Homes
of today
for tomorrow

Decarbonising Welsh Housing between 2020 and 2050

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Executive summary

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1. INTRODUCTION

In March 2018, Cardiff University were commissioned by Welsh Government's Homes and Places division to conduct Stage 1 of their Housing Decarbonisation programme, through the production of a scoping review. This piece of work was to identify 'what works' through a review of case studies (completed projects, mostly domestic retrofit but also new-build) and published literature (including industry publications, academic papers, advice for policy makers and other best practice).

The context is as follows:

1.1 **National and international legislation require that greenhouse gas emissions, specifically CO2, produced across Wales be reduced by at least 80% of 1990 levels, by 2050. Decarbonisation at this scale is a huge national challenge, but also provides opportunities, particularly in the context of the Wellbeing of Future Generations Act. The housing sector has a key part to play in achieving decarbonisation.**

1.2 A particular requirement of the scoping review was that all findings be supported by evidence of 'what works', with clear links to sources / references. A further requirement was that actions to decarbonise housing with potential to impact on fuel poverty, affordable warmth or climate resilience be identified.

1.3 A series of best practice case studies was collated. Literature pertaining to the case studies and to the research topic more generally was reviewed, with further sources obtained via a questionnaire survey (159 respondents). A discussion was then developed around key recurring themes, with a quick-reference system highlighting key actions and challenges along with 'timescale' and 'confidence'.

1.4 During Stage 1, interim findings were presented to the WG Housing Decarbonisation steering group, and to their Decarbonisation Advisory Group (DAG), composed of independent professional and academic advisers. Within these meetings, it was agreed that Stage 1 would include an online survey to collect perspectives and opinion from a wide range of stakeholders.

1.5 This report presents and discusses information collected during Stage 1, and makes recommendations for future stages. The report has been structured to make this discussion as transparent as possible. Case studies are included as appendix 01 and literature reviews as appendix 02. Survey results are embedded in the discussion. 'Headline' observations are described over the following four pages: *Understanding the challenge*, *strategic approaches*, *retrofit: a discussion* and *next steps*.

2.   UNDERSTANDING THE CHALLENGE

The UK government has committed to reduce emissions by at least 80% of 1990 levels by 2050, and contribute to limiting global temperature rise to as little as possible above 2°C. The Welsh Government has a legal duty in Part 2 of the Environment (Wales) Act 2016 to reduce carbon emissions in Wales by 80% by 2050, and Cabinet has agreed to set interim targets as follows: 27% reduction by 2020, 45% reduction by 2030, 67% reduction by 2040 (vs 1990 baseline levels). Key aspects of the challenge include:

2.1   Decarbonising electricity generation is a clear achievement of the last decade. However, progress in the *power* sector masks a failure to decarbonise other sectors, including *housing*. The UK is not on course to meet the legally binding fourth and fifth UK carbon budgets, and will not do so unless risks to the delivery of existing policies are reduced significantly and new policies go beyond achievements to date.

2.2   Housing is responsible for 29% of UK carbon emissions. In Wales the figure is 21%, reflecting the high level of emissions from industry in Wales, and increasing the challenge of meeting carbon budgets.

2.3   The make-up of the Welsh housing stock has been very stable for the last two decades, with a significant increase only in the private rented sector. Low rates of new and replacement housing (around 50% of the demand for new homes) mean that the existing housing stock will be in use for many years to come. More than 90% of today's stock is predicted to remain in use by 2050.

2.4   The Welsh housing stock is particularly old. One third of homes were built before 1919. Just 10% were built in the last 18 years (as of 2016), increasing energy demand for heating and reducing comfort. Despite energy efficiency initiatives, almost a quarter of households currently experience fuel poverty.

2.5   **Welsh housing consists of a range of different dwelling types, ages, physical forms and construction types, many of which have been modified over time to create a diverse stock of varying quality and condition. There is no single 'solution' for a housing stock that varies so significantly. However, a taxonomy of recurring dwelling *archetypes* should reveal appropriate pathways for improvement.**

2.6   It is technically possible to reduce emissions by 80% from baseline levels through changes to the housing stock, but this requires maximum uptake of technically viable actions, including some that presently do not have a financial return on investment over their lifetime. Cleaner energy supply is therefore part of any likely road map.

3. STRATEGIC APPROACHES

Key strategic observations arising from the case studies and literature reviewed as a whole:

3.1   There is a need for a **defined strategic approach** (in stakeholder survey, 50% of respondents considered *strategic changes* to be the 'most important'). To achieve best value, it is necessary to plan and implement retrofit actions holistically, with an understanding of implications in real terms.

3.2   Strategies should **support simple, low-cost options** to reduce emissions. (Withdrawal of incentives has reduced the installation of insulation to 5% of 2012 levels.) A focus only on short term costs is short-sighted, as the total cost of meeting future targets will be higher without these actions in place.

3.3   A strategic pathway must be informed by **clear priorities for the decarbonisation programme**. The UK Fuel Poverty Monitor and Scottish Decarbonisation Route Map both advocate fuel poverty as a key reason for retrofit. However, other reasons to target dwellings include the cost, effectiveness and value of retrofit actions, potential scales of implementation, and potential to impact on housing quality.

