Óleo de Motor Diesel para Serviço Pesado

Jorge A. Manes, Latin America OEM Advisor

Junho 21, 2023

13 Encontro Internacional com o Mercado – América do Sul

Rio de Janeiro - Brasil

Performance you can rely on.

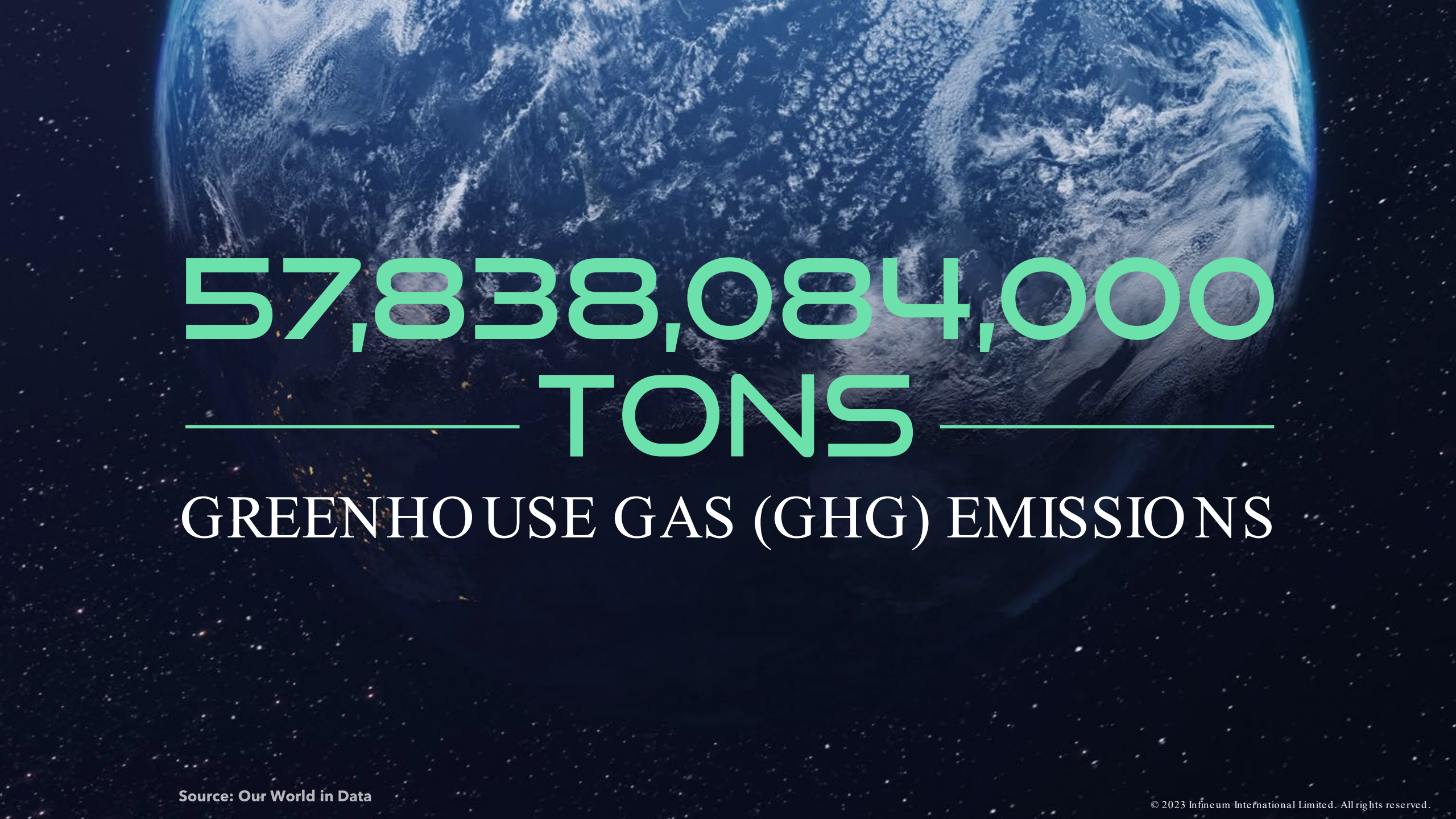
Drivers: Industry ambition towards net zero

