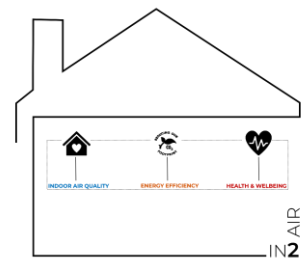


## In2Air

The impact of 'net-zero' household energy intervention on indoor air quality, occupant self-reported general health and wellbeing, and household energy use.

PHR Project: NIHR153617



### **Auditing and monitoring domestic energy consumption**

Acquisition of accurate energy data underpins all carbon reporting and will be used to support Newcastle City Council establish a protocol for energy monitoring to create evidence-based net zero strategies.

#### **1) Level 1 Energy Audit**

Before embarking on implementing building energy efficiency measures, it is important to establish a baseline of the current building performance and where it stands with respect to current standards, so that measurement and verification of proposed interventions are attainable. The American Society of Heating, Refrigeration and Air-Conditioning Engineers (ASHRAE) has developed guidelines for energy audits and categorised them into: Level 1, 2 and 3.

The In2Air baseline data collection study will conduct a Level 1 Energy Audit on all homes in the study that involves a basic walk-through assessment, analysis, and review of utility bills over the preceding 12-month period and other operating data, as well as a short survey with occupants (e.g. hours of occupation, times and periods of use of heating, lighting, domestic hot water, etc; for survey questions see SI-3). Monthly utility bills (electricity and gas), collected from the surveyed homes for up to the previous 12-month period, will enable us to understand energy use patterns, tariff structure, etc. before any interventions.

This basic evaluation is designed to identify energy efficiency problems and understand the current building performance. Data collected will be analysed to create a profile for the selected archetypes and establish baseline energy consumption pre-intervention.

#### **2) Energy monitoring**

In at least two representative homes, domestic energy monitoring will commence 1-3 months prior to the retrofit and continue for a minimum of 12-months. This will allow us to account for seasonal variations, normalise the energy data and, in future work, to compare energy consumption, before and after intervention, for similar months. Information from the Level 1 energy audit will be used to support interpretation of the energy monitoring data.

#### **Electricity**

We will measure and visualise the energy usage at a granular circuit level, in real time using a non-invasive cloud-based analytic platform using eMeter which will be installed on the main switchboard. The eMeter technology has been selected for simple installation and integration with household equipment and systems.

The eMeter platform will show where and how the households consume energy and identify how energy efficient the buildings are in real time. We will plot hourly, daily and monthly profiles. Any atypical events within the data will also be identified. This level of energy use measurement will enable us to identify baseline consumption patterns and in follow-on work will simplify the measurement and verification of energy savings due to the retrofit.

The eMeter platform allows detailed energy use analytics to be accessed and downloaded by the researcher. Such detailed insight into consumption patterns at circuit and device level will

identify energy efficiency opportunities and later on verify the success of the intervention implemented.

### **Gas**

At the study site, groups of four bungalows share a mains gas meter. Individual homes have recently had a heat meter installed which enables gas consumption monitoring at each property. Data from the heat meter is transmitted through the data loggers, managed by a third-party company and directly reported to Your Homes Newcastle. These data will be analysed data to understand the pattern of gas use and establish a baseline gas consumption.

Energy Audit Template

**Building general data**

|                                                              |                                                          |
|--------------------------------------------------------------|----------------------------------------------------------|
| Building Architype                                           |                                                          |
| Address                                                      |                                                          |
| Date of Energy Audit                                         |                                                          |
| UPRN (unique property reference number)                      |                                                          |
| Gross floor area                                             |                                                          |
| Number of stories                                            | N/A                                                      |
| Building Age                                                 |                                                          |
| Energy consumption per m2                                    | [to be calculated as part of the data analysis]          |
| Number of occupants                                          | [obtained from survey data]                              |
| Typical Hours of occupation per week                         | [to be calculated as part of the data analysis]          |
| <b>Start of baseline monitoring date:</b>                    |                                                          |
| Gas MPAN (Meter Point Administration Number)                 | Include digital photography of the meter and the reading |
| Gas Meter reading at start of monitoring (to the block of 4) |                                                          |
| Property heat meter reading at start of monitoring           | Include digital photography of the meter and the reading |
| Electric MPAN (Meter Point Administration Number)            | Include digital photography of the meter and the reading |
| Electricity meter reading at start of monitoring             |                                                          |

Energy Audit Template

| <b>End of baseline monitoring date:</b>                    |                                                          |
|------------------------------------------------------------|----------------------------------------------------------|
| Gas Meter reading at end of monitoring (to the block of 4) | Include digital photography of the meter and the reading |
| Property heat meter reading at end of monitoring           | Include digital photography of the meter and the reading |
| Electricity meter reading at end of monitoring             | Include digital photography of the meter and the reading |

Energy Audit Template

**Building Characteristics**

|                                                                                         |                                                                                                    |
|-----------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------|
| Building structure                                                                      |                                                                                                    |
| External wall cladding                                                                  |                                                                                                    |
| Roof Cladding                                                                           |                                                                                                    |
| Wall insulation                                                                         |                                                                                                    |
| Roof/Loft Insulation [type(s)]                                                          |                                                                                                    |
| Roof/Loft Insulation [type(s)]                                                          | Very minimal; Minimal; Acceptable (recommended amount); Good (above recommended amount); Very good |
| Floor Insulation                                                                        |                                                                                                    |
| Externals Windows (No.)                                                                 |                                                                                                    |
| Externals Windows (type)                                                                |                                                                                                    |
| External Doors (No.)                                                                    |                                                                                                    |
| External Doors (type)                                                                   |                                                                                                    |
| EPC                                                                                     |                                                                                                    |
| <b>Details of ventilation</b>                                                           |                                                                                                    |
| Details of any passive (trickle) ventilation<br>(and their status – in use/covered etc) | e.g. window trickle vents, air bricks, roof vents                                                  |
| Details of any continuous ventilation<br>(and their status – in use/covered etc)        |                                                                                                    |
| Extractor fan(s) in kitchen<br>(if present:                                             |                                                                                                    |

Energy Audit Template

|                                                                                                                                                               |  |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------|--|
| <p>detail location(s) (above hob etc),<br/>Extraction to outside or recirculation,<br/>Maintenance status.</p>                                                |  |
| <p>Extractor fan in bathroom<br/>(if present:<br/>detail location(s) (in ceiling etc),<br/>Extraction to outside or recirculation,<br/>Maintenance status</p> |  |
| <p>Tumble drier<br/>(if present:<br/>detail location (in kitchen etc),<br/>Extraction (none, to outside,<br/>condensing type)</p>                             |  |







**Supplementary information**

| Area No | Description | Notes and observation                                                                                                                                                                                                                                                       |
|---------|-------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|         |             | e.g is water heated by gas but with an electric shower                                                                                                                                                                                                                      |
|         |             | Note: we are not capturing detailed info on individual light fittings and type but if significant lighting in property this should be captured here (e.g. may be useful to consider over the December monitoring period if the property is exceptionally well illuminated!) |
|         |             |                                                                                                                                                                                                                                                                             |
|         |             |                                                                                                                                                                                                                                                                             |
|         |             |                                                                                                                                                                                                                                                                             |
|         |             |                                                                                                                                                                                                                                                                             |
|         |             |                                                                                                                                                                                                                                                                             |
|         |             |                                                                                                                                                                                                                                                                             |
|         |             |                                                                                                                                                                                                                                                                             |