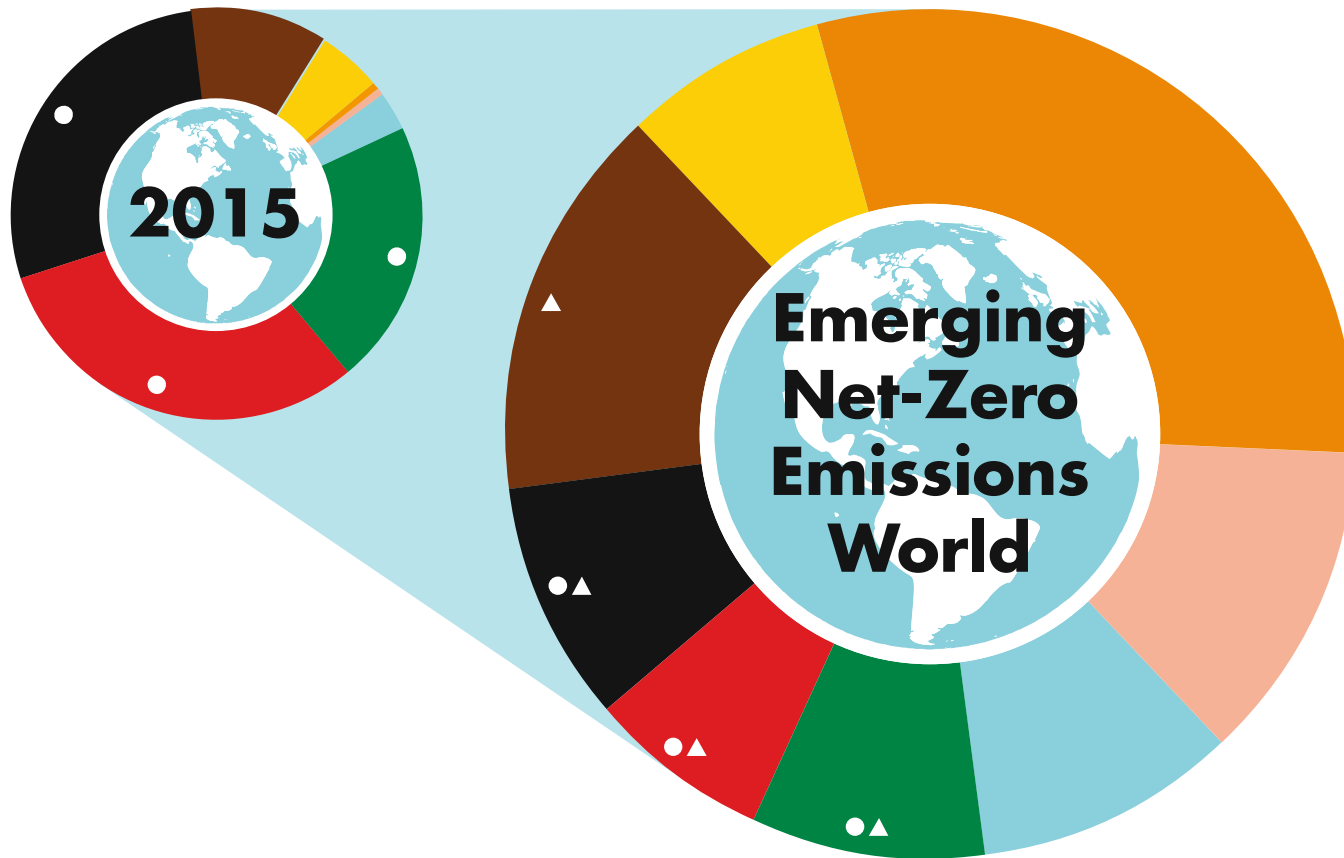


Look to the horizon – A Better Life with a Healthy Planet



United Nations Sustainable Development Goals

Plausible energy mix in an emerging net-zero emissions world, towards the end of the century



Assumes 50% electrification of end use.

