Housing Upgrades: Quality Assurance, Calculation Methods, and Future Factory Blueprint.

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Smart Renovation Factory by INDU-ZERO

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1. Quality Assurance

Monitoring studies on a large number of retrofit projects were carried out in the UK under the Government's 'Retrofit for the Future' programme and the lessons learned published [1]. A principal lesson was that retrofit standards "such as Passivhaus EnerPHit provide a clear assessment method and standard for design and workmanship. They can also improve decision-making as they have checks and balances built into their assessment procedure."

Key elements to be achieved in successful retrofit, based on current knowledge base (Passivhaus and others) include:

- High insulation standard.
- High internal surface temperatures through thermal bridge mitigation at all junctions in the construction, point and repeating thermal bridges including ground and services junctions.
- Low construction air leakage and managed moisture permeability to avoid surface and interstitial condensation and cold air infiltration and draughts. Achieved through attention to construction details and continuous air barrier on inside of construction including around services plus checking with blower door test.
- Elimination of thermal bypass through attention to detail in construction, avoidance of short circuiting air spaces including cavities, sub floors and chimneys, and provision of sufficient wind barrier outside of permeable insulation.
- High internal surface temperatures at windows including spacer and frame plus junctions. Air seals at window openings sufficient to meet airtight construction criteria.
- Overheating mitigation measures to ensure summer comfort.
- Ventilation sufficient to deliver sufficient air quality (filters, flow rates, design intake / exhaust).
- Ventilation system heat recovery, fan power, noise levels and controls (including summer bypass) sufficient to ensure high performance.
- Ventilation system plus intake and exhaust ducts etc. must be sufficiently insulated and have moisture barriers to avoid heat loss and condensation.
- Consideration of adjoining spaces and party walls and other building elements.
- Heating and hot water services need to be well designed to meet requirements across the range of operational conditions without compromising thermal integrity and meet comfort (e.g. delivery temperatures, avoidance of overheating, acceptable noise levels, accessibility for maintenance and control etc.) and hygiene requirements (legionella) etc.

The INDU-Zero project must ensure that technical risks are captured within the upgrade process (see earlier report) and addressed in some way in the future factory blueprint.

It would seem appropriate to leverage existing EU-wide knowledge base as a starting point within the INDU-Zero project. The Passivhaus approach has been supported by projects across the EU since the 1998 ‘Cost Effective Passive House as EU Standard’ (CEPHEUS) monitoring study [2]. Passivhaus design and certification process is based on the ‘Passive House Planning Package’ (PHPP) calculation method. This is limited in resolution as it is based on the ISO CEN 13790 monthly calculation method and requires more detailed simulation to be used for key inputs such as thermal bridges and room by room IEQ [3].

In INDU-Zero the alignment of the ‘Net Zero at the meter’ goal with a standard such as EnerPHit is an open point for discussion. EnerPHit has supporting documentation on many of the above risks.

The PHPP could be useful as a vehicle to capture standardized input datasets for example dwellings to be retrofitted in INDU-Zero. This data could then be used as the starting point for higher resolution models that will underpin the future factory blueprint.

2. Future Factory Blueprint / Integrated Dynamic Simulation

For the future factory blueprint a high resolution and integrated dynamic simulation method will be developed to take forward the industry methods. (ESRU will utilise the ESP-r program [4])

The automated and integrated approach will be compatible with both BIM and Factory Automation. The approach will be to construct high resolution models of existing house and upgrade option descriptions, carry out a performance appraisal utilising a simulation program for an appropriate range of weather conditions and user behaviors, output current and future energy and IEQ performance information to inform design decisions, and deliver final model descriptions in a digital form suitable for the construction of factory automation instructions.

3. References

[1] Retrofit for the Future final report.

[2] EU CEPHEUS project https://www.eceee.org/static/media/uploads/site-2/library/conference_proceedings/eceee_Summer_Studies/2003c/Panel_2/2047schnieders/paper.pdf

[3] PHPP 2009 Manual. Passivhaus Institut.

[4] Clarke J A (2001) Energy Simulation in Building Design (2nd Edn), London: Butterworth-Heinemann, ISBN 0 7506 5082 6..

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