Good Homes Alliance says Code could be better

The Good Homes Alliance (GHA) understands the problems of introducing new codes . However, it has identified major teething problems regarding meeting the new Code for Sustainable Homes (CSH) ...

Problem 1. Electric v/s gas space heating

In all new dwellings it is much easier to achieve CSH levels 3 and 4 by using electric on-peak heating than by the more carbon efficient option of gas heating. The reason for the problem lies with the fuel factor used to calculate the target emissions rate (TER) which forms the basis for the reductions required for the dwellings emission rate (DER). The fuel factor was enshrined in the Building Regulations Part L 2006 and was a compromise position negotiated at that time and does not reflect the true carbon content of fuels. It is set at 1.47 for electric heating, compared to the base case of 1 for gas. As made clear by Communities and Local Government (CLG) recently, the fuel factors "purpose is to provide some relief in the target applicable to dwellings that are off the gas grid or in blocks of flats where a gas service to each apartment is not a preferred choice. The fuel factor means that if the chosen heating fuel is more carbon intensive than gas, the TER is increased (eased)" (*CLG: Building Regulations Energy Efficiency Requirements for New Dwellings, July 2007)*

However, what is somewhat surprising is the effect this has at higher levels of CSH. Many buildings, which achieve level 3 of the Code for Sustainable Homes using electric heating, will have greater CO_2 emissions than those same buildings with gas heating, at Building Regulations levels. In an example an electrically heated flat has 18% greater emissions at CSH level 3 than the same flat with gas built to 2006 Building Regulations. The GHA has even seen calculations for CSH level 4 electrically heated buildings which have greater CO_2 emissions than similar sized buildings designed to Building Regulation standards using gas.

Furthermore it appears that when using gas for heating, with certain compact building types, such as flats and terraced housing, it is actually not possible to reach CSH level 4 at all just through fabric improvements (such as very high levels of insulation and very low air permeability) with solar thermal hot water heating. However by swapping to electric on-peak, despite the higher carbon emissions, these buildings can make Code level 4. So where developers are obliged to achieve CSH level 4, they are likely to specify electric heating as the only practical, cost effective solution. The consequence of this for building fabric improvement, is that while at Building Regulations levels it seems that electrically heated buildings have to achieve a building shell at least as thermally efficient as if these were gas heated, at CSH levels 3 and above, electrically heated buildings can achieve the same CSH levels as gas heated buildings, with less thermally efficient fabric. This means that the building will always be less energy efficient than an equivalent gas heated building, whatever the energy source. As the cost and difficulty of retrofitting energy efficient thermal shells is significant, the UK is thereby losing a great opportunity to reduce emissions.

Problem 2. Large and small-scale buildings and efficient building forms

It is easier to achieve Building Regulations and CSH levels 1-4 if the building is bigger, and the building form is less efficient. Due to the % reduction scale, small and efficient building forms are penalised, and developers are driven to increasing inefficiency of building form. Furthermore, large houses in high value developments will meet high CSH levels more easily than smaller units in denser developments. This runs against the desire to push the high CSH standards in denser, lower cost housing, and means that efficient affordable housing will require expensive and complex renewables to meet high CSH levels, whereas expensive inefficient housing will not.

GHA suggestions

In order to address the two problems identified above, the CSH should:

1. Treat all fuels equally (i.e. based on carbon emissions) for levels 3 and above.
2. Use absolute energy use figures measured in kWh/m^2/year and absolute carbon emissions per year, measured in CO_2/m^2/year, possibly with some relation to occupation density.
3. Include a monitoring requirement for a fixed percentage of new homes, to test whether the designed performance is actually delivering the required CO_2 savings.

The two problems listed above are in addition to the more general concerns we have about certain aspects of the code, particularly the target of autonomous zero carbon new homes, the timescale for changes, and the unknown implications for air quality and human health.

Problem 3. The CSH water requirements

In the context of climate change, water is crucial both in terms of scarcity in dry years, and in terms of associated CO_2 emissions – mostly for heating it. This importance is reflected in the Code as water targets are compulsory and cannot be traded against other measures.

