

Energy Use



Smarter Irrigation for Profit

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National Centre for
Engineering in Agriculture

Centre Pivots

& Energy Implications

Dairy SA, Mt Gambier
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Dairy
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Rural Research and
Development for Profit
Keeping Australian farmers
at the cutting edge



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What is Power? – what is Energy?

- Energy is “the stuff you buy”
- You buy “Litres of Diesel” or “kiloWatt.hours of electricity”
- Power rating is all about how fast you can burn “the stuff you buy”
- A motor with a big power rating in kiloWatts will burn “the stuff you buy” more quickly

Need irrigation but water is heavy.

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Needs lots of energy to shift it

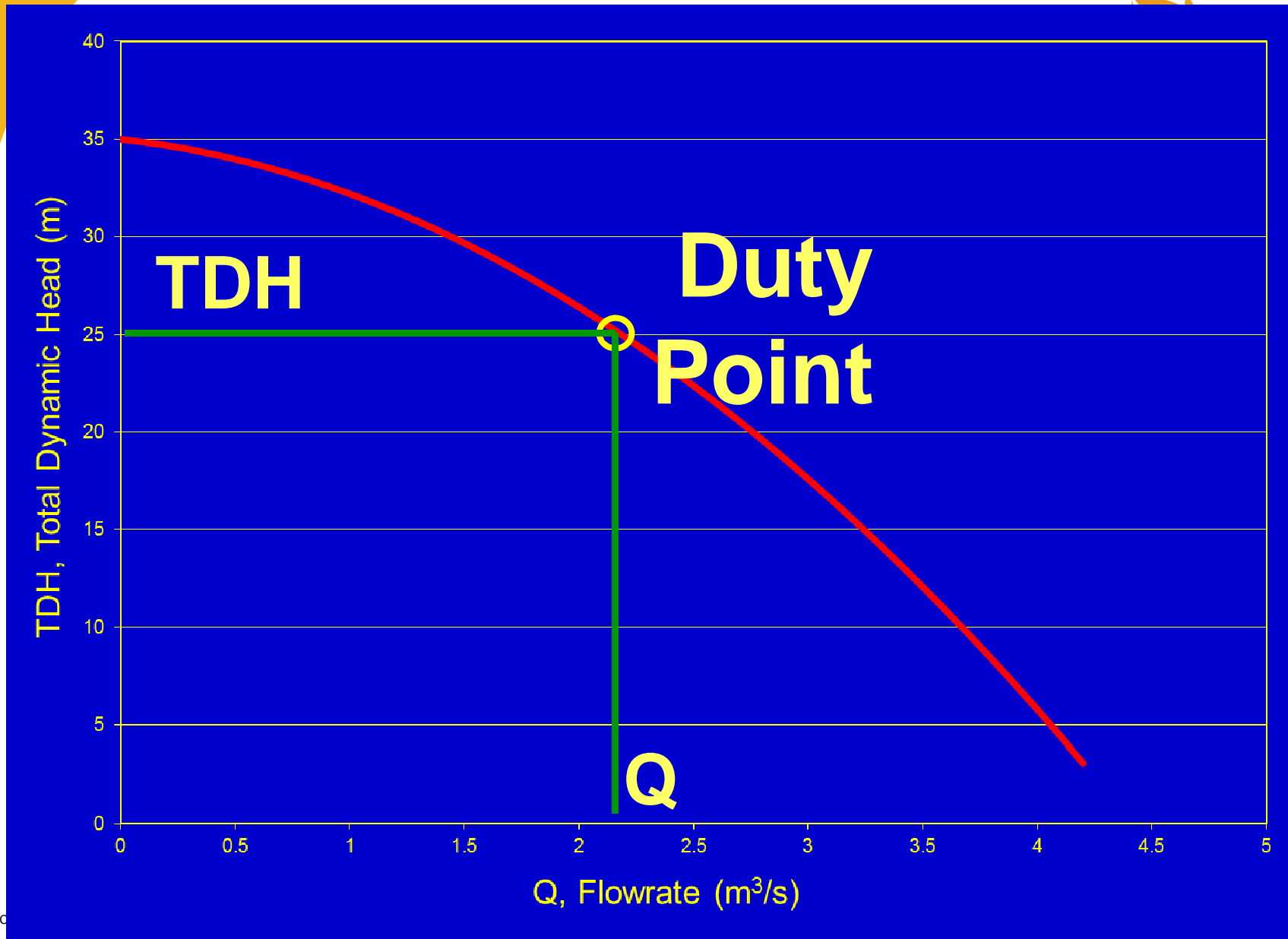
- Water is very **HEAVY** material!!
- 1 Litre is a kilogram. 1000 litres is a tonne.
- 1 MegaLitre(ML) is 1000 tonnes= 20 B-double truck
- Need **Lots** of Energy to lift & move water
- 1 ML in this room (15m × 30m) is 2.22 m deep
- 1 ML on 1 ha is same as 100 mm rainfall
- Every ML per ha is 1000 tonnes per hectare

