Why We Should Be Building "Minimum-Energy" Homes And ***ONLY*** Creating "Zero-Carbon" Homes When The Location Makes It Necessary!

There are three basic 'minimum-energy' strategies involved in creating any "minimum-energy" home and cutting energy consumption to a minimum. But once that has been achieved; it is much easier for the addition of the fourth strategy; when, and/or if, it becomes feasible; to create a genuine "energy-neutral"; i.e. "zero-carbon"; home for the minimum cost!

1. *Build an 'airtight', well-insulated envelope*
2. *Choose the right heating/cooling equipment*
3. *Reduce the need for electricity*
4. *Install renewable-energy system(s) to cover the residual energy needs!*

(1) Building an 'airtight', well-insulated building envelope

It may seem very simplistic but the only reason we need to worry about heating and/or cooling our homes is because keeping our indoor temperature the same as the outdoor air temperature means that it will feel either too hot or too cold for much of the time. However keeping indoor air temperatures warmer or cooler at various times of year requires either the creation or extraction of heat; either way that takes energy.

Anybody who has experienced the 'heat' radiating from a bonfire or brazier knows that whilst the side of your body facing the flames gets warm; the actual air temperature remains much the same because as fast as it gets heated up it rises into the sky to be replaced by more cold air moving in from all sides! Even if the fire is kept going indefinitely; the air around you will still stay cold because of that constant movement!

From the earliest times; mankind has learnt that the only way to make and keep the air warmer is by 'containing' the warmed air; whether within a cave, a tepee, log cabin or a house; so that it cannot escape quite so easily to be replaced by colder air. The more effectively the warmed air can be contained; the warmer the 'fire' can make it ~ which also means that a smaller 'fire'; i.e. less energy, will be needed to keep the air warm.

Obviously; to reduce 'energy demands' the first pre-requisite is to minimise heat-loss / heat-gain when outdoor air temperatures are either too low or too high for comfort.

Fortunately; the UK's primarily maritime climate means that we don't often have a problem with outdoor air temperatures being too high; most summer problems arise from the intense radiant heat generated by direct sunshine which can be dealt with by normal design decisions.

The UK's main problem therefore is combating heat-loss when the outdoor air temperature is too low.

- Heat-loss occurs through two primary routes; one is the escape of 'warmed' air from within the structure which is replaced by 'cold' air drawn in from outside the structure ~ which then needs to be warmed up to replace the warmed air that has been lost. The second is the simple transmission; i.e. loss; of heat through the fabric of the structure due to the 'cooling effect' of the outside temperature ~ which again has to be matched by the creation of more heat in order to replace the heat that has been lost.

It is simple commonsense that the best way to stop the escape of warmed air is by creating a continuous air-barrier to "envelop and seal" the floor, walls and roof of the building. The usual timber-frame building materials; breather-membranes, sheathing and dry-lining; can all be an active part of creating an effective air-barrier as long as the detailing is correct. However; as the saying goes ~ "the devil is in the detail" ~ and most attempts at creating an airtight structure rely far too much on 'taping' around services such as heating pipes and electrical switches & sockets in an attempt to minimise air-leakage! At best it is a time-consuming expedient designed solely to pass the statutory tests and; whatever the outcome of statutory airtightness tests; I doubt that the results would be replicated 5 – 10 years later when the taping has had time to deteriorate and lose its 'stickiness'! When you realise that taping has been used for decades as the standard method to 'supposedly' seal vapour-membranes around 'services', etc. and yet couldn't negate the need for new requirements being introduced regarding airtightness; the taping obviously wasn't actually working! After all; the objective is now to seal those self-same 'gaps' to improve airtightness, so relying on a failed old method to suddenly start sealing 'gaps' effectively and permanently doesn't exactly inspire confidence, does it!?

The recommended ProFrame® approach aims much higher than mere (temporary?) compliance with statutory test requirements; however much those standards may have been improved; the ProFrame® approach provides a genuine long-term solution by using good plain commonsense to solve several problems with one extremely simple and effective practical solution.

- As with so many things; trying to deal with things on a 'piece-meal' basis rarely leads to a sensible outcome; especially when the creation of a continuous 'air-barrier' isn't the only continuous 'barrier' that is needed in the construction! Whereas the UK's traditionally constructed houses are notoriously damp because all the wall construction materials absorb and hold moisture ~ which given the UK's high-humidity (moisture-laden) maritime climate makes the use of concrete blockwork and plaster (both act like sponges) seem incredibly stupid ~ timber-framed houses are designed using a 'breathing wall' construction that keeps houses dry and comfortable by not absorbing moisture from the internal air whilst allowing any moisture within the structure itself to dry-out to the outside.

