# Octopus Podcast Ep7 Heat Pumps - Transcript

**Russell:** [00:00:00] Thanks for downloading Inside Octopus, my name is Russell Goldsmith, and for the first time on this series, we're not recording the show online. Instead, we've come to Octopus Energy's brand new £10 million flagship training and R&D centre in Slough to get an exclusive prelaunch tour of the facilities and discuss why heat pumps are the future of heating. Following all the COVID guidelines to be here today, I'm thrilled to be joined by four members of the Octopus Energy team. So, it's a welcome back to the podcast to Clem Cowton, Director of External Affairs. And then a first time welcome to Aimee Clark, Head of Commercial, Peter Konowalczyk, who looks after the electrification of heat here. And then finally, John Szymik, CEO of Octopus Energy Services. So, first of all, John, we should probably explain to our listeners just exactly where we're recording today, because this place is huge.

**John:** [00:00:50] Yeah. So, we're in our new state of the art facility just outside of London. It’s a training and R&D facility where we'll train upwards of a thousand engineers a year to install renewable heating systems from the end of this year onwards. It's huge. It's big enough to build about 20 homes in here, we've currently got two full size houses that we'll be training on. And I think we're going to do a walk around later. So, we'll talk a bit more about the detail then.

**Russell:** [00:01:10] Yeah, very much looking forward to our tour later John. But let's kick off this episode. We're here to talk about heat pumps and why you guys believe they are the future of heating. So, Clem maybe you can start by just explaining the reasons why we need to decarbonize heating.

**Clem:** [00:01:24] Well, from a very high-level, man-made climate change is killing the planet and we're running out of time to stop it. So, our government and many governments around the world are trying to put in place policies that will enable us to stop burning the gases that cause that climate change and those extreme weather events. One of the biggest culprits, particularly in the UK, is gas, the gas that we burn in our homes to keep us warm and to cook our food. And that heating in the UK, accounts for about 14 percent of our emissions. So, it's a huge, huge sector that's just not really been addressed yet. One of the best ways to do that, not just in heating, but just generally is to electrify, because we're able to make electricity cleanly from natural resources like the wind and the sun, and those resources are abundant and free. So, if we can harness them, we can make very cheap electricity and in turn we can use that to turn into clean heating. So, by doing so, will not only help to address the UK's contributions to man-made climate change, but we'll also be able to stop burning gas inside our homes and hopefully make our homes more modern, safer, cleaner and have a more enjoyable heating experience.

**Russell:** [00:02:45] Do we know how many homes in the UK have gas boilers?

**Clem:** [00:02:48] It's about 18m homes. So, it's a massive, massive number. And actually, we're installing 1.7m gas boilers every year. So, we're actually increasing that problem. That's good news, though, because it also means that if we if we move to an electric source of heating instead, we can overcome it within sort of 10 short years if we carry on at the pace that we're going at the moment.

**Russell:** [00:03:10] Peter, why do you believe heat pumps are the answer then, because I've seen a lot of media coverage about them recently. It’s often the same challenges that are highlighted in that they cost £10,000 versus a £2,500 for gas boiler. You've got to re-pipe the whole house, maybe need new radiators. The hot water doesn't become hot. Are they realistic?

**Peter:** [00:03:32] It's very frustrating to answer questions like that, because actually it is absolutely possible to heat up houses by using heat pumps rather than gas boilers. Look, heat pump is really old technology. People don't know that actually, heat pump is more than 100 years old as a technology. In 1748 the first, artificial refrigeration was established, designed by a Scottish engineer. That's interesting to know. And since that time, of course, we didn't have enough technology to develop it and build it. But right now, heat pumps are really established. If you look at that, we are all familiar with air conditioners. We all have fridge and freezer in the home. We have cars with aircons, and this is normal and natural part of our life. So, it is sad that I have to quite often explain to people that heat pump is actually what they already use. Gas boiler is the unit which does internal combustion, so you are burning gas inside the house and by burning gas, you produce hot water and heating. However, when you look at heat pump, heat pump actually has a technology it's very simple. Heat pump actually harvest energy from outdoor, for example, heat pump out a little bit of electricity and actually produce heating on the other end. There's no burning. Nothing is it's just very, very simple device. And if you look at standard heat pump efficiency is around three to four COP. So, this is when one kilowatt of input of electricity, you have three kilowatts harvested from outdoor, so you produce four kilowatts of output, this would give you COP four. But when you compare with COP numbers, the gas boiler rather than have four, gas boiler has got 0.9. So, this is so far to achieve this what heat pump just easily can achieve. I cannot believe that people really ask how heat pump can heat up our houses. If we size heat pump correctly to house heat load. If we size correctly hot water cylinders, we never run out of hot water. We never feel cold. It will always work with us. And as long as heat pumps can provide enough energy to compensate heat losses, we’ll be fine. And actually, sizing radiators, people as well said there are lots of investment inside house. Yes, sometimes houses have very small radiators, and they need to be replaced to bigger. Sometimes we have to think about slightly bigger pipes. We try to avoid that, obviously, because this will require bigger work. But 90 percent of houses do not need to be very deeply updated. They can easily be compatible with existing heat pumps, especially new heat pumps, when they can work with much higher temperatures.

