

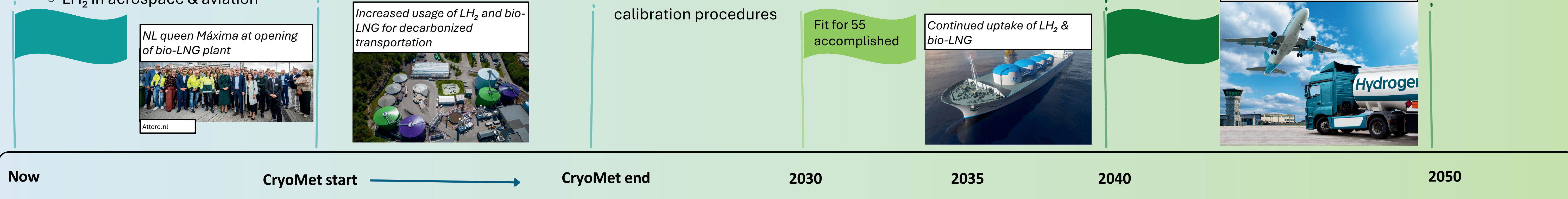


CryoMet

Metrology for reliable liquefied energy gases measurement

Needs

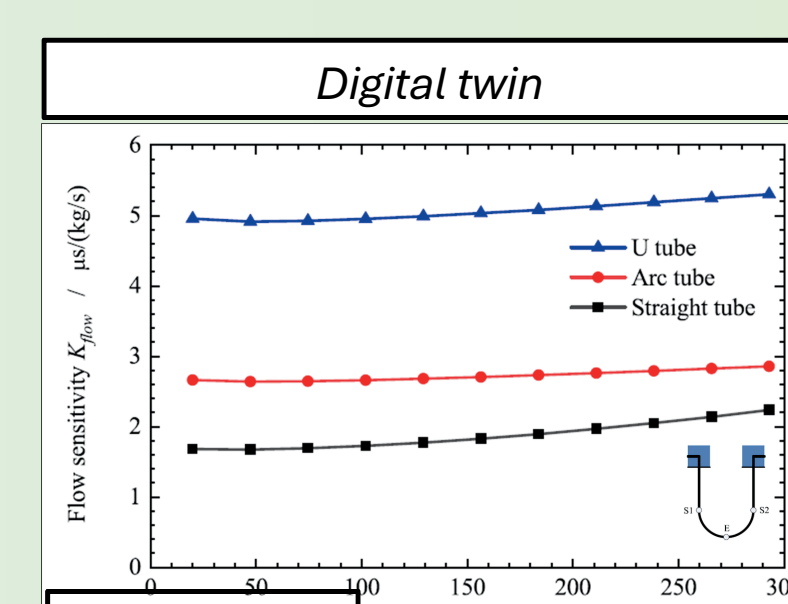
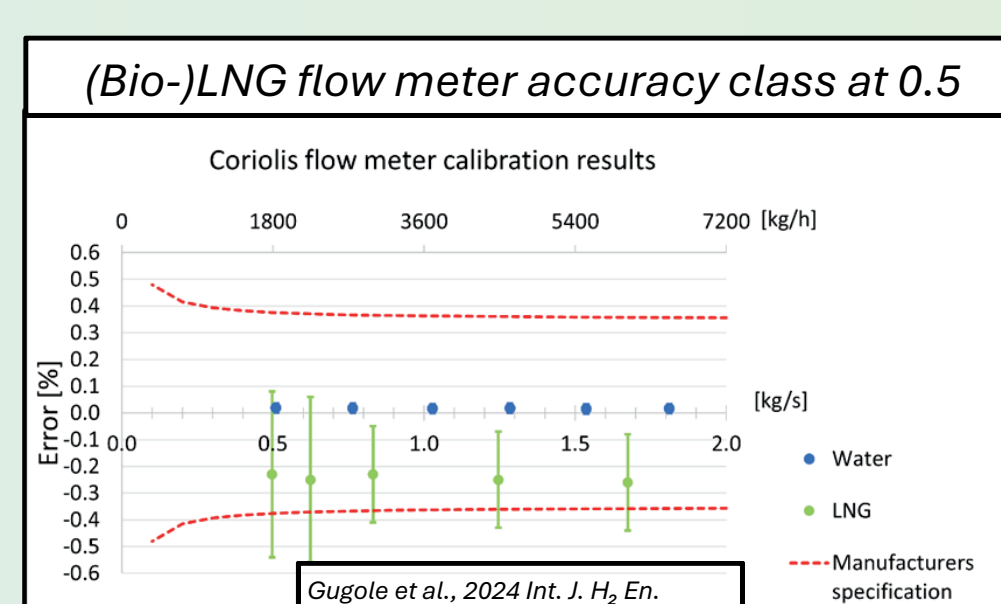
- EU Climate law
- Fit for 55:
 - AFIR
 - FuelEU Maritime
 - ReFuelEU Aviation
- Pilot projects:
 - Bio-LNG fueled trucks and ships
 - LH₂ as road (DelHyVer) & maritime
 - fuel
 - LH₂ large-scale transport
 - LH₂ in aerospace & aviation
- Scarce set of LNG measurement standards
- Unvalidated LH₂ measurement standards
- Cryogenic measurement standards:
 - Bio-LNG
 - LH₂
 - Flow
 - Composition
 - Temperature
- Improved in-field accuracy
- Cost-effective calibration procedures
- Acceptable measurement accuracy adopted in ISO/TC 28 Petroleum, ISO/TC 193 Natural Gas, CEN/TC 282 Biomethane, IEC/TC 65/SC 65B Temperature sensors
- Strong bio-LNG and LH₂ upscaling
- Supported by Europe's proven cryogenic measurement standards
- Immediate GHG reduction
- EU has low-carbon economy
- Mature cryogenic standards serving societal needs across entire bio-LNG/LH₂ supply chain
- Long-haul LH₂ transport by sea
- Bulk of hydrogen used in transportation sector
- Bio-LNG used as decarbonized heavy-duty and maritime fuel; 80% Maritime GHG reduction



