COPSE – stakeholder perspective

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Introduction

This document is written exclusively from the point of view of a single stakeholder reflecting on their participation in the COPSE research project. It is not a review of the project's achievements or failures and it does not represent the opinion and experience of other stakeholders that have participated in the project.

CIBSE is the primary professional body for the engineers who design, install and operate the energy using systems, both mechanical and electrical, which are used in buildings. It is one of the leading global professional organisations, and has produced numerous Professional Guides along with Technical Memoranda and Application Manuals to support the industry.

Currently, it is common practice for engineers to use computer based tools to assess the thermal performance and energy use of buildings during the design stage. A key input in this process is the description of external weather conditions commonly provided in hourly format over a 'standard' year for the dynamic analysis of the building's response to the external environment. The current industry standard weather years are the Test Reference Years (TRYs) and Design Summer Years (DSYs), provided by the Chartered Institution of Building Services Engineers (CIBSE). These weather years are based on past observations (1983 – 2004) and are available for 14 locations in the UK. The TRYs are average years and so appropriate for energy performance calculations, whilst the DSYs are near extreme hot years, appropriate for overheating risk assessments. Other relevant CIBSE resources include the Guide A – Environmental Design. Guide A provides weather data and calculation algorithms for the manual sizing of HVAC systems, as well as comfort criteria for the assessment of overheating. Guide A is currently being revised.

Given the long lifetime of most of the buildings currently being designed or refurbished, the existing weather years, based on a historic baseline climate, cannot allow the industry to examine the future performance of the buildings and assess suitable options. The UKCIP02 climate projections were previously used to 'morph' the historic TRYs and DSYs and provide weather years that can be used to assess future building performance and increase their resilience to future impacts of climate change. These are the CIBSE Future Weather Years and since their release, the introduction of the new probabilistic climate projections (UKCP09) has introduced yet new challenges and opportunities to the adoption of climate information by the building industry. The complexity of the UKCP09 projections raised the need for an in depth analysis of the data to produce new methodologies for the creation of future weather years to be used in building performance analysis.

COPSE objectives

COPSE is one of the five EPSRC funded research projects, started in 2008, following the "The Use of Probabilistic information in Building Design" call, which aimed to examine the use of UKCP09 projections in building design. One of the main aims of COPSE project was to develop robust methodologies for producing weather files, such as TRYs and DSYs, from UKCP09 climate projections and explore their use in assessing building designs for energy use and comfort in the future.

CIBSE's objectives in participating as a stakeholder

CIBSE was fundamental in informing the EPSRC call "The Use of Probabilistic information in Building Design", and was part of the reviewing panel that resulted in 5 research projects, part of the ARCC portfolio. Furthermore, and in order to maximise the knowledge exchange between CIBSE and the ARCC network of projects, CIBSE provided a Technical Advisor to contribute industry expertise to the work of the network. The Technical Advisor aimed to maximise the uptake of ARCC outputs by identifying gaps in the industry and appropriate dissemination routes, and identify research outputs to inform and incorporate in CIBSE available guidance. As a result CIBSE was invited to act as a stakeholder in four of the five projects.

CIBSE's direct interest in participating at COPSE as a stakeholder was related to its need to adopt a methodology for incorporating the UKCP09 information in building design, and more specifically in building simulation. After the release of the probabilistic projections, CIBSE was expected to update the UKCIP02 based future weather files to better reflect the current knowledge. Since CIBSE doesn't have in-house expertise that could undertake the analysis of the UKCP09 information it depended on research such as COPSE to develop the methodologies and advise CIBSE on the subject. CIBSE also was interested in the production of case study examples for the use of risk based approach in the design of buildings, introduced by the probabilistic nature of the data.

COPSE direct contributions to CIBSE knowledge

CIBSE was an active member of the COPSE stakeholder community which resulted in the research outputs directly informing CIBSE knowledge. COPSE developed a methodology for producing TRYs and DSYs for energy analysis of building performance, using the outputs from the UKCP09 Weather Generator (WG), which is currently informing the next generation of CIBSE weather files, current and future. More specifically, COPSE has provided evidence in the use of the UKCP09 WG as the main resource for the production of hourly weather files.

