Innovation in Sustainable Fuels

Session 1 – Advanced Renewable Gasoline

Document prepared by Zemo Partnership

Tuesday 23rd March 2021

Gloria Esposito, Head of Sustainability
Zemo Partnership

Gaynor Hartnell, CEO, RTFA

Zemo Partnership
Accelerating Transport to Zero Emissions

Renewable Transport Fuel Association

Today's Agenda

10:30am	**Welcome and housekeeping**	**Gloria Esposito, Head of Sustainability, Zemo Partnership** **Gaynor Hartnell, CEO, RTFA**
	Session 1 Chair	Steve Sapsford, Managing Director, SCE
10:35 am	Introduction to alcohol to bio-gasoline	David Richardson, Business Development Director, Coryton
10:50 am	Prospects for using bioethanol in heavy duty vehicles	Sam Cockerill, CEO, Libertine
11:05 am	Application of bio-gasoline to a future hybrid powertrain	Adrian Cooper, Head of New Technology & Data Management MAHLE Powertrain Ltd
11:20 am	Adoption of advanced renewable gasoline in motor sports	Pat Symonds, Chief Technical Officer, F1
11:35 am	Panel Discussion	
12:00 pm	Session wrap up and next session	Gloria Esposito, Head of Sustainability Zemo Partnership

All attendees on mute, camera turned off, enter your questions in the chat box

CORYTON

FOR A CLEANER FUTURE

Overview

- Coryton is an advanced fuel supplier focused on formulating and blending speciality and performance fuels
  - 1 litre to over 1 million litres
    - Reference fuels
    - Bespoke fuels
    - Sustainable fuels
- We provide the essential technical expertise and products to support world-leading development and validation across the following sectors
  - Automotive and motorsport
  - Heavy duty
  - Aviation and marine

15 million litres	**3,000** blends
11 countries	**56** people

KEY MARKET SEGMENTS

We operate in six key categories.

RESEARCH

Bespoke solutions, created with partners who lead the way in the development of a more sustainable future through lower carbon emissions.

HEAVY DUTY

Creating unique solutions needed to pioneer ever-better fuel economy, emission performance and power generation.

LIGHT DUTY

Specialist fuel solutions that enable the automotive industry to constantly innovate the future of travel.

MARINE

Developing low-carbon fuels and future solutions for the next generation of marine engines.

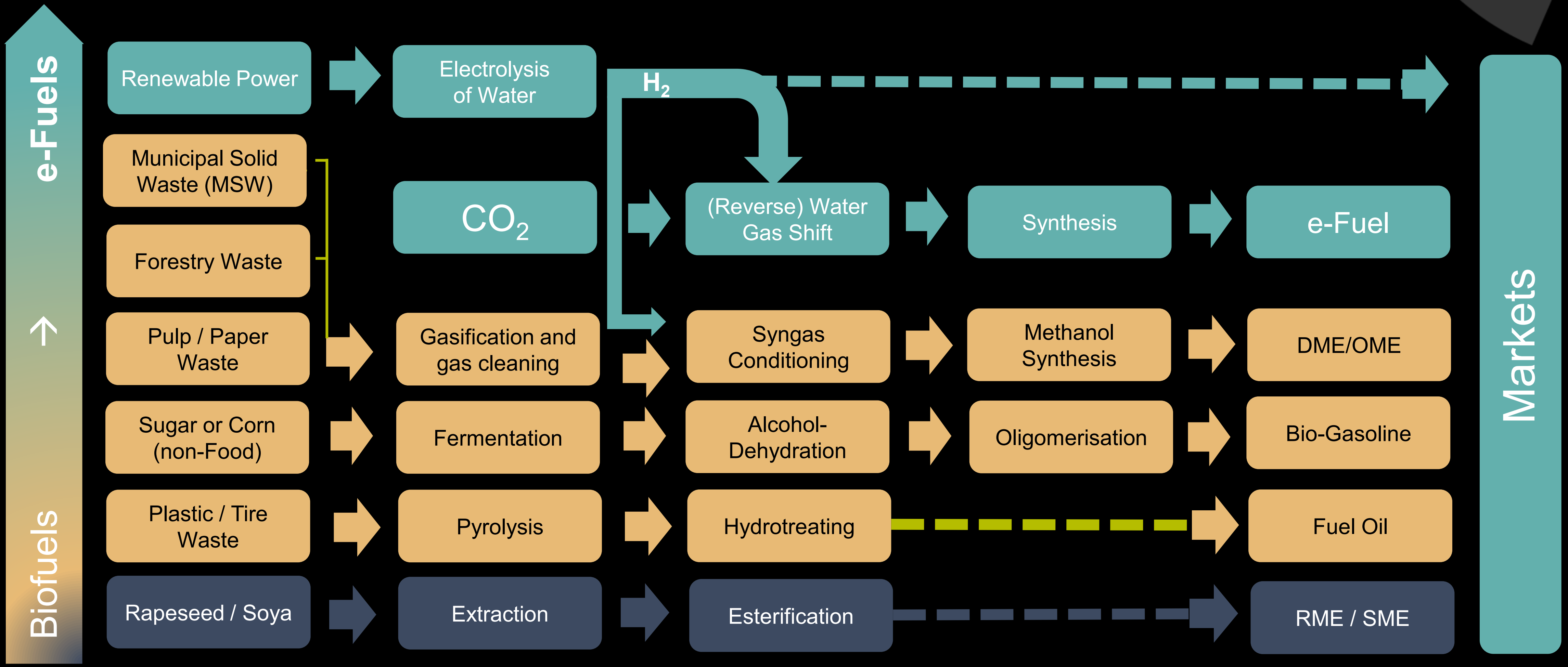
MOTORSPORT

Formulating the most innovative fuels that drive the highest levels of performance whilst minimising carbon emissions.

AVIATION

Delivering state-of-the art hydrocarbon blends designed specifically for the unique demands of the aviation sector.

PATHWAYS TO SUSTAINABLE FUELS



Future Technologies - Gasoline

Product	Operational	Technology	Pot. Timeline
Bio-Gasoline (EtG)	Yes	Alcohol Dehydration	Available in Mill's L/ a
Bio-Gasoline (MtG)	Yes (in demo scale)	Gas-To-Liquid	Available in limited amounts / Commercialisation planned in 5 – 10 years
Bio-Gasoline or Bio-Jet	Yes (in demo scale by KIT (Karlsruhe Institute of Technology))	Fast Pyrolysis	Only R&D volume
Power-to-Chemicals	Yes (in demo scale by for example Siemens / Evonik)	Synthesis	Only R&D volume / Small amount of Bio-Aromatics could become available soon

Future Technologies - Diesel

Zemo Partnership

Product	Operational	Technology	Pot. Timeline
HVO	Yes	Hydrotreated	Available
Bio-Diesel	Yes (in demo scale)	Hydrothermal Liquefaction	Available in limited amounts / Commercialisation planned in >15 years
Diesel from Circular Economy	In development to meet EN590	Pyrolysis using plastic	Volume available (120k MT/ a), but currently low quality and sustainability credits to be agreed.

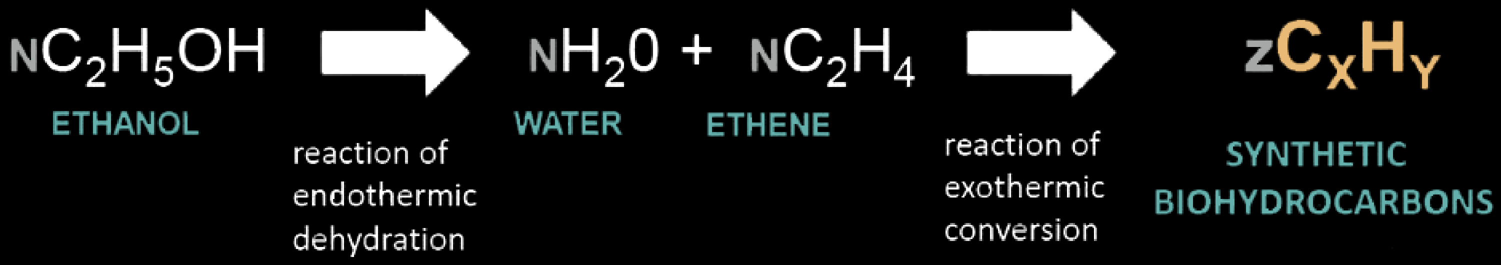
GASOLINE PRODUCTS EXAMPLES

Now very limited biocomponents and streams exist for gasoline applications
Coryton is in the lead developing bio/regenerative –sources with our suppliers

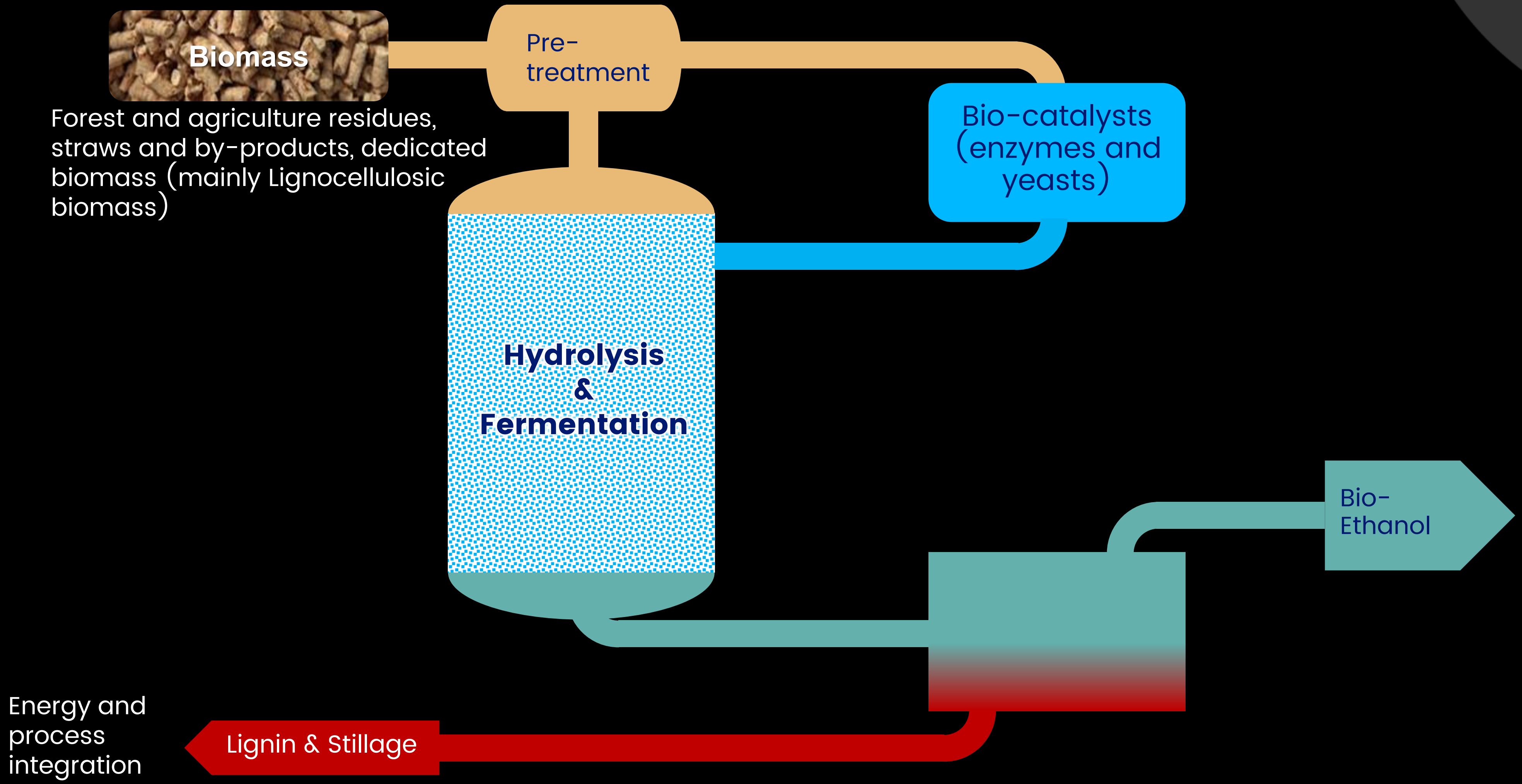
Recent developments:

