

Energy Management in Manufacturing

National Manufacturing Summit
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About The Ecoefficiency Group

- **Originally the Working Group for Cleaner Production, The University of Queensland (mid 90s)**
- **TEG commenced 2013**
- **Specialise in Resource efficiency and Business Sustainability**
- **Involved in CCIQ ecoBiz Program**
- **Clients include:**
 - **Australian Meat Processing Corporation,**
 - **Dairy Australia,**
 - **Uniting Care,**
 - **Qld Dept State Development,**
 - **Qld Dept Environment & Science,**
 - **UN Industrial Development Organisation**

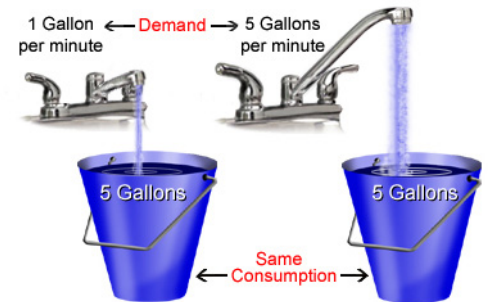
Energy Management – Understanding where to focus your efforts

- Tariffs
- Demand management
- Power factor correction
- Understand your use of energy
- Energy monitoring systems
- Heating and cooling
- Alternate renewable sources
- Funding opportunities

Electricity charges – understanding what you are paying

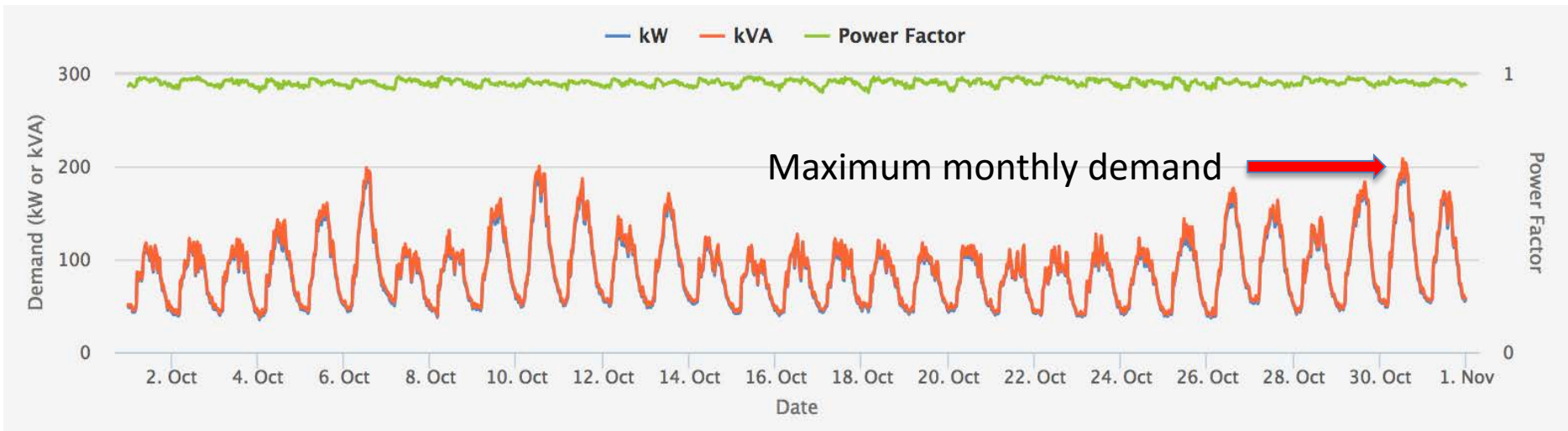
You can be charged in different ways :

- **Service fee** (\$/day)
 - **Flat rate** (cents per kWh).
 - **Time of Use** (cents per kWh) (Time-of-use tariffs – peak, off peak, shoulder)
 - **Demand Charge** (\$/ kVA)
-
- Various combinations of tariffs are available to businesses
 - Frustrations! Retailers don't provide the whole story.....