We all want to live in a more sustainable world

There is an urgent need for action

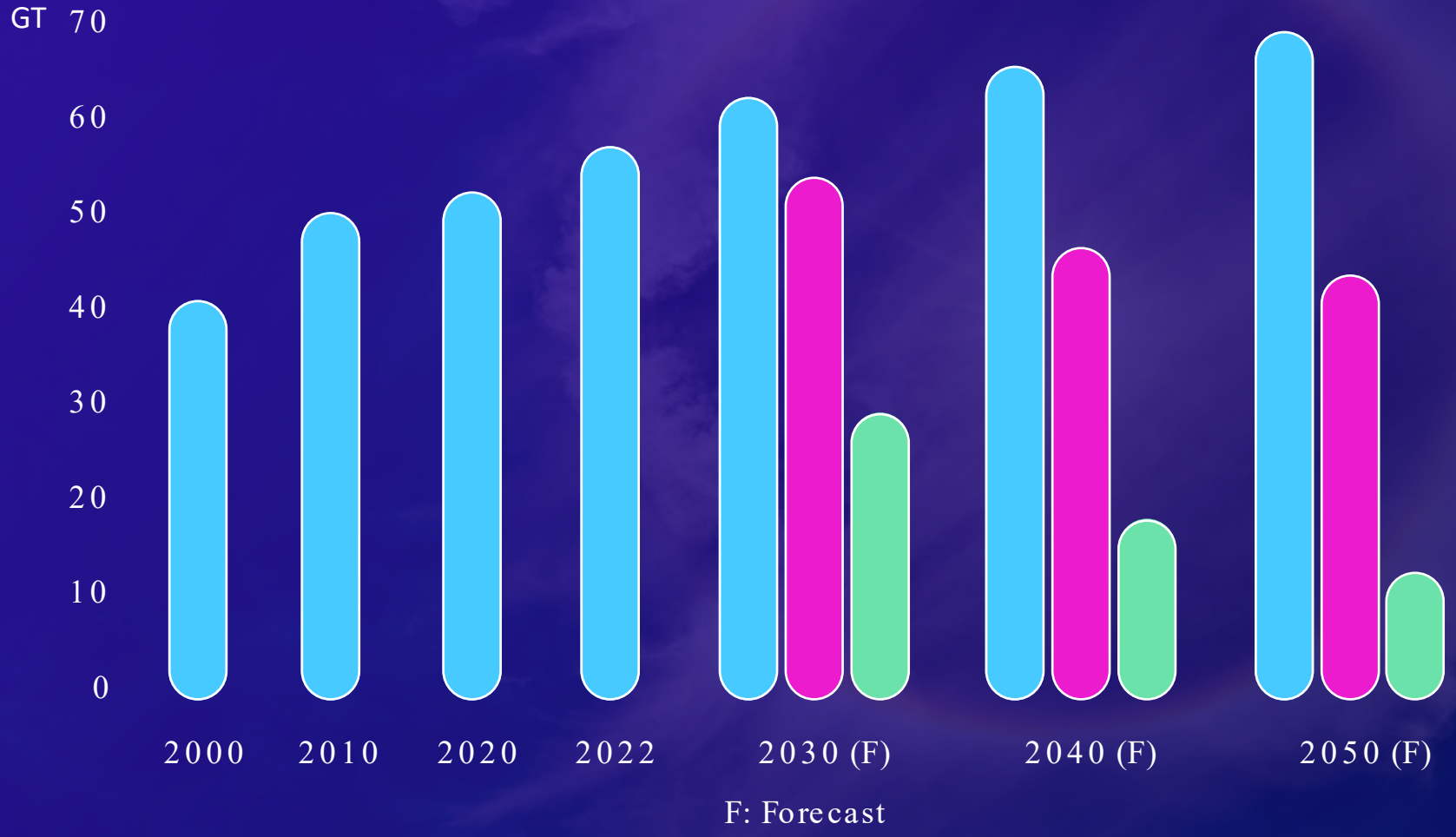
Many industry players are making strong environmental commitments across their entire value chain

But combined efforts are required for success



Source: Our World in Data

Global aggregate greenhouse gas (GHG) emissions



Business as usual

Future country emissions evolve similar to past trends

Do as promised

Countries fully implement the Nationally Determined Contributions (NDCs) they made to fight climate change

