



## Expression of Interest: Integrated Electric Heating Project

### *Dynamic Modelling Capability Consultancy*

The Energy Technologies Institute (ETI) invite expressions of interest from organisations that could work with them in providing a dynamic energy modelling capability and expertise on a consultancy basis to assist in their Integrated Electric Heating Project.

#### 1 Context

The ETI is a public-private partnership between global industries – BP, Caterpillar, EDF, Rolls-Royce and Shell – and the UK Government. The ETI is focused on accelerating the deployment of affordable, secure low-carbon energy systems for 2020 to 2050 by demonstrating technologies, developing knowledge, skills and supply-chains and informing the development of regulation, standards and policy.

Today about 20% of UK CO<sub>2</sub> emissions come from how people use heat and hot water at home. This must be effectively eliminated by 2050 to meet carbon targets at the lowest cost. The ETI's Smart Systems and Heat (SSH) programme takes a holistic, interdisciplinary approach to solving this challenge. Hitachi is an Associate Member of the SSH programme.

The ETI's strategy work has identified electric resistive heating and heat-pumps in individual homes as potentially playing an important part in transitioning the UK to a low carbon future. These diverse heating sources will be deployed in a wide range of homes with a correspondingly diverse mix of thermal properties.

Given that electric heating is likely to play a significant role in the decarbonisation of the UK's domestic housing, the ETI now wants to model electric heating systems in representative homes with specific thermal properties. Recognising the potential role during the transition, this project will focus solely on a gas-hybrid/bivalent test-case, but with the intent to also model other systems at a future stage.

The modelling will consider the interaction in a number of domestic UK building archetypes and household types between the heating system, control system, building fabric, consumer requirements, weather and other energy systems within the home.

Currently, electric heating systems are an unattractive replacement alternative to gas heating systems in terms of cost and performance for most existing homes. The challenges include:

- limited network capacity and competition for use of that capacity with other appliance use within the home, potentially increased by new and expanded uses of electricity, such as vehicle charging or increased IT equipment and complexities such as PV self-generation;
- low heating system power, leading to long pre-heat durations that give the resident a poor experience and cause high losses in older, less thermally efficient homes;
- high costs of delivering peak energy supply, combined with few options for heat storage at the scale required for space heating (building fabric is the obvious thermal store, but is only effective where the building has sufficient thermal efficiency);
- high capital cost of some electric heating system components and installations; and

- proprietary control system protocols at the component level and operating cycle dependent performance characteristics which limit the scope for control integration with the wider energy system to improve customer experience and energy cost.

The objectives of the project are to:

1. through modelling, produce an evidence base setting out the trade-offs between cost, energy use, building fabric requirement and customer satisfaction implications of using currently available technologies set up to deliver similar space and water heating performance as a gas boiler system;
2. based on the modelling insights, create a technology development roadmap setting out the opportunities for future innovation to improve the performance and cost of the systems through greater system integration, component performance improvements and holistic control algorithm development; and
3. further strengthen relationships with heating system component manufacturers and an understanding of the commercial and technical issues involved in greater system integration.

## 2 GENERAL SCOPE

The project consists of 3 stages. During the first stage ETI resource will develop and prepare all necessary detail and data to enable the modelling to be undertaken in stage 2. The second stage will involve ETI working closely with a *Dynamic Modelling Capability Consultancy* partner (hereafter referred to as the modelling partner), procured through this Expression of Interest (EoI), who will provide the stage 2 modelling capability. The modelling partner is likely to be an organisation rather than an individual in order to pull on the breadth of skills required. The modelling partner will use the outputs developed by ETI during stage 1 to select and configure appropriate dynamic modelling tool/environment(s), carry out the modelling work and then provide ETI with the modelling outputs. ETI will then document and disseminate the modelling insights in the third and final stage and consider future activities looking at, for example, other technologies.

Note - this EoI is seeking a dynamic modelling capability to support delivery of initially **stage 2** of this project therefore Stage 1 and 3 are not covered in this EoI. The modelling partner will not be required to participate during stage 1 and 3 unless otherwise agreed.

## 3 TECHNICAL SCOPE

The primary focus of this project is electric heating systems, the boundary of what is to be considered, however, reaches beyond the components of the heating system themselves (see

*Figure 1*). If the heating system is considered to be the heating control system and the heat generation and distribution system, this project will investigate the interaction of these with the building fabric, the occupants behaviour and requirements, the weather and potentially additional options as Photovoltaic (PV) electricity generation, electric vehicle charging, cooking, etc. The idea is that the system includes all elements that need to be considered to enable the efficient management of a property's electricity system.

This project will not directly include an analysis of the interaction with the upstream elements of the energy system such as generation, transmission and distribution or investigate how operational decisions taken at a local area level (such as demand aggregation, higher level sequencing of demand, etc.) could affect the home energy system. These aspects are covered in other work being undertaken by ETI. It will, however, be important to have these constraints and opportunities in mind

when carrying out the investigative work in the latter part of stage 2 of this project and to consider the impact of these elements on the possible relationships between the customer and energy supplier when investigating the operation of the systems.

