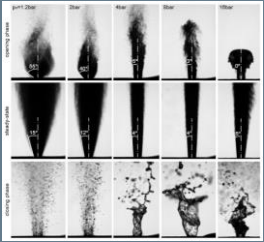
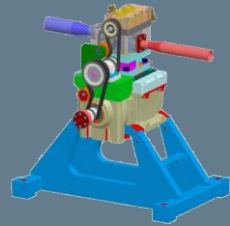


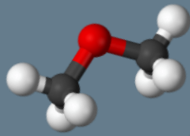
Spray-Chamber



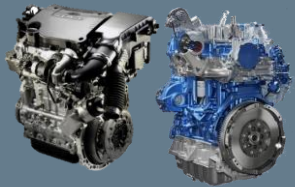
Single-Cylinder



DME



Multi-Cylinder



Vehicle Demonstrator

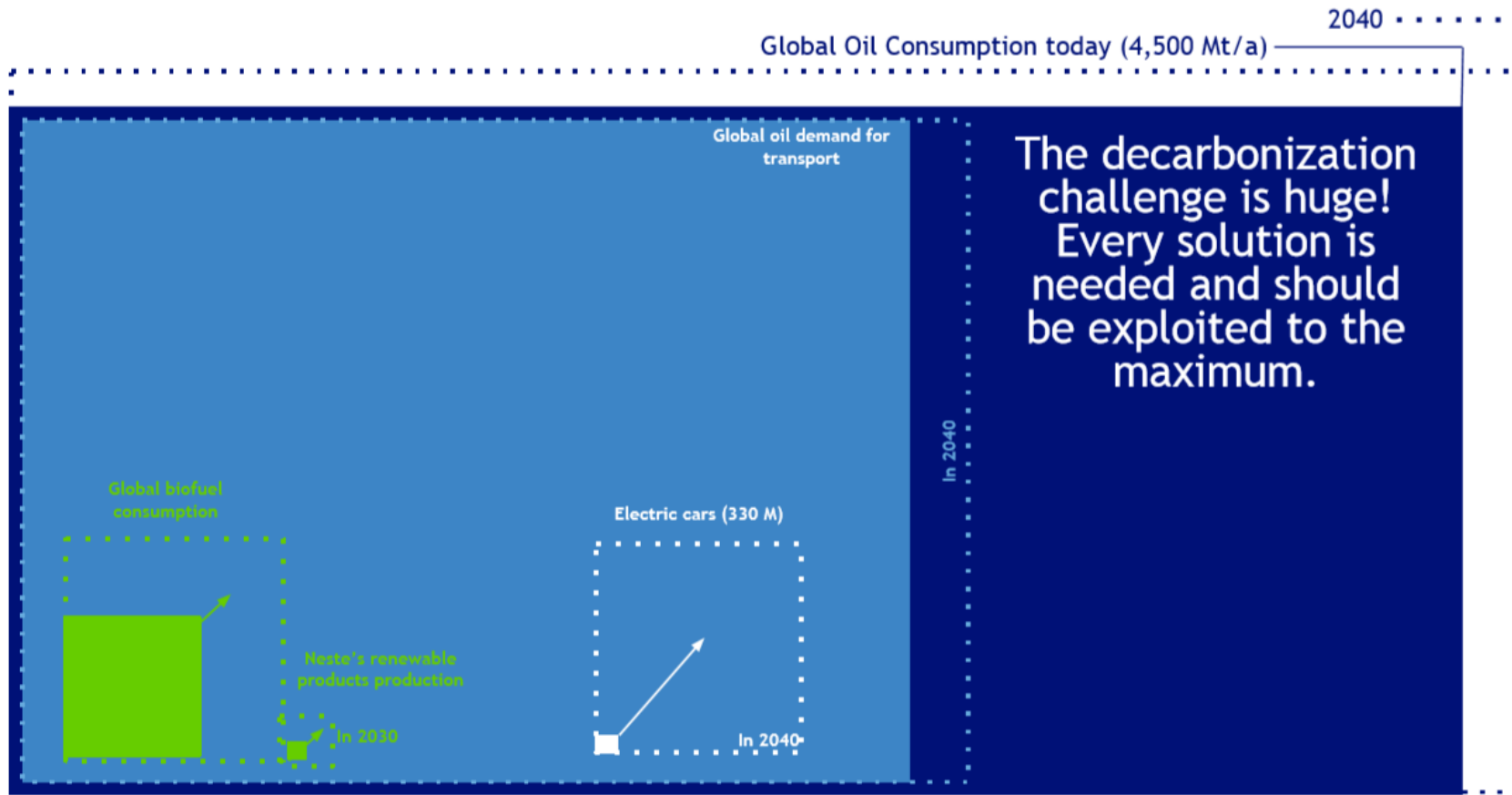


FLEDGED Webinar - October 27th, 2020

DME – Solution for Transport Applications of Today and Tomorrow

