Governance of Green Mobility

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GroKalp Limited

Grokalp
we are your wings

DESIGN THINKING

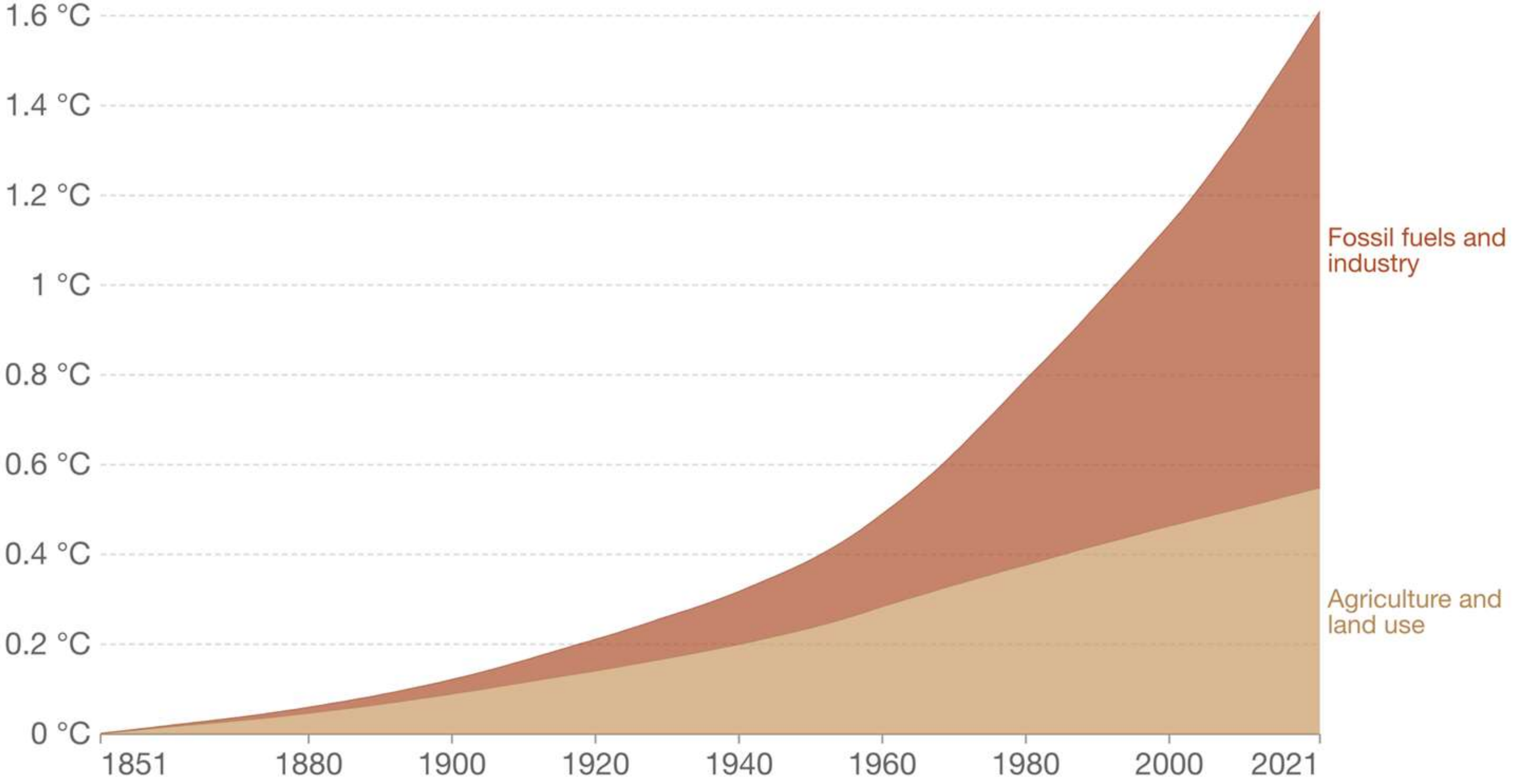
HYDROGEN

AI FOR PARITY

Our Challenge

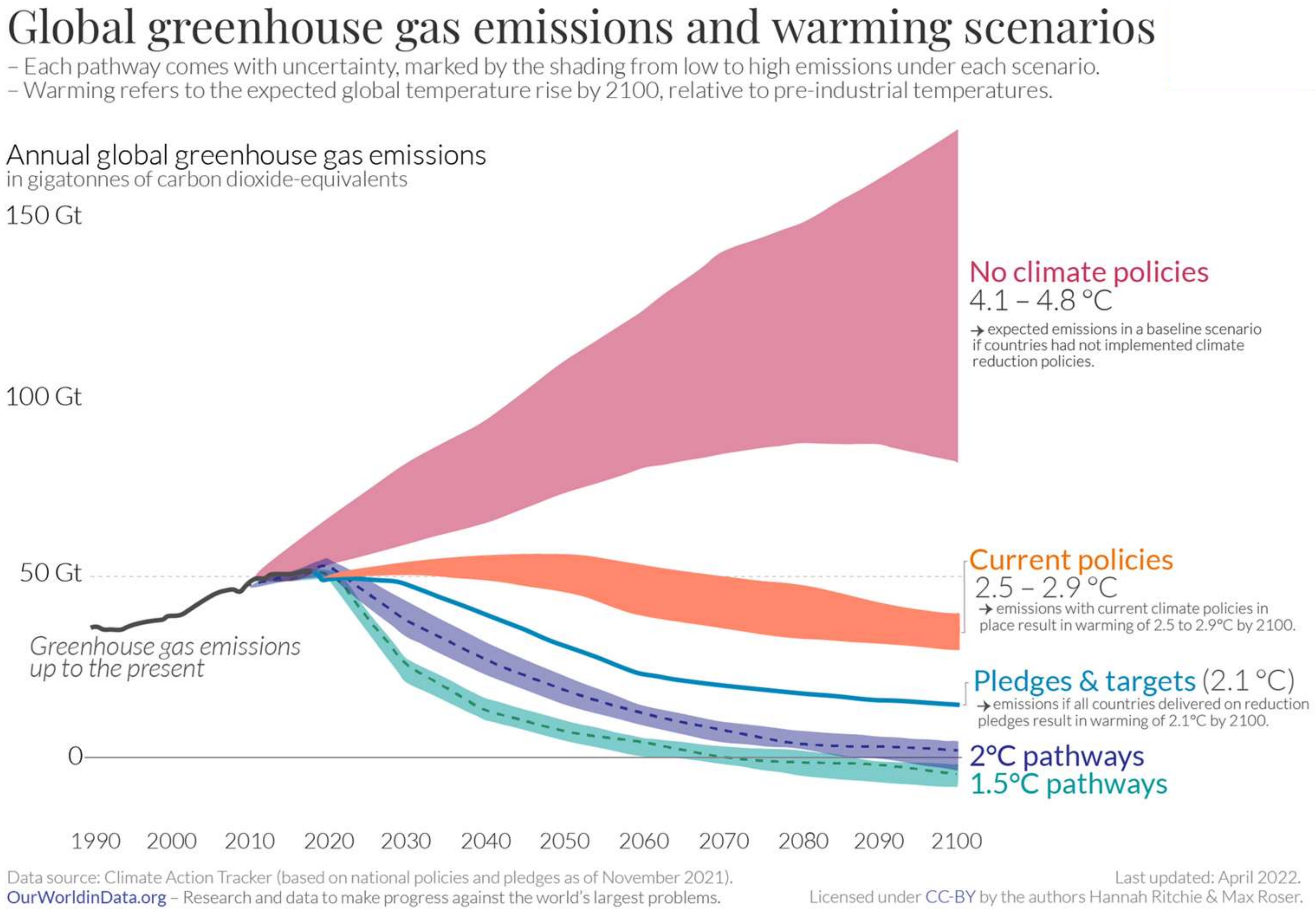
Global warming contributions from fossil fuels and land use, World, 1851 to 2021

The global mean surface temperature change as a result of a country or region's cumulative emissions of three gases – carbon dioxide, methane, and nitrous oxide. This does not include cooling impacts from sulphur dioxide and aerosols, so net warming can be lower.

