How accurate measurements in the energy emission trading? – Estimation by proficiency test for calorific values in solid fuels

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Calorific value of fuels?

The calorific value is the measurement of heat or energy produced from solid or liquid fuels source, and is measured either as **gross calorific** or **net calorific value**.

- Gross calorific value assumes all vapour produced during the fully condensed combustion process.
- Net calorific value assumes the water leaves with the combustion products without fully being condensed.
- The calorific value of coal and peat as received basis, varies considerably e.g. depending on the ash and moisture content in different type of material.

Ability to estimate carbon dioxide emissions?

The Emissions Trading Act is applied to carbon dioxide emissions of stationary installations. An installation belonging to the sphere of emissions' trading needs an emission permit, pursuant to which it has the right to emit carbon dioxide into the atmosphere.

- The monitoring and reporting of emissions data are an essential part of the permit process and the control of emission trading.
- For this emission monitoring, the European Union (EU) Commission has adopted Decision 2004/156/EC, which specifies the monitoring requirements and accuracy levels of the emission data:
  - producers of data need to be accredited laboratories based on EN-ISO/IEC 17025 or show the quality of measurements equally.
- In trading, fuels are compared based on a net calorific value and an emission factor, calculated from the latter.

What tested in the proficiency tests 2008-2010?

Sample type	Measurements
Peat Coal	Gross and net calorific value, C, S, N, H, moisture content of the analysis sample (M_{ad}), ash content

- Additionally, the participants had the possibility to estimate/calculate the **emission factor** (as received) for the samples. For this estimation/calculation reported the total moisture contents as received (M_{ar}) by the provider.

How the performance evaluated?

- As the assigned values used the robust means of the participant results.
- For the standard deviation for proficiency assessment used the reproducibility recommended in the international standards (calorific value 300 J/g, EN 14918 & ISO 1928)
- In some cases, i.e. elemental measurements, the recommendations are not full-filled.

Proftest SYKE accredited proficiency provider PT01 according to ISO/IEC 17043 by the Finnish Accreditation Service (www.finas.fi)

From the measurement to the emission factor

Effective heat capacity (ε, JK^{-1})

Amount of energy required to cause unit change in temperature of calorimeter; calibration step

Gross calorific value ($q_{V,gr,d}$, J)

Calculated from ε and corrected temperature rise with corrections of fuse, wire, N, S or analytical moisture to receive results as dry basis .

Net calorific value ($q_{p,net,d}$, J)

Calculated from $q_{V,gr,d}$ with corrections of H, O or N to receive results as dry basis

Emission factor (as received, tCO_2/TJ)

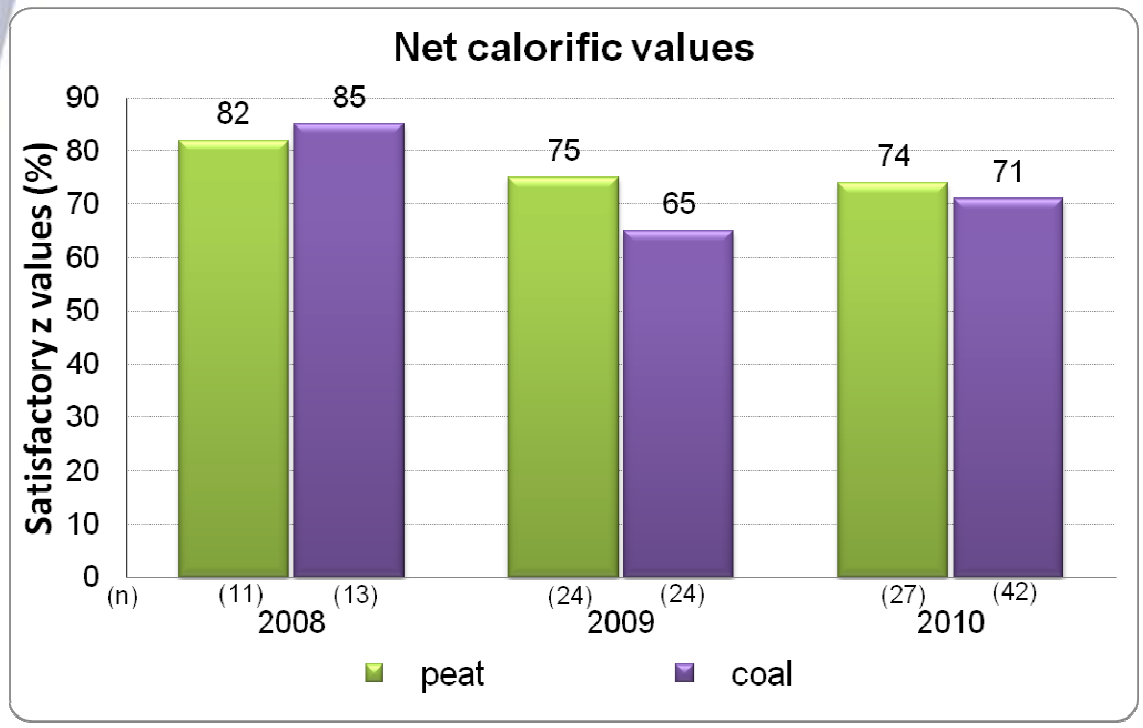
Calculated from $q_{p,net,d}$ with C content and total moisture as received (M_{ar}) for peat and coal