The core problems

The GHA are of the firm opinion that the water methodology requires urgent and major revision rather than incremental adjustment as has been occurring. However, here we can only touch the surface and new practical problems emerge almost every time an assessment is carried out. As with the 'energy' section of the Code, we understand this complexity to be inherent in the approach taken.

The calculated whole-household performance approach used by the Code was deliberately adopted after 'stakeholder consultation' in preference to performance standards for individual fittings. Ironically whilst the performance approach was probably seen as a soft option allowing a trade off between fittings, the reliance on the water calculation tends to force appliance water use values that that are far lower than any appliance standard would have ever been likely to enforce. For example whilst 1.7 litres/min spray taps for the kitchen sink are a logical step to meeting the Code it is unlikely that a proposal for kitchen taps with a flow rate less than 8 litres/min would have ever been accepted by any 'stakeholders'. This is particularly relevant in light of the Water Regulations revision and the Part G proposals for water efficiency in the Building Regulations.

The current CSH calculator:

1. Makes compliance impossible without installing fittings that will be unacceptable to most users. This will lead to disillusionment with sustainable technologies and is likely to create a market for retrofit high water use products. Luckily, fittings such as tap outlets and showerheads can be easily replaced and bath overflows can be blocked.
2. Is very complex and open to errors, confusion, interpretation and clever loopholes. There are an almost infinite number of solutions that can be modelled despite a finite number of functioning products.
3. Measures such as reduced deadlegs, leak detection, effective warning devices for float operated valves and leak free WC mechanisms gain no credit as they cannot be modelled.
4. Cannot account for user behaviour, yet behaviour change is required to deliver the required savings. In attempting to design out behaviour it drives down flow rates and bath volumes to unacceptable levels. Householders wanting or needing a normal size bath for occasional use will be penalised by the calculator.
5. It is based on the assumption of a linear correlation between flow rate and water use. This is not supported by evidence or intuition, particularly for kitchen taps. A points system based on this inevitably drives performance to the limit of acceptability.
6. Means that the higher levels of the code (3-6) require unacceptable performance (flow and volume) and typically reuse. Reuse is very questionable in practical, economic and environmental terms and, as will be shown, offers very limited savings and no guarantee of compliance.
7. Penalises bidets which are assumed to use more water even though they can be used to reduce showering frequency.
8. Rewards those who find clever loopholes and penalises sensible design that is not anticipated by the scoring system. Considerable effort goes into finding ways to score points rather than designing better, more sustainable buildings.
9. Averages out volumes and flows for all fittings in a building (e.g. if there are 3 baths the average volume is taken) whilst the proposal for Part G is to use the highest value. The averaging creates an anomaly in large houses where a higher score can be achieved by installing a large bath in the family bathroom and small baths (to lower the average bath volume!) in the other bathrooms even though showers should use less water. Additionally there is confusion in the industry about how bath volumes are specified.

Behaviour

The current goal of the Code is 80 litres/(person.day) based on the calculator. Even this target can be met in practice with efficient fittings and some care from users such as showering in preference to baths and turning off the tap when brushing teeth. Indeed with best practice fittings and a little care it is not difficult to get below 60 litres/(person.day). However as the Code assumes a fixed behaviour it can only demonstrate water saving by enforcing sub-optimal flow rates and volumes.

A few technologies have been able to demonstrate win-win improvements in efficiency and performance, for example the best examples of showerheads, white goods and WCs can all be shown to work better than some more water extravagant models. Such technologies promise to save water without behavioural change but they can't stop us spending 20 minutes in the shower, washing a single item of clothing or rinsing plates under a running tap. All technologies have a limit and to push too far will inevitably lead to poor performance.

