Sarah Clack:

So today we're here to talk around irrigation energy savings for horticulture, and so we've got Nick O'Halloran and Jeremy Giddings from Agriculture Victoria who are in our irrigation extension team, who go out on farm and do energy assessments of pumped irrigation systems as part of their work for us. So they're going to be sharing some of their findings around those assessments with us today and things that farmers, horticulturists can do to improve the energy efficiency of their irrigation system. So I'll hand it over to Jeremy to get started and if there's any questions, if anyone's having any issues, please pop that in the chat box for us.

Jeremy Giddings:

Thank you Sarah. Thank you for the opportunity to speak. Nick and I have worked on a bit of a presentation and we've found four areas where energy efficiency can be improved. And an easy one is irrigation volume and don't over-irrigate. And we're going to talk about these four topics. So irrigation volume, system performance, quite brief. And then Nick will get into pump efficiency. And then I'll talk a little bit about reducing head requirements with hydraulic optimization and selection of irrigation hardware.

Jeremy Giddings:

I guess with horticulture we've seen a need to adopt drip and micro from a water saving point of view and that brings in energy costs. We've moved away from surface irrigation a long time ago for many people, most people. And now we pressurise our water application and that brings with it in energy costs. And as we've seen over the last 10 or 15 years, an increase in energy charges. So now more than ever we've seen a move to be efficient with energy as well as water, and we do that through irrigation design and through management. And I hope we can address some of those items this afternoon.

Jeremy Giddings:

The first one, and the easiest way, to reduce energy costs is to reduce your pumping time and avoid unnecessary pumping. And this is a topic that we've been talking about for years as a department. There's workshops and fact sheets and everything about irrigating correctly and it's a whole other subject. And I'll quickly go through, but the two main areas that we can reduce our pumping through applying an even application and that's keeping an eye on our pressures and our discharges, whether it's drip or micro, and end up with an even application rate. And again, like I said, this is nothing new from the department, it's been a theme or a push from the department for decades.

Jeremy Giddings:

For good irrigation management, we want to end up with an even application. And the image on your screen was from a study done a few years ago showing the application uniformity over a patch, over a vineyard, and we see a lower application rate only by about a millimetre an hour, on the right-hand side of the screen, and up the top near the green sub-main there is about a millimetre more being applied. And in the past we would've said simply apply more water to make up for that dry spot, now we say fix the uniformity. Water is too expensive, energy is too expensive, the fertiliser losses that go with that, so good irrigation management assumes an even application.

Jeremy Giddings:

The other thing to reduce your pumping time possibly is to start scheduling if you're not already. And sometimes, not all the time, if you start to schedule you can identify over-watering. And here is an irrigation trace on some citrus, first time scheduling for these irrigators. And you can see the trace dominating the top part of the screen in the blue, until about late December when they started to read their data and start to stretch it out and save a little bit of water on the application. And as well as that, these trees started to bounce out of their skin and started to improve their growth and productivity.

Jeremy Giddings:

So they're the two areas. It's a very small subject, we talked about another time. When you do start scheduling, you don't always find that you're over-irrigating, and more often than not, particularly with high-value, high-water use crops, we see an under-watering at the start and our irrigation scheduling actually increases the application. But it is what it is and at least your water is going to the right areas, it's not going out the bottom of the root zone and it's going towards productivity. And that's all I'll say. That's the easiest one to address, is don't over-water to begin with. I'll hand over to Nick.

Nick O'Halloran:

Yeah, rightio. So thanks Jeremy. So what Jeremy's really talking about there, and the first one is reducing the amount of water that we have to pump, which obviously reduces the energy consumption. So the two areas that I'm going to be talking about, and Jeremy, towards the end, one's about reducing the energy requirements per megalitre pumped, and that's really about reducing the pressure that we have to pump against. So every metre of pressure that we're pumping against, at measure at the pump, if you've got a good efficient system is costing about a dollar per megalitre. And as the pump efficiency goes down, as the efficiency of the pump goes down, that cost goes up. And the second thing I'll talk about is improving the efficiency of the pump itself and the way we can look at that.

Nick O'Halloran:

But so operation and maintenance is one of the key ways that we can reduce the energy consumption per megalitre pumped. And the simplest way of doing that is really by running our system to the specifications and not over pressurising the system. So we'll have a bit of a look at what that might look like, why that happens, and some in-field pressure sensors that I think are an important part of... We can go out and just measure pressure and we can change our system, but we'll show there's some risks associated with that, and sensors could be useful in terms of just optimising but also making sure we haven't got any issues with the system.

Nick O'Halloran:

The second thing that we can do is really maintaining the system. So reduce friction losses in our existing system, so getting rid of those biofilms and algae that build up and increase the pressure loss along our irrigation system. That means that we've got to run the pump at a higher pressure to achieve the required pressure at the end of the system and that means higher pumping costs. A bit like Jeremy, I'm not going to go into too much detail here, there's a whole day course on that, but it's really about having systems that we can flush. And this is a big one, I work with annual horticulture quite a bit, having a system with flushing main so it's easy to flush and so that we do do it as required and then using the right products when we're flushing, so chlorination or acid treatment to reduce that head loss in the system.