**Russell:** [00:06:33] So, Peter, let me just understand this, right. You take one unit of energy and then you turn that into an additional three. How does that work exactly?

**Peter:** [00:06:41] Actually, additional four. OK. So let me explain it. You take one unit of electricity, and this electricity will actually be used to harvest energy from outside. So, you take one unit of electricity, you harvest three units of heat from outside. And in total, you have four units of heat, which you can utilize to heat up your house or hot water. It is actually equivalent to the process. Fluids inside heat pump does the main work and actually heat pump is like a fridge. You have cold side, and you have hot side . In a fridge we use cold side to place where we store food. Actually, heat pump works in reverse, so we use hot part of the fridge to heat up our house and cold side sits outside. And when you have correctly sized heat pump, you can heat up whole house compared to, for example, boiler where you have to use very strong boiler to heat up house when you work in reactive mode. So, when you heat up water, you have to do it very quickly. Heat pump can work very slowly and gently. And in this case, you can use much smaller units than boilers. Boilers are typically 30 kilowatts. Heat pump to heat up house will be like 10 kilowatts maximum, six seeks quite often. So actually, size of the heat pump doesn't have to be that big and still based on good controller, good understanding of human behavior and understanding as well weather conditions, that’s very important, heat pumps can prepare a house for you. So, before you arrive, heat pump can start heating this up. Heat pump can produce hot water as well on good time when actually its cheaper energy and heat pump can work for you and with you rather than like a boiler where you have very quick reaction, which actually is unnecessary.

**Russell:** [00:08:53] So this makes it a much more efficient system, then?

**Peter:** [00:08:56] Absolutely, yes. Again, as I said, one kilowatt of electric can give us four kilowatts of heat in total. This is fantastic compared to boiler, which is efficiency 0.9, heat pump has got efficiency four. That's very big difference between both.

**Russell:** [00:09:17] Aimee

**Aimee:** [00:09:18] And just to add on that, what that efficiency means in terms of carbon impact is if you've got a quarter less energy, it's roughly a quarter less carbon as well. So, in terms our overall objective of moving to net zero, if everyone got a heat pump installed in the home, that would wipe out three quarters of their carbon footprint. And as we invest more in renewables, in the grid becomes more green, that will eventually go to 100 percent and they'll be completely net zero.

**Peter:** [00:09:46] There's one more thing which I want to add. Heat pump doesn't burn gas. That's very important, he doesn't emit any NOx any CO2, there's nothing. Heat pump is very, very green.

**Clem:** [00:09:58] It's important to clarify that NOx is a gas a bit like carbon dioxide that also contributes to climate change. But more so than that, it’s toxic inside the home, it actually contributes to asthma, particularly childhood asthma. Poor air quality in the UK, kills around 30,000 people every year. So, this is a very serious problem that we need to address. And part of that problem is inside our homes with the poisonous gases that we're burning there.

**Peter:** [00:10:28] But this is one of the answers. This is like technology answers, I believe actually John can answer that as well from an installation perspective as a large part of heat pump is actually installation cost. This is the part where proper savings can appear.

**Russell:** [00:10:46] Well, John, do you what do you want to pick that up then? I mean, why aren't there more heat pumps in UK, homes right now?