Peak Demand Charges 101

The largest average 'spike' in energy usage in any 30-minute period in that month



Peak Demand Example – commercial printer

Area	Day 1	Day 2	Day 3
Printing machines x 4	31		31
Printing machines x 2	22	22	
Trimming machines	2	2	2
Lighting (Factory Areas)	16	16	8
Lighting (Offices)	9	9	4
AC Units	55	55	20
Air compressor	14	14	10
Forklift	8	8	5
TOTAL kVA	157 kVA	126 kVA	80 kVA
Charge \$/yr	\$35,503.02	\$28,406.52	\$18,226.32

Example charge of \$19.90 / kVA/month

\$35,503 - \$18,226 = 17,276 \$/year potential savings

Reducing peak demand – what can be done

- **Scheduling/ staggering the start up and shut down of equipment**
- **Load shifting - moves the hours of operation of some equipment away from the peak (forklift example)**
- **Use alternative fuels e.g. natural gas, LPG and waste heat from other equipment.**
- **Generate energy on site/offset e.g. solar, biogas**
- **Energy management systems**
- **Install energy efficient lighting, motors, refrigeration, air-conditioning/heating**
- **Install power factor correction equipment**

Power factor charges

If you have poor power factor, not all electricity supplied can be fully utilised.



Pic source: www.energyaction.com.au

- Power factor is the ratio of working power to apparent power i.e. what is used compared to what is delivered.
- The closer PF to 1 the better with the aim of > 0.95 .
- Improving PF helps the energy suppliers and supply capacity

Power Factor Correction

- Qld businesses using > 100 MWh have power factor incorporated into charges – with electricity usage now measured as kVA
- Power factor can be improved/corrected by installing power factor correction equipment (capacitor banks)
- State based funding is available e.g.
www.energex.com.au/residential-and-business/positive-payback/positive-payback-for-business/power-factor-correction

Effect of lighting upgrade on power factor

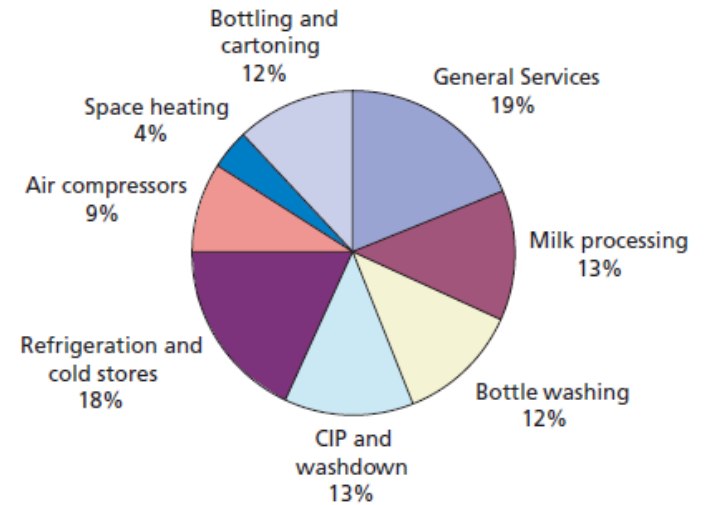
	PF	Peak kVA	Time
Aug-17	0.845	124.5	14:30
Sep-17	0.839	128.9	14:30
Oct-17	0.858	132.1	12:30
Nov-17	0.861	143.5	13:30
Dec-17	0.858	145.7	10:00
Jan-18	0.841	150.5	11:30
Feb-18	0.866	151.3	14:30
Mar-18	0.857	145.5	12:30
Apr-18	0.901	133.6	16:00
May-18	0.905	134.5	16:00

- Full light upgrade of about 200 fluoros and 8 high bays lights with LEDs which was completed end March
- Mar to Apr (145 kVA to 134 kVA)
- Cost of 19.80 \$/kVA demand
- \$200 per month saving in demand charges
- Assuming all things equal