Nick O'Halloran:

But how do we know what pressure we're meant to... or how do we know we're operating the system correctly? Well hopefully most of the farmers we work with or the farmers here, have got irrigation plans. And I know a lot of farmers I work with have them but don't look at them very often, but the plan will tell us exactly how we should be operating the system. A lot of farmers can tell me what pressure they run at the pump, but it's actually the end of the system or at the valves that really dictate how well the system's working and what opportunity there is for savings. And so most of the plans will have the pressure requirements at each of the valves. So here for this particular shift, most of these valves are operating at between 11 and 13 metres. So we need to check that the pressure's correct at those valves. And we can also check the pressure at the end of our lateral. So how much pressure head loss are we losing in the system here? And that relates to how well it's designed and that maintenance, whether we're getting buildup of algae and that sort of thing. And this also tells us what pressures we should be expecting. The minimum pressure here that we should be expecting in that system, sorry, that's maximum, minimum, at the end of those valves.

Nick O'Halloran:

When we're trying to work out how much we can actually reduce the pressure in the system, we need to go to the furthest, potentially one of the largest valves, but the furthest valves on this system our pumps here, we need to go to the furthest valve and look at the end of that valve to make sure we're getting enough pressure there, and then adjust the pump back to reduce that pressure. If we just adjust the valve pressure, we're just moving the residual pressure, there will just be more residual pressure here, there's no energy savings. We actually have to change something at the pump to achieve those savings.

Nick O'Halloran:

The risk, as I said, this is some data that we've been looking at irrigation systems, this is the pressure at different valves at different times, each dot is a different time. And in a lot of cases, as Jeremy said, we've got low pressure. So we've actually got low uniformity because we're not getting enough pressure to the end of those or at the valve, so there won't be enough pressure at the end of those laterals. But then we've got these other measurements up here that are too high. And as I said, for every metre that pressure is too high, it's costing us a minimum of a dollar a megalitre.

Nick O'Halloran:

What we've seen though is that these do actually drift considerably and these measurements were done over a day or two and we're looking into whether maintenance is required of the valves, so is it just that the valves aren't controlling pressure correctly or is it that we're running different shifts and so we've got different upstream pressures and that's resulting in different downstream pressures. But this is one of the places that having those pressure sensors on the valves or on the system, we can keep an eye on that and adjust them as required. There's commercial systems available out there, but we've got a system that we've developed for our assessments where we can put it on and measure pressure over a number of irrigation events and monitor what's happening.

Nick O'Halloran:

This is an example of some data. On this particular system, we had loggers on the pump, on the valves and at the end of the laterals, and this is the pressure at the end of the lateral over a whole season. This system was required to run at about 100 kPa or 10 metres of head, and these are the pressures that we're actually seeing, each little cluster is an irrigation event. And we're seeing we've got almost 25 metres of pressure at the end of the furthest valve that we're measuring. So there's probably 10 metres of pressure that we could take out of this. And so almost $10 per megalitre in savings in energy here.

Nick O'Halloran:

The reason why we think monitoring's important and having these sensors on, is we can see that actually over the course of the season the pressure at the end is dropping and that's because the secondary filter at the valve is blocking up throughout the season. And so by having that monitoring on there, this farmer can now know exactly when the pressure gets too low and he can either increase the revs of the pump or he can clean that filter. But yeah, he can start potentially running this whole system at a lower pressure and making those savings. So as I said, important to monitor, you need to monitor at the furthest-most valve at the end of that system and then reduce the pressure at the pump to make sure we're achieving the right pressure at the end of the furthest-most valve to really realise those potential savings.

Nick O'Halloran:

So next I'll move on to opportunities to make energy savings through improving pump efficiency. So that's really looking at the pump that we select and how we go about selecting that pump. And a big part of that's understanding the best efficiency point of our pumping system. Look at the use of variable speed drives or variable frequency drives, which we use to speed up or slow down the pump. We do see a lot of these on systems, but some the pump selection isn't quite right or the variable speed drive just isn't actually doing anything, it's just set at a constant speed. And then we'll have a look at assessments and what we need to measure and why we need to measure, do these assessments.

Nick O'Halloran:

So when we're selecting the right pump, first of all we need to know the duty point that the pump requires. So for our system, this is a three shift system. Each of the shifts, so this is the blocks that will run on one shift. That shift requires a flow rate of 120 litres per second and a pressure at the pump of 30 metres of head.

Nick O'Halloran:

This is the pump that was on that irrigation system, or this is a pump curve for the pump that was on the irrigation system. And I'm going to have a look at these for a bit, so I'll just go through them. So what we've got here is flow rate at the bottom here in litres per second, and pressure that the pump's achieving in metres head. And so this pump can have a number of different impellers in it. So this is the largest impeller or the smallest impeller, it had the largest impeller in it. And what this shows you is as flow rate goes up, the pressure that that pump can achieve will actually decrease. And in actual fact, the efficiency of the pump increases. These are the efficiency lines, these numbers here. And as flow rate increases, efficiency increases to a point where it starts to decrease again. And that point's called our best efficiency point. That's the optimum point that we could be pumping out with this pump, but we rarely actually have a pump that's sitting at that best efficiency point.

Nick O'Halloran:

So for this one, if you were pumping exactly at that point, you'd be using about 100 kilowatts per megalitre of water pumped or it'd cost you about a $30 per megalitre. I've assumed 30 cents per kilowatt-hour. And it's running at full speed, we're assuming it's running at full speed, 1,480 revs per minute. Now this is a duty point that we actually require. That best efficiency point is a much higher flow rate than we require. We only require 120 litres per second and 30 metres of pressure. So if we've got that largest impeller there and the flow rate's going to be controlled by our irrigation system, we're running valves at the right pressure, so that controls how much flow there is. So we end up on this curve somewhere, and this is a point we should end up approximately. And essentially we create all this excess or residual pressure. So there's about seven metres of excess pressure there, so our pumping costs are about $15 higher than best efficiency point. That's because we've got seven extra metres of pressure that we're creating. But also we can see that the efficiency out here is much lower, we're about 70% efficient.