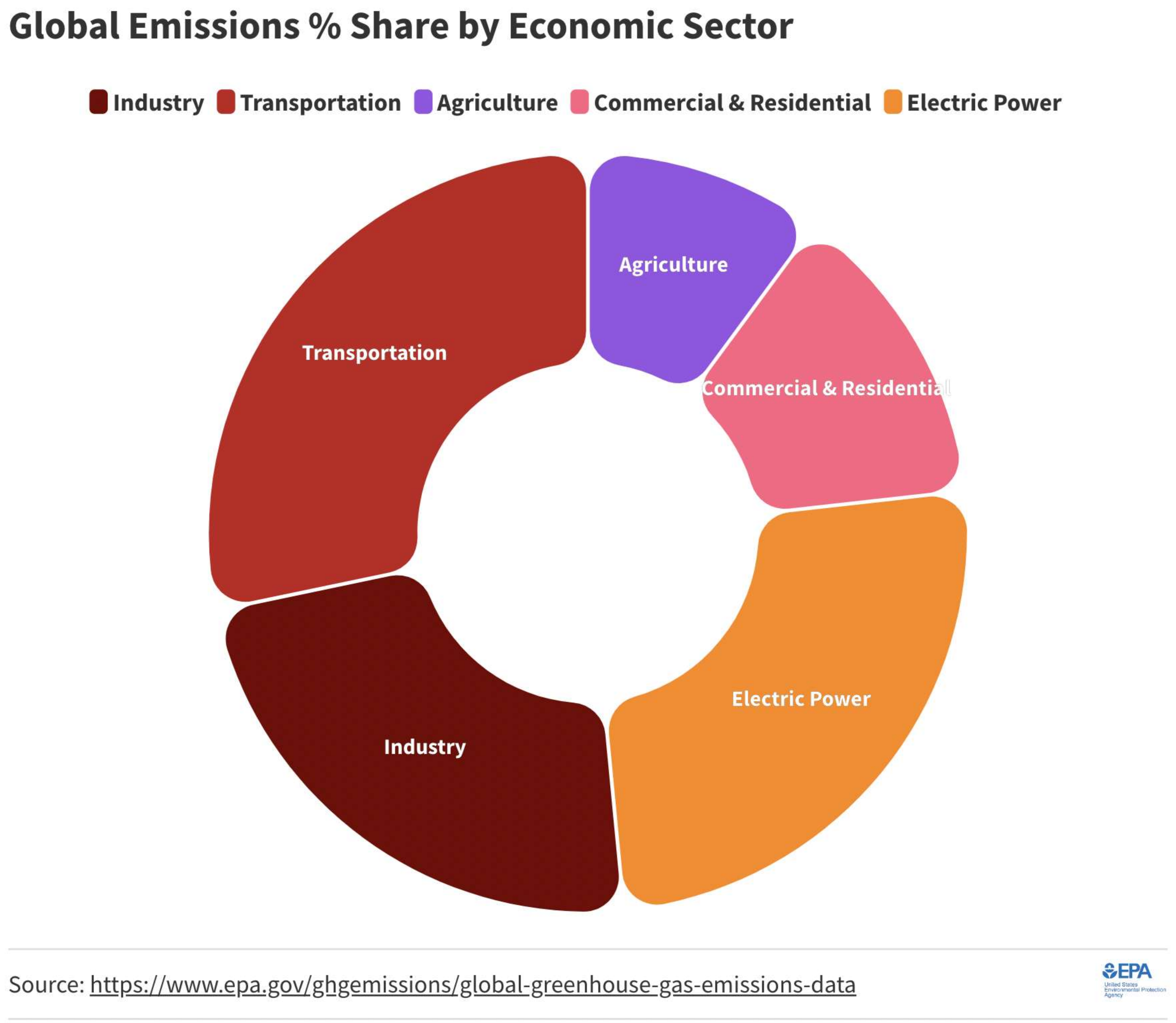


Source: Jones et al. (2023). National contributions to climate change due to historical emissions of carbon dioxide, methane and nitrous oxide.

Policies are Critical



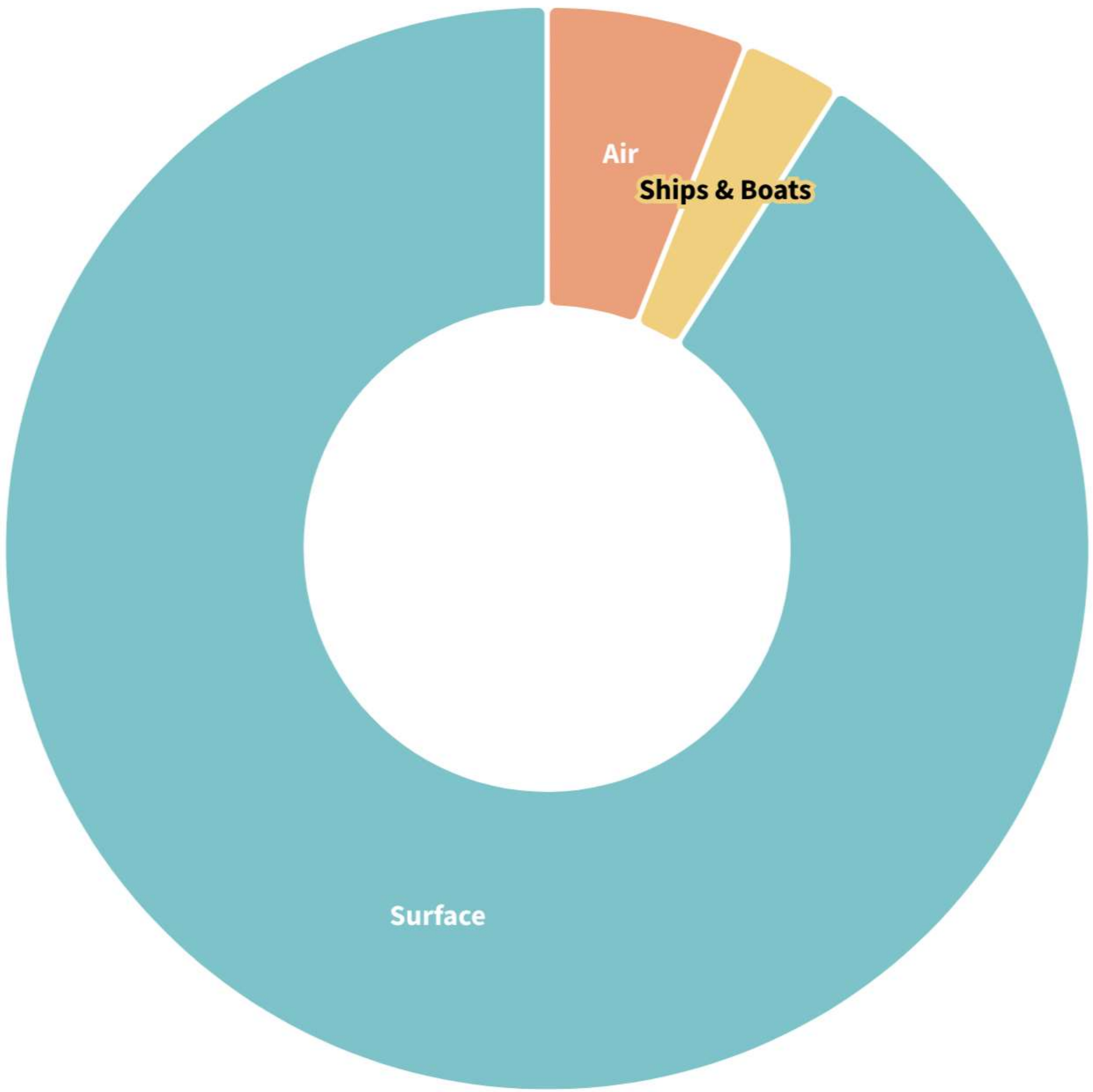
GHG Emission Contribution by Transportation Sector ~28%



