Ultrasonic Meters in Natural Gas and Hydrogen Blends

Wade Stinson

Energy Nexus | Annual Technical Conference

Fuelling the Future

Ultrasonic Meters in Natural Gas and Hydrogen Blends

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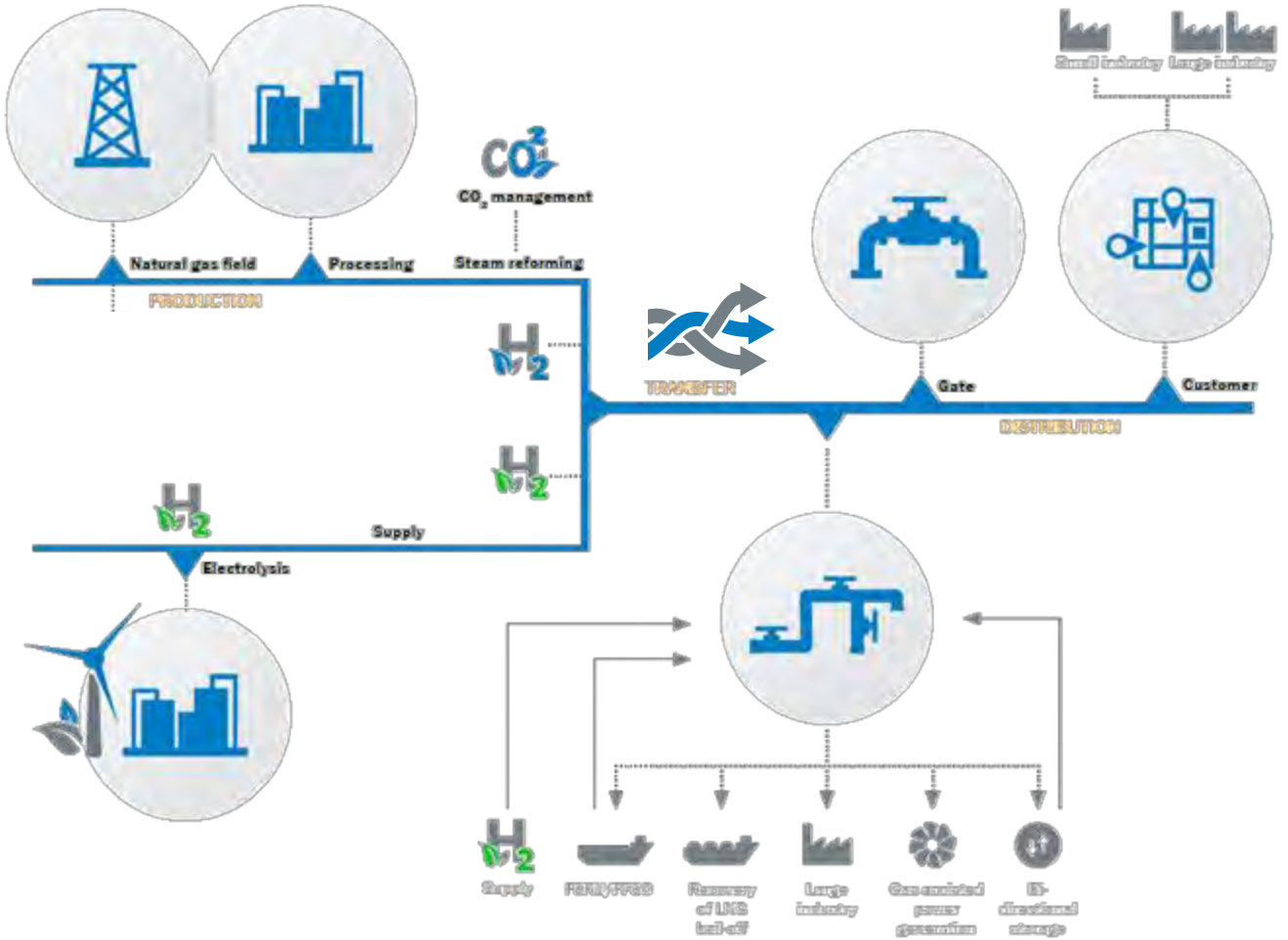
Global Energy Transition