It has been argued that the CSH cannot regulate behavioural change. However the water consumption targets of the Code cannot be guaranteed by technology alone and it is likely that Code compliance will actually promote behaviour that leads to higher levels of water consumption. For example one of the recognised ways to achieve code compliance is very low flow tap outlets of 1.7 litres/min. Such a spray is completely inadequate for anything other than a hand basin and so is likely to be removed. At best it will be replaced with something sensible but at worst it will simply be removed resulting in unregulated flow, and if we are to believe the CSH water calculator, extremely high water consumption.

The same argument applies to showers and again it is unlikely that disgruntled users will be looking for a water saver shower as a replacement. WCs are more difficult to modify for higher flush. The easiest way is to raise the water level but this increases the risk of wastage down the internal overflow. If performance is marginal then double flushing is a risk. Baths are also harder to modify but as most manufacturers are choosing to achieve low volumes by lowering the overflow there is always going to be the temptation to raise this or blank it off.

The other issue is where conscientious householders make an informed decision but are penalised by the fixed assumptions in the Code. For example there is no way to account for people whom mainly shower but enjoy an occasional soak in a standard depth bath. Similarly the installation of a bidet is assumed to use additional

water despite the lack of evidence for this and anecdotal evidence to the contrary. Where a sensible flow is provided at the kitchen tap to allow the filling of pans and washing up bowls, this will be penalised severely by the calculator although extra water use might not occur. Water use behaviour is not a simple case of flow rate multiplied by duration. It is function specific, so lowering the flow rate will not necessarily lead to a lower water use.

How low should we go?

Some measures only work at the individual household scale (energy efficiency, water fittings, drought tolerant planting) whilst others work far better at the national or regional level (energy generation, water supply, leak fixing, incentive based tariffs). Practitioners have long since recognised that achieving a zero fossil energy dwelling that meets modern comfort expectations is a very difficult and expensive challenge. A similar pattern can be observed for water. Although the potential savings are less compared with energy, the requirement for such drastic savings is also less since water is, up to a point, a naturally renewable resource.

Thus a crucial strategic decision is how low do we go at the building level? Practical and economic factors suggest opting for the most cost effective measures first and applying them widely to achieve the required global savings. It is important to stop short of measures that have a high environmental or opportunity cost. This has been the standard methodology as promoted by the Environment Agency, Ofwat, and Water Companies but the Code does not seem to follow this approach. Furthermore, the question needs to be asked as to whether a UK wide standard makes sense for water or should regional water stress lead to different requirements? Does Cumbria face the same challenges as the Thames Gateway?

Rain and greywater

It is generally recognised that the higher levels of the Code effectively force builders to add greywater or rainwater systems with associated diseconomies of scale in terms of economics, life cycle impact and effectiveness. Given the evidence, it seems very questionable to require water harvesting or reuse and yet some consultants suggest installing rainwater systems even at level 3 of the Code to allow a larger bath to be installed. Additionally rainwater reuse;

- does not reduce sewage volume (the reason given in the CSH for not allowing groundwater to count as non potable water)
- has a high opportunity cost (the money could be better spent on other measures)
- is not applicable to typical dwellings with small roofs
- is least effective in areas of low rainfall in dry years when savings are most needed
- requires ongoing repair and maintenance
- can waste a considerable amount of mains water if a valve or float switch jams
- uses more electricity than to treat and deliver mains water
- allows larger dwellings to fit larger baths or less efficient WCs leading to more water use in droughts.

Similar issues apply to greywater but analysis has focussed on rain as this is usually seen as the most promising technology. Since we have no way of guaranteeing a particular level of consumption based on a simplistic micro-component model and a large range of user behaviour, it is questionable whether we should even be setting a standard in terms of daily water use per person. A better approach which fits with the historic role of the Water Fittings Regulations, would perhaps be to set appropriate performance and efficiency standards for fittings and specifying proven techniques to guard against accidental wastage or 'undue consumption'. A tool such as the water calculator can still be used to illustrate the effect of changes including showering rather than bathing.