- 102RON market introduction demonstration fuel (50% Bio)
- 98RON possibilities proposed and tested already (80% Bio)
- 95RON 100% Biofuel possible (95 RON E10)

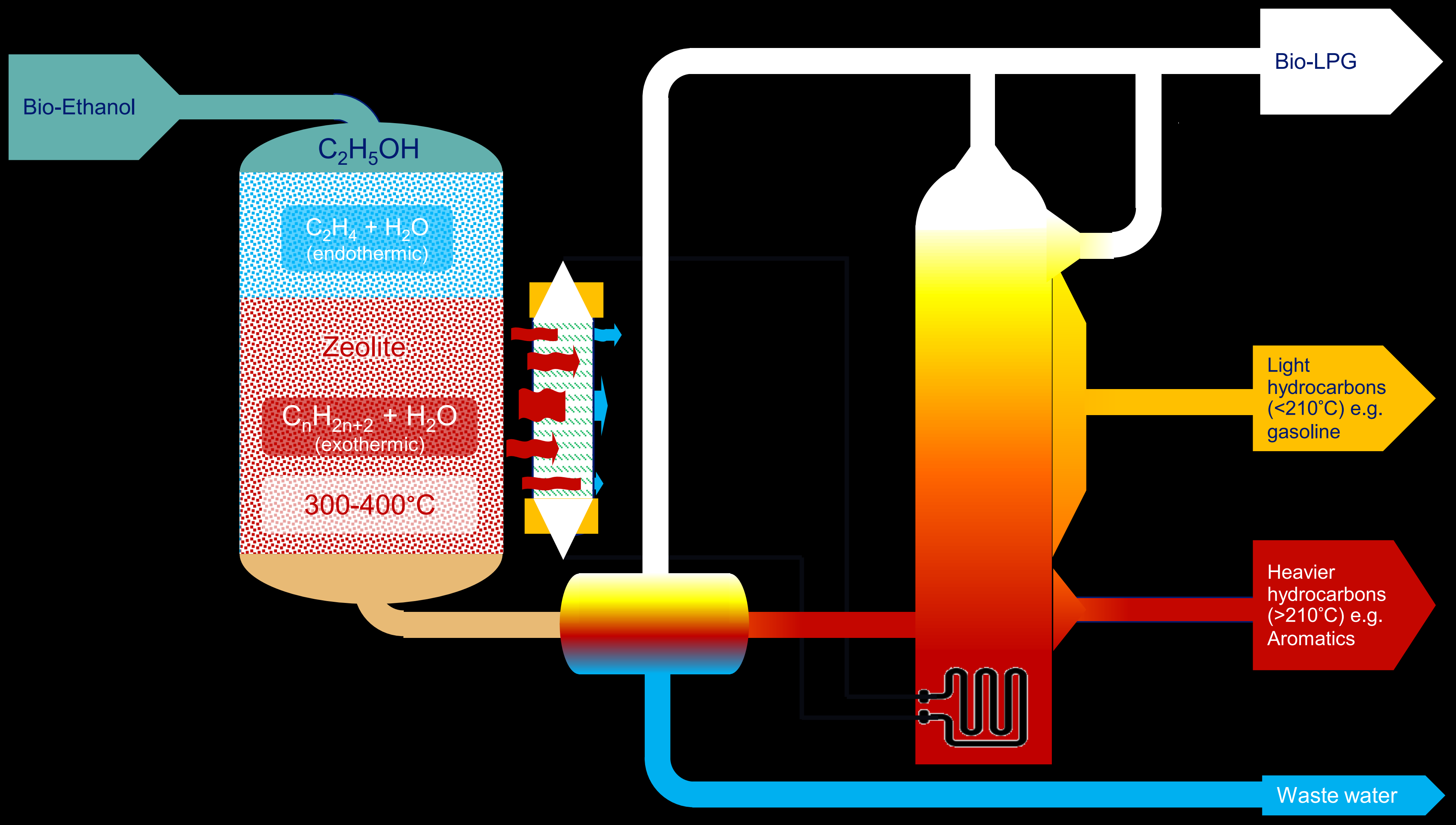
- ETG (Ethanol-To-Gasoline) available now and technology optimized by Coryton
- MTG (Methanol-To-Gasoline) research fuels are being developed now
- Other renewable components can be considered, e.g. Bio Iso-Octane, ETBE



BIOMASS-TO-ETHANOL CONVERSION PROCESS

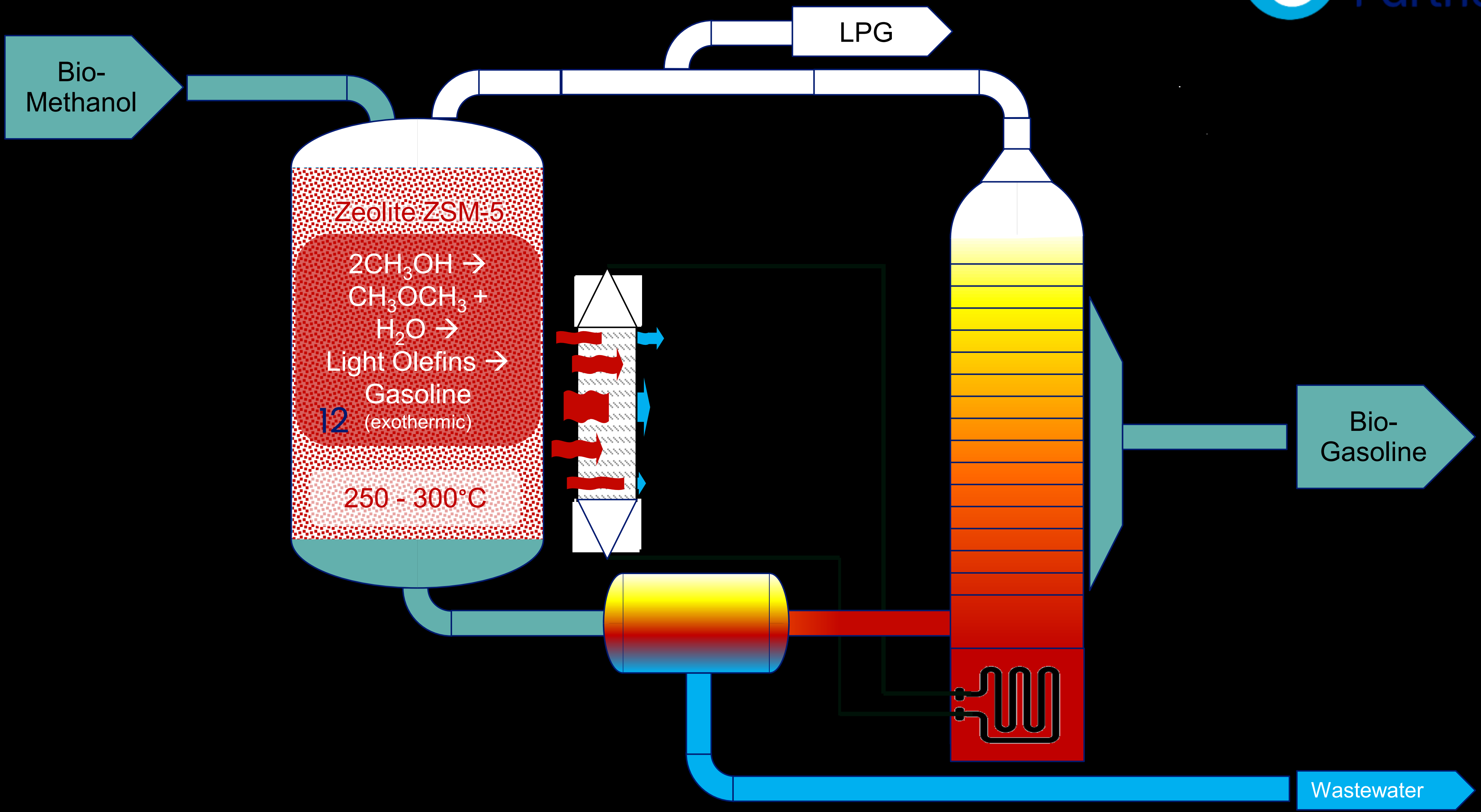


ETHANOL-TO-GASOLINE CONVERSION PROCESS



Stage 2: Bio-Methanol-To-Bio-Gasoline Conversion Process

E- fuel



ENGINE STUDIES

A number a fuel variants have been used in test bench and real-world studies, concentrating on the European market.

Property	EN228 drop-in bio-gasoline fuel specifications		
	95RON E5	98RON E5	98RON E10
Total Bio-Content (%)	88.8	71.8	73.5
Alcohol Content (% v/v)	5	5	10
RON	95.4	97.7	99.0
MON	85.2	86.5	85.3
Net Cal. Value (MJ/kg)	42.0	41.9	41.3
Aromatics Level (% v/v)	34.5	34.6	24.5
GHG Savings (RED II) (%, basis 94.0g CO_2e/MJ)	~80	~65	~66

The advantages of this route are many but cannot be realised until the main issues are addressed

Advantages

- Drop-in fuel
  - No changes to engine systems, components or calibration required
- Significant GHG savings
  - 95RON E10 could have 100% 2G bio-content saving 95% GHG emissions (RED II)
- Increase bio-content beyond E5 or E10
  - Blending into main gasoline component
- Can start to address GHG emissions of existing and future fleet now
  - 300 million light duty vehicles in Europe

Disadvantages

- Accountability
  - Who is incentivised to make this happen? Who is accountable if it does not?
    - CO2 still emitted *at the tailpipe*
    - Cannot control what fuel is put in the car after dealerships
- Availability
  - Lacking incentives and business case to scale up to retail size
- Cost
  - As above
- Unknown long-term effects
  - As above

THANK YOU

CONTACT DETAILS

Name: David Richardson
Role: Business Development Director
Mobile: +44 7714203029
Email: David.richardson@coryton.com

Name: Arne Gimmini
Role: Head of Technical Services
Mobile: +44 7542417909
Email: arne.gimmini@coryton.com

Bioethanol use in heavy duty vehicles

Sam Cockerill CEO, Libertine FPE sam.cockerill@libertine.co.uk

Why bioethanol?

- Renewable source & net-zero compatible

Why bioethanol?

Zemo Partnership

- Renewable source & net-zero compatible
- High efficiency, clean burning combustion, SI/CI/HCCI
- Potential for EuroVII without aftertreatment
- Potential for blends with e-methanol ‘Liquid wind’

Why bioethanol?

- Renewable source & net-zero compatible
- High efficiency, clean burning combustion, SI/CI/HCCI
- Potential for EuroVII without aftertreatment
- Potential for blends with e-methanol 'Liquid wind'

- Energy density 4.7x hydrogen at 700 bar
- Safe, low cost storage & handling

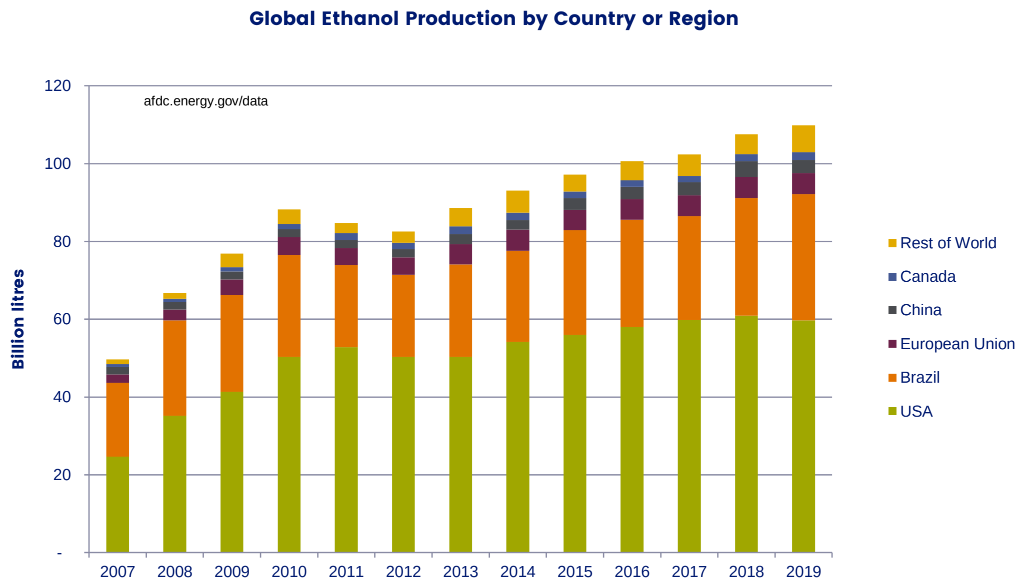
	Energy density (MJ/L, LHV)
Diesel	36.0
Gasoline	32.3
LPG propane	23.6
Ethanol	**21.2**
LNG	20.8
DME	19.2
Methanol	15.6
CNG	9.0
Hydrogen at 700 bar	**4.5**

Why bioethanol?