Understanding energy use

Understanding energy use – milk processing example

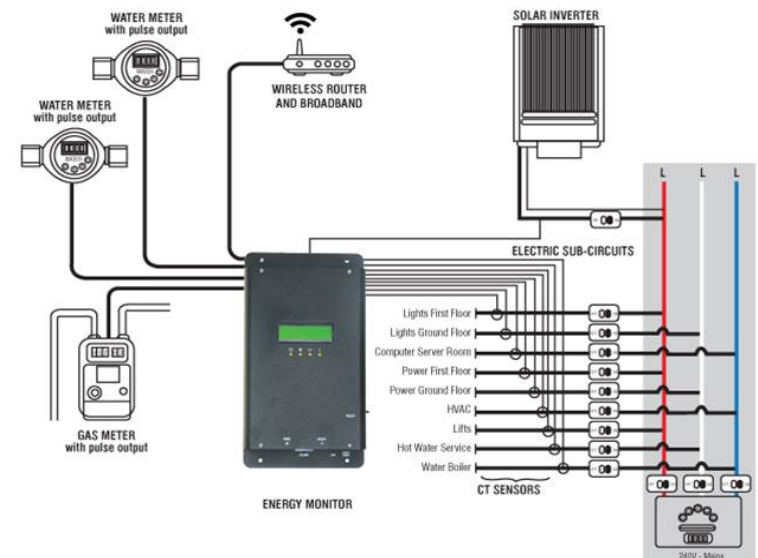
- Refrigeration system
- Air conditioning
- Boilers (steam and hot water requirements)
- Compressed air systems
- Motors (filling and packing machines, conveyors, homogenisers, separators)
- Lighting
- Pumps
- Fans (cooling towers)



- Example electricity split – market milk factory

Energy monitoring systems

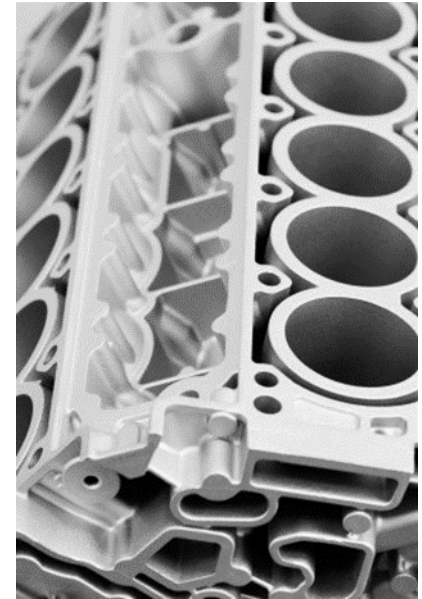
- Real time energy monitoring
- monitor electricity, gas and water usage
- demand side controls
- Electricity only monitoring can be installed for in the order of \$4,000-\$5,000 outright or with monthly subscription for a small to medium facility



Heat Treatment Australia Energy Management System



- Provide metal heat treating services to the defence, mining, automotive, transport and agriculture industries
- Monitors the real-time energy consumption of about 15 equipment items
- A decision hierarchy automates load shedding i.e. equipment items are ramped back or turned off when set peak levels are approached.
- Operators are notified via a light system with green, amber or red, indicating that load shedding is occurring
- The EMS has reduced peak demand by about 30% and saved in the order of 60,000 kWh and \$24,000 per year.



Estimating electricity consumption by equipment - On-off data loggers

How long is the equipment in use and under what load?



Motor logger – on/off - \$92

- Motors
- Pumps
- Compressors
- Fans of HVAC

Three-phase electric motors account for up to 40% of the total electricity consumed in the commercial and industrial sectors!!

