Nick O'Halloran:

So I'm an Irrigation Extension Officer based at Tatura in Northern Victoria. So I work as part of a team of irrigation officers, and we're based in all of the major irrigation districts across the state. We work directly with irrigators, looking at their irrigation water management. They do things like whole farm planning, so looking at the layout and how they design their farms, right through to providing irrigation scheduling information, helping them decide when and how much water they should be applying. And more recently we've been doing work looking at system checks, so looking at how well their current irrigation systems are operating and energy efficiency has become an important part of that. So, today I'll just go over how we go about measuring and assessing energy efficiency of an irrigation system and where the opportunities are to actually improve the efficiency of those systems.

Nick O'Halloran:

I'll touch on a tool that's come out of that, an energy calculator that we have developed, and then we've expanded and created the new prototype. And we're now working with Joc and NSW DPI to expand that even further and hopefully roll that out over a wider area, get better usage of that. But that's in, I guess a prototype stage at the moment, but it's really aimed at helping farmers understand how efficient their system currently is and whether it's actually worth making any changes to their system, whether the savings are going to pay for themselves essentially.

Nick O'Halloran:

So, as I said, I work in Northern Victoria. Traditionally, we mainly have flood irrigation, but we're getting more pressurised irrigation like these centre of pivot irrigators we can see here. I'll just change my pointer. So you can see the distribution of these irrigation systems across the region. So they're going in largely for better productivity and water use efficiency and labor savings. But, the downside to these systems is that they have an energy cost associated with them, you've got to pressurise water. And what we're seeing, and it's been seen across the country, that as energy electricity and diesel prices go up, that the cost of operating the systems actually starts to drive when they use them. So people will start to use them on weekends and at night to take advantage of off peak power. But, I think in a lot of cases, the productivity losses from not irrigating when the crop needs it, is probably going to outweigh the operating cost savings.

Nick O'Halloran:

But I guess what our job is to do is to make sure these systems are as efficient as possible so that farmers are confident to use them when they need them. So, in our assessments, we look at application, efficiency and uniformity, so how well they're putting water out, how evenly they're putting water out. And I guess that's about minimising the amount of water that needs to go through the systems and if you're putting out less water, you're pumping less water, so that's reducing energy costs. But the other side's looking at just how much energy is required for every mega liter of water pumped. And so we, we assess the energy efficiency to try and reduce the actual energy costs.

Nick O'Halloran:

So, just the background for when we're assessing the energy consumption of a pumping system, there's two main components that we actually look at:

Nick O'Halloran:

There's a pumping system efficiency, which is essentially how efficiently the power or diesel is converted into the movement of that water in the pumping system itself. And the second part that we look at is;

Nick O'Halloran:

A total operating pressure, so what pressure is that irrigation system actually having to push against to get water through the irrigation system itself?

Nick O'Halloran:

So, the pumping system efficiency, if that system's a hundred percent efficient, so there's no energy losses in it, it'll take about 2.7 kilowatt hours of energy to pump a million liters of water against one meter of pressure. So, we use meters as a common measure of pressure. It's, equivalent to 10 kilo pascals. So I'll talk about meters of pressure quite a bit. But the pumping system is never a hundred percent efficient. We get efficiency losses in the motor, heat and noise, and so it's important that we get the motor right, and that the sizing of that right and that it's cooled so that it's operating as efficiently as possible.

Nick O'Halloran:

We get efficiency losses in the drive system. Direct shafts are pretty efficient, but if it's a belt-driven system they can sleep and create heat, so there's efficiency losses there. And there can also be efficiency losses in the pump. So there's heat losses in the pump and also that the impeller can spin in the water without moving it, if it's not designed right. Most pumps should be about, ideally will be better than 70% efficient, but it all depends on the design of the system. So, the type of pump, the size of the pumps, so the size of the inlet and the size of the outlet, the impeller size, all impact on how efficient that pump will actually be.

Nick O'Halloran:

And that system has to be designed to match a particular flow rate and pressure of an irrigation system. And if we change the irrigation system and we change the flow rate and we change the pressure, then the efficiency will change. And it could change to the point where a different pump or a different impeller is actually better suited to the job. So we spend a fair bit of time assessing the system, looking at how it's designed and whether it's appropriate for the irrigation system that it's attached to. We see efficiencies ranging from 80%, which would use about 3.4 kilowatt hours per mega liter, per meter head, down to as low as 30% efficient. So using nine kilowatt hours per mega liter. And that variation is all related to how efficient this part of the system is operating.

Nick O'Halloran:

The second part of what we look at is the Irrigation System itself and how much pressure is required to push water through that. So there's pressure required to push water up a hill if there's any hills, not that we've got too many where we are, but there's also pressure required to push water through pipes because of turbulence and friction loss. So, in this particular system to achieve 10 meters of head at the end of the system, that that irrigation system might require to operate properly, we've actually got to apply 50 meters of pressure at this end. And so we actually multiply that number by the efficiency to work at how much power is actually going to be required to pump that system. So an 80% efficient system pumping against 50 meters of head would use about 117 kilowatt hours per mega liter. Whereas, a 30% efficiency system is going to use over 450 kilowatt hours per mega liter. So the efficiency of the system is really important.

Nick O'Halloran:

As we see, if we can change the irrigation system, put bigger pipes on and reduce the head at the pump required to achieve the pressure at the end, we've halved the head at the pump, we've halved the power requirements of that irrigation system. Now, without changing the efficiencies of the pump, in reality, it probably would also impact on the efficiency of the pump. So there's two main areas that we look at, the pumping system efficiency and the irrigation system pressure required.

