www.bre.co.uk

BRE Proposal

DECC Study on Energy Use by Air-Conditioning - Tender Reference Number: 874/09/2014 - LOT 1

Prepared for: Gary Inwood, Department of Energy and Climate Change

Date: 12 November 2014

Proposal Number: 136557 **Version:** 1

BRE
Watford, Herts
WD25 9XX

Customer Services 0333 321 8811

From outside the UK:
T + 44 (0) 1923 664000
F + 44 (0) 1923 664010
E enquiries@bre.co.uk
www.bre.co.uk

DECC
Area 6E
3 Whitehall Place
London
SW1A 2AW

Prepared by

Name Dr. Andrew Lewry and Dr. Christine Pout

Position Principal Consultants – Housing and Energy - Sustainable Energy Team

Date 12 November 2014

Signature 

Authorised by

Executive summary

The purpose of this project is to improve DECC's understanding of UK air conditioning energy use, to reduce the uncertainties in their current air conditioning energy model and to identify areas of the stock where energy savings are more accessible.

In particular the study addresses research questions relating to:

- Stock estimates
  - Product and system lifetime (this is critical to the estimation of the stock from sales data).
  - Ownership by market sector.
  - Regional distribution of the air conditioning stock.
- Derivation of annual consumption from installed stock figures
  - Actual operating hours (as opposed to the "engineering estimates" of the current model)
- More detailed demand modelling
  - Monthly variations of energy consumption
  - Peak energy demands
- System efficiency
  - Sizing
  - Operational practice
  - Potential for improvement

We understand the importance of this work to DECC and the challenge it presents. We also note that improvements to the basic model and the analysis of market data are outside the scope of this study.

An amendment to the original ITT issued by DECC divided the proposed work into two lots. Lot 1 includes a literature survey, assessment of air conditioning inspection reports, the provision of key inputs for modelling electricity demand and an algorithm to calculate peak and monthly demand as a function of degree days. It excludes the acquisition and analysis of monitored data. Lot 2 covers the acquisition and analysis of a significant sample of monitored data. Both Lots include the derivation of recommendations for improving the energy efficiency of the stock of air conditioning systems.

We believe the contents of the Lots are closely inter-related; in particular, the monitoring, the data analysis and modelling inputs and the algorithms. We would have liked to have submitted a bid which covered both Lots but unfortunately were unable to produce a compliant bid which met the time and budgetary constraints set by the ITT.

We have produced a proposal for Lot 1 which recognises that the analysis of monitoring data is crucial for updating DECCs current air conditioning model. Accordingly we have included provision for developing a procedure for analysing monitored data within our main proposal.

We are aware that Cardiff University hold data on monitored buildings and we think that the datasets are sufficiently extensive to provide a suitable sample for this project. Although the use of the Cardiff University databases would probably have provided a more robust solution; unfortunately the costs quoted by Cardiff for extracting the data have proven to be beyond the allocated budget. However, we do have direct access to some detailed UK monitoring data which relates mainly to offices and we propose to use this to develop and test the proposed analysis methodology.

In compiling our bid we have assumed that monitoring data will be provided by the contractor who is awarded Lot 2. However, we acknowledge that this is not certain to happen and so we have constructed a methodology which could be implemented independently of Lot 2 and still provide answers to the research questions, although the answers obtained are likely to be slightly less robust.

We have access to data for 23 mainly office buildings and intend to test our proposed analysis methodology using this data. As well as enabling the analysis methodology to be tested (and refined where necessary) this step should produce meaningful results for offices. If additional monitoring data is provided via Lot 2, then the analysis procedure could be rerun with the larger data sample to generate results for other sectors.

We propose a complementary route to extrapolate and/or check the analysis outputs from the monitored data. This involves combining less detailed, but more extensive energy consumption data with modelling studies. This route has the potential to strengthen the robustness of answers to the research questions posed in the tender and enable more comprehensive coverage of the stock than would be otherwise be possible.

In addition to our main bid we offer three additional separately costed items which we think have the capability of improving the robustness of the research results.

Option A identifies additional data sources; analysis and building modelling that would be needed to provide complementary information to feed into the modelling inputs and algorithm development and would identify the extent of the anticipated benefits that would arise if the analysis were carried out. Option A does not include the cost of any modelling and analysis.

Option B is a telephone survey to complement the analysis of air conditioning inspection reports. This would generate an improved understanding of the take up of energy efficiency measures for buildings with and without air conditioning inspection reports.

Option C offers BRE's experienced HVAC systems monitoring team to investigate key gaps identified in the data sets by carrying out additional monitoring studies. An additional "per building" cost for collecting new monitored data in accordance with the project requirements is provided.

A key requirement for the modelling inputs and algorithms rests on determining how energy consumption for cooling relates to outdoor temperature, expressed in terms of cooling degree days. Cooling degree days are quoted relative to a base temperature, which is the external temperature below which the building does not require cooling. This base temperature will be different for each building type and is determined by a combination of occupant requirements and the characteristics of the building.

[redacted]

[redacted]

BRE is pleased to be able to offer a project team drawn from the personnel that have worked with DECC in previous projects and understand the research needs. The team have lengthy experience in dealing with extractions, analysis and modelling of energy use data in air conditioning systems.

We have supplemented this team with staff drawn from across the BRE Group to enable us to meet the other technical objectives identified in the ITT. Specifically, this includes:

- Practical experts on the design, installation, commissioning and performance of air conditioning systems.
- Practical experts on the performance monitoring of air conditioning systems.
- Staff with expertise in EPBD Air Conditioning inspections and the contents of the reports.
- Statisticians who have dealt with electricity usage data before.

Leading experts in the fields of Energy Forecasting, Air conditioning and energy efficiency in buildings will be used to perform quality assurance and ensure the outputs are of the highest quality

BRE also have a range of software at their disposal to analyse both qualitative and quantitative data.

Contents

1. Understanding the requirement

Energy use for air conditioning buildings in the UK has been rising for several decades, driven by increasing market penetration, especially in buildings other than dwellings. Ownership is still well below saturation levels seen in countries with similar climates but longer histories of air conditioning markets. The overall purpose of this research is to improve DECC's understanding of electricity consumption for air conditioning in the UK.

DECC's current estimates of current consumption are based on modelling carried out by the Market Transformation Programme in 2009 [1] [2]. This modelling generates an estimate of the installed stock of air conditioning which is then converted into consumption estimates using assumed system efficiencies and operating times. There are many uncertainties in this process.

The purpose of this project is to reduce these uncertainties and to improve the granularity of the modelling. In particular it addresses research questions relating to:

- Stock estimates
  - Product and system lifetime (this is critical to the estimation of the stock from sales data).
  - Ownership by market sector.
  - Regional distribution of the air conditioning stock.
- Derivation of annual consumption from installed stock figures
  - Actual operating hours (as opposed to the "engineering estimates" of the current model).
- More detailed demand modelling
  - Monthly variations of energy consumption.
  - Peak energy demands.
- System efficiency
  - Sizing.
  - Operational practice.
  - Potential for improvement.

The scope of the study is confined to "comfort cooling": data centres, industrial processes (and dwellings) are excluded and the following building types are to be considered:

- Offices (public sector and commercial).
- Hotels and Catering.
- Retail.
- Sport and Leisure.
- Warehouses.
- Health.
- Education.

The outputs from the study therefore need to cover the existing stock of air conditioning units.

We can see that the outputs from this study need to complement DECC's existing Government programmes by:

1. Supplementing the energy data collected by BEES (Building Energy Efficiency Survey) to provide information on energy use by air conditioning systems and the trends in air conditioning deployment

2. Providing evidence to improve DECCs current energy demand model for air conditioning by:

   - Improving modelling inputs on usage by

[1] http://efficient-products.ghkint.eu/spm/download/document/id/872.pdf
[2] http://efficient-products.ghkint.eu/spm/download/document/id/871.pdf

  - Providing actual hours of use and energy demand to compare with the current assumptions.
  - Comparing actual energy use for air conditioning with calculations based on cooling degree days and the thermal properties and occupancies of buildings.

- Improving the model to estimate monthly and peak demand by
  - Determining how usage demand varies as a function of (external) temperature.
  - Providing an understanding of the geographical deployment and usage of air conditioning.
  - Providing an algorithm which estimates peak and monthly electricity demand from air conditioning units as a function of degree days, Government Office Region and electricity price.

We note that this is required to inform the 2017 revision of EU regulations on air conditioning units > 12 kW under the Eco-design Directive

3. Assessing the EPBD Air-Conditioning Inspection Database

- Estimating the proportion of air conditioning units that are optimally sized
- Estimating the proportion of air conditioning units that are optimally operated and maintained
- Identifying the most common recommendations to improve efficiency

We can see that it will be important to ensure that the scope and categorisation of the air conditioning units and other parameters explored during the course of the study are consistent with those used in these research programmes where possible. We anticipate that these would be established with DECC at the inception of the project.

We note that improvements to the basic model and the analysis of market data are outside the scope of this study.

An amendment to the original ITT issued by DECC divided the proposed work into two lots. Lot I includes a literature survey, assessment of air conditioning inspection reports and the provision of key inputs for modelling electricity demand, together with an algorithm to calculate peak and monthly demand as a function of degree days; but it excludes the acquisition and analysis of monitored data. Lot 2 covers the acquisition and analysis of monitored data. Both Lots include the provision of recommendations for improving the energy efficiency of the air conditioning stock and reporting back to DECC.

For the purpose of generating our bid we have assumed that monitoring data will be provided by the contractor who is awarded Lot 2. However, we acknowledge that this is not certain to happen and so we have constructed a methodology which could be implemented independently of Lot 2 and still provide answers to the research questions.

2. Methodology

2.1 Introduction

In order to structure the project we have divided the project into a number of work packages. These are identified below:

Work Package 0: Inception and project scoping phase. This defines the scope and categorisation of the air conditioning units and other parameters to be explored during the course of the study. It also establishes the structure of the current air conditioning model and the anticipated improvements.
Work Package1: The Literature survey: This identifies and assesses existing information on energy use by air conditioning systems in buildings. .

Work Package 2: Assessment of air conditioning inspection reports. This extracts and analyses information contained in the inspection reports on the condition of existing installations and on recommendations for improving energy performance.
Work Package 3: Updating modelling inputs and developing a new algorithm for DECC's existing energy model. This involves analysis of data from monitoring studies, information identified in the literature survey and the assessment of inspections reports (and potentially from other sources) to generate the values and relationships needed to update the model.
Work Package 4: Recommendations for improving energy efficiency. This work package draws on the results of the previous packages to identify areas where there is scope for improving the energy efficiency of the air conditioning stock.
Work Package 5: Reporting. This work package covers the synthesis of the research undertaken in the previous work packages to generate reports which encompass the methodology and the results in a clear and accessible form.
Work Package 6: Meetings. This work package covers the inception meeting and the three-monthly project board meetings.
Work Package 7: Project management, progress reporting and communication (with DECC and their contractors).
A work flow diagram which identifies the key relationships between work packages and the outputs is provided in Figure 1. A full size version of the work flow diagram is in Appendix G.