**John:** [00:10:51] Well, I think there's a number of reasons and challenges, but these are things that Octopus are looking to overcome. Cost is currently an issue; a heat pump installation is around £10,000 to an average sized property versus two or three thousand pounds for a gas boiler. It's technology that people aren't hugely familiar with either. I think to understand why it costs so much; you really need to know how the industry works at the moment. And it's effectively an industry that stitched together with small installers that don't necessarily have the buying power or the resources available to really drive down the cost and optimized insulation processes in order to bring these costs down. That's something we can do because we can do this at scale. So, we will optimize the installation process, as Peter points out, we'll make sure that we've got the right people with the right skills, the right parts of the job so that we can reduce the install time and that will directly bring down the cost of these units. It's not something we'll do on our own. We want to continue working with third party installers across the country. We do that now with other technologies and that will always be the case. But we also want to work with manufacturers and the partners that share the vision to decarbonize heating with us to ensure that we get the best possible price for the hardware, so that when you combine reduced installation cost and a reduced hardware cost, you significantly drive that price down. And for us, that's the key starting point. Bring the price down to a point where it’s parable with the gas boiler exchange and then all the other benefits around heat pumps that we've talked about already and we'll continue to talk about in this podcast will be accessible for the mass market.

**Russell:** [00:12:21] Clem.

**Clem:** [00:12:22] Just listening to what both Peter and John were saying, you see massive parallels with electric vehicles. I mean, my nana drove an electric van during the Second World War. And yet it was only when Tesla came into the market and really created a kind of mass consumer product that those costs started to come down. And we're now seeing a revolution in how we drive around our roads. The same will be true of heat pumps. It's not a new technology. So, there's a kind of reassurance that we know how it works and we've got it down, it's not rocket science in terms of how we create the actual technology. But the smart bit is creating a mass market where people really want it. It's easy. It's tangible. People can just, you know, see immediately that it works better than what they've got already. And by driving that scale, we're able to then through the combined innovation of John and Peter and their teams we're able to create this product that the majority of people in the UK will have in their homes within the next 10 to 15 years.

**Peter:** [00:13:21] And this is exactly why I wanted to join Octopus. I’ve seen Octopus like a Tesla of Heat Pumps. This is a company where, rather than talk about electrification of heat, this is a company that wants to do it. This is why I’m here.

**Aimee:** [00:13:38] Absolutely. I mean, 40 percent of people say their next car choice ill be an EV. And you can see heat pumps being there in a few years’ time.

**Russell:** [00:13:47] Well, Aimee, let's stick with you. I mean, what about in terms of the cost to run these? How does that compare?

**Aimee:** [00:13:52] Yeah, so that's definitely another area we're looking to overcome. So, despite the fact that heat pumps are so much more efficient, as Peter said, they're four times as efficient as your average gas boiler because of the way gas and electricity is priced, you know, a lot of the taxes applied just on the elec and not on the gas. That means electricity is five times more expensive than gas. So, when you net those two things off, it's still more expensive to run heat pump than a gas boiler today. We're trying to tackle that. So, we've got some customers using our smart tariffs, like our agile tariff, which varies based on how much green energy there is on the grid. And through using that and programming their heat pumps to run more in off peak times, so putting it on, say, a couple of hours before the peak period in the evening, we've been able to kind of reduce that gap almost to zero. So, it definitely can be done, but to really drive the savings for customers and reach the majority of homes in the UK. That's why we need the policy changes, which I'm sure Clem will have a few things to say about that.

**Clem:** [00:14:53] Well, yeah, I was just thinking about the fact that this quote may not actually originate from him, but Sam Hall, who's the director of the Conservative Environment Network, recently described it as being like putting the sugar tax on bottled water. You've got a fuel that is already 40 percent renewable and getting cleaner all the time, being taxed 10 times more than a fuel that is dirty and is causing not only safety issues in our homes, but also contributing to climate change. The way that you incentivize behavior change is that you make it cheap and easy for people to move to the alternative technology, the alternative product, as we have in electric vehicles, actually, you know, fuel duty on petrol has made filling up a tank of petrol much more expensive than just plugging it into your socket at home. And that's the kind of position we need to get to with heat pumps, it's actually closer than we think. The government recognises that this disparity exists and actually the secretary of state for energy mentioned in an interview in The Times at the beginning of July the fact that the government was really concerned about the differential between the taxes paid on gas and on electricity and that disparity that that creates in terms of how we're asking people to change their behavior. So, it's definitely on the government's radar. I think there's been a little bit of a nervousness historically about the ability of companies in the market to really drive that consumer demand to make a product that people want. They're a little bit nervous that if they take the taxes off electricity and perhaps a few more of them on gas, all that will happen is that, you know, you'll be left with the same problem, and nobody will step into the market and provide the products that people want. Actually, what we're saying is we're able to do that. We've done it before with electric vehicles and with renewable energy. And now we're able to come into the market and make a product that people will really want and that will accelerate our transition to a zero-carbon economy.