An analysis undertaken by COPSE on the solar radiation data produced by the WG showed anomalous projected increase in the clearness of the sky, and the sol-air temperature, resulting in an update of the WG. This analysis further informed the revision of Guide A, specifically the sol-air temperatures and direct and diffuse solar radiation tables.

COPSE also worked on a methodology for the production of hourly weather series, the Design Reference Years (DRYs). The DRYs would be used in the design and sizing of heating and air conditioning systems in buildings, replacing the standard, manual based "one day" calculation with hourly data for PC simulation. The DRYs would be designed to be used with the CIBSE admittance method, currently in Guide A. The new DRY will be further developed and considered in the next revision of Guide A, as well as inform the revision of the CIBSE DSY methodology.

COPSE has also explored the impact of the adoption of different adaptive comfort criteria on assessments of overheating and the consequences for cooling energy demand, using a novel metric, the Adaptive Comfort Degree Day (ACDD), which is currently feeding directly into the revision of the comfort criteria within Guide A.

Missed opportunities

Four research projects were funded to examine the use of the UKCP09 in building design. CIBSE was a stakeholder to all four projects. Although all four projects analysed the outputs of the UKCP09 WG, in producing weather files appropriate for building simulation, they all analysed its outputs in a different way. For example, the COPSE methodology combined the 100 x 30 year WG datasets into one set of possible weather years in order to produce a single TRY and DSY per emissions scenario, while another project, PROMETHEUS, followed a two part selection process, first within each 30 year period and then within the 100 resultant TRYs and DSYs, retaining the probabilistic nature of the files and so resulting in probabilistic weather files.

As a result of the above selection process COPSE produced a single TRY and DSY for each future emission scenario and 30 year time period. This felt appropriate for the building design community as there was already a choice of three risk levels, and therefore three TRYs and DSYs to choose from, stemming from the uncertainty in emissions scenarios (Low, Medium and High). Instead, PROMETHEUS produced a series of probabilities for each TRY and DSY (10th, 33rd, 50th, 66th and 90th), for a number of locations.

The other two projects, PROCLIMATION and Low Carbon Future (LCF) also developed methodologies for the use of the UKCP09 in building simulation, the first by looking at various ways of analysing the WG output to produce probabilistic TRYs and DSYs, and the second by developing a regression tool that could potentially help overcome the issue of large computation requirements when simulating for future climates.

The way CIBSE viewed the above outputs was that although the various methodologies were useful for academic debate, they produced some confusion to the industry and specifically to CIBSE that was trying to inform the new methodology for the update of their future files. The COPSE methodology did not make the most of the probabilistic nature of UKCP09 but instead treated the WG output as a single dataset, just applying to it the existing TRY and DSY methodology. Although the resultant datasets were fewer in number, and arguably more digestible by the industry, they failed to introduce a risk based approach to design, much needed for designing within the uncertainties of the future.

On the other hand, PROMETHEUS produced probabilistic weather files, providing a choice of five probabilities for each future climate. This provided the industry with ready-made future weather files while introducing the use of probabilities in the design process. This availability increased the number of files to be used in simulation, increasing significantly the computational resources required, but without providing a risk based framework for their use. For example would all five probabilities and three emission scenarios (15 files in total) need to be considered for each time period in the future, when assessing the thermal performance of a building, or building specific characteristics and attitude to risk could limit the number of files to be used?

PROCLIMATION looked at different ways of analysing the WG outputs to produce TRYs and DSYs but did not actually recommend one, or provide any evidence for their use in building design. LCF has the potential to address both the use of probabilistic data while reducing computational time by developing a tool. The LCF tool currently concentrates on the treatment of overheating risk but it has the potential to further expand to energy calculations.

Although the choices each project made as to the analysis of the WG outputs were valid and informed by their researcher and stakeholder community, it did not provide any evidence as to which approach is more suited/robust for the industry, what difference, if any, the use (or not) of probabilistic weather files makes in the design of buildings, and none of the projects looked at a risk based framework for using the future probabilistic weather files.

Application of outputs to industry practices – value to users and CIBSE

As a result of the above research, the industry has now available various weather files that incorporate future climates for use in their design tools. This can potentially make the analysis of climate impacts and adaptation options more accessible to the industry and provides a basis for the better understanding and further development of a risk based approach in the design of buildings, which in turn could contribute to more resilient buildings in the future.

