# Introduction to BIOFMET

Workshop on measurements of solid and liquid biofuel key parameters
2 - 3 June 2022, IST, Lisboa, Portugal

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biofMET

EMPIR EURAMET

The EMPIR initiative is co-funded by the European Union's Horizon 2020 research and innovation programme and the EMPIR Participating States

# Partners

CMI (Czech Republic)

DTI (Denmark)

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PTB (Germany)

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**Aim:**

To optimize energy production based on solid and liquid biofuels through more accurate and faster determination of parameters impacting the calorific value (moisture, impurities, ash-content)

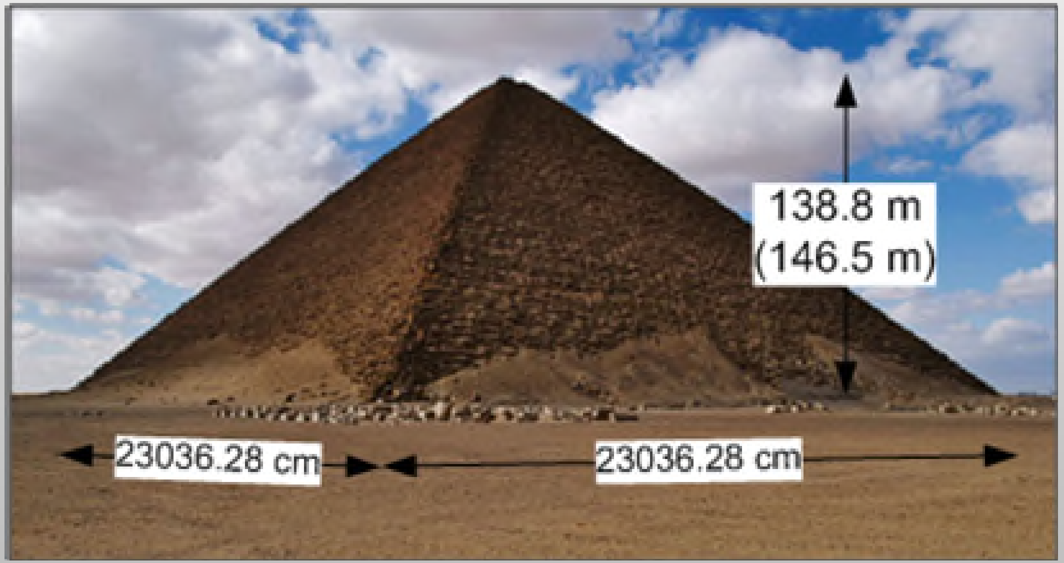
The project is interdisciplinary between thermal and chemical quantities

**Objectives**:

- To develop traceable online measurements for water content in solid biofuels,
- To develop improved methods for the sampling of biofuels
- To develop validated methods for the online measurement of ash content.
- To develop validated methods to determine the amount and nature of impurities in liquid biofuels
- To develop a traceable method for the online determination of the calorific value of liquid biofuels

# What is traceability in a metrological context?

- The Great Pyramid of Giza Built in the 26th century BC during a period of around 27 years
- Oldest and only existing of the "Seven Wonders of the Ancient World"




- The construction is an achievement in itself
- But without well-founded metrology, quality manuals and standards: how could it be done?

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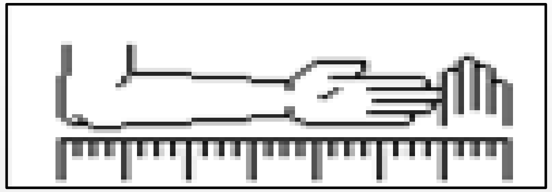
Step 1: Define a unit of length:



The cubit is based on the distance from the elbow to the middle finger of the ruling pharaoh (1 royal cubit = 523.5 to 529.2 mm)

- The royal cubit is divided into 7 palms
- A palm is divided into 4 fingers (called digit) that is: 28 digits for a cubit

Step 2: Realize the unit from its definition

Step 3: Make copies – and calibrate them by comparison

**Result:**
Deviation from horizontal < 15 mm
Base length: 23 036,3 cm ± 5.7 cm

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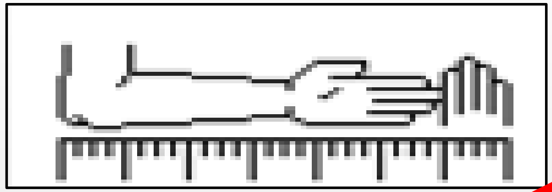

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Traceability, calibration and quality control

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# The decree of the pharaoh is called the meter convention nowadays

In France in 1791 it was decided to define a new unit of length, the meter

1 meter was defined as 1/10,000,000 of the quarter meridian, the distance between the North Pole and the Equator along the meridian through Paris (a physical constant)

By astronomical measurements it was found that the distance from Dunkirk to Barcelona was about 1/10 of quarter meridian

4 platinum rods (base measures) were made and the metrologists Jean Baptiste Joseph Delambre and Pierre Méchain, accurately measure the distance (lasting from 1792 to 1799)

A platinum rod was made that as accurately as possible was a 1/10,000,000 of the quarter meridian – a realisation of a meter was made.