Scientific Excellence

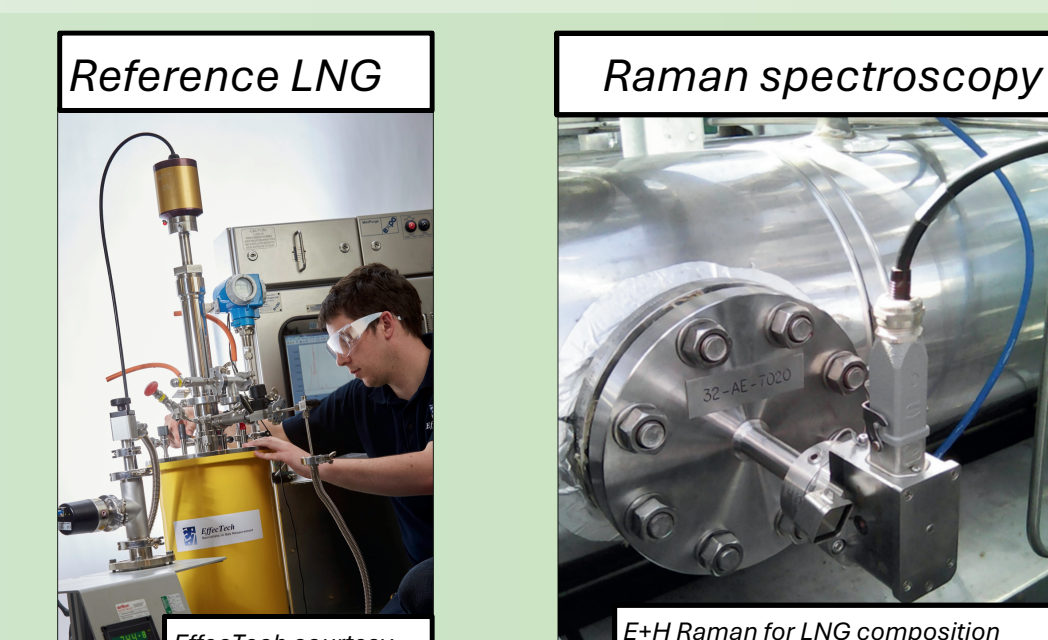
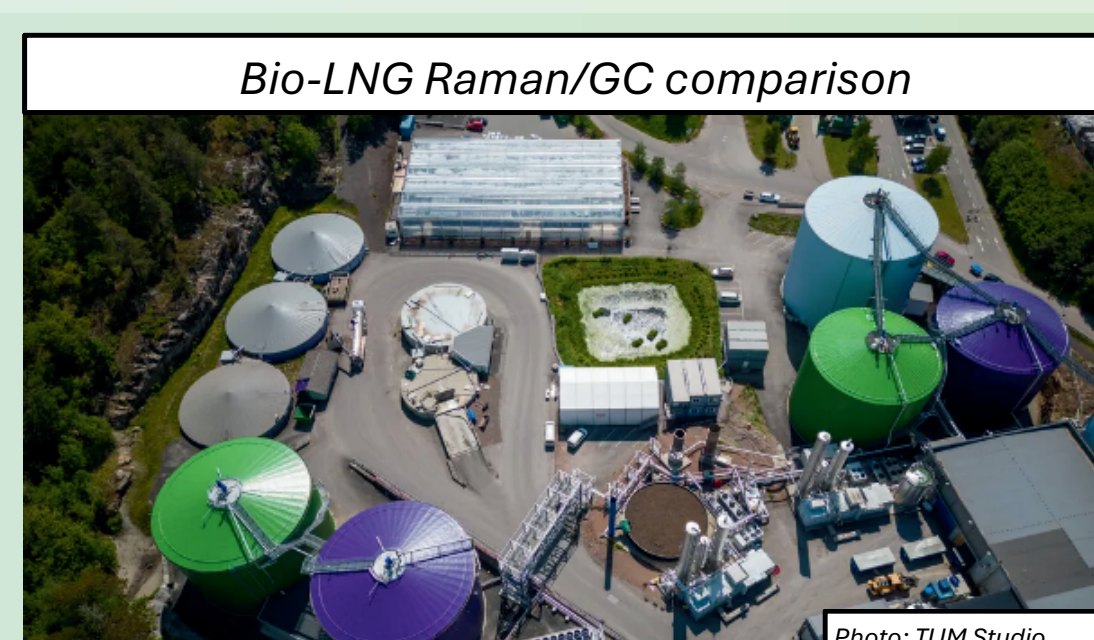
WP1: Liquefied gas flow metering reliability