The major challenges presented by the project are identified in Section 5 along with a risk assessment.

Overall Approach to Lot 1

[redacted]

Quality Assurance

We appreciate that quality assurance of the research and its outputs is of prime importance and in order to manage this we have put in place a team of experts with the skill sets to deal with specific issues.

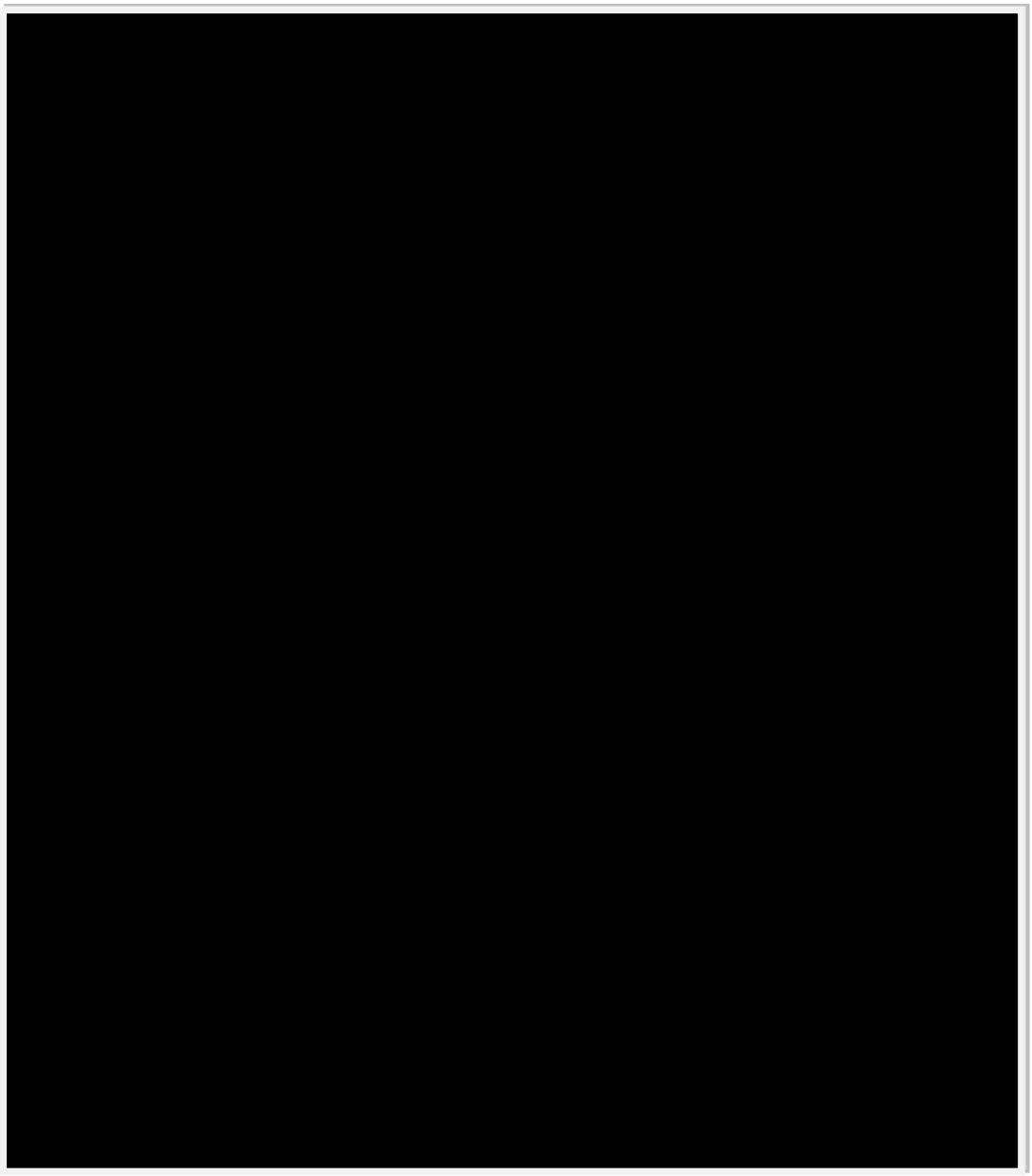


Figure 1: Workflow Diagram

BRE will ensure rigour by putting in place the following measures to monitor, assess and assure the quality of the work being undertaken.

- [redacted] will act as a Quality Assurance reviewer for all Work Packages where data is produced and analysed. BRE will pass on the following items for review:
    - Proposed analysis plan including protocols established for dealing with potential issues such as missing data and outliers
    - Key assumptions and limitations for model arising from the new algorithms
    - Documentation of data availability and quality
    - Documentation of sensitivity and uncertainty analysis

[redacted] and a world-leading energy forecasting specialist with over 30 years of experience in the energy related field. He is a specialist in forecasting techniques and weather and climate impacts on energy use and in developing numerical models, including the relationships between weather and energy demand and undertaking modelling based impact assessments. He is experienced in the analysis of large quantity of data presentation and reporting and possesses detailed knowledge of characteristics of electricity usage demand curves.

- BRE will work closely with:
    - The DECC's model developers to elicit a clear understanding of the relationships between the model inputs and their limitations.
    - **DECC** in making key decisions about particular elements of the data analysis.
- Expert judgement will be elicited on the true behaviour of the peak and monthly electricity demand from air-conditioning units and the agreement with the outputs from the model-forecasted behaviour using the new algorithms.
- [redacted] will review all aspects of:
    - The literature search and engineering assessment of new technologies
    - Assessment of 500 EPBD air-conditioning inspection reports
    - Recommendations to improve the energy efficiency of the air-conditioning stock

[redacted] is a leading expert in the field of HVAC engineering and has worked on Defra's market transformation programme (MTP) and the UK's Enhance Capital Allowances Scheme. Using his wealth of knowledge and experience he will peer review and give a reality check on all of the above outputs.

- [redacted] will lead on Quality assurance for all of the deliverables and will ensure that the technical content of reports is sound and that written material is presented in a clear and consistent manner in line with DECC guidance.

[redacted] is an internationally acknowledged expert in energy efficiency in buildings, particularly in the dissemination and promotion of information and guidance to all parts of the buildings sector.

He is BRE's Director of Sustainable Energy and is responsible for the delivery of a range of technical and policy support on energy efficiency in buildings to Defra, DECC, DCLG and the Carbon Trust. He is currently also responsible for leading key input to the UK's implementation of the Energy Performance of Buildings Directive, to the revision of Part L of the Building Regulations and to DECC's developing Green Deal policy

The Q/A will be an on-going exercise rather than a one-off procedure to ensure that data, analysis and outputs are not drifting from their original objectives and that issues are highlighted as soon as possible. Thus minimising risk to the project in terms of wasted resources and slippage of timelines.

This also ensures that the outputs from each work package are sufficiently robust and will fit in the project downstream; either when feeding into the next part of the project or when they may have to be transferred from the first Lot to the second. This may involve different contractors and is essential that they

communicate with each other early in the process so the output from the first lot will input seamlessly into the second and vice-versa where appropriate.

Specific tests and checks on the data inputs, intermediate results and final outputs are identified at relevant points within each work package.

Additional Options

The following options, which can be provided at additional cost, are also described in this Methodology section.

Option A identifies additional data sources, data analysis and building modelling that would be needed to provide complementary information to feed into the modelling inputs and algorithm development in particular and would identify the extent of the anticipated benefits that would arise if such analysis were carried out. Option A does not include the cost of any modelling and analysis.

In Option B is a telephone survey to complement the analysis of air conditioning inspection reports. This would generate an improved understanding of the take up of energy efficiency measures for buildings with and without air conditioning inspection reports.

Option C enables BRE's experienced HVAC systems monitoring team to investigate key gaps identified in the data sets by carrying out additional monitoring studies. An additional "per building" cost for collecting new monitored data in accordance with the project requirements is provided.

The remainder of this section provides a more detailed description of each work package.

2.2 Work Package 0: Inception and scoping

At the inception and scoping stage it will be important to ensure, in discussion with DECC, that the scope and categorisation of the air conditioning units and other parameters explored during the course of the study are consistent with those used in DECC's research programmes where possible. The nature of the modelling inputs required will also need to be agreed.

We can see that it will be important, in establishing the scope of the study at the outset to ensure that the research requirements of the various areas in DECC will be well served by the results of this work. In particular we can see that it will be important to liaise with DECC's modelling contractors so we can establish the appropriate data and analysis structure to update the modelling inputs and algorithms. Assuming that a contractor is appointed for Lot 2, we think it will be important to establish communications early on in the process

We understand that the scope of the study is confined to "comfort cooling" and that data centres, industrial processes and dwellings are excluded. The following building types are to be considered

- Offices (public sector and commercial).
- Hotels and Catering.
- Retail.
- Sport and Leisure.
- Warehouses.
- Health.
- Education.

We can see that the outputs from this study need to complement DECC's existing Government programmes by:

- Supplementing the energy data collected by BEES to provide information on energy use by air conditioning systems and on the trends in air conditioning deployment.
- Providing evidence to improve DECC's current energy demand model for air conditioning.
- Assessing the EPBD Air-Conditioning Inspection Database.

We can see that it will be important to establish the characterisation categories for the non-domestic building stock and air conditioning system types at the outset of the project. For example to contribute to the review of the Eco-design Directive it will be necessary to separate out systems with a cooling capacity >12kW.

DECC's current model appears to include all fan energy in air conditioning systems and, for consistency; we anticipate that this should be the basis for the present study[3]. For constant-flow systems annual and monthly consumption can be determined from the hours of operation and the flow rate, but for variable airflow systems detailed monitoring is desirable.

Most large "air conditioning systems" also provide a heating and commonly a ventilation (outdoor air supply) service. The predominant demands for electricity in such systems are for the cooling generator (commonly a packaged chiller) and fans, with lesser demands for pumps and controls. (In some systems the cooling generator may also be reversible and able to provide heating). In packaged systems with integral fans the fan consumption is not normally distinguished from that for cooling - or heating: many packaged systems are reversible.

The primary function of fans in most large systems is to provide a ventilation function: the fans operate even if there is no cooling (or heating) demand. It is therefore debatable whether or not electricity used by fans in order to provide a supply outdoor air should be attributed to cooling (as a service) although it is clearly part of the energy consumption of the system. (The provision of cooling slightly increases the fan energy consumption because the presence of a cooling coil increases the pressure rise that has to be provided by the fan.)