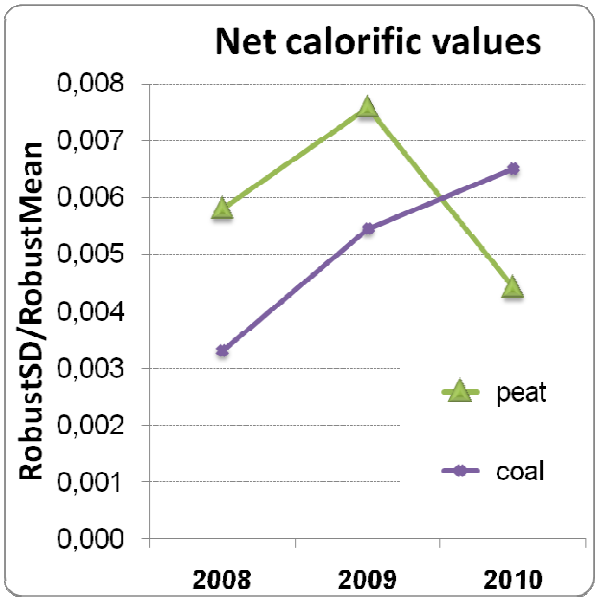
Used e.g. for calculations of CO_2-emissions from stationary installations in the emission trading

Performance evaluation, difficulties?

- Wrongly reported calorific values; not in dry weights or emission factor as received.
- Analytical moisture has a great effect for calculation the gross calorific value as a dry weight basis – high variability in the moisture results!
- Non-independent results:
  - Errors in the elemental measurements caused errors in the calorific values!
  - Error in the gross calorific value influence to the performance in the net calorific value!
- The standard deviation for proficiency assessment (s_p) is rather tight (1-2 %)!
- On the other side, the errors in the elemental measurements caused the outlier calorific value results, which “helped” the data handling a little bit easier!