**Russell:** [00:16:51] Are Octopus Energy, doing anything in particular in terms of working with government on these policies?

**Clem:** [00:16:56] The way we tend to work with government is to open up, to be transparent, to show what we're doing, to show our workings. So, yes, we've been working, I don't want to say closely with government because government makes their own policies, but we have given them the tools they need to understand the reality of the market we're working in. Historically, governments tend to have been told by businesses who'd really like lots of subsidies that the products that they're making a very expensive because they want the governments to subsidize those products. Actually, we're coming into government with a very different message, saying we can make these products very cheap, just take the brakes off and we'll show you what we can do. And I think that reassurance means that governments, that this government is starting to think a lot more seriously about how we tackle this as a mass market proposition rather than perhaps what was historically the case, which is that we would, you know, try to find a few off gas grid homes with oil Agars and try to just do those few very difficult homes who are now starting to think bigger and much more ambitiously about how we can put heat pumps into the vast majority of homes in a way that is a much more enjoyable heating experience.

**Russell:** [00:18:10] So once you've got a heat pump installed, how long is that going to last?

**Aimee:** [00:18:15] So typically they last over 20 years, compared to about 10 to 15 years for gas boiler. And that's because there's much fewer moving parts, it’s much lower temperature. So, you know, with a gas boiler, you have a combustion chamber and you're literally burning stuff while the heat pump, you know, it doesn't tend to get above, say, 55 degrees. So that means it's much easier to maintain and also less likely to break down and last longer. It's a bit like having a fridge in your home. If you think about how many times that's broken down, it's probably much less than say, a boiler. So that's another kind of key benefit that heat pumps will bring.

**Russell:** [00:18:51] So, Aimee, if these policy changes are implemented, is everyone going to be getting a heat pump?

**Aimee:** [00:18:58] Absolutely. We've done some initial testing with our customers and the general public, and the response has been overwhelming. So, we found when you position heat pumps in a simple way, we call them green boilers because that's what they are, the green alternative to heat your home at an affordable price. So, with the prices we believe we can get to, with all the work we're doing in the centre, and you have a really simple customer journey, there's huge interest. So, we put a page live on our website and within a few days we had over 2000 sign ups. The challenge is most people only replace their heating when the current boiler is about to break. So, at that point, you know, it was quite a distress situation. You need something that's affordable within a few thousand pounds. You need it installed quickly and it needs to be really simple. So that's what we're looking to achieve through all of the optimization work we're doing here. We're not just looking at costs. We're looking at all of those things. So, when they go to replace their boiler, you know, heat pumps are a no brainer.

**Clem:** [00:19:55] If we started off from a I think it's often kind of worth thinking about what would we do if we were starting from scratch? Pre-Industrial Revolution, perhaps before, you know, before we all had coal being lugged into our homes? Would we have thought the best way in the future that we'll heat our homes is we'll pump some explosive gas into a very noisy box on the wall and then burn it? Probably not. So now that we've got electricity, we've got these incredible technologies, it seems kind of almost insane not to use them. They're much safer. They're much cleaner. And you get a better experience. We shouldn't sort of shackle ourselves to the solutions of the past just because that's what we're used to.

**Russell:** [00:20:36] Okay. Well, as I mentioned at the top of the show, we're having this conversation at your brand-new training and R&D centre. So, John, should we head out for a tour so you can tell us a little bit more about what you have here and how that's going to help in getting heat pumps into more homes?

**Russell:** [00:20:54] So, John, we've started the tour. Just explain where we are. First of all, then.

**John:** [00:20:59] Yes, so here we are inside the demonstration room. The point of this is to bring visitors to show them what the future technology inside a renewable home would look like. So, what we're looking at here is an example of how you could electrify your home so you could run your car charging, your heating, you could have battery storage all running from green renewable electricity that we've generated and supply to you.