Accordingly; as timber-frame walls need a continuous vapour-barrier behind the dry-lining anyway; it seems very sensible to let one continuous 'sealed barrier' do both jobs. However; as taping is time-consuming and its long-term effectiveness is extremely questionable; it doesn't take much intelligence to appreciate that the best solution to the 'leakage' problem is to simply avoid all unnecessary penetrations of the 'barrier' by ensuring that all the services are run between the continuous 'barrier' and the internal wall surface; i.e. immediately behind the dry-linings; thereby removing the need for any taping around 'services'. (This also has the added advantage of ensuring that all the 'services' have maximum protection against frost, etc. by being on the 'inside' of the insulating layers of the house too!)

- The recommended ProFrame® approach achieves the desired outcome by using either a self-bonding insulation to form an effectively airtight insulated envelope or by overlaying walls and ceilings with a continuous polyethylene damp-proof membrane. Either way; services are installed 'in front of'; i.e. not behind; the continuous air and vapour barrier. That means they don't penetrate the 'barrier' and so the 'barrier' doesn't need to be 'sealed' around them!

For 'super-insulated' homes; the continuous self-bonding insulation can match or exceed any insulation or airtightness level achievable by assembling factory-produced 'SIP' panels on-site; it doesn't suffer from 'thermal-bridging'; it also retains the benefit of full design and construction flexibility instead of house designs having to 'fit' in with the limitations of the manufacturer's 'SIPS' system plus it also conveniently avoids all the problems related to trying to 'fit' factory-produced panels onto site-constructed foundations whilst trying to keep within the exceedingly tight statutory requirements.

Obviously; the fact that using the simple, straightforward ProFrame® approach can be upto 50% - 60% cheaper than using 'SIPS', etc. also helps!

(2) Choosing the right heating/cooling equipment

Naturally the whole point of working hard to build a tight, well-insulated 'shell' is to reduce both the size, cost and need to install heating and/or cooling equipment, and to reduce the 'running costs'; i.e. energy; to maintain a comfortable internal temperature.

Heat pumps work by extracting latent heat from the air, the ground or from water and concentrate it with the help of a compressor and a closed loop of refrigerant. The extracted heat is then transferred to water or air for distribution around the house. In summer, the system can be run in reverse and function as an air-conditioner instead.

High-efficiency gas or oil heating is a viable alternative that can meet the extremely low energy demands in a minimum-energy house ~ some new-generation gas boilers have efficiency rates greater than 95% ~ but beware claims made for 'condensing boilers' ~ they can only achieve the claimed efficiency levels if limited to heating water upto around 50°C; i.e. purely for underfloor heating purposes!

Wood or pellet stoves can easily heat a whole house if homeowners are willing to put up with some extra work. The most efficient designs still don't burn as cleanly as heaters running on natural gas or LPG. Some people contend that as burning wood or pellets is only releasing carbon that the trees have recently 'captured' from the air; using a woodstove is actually carbon-neutral; a rather dubious claim as (a) it negates all the benefits of the former tree's existence, and (b) the same argument could be applied to fossil fuels in the context that they too are only releasing carbon previously captured; albeit from several hundred million years ago!

Electrical heating makes it easy to measure energy performance; just read the meter. For 'super-insulated' houses; i.e. where heating loads are extremely low; electric heating may be a reasonable option. It's very inexpensive to 'install' and easy to zone and/or move room by room. It's also 100% efficient at its point of use. Unfortunately; most electricity producing power-stations are only 30% - 40% efficient and burn fossil fuels (oil, gas & coal) which all produce 'greenhouse gases'. It also leaves you totally dependent upon 'current' availability; i.e. it isn't available if there are power-cuts! (**NB:** That also applies to any heating system that depends upon pumping air or water around the house!)

(3) Reducing the demand for electricity

Irrespective of whether you are seeking to build a minimum-energy home or need to have an energy self-sufficient home; every unit of electricity used counts.

Passive-solar design, the use of 'light-tubes' and even the choice of decoration can reduce the need for electric lights during the day and makes it possible to install smaller heating and cooling equipment. Installing energy-efficient appliances and lighting is another simple, easy way to reduce consumption. Many properties suffer from 'phantom' electrical loads and/or the occupiers increase consumption by leaving appliances on 'standby' all the time; yet another easy fix, especially as it could reduce overall electricity consumption by upto 5%! Obviously; it helps motivate people if it is easy to check the electricity consumption; so simply installing what's called an "energy dashboard" to monitor electrical consumption as it happens can improve efficiency by highlighting the effect of leaving lights and/or appliances turned on.

(4) Achieving "carbon self-sufficiency"; the so-called "zero-carbon" home!