Distribution of Greenhouse Gas (GHG) Emissions by Transportation Mode

Surface - 91%
Air -3 %
Ships & Boats - 6%

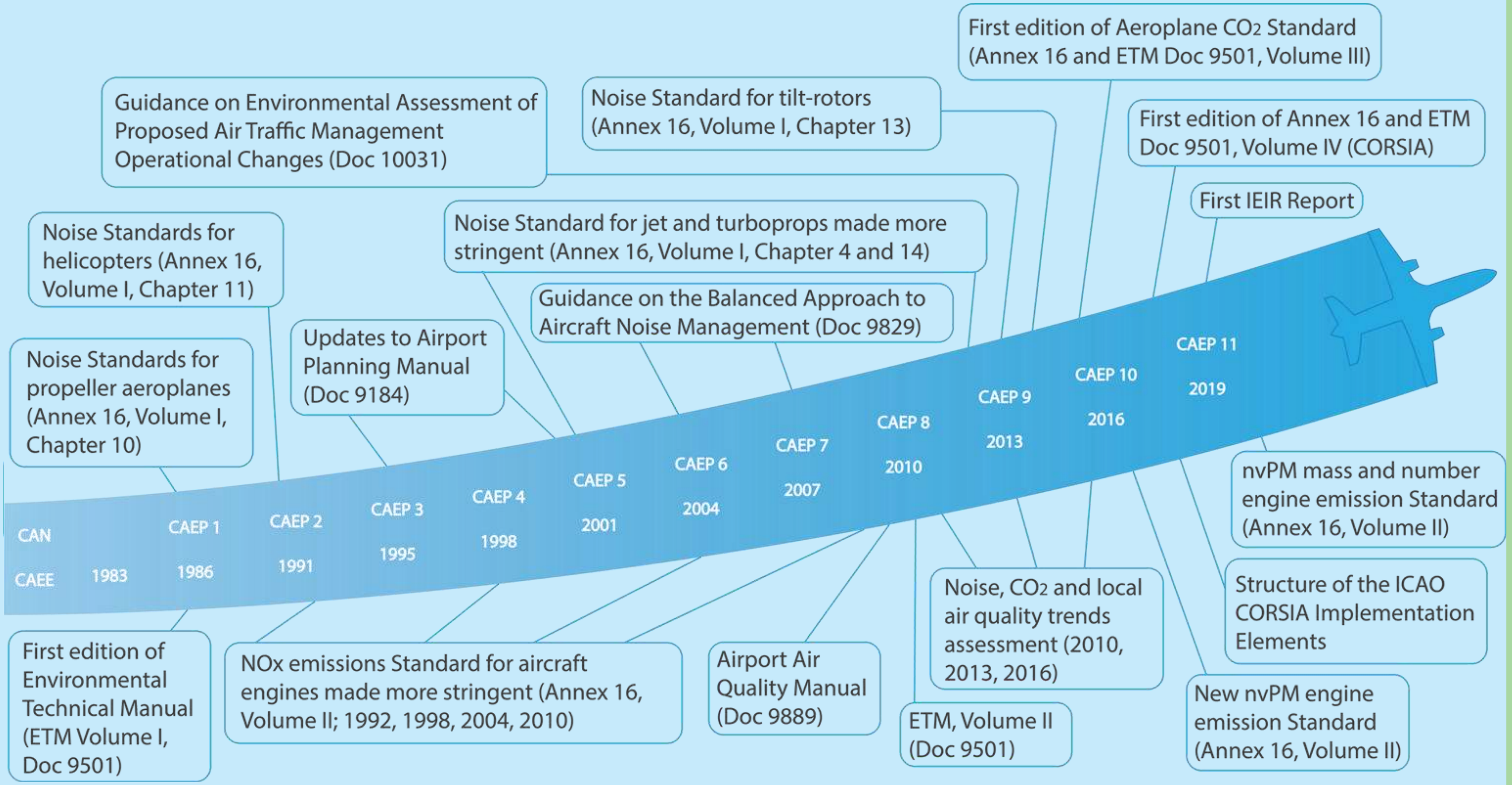
Transportation Sector GHG Emissions by Source



Fast Facts Facts U.S.Transportation Sector Greenhouse Gas Emissions 1990 –2021

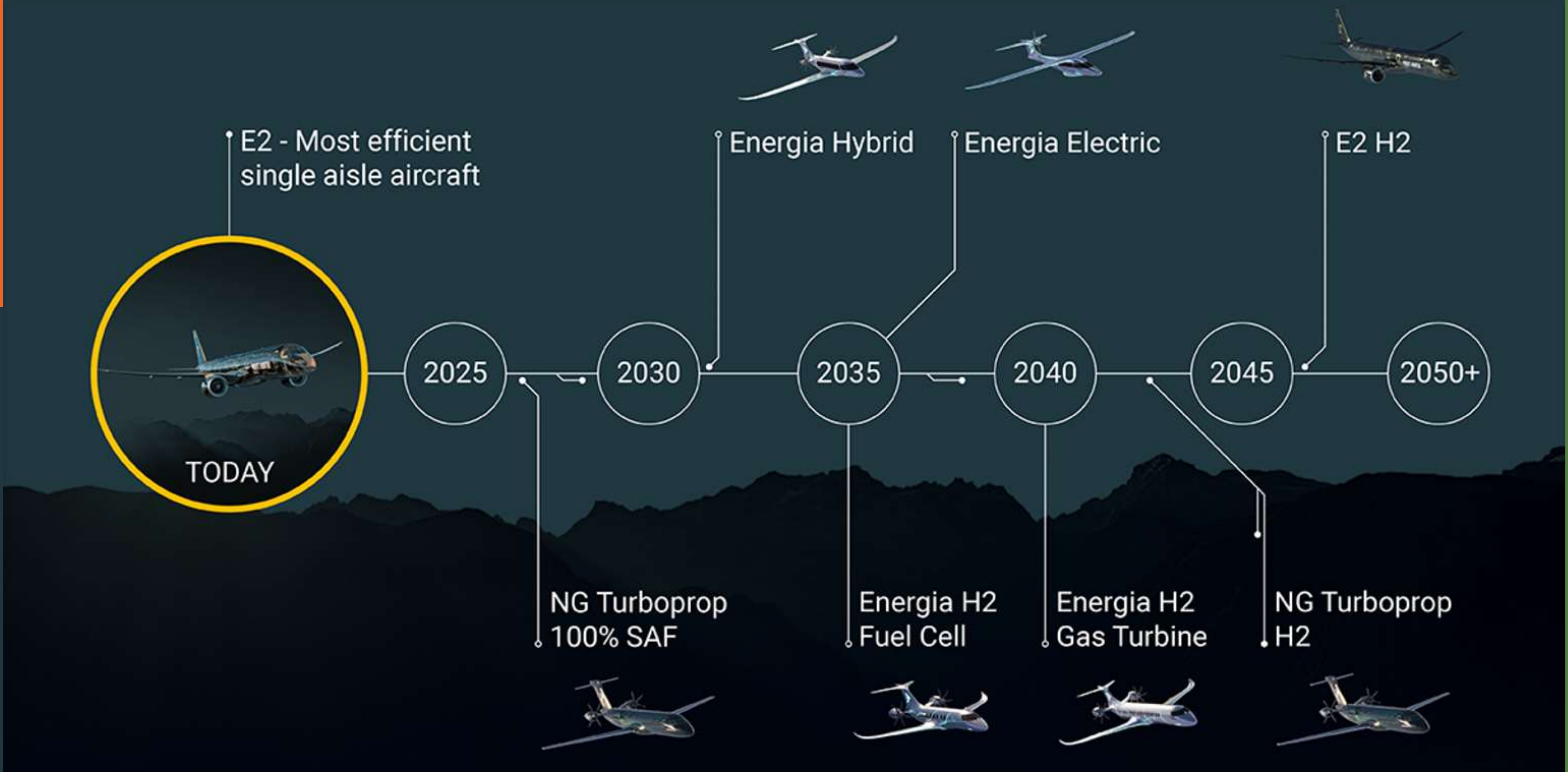
United States Environmental Protection Agency