Nick O'Halloran:

So one option is to put a smaller impeller in that system and that'll get rid of some of that residual pressure at the pump. So that's going to save us about $5 per megalitre, if we put that smaller impeller in. The other option is to keep the original impeller, or it might be the smaller impeller, but I've assumed we're keeping the original impeller, but we've added a VFD so we can now slow down the revs of that system. And effectively what we do is we make sure that the pump now is running exactly on our duty point. We've slowed it down to 1,350 RPMs and there's no excess pressure at the pump. The other thing that the VFD does, you'll notice as we put different impeller sizes in, the efficiency of the pump reduces because we've got a smaller impeller in there, it can't as efficiently take up that space. But by just slowing the pump down, the best efficiency point actually moves with the new pump curve.

Nick O'Halloran:

And so at this point we've got now no excess head, but we've also... the pump efficiency's slightly improved. We're at about 77 percent efficient instead of, yeah, we're on that 75 percent line. So there's two advantages to that variable speed drive, if it's set up right and it's doing its job. We've just got to be mindful that when we slow it down to that, that we are actually achieving the right pressure at the end of the system.

Nick O'Halloran:

So as I said though, a lot of farmers that we visit, they’re annual horticulture and they'll actually plant smaller blocks in their shifts or they won't irrigate a full shift, so they're actually irrigating smaller areas than the system's designed to do. And so we're trying to actually achieve a duty point at a lower flow rate and we can see if we didn't have the variable speed drive, we are now creating even more excess pressure and we're moving to an even less efficient point on that curve. So our pumping costs have gone up to 55... It's $25 a megalitre more than the best case scenario for that pump.

Nick O'Halloran:

If we've got the VFD, we slow it down even further to 1300 RPMs. The efficiency, we're a little bit closer to that best efficiency point, but we've got no residual head. So where we've got these different duty points that we're trying to achieve, that's where the VFD really comes into play. If you've only got one duty point, then there's no need for a VFD. You just put the best impeller in in most cases and the most optimal pump. But where we've got these multiple duty points, VFD is quite advantageous.

Nick O'Halloran:

The other option is to just pick a better pump. So with that last pump our duty point was to the right of the best efficiency point. Here we've selected a smaller pump and the best efficiency point is now at about 115 litres a second, our duty points now to the right of that best efficiency point. Our duty point's also very close to the best efficiency point, so the efficiency is quite high and there's not a lot of residual head. But when we move to that smaller shift, so we move to that 90 litres per second for the smaller shift, we're moving from one side of best efficiency point to the other, so we're staying very close to best efficiency, and as we slow down that pump, it's moving towards our new duty point. So there's two real advantages to this new pump and having the VFD on that pump.

Nick O'Halloran:

The other thing we can look at is, well, why do we need that 30 metres head on this system in the first place? And we can look at what parts of the system are chewing up that pressure. So we've got the suction line, we've got the drippers, we need 12 metres of head for the drippers, we've got some friction loss across fittings and across the valve, we've got about five metres of friction loss in our pipes. And so that's what Jeremy will talk about, reducing that by improving the design of the system, but also that friction loss will increase as we get that algae and blockage and deterioration of the pipe work. So by managing our system, we're minimising the build-up and increasing this component of our pressure requirements. But then we've got this seven metres here for the filter and essentially most systems are designed to run to the higher pressure so that as the filter blocks up, we're still getting enough pressure downstream to have enough pressure at the end of the system.

Nick O'Halloran:

By making changes to where that VFD is controlled from, so measuring pressure downstream of the filter and using that pressure to control the VFD, when there's no friction loss or no... When the filters are clean, there's no head loss across those filters. The pump can now run at 1200 RPMs and achieve a much lower pressure at the pump, but it's still achieving the right pressure at the end of the system. And so that dramatically reduces our pumping costs and the efficiency of that system, because that best efficiency points moved even closer to our new duty point. Then as the filters block, up the VFD measures that pressure's not high enough downstream of the filter, so it starts to ramp up. And so depending on how dirty your water is and how regularly those filters have to be flushed, you'll spend time and once the pressure gets right back up to here, then the filters will back flush and the pressure requirement of the pump will decrease, so you'll be operating in this range. But hopefully if your water's pretty clean, spending a lot of time closer to this point.

Nick O'Halloran:

So some really big opportunities to reduce pumping costs through pump selection and good use of a VFD. We're talking, yeah, we got up to $55 per megalitre and we're down as low as $27. So we're talking $20 a megalitre, if we're pumping 100 or 200 megalitres, that's $2000 to $4,000 in savings per year by using that system well.

Nick O'Halloran:

So the important thing is to check how well the system's going. And we reckon the best time is as soon as the system goes in, make sure that it's doing what it was designed to do. But a lot of the older systems, we check them pump, test them to see that how much deterioration has there been, how much opportunity is there for improvement? Doing this is pretty simple. A little bit complex, but the actual measurements are quite simple, we need to measure power. We can either get that from a power board or a VFD can give us the power consumption of our pump, but we do need that to be dedicated to the pump or only the pump running on it when we're doing the assessment. We need to be able to measure flow rate at the pump and hopefully most people have got flow metres on their pumping systems, it's really important for just ongoing monitoring of the system, and we need to be able to measure pressure at the pump. So this is important when we're testing the system. When you're monitoring it, you want to be monitoring pressure at the end of the system, but when we're doing a pump test, we want pressure at the pump itself. And if we've got a VFD, we need to know what speed the VFD is working at when we're doing the pump test.