In "all-air" systems, fans handle larger volumes of air, much of it recirculated, since the air is used as a heat transfer medium to provide cooling. The electricity consumption of the fans for the additional air volumes is clearly part of the cooling function. In addition, all-air systems can provide "free cooling" in some circumstances, reducing the load on chillers. (However, this energy saving will often be less than the extra fan consumption by this type of system).

We would like to confirm with DECC that energy use by fans for both ventilation and cooling functions should be included in the study.

From previous experience we know that air conditioning systems often only service a proportion of the total building floor area and that it is very common to find more than one system within single building. We would also seek to agree with DECC how we should deal with these issues in the analysis.

We would anticipate liaising with the DECC's modelling contractors at an early stage in the project to establish how the existing model operates and the nature and format of the outputs required, for example any market segmentation employed. We would also want to confirm the nature of the price and Government Office Region relationships that are to be included in the model e.g., model long term rather than short term price impacts and whether the Government Office Region relationship should reflect temperature and/or stock differences.

This will allow the project team to ensure that the data collection and analysis are structured to provide the information needed to generate modelling inputs and algorithms which can be incorporated into the existing structure of the DECC model.

We note that improvements to the basic model and the analysis of market data are outside the scope of this study.

[3] The availability of fan energy measurements one of the criteria included in the selection procedure we propose for selecting any additional monitored data that might be obtained under Lot 2. Our proposed sampling procedure is provided in Appendix F.

2.3 Work Package 1: Literature search

[redacted]

[redacted]

2.4 Work Package 2: Assessment of Air Conditioning Inspection Reports

We will analyse the 500 air-conditioning reports from the Air Conditioning Inspection Certification register to be supplied by DECC and have allowed £20,000 within our budget for their purchase. We are familiar with the aims and processes of the inspections since one of the project team was the lead author for the current version of the CIBSE guidance for the inspections. In particular, as called for, we will analyse the reports for information on the frequency of comments relating to:

- Are air-conditioning systems sized for optimum performance?
- Are they operated and maintained correctly?
- Is there any information on refrigerant leakage rates?
- What are the most common recommendations made by air-conditioning inspectors for improving efficiency?

We note that the reporting template does not explicitly ask for market sector, but does ask for “building type” which we will record. In addition we will collate information on reported specific fan powers and system types, as a shortage of information in these areas is a significant uncertainty for air conditioning stock modelling.

We understand that the reports will be provided in a pdf format and will need to be transcribed into a data file format to enable analysis to be carried out. Queries will then be devised to generate responses to the research questions identified above. We will also provide indications of the levels of variation observed in the sample.

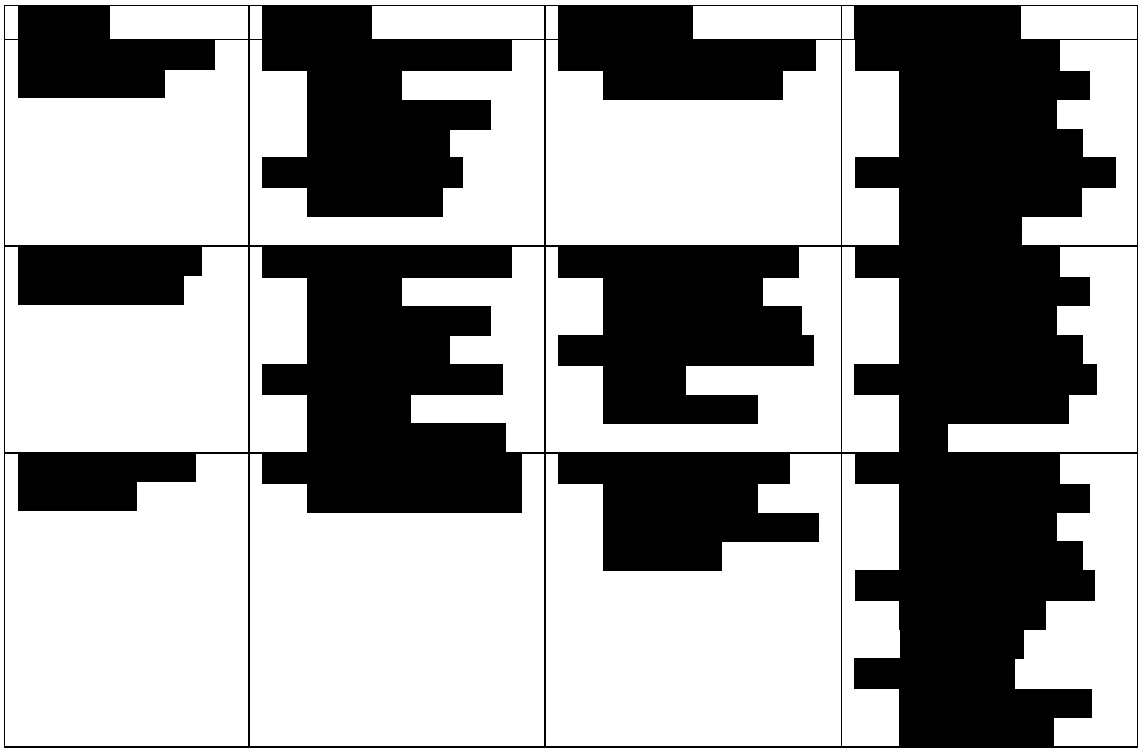
We will try to determine whether the recommendations of the assessors have been followed up, but think that this will be only be possible if we are able to have access to the building managers.

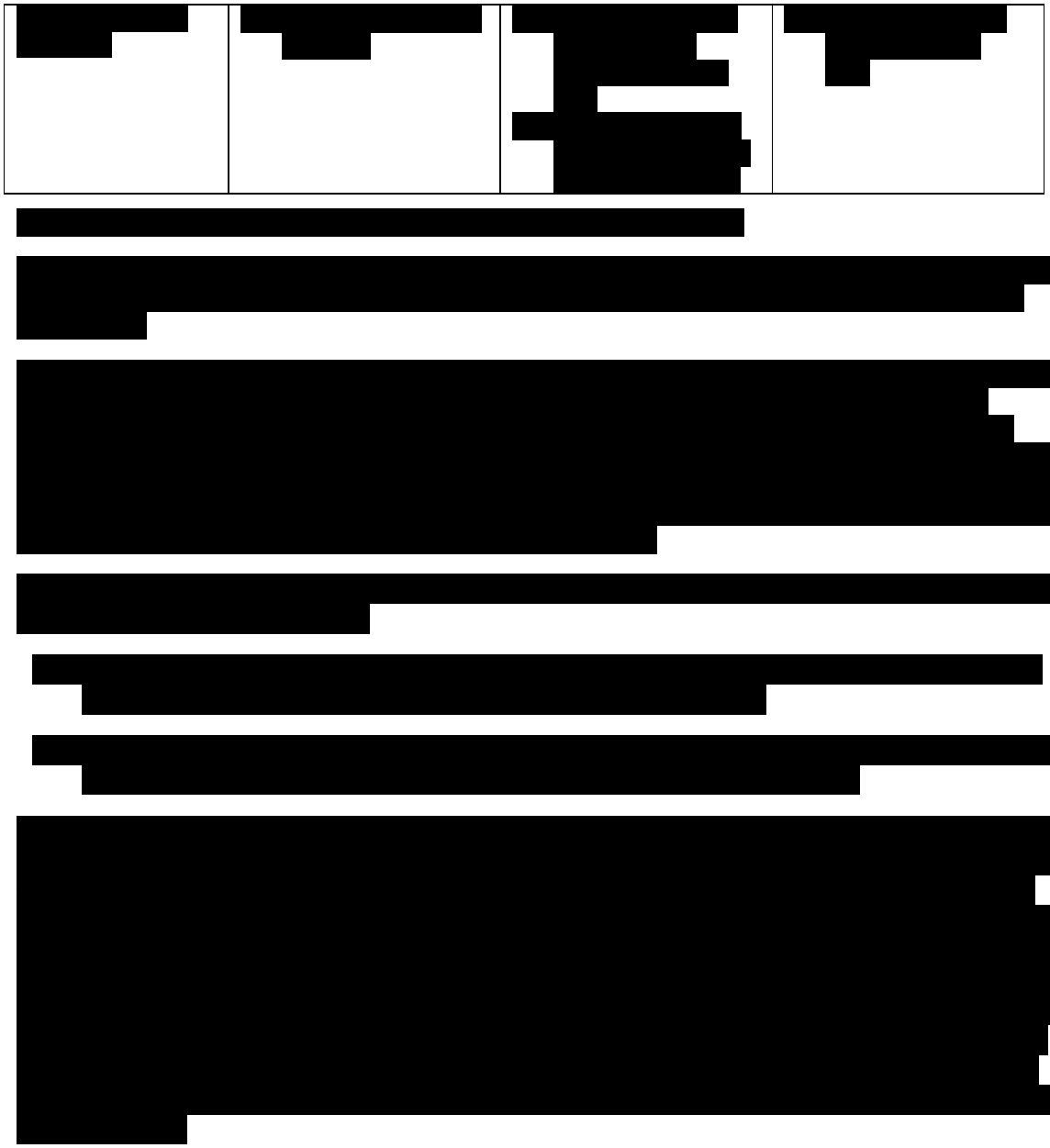
The results of this assessment will be provided in separate report.

2.5 Work Package 3: Update key inputs for DECCs existing model and generate peak demand algorithm

[redacted]

[redacted]





[redacted]

[redacted]

[redacted]

2.6 Work Package 4: Recommendations for improving energy efficiency

We will produce a report with recommendations for reducing UK energy consumption by air conditioning. This will be based on the information gathered from the literature review and from the assessment of EPBD air conditioning inspection reports.

The report will identify areas where the savings potential is expected to be significant. Savings measures are expected to fall into two broad categories

- Improved technical efficiency, which may be achieved by
    - choosing more efficient models,
    - choosing a more appropriate system type (the most efficient system type will vary depending on the cooling demand and characteristics of the building)
    - replacing systems and system components early
- Better system operation and maintenance
    - Improved controls.
    - Behavioural changes e.g., adjusting set points and timers.
- Load Reduction
    - E.g. reducing internal and solar gains.
    - The report will also incorporate the findings of a detailed study we have previously carried out for the whole of Europe[4]. This study assessed potential reduction for each country but the results have only been publicly reported at a European level. It quantified estimates of the 10-year potential savings across Europe. This study specifically included consideration of new European Ecodesign requirements for air conditioning products and also of policies that could be implemented for the two areas identified above, and also for load reduction measures.

For this study we will extract and review the potential savings for the UK and compare our modelling assumptions (such as annual load factors) with data obtained from the each part of the present study.

