HOUSE PLANNING HELP

Episode 182

Extracting energy from watercourses by generating electricity and extracting heat with Justin Broadbent from ISO Energy

The show notes: www.houseplanninghelp.com/182

Intro: You may be able to generate electricity or heat, or even both, from watercourses on your land and you can probably get government incentives to support the construction of the system. We spoke to Justin Broadbent from ISO Energy about the options available for extracting energy from water on your land. I started by asking if this was one of the earliest forms of energy that was taken, or would it be wind power?

Justin: I should think probably in the UK, although I'm not an expert on it, I would actually think probably watercourses were there before wind, for the simple reason that there's much more energy in water because of its density, than wind. So, when you're making basic mechanical objects, it's easier to see how you could use a water wheel rather than a wind turbine.

Having said that, possibly in places like Holland where windmills were the main form of energy, although they have water, it's very flat and there's no flow in the water. It's basically just ponding.

So, I should think in the UK certainly, all the early mills were all driven by water. Grain grinding was done by wind but certainly, the mills for the early Industrial Revolution was all done through water because of the amount of power in the water.

Ben: Where do you choose along a watercourse, or how do you assess when it's right to start extracting energy?

Justin: Well, it depends on what sort of energy you're trying to extract. Any water can be used for energy extraction. A large pond can be used for extracting heat. The amount of heat that be extracted out of it is relative to the size of the pond and the heat load required.

If the pond is flowing, there's a flow in and a flow out, then the energy is effectively being replaced all the time, in which case you can take more. If you have a stream, then the energy is being replaced very, very fast so you can take more energy.

That energy is really heat. You have a constant known 7 to 12 degrees temperature in a flowing river. A pond can actually get much higher than that, but we have a constant. That constant is constantly being replaced. So, you can extract loads of heat out of it.

With regard to electricity, you need, what in industry terms is called, either a flow or a head. A head is like a waterfall or a mountain stream. Something like that has head, and between the top of the stream and the bottom of the stream gives you the calculation of how much energy you can take out of it. To extract electricity, you need head and/or volume, preferably both.

Ben: Is the heat version the simplest, to begin with? Shall we go down that route first?

Justin: It's the simplest and the most likely to be worthwhile, especially in the southern parts of England. If we're in Wales or Scotland then no, hydro looks good. In Southern England, generating electricity is rare. You've got to find a millstream, an old mill. That's where they positioned them.

If you just have a small stream running through your garden, as in fact I do, really the only thing you can probably do is extract heat out of it.

Ben: How would we do that? What are these devices?

Justin: There are a number of different ways.

If you take a pond as the simplest, a pond is fairly slow running water. You simply install some sort of heat extraction mechanism, which is often coils of plastic pipe which recirculates through a heat exchanger and extracts heat out of it.

If you have slightly flowing water then there are items called Energy Blades, which are effectively stainless steel radiators, if you can imagine a bank of four or five radiators made of stainless steel so they don't rust. In a flowing stream, you can extract an enormous amount of energy out of it because almost whatever you take out, as long as you don't actually freeze the water, two seconds later, there's new fresh water coming down the stream.

We have huge manor houses using hundreds of thousands of kilowatt-hours a year out of streams, just by putting in a bank of 20 stainless steel radiators, basically.

Ben: And there isn't a case of affecting wildlife or anything downstream?

Justin: No. Relatively speaking, the amount of energy you're taking out of a stream is very, very small because of the volumes involved.

Out of a pond, there is the opportunity to cool the temperature of the pond and yes, it probably does affect wildlife slightly. But frankly, in Great Britain let's say, it's the same fish that live in the south of England as live in the Highlands of Scotland. So actually, they just probably think that you've moved them up north, after we've cooled the pond slightly.

Ben: You mentioned that you've got a watercourse and you're not doing anything. Is there a reason? I think this period property that you own is heated by a ground source heat pump. Is there a reason you chose one over the other?

