Sustainable Pumping offers EU Taxonomy advantages

There is significant scope within present day irrigation design guidelines to improve both water efficiency and pumping system energy efficiency and contribute in a meaningful way to the objectives of EU Taxonomy. EU Taxonomy frames the questions of sustainability in economic activities with the objective of supporting those which display substantial progresses in sustainability criterion.

Sustainable Pumping is considered a “green traffic light” in an Extended Taxonomy: one which “can bring a substantial contribution to at least 1 of the 6 objectives and not harming the environment”.

Sustainable Pumping actually contributes to two of the six objectives of EU Taxonomy:

- Climate change mitigation – achievable with sustainable pumping practices
- Sustainable use of water – achievable by adopting sustainable pumping parameters into irrigation design, thereby improving irrigation efficiency.

And indirectly to a third one, the preservation of water resource.

What is Sustainable Pumping?

Definition

Sustainable Pumping can be defined as a “balanced mix of environmental responsibility with economic sustainability”.

That is, a minimum of Energy Input (reduced CO^2 emissions) for the Maximum Work Output (Return on Investment) amortised over say 25 years.

Sustainable Pumping has very little to do with the pump. All pumps are very efficient these days and remain reliable with extended service.

However, Sustainable Pumping is everything to do with system resistance[1] in irrigation pumping systems.

Optimising System resistance is crucial to achieving sustainable pumping, but needs to be considered in two steps:

- Design
- Maintenance

In the design phase, pipe size selection considers the life cycle energy costs to overcome friction, in other word Capitalised Cost of Power (CCP), and the capital

[1] System resistance meaning head loss. The pipelines create the system head loss, the pumps merely provide the energy to overcome the pipeline resistance, thereby the pumps only have a minor role in sustainable pumping compared to pipe sizing and condition.

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cost (CAPEX) of the pipeline installation phase. The optimum pipe is the one in which the sum of the CCP and CAPEX has the lowest value in the range of pipe diameters available.

Since system resistance is closely related to water velocity, what are the guidelines?

The United States of America Irrigation Association design criteria for irrigation pipeline specifies water velocity limit at 5 feet/sec (1.5 metres per second). This is regarded as a world standard.

However, 5 feet per second (1.5m/s) was never intended as an energy design parameter but originally intended only as an irrigation design parameter for acceptable CU's and DU's (the resulting water application uniformity).

Internationally, no one has proposed pipeline water velocity limits for energy efficiency, until now.

WATER PUMPING INSTITUE (WPI), based on its 57 years in water pumping and hydraulics, has developed software to determine water velocity limits for optimising pumping energy costs across a wide range of irrigation operating conditions. This software has been widely distributed and accepted by over 750 water engineers worldwide in over 90 course presentations since 2015.

So, what is the water velocity for optimum pumping energy efficiency?

It depends on a number of factors. Theres no one water velocity that fits all.

Firstly, optimum water velocities decrease with decreasing pipe diameter.

Mainline pipes of 300mm and above are generally good with 1.5 m/s, but submain pipes of 32mm require less than 1 m/s to be sustainable.

Not only do reduced submain water velocities have a dramatic effect on pumping system efficiency (sustainable pumping), but the resulting lower differential head loss across the length of submains with reduced velocity equates to substantial improvement to CU's and DU's, resulting in much higher water field application efficiency.

Sustainable Pumping contributes to Sustainable Irrigation:

It can be demonstrated that reducing submain water velocities can improve CU's by up to 15%, when compared to operating at 1.5m/s along the whole submain.

That's a potential 15% water use efficiency improvement, an outcome in addition to sustainable pumping improvement.

Case Studies: WPI has audited numerous large scale irrigation projects, finding significant improvements in sustainable pumping, based on energy costs, with average hydraulic sustainability improvements of 33% but average pump efficiency improvement of only 16%, as shown in the table below.

In this chart, hydraulic efficiency indicates sustainability gains to be made by reducing system resistance. The 33% potential gains are absolutely achievable, but may only be potentiated with some pump optimisation (downsizing).

Also in the chart, potential pump efficiency gains to be made are much less definable because new pumps are rarely works tested, so there is no accurate benchmark to assess potential efficiency improvements from a site test if a pump was to be overhauled. So, out of that average 16% potential pump efficiency gains identified, only 8 to 10% would be considered achievable.

There is, however, potential pump efficiency gains to be made if OFF-BEP[4] and significant efficiency deterioration has been identified.

*LM: Lateral Move; CP: Center Pivot

CASE STUDY			Annual Cost $$ Pumping	PUMP EFFICIENCY ONLY		HYDRAULIC EFFY		TOTAL SAVINGS		Remedial Cost	
Case Study	ML/yr	Irrigation Type		$$/yr saving	Saving %	$$/yr saving	Saving %	TOTAL saving $	TOTAL saving %	$$ Total	ROI
1	140	LM Turf	13,700	$1,800	13%	$5,900	43%	$7,700	56%	$45,000	6.7
2	100	Boom Turf	10,700	$2,900	27%	$3,500	33%	$6,400	60%	$10,000	1.7
3	100	LM Vegies	5,500	$315	6%	$1,085	20%	$1,400	25%	$1,000	1.5
5	470	CP Dairy Pasture	35,900	$6,850	19%	$11,960	33%	$18,800	52%	$48,000	2.4
6	100	CP Dairy Pasture	9,100	$715	8%	$2,400	26%	$3,115	34%	$2,000	<1.0
		TOTALS	$74,900	$12,580	16.8%	$24,845	33.2%	$37,425	50.0%	$106,000	2.8 Ave

These results emphasise the reality of legacy irrigation designs: hydraulic efficiency is very poor because the design standards used were never intended for energy efficiency, only water efficiency.

