Metrological traceability in LNG custody transfer

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Metrological traceability in natural gas energy measurement

- Quantity
  - Volumetric flow rate measurement
  - Metrological traceability to the harmonised m^3
- Quality
  - Composition analysis ISO 6974
  - Calorific value and density calculation ISO 6976
  - Metrological traceability requirements documented in ISO 14111

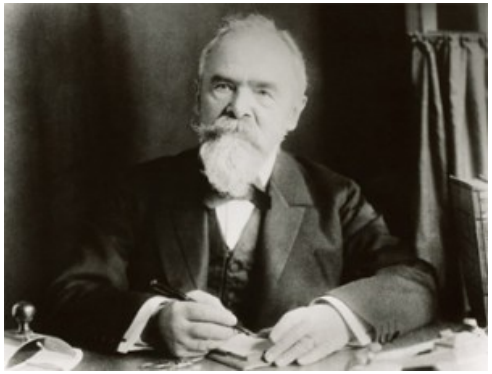
Long history of LNG

1917 First LNG plant in operation
... for the production of He

1941 First commercial LNG plant

1959 First shipment of LNG from USA to UK

1964 LNG train set up between Algeria and UK



Carl von Linde developed commercial air separation in 1895

LNG DISTRIBUTION CHAIN

Large Scale LNG : Reducing Energy Measurement Uncertainties, Transparency, Simpler Processes

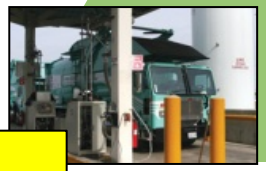
Ocean tanker

Receiving terminal

Pipeline gas

Road tanker

Small ship



Bunkering/Fuelling stations

Trucks

Ships

Buses

Small scale LNG: Regulations (legal metrology), Certified Dispensing Systems, Flow Meter Calibrations

