**As you regular viewers will know, I’m always going on about stuff in our modern world contributing to our ever-worsening climate crisis**. **One of the areas we haven’t looked at in any detail yet though, is the building sector. And that’s a bit of an omission because according to the International Energy Agency, it’s responsible for no less than thirty nine percent of total global greenhouse gas emissions. Those emissions are created by running machinery that compensates for the appalling inefficiencies in the way we currently build houses. Heat energy escapes from our homes through badly sealed windows and poorly insulated walls and roof spaces, and then we spend oodles of cash putting heat back into our living spaces just so it can leak straight back outside again. And in the hotter months those gaps in our buildings’ fabric let all the outside heat INSIDE too, so we spend even more money on machines that pull that heat out of our spaces while more warm air continues to come back in through the holes in our walls and windows. It’s ALL a LITTLE bit stupid!**

**This guy is not stupid. He’s called Dr Wolfgang Feist and back in nineteen ninety-one he built a new home using materials and techniques that he’d developed through many years of research and consultation with leaders in the building industry. That single construction spawned a global movement that’s come to be known as Passive House. The home that Dr Feist built nearly thirty years ago was so well constructed and insulated that it still meets the now very stringent requirements of the International Passive House Institute, by which I mean it uses about ninety percent less energy than a traditional house. The consequence of that is that there’s virtually no requirement for expensive electrical heating and cooling systems, which saves a good deal of money and prevents quite a lot of carbon dioxide from going up into the atmosphere.**

**So surely by now, after thirty odd years, the construction industry builds all new houses to these specifications, right?**

**Hello and welcome to Just Have a Think**

**Anyone who’s tried to build a house will no doubt tell you that it’s a pretty complicated, time consuming and expensive business. Self-builders are often advised to calculate a budget and timeline as carefully as possible and then double it for the real world. One piece of advice that all builders understand though, is that the more time and care they give to the design details before starting the build, the less time and money they’ll need to spend later on expensive remedials and retrofits. No doubt you’ve all heard the cliched business acronym of the 6 ‘P’s**

**In the case of house-building you could replace the first word with ‘Passivhaus’ and you’d have yourself a nice snappy mantra for the movement.**

**So, what are the fundamental principles that make Passive House buildings so much more energy efficient?**

**Well, first of all, you need something called a super-insulated envelope, which means all the bits that separate the inside from the outside, so that’s the walls, roofs and floors. And that means using construction assemblies that double or even triple the thermal insulation of the building compared to most standard building regulations and codes. In northern Europe and the upper regions of North America, buildings are also insulated from the ground using foam-glass or gravel blocks which don’t rot, won’t compact, don’t get attacked by insects and are completely fire-proof.**

**Carefully considered insulating materials don’t just keep things toasty warm inside in the colder parts of the northern hemisphere, they also keep the heat out in warmer environments too, so you get an astonishingly consistent and comfortable ambient interior temperature all year round, wherever you are in the world. Plus, you get improved soundproofing, increased durability, and greater building resiliency**

**But of course, any insulation in a building is only as good as its weakest link. Ideally you want a completely continuous unbroken wrap of materials around the structure, but things do get in the way, like struts for walls and frames for doors and windows, which brings us to the second fundamental principle of Passive House – Minimisation of Thermal Bridging.**

**Any physical component that can transfer heat energy between the interior and the exterior is a thermal bridge. Steel joists and lintels are the worst offenders because of the inherent conductivity of metal, but there’s a huge amount of small architectural detailing on a house build that often gets overlooked as a thermal bridge. Passive House construction aims to avoid as many of these junctions as possible, and where they can’t be avoided, usually for structural reasons, then the builders spend a lot of time on these vulnerable areas, over-insulating connections and protrusions and using intermittent connections to break the continuity of heat flow.**

**That envelope seal is enhanced by the third fundamental principle, which is Airtight Construction. Special membranes, tape and seals are carefully fitted to minimise the volume of uncontrolled air exchange between interior and exterior, which in turn minimises energy use from reheating the air, discomfort from cold air drafts near the walls, and localized moisture and condensation problems.**

**There are strict criteria for a Passive House project to be certified as airtight. The building gets tested during construction with an air blower and it must have fewer than zero point-six air changes per hour to pass the test. Achieving that kind of high standard is where the careful planning comes in, making sure the air barrier is clearly set out on the drawings, specifying the appropriate materials, and detailing the sealing solutions for penetrations and terminations. Quality control is the key here, at every stage, right from the architect to the contractor and through to the trades who carry out the work.**