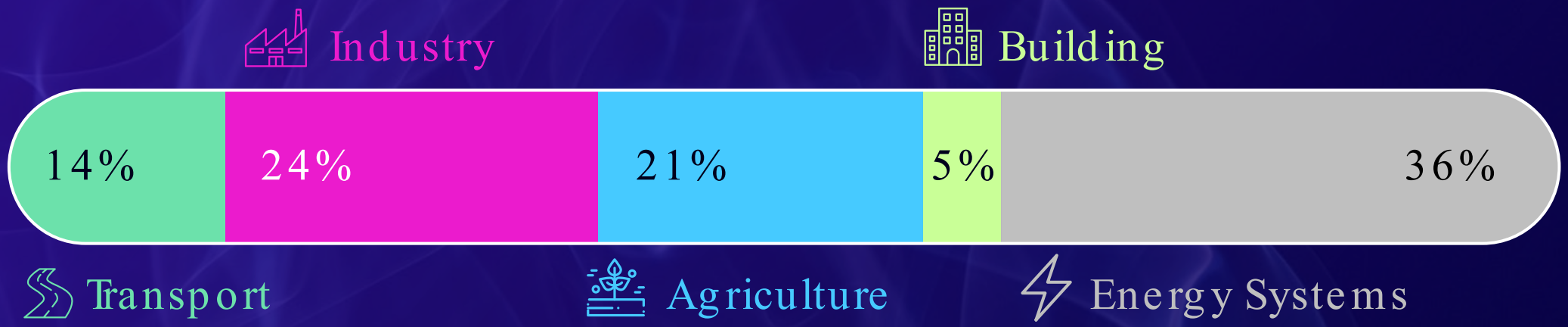
Meet Paris Agreement

What's needed to meet Paris Agreement goal

Source: World Emissions Clock by World Data Lab

Why transportation CO_2 emissions matter

Global GHG Emissions 2022



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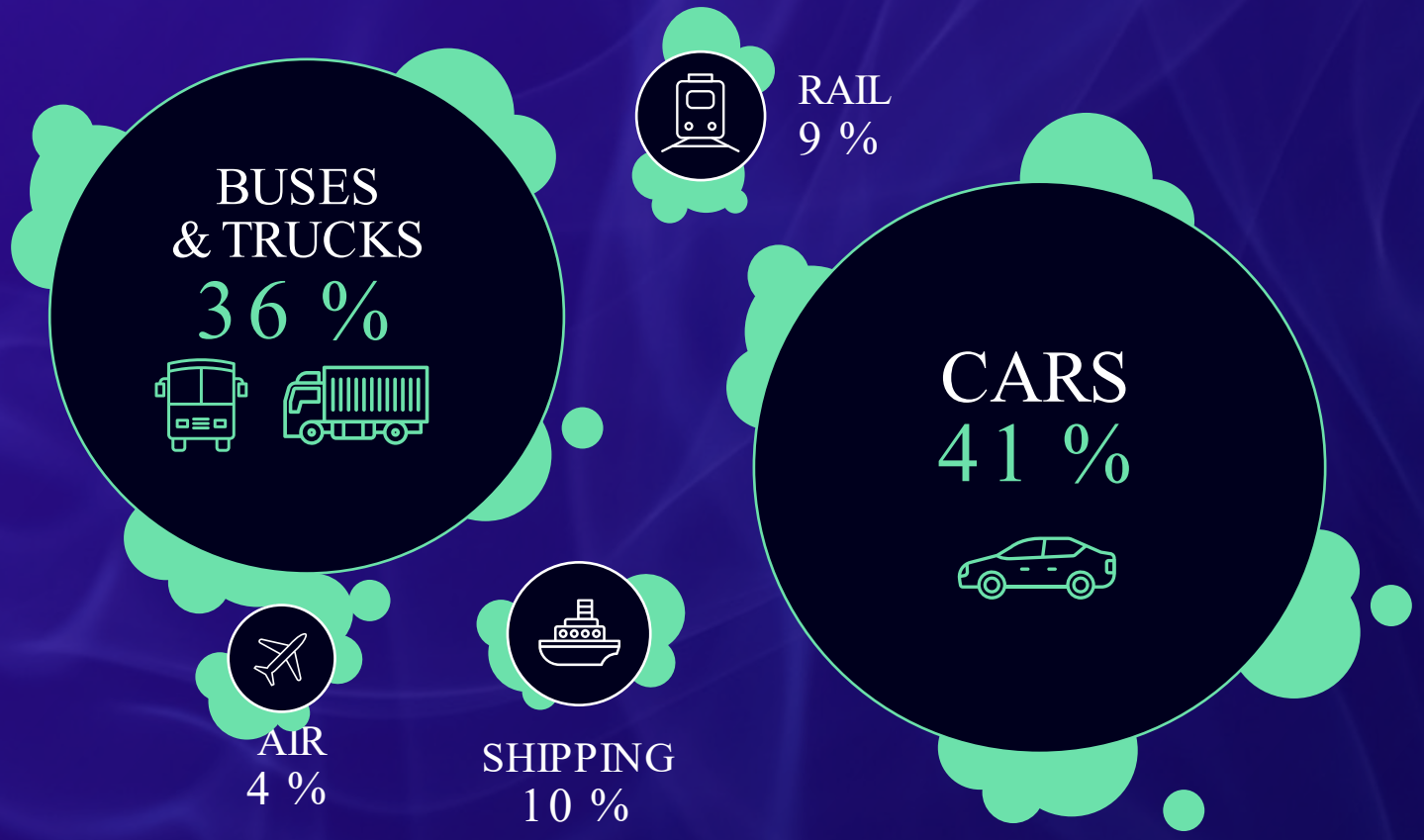
Why transportation CO_2 emissions matter

Global GHG Emissions 2022



14%

Transport

Source: World Emissions Clock by World Data Lab

HONDA

Vision to realize carbon neutrality for all products and corporate activities by 2050

GM

Vision to become carbon neutral in global products and operations by 2040

MITSUI

Goal to achieve net zero emissions as our Vision for 2050

DAIMLER TRUCK

By 2039, aim to achieve CO_2 neutral production at plants and business units worldwide

HYUNDAI

In progress to achieve carbon neutrality by 2045

STELLANTIS

Strategic plan to out CO_2 emissions in half by 2030, and achieve carbon net zero by 2038

RENAULT GROUP

Our challenge is to reach zero CO_2 impact by 2050 in Europe

GE

Ambition is to be a net zero company by 2050

TOYOTA

By 2050, we aim to eliminate CO_2 emissions from our value chain

TATA

Specific goal to achieve net zero greenhouse gas emissions by 2045

YAMAHA

Our goal is carbon neutrality by 2050

ISUZU

Aim for zero greenhouse gas emissions across the life-cycle of the Group's products by 2050

WÄRTSILÄ

Carbon neutral in our operations, and provide a product portfolio ready for zero carbon fuels

VW GROUP

Goal of becoming a company with a net carbon-neutral balance by 2050

FORD

Working to achieve carbon neutrality globally no later than 2050

MAZDA

Achieve carbon neutrality over the entire life cycle of vehicles and supply chain by 2050

NISSAN

Pledged to achieve carbon neutrality across its operations and life cycle of products by 2050

MAN-ES

By 2030, sustainable technologies and solutions will account for 70% of our business

BMW

Goal of complete climate neutrality by 2050 through entire value chain

Taking action today: The transition to net-zero

Full electrification is just one technology approach – issues with LCA and end user acceptance

Affordability

Range anxiety

Charging infrastructure

Paris Climate Agreement

The future is a multitude of technologies

Sustainability

Accelerating decarbonization of all transportation modes

Improve ICE

Expand hybrid production

Develop new fuels and infrastructure

- Multi-fuel
- Multi-hardware
- Multi-technology

Sustainability

Accelerating decarbonization of all transportation modes

Improve ICE

There is room for improvement, today

Diesel engine 50% efficient

Gasoline engine ~40% efficient

Expand hybrid production

Develop new fuels and infrastructure

- Multi-fuel
- Multi-hardware
- Multi-technology

Sustainability

Accelerating decarbonization of all transportation modes

Improve ICE

Expand hybrid production

Smaller batteries in more cars

Develop new fuels and infrastructure

- Multi-fuel
- Multi-hardware
- Multi-technology

Sustainability

Accelerating decarbonization of all transportation modes

Improve ICE

Expand hybrid production

Develop new fuels and infrastructure

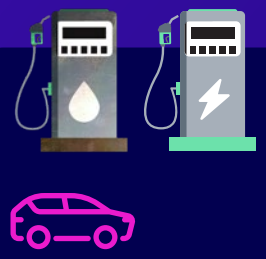
- Green hydrogen
- Green ammonia
- E-Fuels

