



REfurbishment as Manufacturing Industry REMI Project

24 May 2016

REMI - Outline performance and technical specifications

WP2.2 - WP3.1 Deliverable

Introduction

The concept of deep retrofit is not new. The main considerations are around specifications, cost, time and inconvenience to the occupant.

However, when considering the advantages of pre manufactured elemental components and the enhanced quality this would bring, as well as the ability to reduce time and cost on site and ultimately reduce inconvenience to the occupants, a much improved experience and higher quality outcomes can be predicted.

An outcome-based performance specification takes on a new approach based not around the choice of materials or products that can enhance or improve the existing structure or fabric, but one based on building performance standards (e.g. guaranteed energy and indoor air quality performance) combined with a whole-house refurbishment approach. This allows for a long term product warranty and is likely to result in an over-cladding of the existing structure - in essence, building a new house over the existing one.

The existing fabric can therefore be discounted when designing and predicting the thermal performance of the refurbishment, with any insulation contribution provided by the existing fabric only improving the outcome of the finished “retrofit wrap”. But it’s the baseline “wrap” specification that is critical.

From a solution provider perspective the approach we would take would be to base the “wrap” design and technical specifications on an equivalent new build:

- The fabric performance / U-values potentially for all elements, thus reducing heating demand and consequently gas consumption;
- PV to generate electricity;
- Energy planning.

Considering how these could be delivered in a refurbishment solution.

Using the Fabric First approach, the envelope must be designed using detailed energy performance assessment software (i.e. dynamic energy modelling, IES, SAP2012, etc.) to predict regulated annual energy consumption figures for the following:

- Heating;
- Domestic hot water;
- Lighting;

- Ventilation.

We also need to estimate energy requirements for cooking and appliances. Various benchmarks are available including figures used by BRE, Passivhaus and proposed for use by the Innovate UK Building Performance Evaluation programme and of course the figures used in the Dutch Energiesprong model. In addition to the annual consumption figures, calculate the peak heating load requirement.

Once peak load and annual consumption figures have been determined, we have to consider ways of meeting these demands and possibly consider alternative fuel sources and technologies.

- **Heating**
Consider the existing specification and ways this can be improved within the constraints of the current design to lower annual and peak load consumption. Increasing regulatory requirements to have gas safe approved staff to disconnect and reconnect appliances.
- **Domestic hot water**
Consider practical ways in which domestic hot water consumption could be lowered. In UK culture baths need to be retained post refurbishment. However showers over baths will be provided. Consider electric heated showers.
- **Lighting**
Calculate the energy consumption based on LED lighting and cross reference to the SAP lighting assumptions.
- **Ventilation**
Look at all forms of ventilation and calculate both the peak load and annual consumption figures to achieve the desired performance related to air quality (CO₂, humidity).
- Appliances / Cooking.

This research can be split into three main objectives as follows.

Performance Specification (Customer's perspective)

Before a technical specification is created, a baseline performance specification is needed. From the customer's perspective this covers aspects of cost, comfort, convenience etc. However, in order to establish what an achievable performance specification would be, it is helpful, to look at a design energy consumption limit per square metre of floor area of an equivalent robust new-build dwelling. This will give flexibility in house designs/sizes of accommodation.

Typical figures for a 5 person dwelling are reported below. This should cover a number of elements:

- **Cost**
 - Maximum target annual dwelling running cost of £600.00.
 - No additional maintenance cost to property owner for elements included in the solution, the duration of the energy plan.
- **Comfort (wellbeing)**
 - Internal temperature for heating - guaranteed 21°C for living areas (i.e. kitchen, living room); 18°C for bedrooms;

- Summer overheating criterion – no more than 1% of annual occupied hours over a comfort temperature of 28°C (living areas) and 26°C (bedrooms) (NHBC Foundation, NF 46, Overheating in new homes, 2012) ;
 - Indoor Air Quality - CO₂ levels between 800 to 1000ppm (CIBSE Guide B, 2005) used an indicator of adequate IAQ;
 - Humidity – between 40 and 60% for good IAQ;
 - Noise Levels - Minimum 43db (Airborne sound insulation) for separating walls;
 - Maximum volume of domestic hot water – approx. 30 litres per day per person delivered by hot water storage and/or electric shower at 55°C or approx. 40 litres at 40°C (corresponding to 1800kWh/yr, total energy consumption);
 - Daylighting – Daylight factor between 2 and 5 (CIBSE Lighting Guide 10);
 - Secured by design principles to PAS24 Standard.
- **Aesthetics**
 - Planning/kerb appeal and local integration into the vernacular;
 - External appearance to be maintained for 30 years;
 - Engagement of the customer in the project design and choices;
 - Tolerant to the effects of climate change.
- **Time on site**
 - Delivery of the work within 10 working days;
 - Tenant in situ.
- **Tenant support**
 - Engagement in the process (familiarisation with the concept);
 - Post occupancy support;
 - Protection of personal/operational data.
- **Social Value**
 - Corporate and social responsibly.
 - Social economic return on investment, i.e. regeneration of the area.