3.4   Strategies should **commit to effective regulation and strict enforcement.** Tougher standards can further reduce emissions while driving consumer demand, innovation, and cost reduction. Providing long line of sight to new regulations also reduces the overall economic costs of compliance.

3.5   Strategies should **end the chopping and changing of policy**, where policy is evidence-based. Cancellation of key programmes has led to industry uncertainty and therefore cost. Consistent policy provides clear signals to consumers & industry, and gives businesses confidence to build supply chains.

3.6   Stakeholders should **act now to keep long-term options open**. An 80% reduction in emissions implies new national energy infrastructure. While the systems to be implemented for 2050 have not yet been determined, Government must demonstrate commitment by supporting key emerging technologies.

3.7   One 80% reduction scenario* assumed that 95% of easy to treat homes and 70% of hard to treat homes are retrofitted with insulation, draught proofing and glazing by 2050. This suggests a challenging **increase in the pace of retrofit**, particularly in hard to treat homes. *Low Carbon Routemap, GCB 2013

3.8   The **performance gap** between predicted and delivered efficiency must be addressed, to improve cost effectiveness, reduce risk and give greater stakeholder confidence. **Occupant engagement** must also be addressed, as this can have a significant positive or negative impact on operational performance.
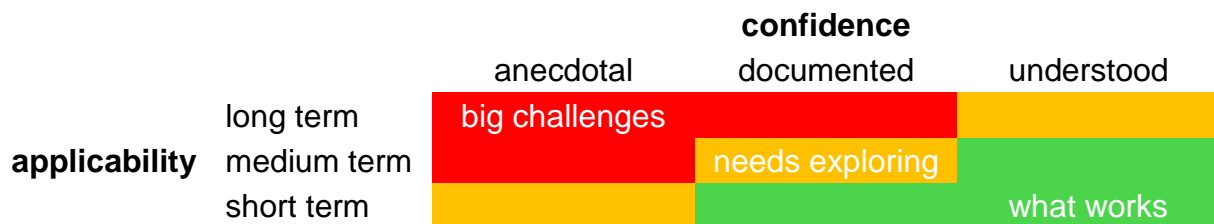
4. RETROFIT: A DISCUSSION

Much is already known about the implementation of individual retrofit actions, including technologies, but there is less clarity over the most effective combinations of actions. There is also conflicting evidence around the effectiveness of actions, which appears to be heavily influenced by occupant engagement, and a lack of confidence generally in the associated costs. The observations below were informed by the case studies:

4.1 Some case studies reduced carbon emissions by around 80% of benchmark levels (demonstrating technical feasibility), but capital costs for most were greater than £800/m^2. High costs are attributable to one-off / bespoke approaches, complex combinations of actions, and emerging technologies.

4.2 A sub group of more recent case studies reduced carbon emissions by between 50% and 80% of benchmark levels (1990), with capital costs between £300/m^2 and £400/m^2. These lower costs are a consequence of more targeted actions and better understood techniques / technologies.

4.3 Most case studies are one-off / bespoke. There is scope to reduce costs by understanding key actions better and benefitting from economies of scale. Importantly, wider benefits (e.g. affordable warmth, health) increase the value of decarbonisation, and potentially offset costs when considered holistically.

4.4 Different sectors of the housing stock require different levers to make retrofit happen. Tenure is likely to have a particularly big influence. Smaller, lower value owner-occupied dwellings are among the 'hardest to reach'. Off-grid owner occupied dwellings are currently among the 'hardest to treat'.

4.5 Wrap-around retrofit includes technical, legal and financial advice, and after-care for occupants, and post occupancy evaluation for further learning. The importance of this is consistently emphasised.

4.6 There are clear issues around supply chain (skills, resources) which require a coordinated response.

4.7 The housing stock is complex and varied, with no single 'solution'. Pathways that deliver on quality as well as emissions reduction are likely to address both building fabric and energy/systems.

4.8 **Decarbonisation of energy (principally electricity) at point of supply reduces the degree to which retrofit must be used to improve *fabric* efficiency as part of a decarbonisation strategy, but misses opportunities to improve dwelling quality and could increase fuel costs / fuel poverty. Future work should target an holistic understanding of the implications of actions that focus on *fabric*, *systems* and *energy*.**

The report discusses an expansive list of retrofit actions under seven themes:

1 thinking strategically
- 1.1 taking advantage of funding 🟩
- 1.2 energy sources 🟥
- 1.3 change in primary energy supply 🟩
- 1.4 fabric first approach 🟩
- 1.5 development constraints 🟧
- 1.6 addressing overheating 🟧
- 1.7 standards beyond Building Regulations 🟩
- 1.8 void reductions 🟧

2 building fabric
- 2.1 spatial constraints 🟧
- 2.2 construction or condition not as expected 🟧
- 2.3 roof upgrade 🟩
- 2.4 wall upgrade 🟩
- 2.5 floor upgrade 🟩
- 2.6 windows 🟩
- 2.7 shading 🟥
- 2.8 air tightness 🟩