**Now obviously if you were to seal the building completely hermetically and then sit inside it for a few days you’d find yourself eventually becoming dead, which would be unfortunate. So, you do need some sort of fresh air supply. But the tried and tested Passive House experience is that it’s far more effective to keep the building envelope airtight and then install an efficient mechanical air exchange system. Which leads us to principle number five - Heat Recovery Ventilation**

**Getting fresh air in and extracting built-up pollutants, odours, Carbon Dioxide, and moisture is essential for a healthy living environment. A Passive House heat recovery ventilator is designed to do all these things. The smart feature is that it extracts heat from the exhaust air and puts it into the incoming air without directly mixing the airstreams together. That way, you don’t lose all your heat to the outside. The standard that a Passive House HRV, system must achieve is at least 75% heat recovery. And in the hot summer months the system can bypass the heat recovery core, so you just get the fresh air without retaining heat.**

**In dry locations, interior spaces with low humidity levels can become uncomfortable and quite unhealthy, so an alternative ventilation system is used called an energy recovery ventilator or ERV. It is similar to an HRV but it can also capture moisture from the outgoing exhaust air and circulate it back into the building.**

**And, you know, if you really just want to get a gulp of outdoor freshness, especially in warmer weather, then there’s nothing to stop you actually opening a window. That is allowed!**

**And windows, or to use the proper lingo, ‘High-Performance Glazing’, are the fifth and final fundamental principle in Passive House construction.**

**By their very nature, windows and glazed doors are designed to provide light and visibility, so they obviously can’t be insulated to the same degree as a wall. That makes them the weakest link in the barrier continuity chain.**

**Passive House glazing systems have nonconductive framing or include large thermal breaks. The frames themselves are also heavily insulated. In most cases, triple-glazed units are used instead of double glazed and the space between each pane is filled with inert gases like argon or krypton. The glass gets multiple low e-value coatings, plus what the industry calls warm-edge or nonconductive spacers. Good architectural design optimises free passive heating from the sun, which can significantly offset the amount of heat a building needs during colder months. And to keep heat transfer down during the hotter months, the orientation of the building and location of glazing plays an important role. Pointing the windows south and using clever shading prevents too much solar heat getting into the house.**

**The building supplies industry has responded very positively to the Passive House standard over the years, with more and more innovative products and services coming to market all the time, all of which are designed to add efficiency and practicality into the design and build. Smart wall systems and ultra slim insulation panels like these, that give the same insulation value as traditional products but with only a tenth of the thickness have vastly improved build quality and speed. And smart electrical and lighting systems like this one from a company called LumenCache are revolutionising the way electrical energy is consumed and controlled by the householder. Their installations run all the lighting in a household from a twelve-volt DC solar power system using the same low cost, low energy data cables found in the IT industry. The power source combines with a battery storage system, so your lighting circuit stays energised even in a grid power outage. DC power is perfectly suited to LED lighting, and with sensor data carried by the Cat5 wires, the system knows when lights can be automatically turned on or off depending on motion within a room, which means ultra-low running costs for the consumer.**

**Building a Passive house used to be regarded as an expensive indulgence for very wealthy people, but thirty years of design and construction experience all over the world, coupled with rapid advances in material technologies mean that today a well-planned Passive House is very competitively priced compared to a traditional construction.**

**Researching these videos is always a time-consuming business, but the sheer volume of information on Passive House construction from governments, organisations and self -help groups all over the world has been quite overwhelming. You might be considering diving into a project yourself, so I’ve left as many links as I can in the description box below, categorised by country and even including information about retrofitting existing homes to Passive House standard, which there simply wasn’t enough time to talk about in this program – although that might be a follow up video at a later date.**

**And of course, if you’ve already got experience of building a Passive House project and you’ve got any helpful hints and tips that others could benefit from, then jump down to the comments section below and leave your thoughts there**

**That’s it for this week though.**

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**If you’re watching this video on the day I posted it, which is Sunday 20th December 2020, then I really do hope the various global lockdowns don’t spoil your Christmas festivities too badly.**

**As always, thanks very much for watching, have a great week if you can, and remember to Just Have a Think.**

 **See you next week**