W. Willems Ford RIC Aachen

THE DEFOSSILIZATION CHALLENGE

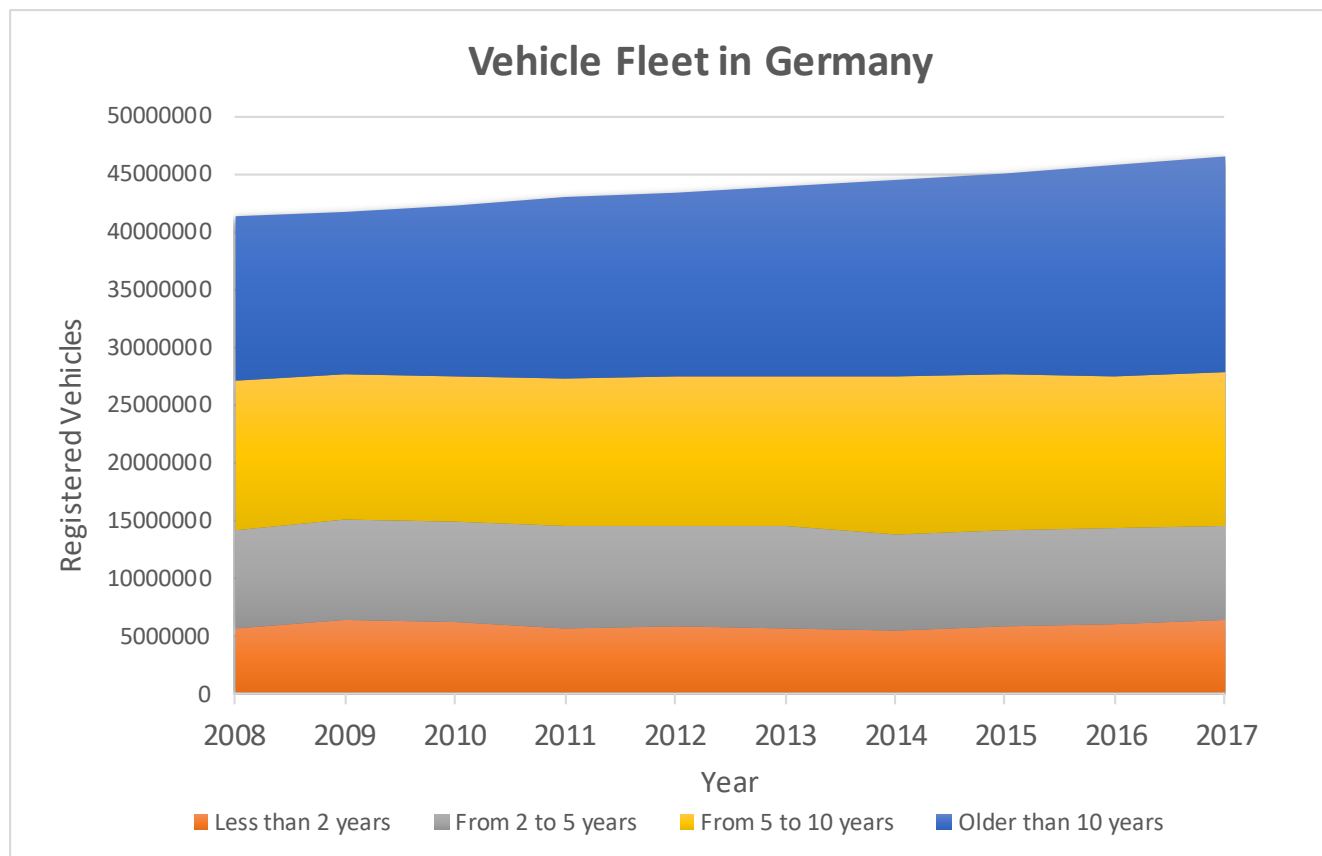


Substituting fossile energy carriers with non-fossile replacements will require more than one technical solution in order to decarbonize transport for new and existing vehicles

Source: Neste based on IEA World Energy Outlook 2019, Stated Policies Scenario.