- (Bio-)LNG flow meter accuracy class at 0.5
- Known (bio-)LNG flow meter dispenser installation uncertainty
- Cutting-edge machine learning, meter diagnostics, flow meter digital twin modelling extend in-field cryogenic uncertainty to LH₂ (-253 °C)



WP2: (Bio-)LNG composition measurement reliability

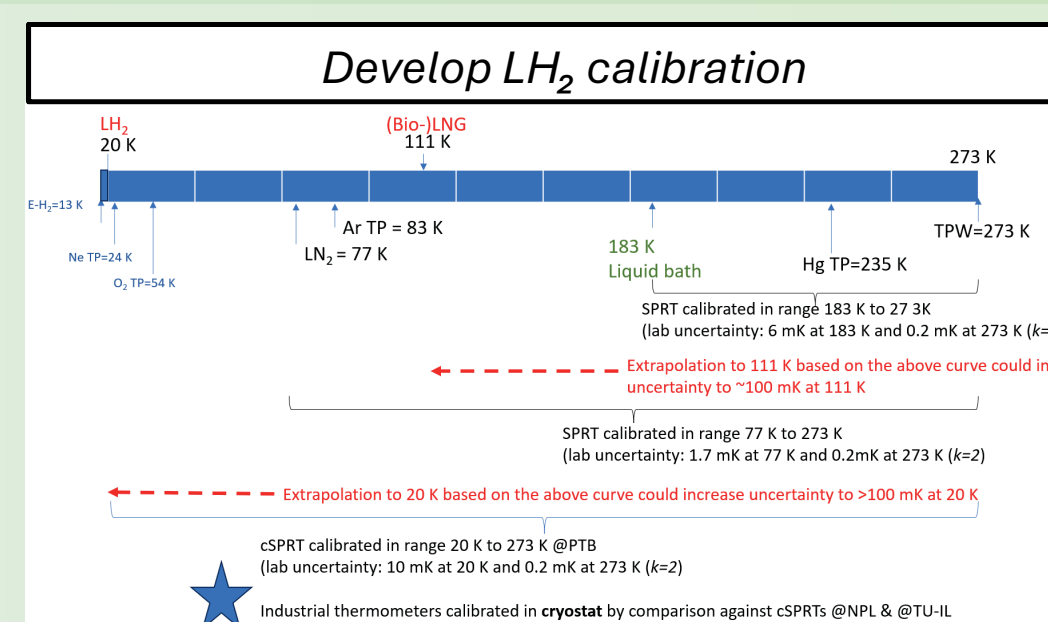
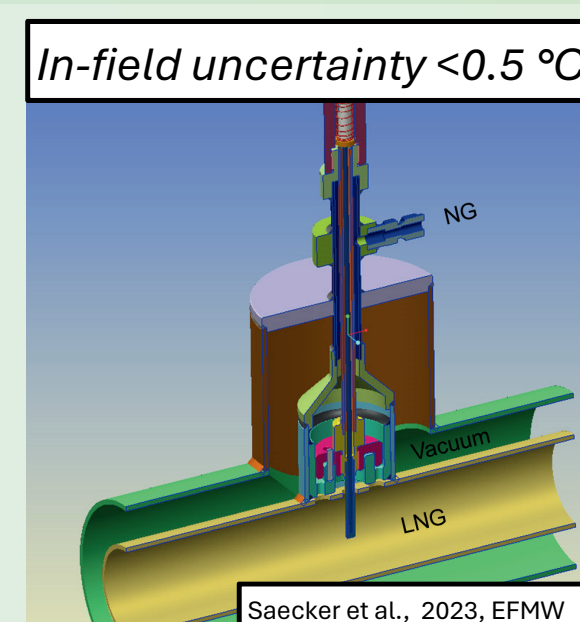
- Remove decades-long doubt on vaporization + sampling uncertainty
- Independent composition measurement by μ GC and Raman
- Novel, independent (bio-)LNG density measurement methodologies and uncertainty estimation