Multi-fuel

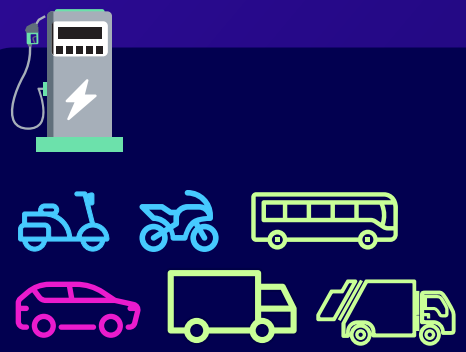
Multi-hardware

Multi-technology

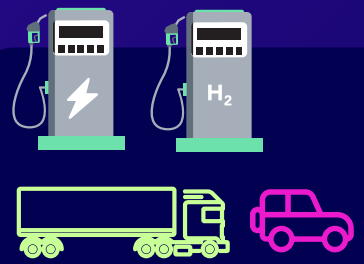
Multi-fuel, multi-technology future



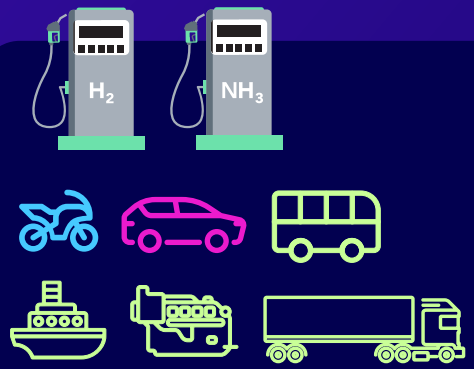
Plug-in hybrid



Battery electric



Fuel cell



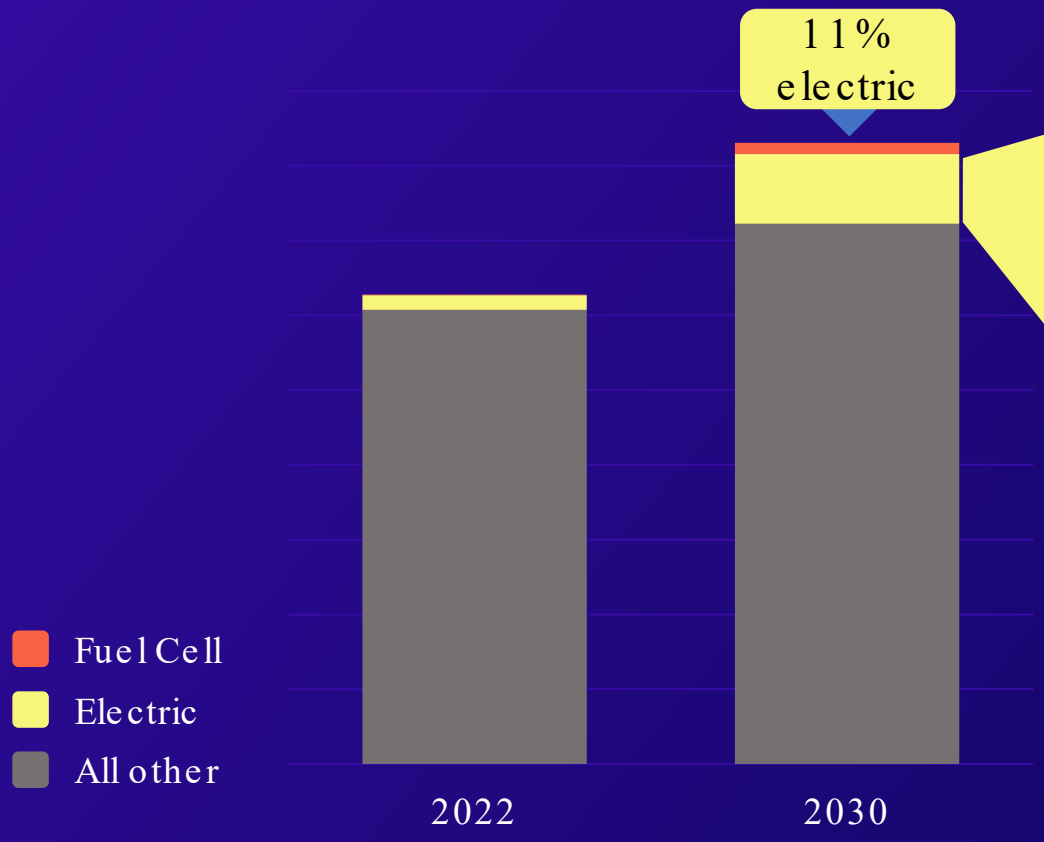
Ammonia/H2 ICE

ICE/hybrid synthetic fuel

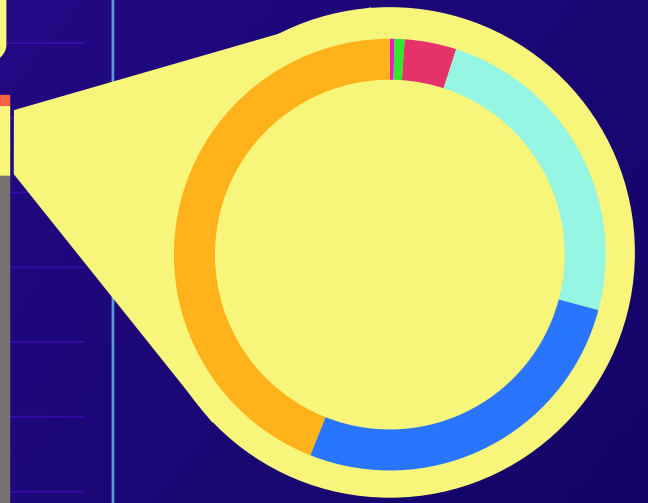
- Air quality
- Climate Change
- Sustainability
- Suitability

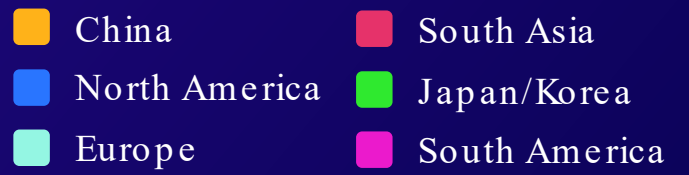
Limited BEV growth in commercial vehicles

Global production trends of trucks and buses



Truck and bus electric production 2030





Source: S&P Global, Light Vehicle Engine + Medium/Heavy CV Engine Production Forecast, May 2023

