NSW GOVERNMENT Department of Primary Industries

primefact

Comparing running costs of diesel, LPG and electrical pumpsets

July 2016 Primefact 1419 First edition
DPI Agriculture Water and Irrigation Unit

Irrigators often ask which pumpset type is best for their situation. In the following discussion, the energy operating costs and other considerations are compared for three pumpset types. Establishment costs have not been considered as these costs are too variable. Electricity infrastructure supply costs, for example, can range from $5,000 to $150,000 or more, depending on the existing level of infrastructure.

Fuel or power costs were determined as at July 2016. Prices available at Sunraysia in south-western NSW are used as an example. Calculations are provided to enable valid comparisons for your local situation. The pumpsets compared are:

- diesel fuel
- liquefied petroleum gas (LPG)
- standard irrigation electricity tariff
- off-peak irrigation electricity tariff.

Energy costs at the shaft

This discussion looks at the cost of providing power at the engine or motor shaft, to make the comparison more valid. That is, the full amount of energy consumed is considered, including losses through any transmissions or drives.

Diesel fuel

The wholesale price for diesel fuel varies daily and retail prices vary from company to company. A general wholesale figure in Sunraysia at the time of writing was 125 cents per litre, including GST.

An excise rebate can be claimed on this cost from the federal customs department. So the approximate price for fuel supplied to primary producers using the fuel on-farm, excluding GST, is around 88 cents per litre

To obtain the cost at the shaft, the cost per mega joule of energy is determined by:

1. **Dividing the cost per litre by the specific energy of a litre of fuel**. Diesel fuel has a specific energy of around 38 mega joules (MJ) per litre. This value can vary depending on the refiner, the source of crude oil and the season. More precise values can be obtained from the major fuel supply companies.
2. **Derating this figure for the engine efficiency**. A reasonable diesel engine efficiency is 35%, meaning 35% of the energy of the fuel is available as energy, converted to mechanical energy, at the engine shaft. (The efficiency figures used in this Primefact are reasonable estimates of efficiency for engines and motors in serviceable condition. Similar figures are used by United Stated Department of Agriculture in Calculating Pumping Efficiency & Performance ENCON2.4 December 2012 Fact Sheet 4. The figures used here reflect improvements in efficiency obtained by modern pump drivers.)
3. **Putting the result into a cost per kilowatt-hour (kWh).** Megajoules and kilowatt-hours are both units of energy: 1 MJ = 0.278 kWh or 3.6 MJ = 1 kWh. Therefore, 1 litre of diesel has 38 MJ or 10.6 kWh of energy.

$$Cost\ per\ kWh\ at\ shaft = \frac{Cost\ per\ litre}{Specific\ energy} \times \frac{1}{Engine\ efficiency} \times \frac{1}{0.278}$$

$$Cost\ per\ kWh\ at\ shaft = \frac{88¢}{38} \times \frac{1}{0.35} \times \frac{1}{0.278}$$

= 23.8 ¢/kWh

LPG (liquefied petroleum gas)

The price paid for LPG is generally negotiated depending on the amount used annually, the consistency of demand, the locality, and distance from the depot. For an irrigation horticulturist requiring about 10–15 tonnes bulk supply per year with a 2-kilolitre (1-tonne) tank, around 85 cents per litre would be reasonable (excluding GST). As there are no taxes on LPG, there are no rebates available.

A reasonable LPG engine efficiency is 30%.

LPG has a specific energy of 25.5 mega joules per litre.

Using the same formula as above:

$$Cost\ per\ kWh\ at\ shaft = \frac{85¢}{25.5} \times \frac{1}{0.30} \times \frac{1}{0.278}$$

= 39.9 ¢/kWh

In addition, for this storage tank size, there is an annual rental fee on the LPG of about $450.

Electricity

Standard day rate

Electricity prices can vary according to supplier. A reasonable figure for Sunraysia is 27.3 c/kWh excluding GST.

A reasonable electric motor efficiency is 90%.

$$Cost\ per\ kWh\ at\ shaft = \frac{27.3¢}{0.9}$$

= 30.3 ¢/kWh

Off-peak electricity (10 pm to 7 am weekdays and all day on weekends and public holidays)

A reasonable figure for Sunraysia is 15.9 ¢/kWh

$$Cost\ per\ kWh\ at\ shaft = \frac{15.9¢}{0.9}$$

= 17.66 ¢/kWh

In addition, there are other charges, sometimes called a service availability charge. A common figure for Sunraysia is 380 ¢ per day which equates to $1,387 per year.

Seasonal operating costs (July 2016)

These figures are for comparison purposes only and are based on assumed power efficiencies. Actual efficiencies will vary depending on the condition and suitability of the engine or motor selected. Local situations, particularly regarding service charges, will also vary.

Below are annual operating costs for a horticulture enterprise with power at the shaft of 30 kW and irrigating for a total of 500 hours over the season, and therefore a total annual usage of 15,000 kWh:

Motor	Calculations	Extra charges	Annual operating cost ($)
Diesel	15,000 × 23.8 ¢ = $ 3,570	nil	3,570
LPG	15,000 × 39.9 ¢ = $ 5,985	annual fee of $ 450	6,435
Electricity (standard)	15,000 × 30.3 ¢ = $ 4,545	Service availability charge $ 1,387	5,932
Electricity (off-peak)	15,000 × 17.66 ¢ = $ 2,649	Service availability charge $ 1,387	4,036

Below are annual operating costs, for a 60 ha centre pivot having a motor with power at the shaft of 82 kW and irrigating for a total of 1,800 hours over the season, and therefore a total annual usage of 147,600 kWh:

Motor	Calculations	Extra charges	Annual operating cost ($)
Diesel	147,600 × 23.8 ¢ = $ 35,128	nil	35,128
LPG	147,600 × 39.9 ¢ = $ 58,892	annual fee of $ 450	59,342
Electricity (standard)	147,600 × 30.3 ¢ = $ 44,723	Service availability charge $ 1,387	46,110
Electricity (off-peak)	147,600 × 17.66 ¢ = $ 26,066	Service availability charge $ 1,387	27,453

How the figures compare will vary as the price of each type of energy varies. Several years ago the price of peak electricity was around 20 ¢/kWh while diesel was only slightly cheaper. This meant that the annual operating cost, even at peak tariff, was much less for electric pumps than for diesel pumps.

Other considerations

When choosing a power source, other factors not included in this simple analysis need to be considered including:

- irrigation management – the effect on costs of daily watering (using standard rate) compared with longer interval conventional irrigation management (using off-peak)
- initial establishment costs (line extension and connection or fuel storage tanks)
- initial engine/motor costs and life expectancy (electric motors are considerably cheaper than internal combustion engines)
- maintenance, repair or replacement costs over the life of the unit
- ease of integration with digital control systems
- personal preferences

- projected energy costs, effect of externalities (e.g. a carbon tax).

More information

Calculating Pumping Efficiency & Performance ENCON2.4 December 2012 Fact Sheet 4

Irrigation system and pump selection. AgGuide Water Series. NSW Department of Primary Industries

Primefact 1410. *Electric pumps — performance and efficiency*

Primefact 1425 *Is your diesel pump costing you money?*

Acknowledgments

Jeremy Giddings, Irrigation Development Officer (Hort), NSW DPI, Dareton

Ross Lake, Manager, Tasco Inland Australia, Mildura

Craig Matthews, Elgas Ltd Mildura

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Published by the NSW Department of Primary Industries.

V15/366 PUB15/475 Job No. 14098