- #### (Bio-)LNG benefits
- Drop-in solution for sustainable transport
 - Immediate GHG reduction
 - Huge potential

WP3: SI-traceable liquefied energy gas temperature measurements

- Prove in-field cryogenic temperature uncertainty to <0.5 °C ($k = 2$); down to -253 °C (LH₂)
- Novel, efficient method for cryogenic gas temperature calibration down to -253 °C (LH₂)
- Develop unique and highly-needed LH₂ calibration capability



- #### LH₂ benefits
- Ultrapure: sustainable aviation & transport
 - Supply chain cost advantages
 - Decarbonized long-haul energy transport

WP4: SI-traceable calibration procedures for liquefied gases

- Groundbreaking SI-traceable LH₂ ortho- and para-spin isomer composition determination
- First comparison of cryogenic flow standards directly on industrial LH₂ flow rates
- Compare Raman and GC (bio-)LNG composition measurement for lower uncertainty



WP5: Impact

>30 stakeholders covering the entire (bio-)LNG & LH₂ supply chain

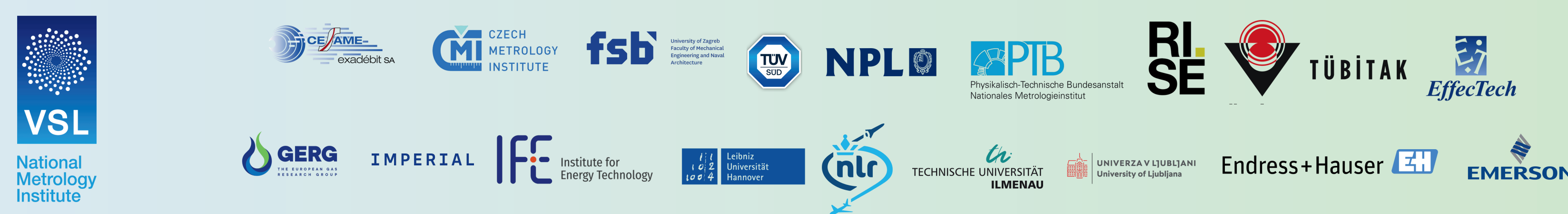
- Objectives fully supported
- LoS from all objective 5 standardization committees
- LoS from hydrogen and biogas industry associations

DCE in place:

- WP1, WP2, WP3 reference datasets
- LH₂ flow standards
- Good-practice guide (bio-)LNG sampling
- Direct density measurements
- Fit-for-purpose LH₂ thermometer calibration
- SI-traceable LH₂ isomeric composition

Standardisation	<ul style="list-style-type: none"> • "the project will provide our committee with new reference data" • "interest to prove the Raman technology"
Metrology community	<ul style="list-style-type: none"> • Demanded traceability progresses liquefied gas measurement standards • Europe is in the lead
Academia	<ul style="list-style-type: none"> • Academia generates higher quality measurement data • Highly cited journal publications underpin technology development
Aerospace/aviation	<ul style="list-style-type: none"> • "Our interest is focused on traceability to LH₂ standards for producing operational aircraft"
Industry	<ul style="list-style-type: none"> • "Understanding accuracy of cost-effective alternatives" • "LH₂ temperature measurement at large-scale" • "LH₂ production plants can improve efficiency" • "The traceable calibration is essential to our customers"
Environment	<ul style="list-style-type: none"> • Metrological barriers for decarbonization of transport are removed • Fit-for-55 GHG reduction and Green deal objectives are achieved
Society	<ul style="list-style-type: none"> • Diverse energy supply avoids social unrest from inflation • Social licence is obtained

Consortium



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++ All of Europe's cryogenic capability represented