Measurements of LNG

Large scale LNG business

Measurement of energy

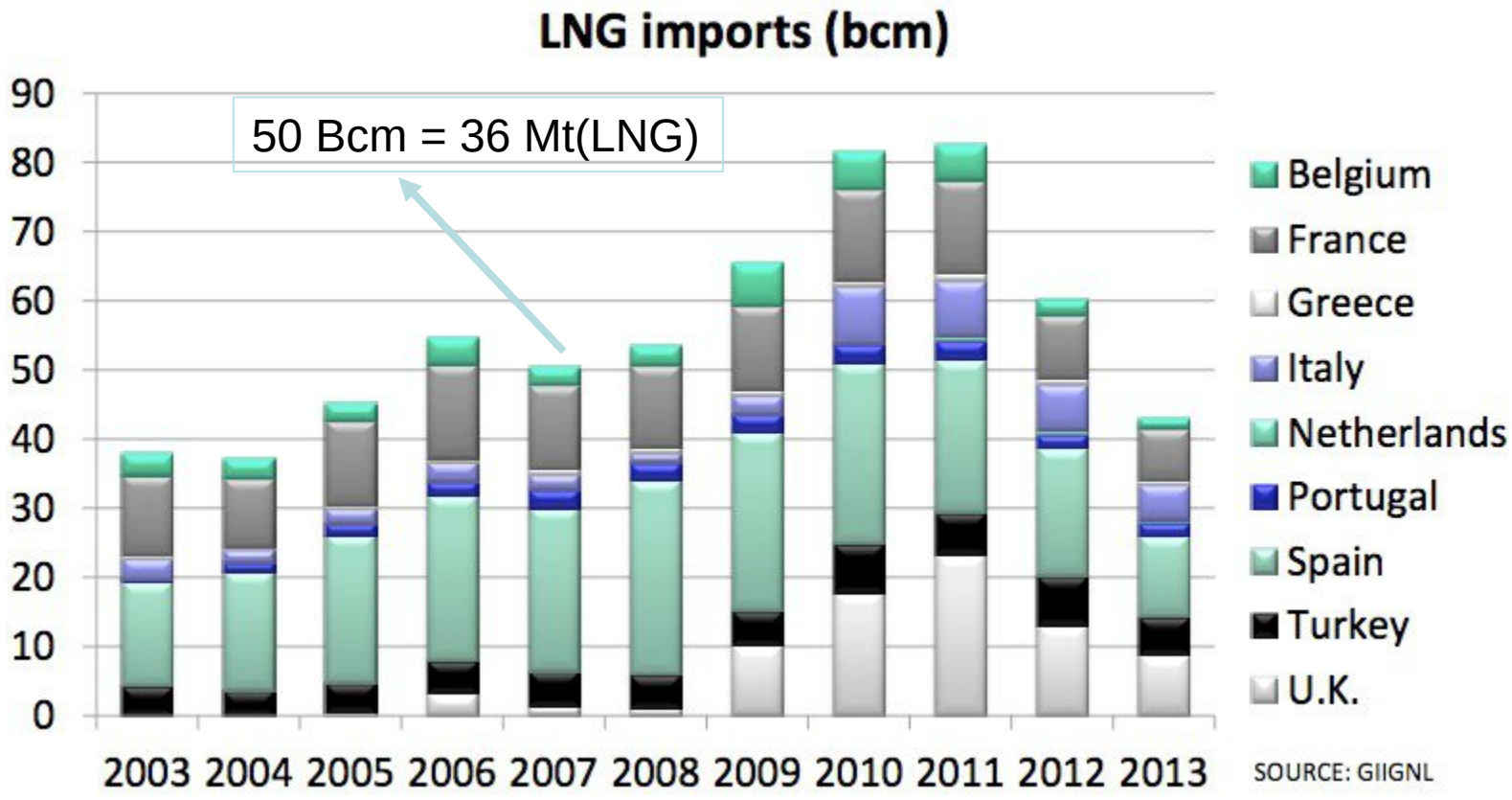
Small scale LNG business

Measurement of energy?

Measurement of kilograms?

Measurement of liters?

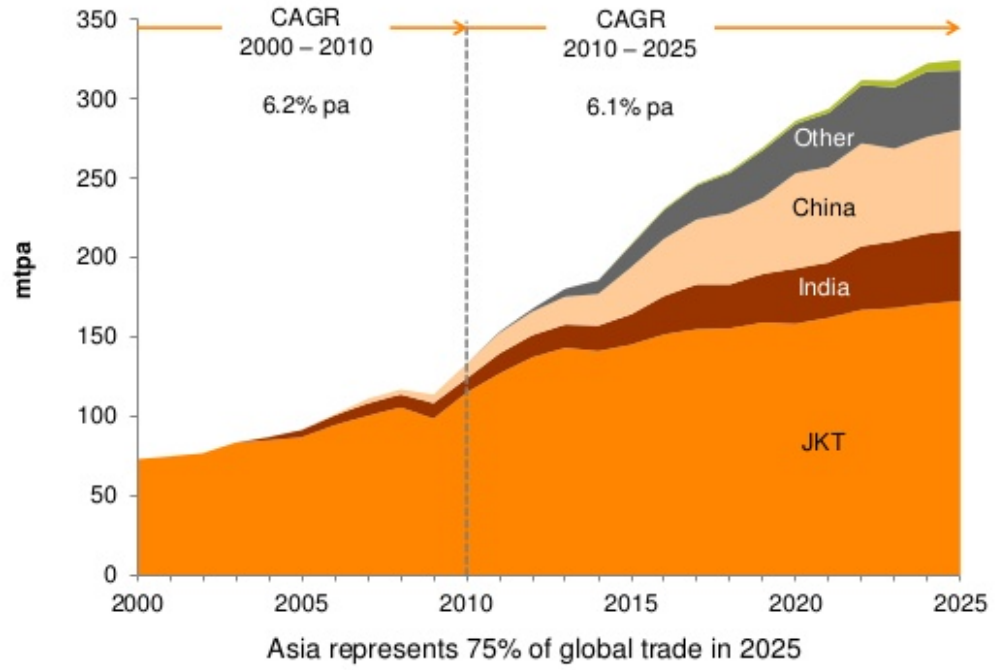
LNG import in Europe



LNG import outside Europe

Strong Asian LNG demand growth

BG GROUP



Source: BG Group outlook 2013

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Impact of measurement uncertainty

Large scale LNG

- Typical terminal (10 bm^3(N)/year)
  Measurement uncertainty equivalent to 25 M€/year

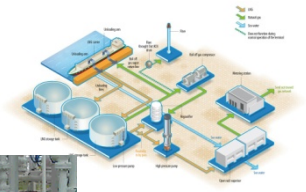
  One cargo load (Qmax)

  Measurement uncertainty equivalent to 500 k€

Small scale LNG

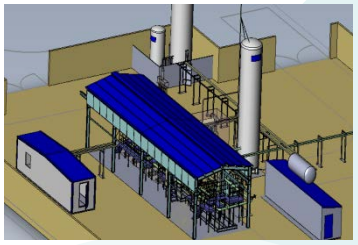
- Measurement capabilities not at par with other fuel legal metrological requirements

Capacity



Reference values up to 10,000 m^3/h uncertainty 0.2% (LNG 5, …)

Large scale LNG, main driver: energy security. Targets: reduced measurement uncertainty, transparency, simpler processes



Reference values up to 1000 m^3/h uncertainty 0.2% (LNG 3 & 4)

Reference values up to 200 m^3/h uncertainty 0.15% (LNG 2b)

Small and mid scale LNG and LBG, main driver energy transition. Targets: certified dispensing systems, reduced measurement uncertainty

Primary reference values up to 25 m^3/h uncertainty 0.1% (LNG 2a)

Primary reference values up to 25 m^3/h uncertainty ~0.2% (LNG I)