Nick O'Halloran:

The reason we do this is what we quite often find is that the pumps aren't achieving the duty points that they should be doing, at the speed that they're doing. So this is an example of pump tests that we did. There was two different pumps, pump A and pump B. Had similar duty points. This is what we actually measured, so doing about that 150 litres a second, 36 metres head. Both were identical pumps, they should have only needed to be doing 1,550 RPMs to achieve those duty points. Pump A was doing 1,800 RPMs and that's all it was achieving, and pump B was doing 1,700 RPMs. So there was obviously a problem with these pumps, they weren't that old. Perhaps impeller deterioration. We think this one has probably been cavitating at some stage and damage the impeller. Might be wear rings on them that need replacing.

Nick O'Halloran:

But also the design of the suction system can impact that and that can be... Or in some cases the pumps just, the way they're set up will never actually achieve the duty point at the revs they're meant to. But sometimes it's design and we see these systems with abrupt turns, bends in suction pipes right before the water goes into the impeller and that really affects the performance of those pumps. And the other big ones, these constrictions just before pipe work goes into pumps. And if that's too abrupt, that has a big impact on the efficiency of the pumps. This is a brand new pumping system that was running at about 15% to 20% below what it should have been, and we think it was largely because of this really abrupt constriction. So ideally they should be designed so that they're more gentle so that the length of that is three times the change in height and the water will more efficiently move into that pump and it'll be more efficient.

Nick O'Halloran:

So yeah, doing that test, really important to know how the pumps performing in that situation on that system. And there's a number of tools that are available. Rob Welke, who we've done some work, has got some really great tools. You do those measurements we spoke about, put the data into the tool, and it tells you what the opportunities are, what the savings are. We've done a similar one for centre pivots and travelling irrigators and developing one for drip irrigation systems. It's a fairly visual one where it shows you exactly where you need to take measurements on the system. And then it tells you your motor efficiency, pump efficiency where head losses occurring in that irrigation system and what the residual pressure is, and adds up the potential savings of that system depending on how much water you're pumping. And we've seen some pretty substantial opportunities for savings by improving the design of these systems.

Nick O'Halloran:

So key points for pump selection is really about when you're operating the system, for every metre you can reduce at the pump, you are saving approximately or better than a dollar a megalitre in water pumped. When we're selecting a pump, we want to select as close to that best efficiency point as we can. And if we've got a variable speed drive or a variable frequency drive on our system, select so the duty point is to the right of best efficiency point for the higher duty points, the higher shifts, flow rate shifts, and it moves to the left when we reduce the size of those shifts. And if we can control that VFD by measuring pressure in the system, the further along the system we can measure pressure the higher the opportunities are. So if we can measure pressure, control the VFD from pressure after the filter, that's even better. Or best case scenario would be controlling it from pressure at the end of your laterals and making sure that there's no excess pressure in that system, and potentially huge opportunities for energy savings there.

Nick O'Halloran:

So I'll pass back to Jeremy.

Jeremy Giddings:

The fourth and final topic is about hydraulic optimization. And as Nick has touched on, regardless of the system, whether it's drip, sprinkler, centre pivot; the higher the pumping head, the higher the pumping costs are. And it's just a normal relationship that exists for all irrigation. This is an old bit of data for me, it actually says that for every 10 metres of pumping head it's costing you $13 for every kilowatt-hour. Regardless of the tariff, regardless of the irrigation system, that relationship exists. So as our energy costs have increased due to no fault of our own, there's been more effort at looking at reducing that pumping head, which is what we do have a little bit of control over. And that's where this term of hydraulic optimization comes in and it's all about identifying the critical valve or the critical pathway which is driving that total head, and that is what determines the pumping head. And is there something we can do at that critical pathway, that critical valve, to drop the pressure required.

Jeremy Giddings:

I'm borrowing some slides from an irrigation conference over 10 years ago. So this sort of stuff was started, we talked about then, and now with our current energy prices it's even more applicable. And here's an example of a critical valve where the engineers have looked at the system and found that by increasing, in this case some drip line from 17 mm up to 20 mm. So switching it over, we've got a lot of systems out there that are due for upgrading. So at the same time as upgrading, we look at the systems as a whole and think about energy savings and look at what can be done at the same time if the system is due an upgrade. And here by increasing that particular valve from 17 mm to 20 mm, there's some installation costs but it saves you three metres head.

Jeremy Giddings:

At the same time. You might look at some sub mains and some restrictions in sub mains. Old design decisions are different to what they are today and there might've been some mistakes made back then as well, but here we see a section of main line, or sub mains, sorry, increase from 50 mm up to 80 mm. Some installation costs there, but it saves ourselves one metre head. Add those together and we've got some prices, we've got some head savings, and if you look at the energy savings that can occur, and this is for a large system, you look at the cost versus the savings involved and with some assumptions in there, here they're saying that those relatively easy savings save themselves over $14,000 a year. Like I said, that was a large system.

