Episode 12

Should You Invest in Renewable Energy?

The show notes: www.houseplanninghelp.com/12

Ben: Dr Derek Taylor is my guest today. Hello.

Derek: Hello.

Ben: I hoping that we can discuss a couple of different aspects today. We've had a theme of trying to look into the energy situation of the world but also you're a man who knows your renewables. So maybe we could start with a quick overview of your career and some of the experience you have gained through the years.

Derek: Okay, well I'm an architect and I originally trained at the Architectural Association but I got interested in renewable energy and low energy building design in 1972 so 40 years ago. From then I started to pursue more of a renewables orientated career and I did a masters in designing wind turbines and renewables, and I came to the OU [Open University]. I took that further and designed a few innovative wind turbines but I kept my architectural roots together and I'm bringing together renewable energy and architecture to try and make that much more effective.

Ben: Where are we at the moment in terms of energy? Day by day, perhaps, the average person has no idea what the concern might be, but with the amount of energy that's left on the planet and how we're generating it, how would you describe that situation and your forecast over the next 20 or 30 years?

Derek: Well, you have to distinguish between different types of energy because obviously buildings currently most of their energy is in the form of heat, whether it's space heating or hot water. Then you have the electricity and then on top of that you have fuels for transport.

Obviously the big constraint is partly running out of oil reserves and there's peak oil, a lot of people are thinking that we've actually got to that point now where we're actually starting to get to the point of depletion. There's still a lot of coal in the ground and a fair amount of gas but the point is that those fuels, if we continue to use them,

are going to emit CO_2 emissions and that's obviously a big concern for climate change.

Ben: Is this something that we need to get sorted in the near future? I mentioned 20 or 30 years. Can you envisage what things might be like then or are we just going to be in much the same situation, that we're still - maybe a bit tougher - but we're still using fossil fuels, we're still just getting by?

Derek: Well, we obviously do need to make a step change. The scientists are saying that we need to have a major cut of about 80% of our CO_2 emissions in the next couples of decades so it's quite a major change.

In terms of renewable energy that's obviously, a big push is happening in terms of the rest of the world. A little bit is happening in the UK. The biggest area I suppose is wind energy and offshore wind energy, which makes a lot of sense in the UK because 40% of the potential wind energy resource in Europe is actually in the UK. That's land based and if you go offshore that's even larger.

I've recently just been updating the wind energy section of our Open University renewable energy course. The last time we did that was 2003 and I noticed that in the year 2000 there was about 30,000 MW of wind globally. In the year 2010, they actually installed 38,000 MW in one year and at the end of the year globally there's 200 GW so it's a phenomenal increase.

In terms of the offshore resources, it happened around Britain much quicker than I thought it would. The UK has the largest offshore wind farm currently in the world, which is off the coast of Thanet and they're currently building a third offshore wind farm in the Thames Estuary, which is called the London array, which they say will produce a fair proportion of London's electricity needs.

If we were able to get to the point where we could tap into floating wind energy technology the wind energy resources around the UK in UK waters would be equivalent to the Gulf Oil reserves but every year.

Ben: So, that's quite impressive. As house owners and house builders should we be looking to have our own renewable technology that we're using or actually saying that is the job of the energy providers to come up with that?

Derek: Well I certainly think there's a scope for a whole range of options. There's building scale renewable energy solutions and then a sort of intermediate, which I would call neighbourhood or community scale and then there's large scale. Then there's really large scale offshore.

In terms of buildings, the ones that make the most sense is making maximum use of solar energy and that can be for electricity generation, hot water and also for reducing space heating loads but also in the summertime for use for cooling.

We can also make use of the ground because the temperature of the ground below a certain depth stays constant throughout the year so we can actually tap that ambient source of energy.

In terms of other renewables, it very much depends on where you are in terms of the usability. Wind energy can make sense but in most cases it doesn't in urban areas and if you're in a rural location and you're a long way from the grid then a wind turbine would make a good deal of sense. Usually the wind energy technology starts to make sense at community scale upwards with a medium scale turbine, a village or a town. That starts to make a good deal of sense because then you can spread the costs through all the householders in the town or the village.

Ben: Is it the case that there are some technologies that are more effective than others or are we just harnessing them all because we need a bit from each?