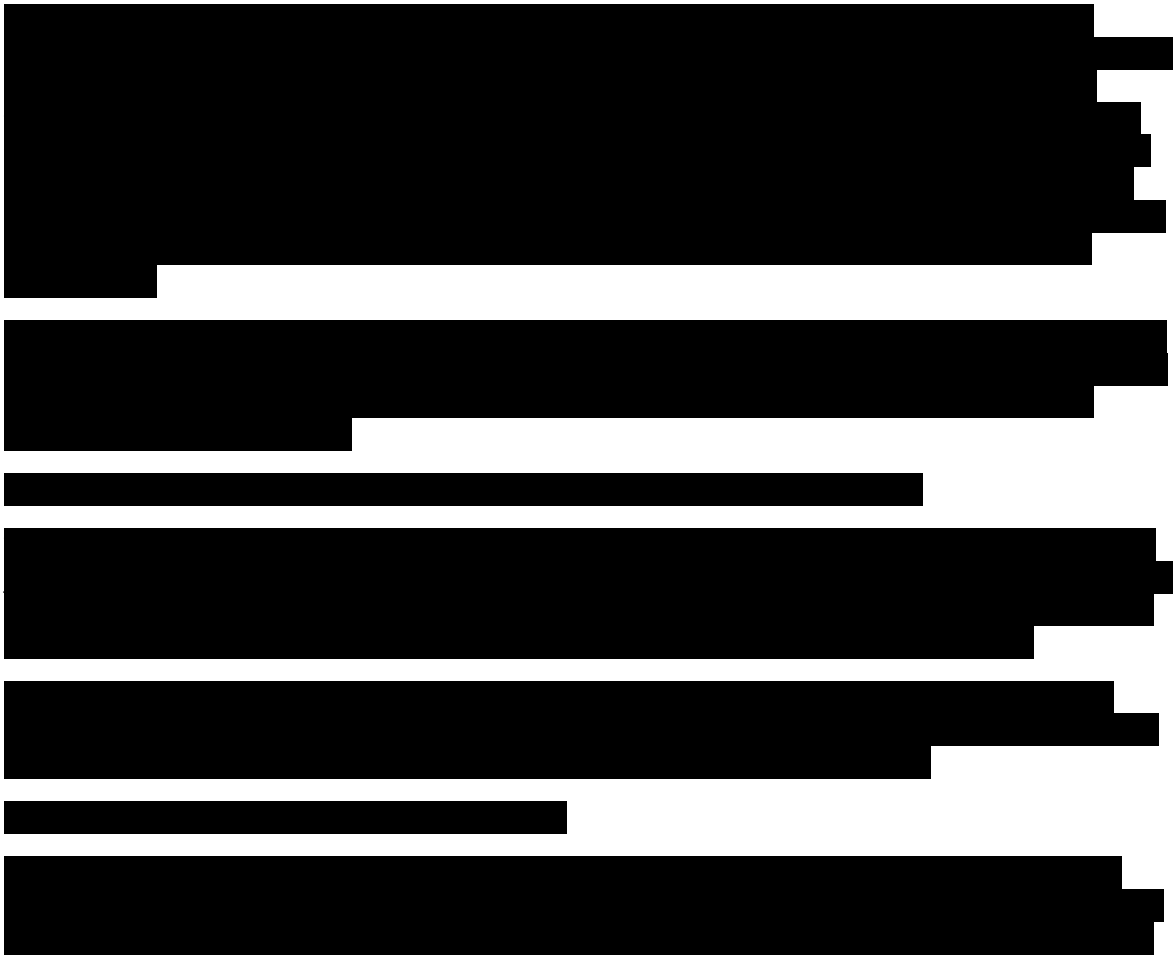
This proposal does not include calculating the potential savings with new data – but will provide quantitative information where it has already been calculated, or simple approximation can be made.

The output from this task will be a report summarising our findings.

2.7 Additional Options

[redacted]

[redacted]



3. Management and Delivery

3.1 The BRE team and its structure

[redacted] will act as the overall Project Manager. He is PRINCE2 qualified and has 15 years varied technical, marketing and management experience within the Carbon and Energy Management Industry preceded by similar experience within various parts of the Environmental and Construction Sectors. He will draw upon his considerable experience in coordinating the input of a number of BRE staff, associates and contractors in support of specific customer programmes and projects.

He will be responsible for all project management issues including reporting to the client; planning; specification; production, sequencing and delivery of outputs; management of resources; contractual issues; and convening and chairing project team meetings. He will be supported in this role by BRE's robust and reliable project management and financial systems to monitor, manage and report on projects. He has also had experience of being a Research Managing Agent (RMA) being seconded to Defra to manage large projects, so understands the processes behind managing such large government contracts. He will be the first port of call for the client and in his absence [redacted] will act as his deputy.

The project will be under the overall supervision [redacted], Director of Sustainable Energy. He is an internationally acknowledged expert in energy efficiency in buildings, with long experience in managing projects for government clients in the energy field. He will also lead on Quality assurance for all of the deliverables.

The technical director will be [redacted] who has many years' experience of co-ordinating the technical outputs of such large projects. Roger is a leading UK expert on the energy efficiency of buildings and air conditioning and has participated in a number of European and UK projects of relevance to this study. He also represents the UK on EBPD concerted action.

Our team structure is illustrated in Figure 3 below and their roles are captured in Table 2. A summary of the core team's relevant experience and skills is contained in Table 3 within Section 4, followed by expertise summaries of each team member.

Name	Project Team Role	Area/s of responsibility
[redacted]	Project Director	Responsible for maintaining project overview, reviewing quality plan and ensuring quality objectives are met.
[redacted]	Project Manager,	Management of the project and the programme of work; point of contact for contractual matters; ensuring work is completed to schedule and to required quality.
[redacted]	Deputy Project Manager.	Deputising for and assisting the Project Manager as required. Ensuring reports are drafted to schedule and to required quality.
[redacted]	Technical director	Responsible for maintaining project technical overview, reviewing outputs and ensuring research objectives are met.

[redacted]	Deputy Technical director, Task leader and Technical expert	Deputising for and assisting the Technical Director as required. Working on Literature search; Updating key inputs for DECCs existing model and generating peak demand algorithm; and Recommendations for improving energy efficiency. Option A - Task leader and Technical expert
[redacted]	QA reviewer	Quality Assurance reviewer for all Work Packages where data is produced and analysed. Liaison with National Grid
[redacted]	QA reviewer	Quality Assurance reviewer for all Work Packages where engineering data and specifications are produced and analysed.
[redacted]	Task leader and Technical expert	Analysis of EPBD inspection reports
[redacted]	Technical expert	Update key inputs for DECCs existing model and generate peak demand algorithm; and Recommendations for improving energy efficiency.
[redacted]	Literature review task input	Undertaking structured literature review.
[redacted]	Admin Support	Support for Project Manager & Project Director ensuring that Milestones met and Deliverables supplied to required quality and on time
[redacted]	Task leader and Technical expert	Option B plus back-up resource.
[redacted]	Task leader and Technical expert	Option C plus back-up resource.

Table 2: BRE team roles and responsibilities

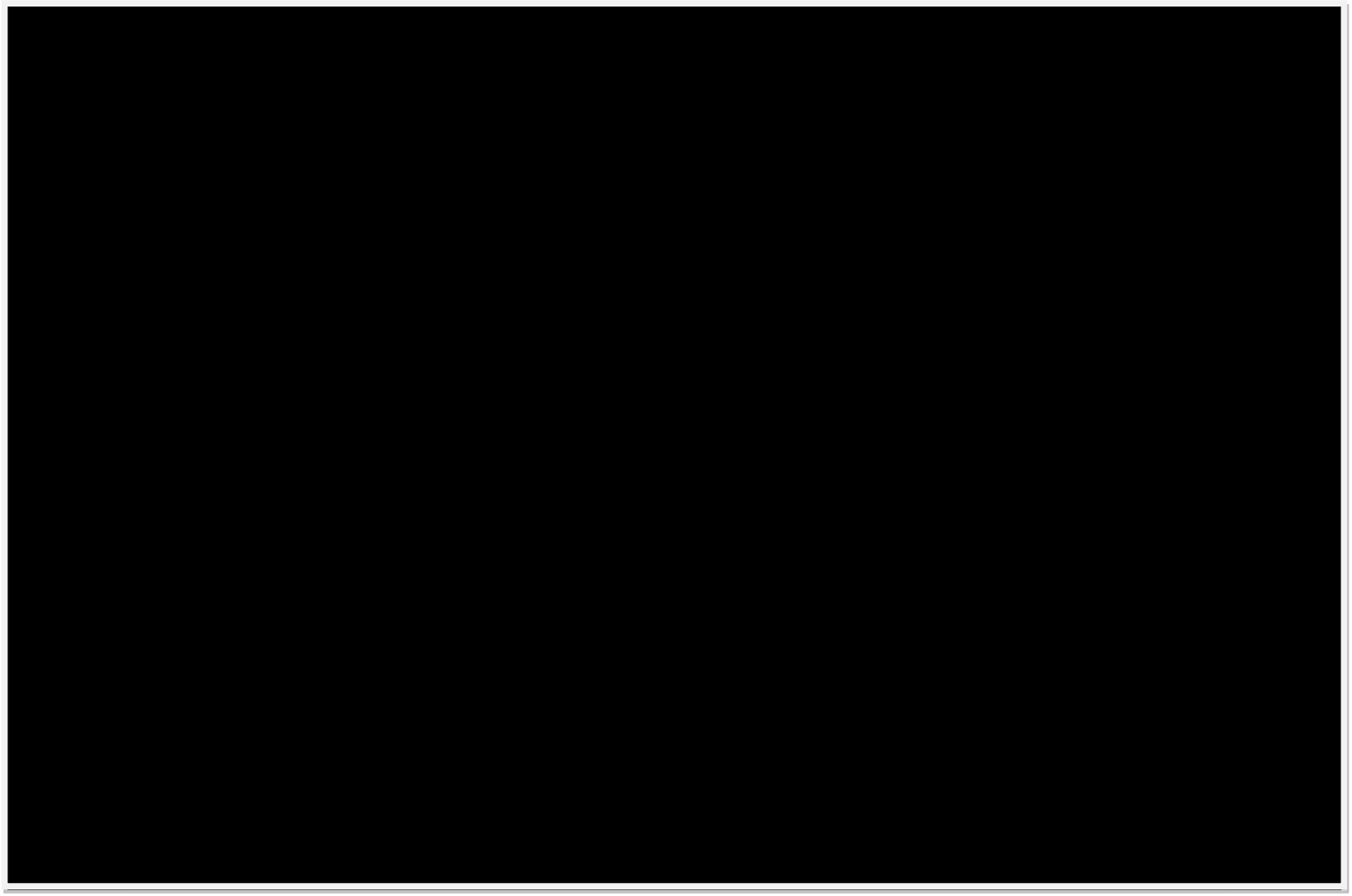


Figure 3: Project Team Organogram

3.2 Quality Assurance: Management Procedures and Deadlines

Proposed quality plan

The purpose of our proposed Quality Plan is to define and implement the means by which the services we provide for this project are fit for purpose.