The CSH water calculation method

The CSH water calculator is based on a simple micro-component model that sums the product of capacity or flow, a use factor (e.g. minutes of use for a shower) and frequency of use per person per day. As it is a regulatory tool, frequency of use for all activities is fixed and is based on interpretation of the 180 page report 'Increasing the Value of Domestic Water use Data for Demand Management'. Whilst such models provide interesting what-if scenarios, there is little evidence of their value in predicting water saving let alone with the accuracy implied by the Code water calculation tool. A more accurate model would need to account for the correlation between fitting specifications such as bath capacity and shower maximum flow rate and measured water use. The data is simply not available for such predictions to be made. For example a very large bath may only be partially filled or rarely used because it feels extravagant or takes a long time to fill by combi boiler. Similarly shower flow rate might be set by user preference or the water-tightness of the shower cubicle rather than the maximum flow rate.

Similarly it seems very unlikely that kitchen tap water use is proportional to flow rate given the need to fill vessels and washing up bowls. Also a flow rate that is too low to fill the bowl quickly might lead to washing up being performed under a running tap. The tap prediction is particularly inaccurate as should be obvious from the worked examples in the full report. Interestingly EcoHomes simply assumed a 50% saving if some sort of water efficient tap was installed. Whilst even this may be too optimistic in terms of savings, it is likely to be a more accurate prediction and neatly avoids rewarding spray taps in the kitchen sink.

Possible solutions

Given the resources that have gone into developing the Current CSH water calculator it seems unreasonable to present a fully worked out alternative here but the following is offered as a starting point for discussion. Any system should;

- be evidence based
- encourage value-for money solutions in terms of water and energy saved
- avoid unintended paradoxical consequences
- reward good creative design rather than a tick box mentality
- avoid giving water saving a bad name, which the widespread installation of tiny baths or spray taps in kitchens will induce.

In focus: the CSH

Option 1. Preferred but previously rejected by 'stakeholders'. The current performance based system and calculations should be abandoned as there is no evidence to support the predictions or the effectiveness of the measures that are forced by it. The current Code encourages easily replaced fittings to be specified at minimum volumes in order to maximise bath and WC volumes. Also, known efficiency measures such as reduced dead legs, monitoring and leak detection, are difficult to model and so are ignored. Instead standards would be set for fittings performance. This option would be compatible with a revised Water Fittings Regulation and any point of sale regulation or labelling. These standards can be tightened in line with improved performance as technology advances. Points could be awarded for measures beyond the base case but with no incentives for solutions that save water at the expense of energy or other life cycle impacts. BREEAM for offices (1998) awarded points for measures such as leak detection, monitoring, extra water meters etc.

Option 2. Political compromise with inherent limitations. A political compromise would be to use an improved version of the EcoHomes calculation with its bracketed predictions and upper and lower limits to flow rates and bath volumes. The usage assumptions and/or predicted water targets would also need to change to avoid the need for poor performance or high environmental and financial cost measures (grey and rain). For example the bath to shower ratio could be reduced and a caveat added to state that the model assumes (say) one bath per week and 5 showers. BREEAM and EcoHomes used a simplified calculation matrix that assumed a 50% saving for water saving basin taps (flow regulators, aerators or auto shut off) and no saving for the kitchen tap other than if a dishwasher was installed.

Whilst the simpler EcoHomes calculation method shines by comparison there are still a number of issues that need to be addressed. WC use would probably be calculated in a standard micro-component way but with some grouping of equivalent flush volumes based on evidence. The number of steps should be reduced from the current 5 to perhaps 3.

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The GHA is proposing to its members a code level of 3++. This refers to CSH level 3 as a basic code aim, but with two additional requirements: The first plus is the requirement for a fixed maximum carbon target ($CO_2/m^2/yr$) and/or a fixed maximum energy target ($kWh/m^2/yr$) according to building type. These will ensure only the best solutions are chosen which will reduce energy and carbon in absolute terms. The second plus is the requirement to monitor homes post occupation for at least 2 years, to compare the designed with the actual performance. The GHA is also developing further social requirements that will enhance the community and personal well being of occupants.