Partnering along the value chain

FLOWSIC



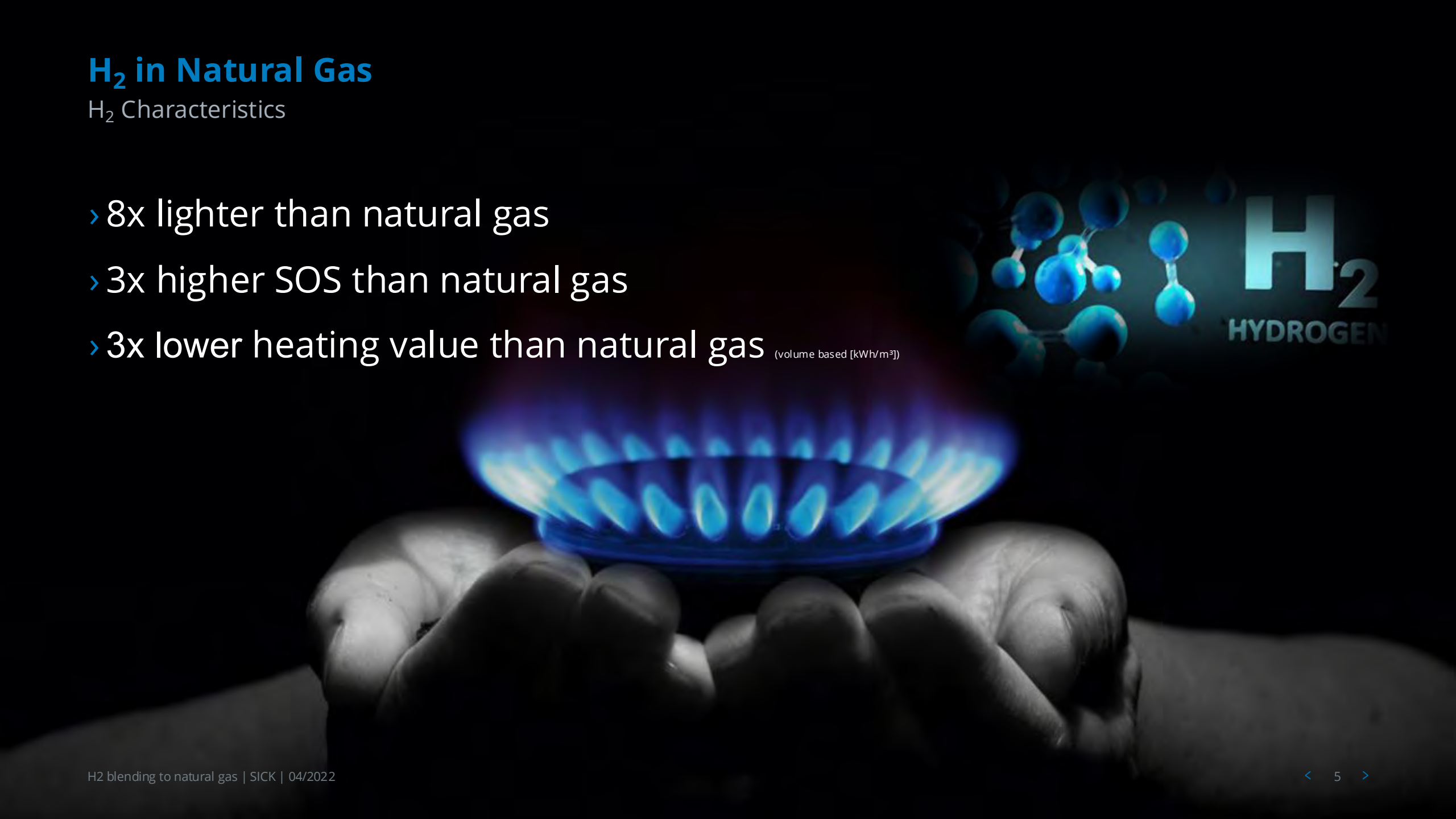
H_2 Blending

Effects on Metering?

H_2 in Natural Gas

H_2 Characteristics

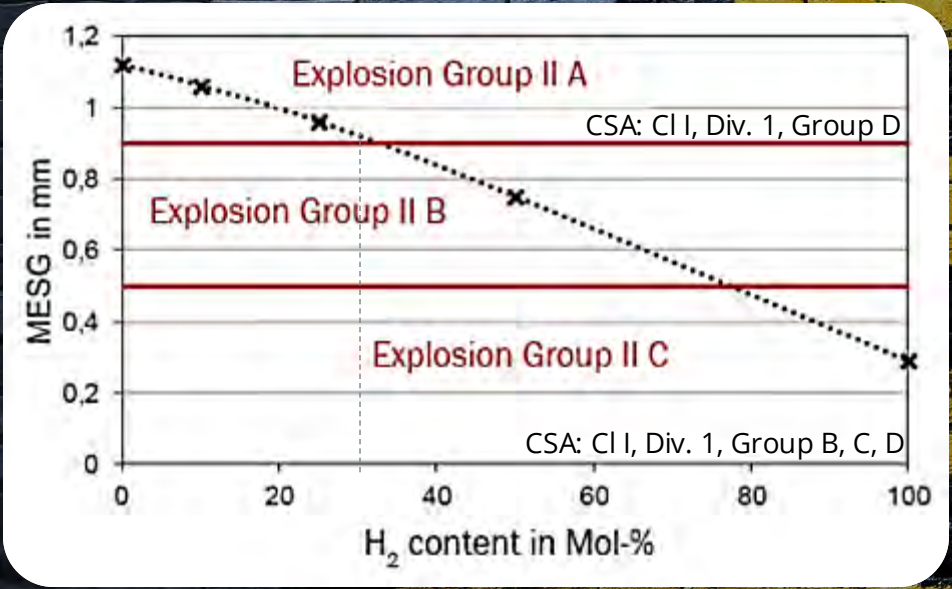
- 8x lighter than natural gas
- 3x higher SOS than natural gas
- 3x lower heating value than natural gas (volume based [kWh/m³])



H_2 in Natural Gas

Effect of H_2 blending explosion protection

- Explosion pressure changes slightly up to 30% H_2
- >25-30% H_2 explosion group IIB or IIC



Source: BAM: Safety properties of natural gas/hydrogen mixtures, 06/2015

H_2 in Natural Gas

Effect of H_2 blending on gas meter material

- 30% H_2 blending: no impact on SICK USM used material
  - Meter body: forged and casted material

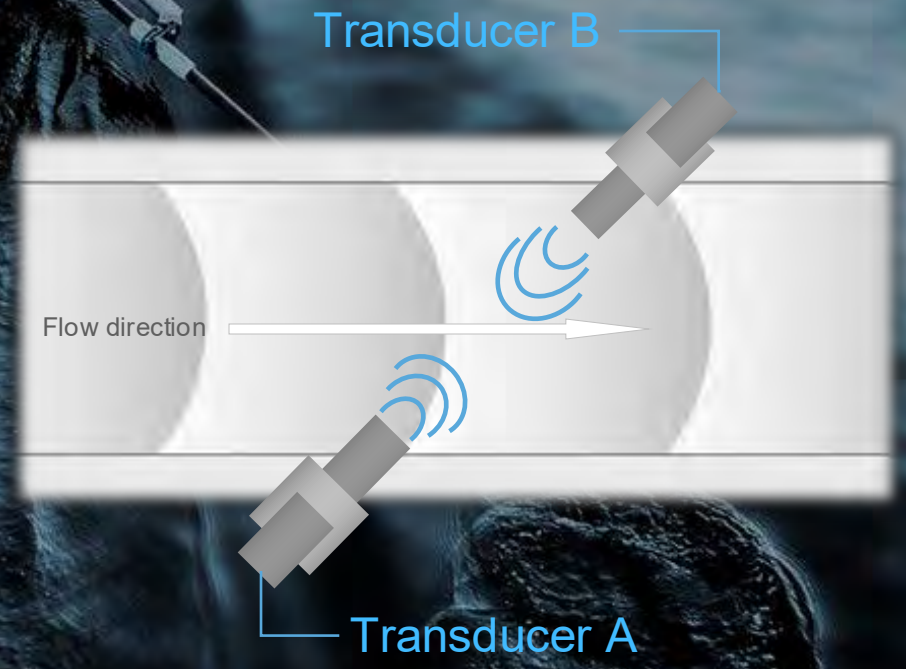
    (e.g., ASTM A350 Gr.LF2, A352 LCC, A182 Gr. F316/316L and Gr. F53)
  - Transducers: titanium
  - Sealings: Viton elastomer
  - Flow conditioner: stainless steel, plastics