ENERGY SOURCE:

GAS

OIL

COAL

BIOENERGY

NUCLEAR

SOLAR

WIND

OTHER

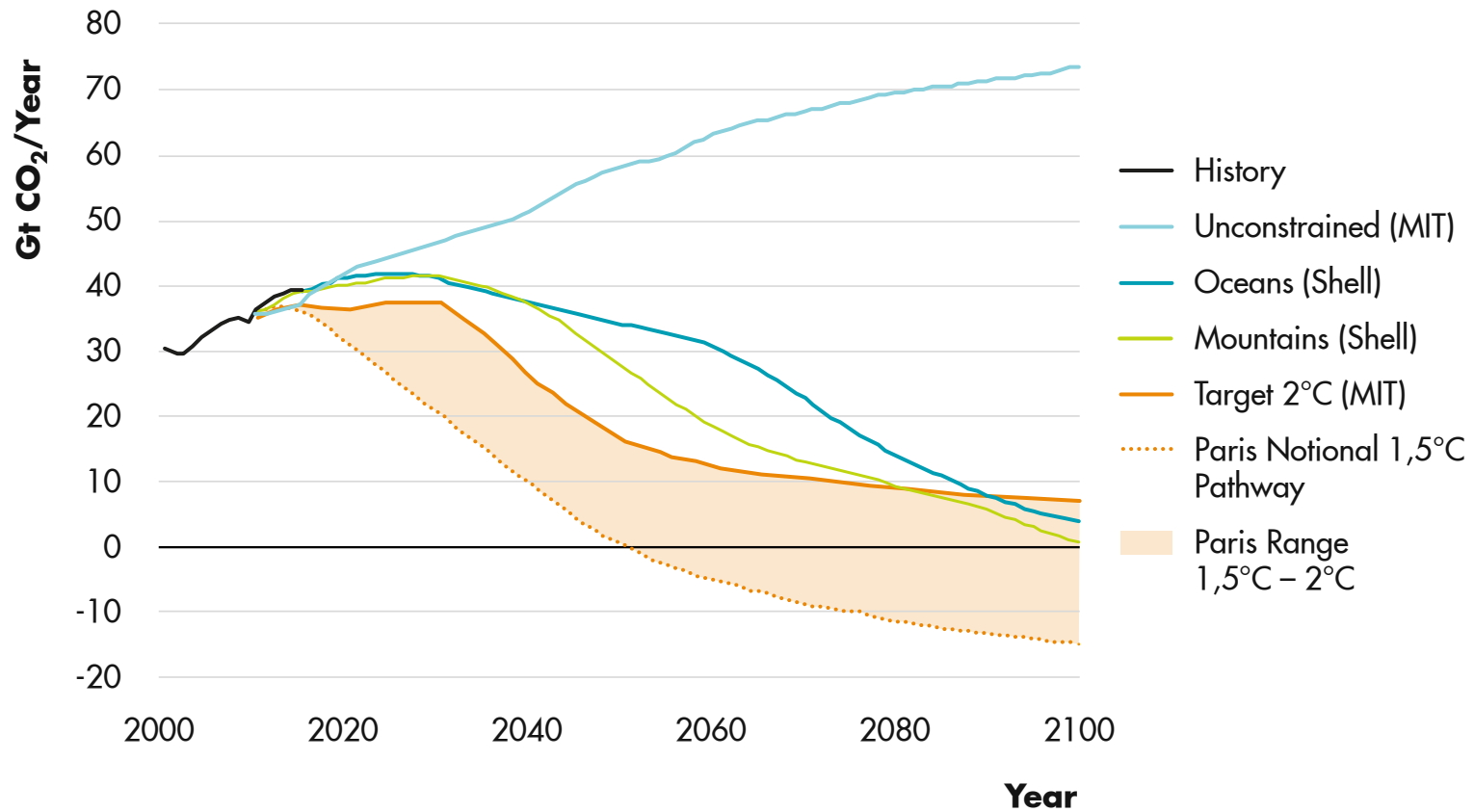
▲ With Carbon Capture and Storage

● Fossil

Source: Shell analysis

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Pathways for total CO₂ emissions