Justin: We started 11, 12 years ago and in those days, ground source was what we understood. As the years have gone by, we've developed how to extract heat neatly out of water.

We do actually have one system. We have a gym in the industrial yard and that is heated via a pond using an Energy Blade, actually.

Ben: So, there's not much in it really, when it comes down to it?

Justin: No. If I was starting all over again, I would probably choose the river, rather than the ground, simply because it's cheaper to use a stream.

The problem with the river that we have here is that it suffers a lot from flash flooding. There's a lot of development going on in the area, as you know, and the amount of flooding is getting worse. As such, it makes it difficult to control what you're actually putting in the river.

But if I was starting again, I'd probably use the river. It's the more efficient way of doing things.

Ben: From a cost perspective, is there anything to consider when you're weighing up your options, like you were mentioning?

Justin: Yes. If you're fortunate enough to have a stream, it means you can just plunk an Energy Blade in the stream, euphemistically – it might be a bit more complicated than that, but you plunk an Energy Blade in the stream and it costs you a couple of thousand pounds to install it and Bob's your uncle, you have an energy source.

To do the same thing with the ground, you might have to dig, off the top of my head, 500m of trenching a metre deep, a metre wide, put a load of plastic pipe in the ground and all the glycol that goes with it etc, and instead of it costing two or three thousand pounds, it's cost you five or six thousand pounds.

So, that's the main driving force. And it won't be quite as efficient. The river will be more efficient because you can cool the ground but you can't cool a river.

Ben: Maintenance?

Justin: Both ways there's very little maintenance as such. It's fairly static. It is a radiator.

Ben: How might it break or come to the end of its lifecycle?

Justin: Well, these things are built of stainless steel so they have quite a long lifecycle. You can imagine that maybe a tree trunk could come down the river.

It's not impossible, obviously. When we're doing these things, we build them with guards on the front, but it's not impossible that something could come down and take it out as it were. You'd probably be able to find it a bit down the stream, pick it up and bring it back. But that is an issue.

In the olden days, before we had these energy blades, we used to use plastic pipe. That was a bigger issue because often that can get dragged down. In fact, it's not strong enough and so we stopped doing it after a while.

Ben: What would it look like then, if we're going down this route? Perhaps there's an example that you've done recently for a customer where we can show some photos of this particular way and what process you went through to completion?

Justin: Different customers do it in different ways. I can give you some photographs for your website to show different ways.

The simplest way is literally if you have a small stream at the bottom of your garden, you just put the energy blade in the stream and dig a small trench back to your heat pump and it's up and running.

Other people go to extremes of making it a feature. I have a couple of clients who actually diverted part of their stream, dug a canal, concreted it in and had a walkway over the top of it so that they can actually demonstrate to people how they're heating their house, their swimming pool or whatever. And it's quite nice. It's quite nice for us as well, obviously, as a company that do these things. But you don't have to go to that extent.

Ben: I quite like that. So, has that pretty much given us an overview of this extracting heat? Is there anything else we need to beware of?

Justin: No. If you have the right spot and you have the right watercourse, then it is fantastic. It's the only way to do it. If you don't, then you can't do it. It's as simple as that. There's no half way. It either works or it doesn't.

Ben: Is there any way we could tell ourselves, or do we need to get someone who knows what they're talking about?

Justin: Get someone in. As a company, we have 50 man-years' worth of experience in this now. You learn by our mistakes; we've made plenty of them along the way.

Ben: Let's move on to more hydro now. We're saying that it has to have this fall of water, a flow of water. Is it one or the other or are you looking for both?

Justin: Ideally, you're looking for both.

If you have a big mountain river, fantastic. You see people building dams. You go to the Alps, you go to Scotland, you go to Wales, they build small dams and then you see the pipe coming down the mountain. That's a traditional hydro system.

It's all about volume of water creating weight in the pipe, which means that you can run a turbine at the bottom of it. The greater the head, which is the technical term for the drop, the more power you can generate.

So, if we think about the south of England, there aren't that many, apart from the North and the South Downs, and you'd be unlikely to get planning permission to do anything on those.