Pumps & Motors

- Install variable speed drives
- Replace oversized motors
- The annual cost of running a motor can be 10 times the purchase price

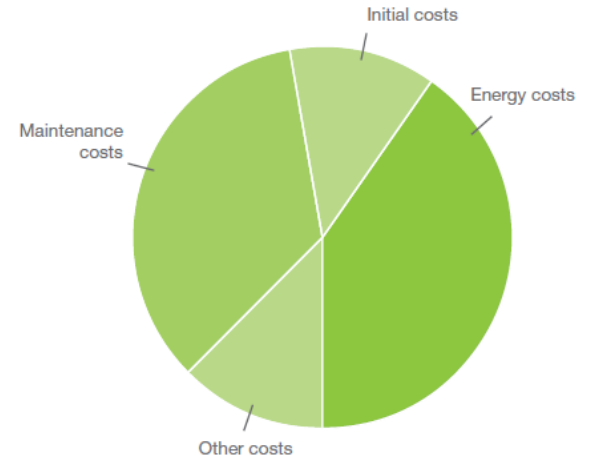


Figure 1: Typical proportions in the life cycle cost analysis for a medium-sized industrial pump.³

Table 1: Energy costs for various electricity costs in a fully loaded 10 kW motor.

Operating Time	Electricity Costs in a Fully Loaded 10 kW Motor			
	16 c/kWh	20 c/kWh	24 c/kWh	28 c/kWh
1 hour	\$1.60	\$2.00	\$2.40	\$2.80
24 hours	\$38.40	\$48	\$57.60	\$67.20
1 month	\$1,168	\$1,460	\$1,752	\$2,044
1 year	\$14,016	\$17,520	\$21,024	\$24,528

Efficient refrigeration systems – opportunities

1. Variable plant pressure control
2. Automated compressor staging and capacity control
3. Remote control optimisation of refrigeration plant
4. Heat recovery from discharge gas and oil cooling
6. Variable cold store temperatures
7. Variable evaporator fan speeds
8. Condensate sub-cooling
9. Refrigeration plant design review
10. Chiller efficiency – full and part load
12. Chilled water/glycol circuit design and control
13. Heat recovery from chillers and chiller/heat pumps units
14. Variable chilled fluid temperatures
15. Variable cooling water temperatures

Refrigeration efficiency is measured in terms of Coefficient of Performance (COP)

$$COP = \frac{\text{quantity of cooling (kW)}}{\text{total energy input (kW)}}$$

The higher the COP, the higher the efficiency of the system



See: NSW OEH, 2011 Technology Report, Industrial refrigeration and chilled glycol and water applications

Maintenance of refrigeration systems (small systems)

- Thermostat on correct temperature
- Ensure seals in good condition
- Pipes are insulated
- Variable speed drives on fans
- Fans and coils are dust free
- Ensure good practices e.g. doors are closed and use of plastic curtains to prevent heat egress
- Condensor fans and coils are clean
- Replace motors on fans when overheating
- Regular defrost
- Ensure condensate run off lines are kept clean and free flowing
- Heat eject from compressor can escape easily e.g. vent outside if possible
- Heat exchange surfaces are cleaned and maintained regularly

Thermal Energy – Steam boilers and hot water

- **Monitor your fuel consumption (gas, LPG or coal)- install gas and water meters**
- **Understand the efficiency of your boiler**
- **Economisers and pre-heaters for inlet air**
- **Maintenance**
 - **Fix all steam and condensate leaks.**
 - **Ensure condensate is returned back to the boiler**
 - **Check burners and controls**
 - **Check for scale, fouling and deposits**
 - **Check insulation**

Richmond Dairies, High Efficiency Boiler

- Installed a high efficiency AGL Boiler 8MW unit with economiser, state-of-the-art combustion control, and the ability to co-fire multiple fuels
- Online gas flow meter to monitor consumption and boiler efficiency
- 85% boiler efficiency
- Project cost - \$700,000
- Gas Savings – 10%
- Payback – 3.5 years