Derek: In terms of the UK situation I think wind energy is the most important in terms of energy as a whole, not obviously specifically for buildings, and solar is also very useful. Apart from that there's hydro where it makes sense but that tends to be located in the mountainous areas of Scotland and Wales. There are special situations in England where you have a river. If it's a former watermill site then it's certainly worth exploring but of course when those were mainly in use there was less water extraction so there was more water running through the system.

I did a renewable energy study for Merton Council a couple of years ago and they actually have a River Wandle running through that which is about 19 km long and in the height of its use there were about 90 watermills operating in that short stretch of river, so there might be some potential locations.

Biofuels is another difficult area. I think growing energy fuels is very difficult to justify when you haven't got much land, but if you're in a forested area then you can obviously make use of the wood. The situation with biofuels probably makes sense if you can use it as waste, like food waste and oil waste. You can then process that with biology to produce gases and fuels, and I think that makes a lot of sense.

In Denmark they have community digesters where the farmers get together and take the manure and the food waste goes there and the sewage goes there. Basically you are mimicking the cow's stomach and that produces methane, basically the same as natural gas so you can run small power stations off it.

Ben: Does anyone think of the power of the tides? It's a very constant source, isn't it, that you can predict which is quite good, but I don't see much development in that area.

Derek: Well, the main problem to date is that tidal energy has been exploited using tidal barrages, which is like a big dam across the estuary. There is one that has been successfully operating in Brittany called La Rance and I think there's one in Canada, but obviously those are very expensive to build and there's very much concern about the impact on the eco system of estuaries, which are very rich eco systems, perhaps as rich as some of the rainforests. They're very low level on the food chain for all kinds of organisms.

The other option, which is actually to use what's known as tidal stream technology, which is essentially underwater wind turbines. So actually look like a wind turbine but they're located under the sea level and they capture the currents which flow around the coasts, where you have a tidal stream. There are quite a few around Britain. One of the big advantages, because water is 800 times denser than air for a given size of rotor diameter you get a lot more power out compared to wind turbine because air is very low density.

So, from that point of view you can actually get away with much smaller devices to give more power output and there are one or two projects which are, I guess at the early stages of usage at the moment. Of course you're locating these devices in very difficult situations and you have to be able to maintain them and they have to be able to cope with the water reliably. There's a lot of interest in them. They're still in the early stages of development.

In terms of wave energy I think that's another even more difficult one to achieve. The energy resources from the waves around Britain is substantial but you have to build devices which can survive 24/7 in the most stormy seas around Britain. People are trying but we'll have to see. Part of the problem tends to be very few of the wave energy type projects actually go through the iterative stages you need to go through to develop a technology. So lots of funding goes into building one device and that fails and there's no money to carry on. You have to learn from those failures to progress the technology. So, we'll have to see. There's obviously interest in Scotland and Cornwall for wave energy technology. It's just whether that interest is sustained with serious long term funding.

Ben: Going back to the big picture and looking at our energy resources over the next few years, is there any way of stopping or are people aware that they can't use that last bit of fossil fuels?

Derek: Well, I don't know. We'll just have to see what happens. I think it's going to be a price constraint more than anything, but I think we can use what fossil fuel reserves we have much more effectively than we are. Certainly in other countries, such as Denmark, where they've actually been much further on with many aspects of this, whether it's design, performance of the houses and also the use of wind energy.

The other big approach is using combined heat and power for district heating. By doing that you can actually make use of the energy much more effectively. What that means is you take the waste heat from a power station and heat houses with it.

I calculated that if you add up all the energy being lost from the cooling towers around Britain, that it amounts to more energy than is used to heat all the houses in Britain but it's just allowed to go into the atmosphere or into the sea if they're coastal locations. Whereas in Denmark they've actually done it so that 65% of houses are heated from waste heat from power stations or large scale boilers for district heating.

Basically you have to have heat mains in the road or in the gardens and each house is then connected to this heat main and takes heat out of it.

Ben: Is that something that can be done quite practically or are we talking a massive challenge here?

Derek: It's certainly practical to do. It's mainly the will to do it. Part of the difficulty is that we have a privatised electricity network and most of the privatised companies obviously want to carry on doing what they're doing. I think there is scope if local authorities can develop their own municipal schemes and there's one example in Woking, which they've managed to actually do that. They had an energy manager who was able to set up such a scheme.

Battersea power station was actually a combined heat and power station when it was operating. There was a pipe which goes under the Thames which heats 4000 houses in Pimlico. They've subsequently re-installed a small combined heat and power station actually at Pimlico now which delivers the same thing.