DR N. SARAVANAN

ASHOK LEYLAND

CHIEF TECHNOLOGY OFFICER

Commercial vehicle OEM activity

BYD

6,115 e-vehicle sales 2022 and 1st semi shipments

Nikola

Plans to ramp production up to 20,000/year

Freightliner

e-Cascadia testing complete – first orders received

Kenworth

T680e now in production

Volvo

e-trucks in series production & more models on the way

Scania

Introducing BEV-based solutions for regional long-haul

Mercedes Benz

e-Actros starts production in 2024

Peterbilt

579EV now shipping

Tesla

First semi delivery to PepsiCo in 2022

The future
a mix of technologies

Full electrification
is the answer
in some markets

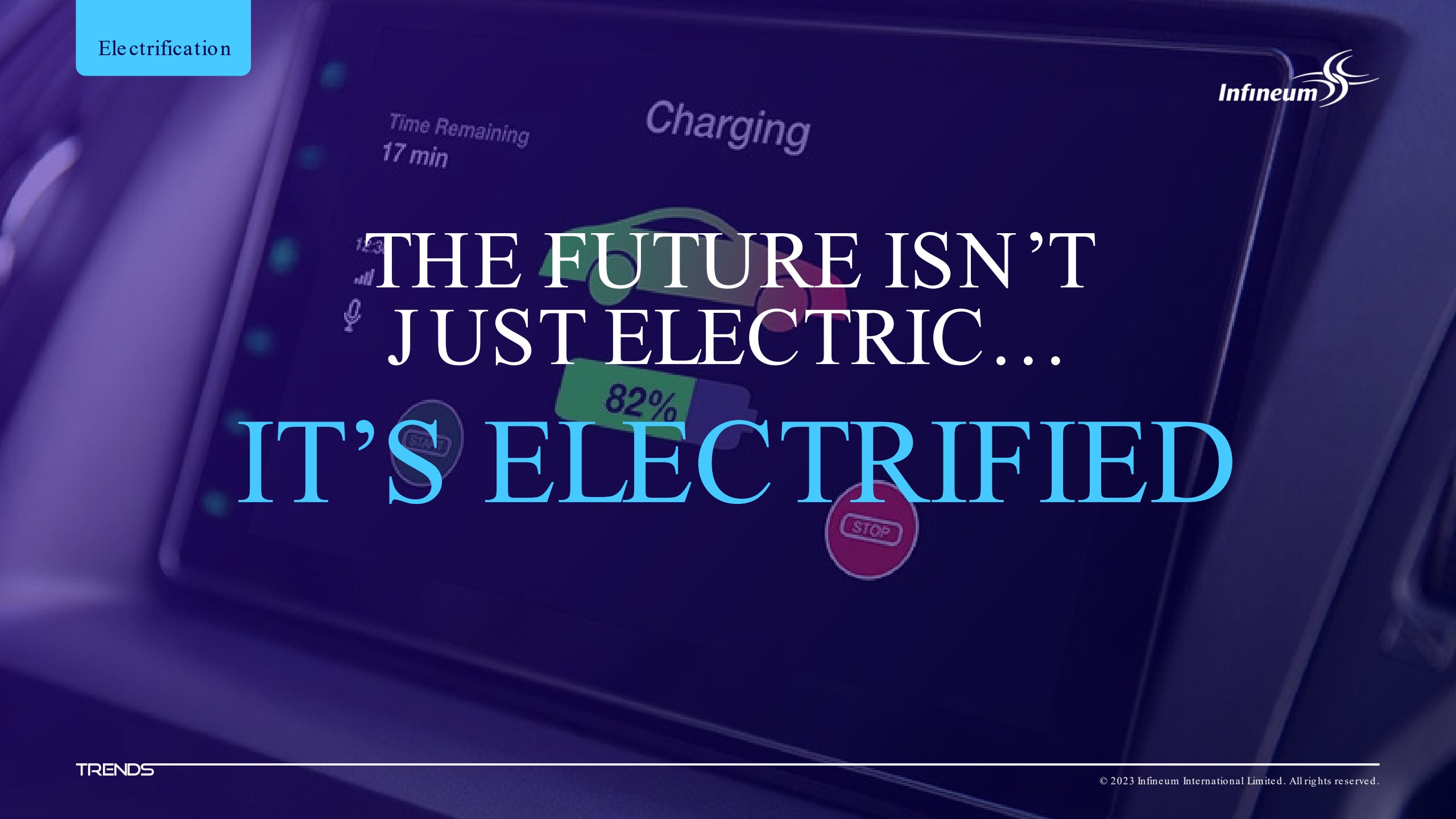
IT'S A GREAT FIT FOR:

- Two-wheelers and passenger cars
- Where electricity is generated from renewable sources
- Where sufficient infrastructure is available

Complexity is increasing and specialized e-fluids are needed

Expect a range of technologies to evolve to meet diverse customer and regional needs

The future will be a mixture of the best qualities of all the available technologies



THE FUTURE ISN'T JUST ELECTRIC…

IT'S ELECTRIFIED

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A multi-fuel, multi-technology future

ICE

Mild/full hybrid

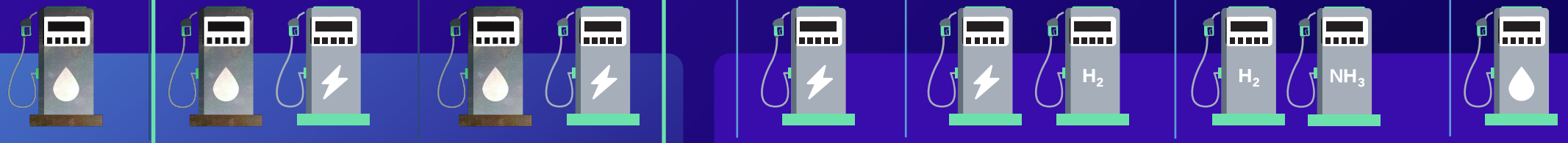
Plug in hybrid

Battery electric

Fuel cell electric

ICE hydrogen /ammonia

ICE/hybrid Synthetic fuel



Lower IN-USE CO_2 emissions TODAY

Zero IN-USE CO_2 emissions TODAY/FUTURE

Hybrids – a long bridging technology to net zero

The sweet spots

Bridging technology to full net-zero technologies

2 vehicles in 1:

Range & convenience
Lower CO_2 emissions

Areas with little e-recharging infrastructure

Cost sensitive markets

Wide range of applications

Mid - large size vehicles

Longer distances

Higher loads

Hybrid trucks activity

Hyliion

Class 8
Hypertruck ERX
production in 2023

Image courtesy of Hyliion

DAF

Testing **CF Hybrid**
10.8L PACCAR MX-11
diesel and 85 kWh battery

Image copyright © DAF Trucks N.V.