Feasibility, design, business case

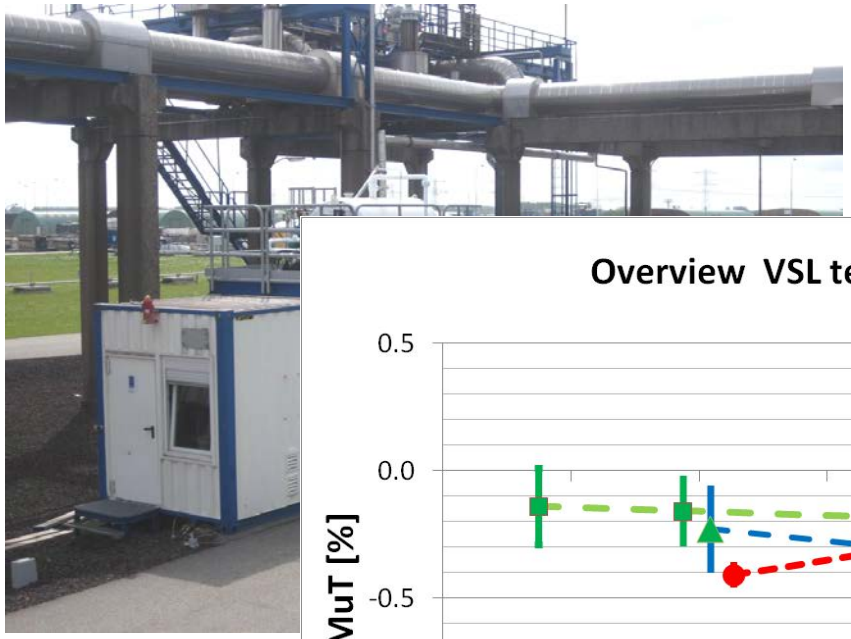
Realization facility

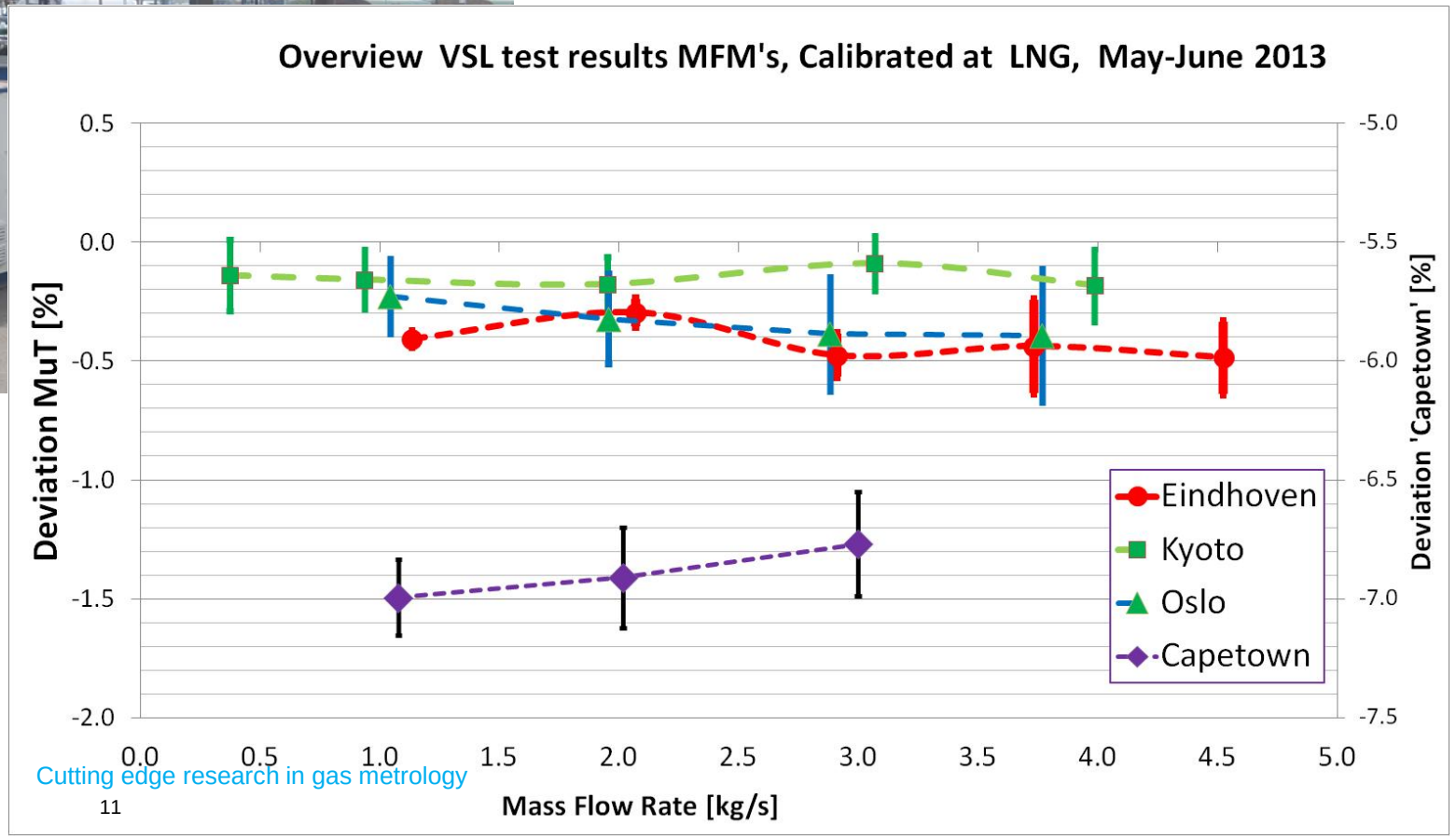
2012 2014 2016 2018 2020 2022 2024