Source: BAM: Resilience assessments of metallic container materials and polymeric sealing/coating and lining materials, Berlin, 01/2015

H_2 in Natural Gas

Ultrasonic Measurement Principle

› Transit time base measurement



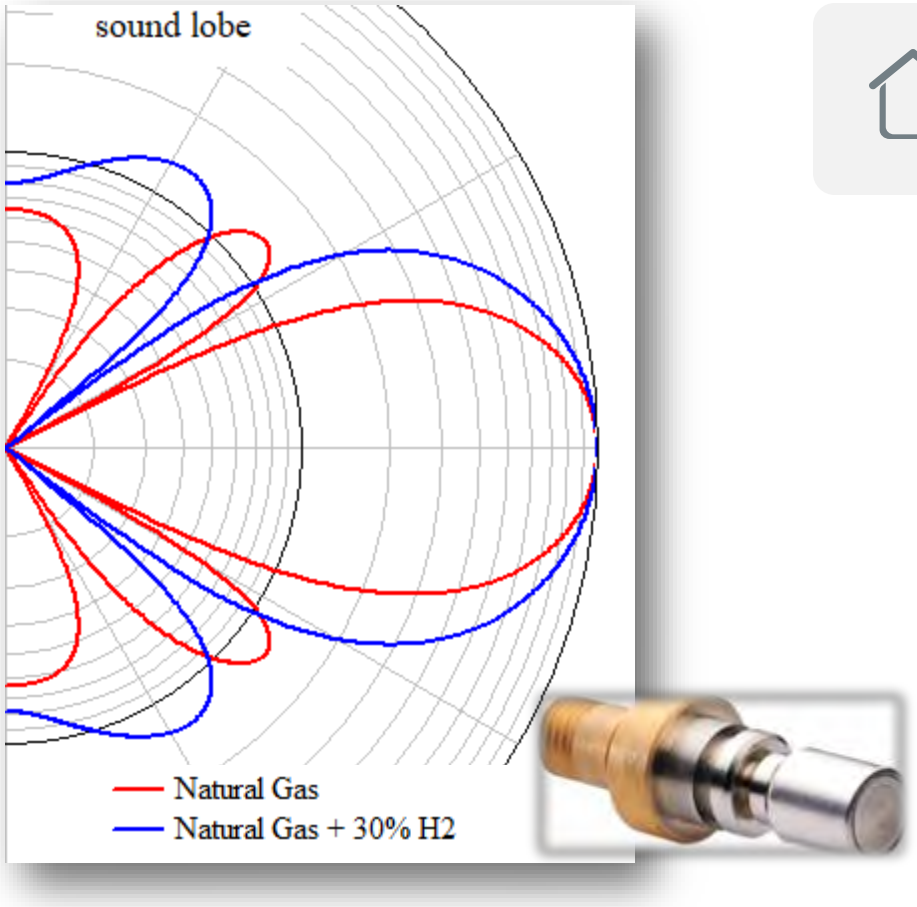
Travel Time
from B to A (T2)

Time Difference
ΔT = T2 - T1

Travel Time
from A to B (T1)