Ben: So, you have to get planning permission going down this route?

Justin: If it's an area of outstanding natural beauty, absolutely you do, yes.

Ben: But on a normal river?

Justin: To dam it, yes you do. To put an Energy Blade in the water, no you don't. It's no different to building a small pier or something like that. And it's easily removable. But to dam a stream, in this country, you do need permission from the Environment Agency, or River Authority as it used to be.

Ben: Is it always a turbine? That's quite a severe piece of kit.

Justin: No. We were just discussing in the south of England you don't have very many mountain streams, and so what you do is if you look at where the old mills were built, it tends to be a hill stream and they would dam it slightly and put a traditional water wheel in place. That would then drive the machinery of the mill.

Those are typically good areas. They built them where they built them because they were good places to build, obviously.

Ben: I was going to say, this might be one of the key giveaways, that you're on an old mill site, and you've actually got a good case study that we could dig into.

Justin: Yes. We have three or four mills that we've converted to do exactly this. If you're fortunate enough to have bought a mill then yes, it's great. Or if you're next to a mill on the same millstream or something like that, then there's lots that we can do for you, probably.

In those cases, traditional turbines aren't any use because you don't have enough head, but you have lots of volume in the stream.

So, in an ideal world you have head and volume and then you can build a traditional turbine. If you don't have the head, then you have to have even more volume. You still have to have some drop. You still have to have, let's say, six feet, two metres of drop. That's enough, as long as you've got a few thousand litres a second going through the stream. In which case, the best way of doing it then is what's called an Archimedes Screw.

Archimedes originally invented his screw to actually send water uphill, when they were sending water around in Rome and Greece. They used the Archimedes principle to actually pump the water in the first place. Nowadays, we tend to mainly use it in the opposite direction, using the flow of the river or the stream, to turn the turbine and on the end of the screw, there's an electrical generator that generates the electricity.

Ben: And it's quite effective? If you had this next to a house, you're going to be able to get a fair amount back, obviously dependent on the size of the river?

Justin: If you're fortunate enough to have the right spot, it is incredibly effective. I have clients who are now generating 15, 20 kilowatts of electricity an hour, which is far, far more than you need for any single house. 24 hours a day, 365 days a year. And effectively, apart from a little bit of maintenance, it'll go on forever.

It's a wonderful way of doing things. We should be doing more of it in this country.

Ben: What happens with that surplus?

Justin: Assuming you're on the electricity grid, which most people are, if you have electricity coming into your house, then we can send it back the other way. They basically sell it back to the electricity companies.

So, it's a bit like if you have photovoltaic panels on your roof, they might produce a few kilowatts. Well, an Archimedes Screw should be able to generate tens of kilowatts. Much more efficient.

Ben: And there were some incentives. Are they still going?

Justin: Yes. The same feed-in tariff that pays you to generate electricity with photovoltaic cells pays you to generate electricity with an Archimedes Screw.

Of course, with PV panels, they only work between the hours of daylight. And if the sun is shining, they work well, if the sun's not shining, they don't work so well. And it tends to be that you're generating electricity during the day in the summer, when you need the electricity the least. With an Archimedes Screw flowing through a river, you tend to generate slightly more power in the winter because the rivers are higher, and it runs 24 hours a day, 365 days a year so, you always have the power when you need it.

Ben: What would wear out or need that maintenance? Because it's obviously got a lot going through it all the time.

Justin: Yes. The screws themselves are fairly maintenance free. The bearings, of course, will one day go, and the gearbox at the top needs maintenance. But it's not a huge amount. It's a fairly basic system in reality. It's heavy but basic.

Ben: I imagine you need quite a big space to put it in. Do they vary a lot in size, or tend to, for this sort of purpose, be a set size?

Justin: As with all these things, size matters I'm afraid. The smaller the size of system, the less return on investment you get.