MARKET PENETRATION AND ITS IMPACT ON GHG REDUCTION



Source: <http://ec.europa.eu/eurostat/data/database>

- Introduction of new technology and its market penetration takes time
- Disruptive technology changes will have an impact with a significant delay time
- Low-CO₂-Technology compatible to existing IC-based powertrain technology has the potential to have a stronger impact on CO₂ reduction

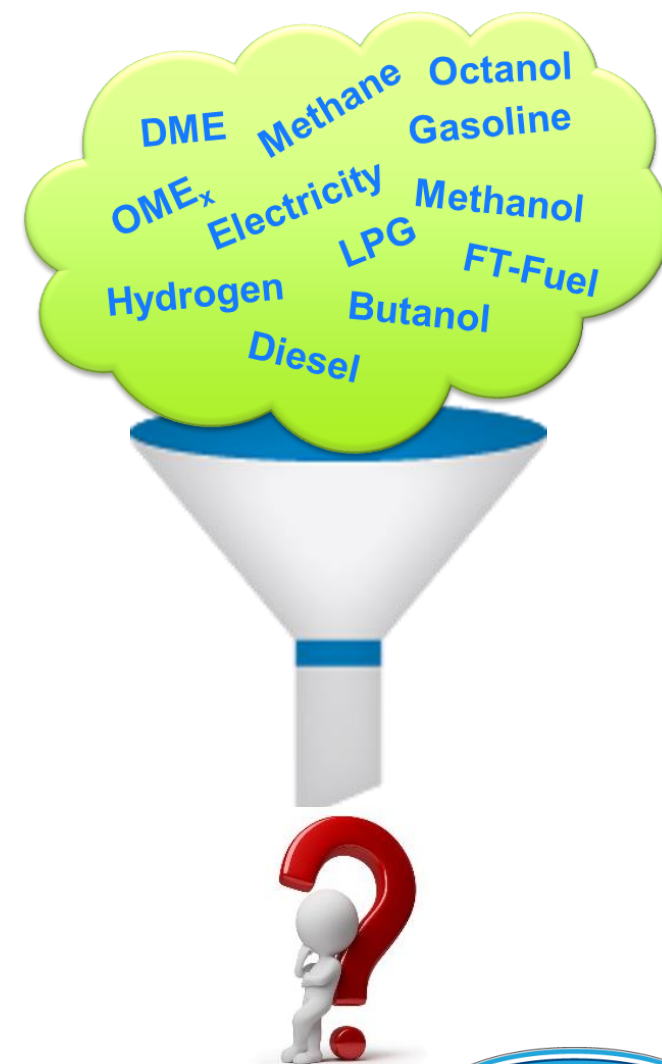


Sustainable Synthetic-fuels

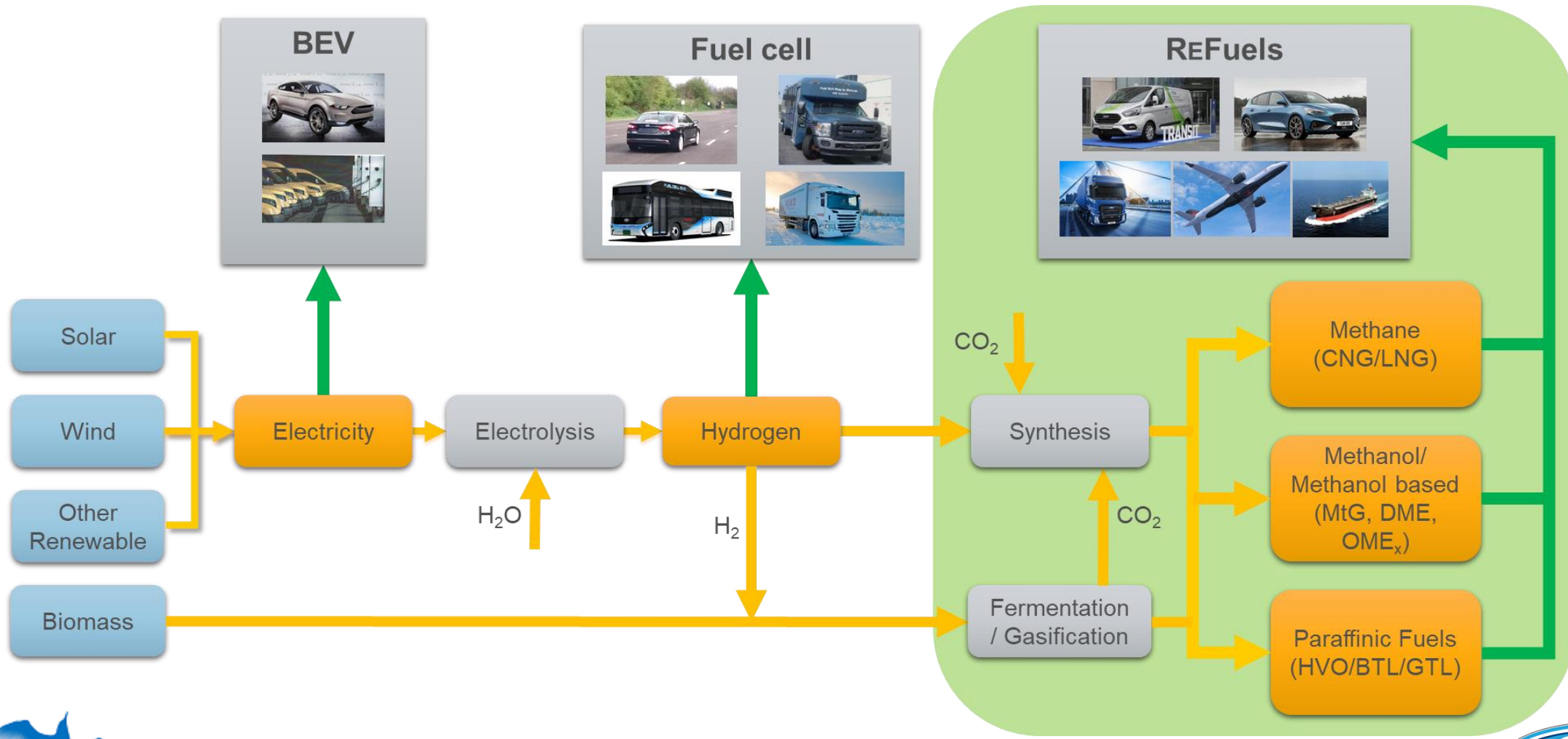


CHALLENGES AND REQUIREMENTS FOR SYNTHETIC FUELS

- Synthetic fuels should give TtW-CO₂-benefits assuming current CO₂-regulation mechanisms
- New fuels should address various problems at the same time (CO₂ **and** emissions)
- Time and Technology Readiness
 - Synthetic fuel solutions need to be available as quickly as possible
 - Fuel standards should be available
- Synthetic fuels should be available globally at reasonable cost
- Synthetic fuels should be compatible with current powertrain technology