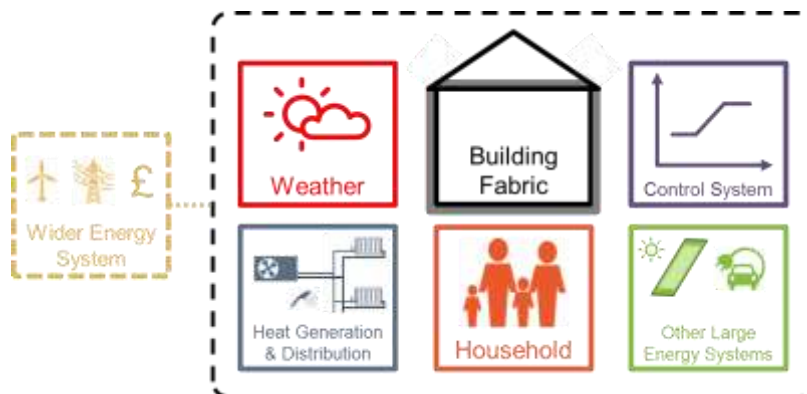


Figure 1: Elements contained in the system boundary and the external wider energy system which should be considered

In order for the stage 2 modelling activity to deliver the expected insight, there are some key requirements placed on the modelling environment used to carry out the modelling work. The modelling environment must be capable of dynamically representing the elements shown in figure 1 and considering the interaction between them.

The granularity of the outputs of the modelling work is expected to range from total annual energy use over a year to the time taken to heat a given room on an example coldest day. Therefore, the model must be capable of running at both levels of detail.

### 3.1 Stage 2 Detailed Technical Scope

ETI will walk through and review the stage 1 outputs with the modelling partner at the outset of stage 2. These outputs are expected to be:

- A definition of the modelling outputs required to evaluate the performance of the systems to be modelled. This is likely to include a range of financial, technical and consumer related variables (eg. energy cost, internal temperature profiles on example day, percentage of year comfort requirement met, etc.)
- Details of the factors to be considered within the model when evaluating the performance of the systems and the level to which they need to be defined. (e.g. To what level of detail do we need to represent the building, the people, etc.)
- A detailed set of scenarios to be investigated including system designs, property data, consumer scenarios, etc.

This will allow the modelling partner to familiarise themselves with ETI's modelling requirements and expectations. They may also suggest improvements/alterations/additions to the outputs.

Using the outputs produced during stage 1, the modelling partner will be required to create the model within a modelling environment(s) and populate it with the required data. They will then run the model covering the full range of scenarios defined during stage 1. This will initially consist of a verification run followed by a technical review with ETI before the full range of scenarios are run.

In parallel, ETI will analyse the modelling results provided by the modelling partner in order to develop additional investigations to be carried out using the model. Working closely with the modelling partner, the ETI will develop and prepare all necessary detail and data for the additional scenarios. The modelling partner will be required to customise and configure the existing model and run these.

The ETI may review the modelling results and additional scenarios with industry and other stakeholders as necessary.

The modelling partner will be required to deliver the following outputs (not exhaustive) for Stage 2:

- after the review of the stage 1 outputs, a proposal of the method of delivering the ETI's requirements, i.e. tool(s)/environment(s) to be used, output formats, input requirements, etc.;
- the modelling tool(s)/environment(s) that have been customised, configured and populated with data based on the outputs developed in stage 1 of this project, the resulting model of which is capable of delivering the ETI modelling outputs;
- resource and capability to customise, configure, populate and operate the model in the timescales as set out in this EoI to run the full set of scenarios developed by ETI during stage 1 and in any subsequent stage 2 developments as described above;
- all modelling results (throughout stage 2) to be provided to ETI in a format to be agreed and within timescales set out in this EoI;
- support in the analysis of the modelling outputs to determine the appropriate additional scenarios to be run;
- support in the development and preparation of all detail and data of the additional scenarios (e.g. feasible technology developments, alternative holistic system control strategies/ algorithms, other system interventions, etc.);
- review and comment on outputs that ETI will have produced during stage 1;
- review and comment on outputs that ETI will have produced during stage 2; and
- attendance at ETI meetings / workshops at ETI and other stakeholder offices.

#### 4 TIMESCALES

It is envisaged that stage one of this project will have an approximate duration of 4-5 months, commencing July 2015. The second stage is expected to complete mid Q2 2016. The third stage will commence towards the end of the second stage and is likely to take several months to complete.

#### 5 PROCUREMENT

The ETI is now seeking a dynamic modelling capability, to support delivery of initially **stage 2** of this project, who will provide specialist consultancy support as required. It is expected that the modelling partner will enter into ETI's consultancy agreement allowing the ETI to procure their time during stage 2 as required. The consultancy agreement may be extended to cover stage 3 of this project and possibly beyond to provide ETI with an ongoing modelling capability if deemed appropriate and agreed by both parties.