It's difficult to describe on the radio but if you have a stream that's two metres across and half a metre deep, then that's a good size. Out of that, you'll probably get something like 10, 15, 20 kilowatts of energy, depending on the fall that you have.

If you have a stream that's only half a metre across and 250mm deep, you might get five kilowatts out of it. But because of the amount of civil engineering and the cost of making these things, actually there's not much difference in the cost between the two. But the return on investment on a system that's producing 20 kilowatts is obviously four times greater than one that's producing five kilowatts.

So, it is rare that as a company we want to get involved with things that are much less than 20 kilowatts, because you spend an awful lot of time and effort in getting permissions and this, and then the costs mount up and suddenly you've found that it's all going to cost £150,000 and you're only going to make £5,000 a year out of it. It doesn't pay back.

Ben: Do you almost divert the river a bit? Because when the river's flowing, you don't want to be building in the middle of this.

Justin: Yes. That's why we always look for mill houses because the millstream has already been diverted off the main river. So it's a nice, controlled environment to work with.

Whatever happens, you always have to worry about the environment, obviously. We're all here trying to do things for the environment. So we don't want to be blocking the river so that fish, eels and animals can't get by. So it always has to be just a part of the stream, if you like. You can't just say 'I'm going to block this stream forever more.'

We did that in the Victorian times and half the rivers became devoid of fish, salmon, eels and things like that. So we, and the Environment Agency, are trying to rectify that situation.

So nowadays, you can't block a stream completely. You always have to have a fish pass or something.

Ben: What is a fish pass?

Justin: A fish pass is exactly as it's called. It's a way of giving the fish a route upstream, without having to go through the mechanism.

Ben: How do they avoid it? How do they not say 'there's something very interesting down there, I'm sure of it'?

Justin: Yes, we put a sign up for them to read. 'Fish this way, eels that way, water that way!'

A fish pass or a fish ladder, as they're often called as well, basically looks like a maze of slow, little drops that they can easily swim up and rest in the middle etc. They're quite expensive to actually put in.

And that's why, again, you go for the bigger sites. Because you might find that the Archimedes Screw costs you £15,000 for a five kilowatt one, and it costs, say, £60,000 for a 20 kilowatt one. That's just the screw. But then the civil engineering is going to cost you another £20,000 either way and the fish pass is going to cost you £30,000 and then getting the planning permission and the consultant's time is going to cost you another £40,000.

So, the whole thing adds up and that's why size matters, at the end of the day, because you need to have something that's going to generate a decent return on investment, otherwise it doesn't happen.

Lots of people start off with the best of intentions but actually, at the end of the day, if you don't get a return on your investment it's hardly worth doing.

Ben: Is there anything else we need to think about with this hydro side of things?

Justin: I don't think so. If you have a stream running through your garden, beside your house or whatever, then it's certainly worth investigating what can you do to use the stream. How can you use the stream to the best of its ability?

The two ways are really either generating electricity and/or generating heat. If you can do both then it's fantastic because you use the electricity to run a heat pump, let's say, which is using the flowing stream to extract the heat out of, and you suddenly find that you've not only got a house that's completely free to heat and cook and use electricity, but you're probably going to get a lot of government subsidies to support the construction of the whole system in the first place.

Ben: And I imagine a lot of this is about payback. Yes, you've got all that money to begin with, if you can just stomach that for a few years. How long do you think some of the systems you've done have taken to repay?

Justin: With government subsidies how they are at the moment – or the incentives we ought to call them, rather than subsidies or grants, because you have to do the work and then claim back the incentive – normally, the incentives for generating electricity go on for 20 years. So, once you're in, you get paid for the next 20 years, which is extraordinary. For the heat, it's normally about seven years.

Assuming everything being even, with heat, you'd probably get your money back between three to five years after the cost of installation. Normally, you'll get about 12 to 20% return on investment for the initial capital cost over a seven-year period. After that, you've got hugely reduced running costs forever more. So, it's definitely worth doing, so long as the government grants are out there.

Ben: Justin, it's always good to catch up with you. Thank you very much.