We will prepare and maintain a Project-specific Quality Register for the duration of this contract. It will be used to summarise all the quality management activities that are planned or have taken place, and provide information for reports. The register will be available for review by DECC.

We are committed to providing our clients with independent, authoritative, practical advice of the highest quality within the scope of the contract – [redacted]

To this end:

- We will comply with all relevant statutory and regulatory requirements.
- We work only in areas in which we have expertise, and this is supported by thorough knowledge and access to all relevant source documents.
- We operate in accordance with our management system which is approved to BS EN ISO9001:2008.
- Our procedures and administration are non-discriminatory, administered in a non-discriminatory manner.
- Our policies and procedures enable us to avoid all conflicts of interest between our activities and those of other businesses within the BRE Group so as to enable us to preserve our impartiality. We will not engage in activities that may endanger our clients' confidence in our independent judgement and integrity.
- We make all efforts to ensure that all staff are free from any commercial, financial and other pressure which might influence our decisions.
- In addition to scheduled meetings with our clients, we will regularly solicit their views on our performance as part of a process of continuous self-improvement.

Independence and impartiality

Our core values are:

- Independence and scientific objectivity.
- Maximising benefit to our clients.
- Making a difference.
- Doing the right thing.

These values ensure that we remain independent and impartial. As a research and education charity for public benefit the BRE Trust (the owner of BRE) has as its overriding activity '*to commission and support research, education, innovation and communication in science, engineering, economics, management and information technology connected with the built environment*'.

The Trust uses its assets to carry out this activity (and is forbidden by law to use its assets in any other way). It employs the income and reserves resulting from the gift-aid received from its subsidiary companies to fund PhD scholarships, research chairs at university centres of excellence plus research and education projects. And as the owner of BRE - the UK's principal built environment research organisation - the Trust uses this unique resource to assist in the delivery of its charitable objectives.

All staff are given training in professional conduct and ethics; and required to adhere to our Code of Conduct. This gives guidance in areas including the maintenance of competence and skills; paying due regard to safety and wellbeing of others; acting with integrity; and the avoidance of conflicts of interests and situations that may give rise to perceived conflicts of interest.

Scope of work

This quality plan includes the proposed work to be carried out in our tender proposal n° 136557, November 2014 to the Department of Energy and Climate Change regarding their invitation to tender 874/09/2014regarding the contract 'Energy Use by Air-Conditioning '.

The project starts with an inception meeting where we envisaged the brief and terms of reference being clarified along with project management procedures and processes. This is also an opportunity to flesh out the deliverables address any other details.

The outcome of this meeting would then be crystallised into a summary inception report which would also contain a more comprehensive project plan.

There are also quarterly project board meetings every 3 months to present progress, any changes to the project plan and any further recommendations for changes to the project scope etc. – see section 3.3.

Variations to work programme

Variations proposed by DECC to the scope or content of the Contract shall be confirmed in writing to the Project Manager. The Project Manager will have the responsibility to communicate this to the relevant members of the project team. If necessary, the Contract and Quality Plan will be amended accordingly.

Variations proposed by BRE to the scope or content of this work and items requiring prior approval by the Commission shall be communicated by the Project Manager in writing to DECC. The variations shall be incorporated into the work programme following written confirmation to the Project Manager that the proposed amendments are acceptable to DECC.

Completed approvals records shall be held on file in hard copy by BRE.

Deliverables

The deliverables will be as agreed between DECC and BRE, as outlined in section 3.3.The progress made on their delivery will be shown in the bi-weekly email reports, which are also deliverables. The general format and level of detail of the bi-weekly reports will be agreed at the inception meeting.

The Project Manager will be responsible for the timely delivery of outputs of a quality which DECC has confirmed meets its needs and which are technically robust, policy aware, and within agreed budget.

Project work progress

The main method of informing DECC of the progress of the work will be through the weekly reports whose content, format and level of detail will be confirmed with DECC at the beginning of the contract. Other communication arrangements will also be agreed at the outset.

Contract and project documentation

The Project Manager will be responsible for ensuring the systematic storing of electronic and paper files of all project documentation, and making available to DECC, on request, any document/file relating to work undertaken as part of the contract. The project documentation includes:

- *Contract management/administration documents,* i.e.:
  All requests and replies for changes in contracts, invoicing matters, milestone reports, progress reports on deliverables, notes on progress and review meetings, complaints, consequential actions, etc.
- *Day to day communications and working documents,* i.e.
  All communications and working documents undertaken in the course of this contract shall be systematically filed, electronically or as paper copies. This will include reports, working papers, correspondence, briefings, minutes of meetings, reports of significant telephone conversations, etc.

All individual items of project documentation shall be in files that are appropriately marked with the Contract Number and relevant dates. They shall be collectively and systematically stored (archived) to enable easy retrieval by task and deliverable. Unless otherwise agreed, all records concerning projects carried out under this contract shall be retained by BRE for the full period of the contract.

Information exchange with DECC

Exchange of information will be by meetings, telephone, post, email, fax and telephone. Copies of all deliverable reports will be provided as an electronic copy emailed to DECC, and where required, paper copies will be supplied to DECC.

Security and confidentiality of data

Regarding security of electronic data, the Project team will follow general BRE Trust policy and procedures. The Project Manager will be responsible for ensuring that the security of data policy is adhered to by all project team staff, including any contracted staff. All DECC electronically filed documents will be:

- *Backed-up according to BRE Trust's internal procedures/ recommendations, i.e. '*Quick guide to using the BRE Desktop and Laptop backup facilities' *– copy available on request. Currently, centrally stored files are backed up each working day, and working files held on PCs and laptops should be backed up at least weekly.*
- *Password protected as individual documents and/or held on servers/hard drives whose contents are generally only available to the project team whose passwords change at least every three months. Laptops containing project information will be password protected. Memory sticks will be similarly protected where appropriate.*

Regarding items of particular confidentiality, e.g. items subject to legal proceedings, then DECC shall inform the Project Manager in writing of necessary additional confidentiality and security arrangements. It is for the Project Manager to communicate these agreed measures to all relevant staff and ensure they are adhered to.

Conflicts of interest

All BRE staff are required to operate under a set of governance arrangements, including codes of conduct, which are set out in depth in the BRE Group Management System. Of relevance to this topic, one requirement is for all staff to:

Avoid conflicts of interest and situations which may give rise to a perceived conflict of interest. Where such conflicts may arise, agree how to deal with them with an appropriate Manager.

[redacted]

It is important to note that BRE has been set up in a manner that ensures that such conflicts of interest should not occur. When BRE was privatised in 1997 the senior management team at the time recognised the possible dangers and undertook a conflict risk assessment to identify the most appropriate way in which to establish the new organisation. This had to be done in such a way that it retained the impartiality and independence for which it has always been known and respected, and which has always been key to the trust that it commands.

The solution identified (see Appendix E "About BRE" for more details) was an arrangement whereby BRE is owned by the BRE Trust - a research and education charity for the public benefit, registered by the Charity Commission (registered charity number 1092193). BRE Trust owns a number of other companies, all of which contribute their profits to supporting the Trust's mission "to champion excellence and innovation in the built environment". The companies themselves are distinct and separate entities. So, for example, BRE is quite separate from BRE Global (a company that deals primarily with certification issues) and BRE Training (who offer energy assessor, among other training courses).

This arrangement ensures that the risk of potential conflicts of interest is extremely low. However, in the highly unlikely event that a potential conflict of interest did arise this would be immediately referred to senior management so that they could take action to put in place corrective measures. DECC would, of course, be informed and consulted if such a situation should occur.

At the present time, there are no issues giving rise to conflicts, nor are any envisaged.

Performance review and reporting

The Project Director will seek a discussion with DECC around the midpoint of the contract, specifically to review contract performance and to ensure that DECC's requirements are being met. This will also inform BRE's own staff review process.

DECC complaints

Complaints relating to the operation of the contract can be made in writing, fax, e-mail or by telephone and should be directed to the Project Manager first, when the following steps will be taken:

- The complaint will be recorded and placed on file.
- It will be resolved as soon as is practically possible.
- The root cause of the complaint will be determined and the appropriate action determined to ensure that the cause for complaint does not reoccur. DECC will be informed of this and the matter discussed with them.
- Any action required will be implemented.
- The Project Director will be informed and will review all corrective actions taken.

Expenses

Travel and subsistence (T&S) will be claimed when submitting invoices, at the agreed rates.

Staff resource planning Tasks

The responsibility for planning resource availability for each Task will be with the Project Manager. Project team members will be expected to identify any resource related problems to the Project Manager at the earliest possible date.

Staff competence and training

The Project Manager will:

- Select and confirm the names of individuals responsible for specific Tasks under the contract, in consultation with DECC and the Project Director.
- Ensure that only suitably qualified and trained staff are employed and that they are adequately supported/mentored in their Tasks.
- Ensure that the staff working on the Tasks are aware of the importance and relevance of their work, and hence how they contribute to the achievement of the quality objectives.

Project organisation, staffing and responsibilities

The staffing, activities and responsibilities will involve the following:

- **The Project Director**

  The Project Director will maintain an overview of the project and in particular:

  - Receive copies from the Project Manager of the quality plan and approve it. Thereafter ensure that the quality plan is carried out and that the quality objectives are met.
  - Review the quality plan to ensure its continuing suitability, adequacy and effectiveness, and assess opportunities for improvement.
  - Receive copies from the Project Manager of the weekly reports.
  - Receive written copies of any DECC complaints and the Project Manager's analysis and recommendations for actions as agreed with DECC, and ensure these are carried out.
  - Agree with the Project Manager the staffing for the Tasks, and any changes to the staffing and for what reasons.
  - Discuss at least annually with DECC, either in a meeting, or over the telephone or by email, the progress of the project and the performance of the Project Team, and any issues DECC wish to raise regarding the project.

- **The Project Manager:**

  The Project Manager, or, when appropriate, the Deputy Project Manager, will:

- Ensure that only suitably qualified and trained staff are employed on the project, that they fully understand their responsibilities and authorities and that they have the opportunity for development and a variety of work experience.
- Monitor the quality and timeliness of the outputs and take overall responsibility for the satisfactory delivery of the project.
- Act as primary contact point between DECC and BRE, and agree variations to the contract;
- Write the weekly report and ensure that it is:
    - Delivered within 5 working days of the end of the quarter and
    - The achieved work programme addresses the tasks set out in the Contract and agreed documents;
- Ensure that the invoice and supporting documents are accurate and according to the contract, and that they are delivered in a timely manner and to DECC's satisfaction.
- Ensure that the Project Quality Plan is implemented.

- **Project Staff:**

  Project Staff will:

  - Be given delegated day to day responsibility for complete Tasks or substantial sub-tasks with call on support and advice from the Project Manager on matters that they are unfamiliar with, or believe to be beyond their current competence to decide.
  - Inform the Project Manager of issues that they foresee may cause problems with the work, the project as a whole, or the best interests of DECC. Issues include possible delays in achieving the task on time and within resources, intelligence information that could affect future actions of the DECC and so on.
  - Support other members of the team on other Tasks
  - Inform the Project Manager with information for inclusion in the weekly report.