Laboratory performance





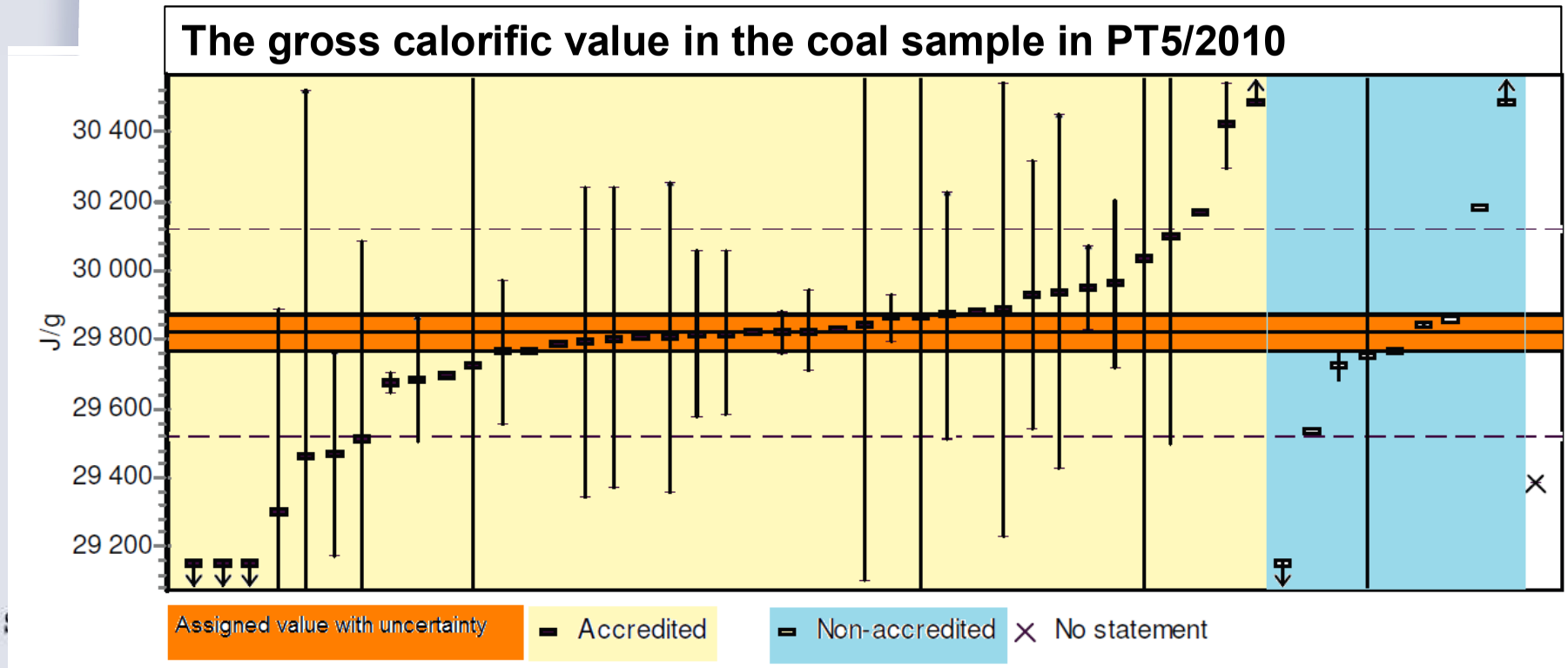
- For the elemental measurements the laboratory performance show bettering trend and over 80 % of laboratories has the satisfactory performance.
- Difficult to estimate the emission factor data:
  - basic problem seems to be in the calculations,
  - harmonization of formula to calculate emission factor is needed!

How accurate measurements?

Measurements done based on various international standards –
no clear statistical differerences were noticed

Several approaches were used for estimating of measurement uncertainty:

- X-chart, existing IQC and validation data (Nordtest TR 537) or CRM data (Nordtest TR 537) and GUM modelling (Eurachem),
- the approach has not made a definite impact on the uncertainty estimates.



Effect of the accreditation?

- In 2010 PT used within the working group (WG) of the European co-operation for Accreditation (EA) for Interlaboratory Comparisons (EA WG ILC in Testing) to estimate the equality of accreditation within the EA bodies (EA MLA).
  - The accreditation works quite well, however the performance of laboratories should be better.

		Satisfactory (n)		Questionable (n)		Unsatisfactory (n)		∑ all (n)	∑ EA (n)
Parameter	**Sample**	**Total**	**EA**	**Total**	**EA**	**Total**	**EA**		
Net calorific value	Peat	20 (74%)	14 (74%)	1 (4%)	1 (5%)	6 (22%)	4 (21%)	27	19
Net calorific value	Coal	31 (72%)	26 (72%)	4 (9%)	3 (8%)	8 (19%)	7 (19%)	43	36

Improvement of quality in measurements?

Factors, which have to be taken into account measurement of calorific value:

- Technical improvements in the measurements are needed, i.e. good sample homogenization, measurements quickly after drying, analytical moisture and calorific value should be measured at a same time.
- The calculation of gross and net calorific value should be based on the formulas of the international standards.
- Harmonization in estimation of measuring uncertainties is needed.
- Reproducibility requirement for the net calorific value should be taken on the account in the international standards.
- Harmonization of formula to calculate emission factor is needed in the EU laboratories.

Thank you for your attention!!

Reports:

Leivuori, M., Rantanen, M., Korhonen-Ylönen, K., and Ilmakunnas, M. 2011, SYKE Proficiency Test 5/2010, Gross and net calorific value in fuels, Reports of Finnish Environment Institute 4/2011

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