Case study: A dairy farmer in SE Australia operated a centre pivot for fodder irrigation. The original 150mm rising main from the 36 l/s pump station was assessed as having a water velocity of 2.1 m/s and a C Value of 110. Subsequent replacement of this pipe with new 200mm pipe reduced water velocity to 1.1 m/s, reduced pumping costs by $18,000 per year and CO^2 emissions by 68 tonnes per year, (based on 0.7 kg CO2 e/kWh). Of these identified savings, approximately 2/3 came from pipeline replacement, 1/3 came from pump efficiency gains.

This case study highlights the second phase of sustainable pumping practices: optimising existing irrigation pumping systems to reduce pumping and GHG emissions.

There are many irrigation systems designed to outdated water velocity limits that will respond to increases in pipe diameter, by way of duplication or replacement, which will yield substantial improvements in sustainability, pumping costs and GHG emissions. That opens up a whole new business model for site energy audits, intended to improve sustainable pumping and greenhouse gas reductions.

Maintenance Phase

All pipes deteriorate in hydraulic efficiency with time.

WPI has decades of experience in measuring Hazen and Williams (H&W) C Values of new and aged pipes. We can anticipate deteriorated pipe performance in most irrigation systems. Iron hydroxide from ground water produces a particularly severe performance drop and can fall from C=150 down to C=60 in months through the increased wall roughness due to biofilm growth on pipe wall and pipe effective diameter. A wall roughness of 0.4mm can reduce a pipe C Value down to C=110, but barely enough to constitute a pipe diameter reduction.

However, whilst that’s a severe case, any raw water (dams, rivers) will cause pipe performance deterioration. Recycled water is especially severe on pipe performance deterioration.

In addition, for the same biofilm thickness, smaller pipes suffer disproportionate reductions in C Values.

If this deterioration is not allowed for in the design stage, or not resolved by adapted maintenance, the significant rise in pipeline friction over the life of an irrigation system will devastate sustainable pumping and sustainable irrigation efforts from the design stage.

Case Study

WPI was called to site of a recycled water pipeline and pumping system in 1999, with 10 km of 450mm rising main.

The transfer pumping station’s output flowrate had reduced 15% over 18 months. The pumps were checked and found to be as-new.

WPI conducted a detailed H&W C Value test and found that the pipeline had suffered a biofilm build-up of only 0.2mm from the recycled water. That biofilm resulted in increased pipe friction which pushed the operating point of the pump higher up the pump curve. The resulting deterioration cost the operator a 15% penalty in kWh/ML pumping cost.

Pigging the pipeline restored the pipe to as new condition.

Photo shows two foam pigs discharging from a pipeline after a pigging operation to clean the pipe of biofilm.

What about the pump, and VFD's?

The pump and VFD[2] are primarily facilitators for the energy required by the pipeline system, so within the intrinsic efficiency of the pump and VFD, they are contributors to, but not principal components of sustainable pumping.

The exception to this is if the pump has deteriorated in operating efficiency, only then does the pump have potentials gains from overhauled efficiency, and therefore sustainability.

Who pays the extra cost?

Who pays the additional cost of the upsized pipes to optimize pumping? That's where EU Taxonomy could come in. EU Taxonomy offers a framework to define and characterize the sustainability of an economic activity. This to support access to green finance packages for identified schemes, for example where additional CAPEX is required to improve sustainable pumping and /or sustainable irrigation. This with proven result in climate change mitigation and sustainable use of water. The EIA has elaborated a draft Taxonomy for irrigation sectors activities, currently under review by the EU commission[3]. The efficiency concepts described in this paper will find their place in this Draft Taxonomy for Irrigation Sector.

Summary

Designing irrigation systems to include optimised water velocities and anticipated pipeline performance degradation has proven advantages for both pumping and irrigation sustainable energy use.

Rob Welke, Author

[2] VFD=Variable Frequency Drive

[3] https://irrigationeurope.eu/en/the-eia-finalized-the-position-paper-sustainable-irrigation-focus-on-the-framework-of-the-eu-taxonomy/

[4] Off Best Efficiency Point

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<u>Training courses</u>

WATER PUMPING INSTITUTE's business model includes training courses, based on Rob's 57 years' experience, and product independence, to empower irrigation professionals to improve irrigation designs and modify existing designs to improve their sustainable pumping and sustainable irrigation outcomes.

WATER PUMPING INSTITUTE will be running face to face classes in Europe in October 2025 for those interested in upskilling in this exciting new irrigation paradigm.

Refer to web site:

https://www.waterpumping.institute/sustainable-pumping-for-irrigation or contact EIA

Regards,

Rob Welke,

Managing Director