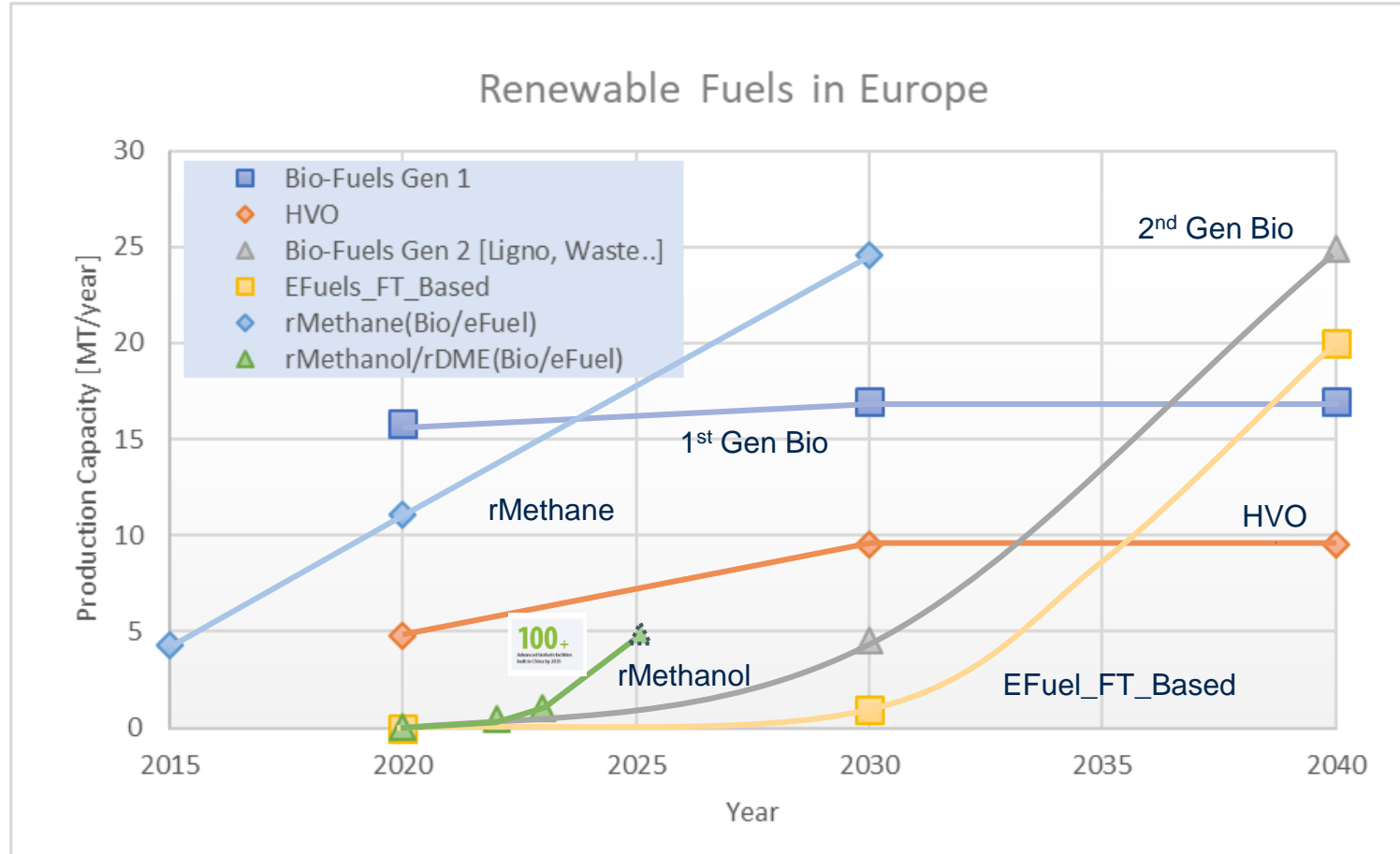


REFUELS → ELECTRO AND/OR BIOBASED (2ND GEN) FUELS



RENEWABLE FUEL AVAILABILITY

Renewable Fuel production currently at a low level (< 10 %) but increasing



- **Liquid Bio-fuels**

- Bio-1st Gen will remain but will not increase further
- Bio-2nd Gen will increase significantly (Lignocell, residue, waste)
- HVO will increase but will stabilize at certain level

- **Methane currently highest availability (Biogas, eGas evolving)**

- **Methanol based fuels steeply increasing (projects North-Africa, Australia, Patagonia in pipeline)**



BMW-C³-MOBILITY-CONSORTIUM – " CO₂-NEUTRAL FUELS BASED ON METHANOL "

- Project funded by the German Ministry of Economy looking at Methanol-based Fuels (Methanol, MtG, OME, DME) for PassCar, light/heavy-duty and marine applications