The full reports including all references and worked examples based on thsese critiques are available from the GHA on request: www.goodhomes.org.uk

Insight

Dave Elliot

Micro power is not enough

The UK Green Building Council's (GBC) new report, 'The Definition of Zero Carbon', says that zero carbon houses should generate all their own energy - and not be allowed to top up with imported power from remote renewable energy generators. However, there could be some near-site generation, as long as that was 'additional' to the national renewable programme. But basically, like the Renewable Advisory Board, and it seems the government, they want no imports.

A new report on MIcrogeneration from Element Energy, backed by BERR and, amongst others, the Microgeneration Council, says the same thing, although it seems to compromise on heat pumps. It comments 'the level of support for micro-generation depends on the degree to which developers are allowed to offset their consumption using off-site electricity generation' and suggest a policy which 'prohibits off-site electricity, but perhaps allows electricity import for heat pumps' which it says 'should stimulate all microgeneration technologies'.

Meanwhile green energy retailer, Good Energy, has been arguing that houses should not be able to earn from exporting power. In a submission calling for a feed in tariff (FIT) for micro generation it says that 'the most efficient use of micro-generation is for it to be used on-site. If a customer maximises on-site usage, then they reduce their need for imported energy. When energy leaves the site, a percentage (approximately 10%) is lost as it travels on the network. FITs, based on export, could encourage microgenerators to export their energy, rather than use it on site. Encouraging export encourages inefficiency'.

However, surely it's vital, in order to make micropower economic, to pay properly for any excess exported power- and indeed to actually stimulate and enable the balancing, locally and if necessary nationally, of the supply and demand variations associated with each individual house? And if there is a shortfall, what's wrong with importing power from large efficient wind turbines in windy areas? Or wave farms, or tidal farms?

Of course to keep it 100% green would mean building a direct wire link to the remote site - as has been suggested for local off-site power. More realistically normal grid links could be used as a common carrier, as happens with green tariff services. After all the regulations simple say that the houses must be net zero carbon over the year, which presumably means they will have grid links and would be allowed to import when they can't generate enough themselves and export when/if they have excess, with the net balance being zero. Surely Good Energy can't object to that?

Obviously, if they are to import more than this, i.e. more than they produce over the year, then there would have to be tight regulations to ensure that developers set up firm contracts for matching electricity used by consumers with renewable power supplied by generators, with no backsliding or changes e.g. when new homeowners took over. And it will have to avoid double counting with the ROC's system.

This only applies to electricity. Hopefully the zero carbon houses will be built so well they wont need much extra heating apart from, say, solar collectors and perhaps biomass, along possibly with a heat pump. But as Element Energy realized, they will need electricity for the latter, and of course, for all the other domestic gadgets. Trying to get it all 100% 24/7 from on-site micropower seems hard, perhaps foolish and maybe even impossible.

Micro-wind seems unlikely to be up to it in most urban areas. PV solar has come a long way- there is now nearly10GW installed around the world. But it is still expensive, and anyway it's used best in day-time occupancy buildings. If you really are insistent on 100% autonomy, that leaves biomass-fired micro CHP - as yet, an undeveloped option.

The belief is that by banning imports, these micropower technologies will improve. Let's hope so. But seeking to get 100% self-sufficiency for each house seems an odd target. Heat yes, electricity no. At the very least some contribution from near site generation will be needed, but that may not always be viable, depending on location and access to local renewable source. So a compromise on wider imports is required.

The Element Energy report is entitled 'The Growth Potential for Microgeneration in England, Wales and Scotland'. It can be found at www.berr.gov.uk/energy/microgenerationresearch

In parallel, EST and the Open University have produced a study of microgeneration heating options and their consumer uptake, entitled nicely: YIMBY Generation – yes in my back yard! It covers solar heat collectors, biomass/wood and geothermal - all of which, as noted above, can make a lot of sense as part of the move to partial self-sufficiency. It can be downloaded from:
http://design.open.ac.uk/research/research _ dig.htm