Jeremy Giddings:

A more recent example and we've got a lot of systems, like I said, are due for replacements or due for upgrades. Here's quite a large system, over 600 hectares, an almond farm. Each of those purple comments in there are the suggested upgrades or changes to the irrigation design. The system design is being looked at holistically not only about energy savings but also about drip drainage, which a system drainage, which is an issue with a lot of systems on sloping ground that we're looking at, with the system continues to run after turning off. But also some energy opportunities as well as using new technology and new approaches.

Jeremy Giddings:

An example in part of that system there on the left-hand side in purple. I haven't got the original here, but I think that the original submain here on the bottom left-hand side started off at 80 mm and went down to 50 mm. Now the suggested change is to start at a hundred, replace it, replace it with a hundred, connect back into some existing 80 and finish off with 80 mm. And again, we've got an analysis over here with some changes in some of these things. You want to look at the bottom line here. Revised duty includes a four metre saving when carrying out these upgrades.

Jeremy Giddings:

And again, if you look at today's numbers and a bit simpler hydraulic analysis, that upgrade costs $30,000. They estimate that the savings from each year and that after a number of years owed for those, that hydraulic optimization, and the savings accrue thereafter for the life of the system.

Jeremy Giddings:

And so there's a lot more interest in this sort of thing because we've got systems that are due for replacing. Nick mentioned Rob Welke, who we've done a fair bit of work with, a lot of you may have done training with him and he's finding that the hydraulic efficiency in the field due to hydraulic optimization often exceeds the savings that can be made in the pump shed through pump efficiency, which is what Nick's talked about. And departments have talked about increasing or improving pump efficiency for a long, long time and haven't got a real lot of movement from irrigators in that way. But when combined with hydraulic efficiency, I think there's greater potential to do that. And I've put a quote from him in there, "There's hundreds of systems out there that could be hydraulically optimised and if the system is due for improvements, let's start to look at this thing a bit more critically at the same time."

Jeremy Giddings:

A couple of tools out there, there's opportunities to do a desktop audit if you like, to see if there's potential savings where you just insert in the yellow cells here. This is Rob Welke's software as well called IPEEATpro, input the data in the yellow cells here. Some pretty simple stuff that is easy to understand, easy to obtain, you don't have to be an engineer or an irrigation designer to find these things. And it will spit out some data to say, "Hey, this might be worth looking at. It may be worth looking at a full audit." It'll actually do the pump efficiency, down the bottom right-hand corner here. And it's saying here, the original efficiency in this particular one was at 75%, no real changes needed. The hydraulic efficiency sitting at 73, which is also pretty good. Some minor changes that might generate $6,000 in energy savings in that particular year.

Jeremy Giddings:

And I think for this particular one he's saying maybe not worry about these savings right now, but when you go to upgrade, think about doing it and these might be the savings that you could make. So it separates pumping from hydraulic efficiency, even spits out some emissions savings data, down the bottom right-hand corner, which is what a lot of people were interested in more so now. So that's like a pre-audit that identifies a potential area to look at out there, and then you might move on to doing a full irrigation audit. And this actually is Rob Welke measuring some systems in the shed and out in the paddock.

Jeremy Giddings:

The other thing you might want to look at for the smaller irrigators in particular, we've got some districts in Sunraysia in both New South Wales and Victoria on the Murray and also in the Murrumbidgee in New South Wales. That are supplied water through a low pressure line that was upgraded from a channel system to a low pressure. And they might be supplied with 10 or 15 metres head and under original designs you might have to provide a booster pump to increase the pressure. Now we're starting to see properties, particularly the smaller ones, be designed or converted to low pressure and utilise that low pressure head without having to re-boost. We see low pressure drip now, larger diameters, less friction loss, 20 mm and 25 mm diameters and emitters operating as low as 50 kPa.

Jeremy Giddings:

There's spec charts now that demonstrate you can operate certain irrigation, certain drips products, as low as 0.25 or 0.4 metres head, which is 25 or 40 kPa and still operate successfully. We also might look at low pressure infrastructure, and on Nick's pump curve earlier he had a seven metre head loss due to filters. There's more filters now available. Alpha filters that used to run at seven metre head, now they're running about four metres head or screen filters, which require a much, much smaller duty, much smaller head loss across the screen. They're being looked at more so as well.

Jeremy Giddings:

So I guess to finish off for me, some key points. A lower pump duty results in a lower energy cost; that relationship holds true, has held true forever. What can we do about reducing our pump duty? Look at the critical valve. The most critical valve on flat ground is probably going to be the valve furthest from the pump. Look at where the most head losses exist in that situation and see if there's some things we can do about that. There's various tools, various consultants, around that help you determine those efficiencies, services available that can do that for you. And certainly, if it's time to upgrade your irrigation system, consider energy efficiency at the same time. There's new ways of thinking. There might've been mistakes, like I said earlier made with systems that are 15, 20, 25 years old and there's new technology out there as well. So certainly consider the energy efficiency when upgrading. Energy prices are not going to go down and we need to look at this thing more critically.

Jeremy Giddings:

That's it for me, Sarah.

Sarah Clack:

Fantastic.

Nick O'Halloran:

There's just some links here as well to, Irrigating Agriculture is a website that we post on regularly on all sorts of aspects of irrigation. And there's obviously Energy Smart Farming, website that a lot of people will be familiar with, this webinar being part of that. And we'd appreciate people doing an evaluation of this session, if you can go to that there. Is that correct, Sarah? By the QR code?

Sarah Clack:

Yep, Yep. The QR code will take you to our evaluation. So before you leave if you'd like to do that, we'll also pop a link into the chat box too as well.