- Renewable source & net-zero compatible
- High efficiency, clean burning combustion, SI/CI/HCCI
- Potential for EuroVII without aftertreatment
- Potential for blends with e-methanol ‘Liquid wind’

- Energy density 4.7x hydrogen at 700 bar
- Safe, low cost storage & handling

- Diverse & mature global supply >100bn litres p.a.
- World-scale producers in UK & established global trade

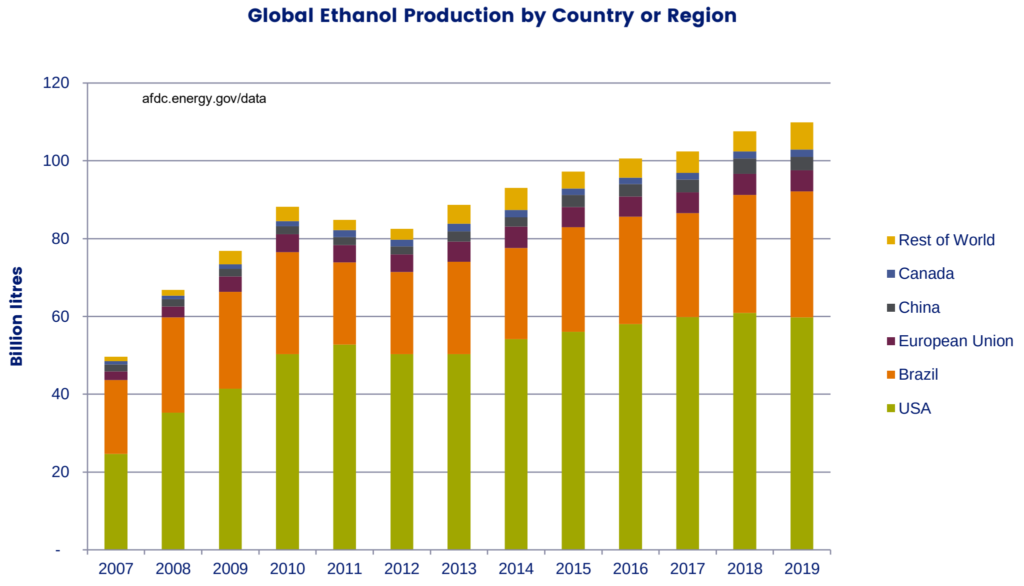


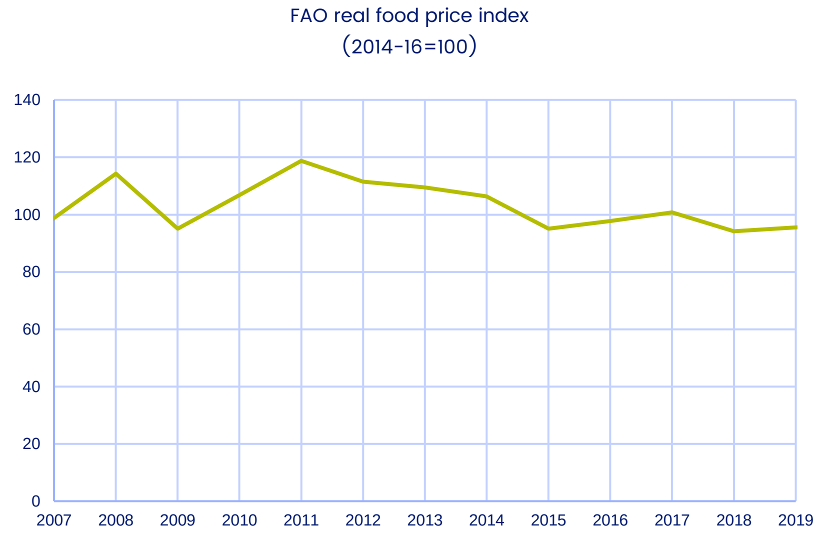
Why bioethanol?

- Renewable source & net-zero compatible
- High efficiency, clean burning combustion, SI/CI/HCCI
- Potential for EuroVII without aftertreatment
- Potential for blends with e-methanol 'Liquid wind'

- Energy density 4.7x hydrogen at 700 bar
- Safe, low cost storage & handling

- Diverse & mature global supply >100bn litres p.a.
- World-scale producers in UK & established global trade
- No apparent link between bioethanol & food prices





The problem

- 2050 truck fleet must be net-zero
- This requires rapid deployment of fossil-free capable trucks by 2030

Payload

Unproductive miles

Unproductive hours

Battery electrification is not enough

Vehicle cost

Charging infrastructure

Available to buy

"The shift to decarbonised transport and logistics must be driven by demand and affordability: Those who operate trucks will not invest in zero-emission technologies if there is no straightforward and affordable way to run, refuel and recharge them"

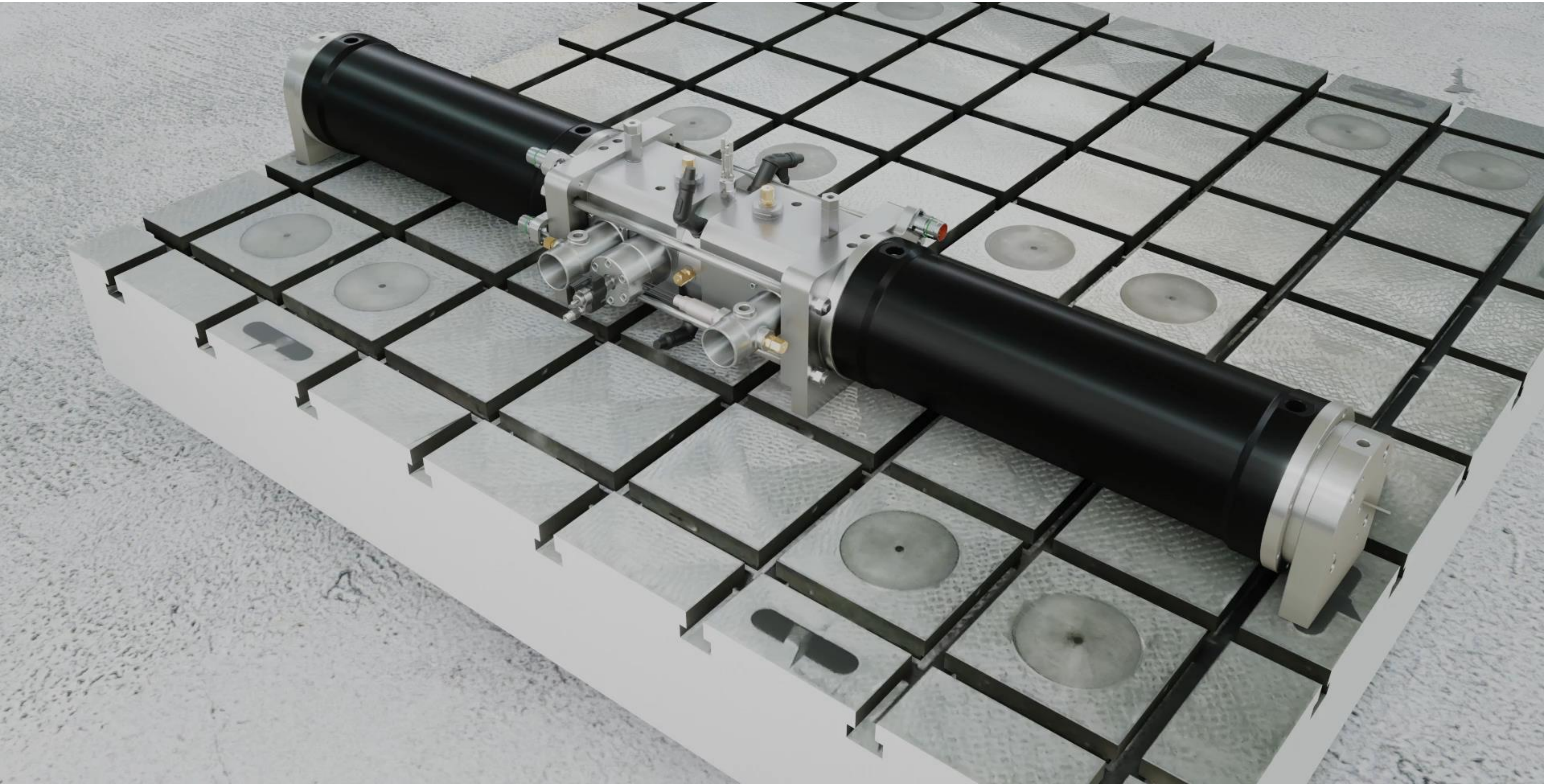
December 2020 joint statement by DAF, Daimler, Ford Trucks, IVECO, MAN, Scania and Volvo Group

Libertine's solution will reduce the cost and accelerate the delivery of net-zero in heavy duty commercial and off highway vehicles

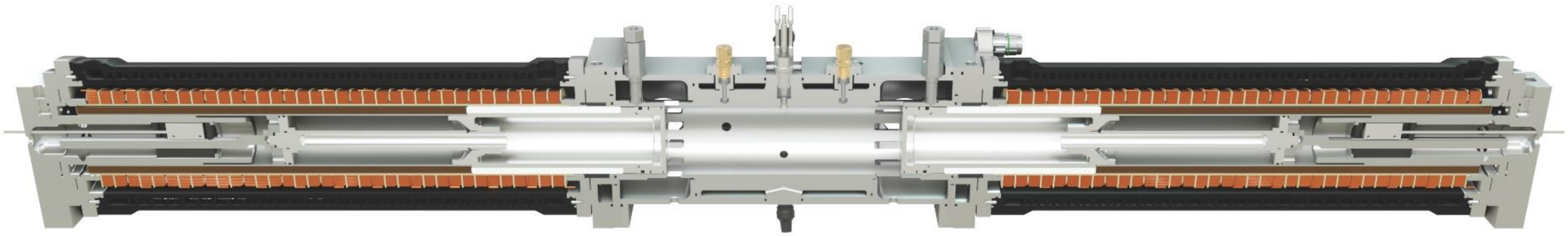
- Compact, modular & high efficiency 'Free Piston' range extender technology
- Optimised for 100% renewable alcohol fuels
- Backward compatible with existing fuels

