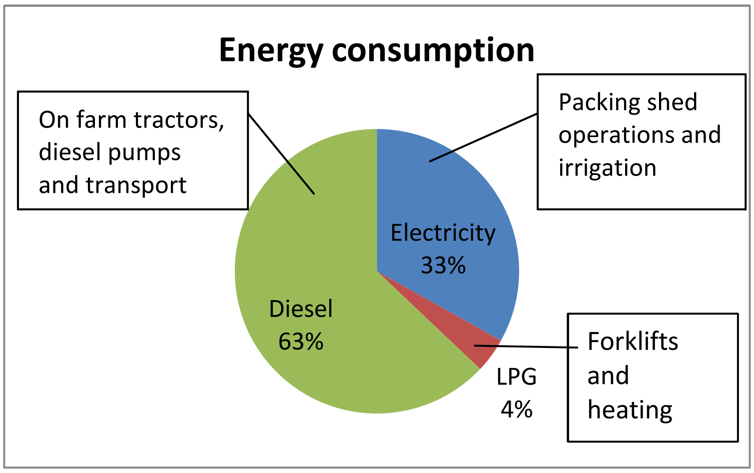
Energy audits point to potential savings on vegetable farms

Energy is of increasing importance as a cost centre in vegetable operations. Saving energy can improve the bottom line; it's a matter of finding where the best and most economic energy savings are hidden.

Infotech Research conducted a series of 22 energy audits of levy paying vegetable growers in 2014, as part of a project with Horticulture Innovation Australia Limited (formerly known as Horticulture Australia Limited). We found that while individual operations vary, most of the energy used on a farm is as diesel fuel for cultivation, planting, irrigation and harvesting. Electrical energy consumption is less but costs about the same as diesel, while LPG is the predominant fuel used by forklifts.



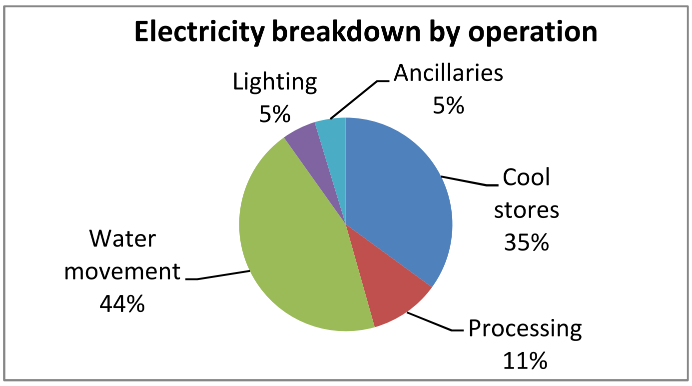
Diesel is an efficient fuel compared to petrol and LPG. Diesel engines average about 35% fuel energy conversion to work. When put through the tractor drive train, this drops to about 25%, so three quarters of the energy in the diesel is converted to heat rather than work.

This efficiency varied in a recent tractor study with efficiencies of 75kW tractors fluctuating between an efficiency of 23% to 31%. At the better efficiency end of the tractor range there is a potential saving in fuel of 25%, so it pays to buy a fuel efficient tractor.

Electric motors are more efficient than diesel engines, usually by about 90%, and simple direct drive chains give a total conversion of electrical energy to work of about 80%. So electrical motors are approximately three times more efficient than diesel engines.

Conversion of diesel fuelled systems to electric systems makes good economic sense where the option exists, such as for irrigation pumps.

Electrical energy consumption



The audits indicated that the majority of electrical energy consumption was split between irrigation pumps and the cooling systems, which take up 80% of the total electrical energy of most grower operations. Processing of vegetables is relatively minor as is lighting and ancillaries such as compressed air. A focus on the big users gives bigger rewards.