Air

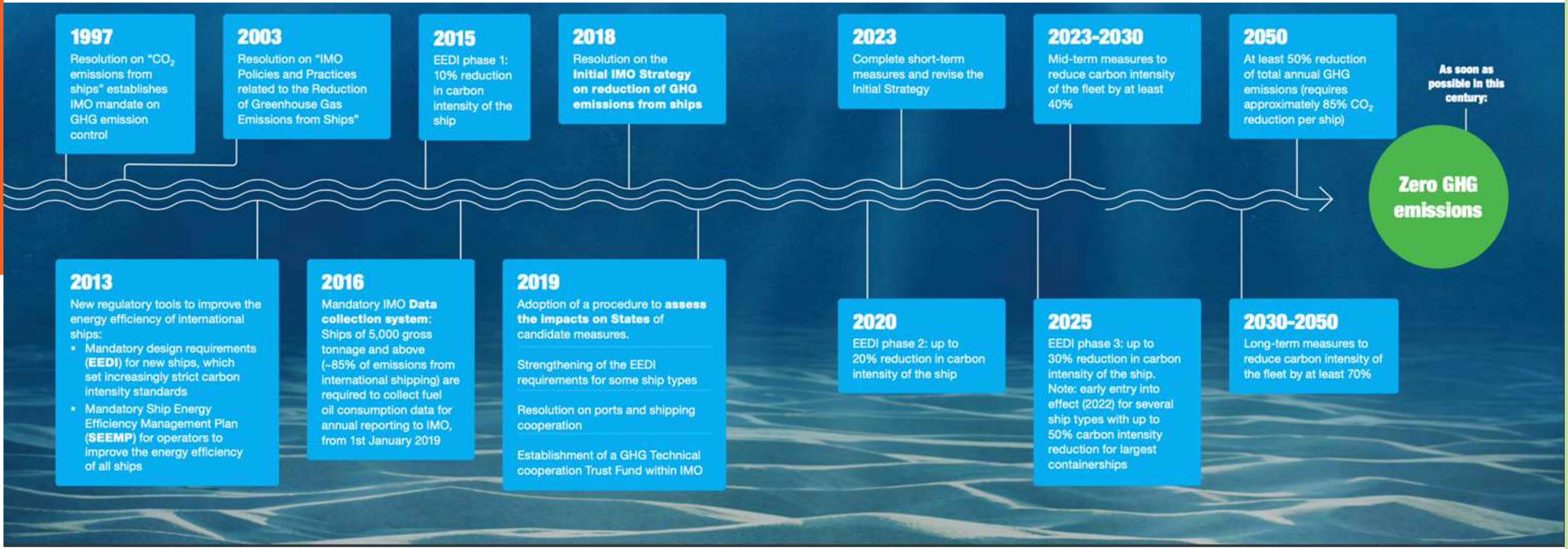


First edition of Aeroplane CO_2 Standard (Annex 16 and ETM Doc 9501, Volume III)
Guidance on Environmental Assessment of Proposed Air Traffic Management Operational Changes (Doc 10031)
Noise Standard for tilt-rotors (Annex 16, Volume I, Chapter 13)
First edition of Annex 16 and ETM Doc 9501, Volume IV (CORSIA)
First IEIR Report
Noise Standards for helicopters (Annex 16, Volume I, Chapter 11)
Noise Standard for jet and turboprops made more stringent (Annex 16, Volume I, Chapter 4 and 14)
Guidance on the Balanced Approach to Aircraft Noise Management (Doc 9829)
Updates to Airport Planning Manual (Doc 9184)
Noise Standards for propeller aeroplanes (Annex 16, Volume I, Chapter 10)
CAN
CAEE
1983
CAEP 1
1986
CAEP 2
1991
CAEP 3
1995
CAEP 4
1998
CAEP 5
2001
CAEP 6
2004
CAEP 7
2007
CAEP 8
2010
CAEP 9
2013
CAEP 10
2016
CAEP 11
2019
nvPM mass and number engine emission Standard (Annex 16, Volume II)
Structure of the ICAO CORSIA Implementation Elements
Noise, CO_2 and local air quality trends assessment (2010, 2013, 2016)
First edition of Environmental Technical Manual (ETM Volume I, Doc 9501)
NOx emissions Standard for aircraft engines made more stringent (Annex 16, Volume II; 1992, 1998, 2004, 2010)
Airport Air Quality Manual (Doc 9889)
ETM, Volume II (Doc 9501)
New nvPM engine emission Standard (Annex 16, Volume II)