H_2 in Natural Gas

H_2 Characteristics and USM Influence



- SICK own transducer development
- 30 application optimized transducers

› Acoustics basics

H_2 content ↑ → Speed of Sound ↑

Speed of Sound ↑ → Sound lobe ↑

Sound lobe ↑ → Line size limitation ↑

→ device design accordingly

H_2 in Natural Gas

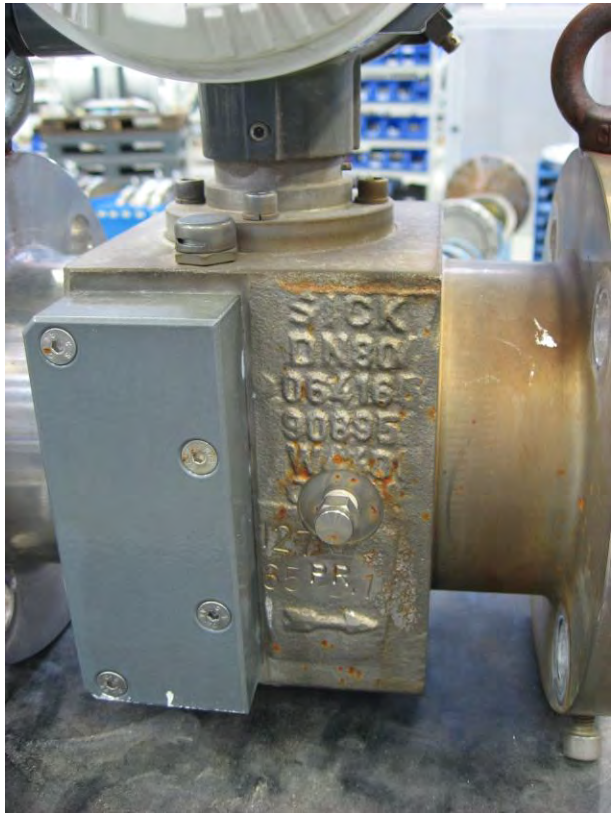
White Paper - Power To Gas

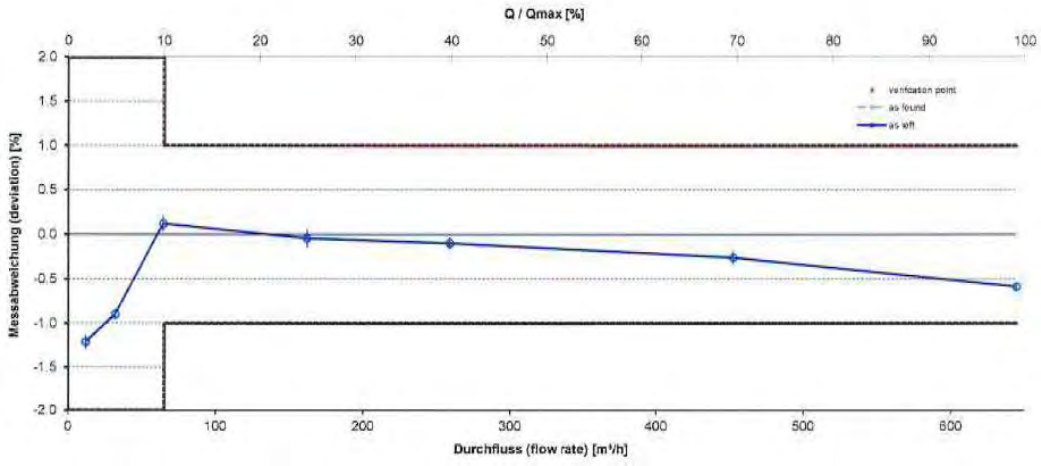
- Power-To-Gas Whitepaper 2019
  - H_2 content in natural gas
  - Fiscal measurement in Mid- and Downstream
  - Based on field experience

100% H_2 Gas Flow Metering - Process Measurement

Reference

- Process measurement. 100% H_2. Produced in 2009!
- Flow rate 12…650 m3/h
- Successful Recalibration in 2015
- Gen. I process H_2 meter