US Hybrid

Natural gas
powered parallel hybrid

Scania

Hybrid: full electric
60 km range
on 30 minute charge

Quiet zero emissions urban operation with extended ICE range

Hybrids in other transport applications

Kawasaki

Hybrid in 2024 product range

Other OEMs

Yamaha & others plan to launch hybrid models

Yutong

11,966 new energy vehicle sales in 2022

Mercedes

Citaro hybrid up to 8.5% fuel saving vs Euro VI diesel

Volvo

Hybrid running on biofuel can cut CO_2 by ~60% vs. a diesel bus

MAN ES

Hybrid delivers 10% savings on fuel oil

Wärtsilä

Marine industry's largest 11.5 MWh hybrid vessels

Lower emissions, longer range and well understood hardware

Advanced ICE Technology

DRIVERS

Emissions regulations

Euro 7
Bharat Stage 6
China 6
US EPA '27

Decarbonization

Tightening CO_2 and fuel economy mandates

Sustainability commitments

Reduce
Reuse
Recycle

End-user requirements

Efficiency
Reliability
Lower running costs

SEVERITY

Testing under real driving conditions

Longer in-service life

On board monitoring

Hardware innovations

Lubricant specification revisions

New lubricant challenges

Advanced ICE Technology

Commercial Vehicles

Infineum

Fuel efficiency vs. previous generation

Daimler Truck 3rd generation OM471

+4%

- Higher compression ratio
- Turbo-charging optimization
- New aftertreatment
- New engine oil pressure control
- Low viscosity lubricant

Daimler Truck New Western Star 57X long-haul

+6%

- Advanced AMT
- Intelligent powertrain management
- Advanced **aerodynamics**

Navistar S13 integrated powertrain

+15%

Reduced weight, low friction materials & finishes

Achates Power

+10%

Opposed piston engine field trials

MAN TGX New D26 engine

+4%

Aerodynamics

Downspeeding **Lighter**

Scania Super 13L engine

+8%

Improved combustion injectors, fuel pump & cooling

SUPERTRUCK II CONCEPTS Freightliner

+5.7%

- Reduced **aerodynamic** drag
- Downspeeding
- Tandem axels
- 48V electrical systems
- Smart oil circuit

SUPERTRUCK II CONCEPTS Peterbilt

+TBA

- Improved **aerodynamics**
- 48V mild hybrid powertrain
- **Waste heat recovery**
- **Lightweight** chassis

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PACE OF SPECIFICATION CHANGE IS ACCELERATING

PASSENGER CARS

2025 proposed
ILSAC GF-7

LSPI throughout lifetime in vehicle

Lower MRV

Durability Improvement

Better fuel economy

Est. 2027
dexos®1 Gen 4

Est. 2028
ILSAC GF-8

COMMERCIAL VEHICLES

2027
API PC-12

Two new categories

Lower HTHS

Wear & oxidation performance

Seals protection

Tighter chemical limits

New and replacement tests

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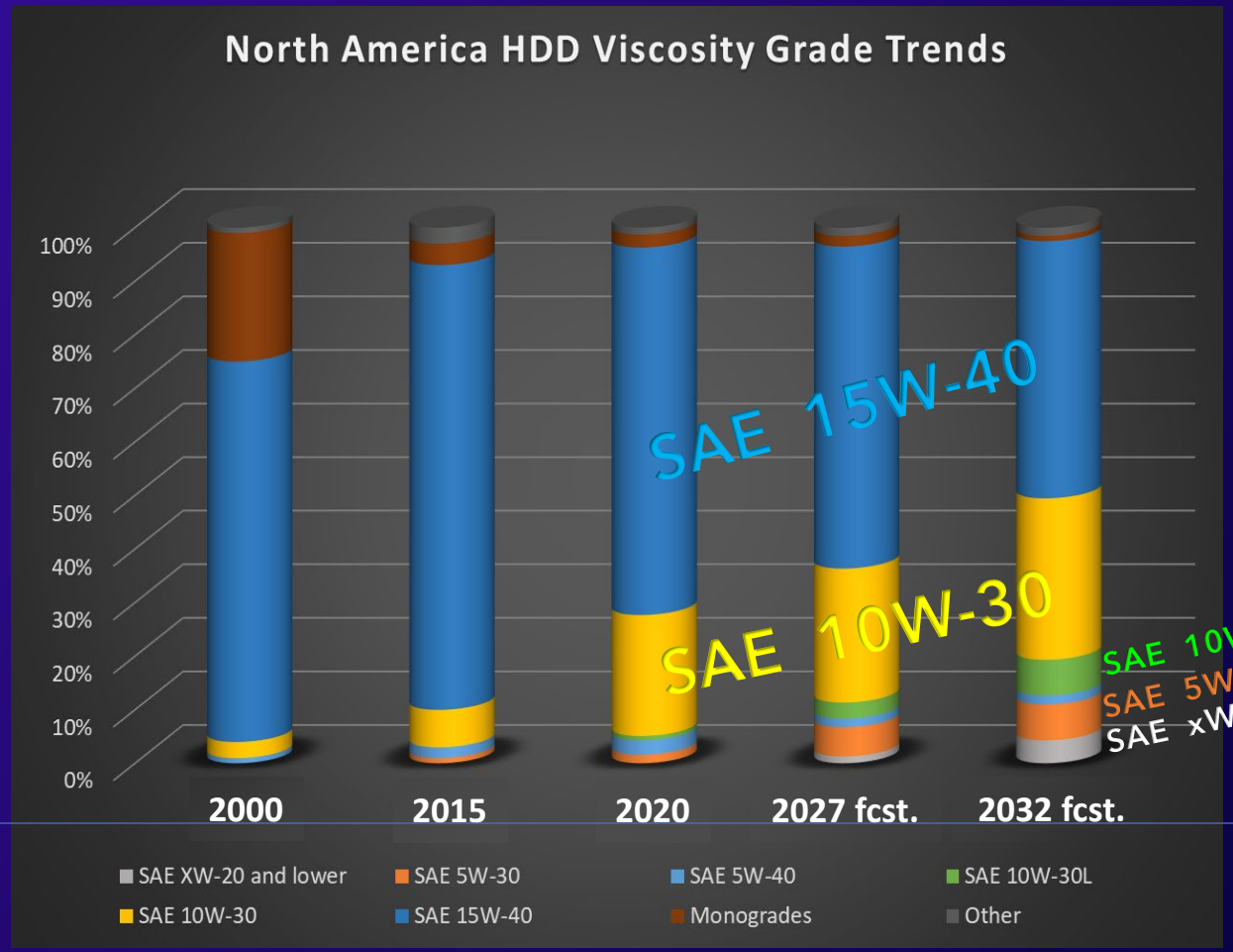
Growth of lower viscosity grades is happening