On the other hand the case for using multiple weather files still needs to be made. At the end of the four projects CIBSE was unable to decide on a preferred methodology for producing the data. Nevertheless, as a result of CIBSE's participation in COPSE and the other research projects the following actions were taken by CIBSE to introduce the UKCP09 to members and industry in general:

<u>Short term solution</u> - the previously used "morphing" methodology was used to produce UKCP09 probabilistic TRYs and DSYs. Three probabilities were produced (10th, 50th and 90th). This approach is currently under review.

The PROMETHEUS datasets are recommended by CIBSE for use in the design of buildings for the future, until the above morphed datasets are released and/or a long term solution is established.

<u>Long term solution</u> – CIBSE's Climate Task Force has brought all researchers from all four projects together to advise on a way forward, i.e. use of the WG to produce both current and future weather files, the number of probabilities to be provided, case studies and a risk based framework for their use.

CIBSE's contributions as a stakeholder

CIBSE's contributions as a stakeholder involved providing access to data, organising coordinating activities between the four projects to encourage discussions, promoting outputs via the TSB competitions "Design for Future Climate" and inviting ARCC CN to present research outputs at CIBSE events. Above activities aimed to improve the knowledge exchange between the projects and between the projects and CIBSE, and to maximise the exposure of the projects and their work to CIBSE members and the wider stakeholder community.

Stakeholder engagement

The COPSE proposed terms of reference for the stakeholder group were the following:

- To provide guidance on the focus of the research and the form of outputs, from the perspective of potential users of those outputs.
- To contribute to the research, e.g. through identifying and making available building data and simulation outputs and facilitating the preparation of case studies etc.
- To be a channel for communicating the progress and outputs of the research to potential users and beneficiaries.

Regarding COPSE's expectations from CIBSE as a stakeholder this translated into CIBSE functioning as a vehicle for the dissemination of outputs. COPSE's original proposal scheduled 8 meetings in total to engage key professionals, 4 meetings in the first year and two meetings in the second and third year. Five meetings were organised throughout the life of the project, three meetings during the first year and a half and two meeting over the last year, focusing on receiving early feedback on proposed research and stakeholder needs, and present the research outputs.

CIBSE felt that because of the size of the project, 5 work packages, the five meetings were not sufficient to maximise the knowledge exchange between researchers and stakeholders, and especially between researchers and CIBSE. Stakeholders were always on the receiving end without many opportunities to inform the research. Further means of engaging with CIBSE would have been beneficial, especially during the period of project output development, also making the most of CIBSE's involvement in other similar research. This could have been achieved with one to one meetings/interviews/discussions giving the researchers the opportunity to present their interim outputs to CIBSE and receive focused feedback.

For this particular project there were exceptional circumstances as most of its stakeholders were also stakeholders in other very similar projects. This arrangement required even higher levels of stakeholder engagement and communication, as well as coordination between the project outputs. Although both the ARCC-CN and CIBSE organised focused meetings to facilitate the discussions between the researchers and between researchers and stakeholders, the above wasn't sufficiently addressed, partly because of reluctance to share early/unpublished research outputs, which resulted in later stakeholder confusion.

Gaps and further research

As also highlighted earlier, and as a result of its participation in COPSE and other similar research, CIBSE felt that further research should concentrate on the use of the research outputs so far (specifically from the use of the probabilistic UKCP09 in building design) to undertake comparisons between methodologies and datasets and assess adaptation options:

- How do Weather Generator outputs compare with observed weather files? Could the WG replace the need for large sets of observed data?
- How important is to retain the probabilities in building simulation, i.e. is low, medium and high (to describe the emissions scenarios) enough to capture the wide range of climate uncertainty, or do we need 10th, 33th, 50th etc. percentiles associated with each of the above emissions scenarios. How much difference, if any, does it make when building energy and thermal performance are considered? What types of buildings are more sensitive to the use of probabilistic weather files?
- How can the industry incorporate a risk based approach to design but without significantly increasing computational requirements?
- Using the above datasets, what are the most effective adaptation options? For which type of buildings? For new or refurbishment projects?
- How can the industry evaluate the appropriateness of various adaptation measures introduced?