LNG Flow measurement

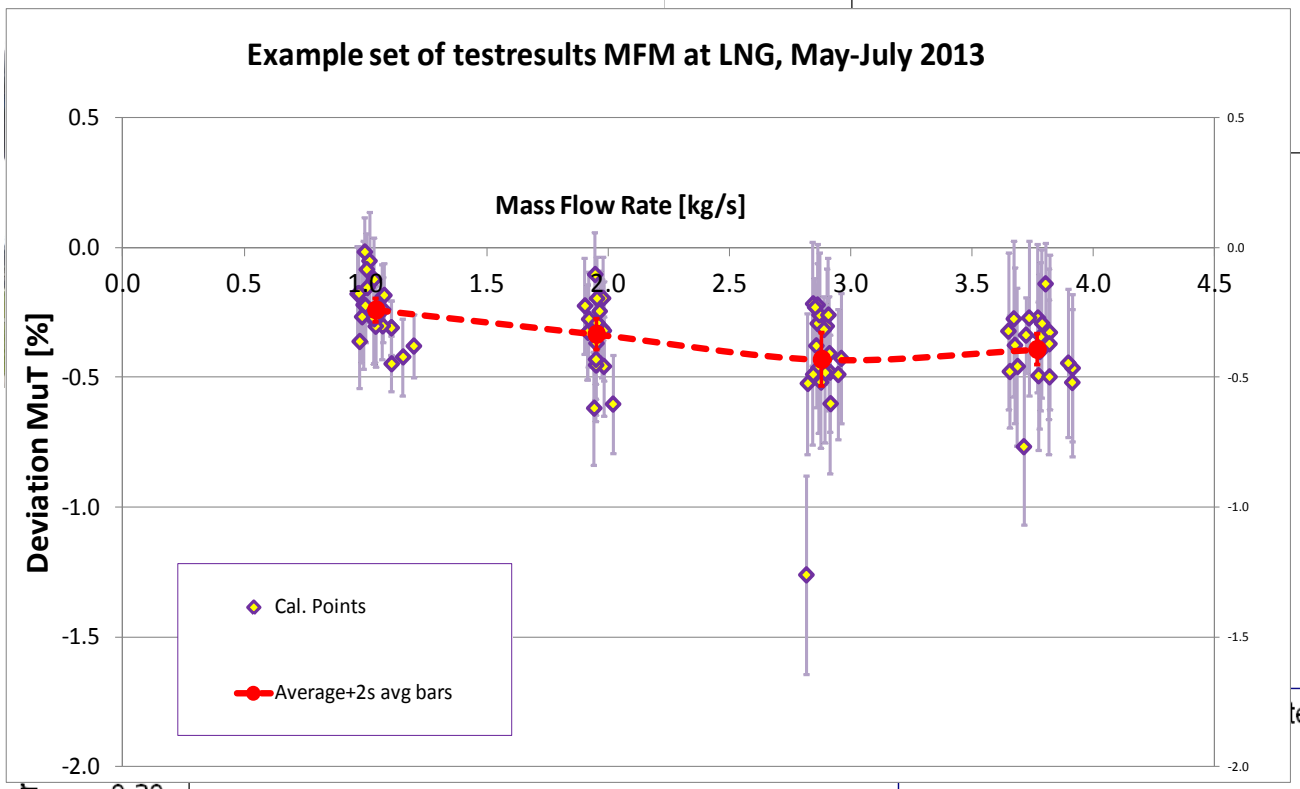
Primary standard 25 m³/h

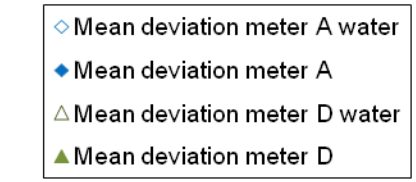
Water based calibration?

