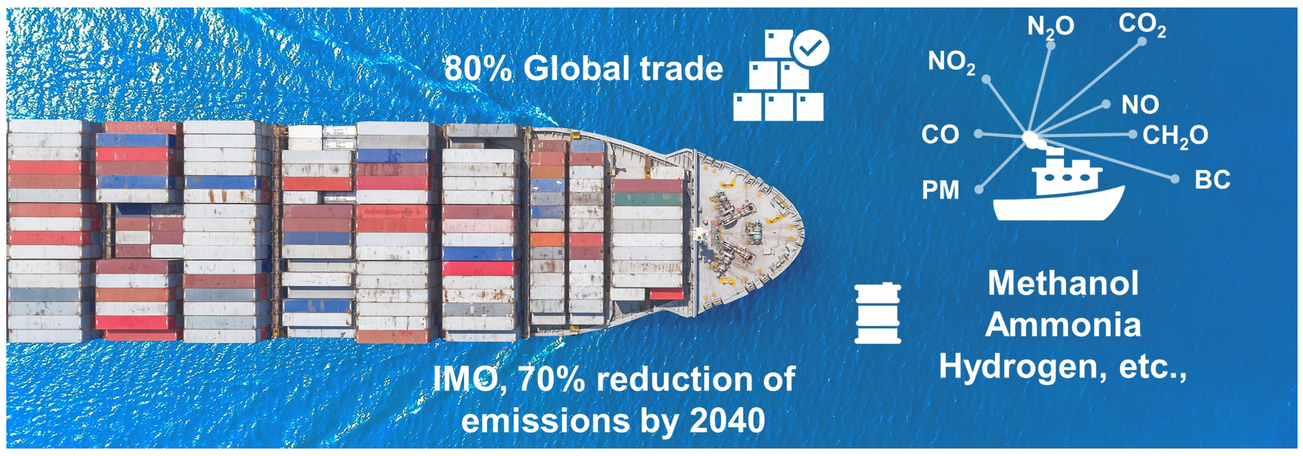
23IND09 MaritimeMET – Metrology for green maritime shipping:

Emission control through traceable measurements and machine learning approaches

Needs



Metrology

- Emission measurements
- Dynamic quantities
- Machine learning approaches

Objectives

- Traceability of emission parameters
- Dynamic pressure (0.1–30 MPa) and temperature up to 2500°C uncertainty of 1%
- Virtual sensors and uncertainty budgets for ML models

Approach & Impact

TASKS, ACTIVITIES & INTERACTIONS

WP 1: Traceable Emission Measurements

Reviewing options for emissions; PM | BC; (D3) Low-cost sensors; (D2) Good practice guide & uncertainty budgets; NOx, N_2O, CO, NH_3, CH_3OH, CH_2O; (D1) Optical Gas Standard; Engine characterization tests; Primary reference gas; *UV/IR spectroscopy*; (D3) Develop new sensors; Uncertainty budgets

WP 2: Traceable Dynamic Pressure

Impact mass method; Mathematical model; *UV/IR spectroscopy*; Dynamic influence & Spectroscopy investigations; (D4) Calibration method; (D4) Inter-lab comparisons; Engine characterization tests; Shock tube method; Commercial sensors; (D6) Uncertainty budgets; Good practice guide

WP 2: Traceable Dynamic Temperature

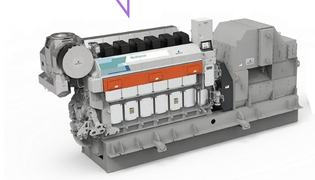
Radiance facility; Fiber optic spectrometer; Thermal imaging; Fiber optic sensors; (D5) Calibration method; Good practice guide & (D6) uncertainty budgets; *UV/IR spectroscopy*; Shock tube & Spectroscopic methods; *UV/IR in cylinder & engine exhaust*

WP 3: ML Approaches & Virtual Sensors

Emission models; (D7) Model uncertainty; (D8) Virtual sensors; (D7) Machine Learning Approaches; Fundamental experiments; Chemical kinetic model; Engine performance models

Engine validation; Fiber optic and UV/IR Measurement data; Pressure sensor; Low cost sensor

Application and validation - Engine test benches and on-board ship



OUTCOME & BENEFITS

- Wider application of OGS
- Development of portable sensors (PAS)
- Sensor calibration for industry
- *ISO/TC 158, BIPM CCQM-GAWG Gas Analysis, and CEN/TC 264/WG 40*

- The first CMCs in the dynamic pressure range
- Established methods for uncertainties estimations
- Dynamic calibration services
- *ISO/TC108/WG34/WT19 666 Dynamic Pressure Calibration*

- New dynamic temperature sensors up to 2500 °C will be accessible.
- Spectroscopy-based temperature measurements
- *Consultative Committee for Thermometry (CCT)*

- Improved ML approaches for engine & emission model with uncertainties
- Validated concept of virtual sensors
- *JCGM WG1 on the Expression of Uncertainty in Measurements*

IMPACT

Industries

Work Package 1,2,& 3

Environmental, Economic & Societal Impact

Environmental

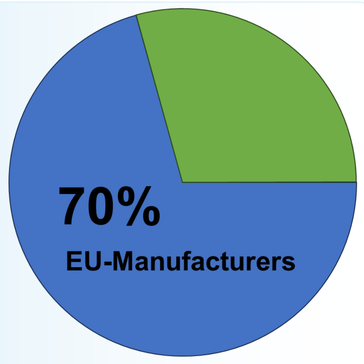
Increase: Efficiency; Sailing distance; Revenue for operator

Decrease: Fuel consumption; Emissions; Taxation

Economic

1€ spend equals 1.8€ supported in EU economy

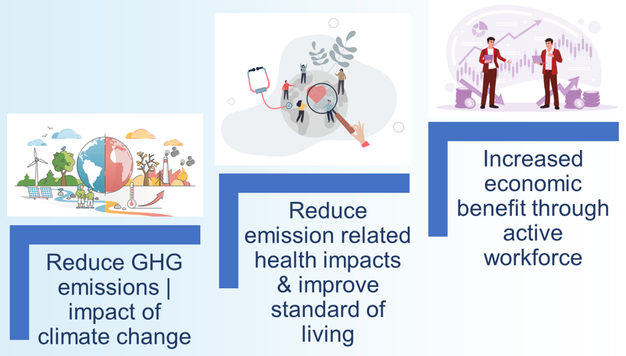
1 job in maritime sector generates 1.9 elsewhere EU economy



Market Share - Low to Medium Speed Engines

2 Billion € per year

Societal



Standardization & Technical Committees

- ISO, CEN, BIPM, IMEKO TCs
- IMO (international maritime organization)
- National standardization bodies

WP 5: Management

WP 4: Impact

DCE Plan

Consortium Members

FORCE TECHNOLOGY, WÄRTSILÄ, instrumatic.com, GERG, Technische Universität Braunschweig, DTU, LCC, TEKNOLOGISK INSTITUT, DFM Danmarks Nationale Metrologiinstitut, CZECH METROLOGY INSTITUTE, Arts et Métiers Sciences et Technologies, TÜBİTAK, VSL, RI.SE, VTT, PTB Physikalisch-Technische Bundesanstalt National Metrology Institute

Project Collaborators

SIEMENS, PCB PIEZOTRONICS AN AMPHENOL COMPANY

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METROLOGY PARTNERSHIP

EURAMET