# SI-system (2019) Definition from physical constants


- the caesium hyperfine frequency $\Delta\nu$ 9 192 631 770 Hz
- the speed of light in vacuum $c$ 299 792 458 m/s
- the Planck constant $h$ 6.626 070 15 x $10^{-34}$ J s
- the elementary charge $e$ 1.602 176 634 x $10^{-19}$ C
- the Boltzmann constant $k$ 1.380 649 x $10^{-23}$ J/K
- the Avogadro constant $N_A$ 6.022 140 76 x $10^{23}$ $mol^{-1}$
- the luminous efficacy of a defined visible radiation $K_{cd}$ 683 lm/W

It is by fixing the exact numerical value of each that the unit becomes defined, since the product of the **numerical value** and the **unit** must equal the **value** of the constant.

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# Metrological Traceability

- Metrological traceability is a property of a measurement result whereby the result can be related to a reference through a documented unbroken chain of calibrations, each contributing to the measurement uncertainty

- Measurement uncertainty ensures that a measurement result is related to a reference on a "higher level" that in the end is compared with a primary realization of the unit – measurement uncertainty is a measure of the quality of a measurement.

- Thus, traceability is needed in order to make trustworthy measurements on all levels independent of method or instrument type.

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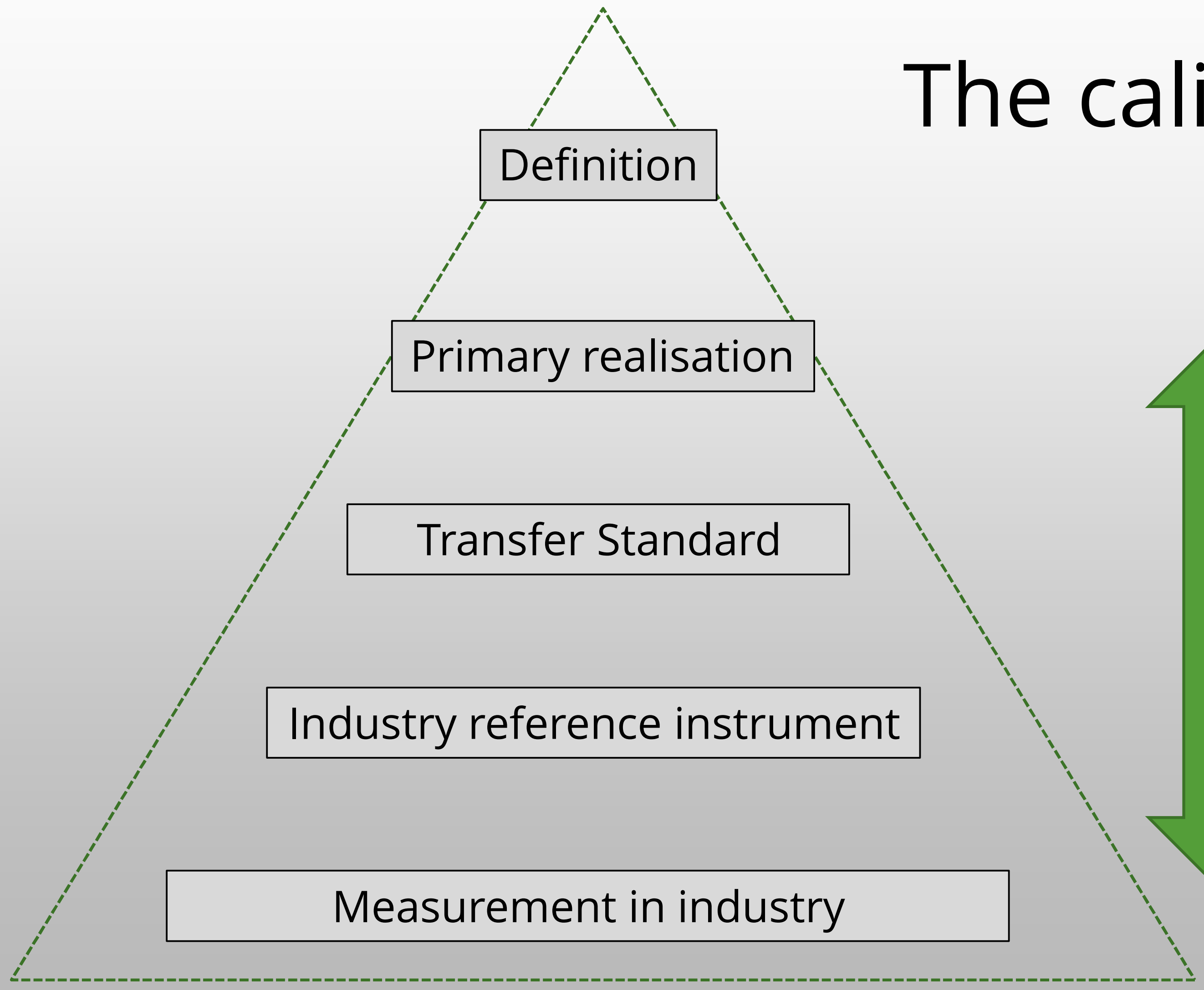
# The calibration hierarchy