**Russell:** [00:21:23] Yeah, I was just going say, for the sake of those listening, because obviously, I mean, we'll have some supporting images for social media, but can you just explain what we can see on the wall here?

**John:** [00:21:31] Yeah. So, what we're looking at is a smart meter, which is a vital enabler to be able to run all the other renewable technologies and the Smart Meter rollout program is in full swing now. So, we've got a smart meter through to some batteries. So, these are give-energy battery units which actually store excess power. So, if you've got solar panels, for example, we can store the power that you're not using and use that later on. We've got a vehicle to grid charger here. So, these are incredible piece of kit. So, what this does is it allows you to charge your vehicle, but it can also take power from your vehicle and put that back onto the grid or into your battery. So, at times when energy is being generated from non-renewable sources, for example, when it's particularly expensive, you can actually extract the surplus power from your car at times when the energy grid is very green and the prices therefore typically are low as well, you can take power and put it into your car. So, it just allows you to kind of almost run a mini energy centre at home, which is really exciting technology. And then there's a full life,

**Russell:** [00:22:29] I was just going to say we should say that, yeah,

**John:** [00:22:31] Yeah. So, we actually have got a vehicle inside here to show people how that would connect to the chargers and how that works. So, we've driven that in very, very carefully. And then just on the other side here, we've got an example of a wind turbine. Octopus invest in renewable generation. So, we do actually have wind turbines in the UK and there's a solar panel on the wall there as well. Again, we generate a lot of renewable energy from solar in the UK.

**Russell:** [00:22:54] So this is already looking good. But I know the real kind of like the big stuff is behind this wall here. So do you want to just talk us through that.

**John:** [00:23:02] Exactly. So, yeah. So, we've got a switch glass wall here that's frosted. So, when our visitors are ready, we can we can flip the switch and then they'll be able to see what's on the other side of that. And if we walk round here, what you'll see Russ, is we've got two full size houses.

**Russell:** [00:23:15] Wow. So, I mean, for those I'm trying, obviously you're here every day, but this we're kind of stood in what looks like a huge aircraft hangar, basically. I mean, this is massive.

**John:** [00:23:272] Yeah. It really is a massive space. You could probably drive an aircraft into here no problem at all. We had HGV in here actually the other day unloading, and it was just tucked over in the corner of the building dwarfed. But you’re right, you take the scale for granted a little bit when you're here every day. But yeah, it's just in the corner of this building are two full sized, three-bedroom houses now what these are is typical construction types that we'll come across. So, these are effectively live training rigs for our engineers. So, the first one we're looking at here, which is a nice white rendered house is a sort of 2000 era this is a timber frame property and this is typically how they would have been built and it's built exactly as it would have been with the right heating types, right plumbing systems, right electrical systems. So that allows our engineers to practice on a more modern home. And what they'll be doing here is taking out a gas combi boiler, for example. They'll be putting in an air source heat pump and vehicle charging another technology, maybe battery storage. But we looked at just there and the next to that, we've got a 1970s brick-built house. So, again, this is built exactly how homes would have been built in the era. We had to find some very experienced builders that could remember exactly how all these houses were stitched together back then. But again, slightly different construction type - cavity walls, brick built, all the heating system is run with copper pipes, electric meters tucked under the cupboard under the stairs, which is where you typically find them in those types of property. So, again, this is another example of a live house where engineers can train to take heating systems in and out in practice to fully optimize.

**Russell:** [00:24:54] And just remind us how many are going to be trained a year here.

**John:** [00:24:57 We'll be training about a thousand engineers a year here, and those would be our own directly employed engineers and will also be working with the third parties that we support. We have a network of smaller organizations across the UK that we work very, very closely with and we want to continue to do that.

**Russell:** [00:25:12] And that's going to be every day. As soon as you’re open for business.

**John:** [00:25:17] Exactly that. Exactly. As we drive customer demand, therefore, we need to drive the number of qualified engineers that we have. And, you know, and that's what we'll start doing from later on this year.

**Russell:** [00:25:25] Okay, so just explain. So, we've moved past the houses, now, I can see a whole load of pipe work. But what was an original combi boiler on the wall is that?

**John:** [00:25:35] That's right. Yeah. I mean, I'm hoping that will ultimately become a museum piece. Our objective here is to rip all of these out of properties in the UK and replace them renewable heating. But there is a combi boiler system in a training rig here. So, again, our engineers can practice how to decommission those systems, take that out of a property and you've got a series of training bays here with all different technologies in, and so you take the old system out of one and in the training bay next to that, they'll be practicing and installing a heat pump system, for example, and the hot water tanks that go with that.