Despite earlier remarks about the stupidity of blindly pursuing a policy of making every new home "zero-carbon" because of the ridiculously high capital and running costs involved relative to the amount of energy likely to be produced and the sheer impracticality of physically fitting every individual 'home' with sufficient "renewable-energy" generation equipment anyway; there will always be locations where the lack of 'mains' facilities make "self-sufficiency" highly desirable.

- In fact; simply using refrigerators and freezers to store food makes virtually everybody more self-sufficient by increasing the interval between consecutive shopping trips to buy food! Buying tools and using them to repair and/or maintain our appliances or property also helps to make us more self-sufficient; so achieving a degree of self-sufficiency is nothing new!

We already expect that many rural properties will require 'off-mains' drainage; i.e. sewage treatment on-site; and the use of private boreholes in the absence of 'mains' water. Remote properties often have to rely upon generating their own electrical power too. Even when such properties are connected to the national grid, having 'back-up' electricity generating capacity is often a very sensible safeguard against the frequent 'power failures' they can experience. Similarly; the need to store fuel; such as LPG, oil and coal, etc.; onsite ~ for heating and/or cooking purposes ~ is taken for granted when 'mains' gas isn't available and using electricity is deemed to be far too expensive and/or unreliable!

Of course; all such examples of how we already benefit from being "self-sufficient" in our every-day lives highlight exactly why we do whatever it is ~ we do it because we benefit from doing it!

- The problem with trying to make all new homes "zero-carbon" is that it is physically a highly impractical proposition for the vast majority of new properties and it will invariably be massively and disproportionately expensive when compared with community-based alternative "renewable-energy" schemes which can generally achieve the necessary economies of scale to make them viable ~ thanks to the very favourable rates now available for "renewable-energy" sold to the national grid! So the problem with trying to make all new houses "zero-carbon" is that the vast majority of house-buyers and owners will ***NOT*** feel or see any benefit in return for the substantial additional expenditure incurred ~ people simply won't want to do anything that they don't benefit from doing.

However; there will always be exceptions where achieving "zero-carbon" would be very desirable for an individual new property or a small group of new properties. It might even allow otherwise impractical locations, e.g. isolated barns, to be made useable; besides which, looking at the alternative "renewable-energy" generating options can also be very useful for reinforcing the basic reality that it is always much easier and cheaper to make changes that reduce energy needs by a kilowatt than it is to produce an extra kilowatt of energy ~ irrespective of whether you actually need to have an "zero-carbon" home or not.

So what are the basic options and choices available if, for some reason, it becomes necessary to make a new property "zero-carbon"?

Photovoltaic systems are probably the easiest "renewable-energy" generators to fit on both new and existing houses because they just need a suitable sloping roof surface; preferably facing to the south-west and between 25 – 40° pitch; that is free from shadowing by trees or adjacent buildings. Deciding how large they need to be must be means making certain assumptions about how much electricity mechanical systems, lights, and miscellaneous plug-in appliances will use, and then factoring in for the 'unknown'! As things stand, it needs substantial government subsidies and/or major improvements in the technology to drive-down prices if photovoltaics are to become affordable and offer a realistic 'payback' upon the capital cost involved. Current prices won't leave much change out of a thousand pounds ~ just to generate enough power for a couple of 100 watt light-bulbs!

Wind turbines for individual homes pose a different sort of problem. Wind conditions can be extremely variable, even within the same locality and most sites will require careful monitoring to predict whether the investment for a wind-turbine is worthwhile. Then there is the physical problem of where and how to erect the size of wind-turbine deemed necessary to meet energy generation 'targets'. However; for those houses with the right location and sufficient space; using wind-power can halve the cost of a comparable photovoltaic installation!

Solar hot water systems can provide 40% - 80% of domestic supply but generally need a backup energy source, such as electricity or gas, to heat water when solar panels can't. Costs also vary widely, from a couple of thousand pounds for a simple 'top-up' hot-water system for the summer months to upwards of a couple of hundred thousand pounds for system big enough for a small family to enjoy hot-water on a typical (UK) winter's day.

- It must seem very obvious by now why every kilowatt hour that can be saved is so precious; it's because the cost of producing power from "renewable-energy" sources on-site is so high.

When it comes to making a big dent in the residual energy consumption in a "minimum-energy" house, every extra bit helps! All electrically operated kitchen appliances, media appliances, lighting, etc. need to be as energy-efficient as possible and to be 'shut-down' when not in use.

Clean power benefits everybody

"Renewable energy" is essential in a "zero-carbon" design. Solar hot-water collectors, photovoltaic panels, and wind generators are all sources of clean energy that create no carbon emissions. However solar and wind potential varies considerably around the UK reflecting differences in local weather patterns, altitude and topography.

For "zero-carbon" homes; the assumption is that weather and household patterns will be as expected, so that overall 'imported' energy use should be balanced out by 'exported' "renewable-energy". As always, the devil is in the detail!

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