Nick O'Halloran:

So this is just some data from the assessments that we've actually done looking at the energy efficiency of systems in the Shepparton and the irrigation region. Here we've got that total pressure that the system is working against, the total dynamic head, ranging from low to pretty high and this is the energy requirement in kilowatt hours per mega liter. And so, ideally, when we change the efficiency of the system, we're pushing points down this way. When we change the total pressure of the operating units, we're pushing them back this way.

Nick O'Halloran:

And ideally systems will be designed down here. We work with farmers to try and get them designing systems down here, but that usually means that the capital costs are going to be higher, it's going to be more expensive to set that system up. So we end up with systems here that are a bit cheaper to set up, but the compromise is they're a little bit more expensive to run. Systems up here are always going to be expensive to operate and ideally we shouldn't be trying to not produce systems like that, but there's plenty of them out there. And they're the farmers that we spend a bit of time with.

Nick O'Halloran:

So I was just going to show a couple of examples of farmers that we've worked with. Some of these points are the same system, but we've actually made changes to the system. So this particular farmer had a center pivot, something like this one, operates at a pretty high pressure, and that was basically because it was an old pivot with an end gun on the end of it that didn't have a booster pump. So end-guns are usually an add-on, they're a cheap way of extending the length of the pivot and getting some extra land, but because they have to throw the water so far to irrigate, they're very energy intensive.

Nick O'Halloran:

Though we encourage farmers not to put them on because they don't irrigate very evenly, so they do an ordinary job and they also cost a lot to run. So this particular farmer had decided to take his off, but because at the other end where the pump is, or at the pump shed over here. Because it didn't have any way of reducing the speed of that pump, once he took the end gun off, it didn't actually change the pressure of the system.

Nick O'Halloran:

So we actually got him to put on a whole lot of new nozzles that allowed him to put out more water through that irrigation system, and that dropped the pressure. So, that cost about $300 and that dropped the pressure from about 50 meters of head at the pump back to about 42. That's about a $10 a liter saving in pumping. He pumps 300 mega liters a year, that's $3,000 a year in energy savings on that system, just by having a look at it and changing those nozzles and taking the end gun off. It's over $40,000 over a 15 year period. So, a small change to that system can have a big impact on cost, certainly paid for itself very quickly.

Nick O'Halloran:

And the final system I just wanted to have a look at was this one up here. It was an interesting one, horribly inefficient, is a very small system, only about three hectares. It had a horribly oversized pump and motor and a generator to run the towers to make the wheels turn on the pivot. And so it was using a huge amount of energy per mega liter pumped, but because it was such a small system, he only pumps about 24 mega liters a year through it. We couldn't come up with any changes to that system that was cost-effective. He just wasn't using enough water through that system to pay for the changes that he was making. So, unfortunately, he's put in this inefficient system, he's sort of stuck with it, he can't justify changing it. So it's really important to get them right at the start, ideally. But it's also important to look at the total amount of water that the systems are using to work out how much money has been spent on pumping, and therefore, if a change is cost effective or not.

Nick O'Halloran:

So the irrigation energy calculator we're working on, I won't go into it much, I think it's pretty exciting. So, to do those calculations that we've done and work out where the savings are, is quite.. We spent a reasonable amount of time doing measurements in the field but then a lot of time doing calculations when we get home, that the average farmer is not going to do.

Nick O'Halloran:

And so it's really difficult to work out what the savings are going to be, whether it's worth making changes or not. And so this calculator is a really simple way of working out if these improvements can be made, where those improvements need to be made and what the savings are likely to be. There's a few extra add-ons on here that I won't go into, but the information that goes into it is really simple. The main things are essentially the length of the pivot, the amount of water that you use per year, so we add that up over the course of the year the area, and over 15 years to work out how much water they're pumping over the life of the system. You have to put in how many kilowatt hours per mega liter, so the energy use, consumption of the system as it is at the moment. And then the only other information they put in is pressures that you can measure on different points on the pivot, so pressures at the pump, pressures at the tower and at the end of the system and their regulator ratings.

Nick O'Halloran:

And so this looks at the pumping system efficiency. So this one's 82%. That just looks at the pressure at the pump and the energy used to work out the efficiency. So this one's quite good costing $45 a mega leter to pump, but then it looks at pressures at different points and how much head loss is occurring in the system, so over this whole system, they're losing using almost 47 meters of pressure. Ideally, the optimum that these calculators worked out for that size system, should only be losing 32 meters, so that comes up as a red light. That shows that it's losing 16 meters of head pressure between the pump and the pivot, it should only be losing four meters. So, that could be a filter that's blocked, it could be a constriction in a pipe somewhere that that needs to be fixed up, or it could be that this whole pipe is just too small or the flow rate's too high for that pipe.

Nick O'Halloran:

So it identifies that there's a big opportunity, could potentially save up to $4,000 a year by changing something between those two points. You got to go out and work at what that issue is, but at least, you know where to look. And then the pressure loss between the pivot and the end of the system on this one's almost nine meters, it should be six meters so that's not too bad. But it might be something very simple like regulators that are faulty, fairly easy to fix, could save $800 a year by fixing up that section of the pivot. It also tells you about the pressure at the end of the system.

Nick O'Halloran:

There's two PSI of excess pressure at the end of this system, I'd say that's not a problem, what shows up as green. But that's actually costing $500 a year that excess pressure at the end of the system so you might be able to back the system off. But across that whole system there's potentially $80,000 worth of savings in energy that could be made. So a really quick and simple way of identifying where the issues are and what the savings are likely to be of making changes, so you can compare them to the cost of making the changes.

Nick O'Halloran:

So that's pretty much all I wanted to cover today, thanks to the team who helped us out and in the field and also DELWP And for me, it's the Golden Broken CMA that fund the work that we do.