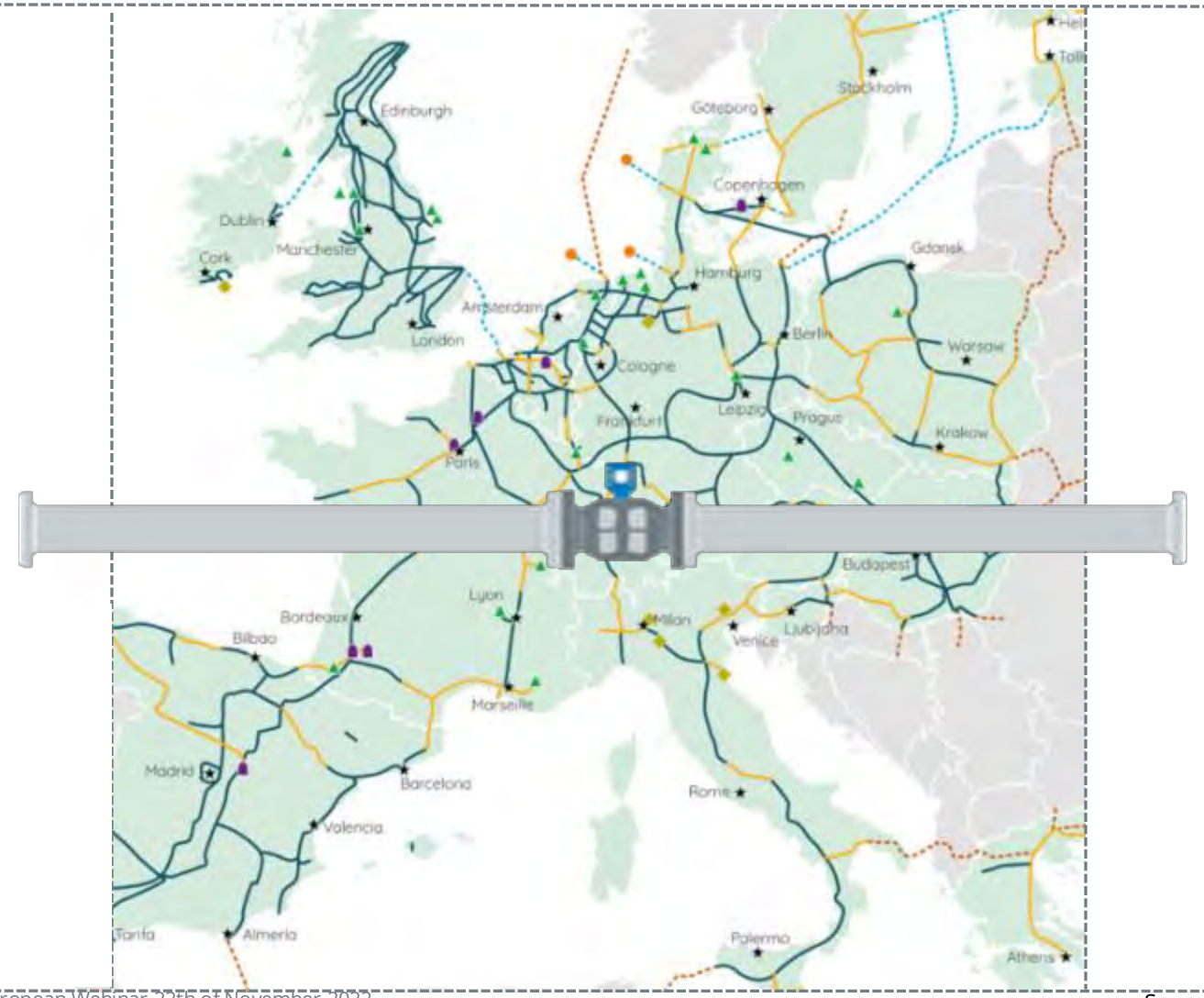


100% H_2 custody transfer measurements

Hydrogen Value Chain

H_2 Transportation

H_2 Production

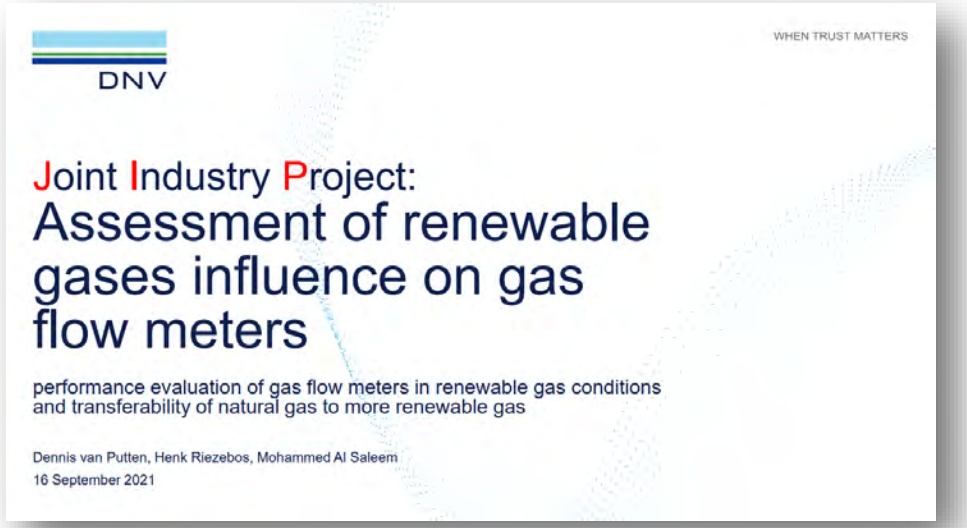


H_2 Utilization

› Source of pictures:
› -The European Hydrogen Infrastructure Backbone

H_2 in Natural Gas

Effect of H_2 blending on meter error



JIP: independent 3rd party project to test renewable gases influence on gas flow meters

- Injection of up to 30% H_2 and CO_2 in natural gas
- 9 meter manufacturers
- 10 end users

H_2 in Natural Gas

SUMMARY MIDSTREAM FLOWSIC600/-XT

SICK
Sensor Intelligence.

SUMMARY

- S6 Sensor System: confirmation of installed base: ≤ 0.1% at 10% H_2
- R&D new H210 Sensor system: deviation to base line: ≤ 0.25% at 30% H_2
- Repeatability: ≤ 0.05%
- OIML R137 Part 1 requirements fulfilled
  (defined in chapter 5.13.5 „different gases“)
  - OIML class 1.0 (MID) requirement of MPE ±1.0% fulfilled (Q_t … Q_{max})
  - OIML class 0.5 requirement of MPE ± 0.5% fulfilled (Q_t … Q_{max})
- Market release with MID approval scheduled mid 2022

H2READY

Source: SICK data evaluation based on DNV JIP, 3rd party test data 05/2021

H_2 in Natural Gas

FLOWSIC500 in pilot application with H_2 blending

FLOWSIC500 - “H_2 injection in gas distribution“

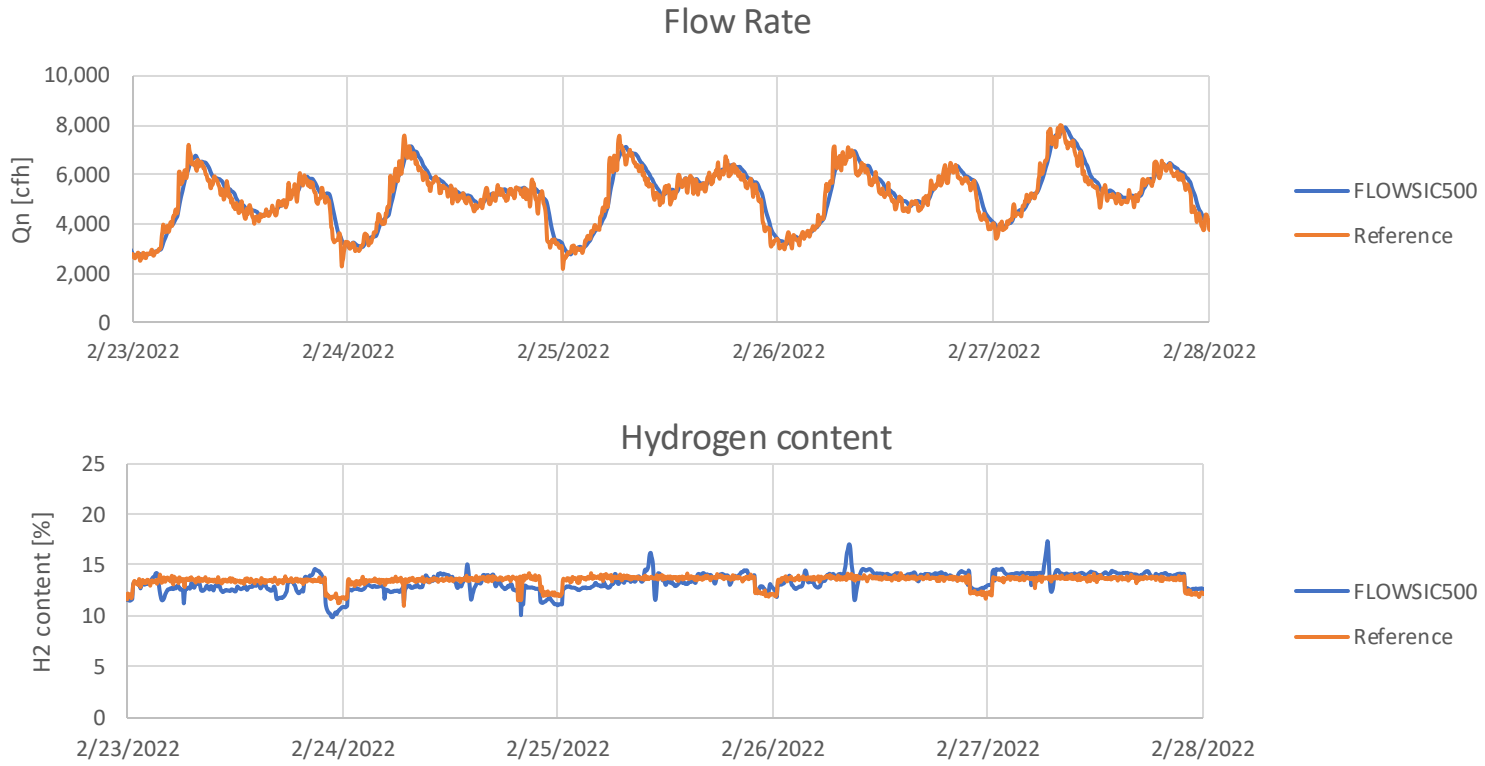
- Installation with excellent comparison data:
  - USM for 100% natural gas measurement
  - Rotary for 100% hydrogen measurement
  - FLOWSIC500 for gas mixture measurement
    - H2 blending from 10…15…20%