Supported by:



on the basis of a decision
by the German Bundestag



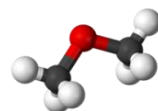
Closed Carbon Cycle

MOBILITY

Klimaneutrale Kraftstoffe
für den Verkehr der Zukunft ab Heute



ECOBLUE



DME

Workpackage C4



RWTHAACHEN
UNIVERSITY

GRILLO

Fraunhofer
ISE

FEV

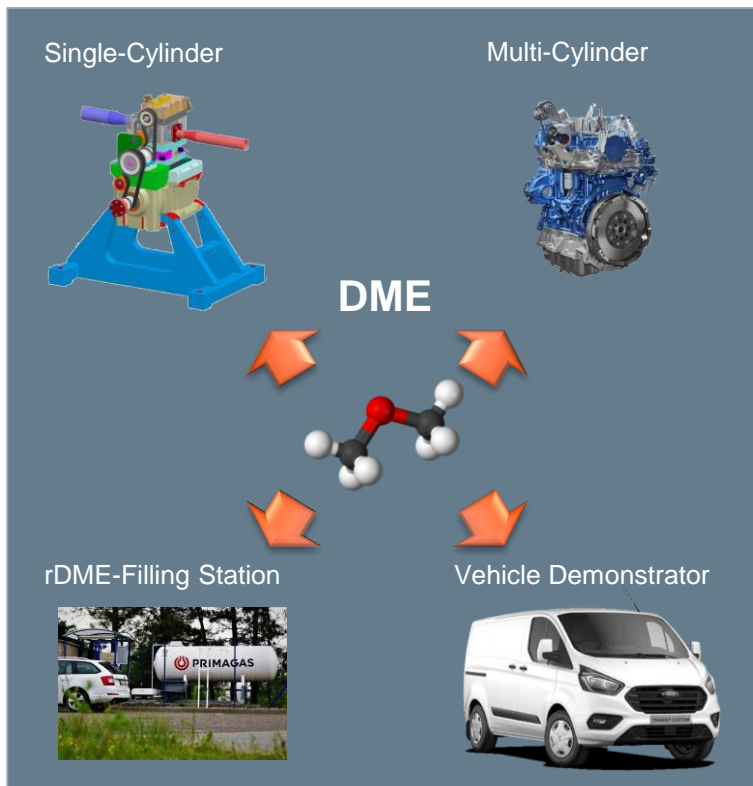
DENSO

SHV ENERGY

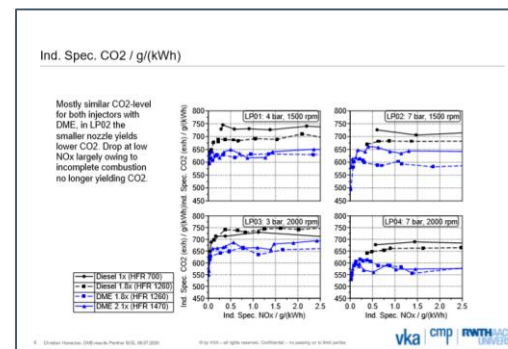
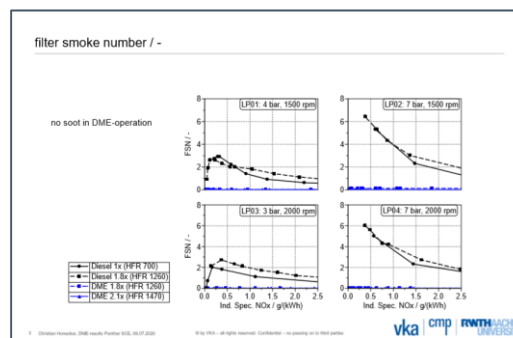
- Fully optimized Engine System
 - Air-Path, Combustion System, AT
- RDE-Compatible
- Target Euro 6+



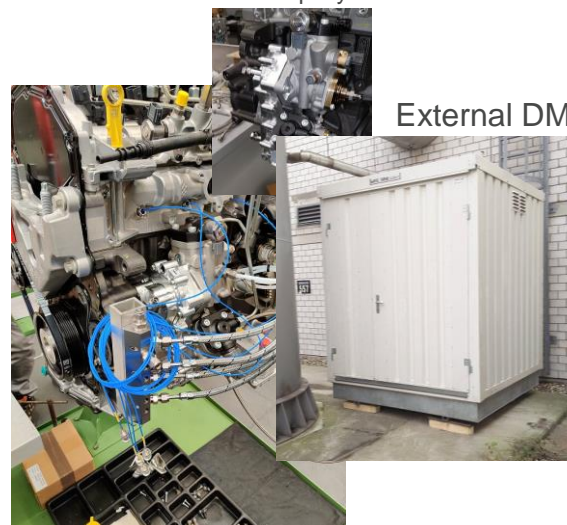
BMW-C³-MOBILITY-CONSORTIUM – " CO₂-NEUTRAL FUELS BASED ON METHANOL "