Key Performance Indicators and monitoring the quality of the service

We will monitor and evaluate the quality of the service we provide in accordance with BRE's Quality Management system which is certified to meet ISO9001:2008. This certification demonstrates our ability and commitment to consistently monitor and provide services that meets clients' requirements (inclusive of any relevant statutes and regulations, if applicable).

We would expect to conduct this monitoring principally through the weekly progress reports and meetings with DECC. Progress reporting will focus upon: Issues; Changes to the Risk Register; Milestones and Deliverables. In addition, BRE's Management and Quality Department monitor and evaluate the quality of service through customer feedback process and internal audit programmes. Qualified auditors carry out internal audits to planned programmes across all areas of the business to ensure that quality of service is being continuously achieved.

BRE's Customer Satisfaction process applies to all projects. We ask customers for in-depth feedback – through structured questionnaires and face-to-face reviews - on how well we met their needs, levels of service, value for money, timeliness, quality of communication, staff helpfulness etc. The process enables us to monitor and measure results whilst also seeking crucial opportunities for improvements. All results are monitored by our Quality Assurance team and reported to top management. Furthermore, results are included in the mandatory six monthly 'QMS Management Review' which is subject to surveillance by LRQA to ensure we continuously meet our clients' requirements in adherence to our ISO 9001:2008 certification.

3.3 Deliverables

Inception meeting and report

We envisage the inception meeting having the purpose of:

- Clarifying the brief and terms of reference;
- Putting procedures and processes into place regarding delivery and finances;
- Fleshing out the specifications of the deliverables;

- Ironing out any other details.

The outcome of this meeting would then be crystallised into a summary inception report which would also contain a more comprehensive project plan.

Reporting

- Inception report containing the agreed plan for the project
- Quality assurance plan, including details of who will sign off outputs, and their role within the contractor's organisation.
- Email updates of an agreed minimum frequency of 2 weeks and a phone update each month.

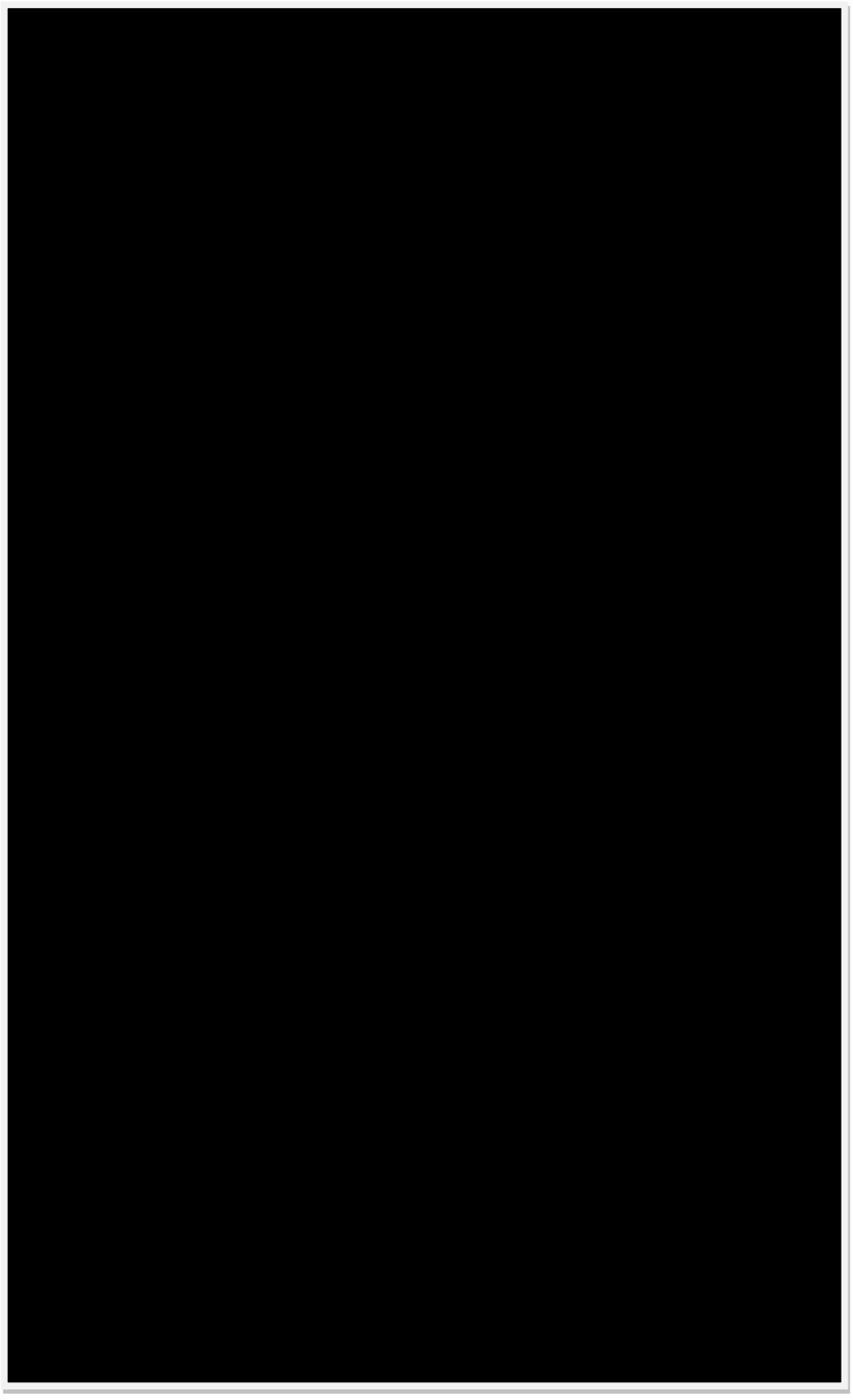
Project Board presentations

- Project board meetings every 3 months where we will present progress to date in PowerPoint for use by DECC; this will include any changes to the project plan implemented and any recommendations for changes to the project scope etc.

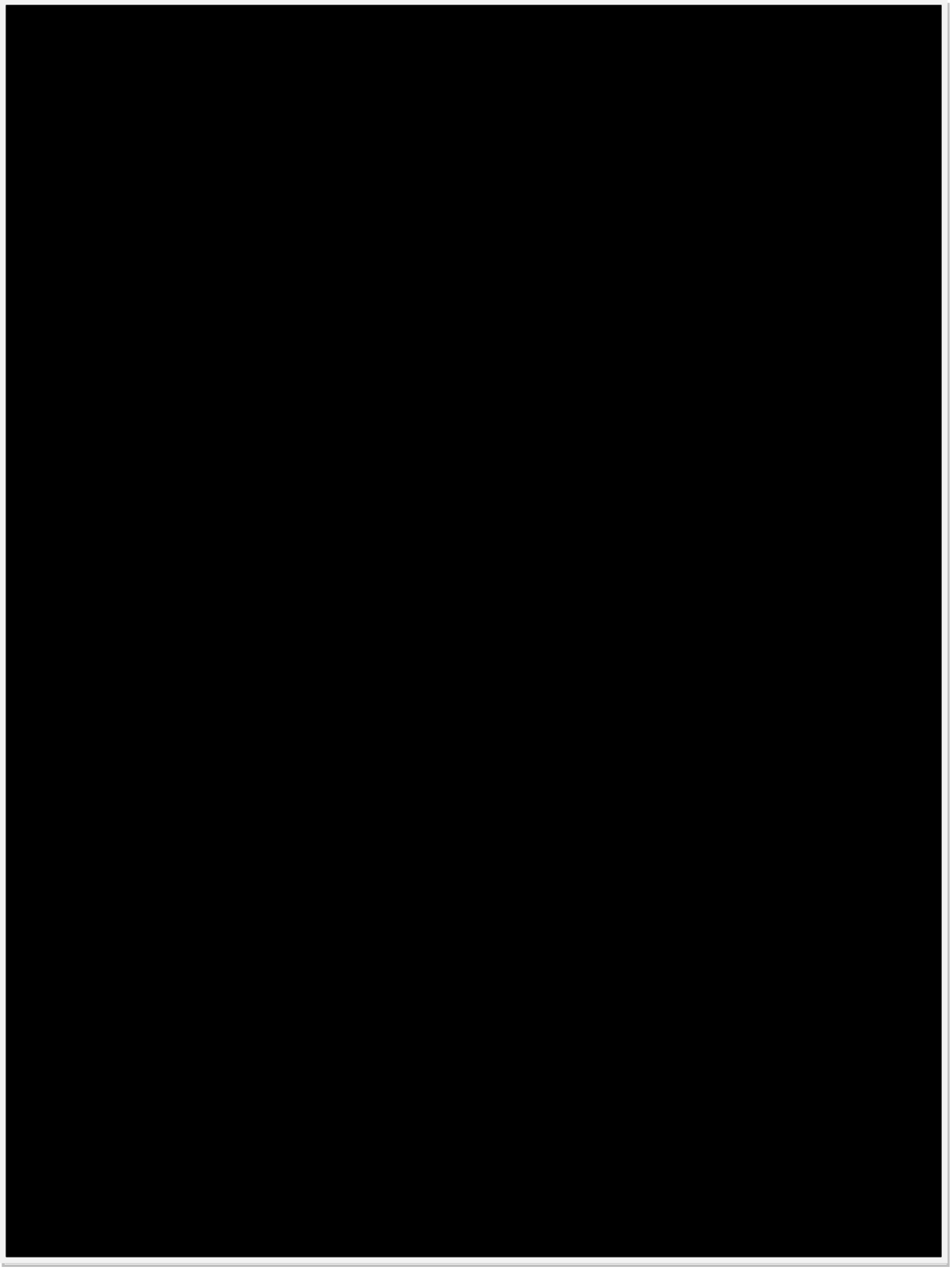
Outputs

- A literature review, which specifically addresses the issues of operational patterns of air-conditioning systems in the UK non-domestic stock, trends in deployment and new technologies which may impact electricity demand from air-conditioning.
- A report on the assessment of the air-conditioning inspection reports in the EPB Register, including details on the range of systems and buildings inspected, the most common conclusions regarding efficiency and operation, the most common improvements recommended by the inspectors and whether these recommendations were implemented.
- Report on data collection procedures, including: methodology; instruments; assessment of bias in sample and approach taken to this in drawing conclusions
- Monthly updates on percentage of data collection
- Interim findings report
- Presentation of results
- Summary of the main findings from the examination of the air-conditioning inspection reports in the EPB Register
- An algorithm to estimate the peak electricity demand and monthly from air-conditioning a function of degree days, GOR and electricity price. DECC's projections of electricity prices should be used as an input.
- Draft report, including summary of methodology
- Final report in the DECC template for publication
- Technical report/annex, to include (for quantitative data) assessment of uncertainty in results
- A presentation of summary findings in PowerPoint for use by DECC

3.4 Delivery Plan



3.5 Resource Input



4. Skills and expertise

Our proposed team and its structure are described earlier in Section 3.1. It is drawn from the personnel that have worked with DECC in previous projects and understand the research needs. The team have lengthy experience in dealing with extractions, analysis and modelling of energy data.