Source: Shell analysis - World Energy Model and MIT 2015 & 2016



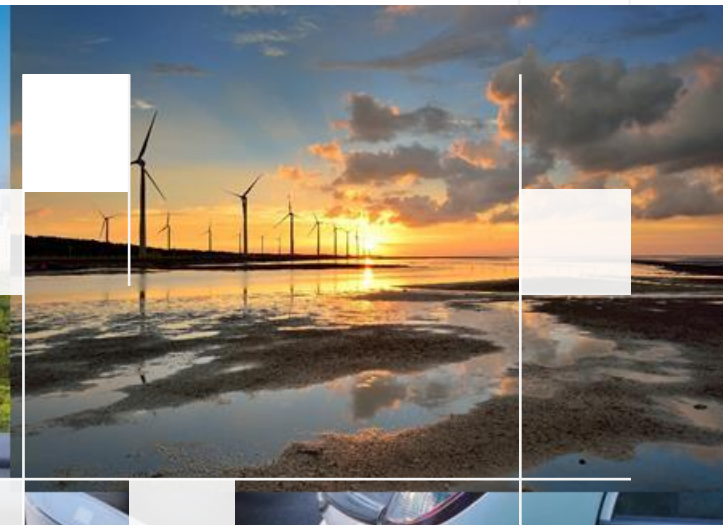
Energy System



**Primary
Sources**



Conversion



Consumption



Pace of Change – Large systemic inertia built-in

Average infrastructure turnover in years

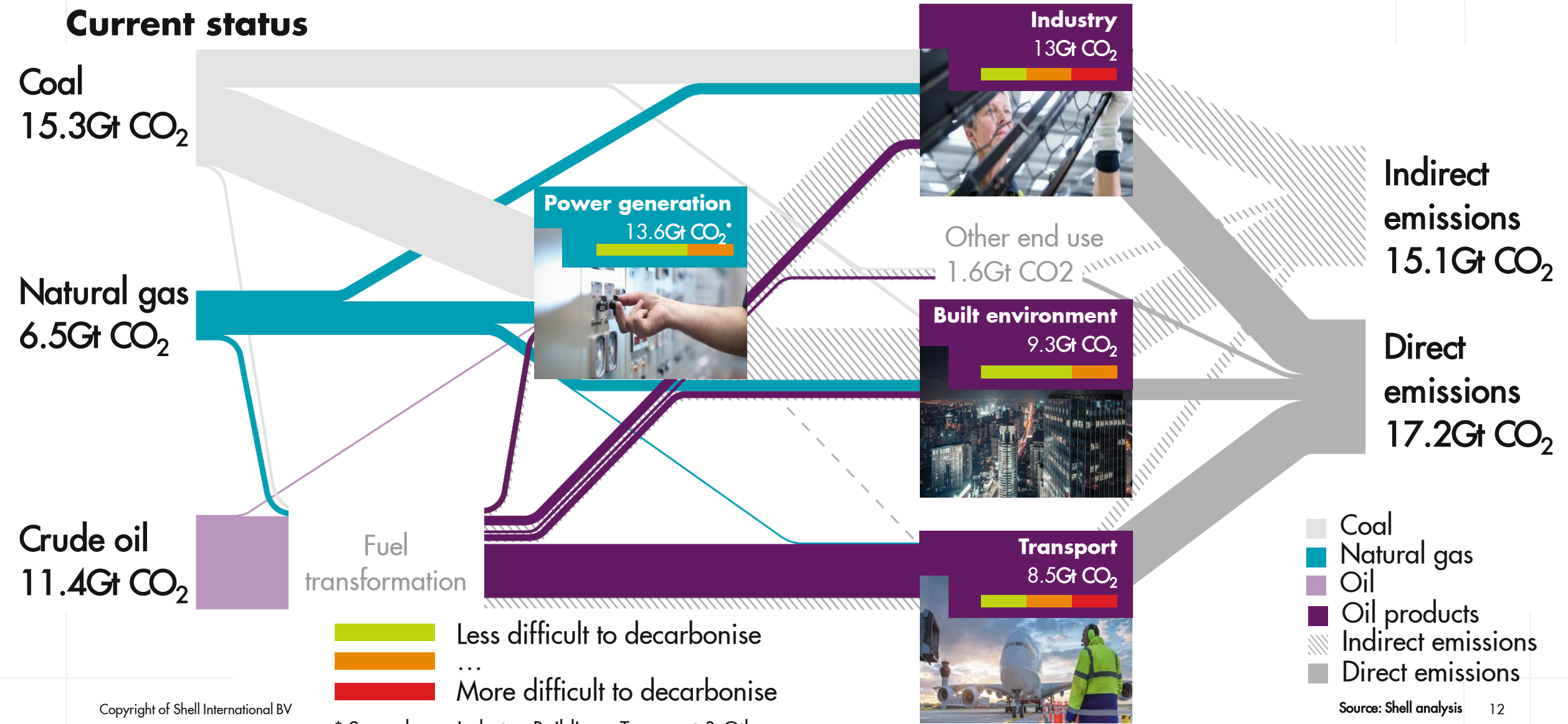


Source: IHS Energy © 2015 (Illustrations sourced from Shutterstock by IHS)