For every step in the chain of calibrations the uncertainty increases

Too low uncertainties ”breaks” the traceability chain

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Definition

Primary realisation

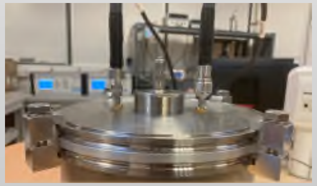
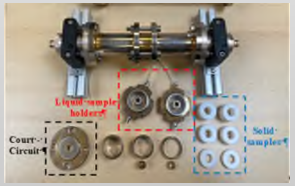
Transfer Standard

Industry reference instrument

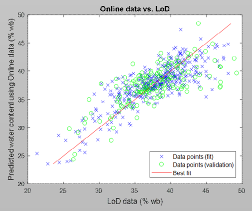
Measurement in industry









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# Summary of the project

The key targets to be reached by the end of this project (and to be exploited in the 5 years that follow the end of the project) are as follows:

- Calibration methods and services are available for industry that ensures traceable on-line measurements for water and ash content in biofuels
- New methods, reference materials and services are available for determining the amount and level of impurities in liquid biofuels
- New methods for sampling of biofuels have been researched, validated and demonstrated and new automatic sampling devices for “representative sampling” is available on the marked.

This project will be considered a success if these targets are met and take up of the results has been demonstrated by standards developing organisations and end users.

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# Agenda day 1

10:30-11:00 An improved procedure for the determination of biofuels’ calorific value by bomb calorimetry, Moaaz Shehab, PTB

11:00-11:30 Coffee break

11:30-12:00 Water in solid biofuels: Accurate measurements, off-line and on-line, Henrik Kjeldsen, DTI

12:00-12:30 Reference techniques for moisture measurement implemented at LNE-CETIAT, Eric Georgin, LNE-CETIAT

12:30-13:00 Development of acoustic hygrometer at CMI, Michal Voldán, CMI

13:00-14:30 Lunch break

# Agenda day 1

14:30-15:00 Transfer standard developed at LNE-CETIAT, Bayan Tallawi and Eric Georgin, LNE-CETIAT

15:30-16:00 Online radio frequency characterisation of water content in liquid biofuels, Pierre Sabouroux and Floriane Sparma, AMU

16:00-16:30 Coffee break

16:30-17:30 Poster session

- Improved metrological methodologies to address the challenges associated with the determination of biomass key parameters in the laboratory – calorific value, Moaaz Shehab and Kai Moshammer, PTB
- Preparation of solid biofuel sample materials for reference measurements, Helena Strauss, DTI
- Development of traceable methods for the analysis of selected elements in solid biofuels as wooden material and ash, Katarina Hafner-Vuk, IMBiH
- Calorific value measurements at TUBITAK UME, Kemal Özcan TUBITAK
- Determination of impurity and residuals in solid and liquid biofuels, Alper İşleyen, TUBITAK
- Reference Materials, Alper İşleyen, TUBITAK
- Sampling: Equipment, test, validation and demonstration, Timo Huotari, PROMETEC
- Acoustic measurement of moisture, Libor Husník, CTU

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# Agenda day 2

9:30-10:00 Test and validation of a fully automated sampling system for solid biofuels, Henrik Kjeldsen, DTI

10:00-10:30 Proper Selection and Use of Reference Materials, Alper İşleyen, TUBITAK

10:30-11:00 The use of AI/ML for improved online moisture measurement, Radek Strnad, CMI

11:00-11:30 Coffee break

11:30-12:00 45 Years of Experience in Engineering, Manufacturing and Installing Thermal Energy Systems, Miguel Horák, Torbel

12:00-12:30 An advanced biorefinery concept, Sérgio Silva, Bio Green Woods

12:30-13:00 Wrap-up

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