We have supplemented this team with staff drawn from across the BRE Group to enable us to meet the other technical objectives identified in the ITT. Specifically, this includes:

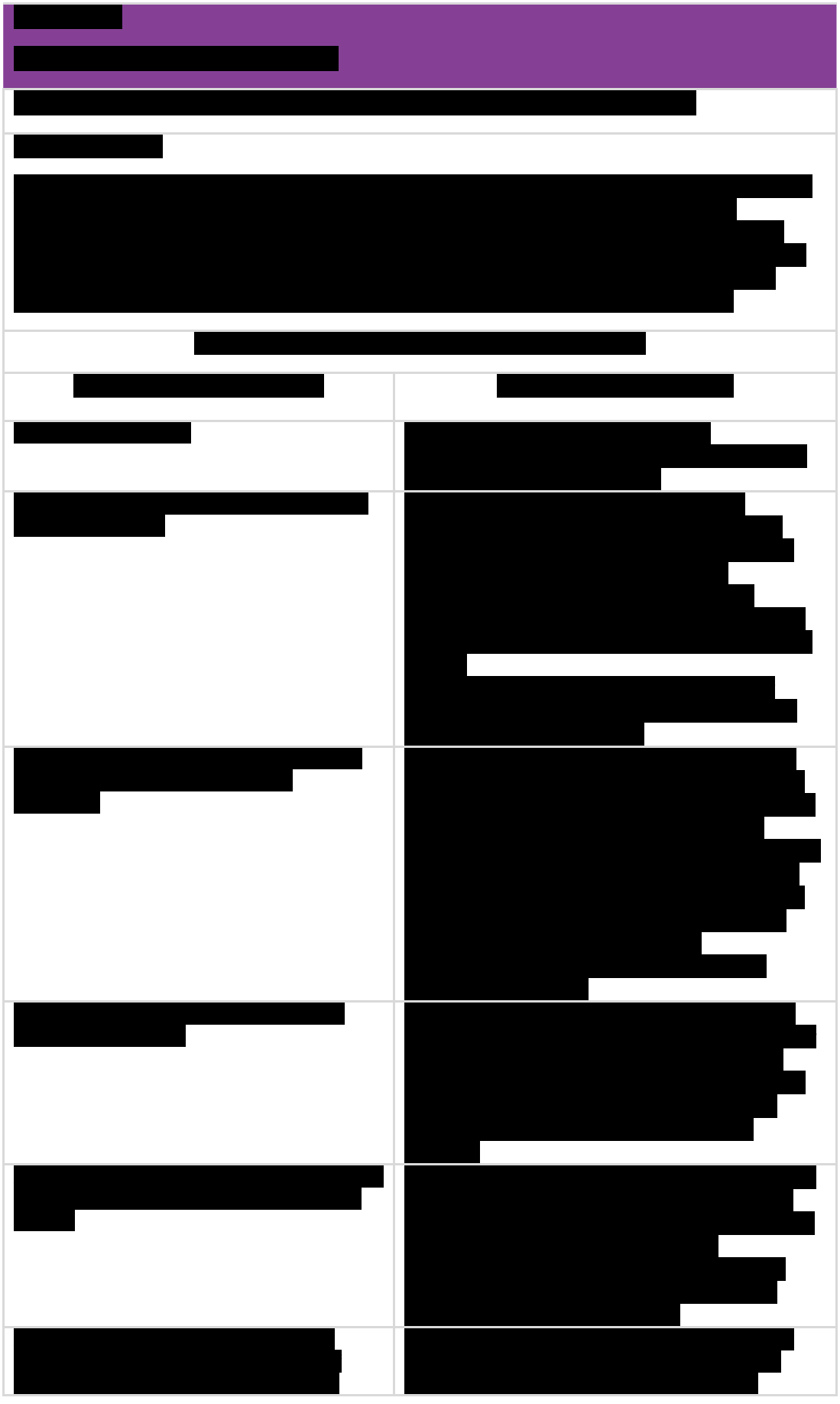
- Practical experts on the design, installation, commissioning and performance of air conditioning systems.
- Practical experts on the performance monitoring of air conditioning systems.
- Staff with expertise in EPBD Air Conditioning inspections and the contents of the reports.
- Statisticians who have dealt with electricity usage data before.

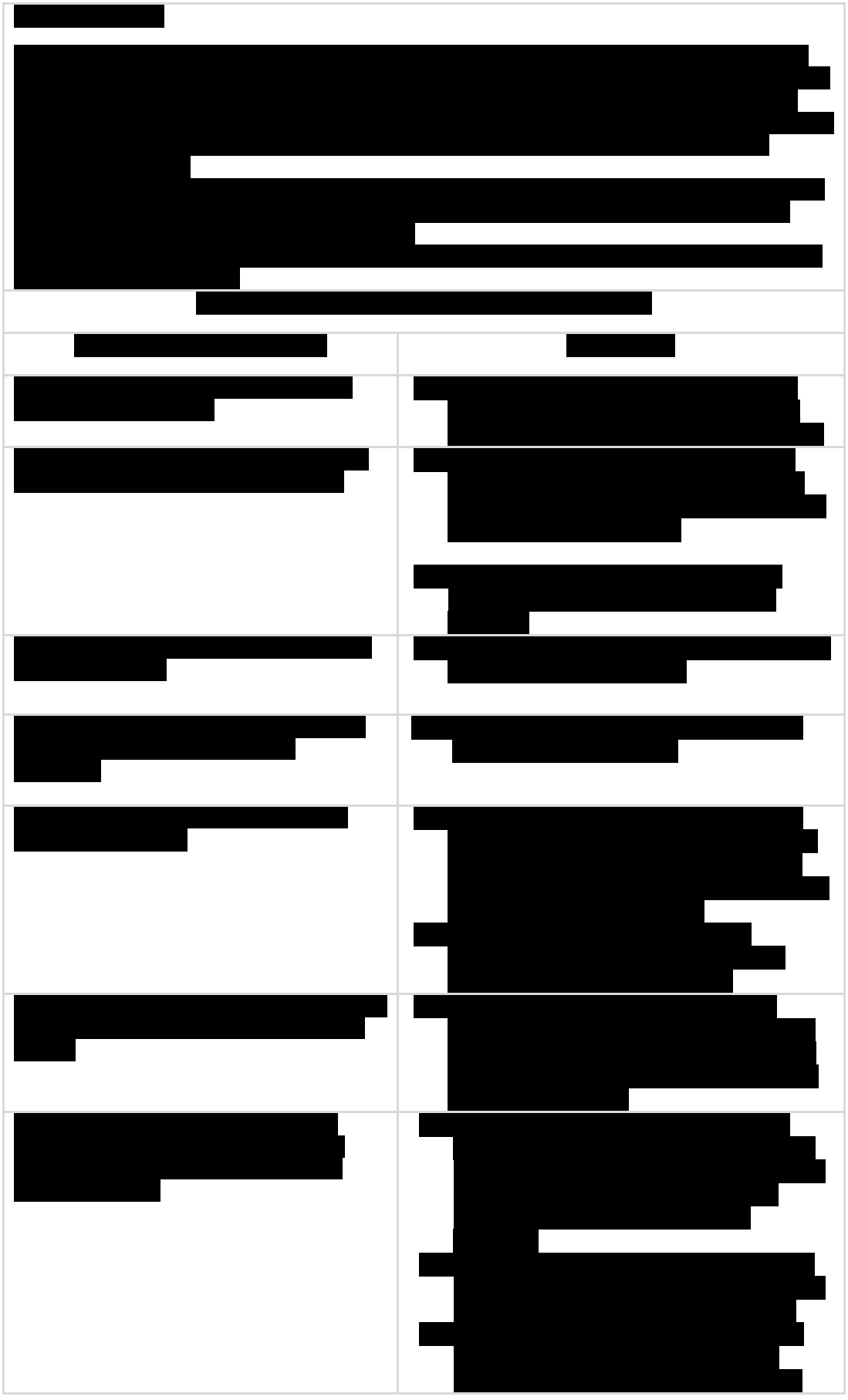
BRE also have a range of software at their disposal to analyse both qualitative and quantitative data. In addition to the use of MS Office software to an expert level, the following specialist software is used:

- SPSS 22 (for statistical analysis and modelling).
- R version 3.1.1 (for statistical analysis).
- GPOWER version 2.0 (for power calculations and sample sizing).
- AMOS 16.0 (for structural equation modelling).
- NVIVO (for qualitative analysis).
- OR software tools e.g. modelling, decision analysis.

In addition, in order that all reports meet DECC's needs, we have included staff who will perform a continuous QA review. [redacted]

To facilitate assessment of staff expertise we have created a simple table (see Table 3) that summarises all of the team's expertise in the core areas identified by DECC in their ITT and further detail is provided in the subsequent expertise tables.





5. Challenges and Risks

4.1 Challenges

[redacted]

[redacted]

4.2 Risks

[redacted]

Risk Register

[redacted]

6. Pricing

[redacted]

7. Conflicts of interest

Declaration 3: Conflict of Interest has been completed, signed and is contained within Appendix A.

Appendix A: Mandatory Forms

Declaration 1: Statement of non-collusion

Declaration 2: Form of Tender

Declaration 3: Conflict of Interest

Declaration 4: Questions for tenderers

Declaration 5: Code of Practice

Appendix B: Curricula vitae of project team

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

- [redacted]
- [redacted]
- [redacted]
- [redacted]
- [redacted]
- [redacted]
- [redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

Appendix C: Terms and conditions

The Contract will be undertaken in accordance with DECC's Standard Terms and Conditions of Contract for Services, (including Hire, Lease and Facilities Management) revised 10/12 (the "Terms and Conditions") subject to the following amendment agreed with DECC being made to the Terms and Conditions:

The words "be limited to a sum of £4,000,000" in clause 18 (7) (Indemnities and Insurance) be replaced by the words: "be limited to a sum of £2,000,000" '.

Appendix D: Quality & Environment

BRE is the pre-eminent centre for research in the built environment within the United Kingdom. Our Management System is approved to BS EN ISO9001:2008, 'Quality Management Systems' - certificate number LRQ 4001063, as well as to BS EN ISO14001:2004, 'Environmental Management System - certificate number LRQ 4001064.

Our Management System is also closely aligned to ISO/IEC 27001:2005 Information Security Management Part 1 Code of Practice.