Early adopter operator economics & potential:	Operator revenue per km	Operator km per week	Operator standing cost per week	Rapid uptake potential?
Battery electric (~400km battery range)	✗ Less payload More dead legs	✗ Recharge time	✗ Battery cost	✗ Charging infrastructure & new product launches by 2030
Battery electric (~200km battery range) + range extender	✓ Reduced impact on payload	✓ No impact on utilisation	✗ Battery cost	✓ New product launches by 2030

intelliGEN development engine platform, 20kWe *IGN20-MVP2*



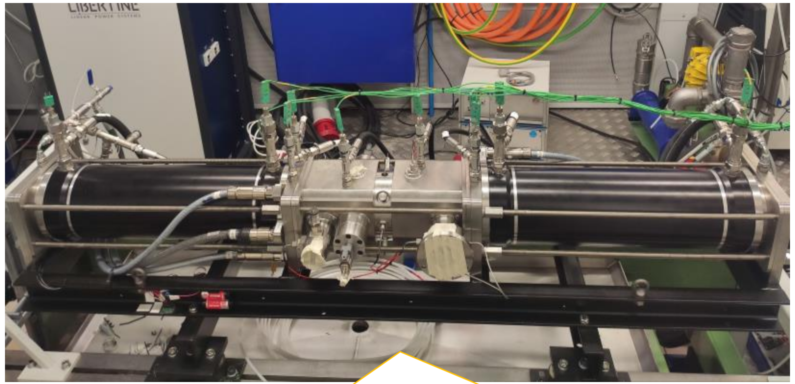
Linear e-machine and control technology platform solves piston motion for Free Piston Engine developers



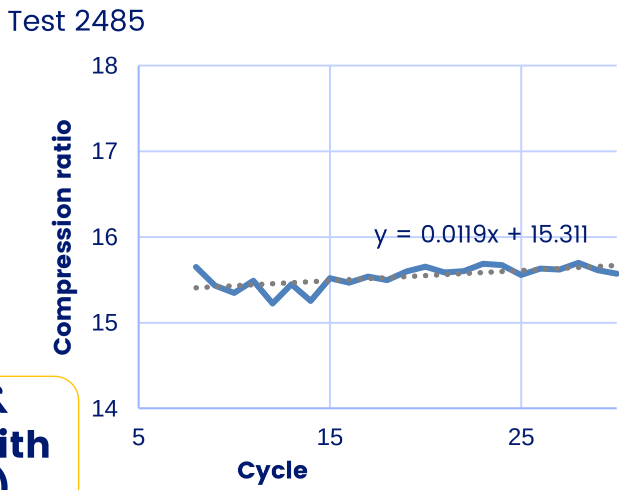
Our patented, lab proven technology

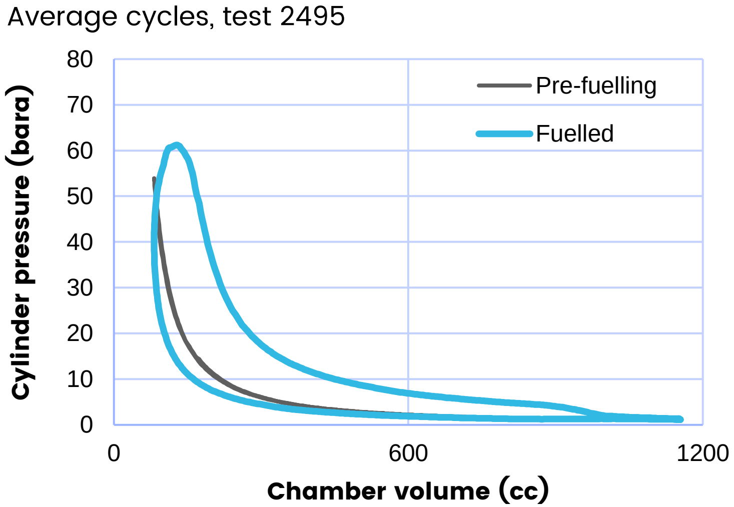
Delivers real time compression ratio control

For better combustion with 100% renewable alcohol fuels



Combustion development & demonstration programme with MAHLE Powertrain (2020 Q4)





LIBERTINE
LINEAR POWER SYSTEMS

2021 development plans

IGN20-P1

(2020 Q4)

IGN60-P1

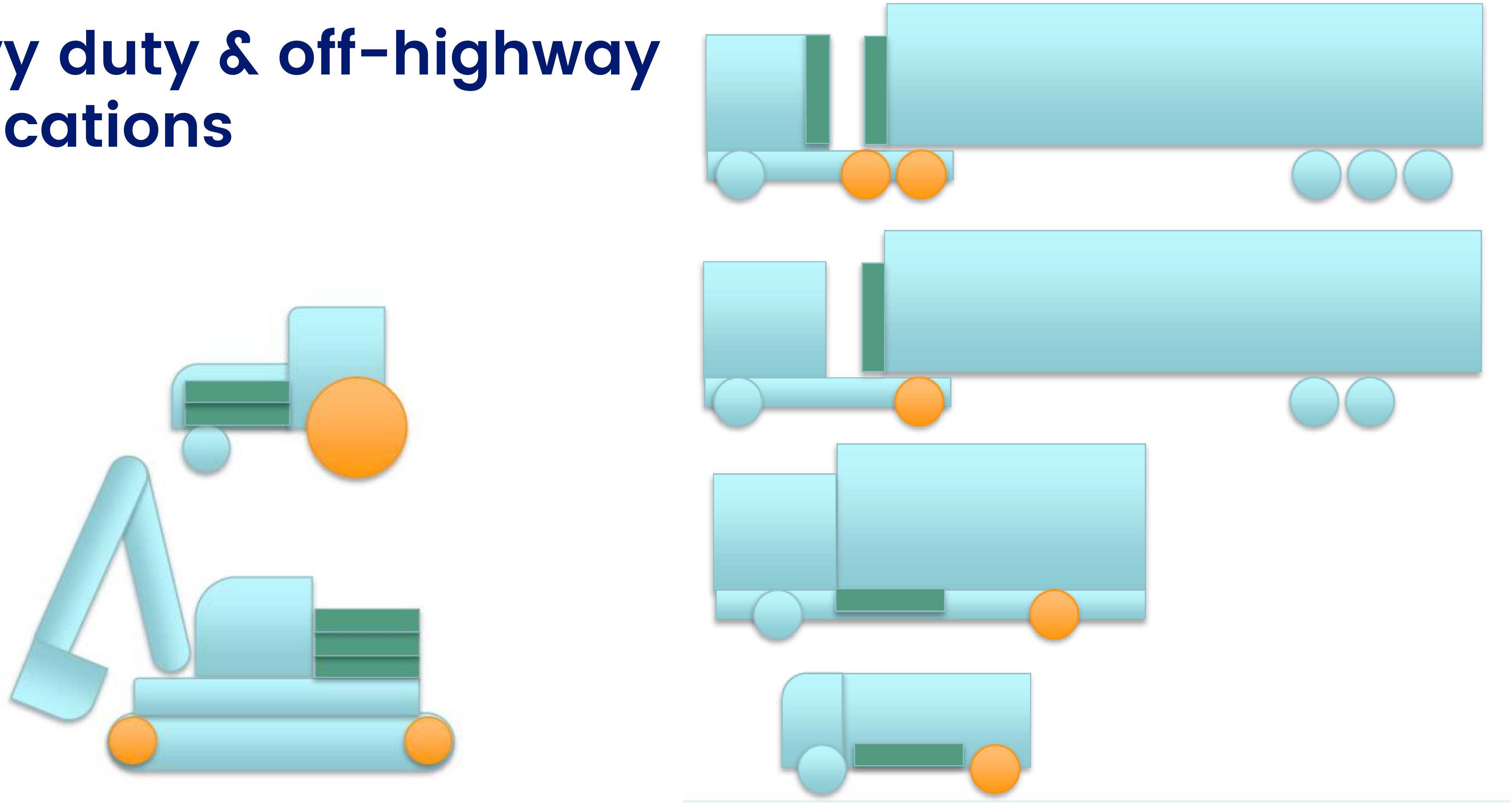
(2022 Q1)

- **Combustion development engine**
- **Leverages multiple existing advances**
  - Libertine e-machine & control platform developments 2017-2020
  - MAHLE Powertain pre-chamber combustion technology (MJI)
  - Opposed piston 2 stroke IC category developments 2010-20
  - Related technology advances (SMC, power electronics, controls)

- **Multi-cylinder n x 60kWe**
- **Efficient e-machines & gas bearings**
- **MAHLE Powertrain combustion systems**
- **Enhanced packaging & cooling**
- **Longer duration test capability**

Heavy duty vehicle REx space envelope & mounting location option (currently used for refrigeration plant on some trailers)

Heavy duty & off-highway applications



Thank you

Bioethanol use in heavy duty vehicles

Innovation in Sustainable Fuels

www.libertine.co.uk

Sam Cockerill CEO, Libertine FPE

sam.cockerill@libertine.co.uk

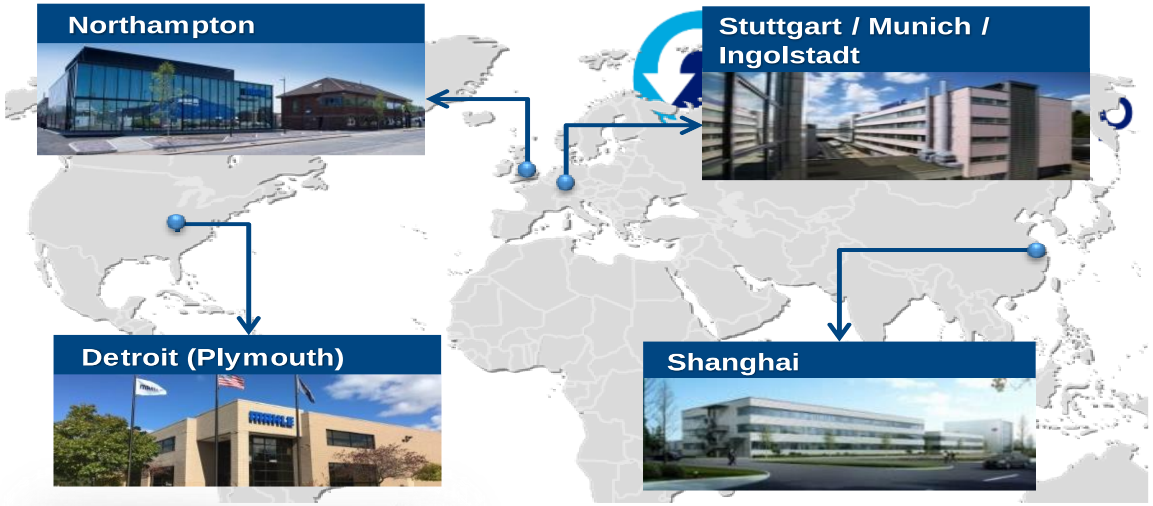
LIBERTINE LINEAR POWER SYSTEMS

Application of Bio-gasoline to a Future Hybrid Powertrain

Adrian Cooper | Research & Advanced Engineering | 23.03.2021

MAHLE
Powertrain

MAHLE Powertrain
Our company



Who We Are

A global **Engineering Services** provider specialising in **high efficiency powertrains**

History

1958 Cosworth founded by Mike Costin & Keith Duckworth

1998 Road car division acquired by Audi

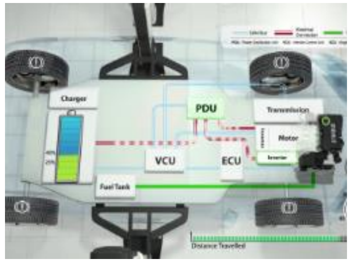
2005 MAHLE Powertrain established under MAHLE