Heavy-duty motor oil

Notable fuel economy benefits moving fleets from SAE 15W-40 to lower viscosity grades

- SAE 10W-30 and lower grades grow at expense of SAE 15W-40
- SAE 5W-XX grades grow slowly
- SAE XW-20 oil enter with PC-12
- API "F" oils will slowly grow



Powering the future

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A multi-fuel, multi-technology future

ICE

Mild/full hybrid

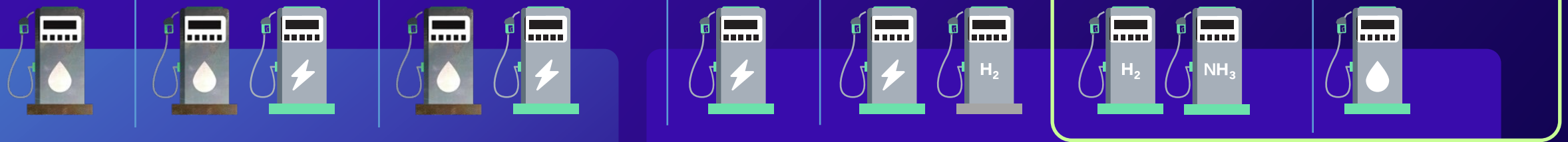
Plug-in hybrid

Battery electric

Fuel cell electric

ICE hydrogen /ammonia

ICE/hybrid Synthetic fuel



Lower IN-USE CO_2 emissions TODAY

Zero IN-USE CO_2 emissions TODAY/FUTURE

Cleaner and more sustainable fuels support the transition to net zero

Synthetic fuels

- e-methane
- e-methanol
- e-kerosene
- e-diesel
- e-gasoline

Advantages ↑

Potentially carbon neutral if produced with renewables

—

Abundant raw materials – waste/atmospheric CO_2

—

Easy and affordable for ICEs

—

Existing infrastructure can be used

Disadvantages ↓

Not carbon zero

—

Energy intensive production

—

Expensive to produce

—

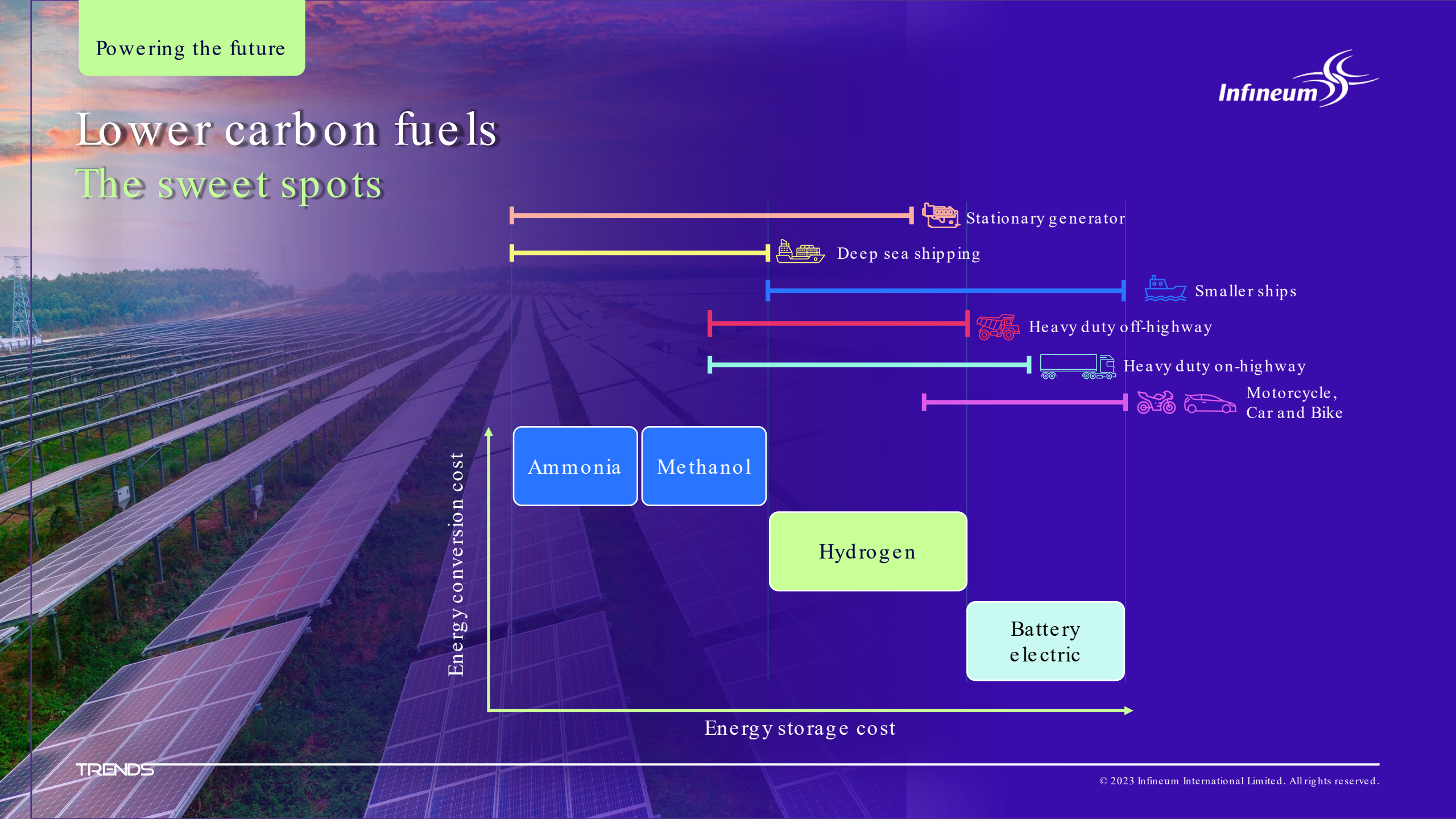
Investment to scale

By 2070 e-kerosene (SAF) may meet 40% of aviation energy demand

SAF = Sustainable Aviation Fuel

Lower carbon fuels

The sweet spots



Powering the future

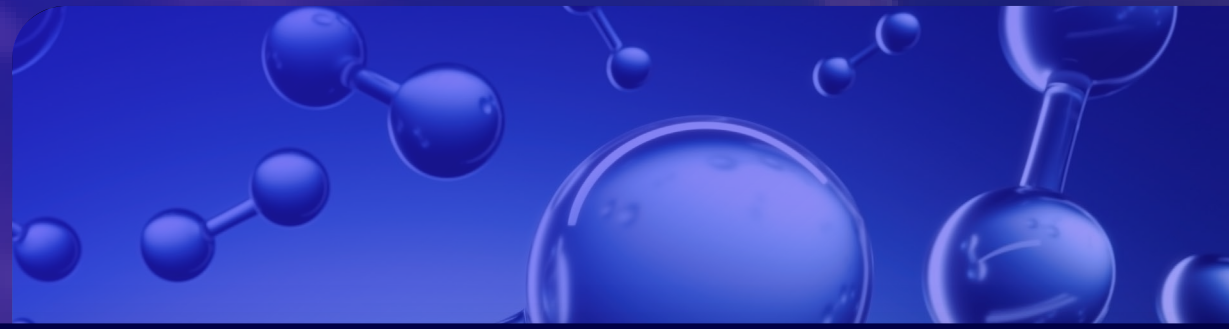
Growing interest in hydrogen

Advantages ↑

- Zero carbon emissions
- Renewable resource
- No range anxiety
- Fast filling

Disadvantages ↓

- Cost and availability
- Energy intensive production
- Investment needed in infrastructure
- High initial fuel cell vehicle cost
- Safety – flammability
- Storage – leakage and volumes



9.2% Annual growth expected in hydrogen production market

700 H_2 filling stations in 2021

23k Could be in use globally by 2040

H_2 Powered vehicles set to grow in all transport modes

Hydrogen ICE (H2 ICE) vs. Fuel Cell

Hydrogen is an excellent combustion fuel

—

Forms even mix in air quickly

—

Wide flammability range

—

Low ignition energy

—

High laminar burning velocity

—

Very high research octane number RON 130

Advantages ↑

Mature hardware technology

—

Proven performance and durability of engine

—

High efficiency at full load

—

Low sensitivity to fuel quality

—

Lower lifecycle emissions

—

Established supply chain

—

Existing skilled workforce

—

Low risk

—

Fit for purpose

—