Part of that scale of development enables you to build in very large heat stores, so you can actually store heat when you're generating electricity which may not be the time when you need the heat but you can then but you can then generate it at the most valuable time. It also enables you then to think about storing heat from other sources from solar or if you have too much wind energy you can use that to charge up the heat stores.

It gives you more of a robust system and enables you to expand more, larger scale renewable energy. With that sort of scheme in place you can then think about having solar collectors operating in the summertime which then store from summer to winter so that you can actually heat houses in the wintertime or you can use solar.

Ben: A quick word on nuclear power because it is something that does generate well, but why do we want to avoid this?

Derek: Well, there's all kinds of reasons. It's very expensive. There's still uncertainty about what fuels are going to be available for nuclear, as well. There's still discussions about what's going to be the most useful type of fuel. Up until now we've been using uranium but there are new types of fuels being looked at.

Of course, it's a question of who's going to pay for it and if it's going to be privatised. So far there's not been a lot of interest to do that in the UK. France has been very successful and as I understand it to date there's about 80% of their electricity comes from nuclear but I think the new president is talking about closing some of them down. I don't know what's happening about that.

Then the issue is what do you do about the nuclear waste. There's a whole how many years in the future will we have to offset funding

to look after the waste because at the moment there's no reliable way of disposing of it.

Ben: What does that mean? Do you just put it in the ground and leave it? Is that not the case? Are we saying that we really don't know what that means? Or do you have to look after it and nurture it?

Derek: Well, obviously you can put it in the ground but in the future will people know what's actually below the ground at that point, if you're talking a hundred years in the future for instance?

Ben: Okay. I know that you have been involved in one project, perhaps the most energy-efficient house in the UK, so I wonder whether you could tell us a little bit about that project?

Derek: Okay, this is a house in Herefordshire which is done in collaboration with an energy consultant who wanted to put his money where his mouth is and try and develop a house that didn't need any heating. So we developed a new approach, which is what we call super passive solar.

Historically there are two strands of developing low energy buildings. One is known as the super insulated approach that tends to be a lightweight construction but lots of insulation. The other approach is known as passive solar, which was reliant on lots of solar orientation, lots of glazing, high thermal mass and you trapped the solar gains in the thermal mass so it acts like a storage heater.

Historically they haven't worked particularly well in the UK because we tend to have quite high cloud cover so traditional passive solar tends to be useful only in the spring and autumn times. You don't get a lot of benefit in the wintertime whereas super insulation gives you a bit of benefit. So our approach is to combine the two so you have a high level of thermal mass but it's inside an insulated envelope, which is super insulated.

In order to make that work you need to face the building south and also to use very high performance windows which can allow a high level of solar gains through the glass but also not let it out. This requires probably triple glazing and some of the Passivhaus standard windows are probably suitable for that but you have to make sure that the right type of glass is used when you're south facing because you obviously don't want to stop the solar gains coming through, so you need glass that is very transparent to solar gains. On the north facing windows you can get away with not having that characteristic. So, you can actually have different types

of coatings on the glass which are essentially transparent to light coming in from the sun, which comes in at shortwave, but when it comes into the building optics heat up and then they emit long wave and the special coating then reflects those gains back into the window. That's known as a low-E coating (low-emittance).

So basically you need solar gains coming in and enough thermal mass to store it and using spare thermal gains from people and objects in the building, but you obviously need to have heat recovery from ventilation because one of the other heat losses after the insulation is heat loss through the ventilation system. So you have to have a way of extracting the heat from the out going air and putting it onto the incoming air and by working all those things together you get to a point where you don't need any heating system. You can pay for that by not having to pay for the heating system by paying for the extra insulation.

Ben: So how different is this to Passivhaus?

Derek: It goes a little bit further than Passivhaus. Passivhaus is great. It's unfortunate they chose the name Passivhaus because it's confusing with passive solar. I mean it's basically ultra super insulation approach. The Passivhaus design system doesn't really take into account the thermal gains from thermal mass, so you can't get that extra point further of actually optimising the design to get to zero space heating, although a lot of Passivhaus buildings are getting pretty close to that.

Ben: What do you think then for us – this podcast is very much aimed at people who are looking into renovating and building their own houses and energy efficiency is definitely at the forefront of our minds, but should we just be concerned with making our own buildings well insulated, airtight, all of these key factors or is there anything else we should be doing?