Sources of energy-related CO₂ emissions in key sectors

Different sectors, different challenges, different paces of decarbonisation

Current status



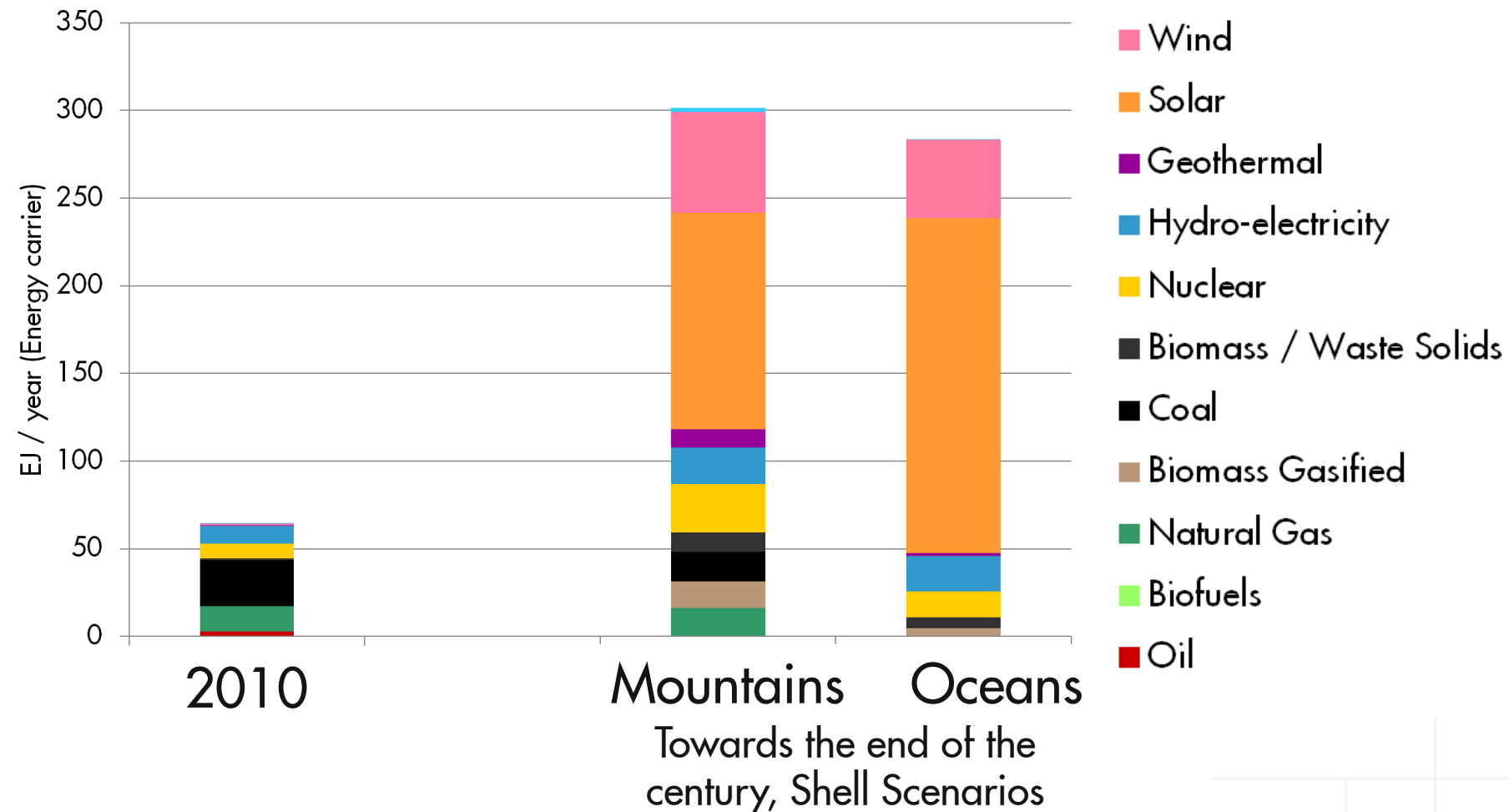
Decarbonisation and Efficiency go hand-in-hand with Electrification