Sarah Clack:

So if any people have got questions, please place them in the Q&A box. If you do have a microphone available and would like to be unmuted, we can arrange for you to be unmuted to ask your question directly to Nick or to Jeremy or both. And we have had one question come through so far.

Sarah Clack:

So the first question is around measuring flow rates. "So flow rate sensors and equipment can be expensive, not many systems have inline flow metres. Pulse water metres are the most common for water consumption. Does the department or does your team, have or utilise portable ultrasonic metres?"

Nick O'Halloran:

We do. So when we're doing assessments we use ultrasonic, so it just straps around an exposed pipe and can provide a pretty accurate measure of flow. When I'm talking about monitoring flow, the key times are obviously... when you're doing an assessment you need to know flow rate. But it's really a monitoring thing, you don't have to monitor that. I don't think flow rate needs to be live to your phone essentially. You can check that when you're running particular blocks and go and check the flow rate's right. Yes, things are working about right.

Nick O'Halloran:

But I think the thing that is more important to monitor in an ongoing fashion and get some sort of warning when it's low, is pressure. If we're measuring pressure at the end of our systems, so on the furthest blocks or our furthest valves, and that can give us a warning when that's low, then we can respond. We can go out and change something on the pump and make sure that it's working correctly. Flow would be nice, but as you say, it's expensive to do so. Flow's really just about just occasional monitoring or doing a pump test. Hopefully most systems do have a flow metre on them, but yeah, we do see them without flow metres.

Nick O'Halloran:

Anything to add to that Jeremy?

Jeremy Giddings:

No, no, you're exactly right Nick. But I've got a question for you. Energy prices have increased for a long, long time and we've talked about it today, need to look at energy prices, but are you seeing irrigators more interested? Or is that our job here, to make people aware that there's opportunities for savings here?

Nick O'Halloran:

I think it is a growing interest. I think part of what I see is, I think part of getting this right is about being able to schedule and irrigate when you need to. And what I see a lot of is farmers going, "No, no energy's not important, but I only irrigate at night and on weekends because that's when off-peak energy is available." And then they're not getting enough water onto this... And their cost in yield and that yield loss, far outweighs the energy savings. But if we can minimise our energy costs, then we can irrigate when we need to and run the system as much as we need to. And so people are concerned about it but aren't realising that it's impacting how they're doing things. And it is, yeah, there are more people who are looking for opportunities as well I think.

Jeremy Giddings:

I think off-peak power has affected the way we schedule negatively over time, but as we move to drip and micro, weekend watering, we've had to go midweek and then we've gone overnight I guess. But as crop blocks have got larger, we've had to irrigate during the day anyway as well.

Nick O'Halloran:

Yep, yep. There's definitely a consideration in design more now I think.

Jeremy Giddings:

Well, irrigation companies know this and they're designing it. We're monitoring things more closely than we ever have. We've realised that biofilm and algae and whatever, significantly increased friction losses very quickly. So that's another reason to keep your system clean. But we're monitoring these things closely. They're developing tools like filters that have less head loss through them, as a result of this pressure from energy suppliers.

Nick O'Halloran:

Yep. I think the other thing I noticed is when you're getting a system designed, not realising the consequence of making a change to the system and what impact that'll have on operating costs. So comparing quotes and not looking at that it's exactly the design and smaller pipes or different pumps, and what impact that's actually going to have on the operating cost of the system. So yeah, it needs to be brought into that and considered in design and quoting and installation of the system as well.

Jeremy Giddings:

Yeah. Just like one of the earlier slides where I said one millimetre difference in application rate, who cares? Let's just water more and make up for that. Likewise, here you're only saving four metres head, but gee, I know it's a large system, but the returns on that investment quite quick and they accrue over time after that. And if there's tools around that can help identify this sort of stuff, certainly worth having a look at.

Nick O'Halloran:

Yep, yep. Any other questions that we're not seeing there, Sarah?

Sarah Clack:

All right. So there's a question there from Rick. And it is, "Is that Efficiency Savings tool free to use?"

Jeremy Giddings:

How did we get it, Nick?

Nick O'Halloran:

So I think with Rob's one you have to have done the course, so you get someone who's done the course to do that with him. The tools that we've developed are free, so they're available on that irrigating agriculture page. You can download them. They're only an Excel based format. But yeah, they are freely available at Irrigating Agriculture.

Jeremy Giddings:

So this one here on screen, the one on the left, is that ready to go?

Nick O'Halloran:

Not quite ready to go yet, it's still in development. But as I said, there is one for centre pivots and travelling irrigators, and we are looking to complete that one and do some testing of it.

Jeremy Giddings:

Yeah.

Sarah Clack:

All right, thanks for that guys. I've popped a link in to Irrigating Agriculture in the chat box. Also too, somebody did let me know that the evaluation link wasn't letting some people access it, and I've changed the permissions on access so that that will allow everybody to access it now. Apologies for that.

Sarah Clack:

There's a question here from Jeff. "There would seem to be a good match between times solar electricity is available and the times irrigation is most required. Do you guys have any comments around that?"

Nick O'Halloran:

Yeah, potentially. So we've done a bit of work looking at the use of solar and how that can match in. If you've got a solar system, it's important to make sure that the solar system is big enough that you'll tend to irrigate more during the day to utilise that solar energy. But the solar system's not big enough for your pumping system, you'll actually be using more daytime energy and potentially bills can go up. So it is important to match the solar system to the size of your pump.