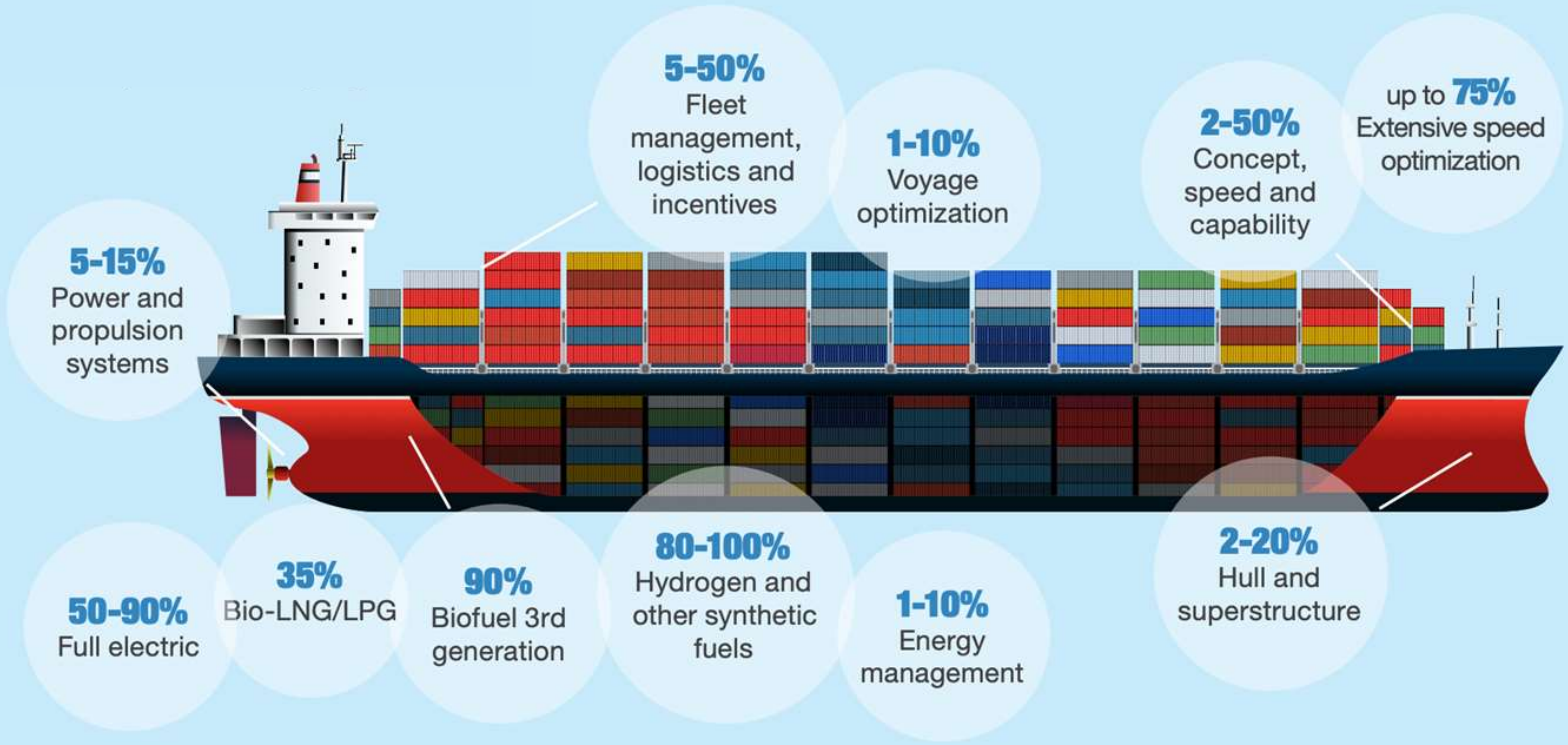
Air


E2 - Most efficient single aisle aircraft
TODAY
2025
NG Turboprop 100% SAF
2030
Energia Hybrid
2035
Energia Electric
Energia H2 Fuel Cell
2040
Energia H2 Gas Turbine
2045
E2 H2
NG Turboprop H2
2050+

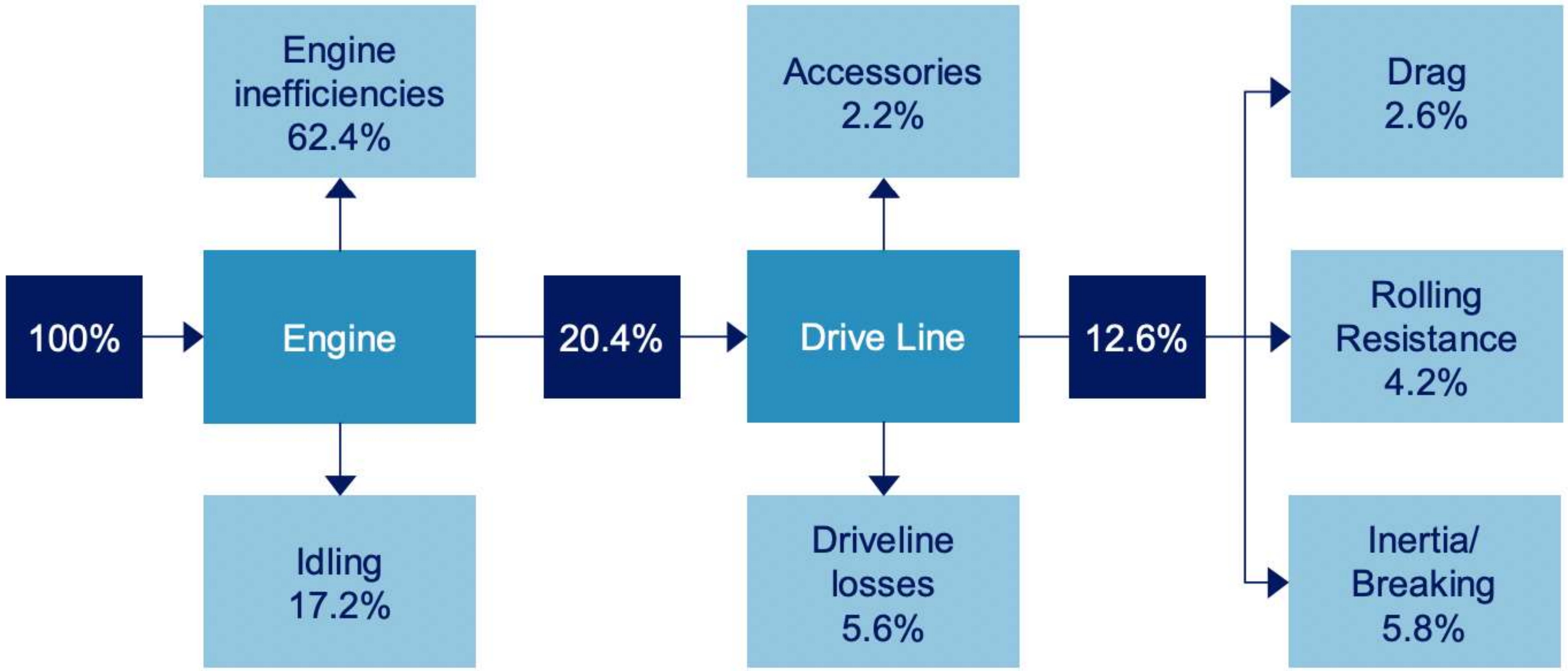
Timetable of IMO action to reduce GHG emissions from ships