Core Capabilities

ENGINE DESIGN & DEVELOPMENT

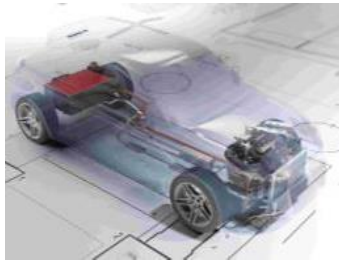
TRANSMISSION & E-AXLE

ELECTRIFICATION



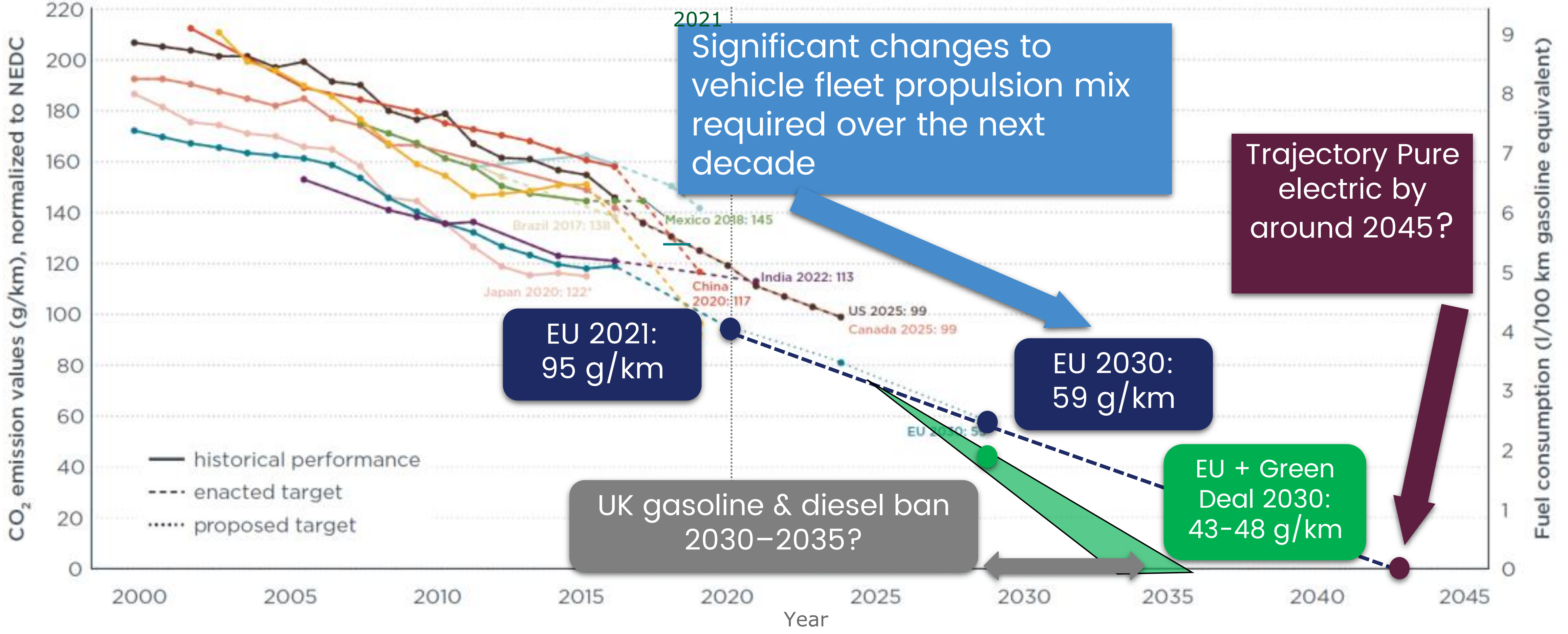
CONTROLS & SOFTWARE

PROTOTYPE ASSEMBLY



VEHICLE INTEGRATION

Fleet CO_2 limits EU



CO_2 targets are driving manufacturers towards increased electrification

Targets based on 1400 kg vehicle mass for "average vehicle"

Source: ICCT Jan 2019 CO_2 Emission Standards for Passenger Cars and Light-commercial Vehicles in the European Union

Source: China SAE on 27th Oct.2020

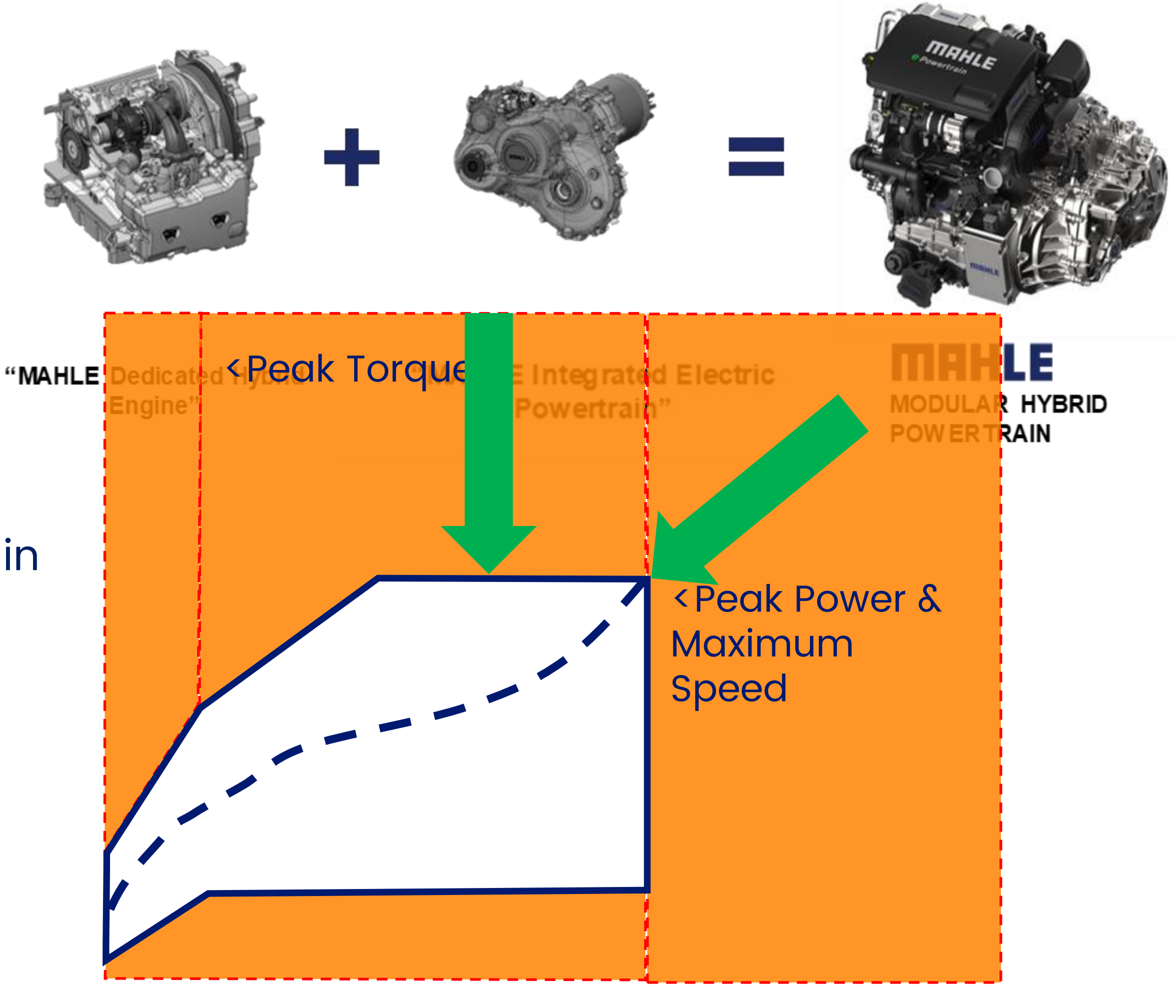
MAHLE Modular Hybrid Powertrain Concept

Description

- Plug-in hybrid driveline unit optimised for requirements of next generation passenger vehicles
- Engine, traction motor, generator and transmission designed as a fully integrated unit

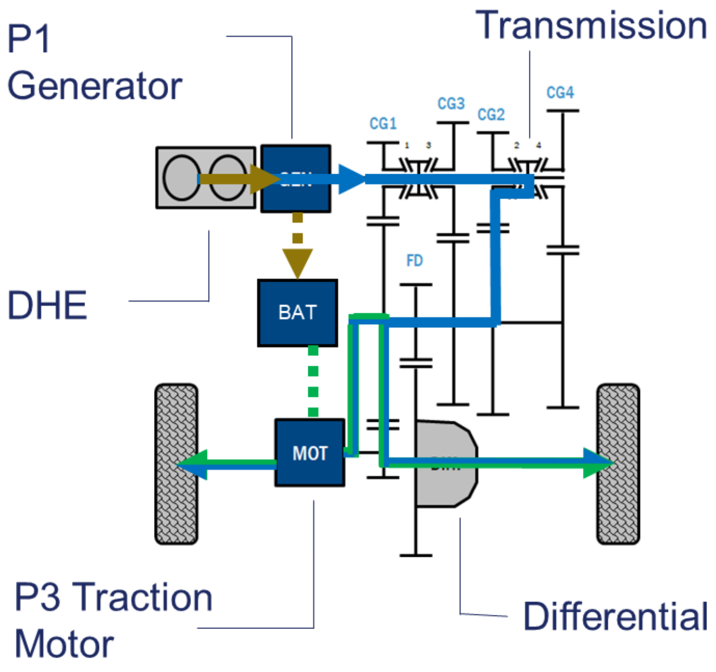
Key features

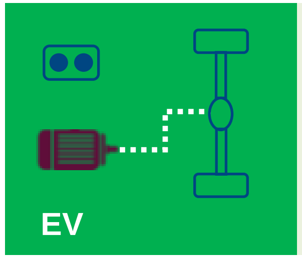
- Full dynamic performance provided by electric powertrain
- Plug-in solution with 80-150 km electric only range
- Dedicated Hybrid Engine (DHE)
  - Only required to produce charge sustaining power
  - Reduced operating region & transients
  - Enables higher efficiency
  - Control of engine independent of driver demand
  - Improved emissions control
  - Compact modular design



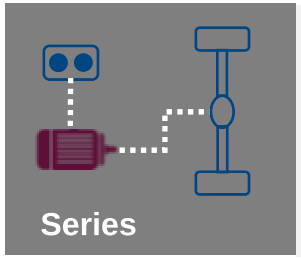
MAHLE Modular Hybrid Powertrain Operating Modes & Scale-ability

Zemo Partnership

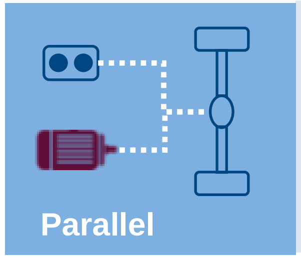




Battery-Electric Drive:
→ DHE is off
- Transmission in neutral



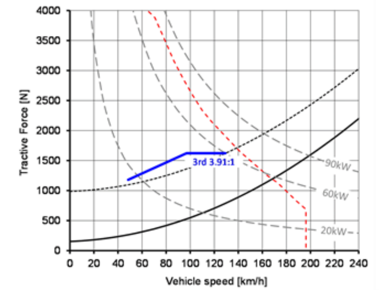
Series Hybrid Mode:
→ DHE acts as a Range-Extender



Parallel Hybrid Mode:
→ DHE assists with driving
- Directly coupled to wheels

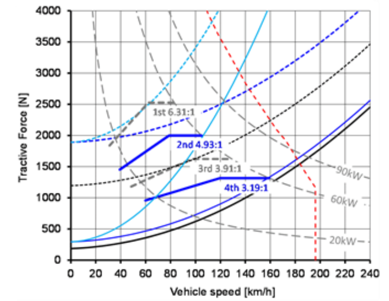
Compact Car

60 kW DHE
1 speed transmission
75 kW* traction motor



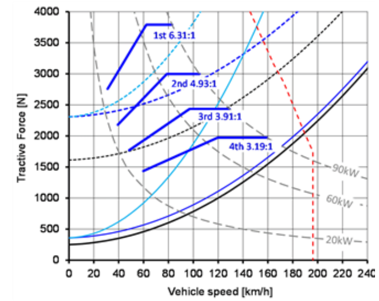
Compact Crossover SUV

60 kW DHE
2 or 4 speed transmission
127 kW* traction motor



Large 4x4 SUV

90 kW DHE
4 speed transmission
190 kW* traction motor



Dual mode hybrid – best of Parallel and Series hybrids plus direct eDrive for seamless torque delivery