Technical Specification (Solution provider response to performance specification)

The provider of the refurbishment solution will then need to consider the technical specification that will deliver the performance solution set by the customer. There will not be a single technical specification that will achieve this and different solution providers may choose to fulfil the performance specification through different approaches. This section therefore describes one way in which this could be achieved.

To this regard, first some general concepts for a better understanding of a house energy performance are reported. The energy performance of a house consists of three parts as follows:

- *Building-bound use.* This is the energy needed for space heating and cooling, water heating, ventilation and auxiliary energy (the energy required to operate building-bound energy installations) of the house – in the UK this is synonymous with the regulated energy (excluding lighting). At a living room temperature of an average 20-22°C and a healthy indoor environment (including ventilation), the regulated energy requirements depend largely on the performance of the property and the external conditions. A typical maximum building-bound use is between 3,000 and 4,000 kWh per house per year.
- *User-bound use.* This is the energy consumed by the user for lighting the house, cooking and household electrical appliances – unregulated energy. A standard family has a user-related energy consumption of between 2,500 and 4,000 kWh.

- *Generation.* For net zero operation, the local generation of energy, for example by means of PV panels, should be sufficient to cover the maximum building and user-bound energy consumption.

Experience tells us that in order to achieve these set parameters, the main building fabric should be designed to an elemental U-value of approx. $0.18\text{W/m}^2\text{K}$. Under building regulations in the UK there are specific performance requirements for refurbished elements, however we are hoping to push the performance up to a new build level based on the technical specification reported below. They can be used as key performance indicators to manage the expectations of the project and provide more certainty and confidence in the model.

In view of the performance guarantee, designing the solution, the solution provider may consider trade-off between more expensive longer lasting options.

- **Performance Assurance**
 - Energy performance to be guaranteed for 30 years after refurbishment – this could be achieved by a combination of long lasting components and systems coupled with lower maintenance and replacement intervention or by lower capital cost components and systems that need to be replaced more frequently.
 - Quality of environment - indoor climate standards, as based on the performance specifications, guaranteed for a period of 30 years.
 - The supplier guarantees the complete performance specification with relevant elements guaranteed for a standard for a period of 30 years.
- **Fabric performance**
 - Floor $0.18\text{ W/m}^2\text{K}$ (where constructional upgrades allow);
 - Roofs $0.11\text{ W/m}^2\text{K}$;
 - Windows $1.5\text{ W/m}^2\text{K}$;
 - Doors $1.4\text{ W/m}^2\text{K}$;
- Air tightness – less than $5\text{ m}^3/\text{hr}/\text{m}^2$ at 50 Pa (minimum allowable standard is $10\text{ m}^3/\text{hr}/\text{m}^2$ at 50 Pa).
- **Energy performance requirements**
 - Maximum design annual space heating demand of $30\text{ kWh}/\text{m}^2$;
 - Maximum design annual DHW demand of $25\text{ kWh}/\text{m}^2$;
 - Maximum design annual appliances/lighting/cooking demand of $45\text{ kWh}/\text{m}^2$.
- Ongoing monitoring to verify actual building performance and identify disagreements with the expected performance. Monitoring devices to be installed and maintained at the supplier cost. Systems in place to highlight potential issues and implement rectification/repair or alert if due to occupant behaviour.
- **Time on site**
 - Solution provider to complete the refurbishment within 10 working days on site.
 - Tenant support throughout the process and in their refurbished dwelling – especially w.r.t. operation of new systems, impact of behaviour on energy use. Must be done sensitively – not ‘big brother’.
- **Design Quality**

- Tenant satisfaction also critical to achieve product buy-in (e.g. quality, kerb appeal, design uplift);
- Optimise building quality design to meet customers' satisfaction (e.g. aesthetic);
- Good quality design as key aspect of sustainable development.

- **Social Value**
 - Corporate and social responsibly;
 - Socio-economic return on investment.

- **Added value**
 - Engage with a property MOT, reduce reactive maintenance costs at source;
 - Customer Service process.

Summary

This is not just about refurbishment; this is about an engineered product solution based upon the capabilities of the manufacturing industry that delivers a more predictable solution.

This is as much about guaranteed performance through design as it is about improvement of existing stock.

The outcomes of this method are as important as the technical approach and so it is about a fully integrated approach and not just one of specification and site delivery. This is a holistic, long term, assured delivery method offering predictability to owner, user and investor.