H_2 in Natural Gas

FLOWSIC500 in pilot application with H_2 blending

FLOWSIC500 - "H_2 injection in gas distribution"

› Data Snapshot @ about 15% H2 injection



H2READY

H_2 in Natural Gas

Test Campaign FLOWSIC500 H2-ready

DVN test facility Netherlands

- 5-day test campaign, ordered by SICK
- Proof of FLOWSIC500 performance, up to 30% H_2
- Generation of data basis for MID approval

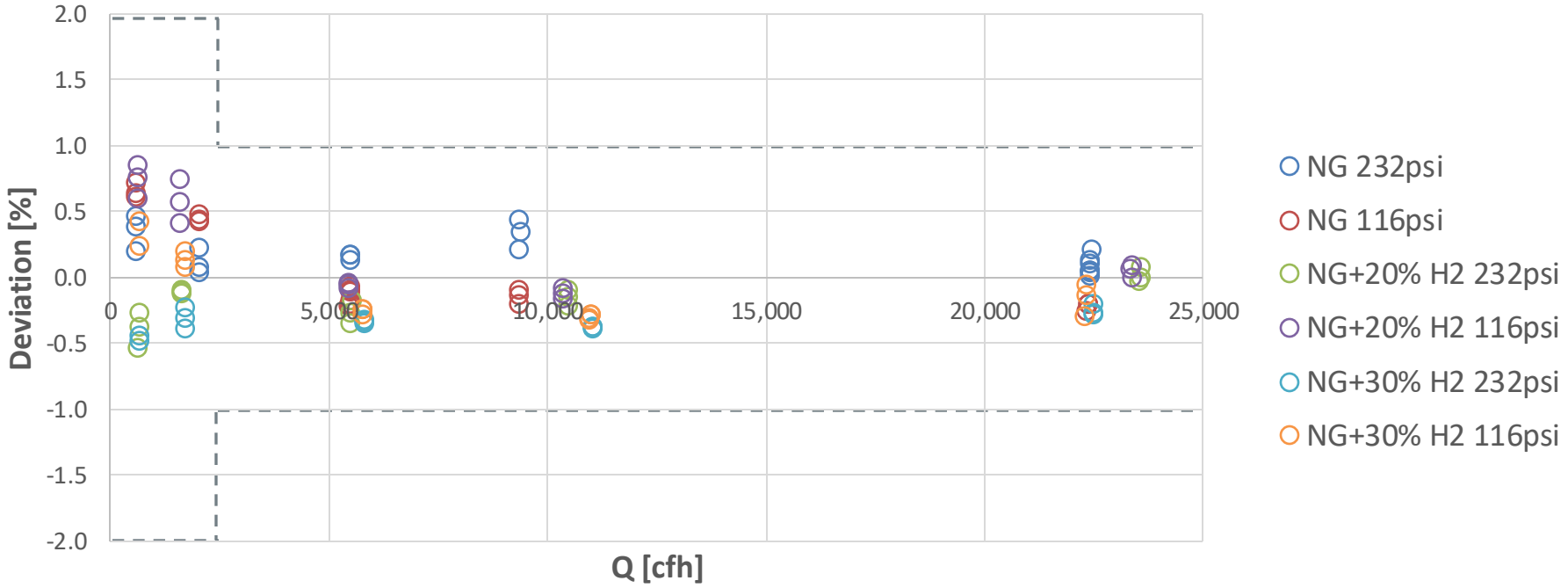
- Tests conditions
  - Gas: NG, H_2 (20, 30%)
  - Pressure: 116psi, 232psi

- SICK device: FLOWSIC500 DN100 | 4”

H_2 in Natural Gas

Test Campaign FLOWSIC500 H2-ready

- Performance Evaluation @ DNV Test Facility (NL)
  - Successful test, accuracy limits (class 1) reliably ensured



H_2 in Natural Gas

SUMMARY DOWNSTREAM FLOWSIC500

- 10% H2 blending available today

- Up to 30% H_2 blending
  - Internal testing successful
  - Field installation and testing successful
  - DNV lab testing for 30% H_2 just finished with good results
  - Market release with MID approval scheduled mid 2022

Gas Quality Indicator

Field Trial FLOWSIC600-XT

- FLOWSIC600-XT pilot project “HyDeploy”
  - USM for 100% natural gas
  - Thermal mass flow meter for 100% hydrogen
  - FLOWSIC600-XT (USM) for mixed gas
  - H_2 content: 10 … 15%