Power generation

13.6Gt CO₂



Final Consumption - Electricity

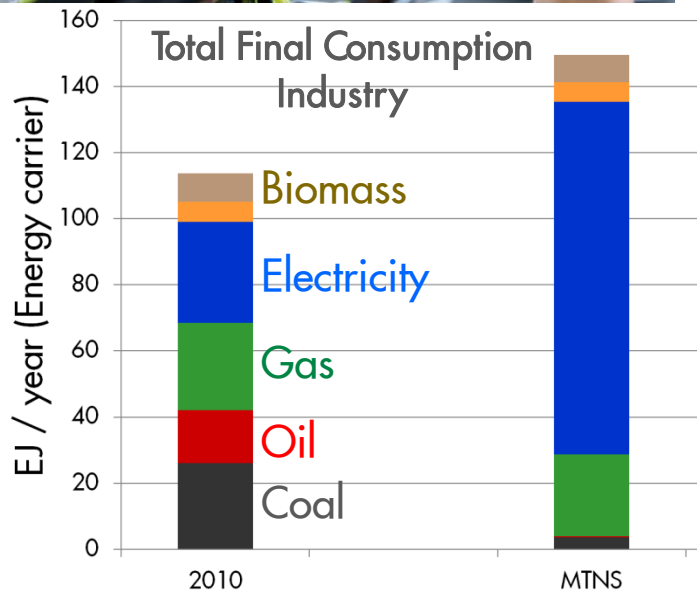


Source: Shell analysis, World Energy Model

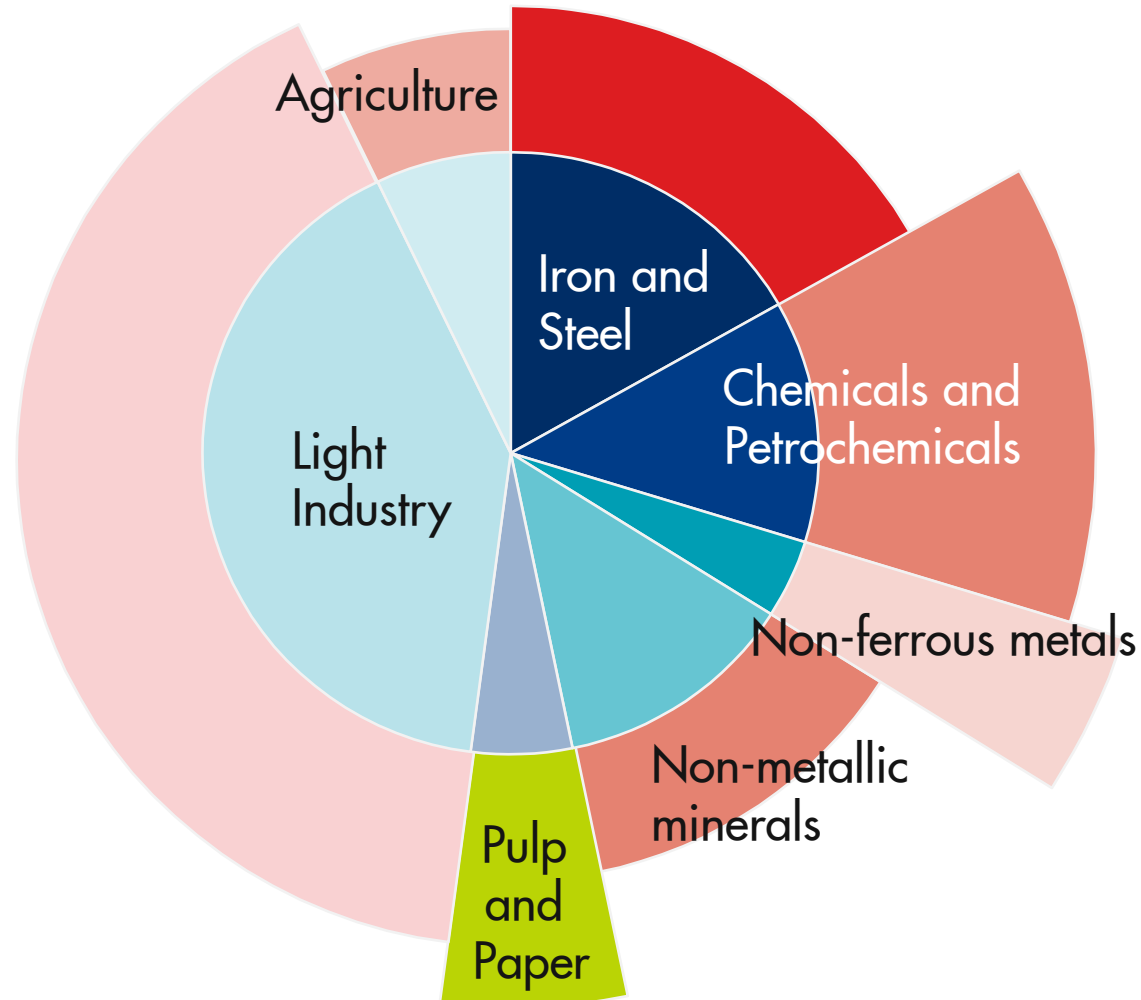
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Major overhaul required of demand, supply and distribution infrastructures