ETI requirements will be provided to the modelling partner in the form of a Tasking Order. This order will be agreed with the modelling partner and will state the ETI requirement (from the list of outputs that are likely to be required from the modelling partner described in section 3.1 above), timescale in which the modelling partner should complete the work, acceptance criteria to be used by ETI to sign off the completed work and total fixed cost to complete the work using the modelling partner's rates. It is envisaged that completion of ETI requirements can be undertaken at the modelling partner's office (unless otherwise agreed).

##### 5.1 Selection

Organisations wishing to participate in delivering the work described in Stage 2 of this project should submit an EOI. Our criteria for selecting an organisation will be:

- experience of and ability to define, customise, configure and operate modelling tools/environments (e.g. EnergyPlus, Matlab/Simulink, Dymola);

- organisations who can show a route to transferring any model(s) and code developed during the project to the ETI for future internal use with consideration given to proposed costs, IP rights and terms, and level of expertise required to use the model(s);
- experience of and ability to create complex modelling scenarios that include building physics, heating system dynamics, control system dynamics and the consumer's behaviour and needs;
- practical experience on developing building models, and can demonstrate complex thermodynamic analysis with building models in previous projects;
- has a good understanding of the range of domestic heating technologies required, including performance characteristics;
- ability to make sensible, evidence based assumptions for parameters where there is a paucity of data available;
- understanding of interaction with control systems and other domestic loads; and
- day rates and value for money.

If you believe you can contribute expertise to stage 2 of this project, please complete and return the form at Section 6 below.

**Responses must be received, using the form at Section 6, by e-mail to [marc.brown@eti.co.uk](mailto:marc.brown@eti.co.uk) and [stuart.mckinnon@eti.co.uk](mailto:stuart.mckinnon@eti.co.uk) no later than 16:00 on Tuesday 8<sup>th</sup> September 2015. You may be required to present your response to an ETI panel w/c 14<sup>th</sup> or 21<sup>st</sup> September 2015 at our Birmingham office.**

## 6 Response Form

<b>Outline Response</b> <i>Responses must be received, using this form, by e-mail in Microsoft Word and PDF formats to <a href="mailto:marc.brown@eti.co.uk">marc.brown@eti.co.uk</a> and <a href="mailto:stuart.mckinnon@eti.co.uk">stuart.mckinnon@eti.co.uk</a> no later than 16:00 on 8<sup>th</sup> September 2015.</i>	
<i>In no more than 3000 words please complete the following sections:</i>	
<b>Details of organisation</b>	
Full Organisation Name, Registered Address and Number (if applicable):	
Contact Details (name, job title, mailing address, e-mail address, phone number):	
Type of Business (sole trader, limited company, partnership, etc):	
<b>1. Summary:</b> Summarise your organisation and its <b><u>relevance</u></b> to the modelling partner role described above.	
<b>1a:</b> Why is your organisation interested in participating in stage 2 of this project:	
<b>2. Contribution:</b> Describe in detail how your organisation would deliver the scope as detailed in section 3.1 above. Please include an organogram (attach the organogram separately to this response form) showing the individuals who would form part of your project team. Please also outline a brief resume of each individual, their skill set and experience. Please also explain why you feel this skill set is necessary (resumes may also be attached separately).	
<b>2a:</b> Please confirm availability and stability of the project team you have set out in answer to question 2 above to mobilise sufficiently and for sufficient duration for stage 2 of this project and possibly beyond.	
<b>3. Expertise &amp; Experience:</b> Outline your organisations significant current or recent experience (and expertise and capabilities developed) relevant to the modelling partner role described above. <b><u>Your answer should demonstrate where possible evidence of the criteria set out in section 5.1 above.</u></b>	
Project description, location, outline scope and summary of the nominated modelling partner's specific role.	Start / End Dates

<p><b>4. Specific background knowledge / intellectual property:</b> Please define any specific background knowledge or intellectual property you would expect to bring into stage 2 of the project and how this may support delivery of stage 2. Please also outline any IP terms, rights, costs should ETI use the modelling tool(s)/environment(s) after the project (see question 5 below).</p>	
<p><b>5. Transfer of modelling tool/environment to ETI:</b> Although a degree of customisation and configuration may be required, modelling tools are already available which can be used to do this kind of work. This activity is about using existing tools to build a capability to address certain kinds of questions rather than about writing a new tool. On this basis please outline how the modelling tool(s)/environment(s) could be transferred to ETI at some point towards the end of this project highlighting possible costs, skills required to use, IP considerations/implications of such a transfer.</p>	
<p><b>6. Risks:</b> Please provide a list of potential project risks and your proposed mitigation paths.</p>	
<p><b>7. Day rates:</b> Please provide your consultancy day rates for your project team.</p>	
Grade	Day rate (£) <sup>1</sup>
Other costs	£

For the avoidance of doubt, this EoI and any Response shall not constitute an offer and or an actual or implied agreement between the ETI and respondents to the EoI. Project work is entirely dependent upon the ETI and a selected party (following a selection process) mutually agreeing terms and co

<sup>1</sup> Note – these rates and other costs will enable ETI and the modelling partner to agree a fixed cost for project deliverables.