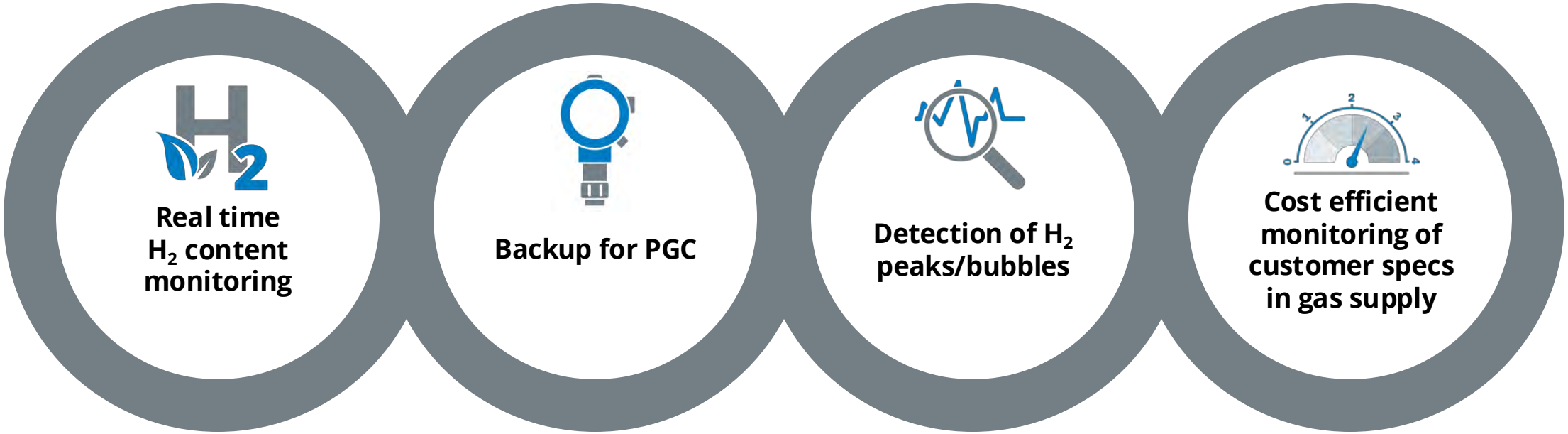
ULTRASONIC METERS HAVE EVERYTHING IT NEEDS TO MEET DEMANDS OF THE FUTURE NETWORK OPERATION

- Proven measurability and accuracy
- IP based communication allows for 24/7 remote access
- Real-time diagnostics support operational control
- And there is even more to name...

H2READY

H_2 in Natural Gas

How to use USM to check the gas quality?



➔ **With the help of the NEW Gas Quality Indicator (GQI)!**

H_2 in Natural Gas

Gas Quality Indicator (GQI)

INDUSTRY 4.0 READY

SICK Sensor Intelligence.

What is the Gas Quality Indicator (GQI)?

$$GQI = f(SOS, P_{act}, T_{act}, P_{ref}, T_{ref}, \ldots)$$

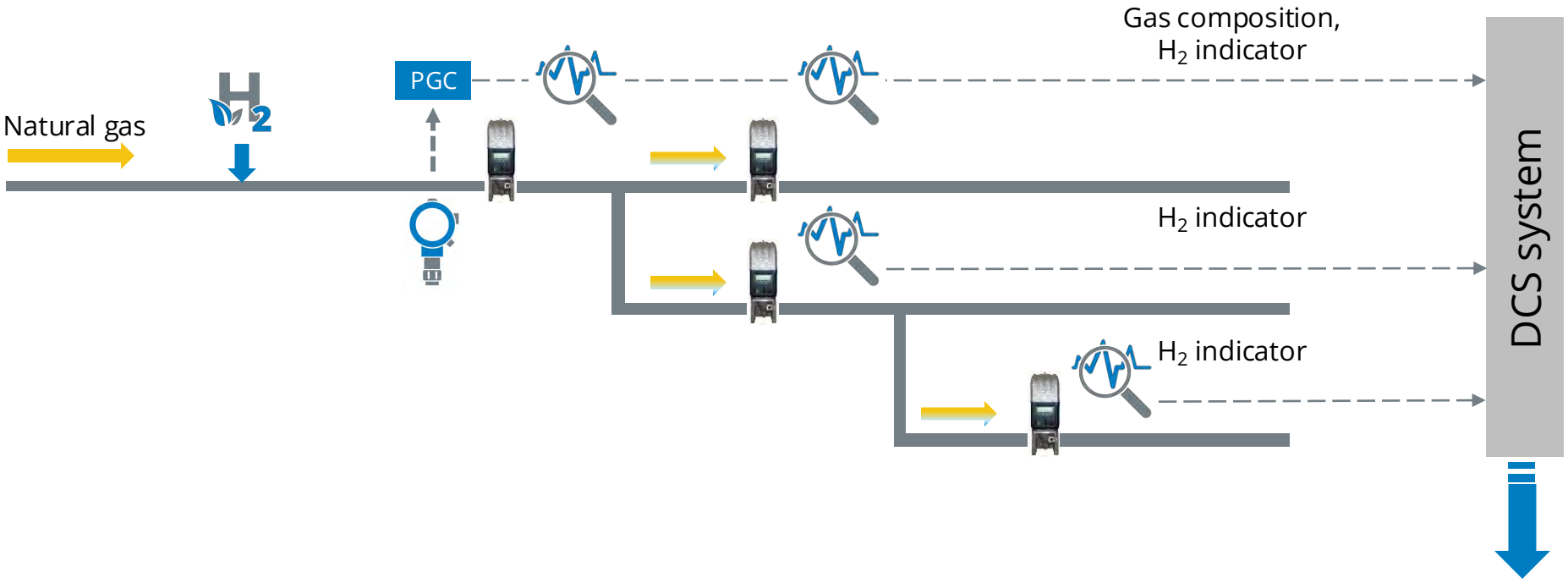
GQI will be implemented as:

- Licensed feature
- Firmware register
- Part of diagnostic values

FLOWSIC Solution for Natural Gas Networks

GQI - Real time Hydrogen content indicator

› Application example: Monitoring of hydrogen **change over time in network**



Real-time correlation between PGC analysis and H_2 indicator
Knowledge about network gas quality

Gas Quality Indicator

Field Trial FLOWSIC600-XT - Results

SICK
Sensor Intelligence.