Industry
13 Gt CO₂

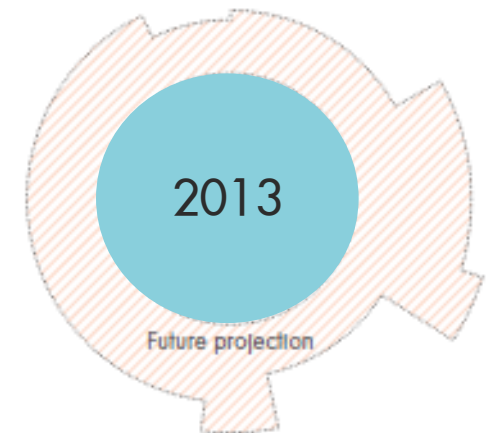


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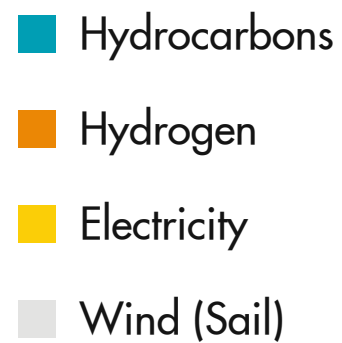


Reliance on hydrocarbons

- Strongest
- Medium
- Weak
- Weakest
- Biomass (recycled own waste)