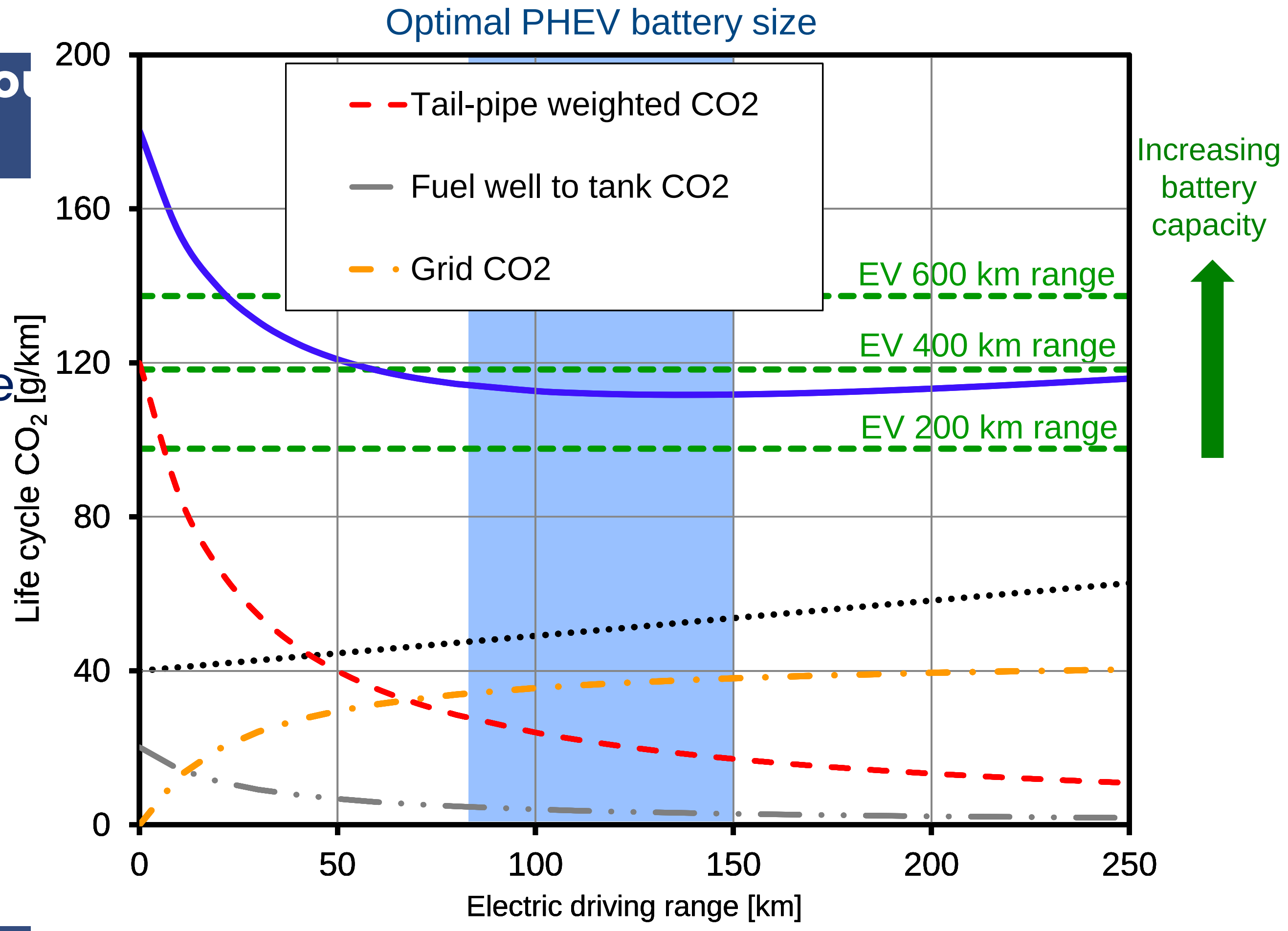
Vehicle life-cycle CO_2
Is there an optimal battery size for a PHEV?

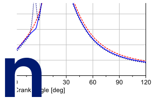
Complex and rapidly evolving situation arou
life cycle CO_2 assumptions!

PHEV – Optimal Battery Size based on recent reports

- Analysis: 1400 kg vehicle, Conventional engine (120g/km CO2), 150,000 km life
- Utility factor based on R101 tail-pipe weighting factor
- Well to tank contribution also considered
- Grid CO2 intensity for EU Mix: 296 g/kWh
- Battery embedded CO2 95 kg/kWh

80-150 km EV range is desirable





MAHLE Modular Hybrid Powertrain Dedicated Hybrid Engine

Specification

- 2 or 3 cylinder options
- Port fuel injection Miller-cycle operation, high CR and external EGR
- 2 valves per cylinder & SOHC
- Reduced complexity, optimized for hybrid use case

MAHLE Jet Ignition system

- Reduced burn durations
- Reduced knock tendency enables higher CR
- High Efficiency at low cost
  - >40% BTE

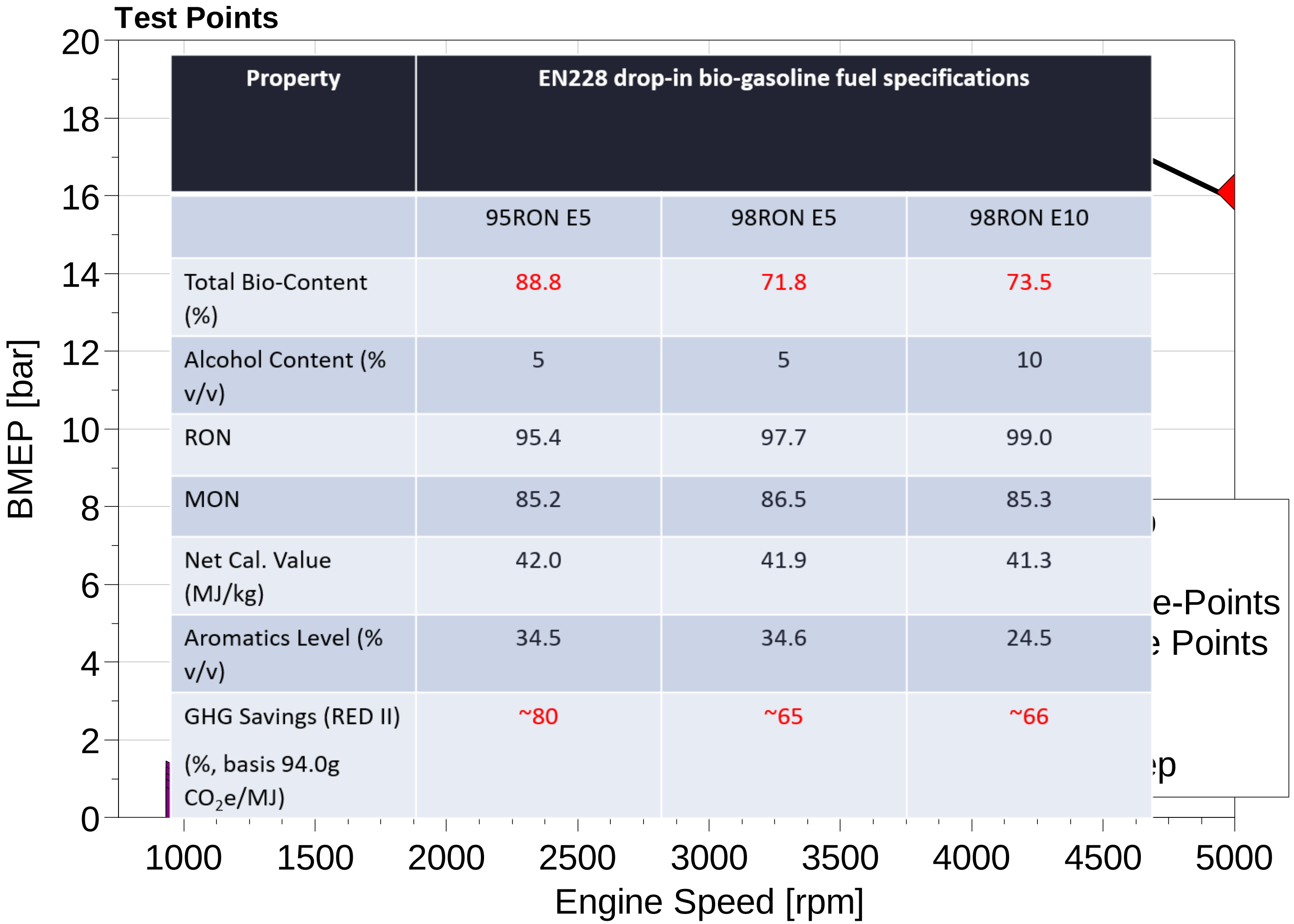
Bio-Gasoline Testing

Test Programme

- Testing completed on 3-cylinder modular powertrain development engine

- 5 Coryton fuels assessed
- All fuels compliant with EN228
- 2 x 95 RON fossil fuels
- 3 x Bio-gasoline blends
  - 95 RON E5
  - 98 RON E5
  - 98 RON E10

- Fuels assessed over range of typical operating conditions

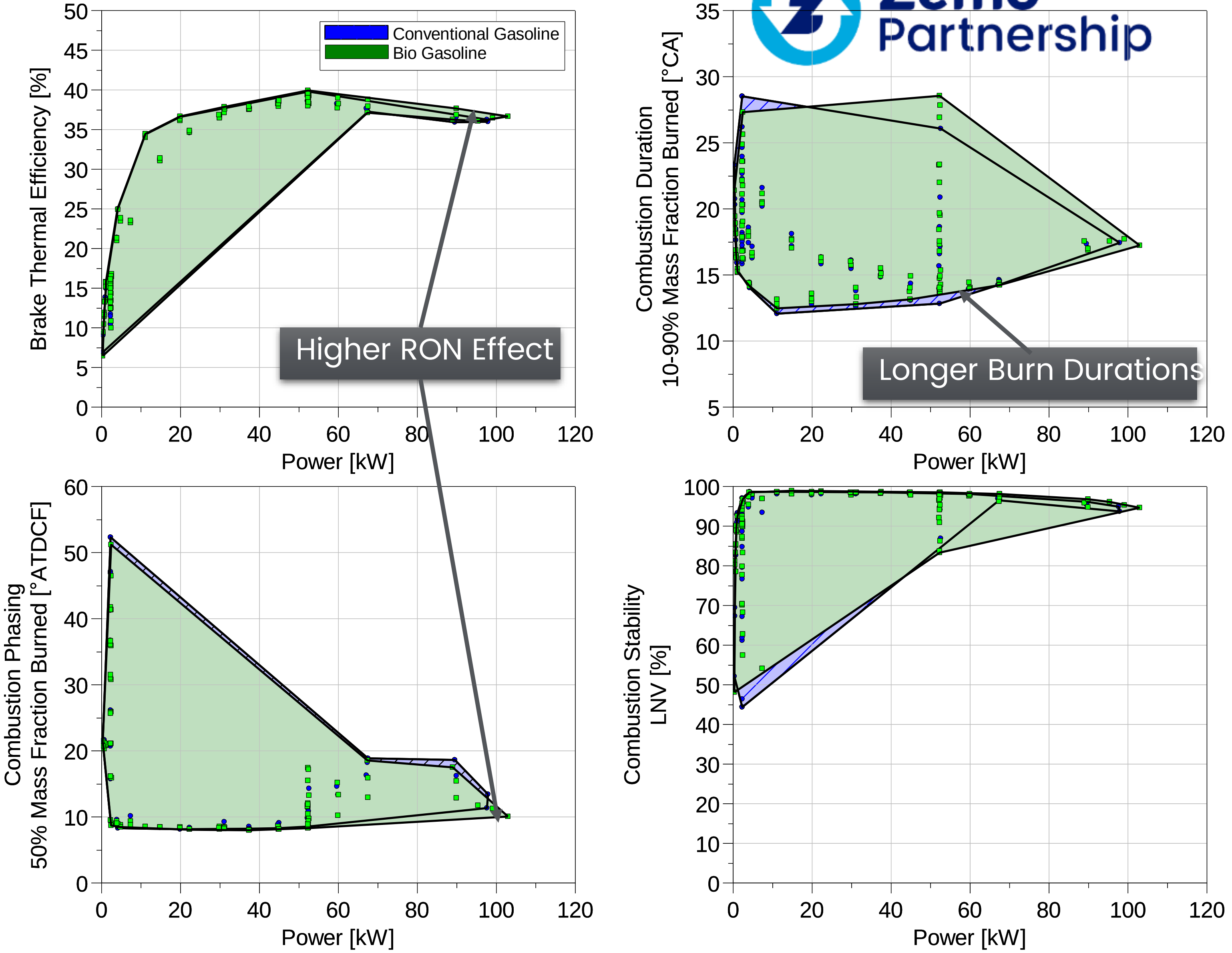


Property	EN228 drop-in bio-gasoline fuel specifications		
	95RON E5	98RON E5	98RON E10
Total Bio-Content (%)	88.8	71.8	73.5
Alcohol Content (% v/v)	5	5	10
RON	95.4	97.7	99.0
MON	85.2	86.5	85.3
Net Cal. Value (MJ/kg)	42.0	41.9	41.3
Aromatics Level (% v/v)	34.5	34.6	24.5
GHG Savings (RED II) (%, basis 94.0g CO_2e/MJ)	~80	~65	~66