BRE is a UKAS accredited testing laboratory, number 0578 and has been accredited at its main site for a range of tests against BS EN ISO/IEC 17025 (General requirements for the Competence of Testing and Calibration Laboratories).

Our quality policy is to:

- Comply with all relevant legislation
- To provide authoritative and independent services and products that fully satisfy our clients' requirements
- Continually improve the effectiveness of the quality management system and the provision of our services and products

The Chief Operating Officer is responsible for implementing the policy.
This will be achieved by:

- Establishing, implementing and maintaining a quality management system certificated against ISO 9001:2008
- Setting and reviewing measurable quality objectives and ensuring those objectives are met
- Providing the necessary resources and ensuring responsibilities and authorities are determined and communicated within BRE
- Reviewing the effectiveness of the quality management system and assessing opportunities for its continual improvement.
- Seeking structured quality feedback from our customer.

Our environmental policy is to:

- Aim to comply with all relevant environmental legislation.
- Continually improve our environmental performance.
- Contribute to economic, environmental and social sustainability in the short and long term.

The BRE Group Board is responsible for implementing the policy.
This will be achieved by:

- Maintaining an environmental management system, aligned to ISO 14001 and ISO 9001.
- Setting objectives and targets to minimise the negative environmental impacts and maximise the positive environmental impacts of our operations.
- Training our employees to achieve and maintain high standards of environmental performance.
- Using products and processes that assist in reducing the environmental life cycle impacts of our activities and those of our clients and supply partners.
- Communicating openly and consulting with stakeholders on environmental issues.

Appendix E: About BRE

BRE www.bre.co.uk is an independent, research-based consultancy, testing and training organisation, offering expertise in every aspect of the built environment and associated industries. We help clients create better, safer and more sustainable products, buildings, communities and businesses, and we support the innovation needed to achieve this.

BRE Group is a world-leading centre of built environment expertise, research and training, and includes BRE Global a third-party approvals organisation offering certification of products and services to an international market. The BRE group of companies is wholly owned by the BRE Trust, the largest UK charity dedicated specifically to research and education in the built environment. Set up in 2002 to advance knowledge, innovation and communication for public benefit, the Trust uses all profits made by the BRE Group to fund new research and education programmes that will help to meet its goal of 'building a better world together'.

Please visit our BRE Group websites for more information about our products and services

www.bre.co.uk/global BRE Global is an independent, third-party approvals organisation offering certification of products, services and systems to an international market. BRE Global is responsible for the internationally renowned BREEAM and LPCB certification schemes

www.bre.co.uk/ventures BRE Ventures brings together innovators, networks and funding streams and leverages these against the BRE Group's world-class expertise and facilities to bring innovation to market quickly.

www.bre.co.uk/innovationpark The BRE Innovation Parks (are world leading and ground breaking demonstration developments designed to give a glimpse of how the future delivery of sustainable buildings and communities can be achieved.

www.breeam.org The world's leading design and assessment method for sustainable buildings

www.brebookshop.comThe BRE group bookshop

www.GreenBookLive.com - GreenBookLive is the unique reference source and online listing of environmental products and services

www.RedBookLive.com Products, services and companies listed in the LPCB Red Book Database.

The BRE Group headquarters is in Watford near London and offices in the UK and around the world. For a full list of our offices and contacts please see our website.

Nine things you might not know about BRE

BRE is a world leading research, consultancy, training and testing organisation delivering sustainability and innovation across the built environment and beyond.

BRE has a unique range of testing facilities, including a structures lab that can contain a four-storey flat, an extreme speed wind tunnel, a burn hall that can accommodate 10MW intensity fires, and an anechoic chamber.

BRE was set up by government in 1921 and became an independent company in 1997.

BRE employs a team of leading research scientists, engineers, architects, surveyors and psychologists who have expertise is virtually every aspect of the built environment.

The BRE Innovation Park Network currently has parks at different stages of development in England, Wales, Scotland, China, Brazil, Canada and the USA. These provide opportunities for collaboration across the world.

Over 20 years ago BRE developed the world's first environmental scheme for buildings, BREEAM. To date over 1 million buildings have been registered around the world.

BRE is owned by the BRE Trust, a registered charity. The profits made by BRE are used by the BRE Trust to conduct research projects that benefit society.

BRE is entirely independent of Government, commercial sector or vested interests of any kind. We are only influenced by the facts.

In 1940, BRE built the first model of the Mohne Dam used by Barnes Wallis in planning the Dambusters' Raid. It is now a Scheduled Historic Monument.

Our services include:

A
Accreditation
Acoustics
Air conditioning
Air quality
Airtightness
Alarms
Approvals
Approved certifier of design (ACD)
Assisted living
Aviation

B
BIM
BRE National Solar Centre
BREEAM
BREMAP
Building Regulations
Building Research Housing Group
Building services

C
Cables
CALIBRE
Carbon footprinting
Carbon management and offsetting
CE marking
Certification
Cladding
Climate change
Code for Sustainable Homes
Composites
Computational fluid dynamics
Concrete
Conservation
Consultancy
Continuing Professional Development (CPD)
Corporate social responsibility

D
Dangerous Substances
Daylighting
Decent homes
Deconstruction
Demolition Design
Disability and access
Domestic energy assessor (DEA)
DSEAR
Dust testing

E
EcoHomes
Embankment dams
EMC testing
Energy
Energy efficiency and management
Energy performance certificates (EPC)
Energy Performance of Buildings Directive
English House Condition Survey
ENVEST
Environmental assessment
Environmental consultancy
Environmental impact assessment (EIA)
Environmental profiles
Eurocodes
English House Condition Survey
ENVEST
Environmental assessment
Environmental consultancy
Environmental impact assessment (EIA)
Environmental profiles
Eurocodes
Events
Expert witness

F
Facades
Facilities management
Fire consultancy
Fire Detection
Fire risk assessments
Fire investigations
Fire safety
Fire testing
Flooding
Floors
Foundations

G
Glass and glazing
Green Book Live
Green buildings
Green Deal
Green guide to specification
Green Print
Ground engineering

H
Health and safety
Healthcare
Heritage buildings
Home Information Pack
Housing
Housing stock modelling
HVAC

I
Indoor air quality
Industrial
Infrastructure
Innovation
Innovation Parks
Intelligent buildings
International

L
Lean construction (CLIP)
Leisure
Lighting
Loss Prevention Certification Board (LPCB)
Loss Prevention Standards (LPS)
Low carbon buildings programme
Low impact buildings

M
Masterplanning
Materials

S
SAP
SBEM

T
Testing
Thermal performance

Microgeneration
Modelling
Modern Built Environment KTN
Modern methods of construction

N
Noise

O
Occupant surveys (POE)
Offices

P
Planning
Pollution
Prisons
Procurement
Product approval
Product development
Property protection
Publications

R
R&D
Radon
REACH
Recycling and re-use
Red Book Live
Refurbishment
Renewables
Resource efficiency
Responsible sourcing
Retail
Risk assessment
Roofs
Schools
Security
Site Waste Management Plans (SWMP)
SMARTWaste
Smoke alarms
Social research
Solar shading
Sprinklers
Standards
Stock condition surveys
Structural engineering
Sustainability
Timber
Training
Transport
T-zero

U
UKAS

W
Waste and recycling
Water
Whole life performance and cost
Wind

Z
Zero carbon

Appendix F: Sample Selection Procedure

The sample buildings for monitoring will be selected from the available sources by filtering against a number of criteria.

We will agree the selection criteria with DECC and envisage that they will include:

- Data quality and completeness

o Our intention would be to only include buildings that meet or exceed the data collection requirements for energy consumption in section 4.3.1 of the ITT.

o We believe that the key data are available but anticipate that some items may be difficult to obtain. Our suggested priorities are listed below.

 The following items should be considered essential

• Monitored electricity consumption of the air-conditioning unit, on a half hourly basis, or more frequently, for 1 year

o We believe that a full year's data (possibly with small gaps) is necessary

• Daily external temperatures (more detailed will be preferred)

• .Internal temperatures

• Sufficient monitored data to be able to infer the hours of occupancy of the building

• Data on the areas and uses of air conditioned space (including overall market sector)

o We expect more detailed information about building and systems to be available for many buildings, though not necessary in the format of SBEM data sets. If the building has an Energy Performance Certificate (which is likely for recent buildings but less probably for older ones), and we can obtain the .nct files on which this is based, we can extract the SBEM dataset.

• Type of air conditioning system

 Highly desirable

• Surveys of installed equipment and lighting

o These are available for some of the proposed buildings

• Age, type, model, rated kW, location and maintenance schedule of the air-conditioning

o This information should be generally available.

• Separate motoring of fans and cold generators

o This will be available for most of the potential sample.

• The air-conditioning inspection report for the air-conditioning equipment

o May not be available for all buildings

 Desirable but may be difficult to obtain

• Floor plans (in addition to area of conditioned space)

o Should be available for most buildings

• Records of actual occupancy levels

o Unlikely to be available

• An SBEM style survey of the building, to establish heat loss, solar gain

o Taken literally this would mean the EPC data file (or equivalent for overseas buildings). Only about one third of UK commercial buildings currently have EPCs and there could be data protection issues. However, much of the information is likely to be available in other forms.

• Information on refrigerant leakage. We will seek access to inspection reports (which should include qualitative information) and f-gas reports (recording gas replacement

 The display energy certificate for the building

• This will only be available for public buildings

 An interview with the energy manager, specifically orientated around the use of air-conditioning

• We will approach current building energy managers with a view to such interviews

- UK or similar climate

o However, we propose to temperature-correct all consumption data as described in section 2.5.2.3 below

- Representative of different market sectors

o Our current analysis suggests that by far the largest sector by installed cooling capacity is offices, followed by leisure and hotels, retail and health.

o In order to carry out meaningful inter-sector comparison it would be preferable to have roughly similar numbers of buildings from each of these sectors, enabling scaling up to mimic estimates of the distribution in the stock.

- Representative of different types of system

o Ideally all the systems types described in the ITT section 4.3.1.ii plus all-air systems (constant and variable flow), active and passive chilled beams, packaged rooftop units and possibly dual-duct and terminal reheat systems. From simulation studies and the BACED project we know that there are systematic differences in energy efficiency between different types of system, but also differences for systems of the same type.

o We have previously estimated the proportion of different system types in the stock, by total cooling power. Chiller-based systems dominate but, although there are estimates of the installed stock of some components of such systems, there is no reliable information on the relative prevalence of different types of chiller-based systems. We have constructed an approximate distribution based on the historical reviews and similar sources. This general view has been confirmed by current and former practitioners who have seen it, but we cannot claim statistical robustness.

The outputs from this element of the methodology are the selection of the sample and a spreadsheet of the static attributes of the selected buildings.

We will discuss with DECC whether the sample is acceptable before extracting data to support the development of algorithms for monthly weightings and peak demands.

[redacted]

[redacted]