Nick O'Halloran:

If you're in Queensland, if you're in southern Victoria, having two-way moving solar systems, really extends the irrigation period because it follows the sun. As you go further north and you're directly under the sun, so it gives you more hours to irrigate in. And that becomes important obviously because we want as many hours to irrigate as we can get with the solar. As you go further north, having one-way fixed or fixed solar, can be better or equally as appropriate.

Nick O'Halloran:

But yeah, that's definitely something there's potential for, I think in the future. And I don't know, Jeremy, are you seeing people with solar on their irrigation systems?

Jeremy Giddings:

Yeah, certainly a bit more. And it makes them freer to irrigate during the day and obviously a little bit of more water use during the day with applications during the daytime period.

Nick O'Halloran:

I think the other thing is in matching that size, it's important if they're too big, you're not necessarily irrigating every day, so you're producing a lot of solar. So you need to think about how you're using that solar in the interim, how you save that, whether you're pumping water or batteries. Although batteries can't store much on that size system, but yeah, matching the size, really important.

Jeremy Giddings:

Yeah, so we're mostly talking about today about how to reduce your energy usage, and I guess the availability of solar might mean that people are less interested in hydraulic optimization and things like that, because I think it's sort of virtually free anyway. But certainly it's always going to be there and it's certainly worth looking at, especially as systems get older.

Sarah Clack:

All right, thanks for that guys. And I like to think of it, on the Energy Smart Farming we like to think of it as, reduce energy wastage, optimise energy efficiency, and then to look at our renewable energy options so that we aren't over-sizing our renewable energy systems and over-investing in those systems, so we can get the best out of those systems and not putting too much capital into them.

Sarah Clack:

We've had a question from Uma, hopefully I've got your name correct, pronunciation correct there. "For small farmers, less than 10 acres of horticulture farms, which energy source would you recommend, petrol or solar, if electricity option is very expensive?"

Jeremy Giddings:

Nick, are you interested in that?

Nick O'Halloran:

Yeah. Oh look, electricity, it's usually cheapest if it's right there, but if you've got to connect it for a small farm, it can be pretty expensive. Yeah look, solar may well be an option. I guess what you've got to look at is if you're going to have solar, you've got to design your system so that the system capacity, so you can get enough water out in the hours of the day where you've got sun. So you're not going to have the opportunity to irrigate at night anymore, so you have to be able to irrigate during the day. So you have to design the system with enough capacity to get the water out over that period. If the system's currently designed to be able to irrigate 24 hours a day and then all of a sudden you've only got eight hours a day, then you're going to lose productivity.

Nick O'Halloran:

Look in terms of the overall cost of the system, I don't know how it compares to diesel. I would imagine once it's installed it's obviously quite a bit cheaper to run. Not sure about the installation costs. But then obviously you've got with diesel, you've got environmental considerations and you've got to bring diesel to the pump regularly, and that's why people tend to go towards electricity where they can. There's those management side of things, people stealing your diesel. But yeah, so I couldn't give you a real clear answer, but just whatever you choose, make sure that the system's designed to irrigate the whole area in the time you've got available with that system.

Jeremy Giddings:

We had a bit of interest in gas a few years ago and did some analysis; and running costs for gas and diesel was always higher than electricity. It's just that infrastructure and connection cost that I think Uma's concerned about. But again, you do your analysis, but people were quite surprised about the running price for gas. When you convert kilojoules over to kilowatts and that sort of stuff, the efficiency conversions are quite low.

Sarah Clack:

All right, thank you guys. I've had a comment here from Stephen Soutar, who is a service provider down in Gippsland, saying that he's just completed a fixed irrigation system running on solar at a dairy farm in Gippsland, and the operating cost is 1.90 cents per kilowatt-hour. And also he's got a comment here about Wilandra Farm in Gippsland, has operated irrigation on solar for the last three years at an average cost of 4 cents per kilowatt-hour. And if you want to know a little bit more about Wilandra Farm, you can go to the Energy Smart Farming page, and we've got a virtual farm tour of Wilandra and there's a video case study of them on there as well. If you'd like to learn more about them.

Nick O'Halloran:

I'd be interested to know, just quickly, with the solar systems, are they grid-based electricity with solar feed in to the system, or are they solely a hundred percent solar? Because we've got a lot of electric grid-based systems that have solar on them up here, but none that are complete solar that I'm aware of.

Nick O'Halloran:

Yep. He says that's still connected to the grid. Now I think that's valuable in terms of doing something else with the power as well, if you can get a feed in for the excess power you produce.

Sarah Clack:

Yeah, that's very true. We are coming close-

Nick O'Halloran:

Buy a battery as well. Yep.

Sarah Clack:

Yep. Beautiful. Nick's getting more information through.

Nick O'Halloran:

Perfect. Reading the comments.

Sarah Clack:

So we're coming to the end of our time, so it's close to 1:00PM. So for those that do need to leave, please feel free to. Nick and Jeremy, do you have time to stay on further or for longer-

Nick O'Halloran:

If there is some more questions? Yeah.

Sarah Clack:

... or do you need to head away?

Nick O'Halloran:

Here all day if we need to be.

Sarah Clack:

Because yeah, if we do have some, if you guys do need a head away, we can just get back to people with the answers if we needed.

Nick O'Halloran:

Yep. Any more questions coming through?

Sarah Clack:

Yeah, there is a few more questions in here. So there was one about, "Any recommendations if you rely on submersible pumps as there are more variables with them, i.e. speed influences cooling?"