Energy consumption and emissions challenge – Transport



Source: Shell analysis

Plausible future



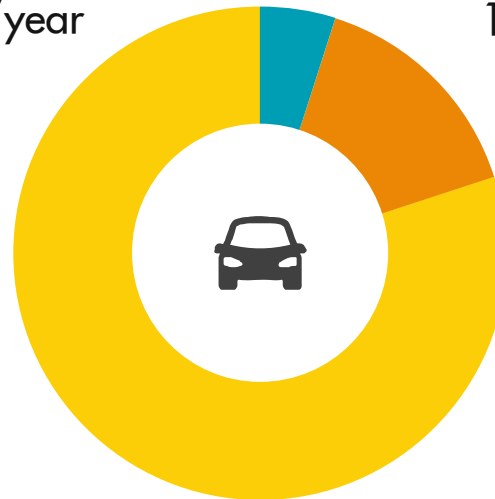
Rail
5 EJ/year



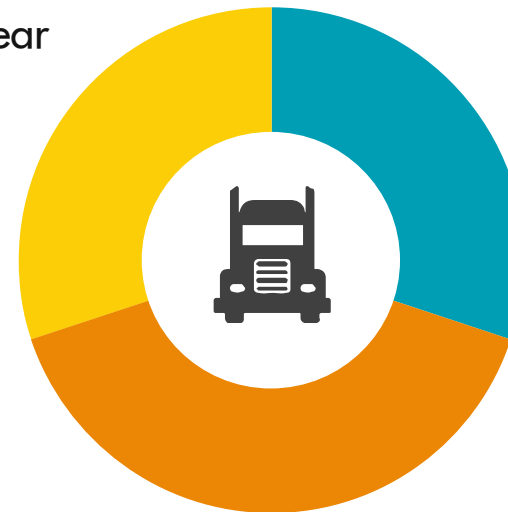
Ship
19 EJ/year



Air
30 EJ/year



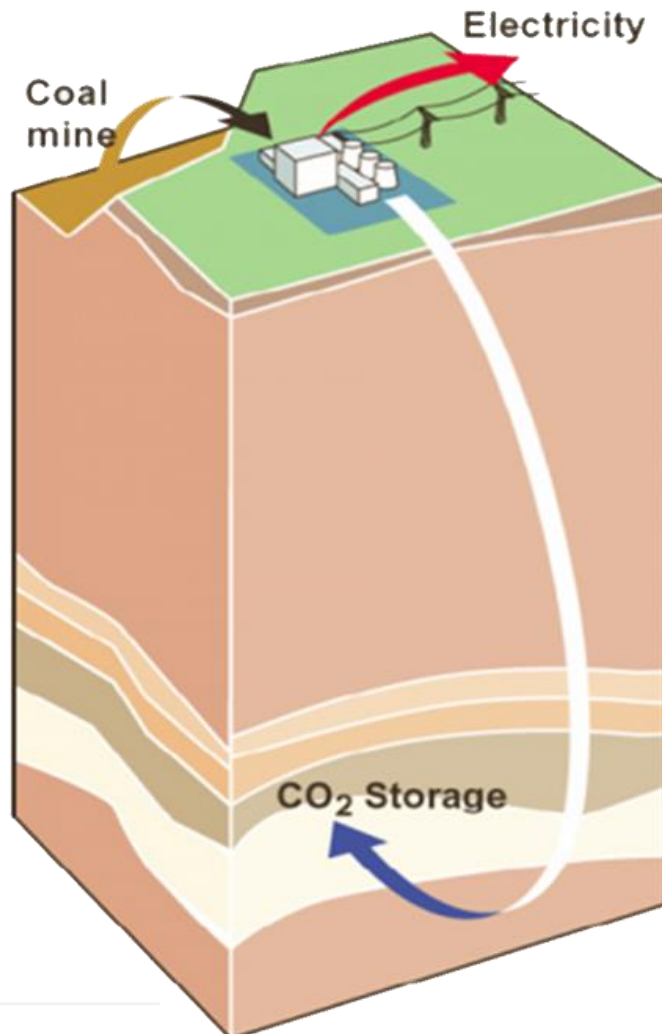
Road – passenger
64 EJ/year



Road – freight
67 EJ/year

Carbon Capture and Storage (CCS) & other Technologies to address remaining emissions

Carbon Capture and Storage



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Bioenergy with carbon capture and storage (BECCS)



Reforestation



Direct CO₂ capture from the air with storage (DACCS)