Renewable Energy Sources

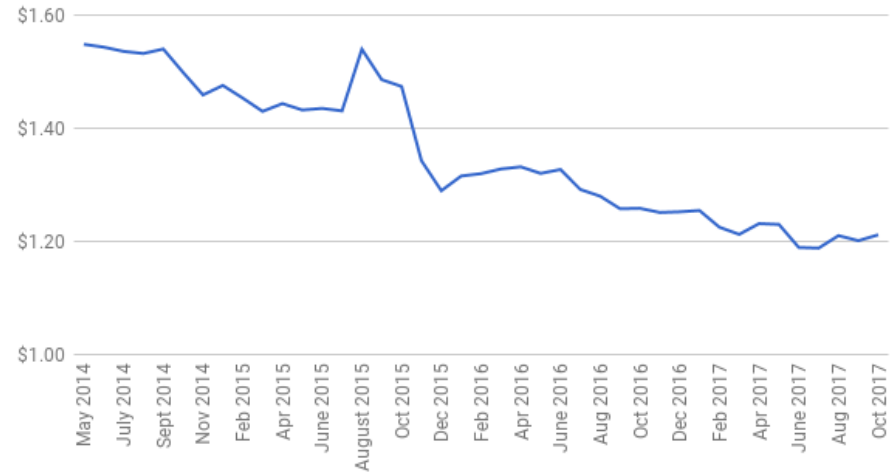
Solar PV and battery

- Reducing dependence on grid power
- Peak shaving
- Solar PV prices dropping and average battery pricing approaching \$1000/kWh

Types:

- Lithium ion – Tesla, BYD, AGL, Ergon, Zen Energy, ENOPTe
- Redox flow – e.g. zinc bromide – (RedFlow)
- Lead acid – e.g. wet cell, gel (Allgrid)