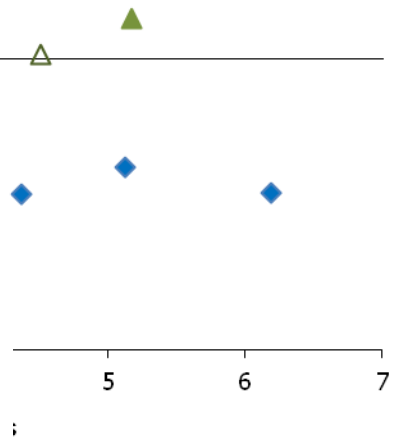




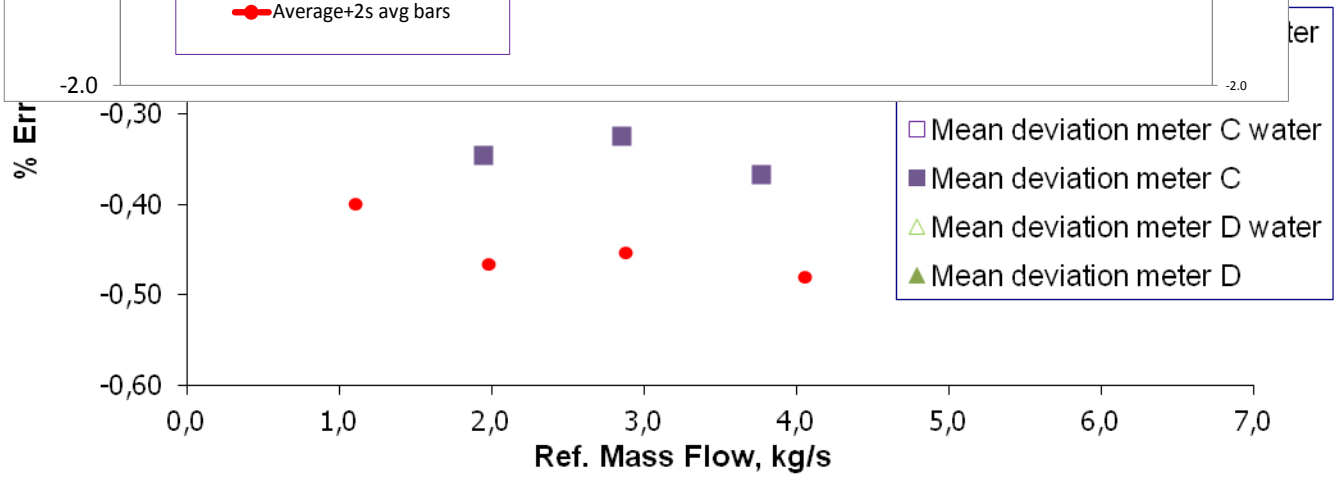
Primary
Water bas







Water vs LIN



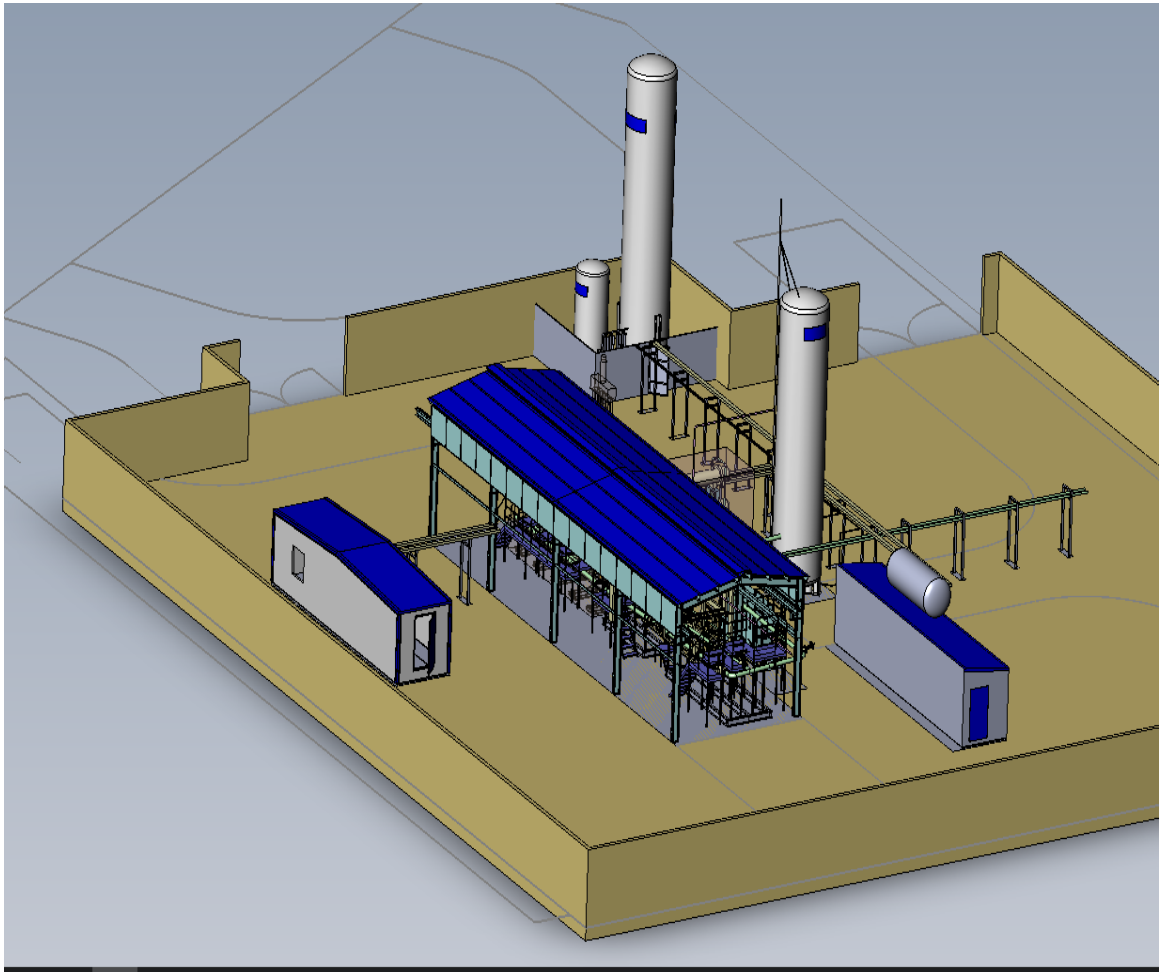
Water vs LNG

LNG research and calibration facility

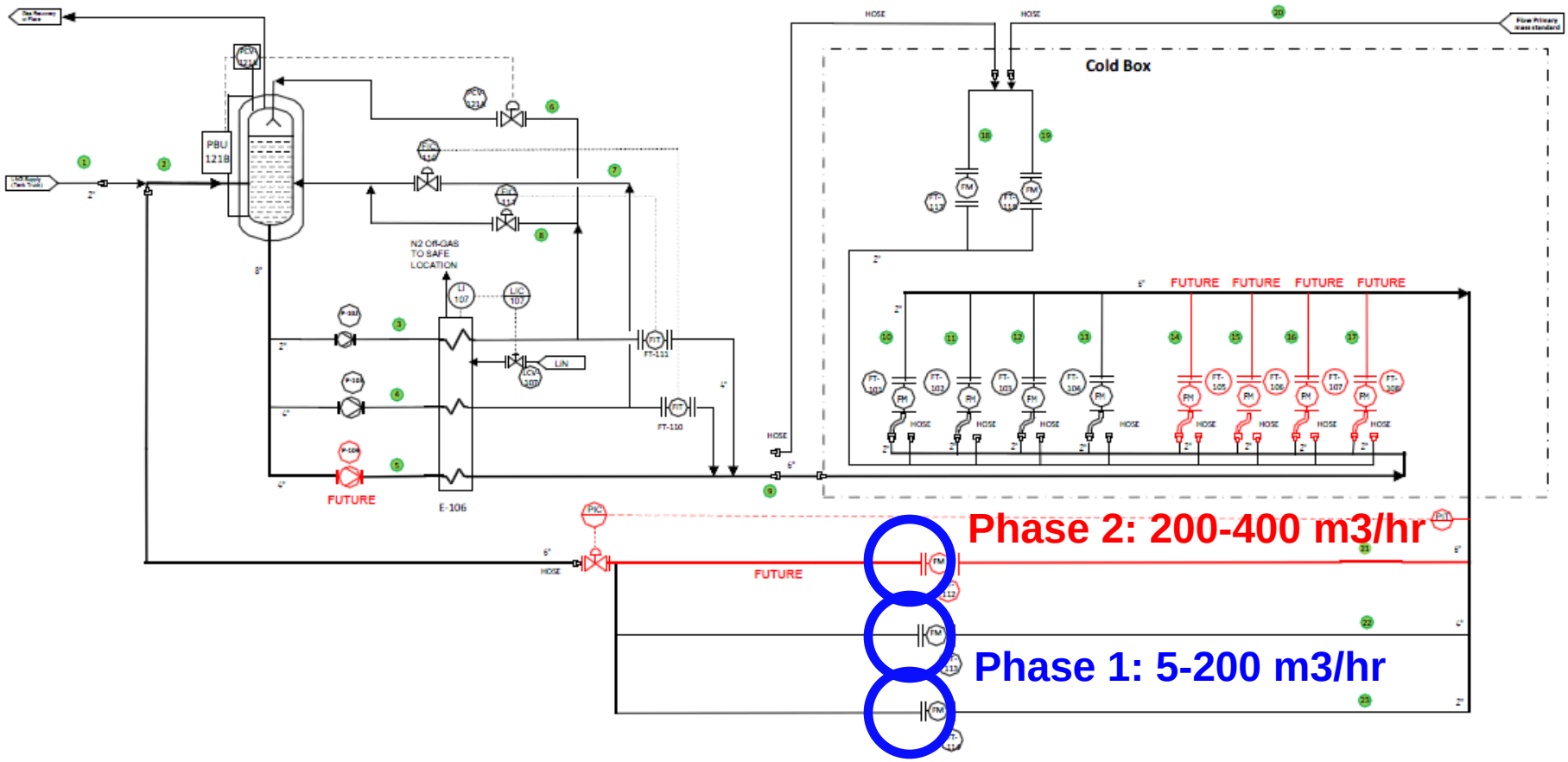
Site preparation

Technical drawings

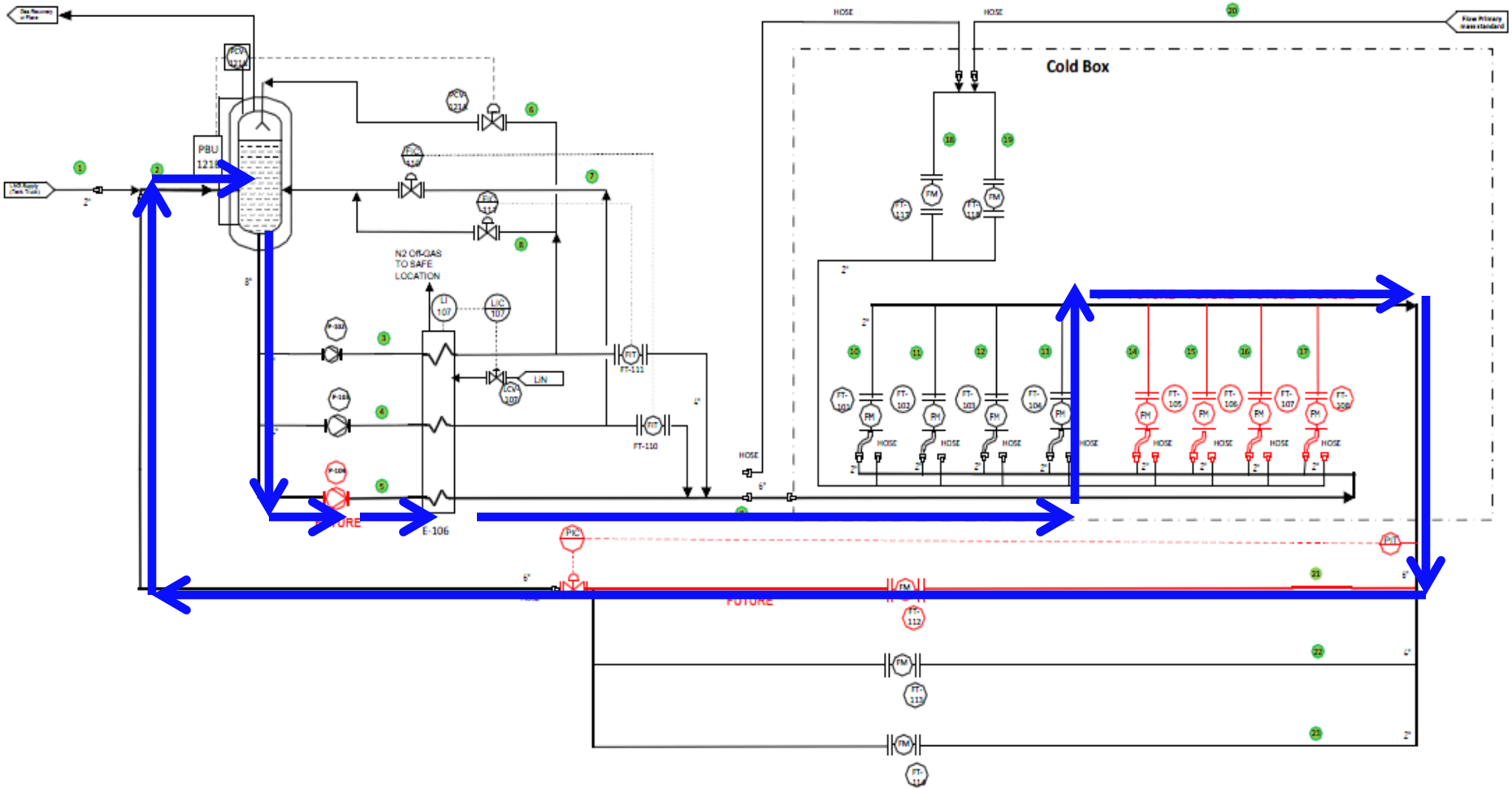
Overview



First and second phase



Calibration mode



Traceability

LNG composition

Two ways …

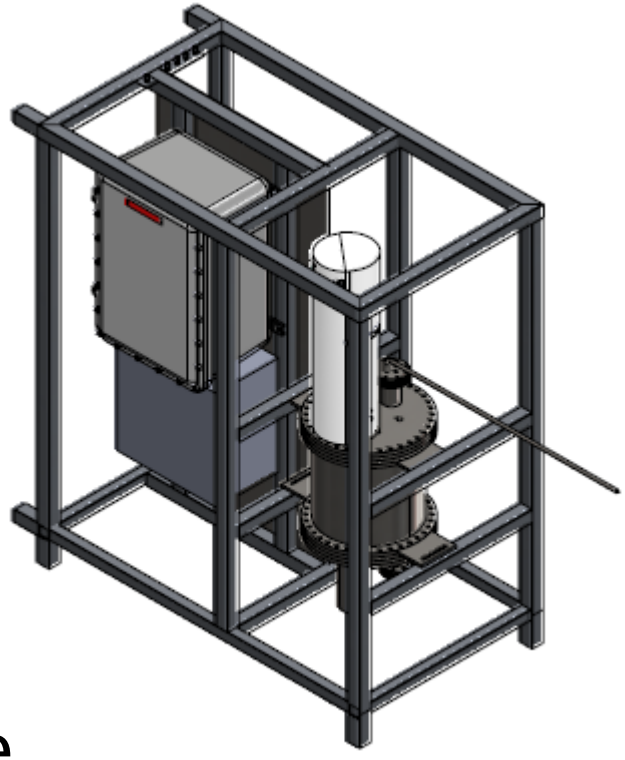
1. Sampling and gas chromatography
   - Sampling
   - Vaporising