Cooling produce
The average energy used to run cool stores totalled 62 kWh per tonne across the 22 growers audited. This was compared to the sensible heat required to be extracted from a tonne of vegetables, starting at 30°C and cooling them to 2°C requires 111MJ/tonne (30.8 kWh/tonne including an allowance for respiration). This is almost 50% of the average energy used, so the losses are also about 50%.

Reducing losses is the cheapest way to save. In cool rooms this comes down to better insulation (particularly the floor – if not already insulated), protecting the cool store from the sun's heat, reducing heat from fans, forklift exhausts and cooling losses through doorways.

Improving chiller system efficiency is the next step in saving energy. This costs real money as chillers are not cheap. Before investing in a new chiller it may be worth considering the servicing regime of the chiller and fan systems employed. Chiller efficiencies were measured across a group of potato growers in the UK at a COP[1] of 0.7 (ave.) while new systems are available with a COP of 4. This will save 82% of the energy used by an old inefficient chiller.

Efficient water movement
Delivering water to crops and moving it between dams requires energy. Electric systems were compared, where possible, during the audits arriving at an average energy per ML moved to crops of 260 kWh/ML. The variation recorded between growers was from 200 to 460 kWh/ML and pump efficiencies measured varied from 20% to 75%.

Design of the irrigation system is critical to pumping efficiency with low pressure irrigation systems being more efficient. Irrigation mains can contribute to pumping pressure and energy costs with the pressure varying in inverse proportion to the pipe diameter to the power 5. So doubling the main diameter reduces the pressure loss by a factor of 32. Pressure also varies as the square of the flow rate so low pressure slow irrigation systems such as trickle irrigation can save pumping energy by large factors.

Restrictions in water flow using "T"s and elbows add to pressure, designing the pipe work to reduce turbulence and smooth water flow improves energy efficiency.

The pump itself needs to be able to supply pressure at the highest duty requirement and, if this varies, most irrigation systems encountered used a chocking valve to reduce the flow rate. Varying the flow rate electronically with a VSD is more energy efficient than using a valve and can save 30 or 40% of the pump energy if duty cycles vary a lot.

Growers can measure pump efficiencies and energy costs of pumping to determine where the opportunities lie for efficiency improvement.

Setting targets is necessary
"Fail to plan and plan to fail" is an old adage that may be better stated as fail to have a target and then you don't know whether you are efficient or not and whether you are improving or going backward.

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[1] COP stands for Coefficient of Performance for cooling systems the COP= sensible heat removed / energy input and can be from 2 to 4 for new chiller systems.

You can do your own energy audit and set your own plans for improvement.

Possible Grower Actions

A. Reduce energy losses (wastes)

a) Better insulation of cool stores
b) Insulation of cooling systems (chillers, flumes, hydro-coolers...)
c) Reduce the effects of solar heating
d) Reduce evaporation of water from irrigation systems
e) Reduce run off from irrigation
f) Reduce idling plant and equipment (esp. during breaks)
g) Lights off when not needed
h) Stop cool room fans when doors opened
i) Reduce restrictions in irrigation mains (build-up of sand and algae)

B. Improve energy use efficiency

a) Chiller efficiencies (COP from 0.7 to 4, VSD control)
b) Pumps efficiency maximised
c) Pump diesel to electric conversion (plus the addition of VSDs to accommodate duty cycles)
d) Irrigation systems conversion to low pressure (guns >> fixed, boom>>pivot, spray>>drip)
e) Belt drives to direct drives
f) Forklifts to conveyors / flumes (diesel/LPG to electric)

C. Secure the cheapest reliable energy supplies

a) PV panels
b) Grid electricity
c) Wind
d) Batteries / Fuel cells / Gen sets
e) Fuel storage
f) Water storage

D. Establish Energy Management Systems

a) Control and secure energy supplies
b) Establish targets for energy efficiency
c) Monitor cost and efficiency in major areas of consumption

Details of these suggested opportunities, including costings and payback periods can be found at Infoveg www.ausveg.com.au/infoveg and search for project VG13054.

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Horticulture Innovation Australia