Lots of Energy needed to lift water



- 1 ML per ha is 20 B-double trucks per ha!!
- In an ideal world, each MegaLitre (ML) lifted up one metre of height uses 9.81 MegaJoules (MJ) or 2.725 kiloWatt.hours (kW.h) of Energy
- In the real world, to lift 1 ML up 1 metre, with pump efficiency of 70% and electric motor efficiency of 90% you need 4.55 kiloWatt.hours(kW.h) of Energy
- Best possible case is 3.3 kW.h per ML per metre lift
- Worst likely case is 5.8 kW.h per ML per metre lift

Pump Curve



Total Dynamic Head



- Total Dynamic Head
 - Is a measure of the energy per unit weight imparted to the water by the pump
- Calculate from :
 - the discharge dynamic head minus the suction dynamic head
 - each dynamic head is measured relative to the pump centreline

Energy use of Centre Pivot



- Example : CP of 400 metres length with 450 metre length of 150 NB PVC pipe Class 6 to a pump 2.5 m lower than pad at centre of machine, with vacuum gauge reading of 5 m :
- A 6 mm per day sprinkler package will have a flow of 34.9 L/s and a pump TDH = 37.3 m head
- A 8 mm per day sprinkler package will have a flow of 46.5 L/s and a pump TDH = 47 m head
- Comparison with 42 mm applied for the week, which is 21.1 ML pumped for the week.

Energy use of Centre Pivot



- For same 400 m long machine
- Calc'd with ToU 128 : Summer, 7am to 9 pm 41.26 c/kW.h, rest at 22.52 c/kW.h, 75.41c/day
- The 6 mm per day sprinkler package will run all week (168 hrs) & have pumping costs of \$1091/wk, which is \$51.72 per ML pumped
- The 8 mm/day pack runs 98 hrs off-peak, and 28 hrs peak rate, and would have pumping costs of \$1209/wk, which is \$57.31 per ML pumped

Irrigation Energy Costs



- Moving water is all about using energy (kW.h)
- Every ML of water per ha is a 1000 tonne/ha
- Increasing energy costs force improved conversion of the energy you buy (kW.h)
- Electricity(kWh) to pump 1 ML = $(2.725 \times \text{TDH}) \div (\text{Eff.}_{\text{Pump}} \times \text{Eff.}_{\text{Drive}} \times \text{Eff.}_{\text{Motor}})$
- Moving toward lower pump TDH
= lower energy costs
- Don't burn your profit to irrigate better

Sisters Creek site



Centre Pivot details

- 5 span centre pivot machine with End Gun.
- 315m in length and irrigates 37 hectares
- Dam water source
- A 75KW motor coupled with a centrifugal ISO pump

Energy use in pumping

Pivot Site	Flow m ³ /hr	Pump Size	Motor size (kW)	kWh/ML	\$/kWhr	\$/ML
1	232	150x125-315	30	113	0.23	\$26.08
2	225	150x125-315	37	157	0.23	\$36.16
3	316	150x125-250	75	220	0.23	\$50.65
4	163	100x75-315	45	304	0.23	\$70.00
5	92	100x65-315	75	787	0.23	\$181.05

- Benchmarks
 - 4-8 kWh/ML/meter head
 - 150-300 kWh/ML
 - \$30-70/ML Daley and Callow 2014



System capacity and the green drought