Cost savings

—

Retrofit existing ICEs

OEMs investing in H2 ICE technology

Debit vs. fuel cell ↓

Efficiency

—

NOx emissions

Hydrogen ICE in Heavy-duty trucks

Cummins/Tata collaboration
includes H2ICE

Tata
India's first hydrogen ICE powered concept truck

HyCET collaboration
Two 18t and two 40t trucks + infrastructure

HyTrucks
Cummins /Scania

SINOTRUK & Weichai
Launch H_2 Yellow River Truck

DAF
Hy Trucks XF
H_2 Innovation Truck prototype

Scania/Westport
Demonstrator trucks unveiled

Strong interest in China
Yuchai, FAW, GAC,

H_2 opposed piston engine
working group launched

Challenges of H2 ICE

	Pre-ignition	Water accumulation	Aftertreatment protection
	Knocking Engine damage	Separation Freezing Corrosion White sludge	No carbon emissions Less NOx management Could eliminate need
	Fuel mixing Piston design Spark plug design	Duty cycles	Legislation Customer perception
Formulation	Metals balance Viscosity Deposit control	Viscosity control Corrosion inhibitors Emulsifiers	Lower SASH Depends on technical response to legislation

Fuel economy improvement and lubricant reformulation required

Infineum

Increasingly complex fuels picture ahead

Not sustainable
Higher CO_2 emissions

- Gasoline
- Diesel
- Natural gas
- Electricity: fossil fuels

Transport continues to rely on oil products for 91% of its final energy

Not sustainable
Lower/zero CO_2 emissions

- Electricity: nuclear
- Blue hydrogen
- Blue ammonia
- Methanol
- LPG

Sustainable
Lower CO_2 emissions

- Renewable biofuels
- Electricity: chemical/gas waste
- Bio-ethanol
- Renewable CNG
- Bio-butanol
- Synthetic fuels
- Green methanol

Sustainable
Zero CO_2 emissions

- Electricity: Wind/solar/hydro
- Wind propulsion
- Green hydrogen
- Green ammonia

Commercialization and scale up of new fuels is essential

Towards net zero and sustainability

Summary

An increasingly complex world

Focus on sustainability and environmental protection

ICE remains significant even with electrification

Advanced lubricants are needed

- Hardware innovation
- Engines in use

Future lubrication challenges

Changing specifications	Increasing number of tests	Increasing performance requirements
Maintaining performance over longer periods	Formulation envelope closing	More base stock types and qualities
More fuel types and qualities	Wider viscosity grades – old and new vehicles	Restrictions on raw materials