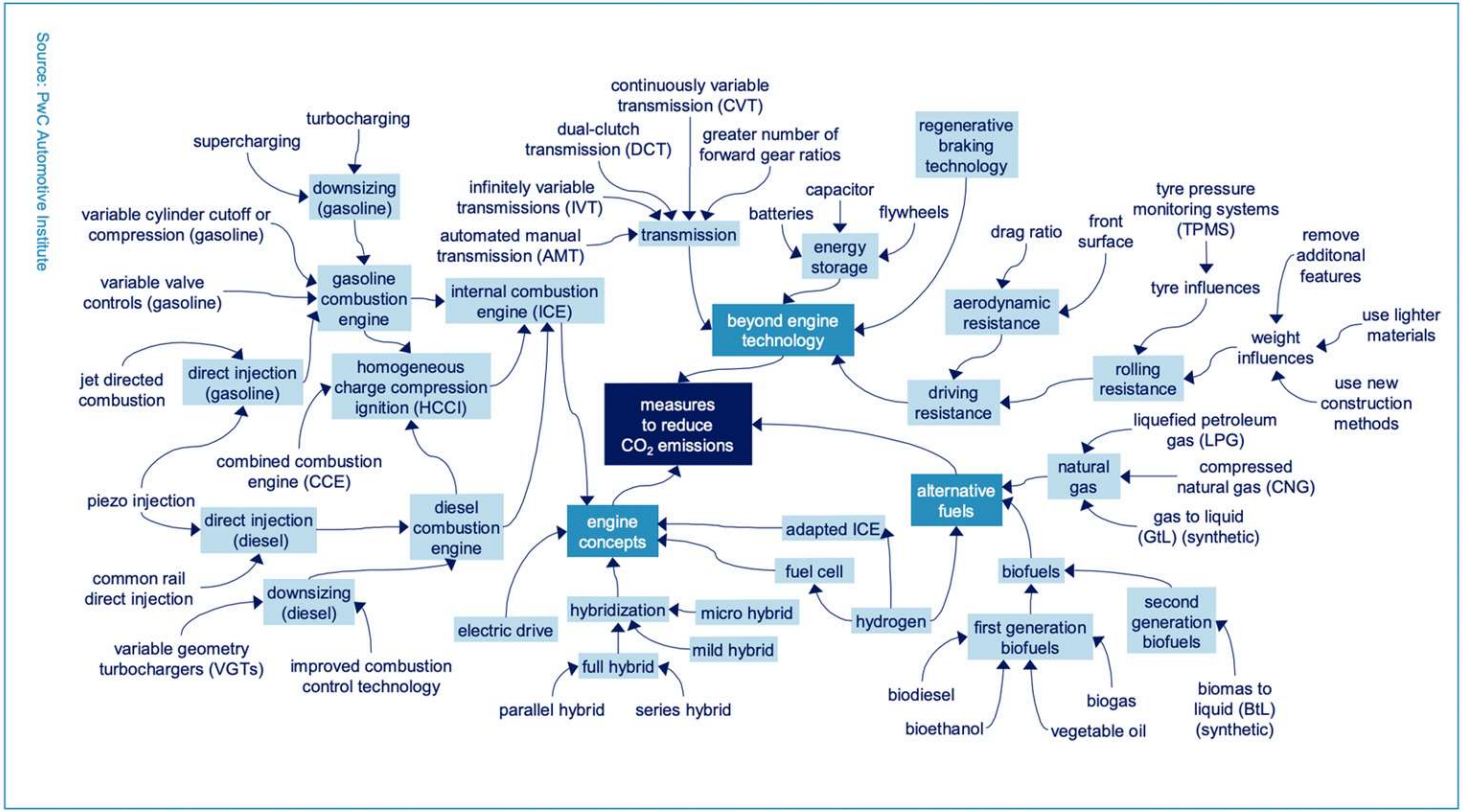
A wide variety of design, operational and economic solutions



Compared to 1970 vehicle models, new cars, SUVs and pickup trucks are roughly 99 percent cleaner for common pollutants however ~87% energy is still lost for other reasons