Average Commercial Solar PV System Prices - All system sizes



Source: www.solarchoice.net.au

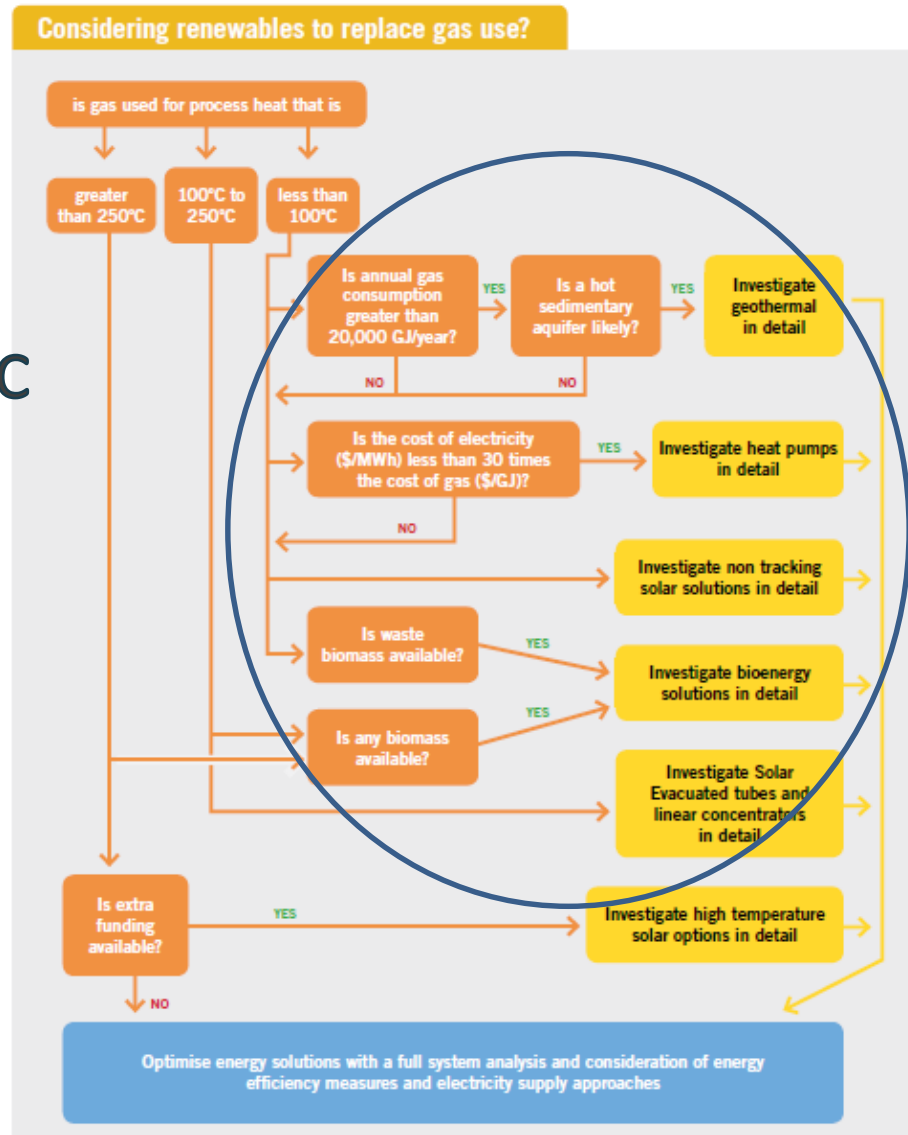


Renewable energy options to replace gas

- For gas uses of < 100 deg C, 100-250, > 250 deg C

Consider

- Geothermal
- Heat pumps
- Solar PV
- Bioenergy
- Evacuated solar tubes
- High temp solar options



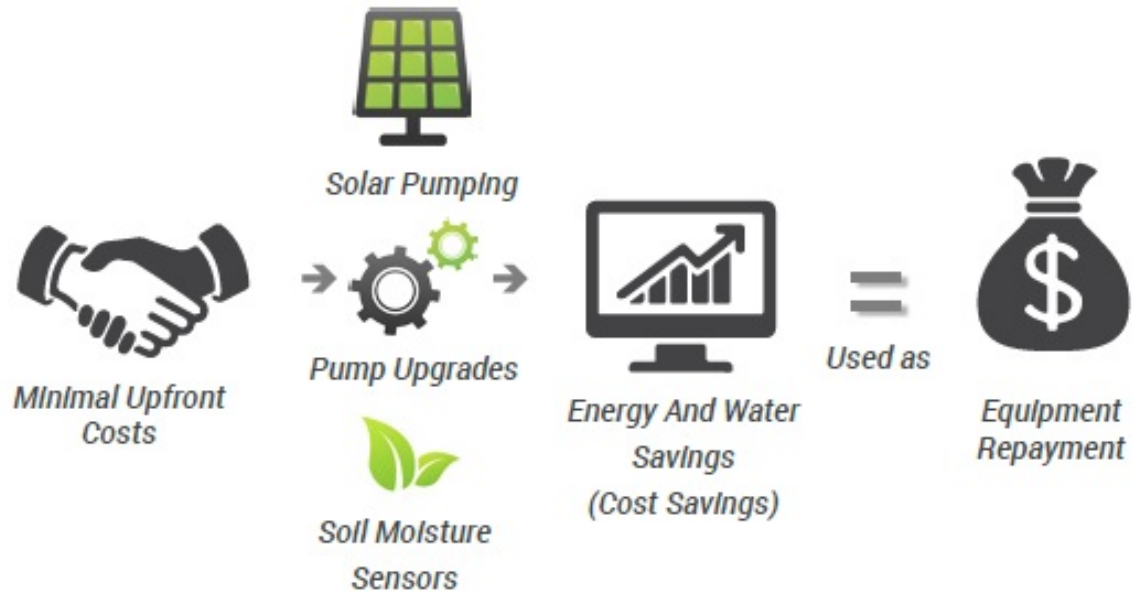
www.arena.gov.au/resources/renewable-energy-options-for-australian-industrial-gas-users

Funding

- State based rebates e.g. www.energex.com.au/residential-and-business/positive-payback
- Green loans for cars, solar, energy efficiency – check your bank for rates,
- Solar leasing arrangements
- On-bill finance e.g. AGL and Origin – cost of installation is repaid via elec bills
- ARENA - arena.gov.au/programmes/advancing-renewables-programme/
- Clean Energy Finance Corporation (CEFC) - www.cleanenergyfinancecorp.com.au
- Emission Reduction Fund
- Regional Development Associations
- www.grantslink.com.au

Funding

Energy Efficiency Partnerships (EEP)



Energy Management – lots to consider,
lots of opportunities with a systematic
approach

Thank you!



Go Socceroos!!!