Single-Cylinder Measurements @ VKA/RWTH Aachen



Multi-Cylinder Measurements @ Ford R&A Twin-Pump-System

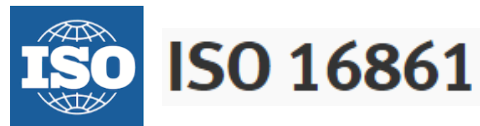


Filling station in preparation @ SHV Energy/Primagas



DME-STANDARDIZATION DIN TS 51698

- Kickoff of Standardization Efforts: November 2018
- DIN Standard: Development of a new DME-Standard dedicated to automotive/heating applications
- DIN Workgroup lead by Ford and Tec4Fuels



- Translation into German



- Extended ISO-Standard
- Monofuel (→ no blend)
- Odorant: → 3-nose test (no sulfur additive preferred)
- Specifying Lubricity by defining lubricity agent and concentration



National Standardisation/Mirror organization of ISO

The logo for DIN (Deutsches Institut für Normung), consisting of the letters "DIN" in a large, blue, sans-serif font with horizontal lines above and below the letters.

Dimethylether (DME) für den Einsatz als Kraftstoff
(NAK 51698)

- Joint developement of requirements and specifications
- DIN TS 51698 almost finished → Released early next year
- Fuel in C³-Mobility according to DIN Technical Specification



UPCOMING ACTIVITIES – DME BLENDING



Start 2021

	Diesel-Base	Powertrain-Solutions	
Fuel/Blend	100% Diesel = X (X=EN590, EN16540, BioDiesel) Mono-Fuel	DME+X (X=EN590, EN16540, BioDiesel) Bi-Fuel	100% DME Mono-Fuel
Tank-system	Diesel-System	Diesel+Pressurized-Tank-System	Pressurized-Tank-System
Injection System (Rail/Injektor/Pump)	Diesel-Common-Rail Fuel-lubricated	= Diesel-System	DME-Common-Rail Oil-lubricated
Combustion System (Bowl, Nozzle, Swirl)	Optimized for Diesel	= Diesel-Definition	Optimized for DME
Airpath (Turbo-charger, EGR, Cooling circuit)	Optimized for Diesel	= Diesel-Airpath	= Diesel-Airpath (evt. simplified)
Aftertreatment System (DPF, LNG, SCR)	Optimized for Diesel	= Diesel-System	Optimized für DME (Simplified → DPF)
Complexity	-	Moderate + Tank-System + Mixing Unit HP-Pumpe (dynamic operation)	High + Tank-System + Injection-System + Combustion System + simplified AT-System

- 1. Definition of suitable fuel blends:** Suitable cold-stable DME-X (X=Diesel(EN590), HVO/GTL (EN15940), BioDiesel) with appropriate additives are to be developed for operation with an almost unchanged injection/air/exhaust aftertreatment system.
- 2. DME-Quality:** The influence of the DME quality (impurities during production) on combustion and emission behaviour shall be shown in the blends but also in a 100% DME configuration on the single-cylinder or full engine.
- 3. Demonstration on vehicle:** Based on the demonstration in a DME/DME blend capable vehicle, the drivability of the most promising blend towards the end of the project will be demonstrated



CONCLUSIONS

- Synthetic fuels have a strong potential to play a major role in future sustainable mobility
- For CI based powertrain applications, DME is a very attractive Diesel fuel replacement since it provides benefits with regard to Tank-to-Wheel efficiency, criteria emissions and energy density
- The potential of DME has been proven in a public funded project (BMW i) led by Ford, and will be investigated in follow-up projects including vehicle and infrastructure demonstration
- Continuation of investigations related to DME and other promising Synfuel-candidates important in order to support defossilization