**Russell:** [00:26:01] Just on the other side of this wall, then, this is where we've got the heat pumps. You've got a couple of different sizes here, just explain the different sizes and what the difference is.

**John:** [00:26:14] Absolutely. Some of these heat pumps are different sizes for different property types. So, like your gas boiler, depending on the size of your property, you'll have a different heat demand and therefore you'll need a slightly different sized heat pump. So, we've got everything from a typical heat pump that you would use here for two, three-bedroom house to a slightly larger unit over there, which might be, you know, four or five bedroom property. You know, we can tackle any property size with the different hardware. And we've got training rigs where engineers will be able to fault find, identify issues. Part of the ownership experience of a heat pump is that we will provide maintenance and servicing for those. They're much more reliable than a than a gas boiler, as we talked about earlier. But in the rare occasion where there might be a fault to diagnose and then this is the sort of a training rig that you would practice that and try and identify those.

**Russell:** [00:27:02] And in here, looks like we've got like something it's almost like being dissected. We can see the inside and the workings here. Just explain what we're looking at.

**John:** [00:27:09] Yeah, we've built this actually to show people what's inside that magic box that is a heat pump. You have the box of magic that sits on the outside of the house. But really, what's inside there is almost like a refrigeration unit working in reverse, as Peter described earlier. So, you've effectively got a fan, a heat exchanger, and a compressor. And what we can demonstrate here is drawing in cold air. And in this example, we're actually using the heat that we generate from that to warm up the water in the fish tank here just for demonstration purposes. But obviously in your home, that would be warming up the water that's in your hot water tank for your showers and for your hot water out the taps. And it would also be providing you hot water for your heating system, for your radiators.

**Russell:** [00:27:48] And it's not just the heat pumps that you're dealing with here, is it because we just walk past another area?

**John:** [00:27:53] Yeah, absolutely. So, we're installing about 10,000 smart meters a week at the moment with 500 engineers all across Great Britain installing those day in, day out. So, what we've got here is training rigs for all different types of metering that engineers would come across. You can imagine engineers come into homes and find all manner of ages and design and types of meters in existing positions. So, this is to allow them to train on that. We can also train there on electric vehicle charging point installations, battery storage installations, and gas and electricity meters as well.

**Russell:** [00:28:21] And I need to ask the question, because when we arrived here, we walked past the first part of this, as I said, which is like a huge aircraft hangar. And there's 10 very smartly branded up Octopus Energy vans. Just what's going on in this section here.

**John:** [00:28:39] These are actually the first half of our new order of fully electric vans. So, these are Peugeot electric vans. Our engineers will be driving these very, very soon as part of our drive for decarbonization. We also have to think about the emissions of our fleet and we're electrifying our fleet. And these are the first examples of how we're doing that. So, fully electric vans brand new wrapped in the bright Octopus livery.

**Russell:** [00:29:02] Yeh, you can’t miss these can you!

**John:** [00:29:04] Absolutely. And you'll spot the difference on these ones because they've got a nice green glow in the dark electric cable running down the side so that people know the difference between these and the diesel version. So, yeah, these are part of our new fleet. And also, what we've got here is a huge amount of space where we're going to have our R&D centre. So, what will actually be doing here is testing the sorts of hardware that we were looking at earlier. So, heat pump hardware, for example, and we will be able to test that in weather chambers where we can simulate weather conditions and weather patterns from any point in time, all sorts of stress testing, research and development, continuous innovation, which is going to be necessary as we drive the roll out of heat pumps in the UK over the next few years.

**Russell:** [00:29:42] John, thanks for that. It's just an incredible, incredible space and everything that you're doing in here. So, I really appreciate the exclusive tour for Inside Octopus.

**John:** [00:29:50] Thanks for coming down.

**Russell:** [00:29:53] Well, that's actually it for this episode. So, John, Aimee, Clem, Peter, best of luck with all you're doing here. And thanks again for joining us on Inside Octopus. As always, if you've got any comments on anything we've discussed today, please do get in touch via the website that Octopus dot Energy or via the usual social channels. But for now, from me, Russell Goldsmith. Thanks for listening and goodbye.