Bio-Gasoline Testing

Combustion Metrics

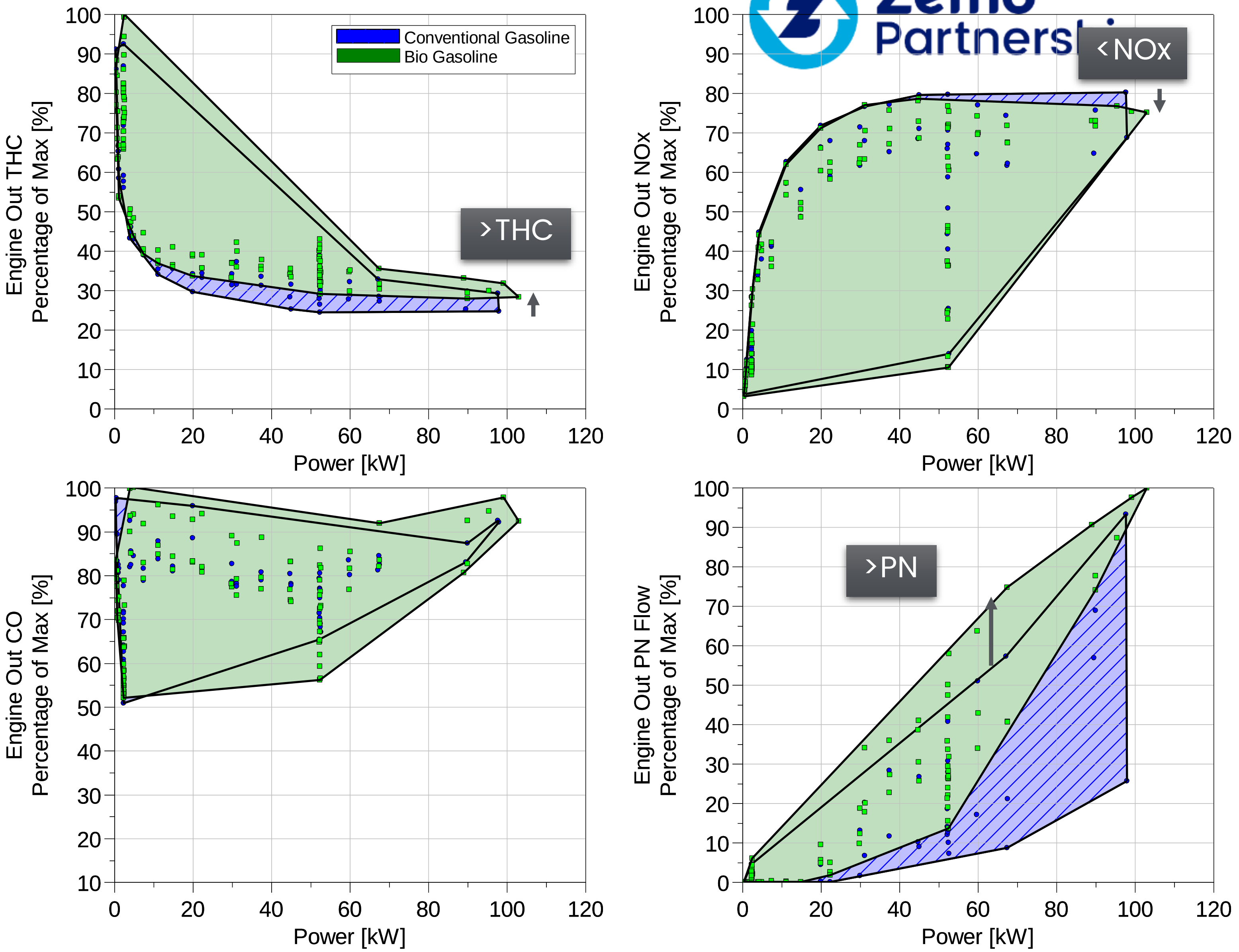
- Key combustion metrics collated:
  - Brake thermal efficiency
  - Combustion duration
  - Knock resistance (Combustion phasing)
  - Combustion stability
- Similar performance across all fuels
- High power thermal efficiency and improved combustion phasing due to higher RON
- Slight increase in burn durations with Bio-gasoline



Bio-Gasoline Testing

Raw Emissions

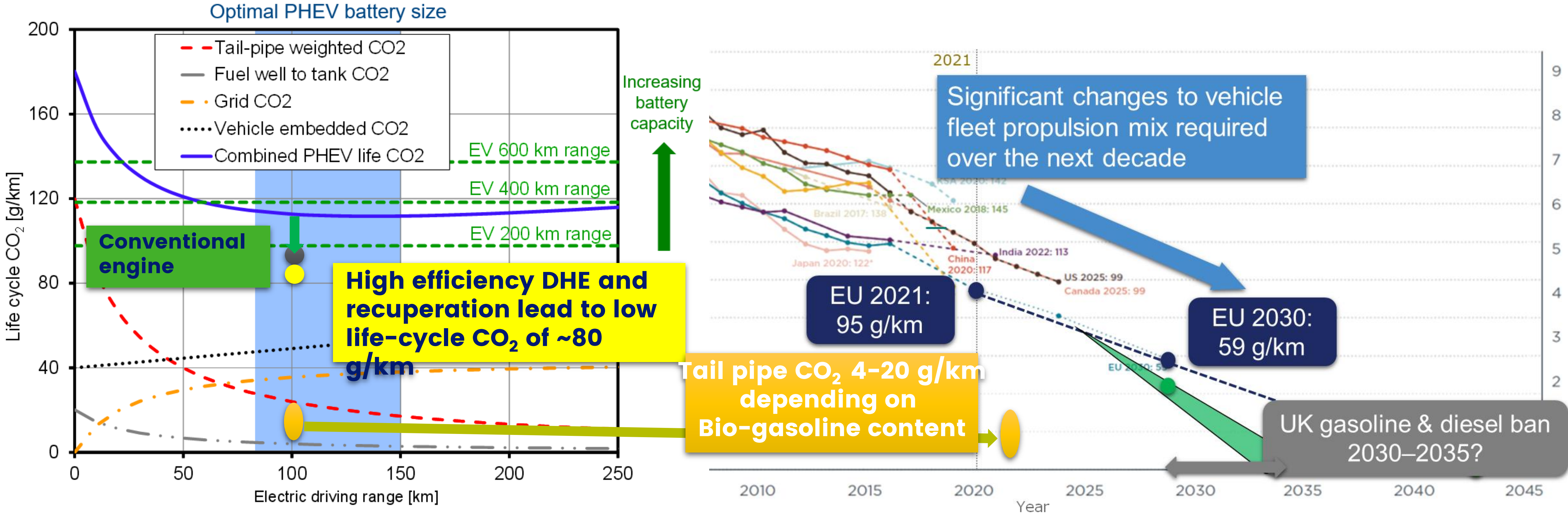
- Comparison of raw engine out emissions before aftertreatment
  - THC, NOx, CO & PN Flow
- Emission trends comparable
  - Raw THC and PN emissions slightly higher with bio-gasoline due to the higher proportion of heavy fractions
  - Raw NOx emissions slightly lower
- Effect after aftertreatment negligible with fully warm aftertreatment
- Further testing planned to evaluate alternative blends and quantify effect on tail pipe emissions



Effect of Bio-gasoline on Life-cycle and CO_2 emissions values

Effect of 80% reduction in tailpipe GHG (RED II) – Based on 95RON E5 Bio-gasoline

- Estimates for PHEV with 18 kWhr Battery ~100km range



Summary

- Bio-gasoline exhibits near identical combustion properties to regular gasoline
- Sustainable Bio-gasoline offers
  - Drop-in solution for existing fleet
  - Life cycle CO_2 reductions
- For high duty applications plug-in hybridisation an appropriate technology
  - Local emissions free driving
  - Long range capability with small battery
  - PHEV enables optimised use of both battery and biofuel resources
- MAHLE Modular Hybrid Powertrain:
  - Scalable and cost optimised
  - High efficiency through MAHLE Jet Ignition®

Thank you

Adrian Cooper | Research & Advanced Engineering | 23.03.2021

MAHLE Powertrain

F1 and its role in a low carbon economy

Pat Symonds
Chief Technical Officer
Formula 1®

UNLEASH THE GREATEST RACING SPECTACLE ON THE PLANET

STRATEGY

F1 Sustainability

COUNTDOWN TO ZERO

ACCELERATE TECHNOLOGIES THAT DECARBONISE THE WORLD

BY 2030 ↘

NET ZERO CARBON FOOTPRINT FROM FACTORY TO FLAG

ON THE TRACK

Net zero carbon powered race cars

ON THE MOVE

Ultra efficient & low/zero carbon logistics & travel

WHERE WE WORK

100% renewably powered offices, facilities and factories

BALANCE TO ZERO

Credible offsets and breakthrough C02 sequestration programs

POSITIVE RACE PRINT

LEAVE A LEGACY OF POSITIVE CHANGE WHEREVER WE RACE

BY 2025 ↘

EVERY RACE TO QUALIFY AS AN F1 SUSTAINABLE SPECTACLE

WHAT WE USE

Sustainable materials with all waste re-used, recycled or composted

TO THE RACE

Incentives and tools to offer every fan a greener way to reach the race

WHERE YOU WATCH

Circuits and facilities that are better for fan wellbeing and nature

WITH OUR HOSTS

Opportunities for local people and causes to get in on the action

FOUNDATIONS | RESPONSIBLE SOURCING | TRANSPARENCY & REPORTING | ENVIRONMENTAL COMPLIANCE | HEALTH & WELLBEING

COUNTDOWN TO ZERO

Accelerate technologies that decarbonise the world

Net Zero Carbon emissions from factory to flag by 2030

Our goal is to systematically reduce the CO_2 emissions generated by our operations, events, logistics and race cars to Net Zero by 2030.