Derek: Well, certainly for new buildings I think you have to push that envelope as far as you can because it's much more difficult to upgrade so if you can design as much insulation as possible and to get to Passivhaus standards would be at least very well worth doing and shouldn't cost you a great deal more on top of the building.

If you go to super passive then you can probably get to cost neutral so you are probably offsetting the cost of the heating system and also having to replace the boiler 15 years down the road. So it's certainly well worth doing that. Obviously there are sometimes constraints about what you can do if you're not going to be exposed

to solar gains which in terms of the super passive approach then you do need to have a good orientation towards the south, not necessarily directly south but pretty close, in order to maximise the passive solar gains. Obviously if you're overlooked then that's not going to be too easy.

In terms of existing buildings I think it's a whole different kettle of fish. I would certainly encourage people to upgrade their buildings to Passivhaus if they can do it but it's not a cheap option. If they have the resources to do it then it's probably best using that money to go into that than building an expensive new kitchen, for instance. You have to make your choices of where you're going to spend the money but for existing buildings you really need to think about external insulation to be effective. You can do some internal insulation but it can be very problematic and you could have all sorts of problems in the future if you don't know what you're doing.

Ben: You are changing how the building is meant to work, aren't you, when you do this? So, are we all heading down this path whether we like it or not?

Derek: Well, buildings represent something like 40% or 50% of total energy consumption so we do need to address that. In terms of existing buildings I think if you're able to externally insulate then that's great but obviously there are changes in the outside appearance which may be a difficult thing to get through.

The problem with internally insulating walls is obviously you're actually engrossing onto the floor area and in order to get to Passivhaus standards of insulation you're going to be talking about 200 to 300 mm of insulation, which is fine if you're prepared to do that. The difficulty with solid walls for instance though is that prior to that wall being internally insulated, it's been kept warm by the space heating of the house but once you put insulation between it and the heating then it's obviously a cold object and it's a cold surface. So, unless you actually do that internal insulation correctly, if any vapour gets into that structure it will actually hit this cold wall and can condense and can cause you condensation problems and potentially rotting problems so you do need to know what you're doing if you do that.

The other big difficulty though . . . If people are prepared to do that and they have the funding to do that I would certainly encourage it but to do it properly and to get the right help. But given that there's about, of the order of over 20 million houses which are needing to be upgraded and we have one or two decades to do this, I've been

looking at a different approach of how we might actually reduce the CO_2 emissions from buildings. That reflects back to what I was talking about earlier which was combined heat and power, and district heating. So, if we were actually to invest in that, certainly in our villages and towns and cities, that would then enable the existing buildings to start to use heating which was actually low carbon so that would then buy some time to upgrade the performance of the buildings.

There's no point putting in a little bit of cavity wall insulation, if we're going to require 300 mm of insulation to get to the 80% reductions in CO_2 that we're talking about. We're only going to get one hit to do this, so we might as well do it properly. If we can set up a scheme where everyone is connected to a heat network - well those who can be – that means they're then using low CO_2 energy and then there's a potential revenue stream for the sale of that heat to people which can then be used to fund insulation of buildings down the road. The big difficulty is how you're going to fund the investment if you don't do that.

Ben: One last question then that's along this theme and it's something that I've been thinking about a little bit. The piecemeal technique where you can't necessarily afford . . . You'd love to build a Passivhaus but you don't have the money to so you come up with an energy target over a certain amount of years and do this and that. Is that the best approach or is it better to do nothing and then just to do this big hit?

Derek: Well, I would certainly think it's worth doing incremental improvements. The main thing is to try and have a plan or a strategy so you're not going to foreclose on the options. So you can do the things that are easy to do first of all but making sure that doesn't undermine the improvements that you can do later on. Incremental improvements of insulation are tricky. If you have a wall cavity which needs insulating then you should obviously do that. If you have a loft that can be insulated then certainly the more upgrades you can do to that the better.

To actually get to the Passivhaus levels of performance, you're talking about 400 mm of insulation, probably, and I suspect that not many people have got that in their roof. [Derek laughs.] But because of these things we've been coming up with a different approach for new buildings which may also be applicable to extensions and maybe for external retrofits for new buildings. That's taking more of an engineered, manufacturing approach so that we

actually have super insulated design which can be installed very quickly and achieve zero heating.

Ben: Well, thank you very much. We've had some great information today. So Dr Taylor, thank you.

Derek: You're welcome.