Nick O'Halloran:

Yeah, so we're talking bores presumably. Submersibles tend to be less efficient but... And you can do the same thing, you can have them on a variable speed drive. I'm not sure what the limits are in terms of how slow they can go. What was the question again?

Sarah Clack:

So any recommendations if you rely on submersible pumps as there are more variables with them, i.e. influences cooling?

Jeremy Giddings:

Yeah.

Nick O'Halloran:

Yeah, you can only slow them down as much as I guess the specifications say. But other than that, in terms of they'll still have a best efficiency point... All of the principles we've talked about are the same, but you've just got to understand the limitations of your pump. So they'll still have an optimum flow rate and pressure. Variable speed drive will still affect the efficiency in the same way. Designing the system to be close to that best efficiency point still required. Reducing total head. So yeah, I think all of the same principles apply.

Sarah Clack:

Awesome, thanks Nick. I'm not sure if you guys covered this one earlier or not, I was slightly distracted at the time. "Do irrigation systems typically operate entirely in the turbulent flow mode or are there design options to promote laminar flow with attendant energy cost savings?"

Nick O'Halloran:

Well, I'm not a hundred percent sure about modes, but I guess that's a bit what I was talking about in terms of I haven't seen any devices specifically to get laminar flow, but getting that design particularly of the suction to get that most efficient flow into the pump, is important I think. But I'm not sure of specific devices to improve that.

Jeremy Giddings:

Yeah, I'm not sure…

Nick O'Halloran:

I’ll have to take that on noticed.

Jeremy Giddings:

…what's meant there. Drip irrigation's turbulent flow through the emitter and it needs to be. There is a head loss there, probably more than laminar flow, but it's important to keep the emitter clean and that's what turbulent flow does.

Sarah Clack:

If a question hasn't been answered properly, reach out if you'd like more on that.

All right, so next, there's two more questions sitting here at the moment. "Does the size diameter of the drip line impact energy use?"

Jeremy Giddings:

Absolutely. The inside diameter of all pipe solids increases energy use and that's what we were trying to demonstrate. And some examples there of converting from 17 mm diameter to 20 mm to 25 mm even. Has some issues with drain out and drainage and flushing, but certainly from an energy point of view, if you've got the tools to be able to reduce your head with a variable speed drive, and slow down the speed of the pump as a result of having less head due to larger pipe diameter, it's an energy saving.

Nick O'Halloran:

So definitely in the design, most designs, if you read the spec sheets for drip systems, it'll have the maximum lengths for particular pipe sizes and number of... it's essentially the number of drippers on it. And what that is, is about trying to keep that head loss along the lateral line to or less than one and a half metres. And so if you make the system, the lateral is longer than that, longer than they specify, it means it'll have a higher flow rate, that's too high for that pipe size and you get more than that metre and a half head loss. So then they'll say go up to the next pipe size so that you can get the flow you require to the end without that head loss. So normally that's dealt with in the design of the system, but you still need that flushing and maintenance of the system, because as you get crud build up in the line, that'll increase that head loss above what it's designed to.

Sarah Clack:

Thanks Nick and Jeremy. "What role does cavitation play in pump efficiency and how can growers prevent it?"

Nick O'Halloran:

Yeah, so it will definitely impact pump efficiency, but I guess more importantly, it impacts the pump life. You'll destroy your impeller, that's the bigger problem. So it's really in design. When you design it, we didn't go into that at all, but it's about having not too much static head so you're not lifting the water, the water's not too low below the pump. But then also having the right size pipe so that you're not getting friction loss in the suction pipe between the pump and the water. So every pump, you can't specify exactly what the limit to suction of any pump, it varies depending on the pump and the flow rate, but you've got to get that right in the design. But any fittings, bends in pipe and those constrictions, that all impacts on the total suction head, which will, if that's too high, that's when your cavitation occurring, if that suction head's too high for the system. So you've got to get all of that right. But what I was talking about earlier was really we're not seeing cavitation in these systems, but we think it's that flow. We're not getting laminar flow into the pump and that's causing a drop in efficiency of the pump even though we're not getting cavitation occurring.

Sarah Clack:

All right. Hopefully that answers your question, Peter. And then there's just a quick comment, there's a comment here around, be lucky to get more than 4 cents of feed in on solar. They have multiple systems with solar and it's challenging to match solar to irrigation patterns. Also, much less cost-effective when there is no roof to mount solar on. If you can save money by making your system more efficient, you save that money on every megalitre, you may not see savings from solar on every megalitre.

Jeremy Giddings:

Good point.

Sarah Clack:

Yeah.

Nick O'Halloran:

Yep, yep, yep. Exactly. So as I said, we've done a little tool that enables you to match a solar system to an irrigation system, and it shows you how much, what those potential savings are. But yeah, minimising pumped head, minimising energy costs from the start, that'll all reduce the size of the solar system required and make that hopefully more cost-effective for doing something with that excess solar. Even other than feeding it into the grid can be good, if you've got a dairy heating some water or I don't know how else you can use it. Or pumping water and storing it, or yeah, there's lots of opportunities to look at.

Sarah Clack:

Yeah, definitely. And yeah, encourage people if they are interested to have a look at the Wilandra Virtual Farm Tour on the Energy Smart Farming page or to have a look at the video case study that's there. And Stephen's just put a comment there around Wilandra paid 4 cents per kilowatt-hour for power on average over the three years. So that's what they paid for power rather than potentially the capital cost of their system.