

EURAMET and the Energy Challenge

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Background, Goal and Outline

Background:

- Europe (and the rest of the world) facing the "Energy Challenge"
- Priority of EC Strategy for Energy 2020: achieve a safe, secure, sustainable, affordable and efficient energy supply

Goal: show the impact of EURAMET metrology research on European energy infrastructure

Outline:

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- Energy chain: Extraction, Processing, Distribution and Consumption
- Show the impact of EURAMET along the chain through three JRPs:
 - \rightarrow Gases
 - \rightarrow LNG
 - \rightarrow Smart Grids



The energy chain



Offshore or on-shore gas field

Gas plant: dehydration and removal/separation of various components

High-pressure pipeline or LNG

networks through medium pressure pipeline

- Power plants (35%)
- Large customers (10%)
- Retailers (25%)
- Storage



The energy chain





Natural gas processing plant





removal

Extracted gas is not suitable for high-pressure transmission and consumption:

• Safety:

 $(CO_2 \text{ and } H_2S)$

 \checkmark Remove CO₂ and H₂S to avoid corrosion of pipeline, plant and domestic appliance

rejection

recovery

 \checkmark Remove H₂O and higher HCs to avoid corrosion, condensation and hydrates formation in the pipeline

Economical Value:

Composition of the NG determines its value

 Find optimal balance between satisfying contractual values of the NG parameters and cost effective operation of the plant

Accurate/traceable measurements of NG parameters (water content, calorific) value, ...) are crucial for the gas industry



Dehydration: removal of water vapour

> Typical contractual requirement: $T_d < -10$ °C at 65 bar

The water dew-point of natural gas is measured on a continuous on-line basis at high pressure with humidity sensors and analyzers

Such devices are calibrated at atmospheric pressure and in nitrogen or air (conditions completely different from field conditions)

> Substantial extrapolations lead to deviations in the measured T_d of up to10 °C or more, while an accuracy of 1 - 2 °C is actually needed

> For the plant operator, each ^oC of T_d means M€s in plant operational costs



Natural Gas Dehydration



ENG01: Characterization of Energy Gases (safety and efficiency of trade and transportation of energy gases in European pipeline network)

Development of new primary dew-point temperature standards for high-pressures and non-air gases

Experimental determination of enhancement factors for energy gases

Evaluation of existing humidity sensors under real operating conditions (in field)

Development of novel humidity sensors



Primary High-Pressure Dew-Point Generator

Dew-point sensor



The energy chain





LNG: alternative to pipeline

LNG: Liquefied Natural Gas

Volume ratio gas to liquid is 600:1 (efficient)

Allows trading between countries not connected by pipeline (flexible)

EU energy policy: diversified and secure energy supply

Contribute to emissions reduction (cleaner and higher calorific value than oil)

 Globalization favours short term contracts ("spot market")

LNG trade expected to increase by 7 % per year until 2020







LNG chain





LNG chain





Custody Transfer

> When LNG is traded, measurements are taken of volume V_{LNG} , density D_{LNG} and calorific value C_{LNG} to calculate the amount of energy transferred E_{LNG} :

$$E_{LNG} = V_{LNG} \cdot D_{LNG} \cdot C_{LNG}$$

Sound metrological framework not fully in place

Accuracy of the measurements is crucial to establish the consensus between the buyer and the seller

- Present measurement uncertainty: 1 %
 - 1 LNG ship ≈ 140 000 m³
 → € 200.000/shipment
 - 1 LNG terminal ≈ 12 bm³ annual capacity
 - \rightarrow € 30 Million/year/terminal
 - Global
 - \rightarrow €1 Billion/year





ENG03: Metrology for LNG

- Reduce custody transfer measurement uncertainty by a factor 2
- Developing traceability for LNG flow meters
- Testing and evaluating LNG quantity metering systems
- Improving LNG composition measurement systems
- Reducing uncertainties in LNG density and calorific value calculations
- Contributing to measurement guidelines, written standards and legal metrology







Distribution





Electrical Energy Infrastructure

- Conventional electricity grid
 - Passive system
 - One-way energy flows





Smart Grids

> Renewable energy sources: increasing number of wind turbines and solar panels

A house: not only consuming energy but also producing energy ("prosumer" = producer + consumer)

Grid evolves into active system with bidirectional energy flows

Loads largely varying in a complex way ultimately causing instabilities of the grid

> Need intelligence to handle this new complex situation \rightarrow Smart Grids

Ability to accurately measure is essential

Maintain continuity and quality of electricity supply and guarantee fair trade of energy





ENG04: Smart Grids

- On-site measurement of PQ
 - Portable systems and measurement routines





 "PQ in Europe is responsible for serious reduction in industry performance with impact exceeding 150 bn€ /year (80-90% due to black-outs)"

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Anglesey study: solar PV retrofitted housing estate



UK study: "A single on-site study performed within the ENG04 JRP

shows 167 kt projected carbon savings"