TITLE: Metrology for Thermal Efficiency of Buildings

Abstract

European countries use around 40 % of their primary energy to heat and cool buildings. The EU has therefore introduced regulation related to the thermal performance of buildings [1] to improve energy saving and efficiency and to harmonize the Member States legislation.

The EU pledged to achieve a 20 % reduction in energy use by 2020; this can only be achieved by rapid introduction of highly effective insulating products and designs. Identifying the most effective products and design relies upon reliable, independent, traceable measurements of the thermal performance of component building materials in the laboratory and in-situ. Furthermore in-situ measurements can be used to monitor the energy performance of existing entire buildings, and are crucial as input data for new building designs, or insulation upgrades.

Joint Research Projects (JRPs) submitted for this topic should addresses the metrological challenge of providing traceability measurements of in-situ building materials, and component materials and designs.

Conformity with the Work Programme

This Call for JRPs conforms to the EMRP 2008 [2], section on "*Grand Challenges"* related to *Energy* on pages 8 and 23.

Keywords

Building energy efficiency, insulation of buildings, in-situ thermal performance. emissivity, thermal conductivity, thermophysical properties, thermal imaging, radiation thermometry; remote sensing.

Background to the Metrological Challenges

To meet the constraints imposed by the Kyoto Protocol on reducing greenhouse gas emissions, the EC Directive 2002/91/EC [1] laid down a series of requirements concerning energy efficiency in new buildings and major renovation of existing buildings. At the end of 2006, the EU pledged to cut its annual consumption of primary energy by 20% by 2020. The European Commission considers the biggest energy savings are to be made in buildings, with savings potentials estimated at 28% by 2020.

The energy saving measures for buildings have concentrated either on increasing the thickness of conventional insulation and/or super-insulating materials for existing and new homes, and the upgrading of insulating glazing products. Sadly, the metrology to support the claims of new products is not always reliable and is rarely traceable. Building designers are calling for

reassurance that new insulation innovations provide accurate performance data, so that the products specified indeed reduce entire building energy consumption/loss as claimed and meet the regulatory requirement. This need has been highlighted by certain types of new product being sold with exaggerated claims based on measurements made within universities using techniques that have not been validated or standardised. The resulting controversy has lead to increased industrial calls for reliable measurements of the real in-situ thermal performance of building components.

This Call for JRPs therefore addresses the metrology needs of a number of building materials, and also calls for metrology to support completed buildings, and building design.

Measurement of the thermal conductivity of insulating materials by NMIs has been traditionally based on small samples about 300 X 300 mm with thicknesses of up to 150 mm. This has made it difficult to accurately measure both conventional materials and new insulating materials such as wood fibre and multifoils which are often very spatially inhomogeneous. Further measurement problems are created by some super-insulating products (eg evacuated panels and aerogels) which have high or very high thermal resistances and which are also non-homogeneous. In addition standard, small test samples cannot be cut from many of these innovative products for fear of destroying their insulating performance, and thus these materials cannot be accurately measured as they exit a production process and so quality control is compromised.

The emissivity of coated glass panes has been determined by measuring the near normal regular spectral reflectance in the spectral range from 5 µm to 50 µm in accordance with the documentary standard EN12898:2001 [3]. Those spectral reflectance measurements are performed by comparison to calibrated mirrors, using infrared spectrometers (mostly FTIR) fitted with specular reflectance accessories. Thus the availability of capabilities for calibration of infrared spectral reflectance should be permanently maintained by one (or more) NMI in EU. At present, it appears that no European institution is able to easily perform traceable calibration in spectral reflectance over the 5 µm to 50 µm spectral range or to supply reference mirrors calibrated over that range.

Scientific and Technological Objectives

Proposers should aim to address all of the stated objectives below. However where this is not feasible (i.e. due to budgetary or scientific / technical constraints) this should be clearly stated in the JRP protocol.

The objectives are based around the PRT submissions. As experts in the field, JRP proposers should establish the current state of the art, which may lead to amendments to the objectives - these should be justified in the JRP proposal.