   - Gas chromatographic analysis
2. Online measurement
   - Probe
   - Raman spectroscopy?!

Metrological traceability

- Option 1
  - Issues with sampling
  - Issues with vaporising
  - GC analysis conformant ISO 6974 and traceability as for natural gas
- Option 2
  - Calibration of Raman spectrometer using liquid (!) reference standards
  - Reference standards should be connected to existing PSMs for natural gas

Composition standard

- Special design sampler (subcooled conditions)
- Vaporisation at supercritical conditions
- Gas chromatograph
- Sampling volume flow rate 7,5 ml/min (≈ 5 L/min gas)



Validation of the LNG composition standard

reference gas standards

Reference Liquefier

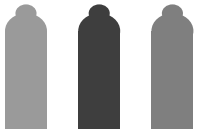
Developed within the project

Sampler & Vaporizer

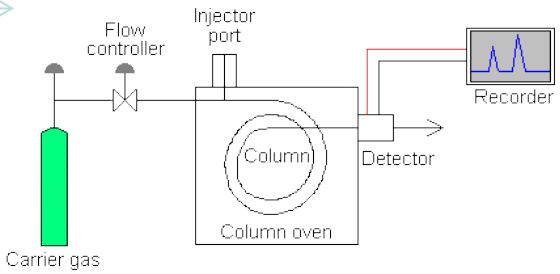
Supercritical vaporizing

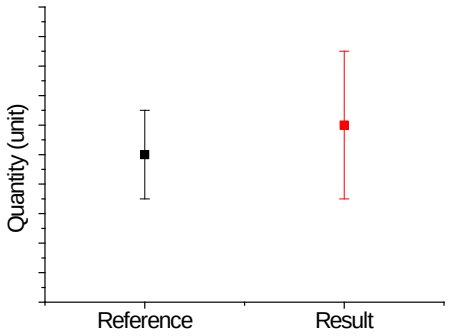
Measurement 1 (Reference)

Measurement 2 (Result)



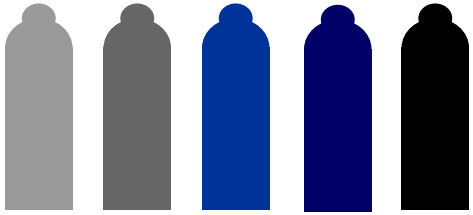
LNG calibration gas





Composition measurement system for LNG

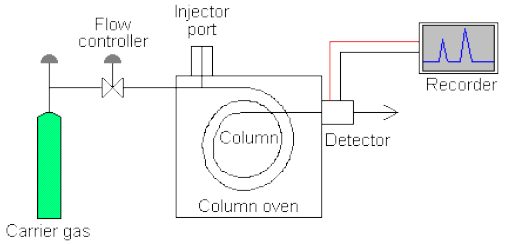
Supercritical vaporizing



calibration gas mixtures

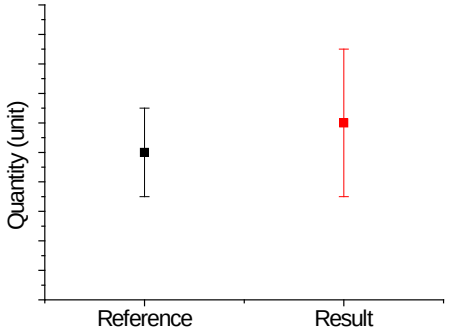
Measurement 1 (Reference)

LNG loop



Measurement 2 (Result)

Commercial Sampler Vaporizer



In conclusion …

- LNG is metered using mass flow rate measurement
- Calibration of flow meters requires LNG
- Sampling and vaporising critical for traceable energy measurement
- Raman has still to prove that it is a full-fetched replacement for the GC
- Connection to existing infrastructure for natural gas critical success factor

Acknowledgement

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