3 renewables
- 3.1 Heat recovery 🟩
- 3.2 Combined Heat and Power (CHP) 🟧
- 3.3 Photovoltaics (PV) 🟩
- 3.4 Electric battery 🟧
- 3.5 Wind 🟧
- 3.6 Solar Thermal 🟩
- 3.7 Transpired solar collectors 🟧

4 services
- 4.1 gas 🟩
- 4.2 oil 🟧
- 4.3 biomass 🟧
- 4.4 heat pumps 🟧
- 4.5 radiant heat 🟩
- 4.6 underfloor 🟧
- 4.7 storage 🟧
- 4.8 ventilation 🟧
- 4.9 district heat networks 🟥

5 financial
- 5.1 availability of finance 🟧
- 5.2 high cost of actions 🟧
- 5.3 unexpected costs 🟧
- 5.4 payback periods 🟧
- 5.5 maintenance costs 🟧
- 5.6 locked-in investment 🟧

6 supply c.
- 6.1 Knowledge - good advice / emerging tech. 🟧
- 6.2 Materials and products- perf. and availability 🟧
- 6.3 skills- workforce and capacity 🟩
- 6.4 skills – training and apprenticeship 🟧

7 people
- 7.1 occupant engagement 🟩
- 7.2 occupants stay put 🟧
- 7.3 simple controls 🟩
- 7.4 smart meters and homes 🟥
- 7.5 entrenched behaviour 🟩
- 7.6 health issues 🟧
- 7.7 influencing lifestyle 🟥

Retrofit actions are categorised using the following RAG assessment:

		confidence		
		anecdotal	documented	understood
applicability	long term	big challenges	big challenges	
	medium term		needs exploring	
	short term		what works	what works

5. NEXT STEPS

5.1 Welsh Government should decide on the decarbonisation programme's priorities (e.g. an exclusive focus on emissions versus a combined focus on affordable warmth / fuel poverty / quality of homes). Further work that delivers an holistic understanding of options should be used to inform decision-making (see Retrofit, point 4.8).

5.2 **A clear next step should be the application of Stage 1 knowledge to the specifics of the existing Welsh housing stock, beginning with the creation of a taxonomy that represents the existing housing stock. This taxonomy should break the housing stock down into recurrent dwelling *archetypes* using a big dataset.** (e.g. EPC dataset 2016, which was also used for the IWA *Re-energising Wales* study.)

5.3 Each dwelling *archetype* within the taxonomy should be interrogated and understood in detail, using a finer grain dataset e.g. the emerging Welsh House Condition Survey (2018).

5.4 A road map for decarbonisation can be developed when Stage 1 knowledge is applied to this taxonomy.

5.5 The road map is likely to incorporate:

Goals–mapped from the Wellbeing of Future Generations (Wales) Act 2016.

Levers–to initiate decarbonisation.

Pathways–strategic combinations of actions designed to decarbonise.

Actions–individual measures designed to decarbonise.

Challenges–understanding barriers and limitations that reduce effectiveness of actions.

Targets –aspirations for the level of decarbonisation to be achieved.

5.6 Potential pathways should be identified for each dwelling archetype, giving due consideration to house condition and wider benefits (as reflected by the WFG Act). By identifying distinct pathways for different archetypes it is possible to reduce uncertainty and increase industry's capacity for delivering change.

5.7 Pathways are likely to be iterative and additive, with consecutive improvements between 2020 and 2050. The levers for delivering change will vary, and are likely to be heavily influenced by tenure.

5.8 Cost should be reported within future work. However, cost information must be forward thinking, not retrospective. It must consider future trends, economies of scale, supply needs and wider benefits.

5.9 To deliver best value in terms of decarbonisation and impact on dwelling quality, it may be necessary to vary the performance targets that are prescribed, based on dwelling location, type, tenure etc.

Point 5.6 - The WFGA goals can be used to holistically map the potential benefits of decarbonisation of the existing housing stock:

WFGA goal:	short term benefit:	medium term benefit:	long term benefit:	focus:
>80% carbon reduction	low embodied CO_2 locking in carbon	reduced carbon footprint potential for carbon negative	decarbonising communities meeting international targets	CO_2
Local / Wales supply chain	addressing cost and value local resource use	more affordable housing supporting Welsh suppy chain	affordability, local economy skills and community building	capital
greater climate resilience	robust, low maintenance changeable by the community	resilient to climate change acessible construction	adaptability and resilience reskilling and empowering	change
reduce burden on healthcare	natural resource use breathable construction	healthy internal environment reduced impact on environment	positive health benefits reduced strain on public services	health
affordable warmth for all	low embodied energy reduced heating bills	energy generation offsetting rental costs	affordable warmth for all energy positive homes	energy
community-led action	flexibility in layout constructable by end user	long life loose fit 'other' procurement pathways	meeting specific housing need flexible, high quality homes	space
improved placemaking	variety in form and materials suitability to different contexts	building strong neighbourhoods creating places with character	supporting people, communities and distinctive places	place

Point 5.7: Levers for delivering change will vary, and are likely to be informed by tenure. Pathways may deliver phased improvements between 2020 and 2050.