Enhanced ocean uptake



Soil carbon uptake

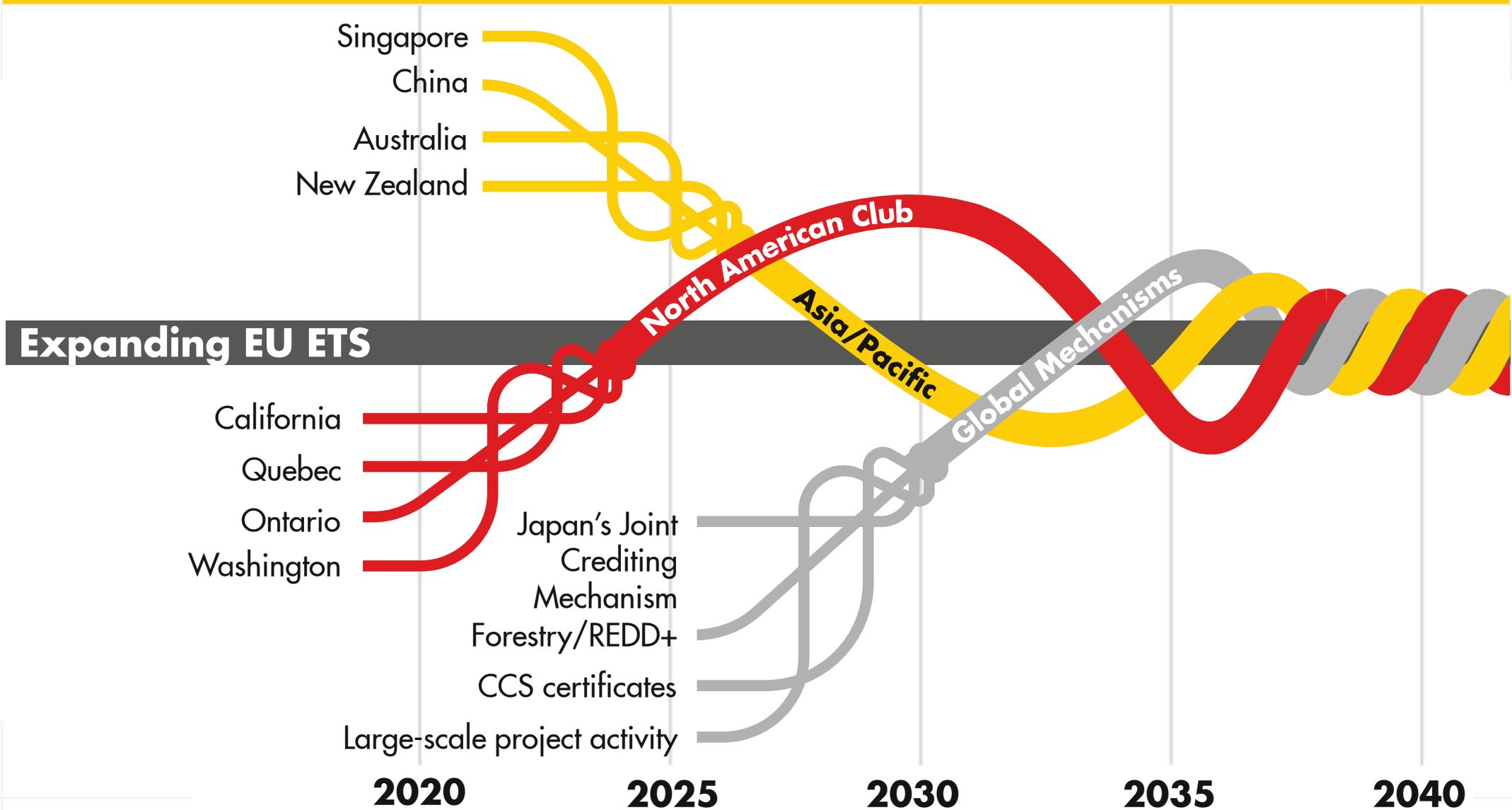


Mineralisation and enhanced weathering



Building with biomass

Development toward a global carbon market is key to the transition



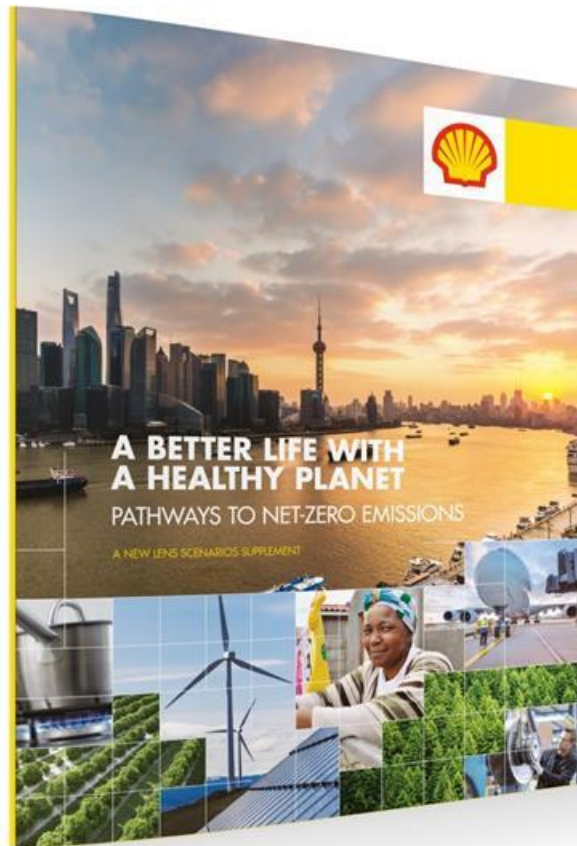
Steps towards a prosperous net-zero emissions world ... *all* of this is required ... simultaneously

Efficient electrified buildings	Low emissions transport	Transformed industrial processes	Sustainable agriculture	New behaviors
Zero emissions power sector	Deep electrification & smart grids	Compact cities & integrated infrastructures	Carbon dioxide capture & storage	
Carbon Pricing		Demonstration & Deployment	Targeted funding	
International mechanisms & funding	Cross-border leakage measures	Energy pricing & fiscal policies	Integrated planning & policy dvlpm.	Mitigation of negative impacts



Q&A

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www.shell.com/scenarios