Energy saving through an improved monitoring of thermal and radiometric parameters in buildings is the main goal of the research. The objectives of your JRP should include:

1) Development of traceable measurements methods for building materials, glazing and insulation, including:
   a) thermal, radiometric and photo-colorimetric measurements for the characterisation of translucent and innovative glazing units and coatings
   b) thermal conductivity of very thick traditional insulating materials (~0.3 m) and very thin novel super-insulating materials. Develop certified reference materials for both thick and thin super insulators.

2) Development of traceable in-situ measurement methods of thermal properties, performance and behaviour of buildings and building structures and components under consideration of
   a) application of pseudo realistic environmental conditions
   b) real (outdoor) environmental conditions
   c) application of traceable thermal imaging
   d) In-situ sensor networks and their remote/ self-calibration.

Potential Impact

Proposals must demonstrate adequate and appropriate participation/links to the "end user" community. This may be through the inclusion of unfunded JRP partners or collaborators, or by including links to industrial/policy advisory committees, standards committees or other bodies. Evidence of support from the "end user" community (eg letters of support) is encouraged.

Where a European Directive is referenced in the proposal, the relevant paragraphs of the Directive identifying the need for the project should be quoted and referenced. It is not sufficient to quote the entire Directive per se as the rationale for the metrology need. Proposals must also clearly link the identified need in the Directive with the expected outputs from the project.

In your JRP submission please detail the impact that your proposed JRP will have on the following Directives of the European Commission:

"The Energy Performance Of Buildings Directive" [1] and
"The Construction Products Directive" [4]

You should also detail other Impacts of your proposed JRP as detailed in the document "Guidance for writing a JRP"

In response to the need for standardised measurement techniques, CEN (through Technical Committee 89 - Thermal Performance of Buildings and Building Components [5]) have recently decided to create a new expert working group for in-situ testing methods. This working group will only be able to have an impact if new measurement expertise, techniques and facilities can quickly be developed.

You should detail how your JRP results are going to:

- Feed into the development of urgent standards through CEN and other appropriate standards
- Transfer knowledge to the construction sector, including materials suppliers.
- Feed into the proposed JTI (Joint Technology Initiative) "Energy Efficient Buildings in Europe" [6]

Additional information

The references were provided by PRT submitters; proposers should therefore establish the relevance of any references.

[1] Council Directive 2002/91/EC of the European Parliament and of the Council of 16 December 2002 on The Energy Performance Of Buildings http://eur-lex.europa.eu/smartapi/cgi/sga_doc?smartapi!celexplus!prod!DocNumber&lg=en&type_doc=Directive&an_doc=2002&nu_doc=91

[2] European Metrology Research Programme. Outline 2008 Edition - November 2008, http://www.euramet.org/index.php?eID=tx_nawsecuredl&u=0&file=fileadmin/docs/EMRP-outline2008.pdf&t=1248796946&hash=9da9ceb781370f04c322ac48068deca5

[3] BS EN 12898:2001 “Glass in building - Determination of the emissivity”

[4] Council Directive 89/106/EEC of 21 December 1988 on the approximation of laws, regulations and administrative provisions of the Member States relating to construction products also known as “The Construction Products Directive” http://ec.europa.eu/enterprise/construction/internal/cpd/cpd.htm

[5] CEN Technical Committee 89 - Thermal Performance of Buildings and Building Components Executive Summary: http://www.cen.eu/nr/cen/doc/ExecutivePDF/6072.pdf

[6] Energy Efficient Buildings In Europe Initiative http://www.e2b-ei.eu/default.php

[7] Communication from the Commission: Action Plan for Energy Efficiency: Realising the Potential, COM(2006)545 final, Brussels, 19.10.2006 http://ec.europa.eu/energy/action_plan_energy_efficiency/doc/com_2006_0545_en.pdf

[8] EN ISO 13790:2008. “Energy performance of buildings -- Calculation of energy use for space heating and cooling”. http://www.iso.org/iso/catalogue_detail.htm?csnumber=41974

[9] BS EN 15251:2007. “Indoor environmental input parameters for design and assessment of energy performance of buildings addressing indoor air quality, thermal environment, lighting and acoustics”. http://www.bsigroup.com/Shop/Publication-Detail/?pid=000000000030133865

[10] The European Portal for Energy Efficiency in Buildings http://www.buildingsplatform.eu/