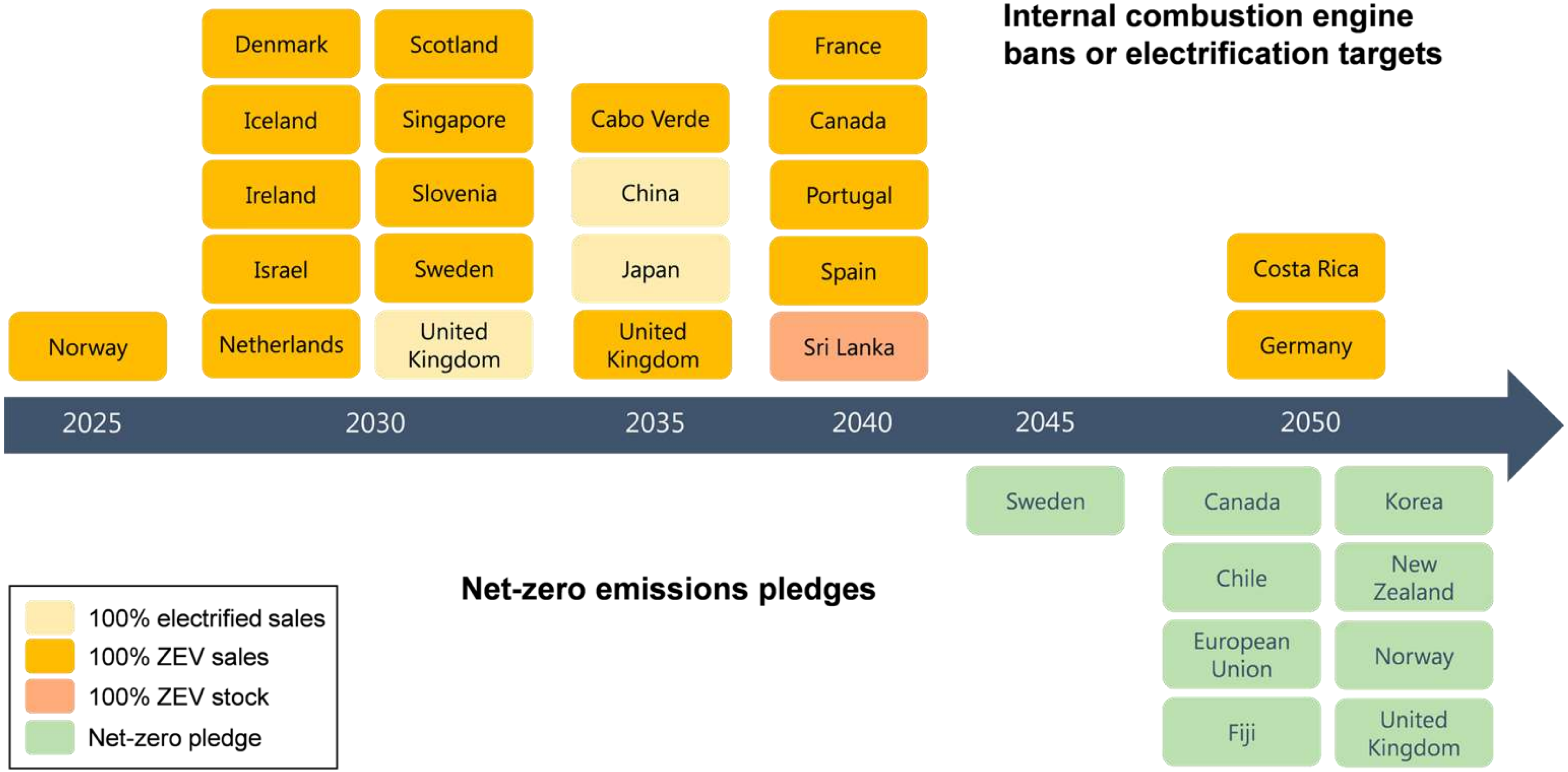


We have to Think Beyond ICE Age

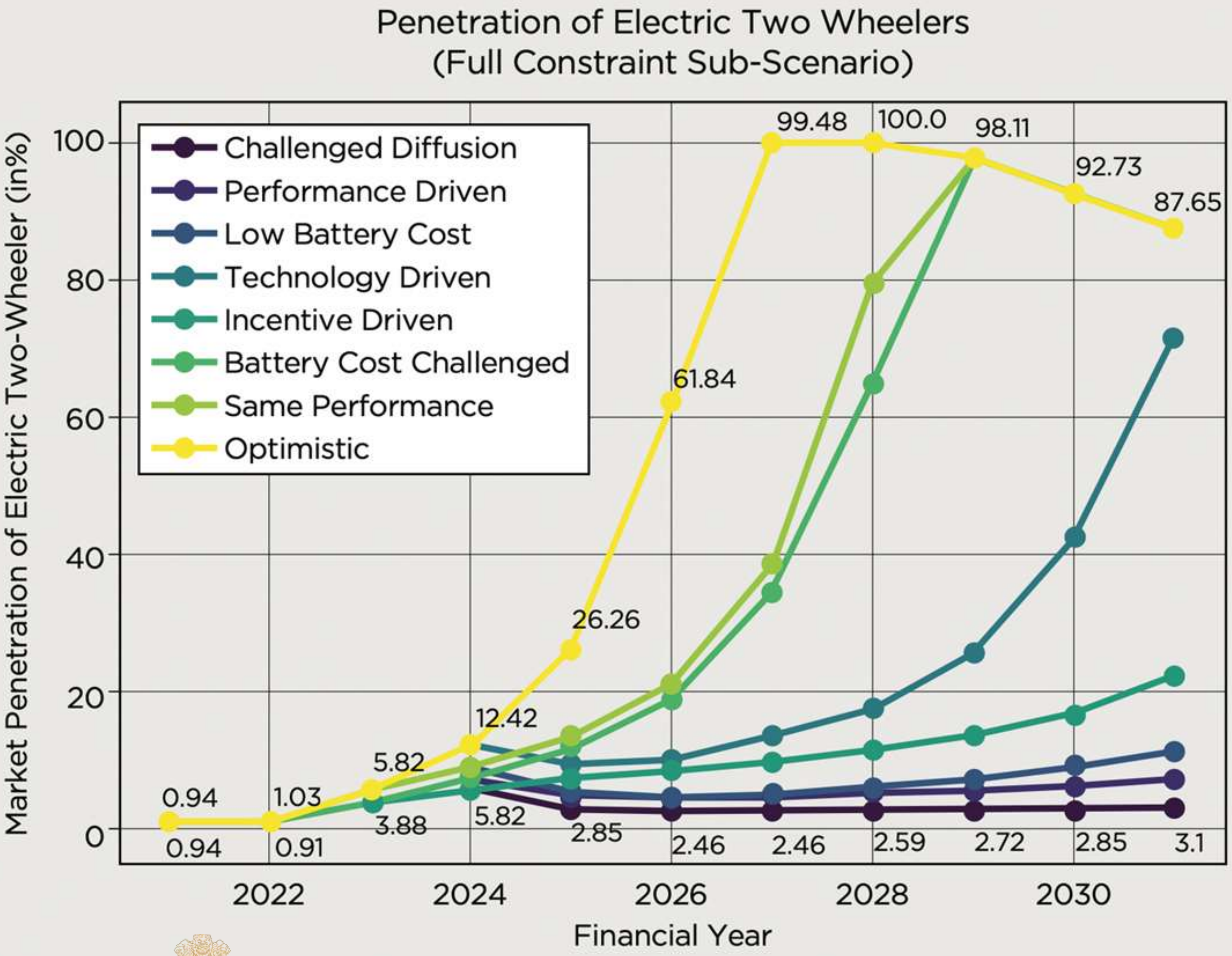


Technological advancements in ICE vehicles to reduce emissions

Electric Vehicles Transforming the Surface Mobility landscape



Electric Vehicles Transforming the Surface Mobility landscape

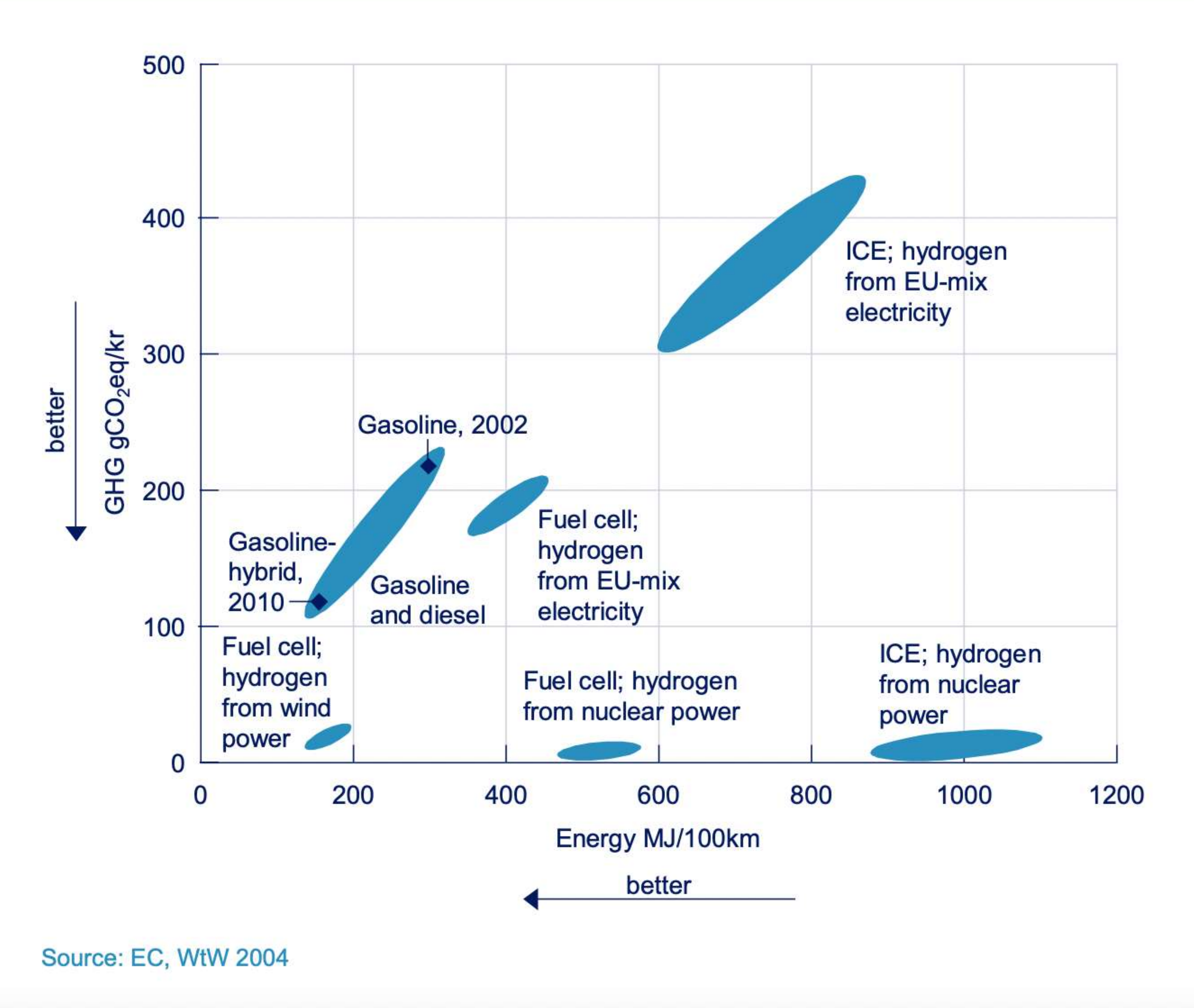


NITI Aayog

Niti Ayog Report - Forecasting Penetration of Electric Two-Wheelers in India

Grob

Beyond ICE and Electric Vehicles



Global Benchmarking GH2 Policy and Roadmaps

						
GH2 POLICY	**ADAPTIVE** GH2 EXPORTS	**MATURE** FCEV PV FOCUS	**INDICATIVE** DEV. PROJECTS – CLUSTERS	**MATURE** INFRA FOCUS	**MATURE** TRANSPORT, CALIFORNIA FOCUS	**EARLY STAGE** TECH. DEMOS, ICE-H2 (PAST)
GH2 PRODUCTION	Leveraging RE strengths to produce, export GH2; Carbon capture to be used extensively	GH2 imports from Australia	**6 GW electrolyser capacity, 1 MT GH2 by 2024**; and 2X40 GW electrolysers capacity, 10 MT GH2 by 2030	**World's largest 10 MW** Fukushima Hydrogen Energy Research Field FH2R, GH2 imports	Focussed on RE electrolyser production, exploring biogas/methane (from dairy)	R&D and demonstration pilots on electrolyser and FC tech (across technologies)
GH2 SUPPLY CHAIN & MANUFACTURING	H2 Energy Supply Chain (HESC) Pilot Project, H2 Utility Renewable Hydrogen and Green Ammonia Supply Chain Demonstrator	Global leadership in FC Passenger Vehicles and Power Generation, **constructing new nationwide H2 pipeline network**	**Global lead on PEM electrolyser** tech, FC tech; coupling strategies by use-cases – H2 valleys, industrial clusters	Building GH2 infra, imports and strategic co-production/ transport from Australia, KSA, Brunei	Primarily privately funded initiatives, manufacturing	Domestic manufacturing imperative to bring costs down
FUNDING & INVESTMENTS	Committed **over AU$146 mn on H2 supply chain projects** in last five years	**USD 1.8 bn budget for establishment of a public-private H2 vehicle industry ecosystem by 2022**	Strong state funding, private investments; Country plans (Germany USD 7bn, France, Netherlands, Spain, Portugal)	**Spent $1.5 billion on H2** tech R&D and subsidies, USD 664 mn 2020 budget	DOE has been spending USD 100 mn annually, separate USD 30 mn SO-FC program	R&D spends on demonstration projects, 2 re-fuelling stations in Delhi, CoE established