CARBON FOOTPRINT

Measuring the F1 carbon footprint

POWER UNIT EMISSIONS

0.7%

POWER UNIT EMISSIONS
All emissions associated with the fuel usage of the power units across all 10 teams, at all 21 Grands Prix, and at pre-, mid- or post-season testing

EVENT OPERATIONS

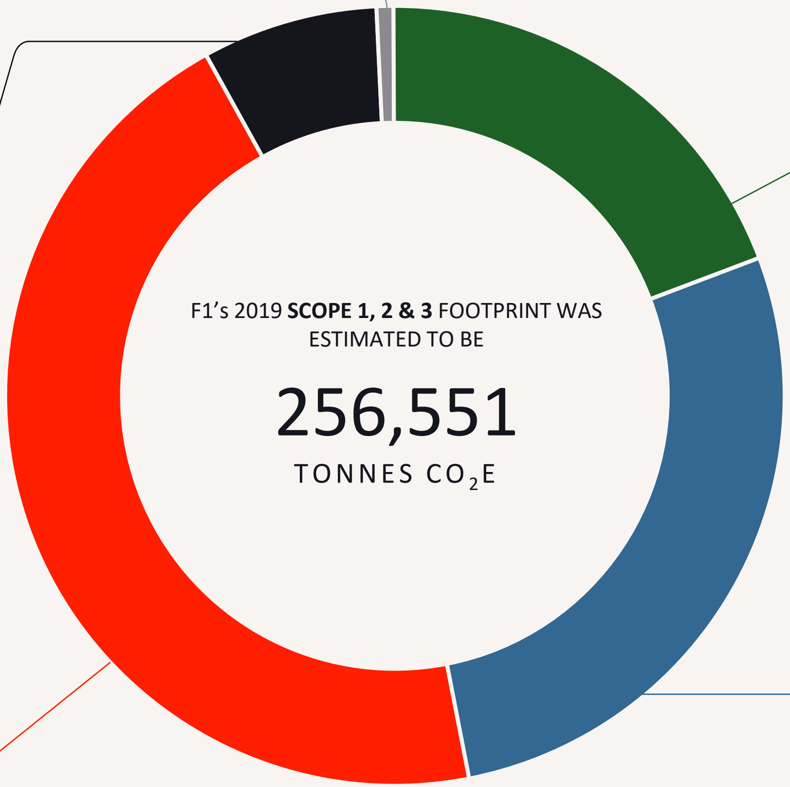
7.3%

EVENT OPERATIONS
All event impacts including broadcasting, support races, Paddock Club operations, circuit energy use, generator use & teams at circuit impacts (excluding Power Unit emissions)

LOGISTICS

45.0%

LOGISTICS
All road, air or sea logistics across the sport including the movement of teams equipment, F1 equipment, Paddock Club equipment and race tyres



FACILITIES AND FACTORIES

19.3%

FACILITIES AND FACTORIES
All F1 owned or operated offices or facilities, as well as all teams owned and operated offices, factories or facilities

BUSINESS TRAVEL

27.7%

BUSINESS TRAVEL
All individuals air and ground transportation, as well as hotels impact for all F1 Teams employees and employees of major event partners

A SHORT HISTORY

1995 – 2005

3 litre V10

694 kW (930 BHP)

2006 – 2013

2.4 litre V8

578 kW (775 BHP)

+ 60 kW Electrical

2014 – 2025

1.6 litre V6

600 kW (800 BHP)

+120 kW Electrical

Efficiency (ICE only)

V10

194 kg/hr fuel flow

30% BThE

310 BHP / Litre

V8

165 kg/hr fuel flow

30% BThE

323 BHP / Litre

V6

100 kg/hr fuel flow (regulated)

51% BThE

500 BHP / Litre

A POWER UNIT FOR TOMORROW

A new mission and a new objective

F1 has, for many years, contributed to ever more efficient engine architectures. Now is time for a fundamental rethink. Now the power unit and the fuel must be developed in a symbiotic manner

A POWER UNIT FOR TOMORROW

Disruption from within

A NEW PHILOSOPHY

Set the target not the technology

Measure: Minimum energy use

- Open minded approach to thermal propulsion units
- Honest approach to full Life Cycle Analysis
- Energy is the new currency

PROMOTING TECHNOLOGY

Make the non-engineer aware of Motorsports contribution

Measure: Public awareness Of PHEVs and ultra low carbon fuels

- Take a proactive role in showing the public, climate change activists and policy makers that motorsport has a positive role to play in taking low carbon mobility through TRL 3 to TRL 8

A FUEL FOR TOMORROW

A PRAGMATIC, STAGED APPROACH

2020

The Current Situation

A minimum of 5.75% (m/m) of the fuel must comprise bio-components.

2022

A Statement of Intent

A move to 10% Sustainable Ethanol

Article 16.4.4
A minimum of 10% (m/m) of the fuel must comprise advanced sustainable Ethanol.

A FUEL FOR TOMORROW

A PRAGMATIC, STAGED APPROACH

2025

Symbiosis

- An energy based formula?
- A fuel and engine designed to be mutually beneficial
- Defining a Fuel Merit Rating:

  Autoignition Index
  Flame Speed
  Emission Qualities
  Charge Cooling.........

A POWER UNIT FOR TOMORROW

Disruption from within

THE DRIVE FOR EFFICIENCY

Targeting ultra-high thermal efficiency

Measure: Have we achieved Technology breakthroughs

- Toward 60% Thermal efficiency
- Reduced emissions (NOx PM2.5)
- Reduced mass

A POWER UNIT FOR TOMORROW

Disruption from within

THE FUTURE POWER UNIT
A TEASER!

Possible Technologies

- Tailored fuels
- Water injection
- DME or similar injection
- (Octane on Demand)
- Additional exhaust heat recovery
- Front axle energy recovery
- Improved gas exchange

THE FUTURE POWER UNIT
A TEASER!

Possible Technologies

Active pre-chamber

HCCI or spark assisted HCCI

1000 to 2000 bar injection pressure

λ2

Adiabatic like target

Sustainable Fuel Target

		Min	Max
RON	[-]	100	104
MON	[-]	85	88
Oxygen content	[wt%]	0	5.2
DVPE	[kPa]	50	70
Density	[kg/l]	0.700	0.780
LHV	[MJ/kg]	40.5	44
Stoichiometric ratio	[-]	13.5	15

Achieved

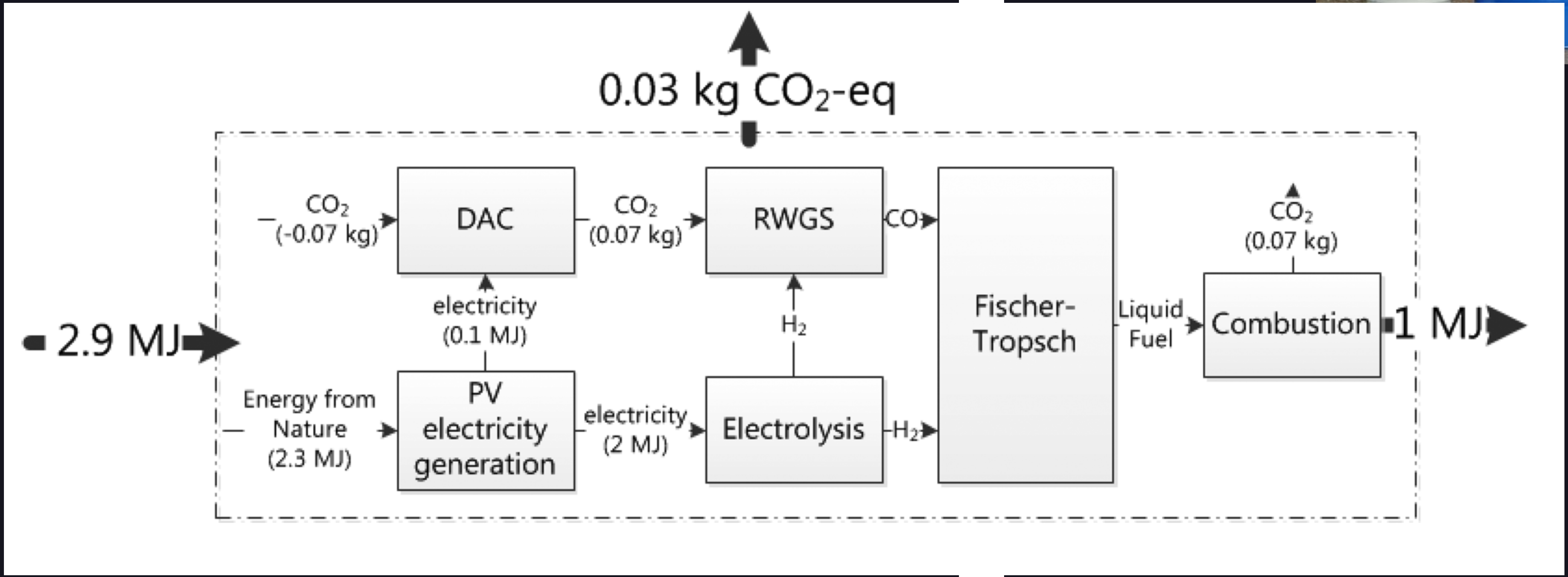
	%mass	
Renewable Gasoline	**+/- 65**	Base fuel, low RON
Ethanol 2G	**+/- 15**	Hi RON, low LHV, low DVPE
TOLUENE	**+/- 20**	Light aromatic, Hi RON, low DVPE, dense
O2 % m/m	**+/- 4.5**	

ANALYSIS	RESULTS	REPRODUCIBILITY	METHODS
Content in Aromatics	**43,95** *% (m/m)* **38,91** *% (v/v)*		GC-Calculated
Measured LHV	**38,79** *MJ/kg*	**0,40** *MJ/kg*	ASTM D 240
Density @ 15 °C	**777,9** *kg/m³*	**1,2** *kg/m³*	NF EN ISO 12185
DVPE	**46,1** *kPa*	**1,58** *kPa*	NF EN 13016-1
RON	**100,8**	**[0,7 ; 1,0]**	NF EN ISO 5164
MON	**87,6**	**0,9**	NF EN ISO 5163

Pathways

Pathway	RON	Density	LHV (Energy in the fuel)	High-C Aromatics (emissions)	Drop-in fuel (RON/LHV)	Availability for 2024	Availability for 2025	Comments
Waste-to-fuel (Hydrothermal liquification, pyrolysis or alcohol-to-fuel)								Commercial scale available, definition of waste EU v US. RON boost may be needed
e-Methanol							TBC	Could be used as fuel but LHV only half that of gasoline
e-MtG **(MtG = Methanol to Gasoline)**							TBC	CO2 used can be recycled or bio or direct air capture
e-FT Naphtha to Gasoline **(FT= Fischer Tropsch process)**							TBC	Limited options for naphtha upgrade. CO2 as above
2nd Gen Ethanol								Available. Some market relevance.
2nd Gen Bio-or e-sourced Hydrocarbons							TBC	Some components available. Danger of supply monopoly. No market relevance.

Energy Balance



Energy and Climate Impacts of Producing Synthetic Hydrocarbon Fuels from CO2
Coen van der Giesen, René Kleijn, and Gert Jan Kramer
dx.doi.org/10.1021/es500191g | Environ. Sci. Technol. 2014, 48, 7111−7121


UNLEASH THE GREATEST
RACING SPECTACLE
SUSTAINABLE
ON THE PLANET

Thank you

Any questions? Please get in touch

Gloria Esposito
Head of Sustainability
E: Gloria.esposito@zemo.org.uk
T: 020 7304 6038

Interested in joining the Partnership?

E: Carolyn.webb@zemo.org.uk
T: 0207 304 6880

Next Webinars

Session 2: Advanced Renewable Diesel

25th March, 10:30am – 12pm

Session 3: Advanced Renewable Gaseous Fuels

31st March, 10:30am – 12pm

Session 4: Sustainable Aviation Fuels

1st April 10:30am – 12pm

Zemo Partnership, 3 Birdcage Walk, London SW1H 9JJ
T: +44 (0)20 7304 6880 | E: hello@zemo.org.uk @Zemo_Org | www.zemo.org.uk

Interested in joining Zemo

Our work covers six areas related to accelerating the transition to a zero transport future.

Buses & Coaches

Action programmes to speed the introduction of zero emission buses in the UK by working with passenger transport companies and local authorities

Cars

Working with manufacturers, fleet operators, environment and consumer groups to accelerate the adoption of zero emission cars.

Fuels

We explore measures to increase the adoption of sustainable low carbon fuels such as biofuels and renewable hydrogen.

Commercial Vehicles

For manufacturers, freight transport operators, technology suppliers, technical expert and others interested in accelerating the transition to cleaner, greener road freight.

Energy Infrastructure

Formed to make suggestions to Government and industry to ensure that the GB energy system is ready for and able to facilitate and exploit the mass take up of electric vehicles.

Collaborative Initiatives

Joint working group projects where content crosses over, overseen by the members' council.

Renewable Transport Fuel Association

Zemo Partnership

- Established end of August 2020, with 12 founder members
- Membership now exceeds 30 (and includes all UK bioethanol and biodiesel producers, all companies dispensing biomethane to transport, along with prospective SAF and development fuel producers)
- Formed to champion the contribution that renewable and low carbon fuels can make towards the decarbonisation of UK transport
- www.rtfa.org.uk
- Contact: Gaynor Hartnell, CEO

  gaynor@rtfa.org.uk