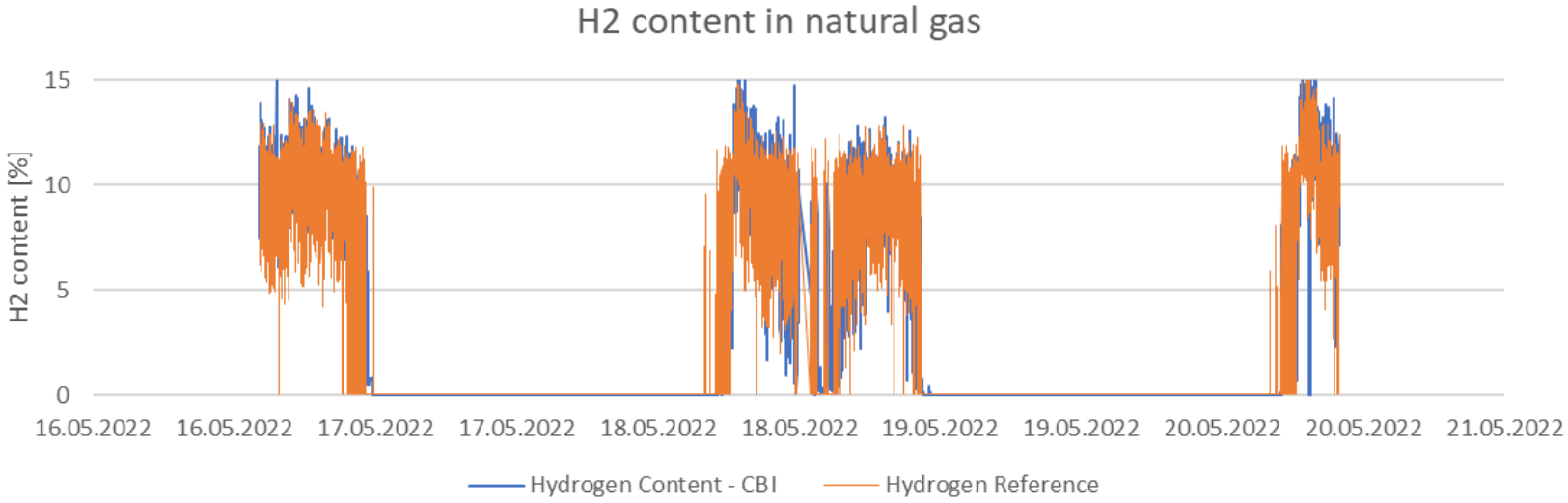
› FLOWSIC600-XT in “HyDeploy” UK

Gas mix: ~15 Vol.% H_2

Pressure: 1.1bar

Temperature: 60°C

Absolute deviation ø: ±0.6
(GQI vs. reference)

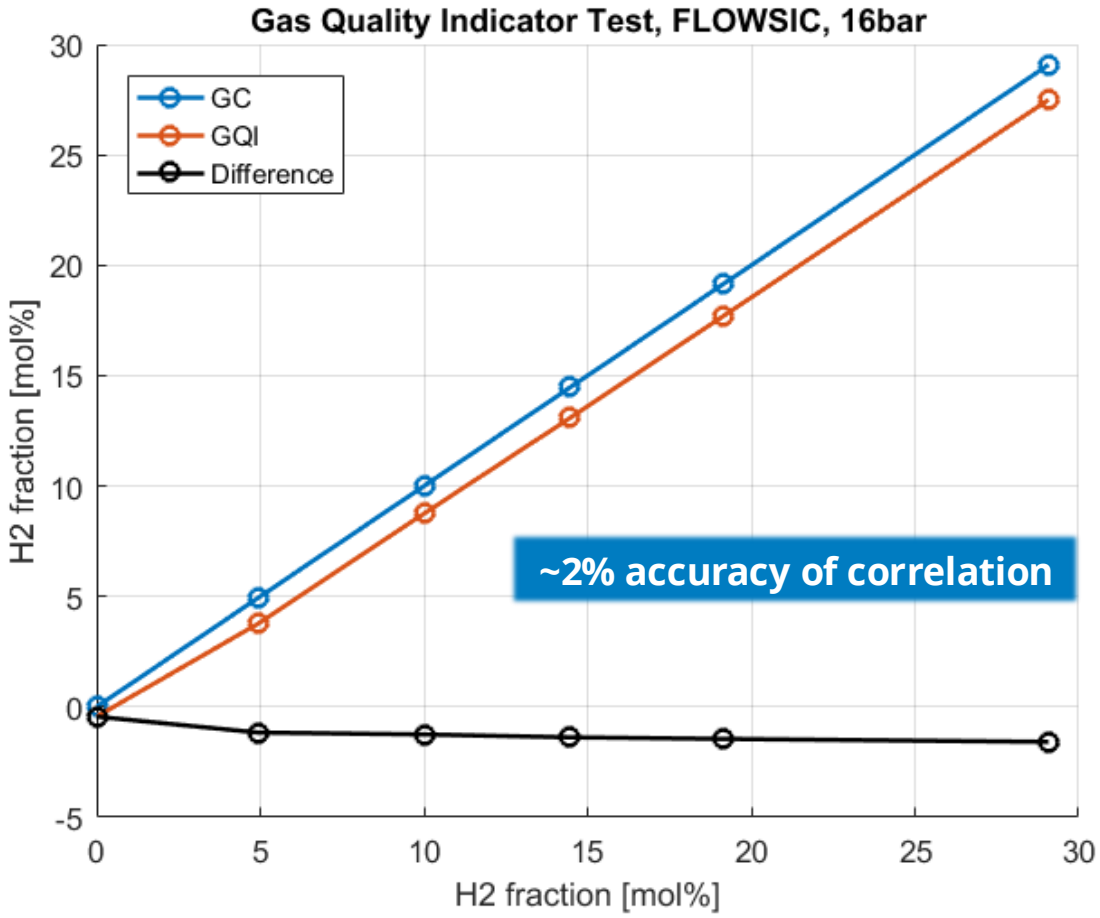


FLOWSIC Solution for Natural Gas Networks

Gas Quality Indicator (GQI)

Take aways:

- Correlation GQI to H_2 concentration at constant base gas mixture <1.5%
- dynamic response from GQI in real time compared to GC system causes deviations at rapid gas mixture changes



H_2 in Natural Gas

Key take aways

- Investment in H_2 economy is significant
- Gas community prepares for the changes
- First tenders specify H_2-redyness already

- FLOWSIC installed base is ready up to 10% H_2
- H_2 assessment supports the way to 30% H_2 for installed base
- New devices will support 30% H_2

- Remote connectivity, diagnostics and use of **G**as **Q**uality **I**ndication can help to improve operational excellence
- Partnering is essential to lift full potential

WE ARE H_2READY – ARE YOU?