PRIORITY USE-CASES – TRANSPORT, INDUSTRY, POWER, BUILDING/HEAT	H2 Hubs/Valleys, H2 in remote applications (microgrids for mining)	**By 2030, 800K FCEVs target (100K trucks)** 6.2 mn FCEVs production by 2040. FC Power Generation target is 15 GW by 2040	Global leadership in EC, FCEV, Focus on Industrial Clusters	FCEVs through private sector collaboration and residential use/ building	**Largest FCEV Vehicle population**, focus on refuelling infra and H2 transport (gas/liquified).	Not articulated beyond H2-ICE engines, 2020 targets unmet; bus/vehicle prototypes
PUBLIC & INDUSTRY PARTNERSHIPS	NERA supporting SMEs; legal framework for large-scale production, H2 as energy carrier	**H2Korea PPP, HyNet SPV** – 13 companies, Hydrogen Law	Open, competitive H2 market by 2030; European Clean Hydrogen Alliance, Hydrogen Europe, FCHJU	**JapanH2Mobility (JHyM)** consortium – 11 companies	CEC Clean Transport 64 H2 refuelling program. US DOE Fuel Cell Tech Office H2@Scale research	MoUs with Japan, Korea, US and Australia on G2G collaboration
ECO-SYSTEM DEV STRATEGIES						

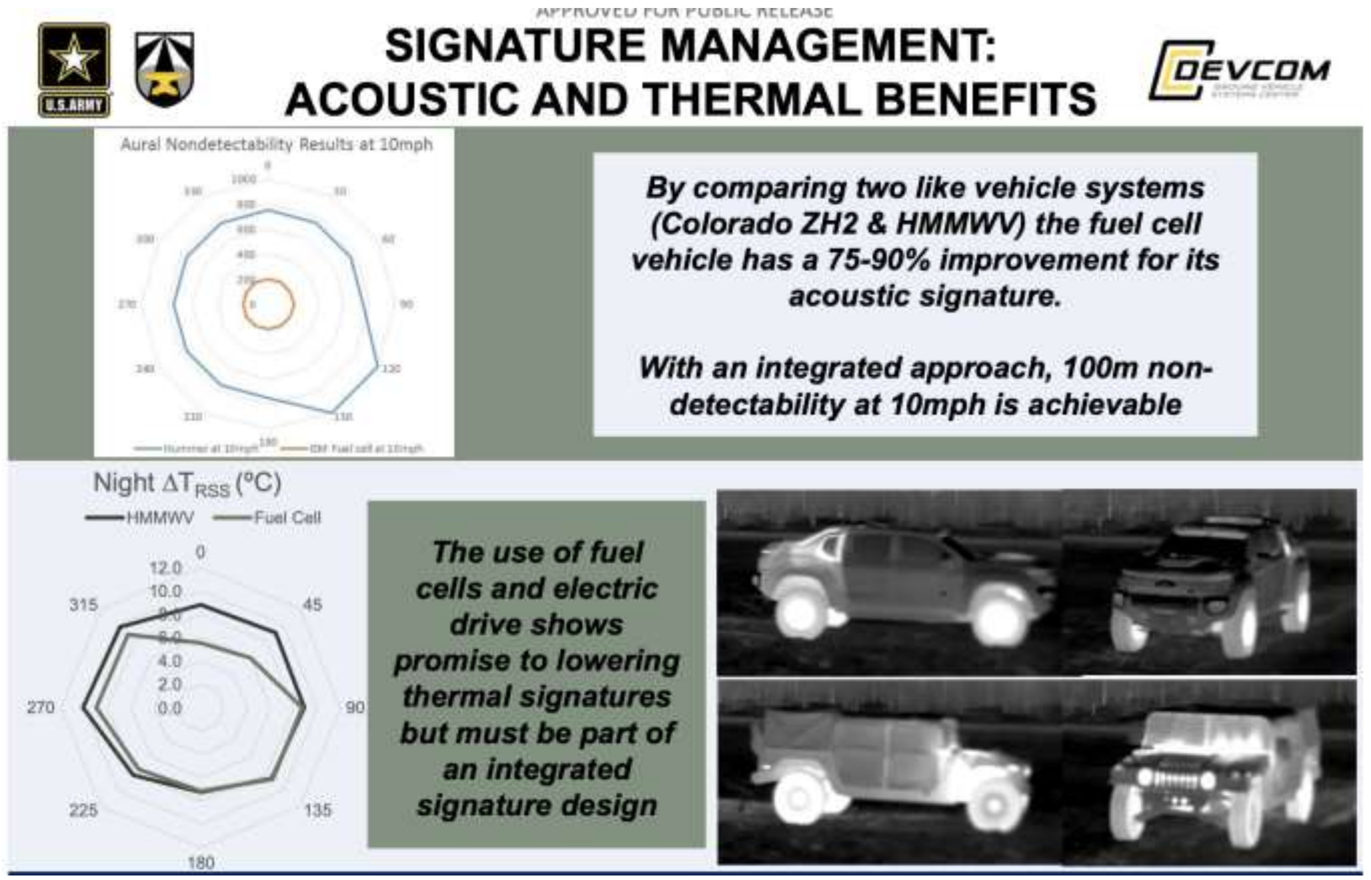
NOTE: In addition to above, China and Chile have announced country H2 plans as well.

Green Energy in Defense

Hybrid Tiger leverages NRL's Ion Tiger long-endurance hydrogen fuel cell demonstrator:

__26hr endurance__ on gaseous hydrogen, 2008

__48hr endurance__ on liquid hydrogen, 2010



Hybrid Tiger is Group 2 UAS with multi-day endurance

- 23 kg, 7.3 m wingspan autonomous air vehicle.
- Fuel cell and hydrogen fuel account for ~66% energy.
- Solar arrays in the wings account for ~33% energy.
- Environmental energy extraction via autonomous soaring capable of +50% endurance, depending on conditions.
- Energy-optimal guidance can reduce fuel consumption by up to ~30% depending on weather conditions.

Hydrogen Fuel Cells Could Power the navy's Future Robotic Submarine

Net Zero Emissions -

It is difficult, it is complex, it is costly but It is necessary

KEEP INNOVATING

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