Energy Efficient & Cost Effective Milk Cooling

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Covering

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Some observations on:

- Milk cooling changes
- Working out what you need to do
- Options and factors to take into account
- And a few comments on dairy shed efficiency in general

Milk cooling regs changes

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- New regs (NZCP1) require from 1 June 2018:
  - Milk cooled to 10^0C within 4 hours of start of milking
  - Milk cooled to 6^0C within 6 hours of start of milking or 2 hours of end of milking
  - Milk in vat not to exceed 10^0C when 2nd milking added
- Current requirements are 18^0C or less at end of milking and cooled to 7^0C within 3 hours of end of milking
- From 1 Aug 16, i.e. this season, you must record milk temperatures over two consecutive milkings – once near peak and once in Feb
- Farms not meeting existing requirements need to fix straight away

Temperature Profiles

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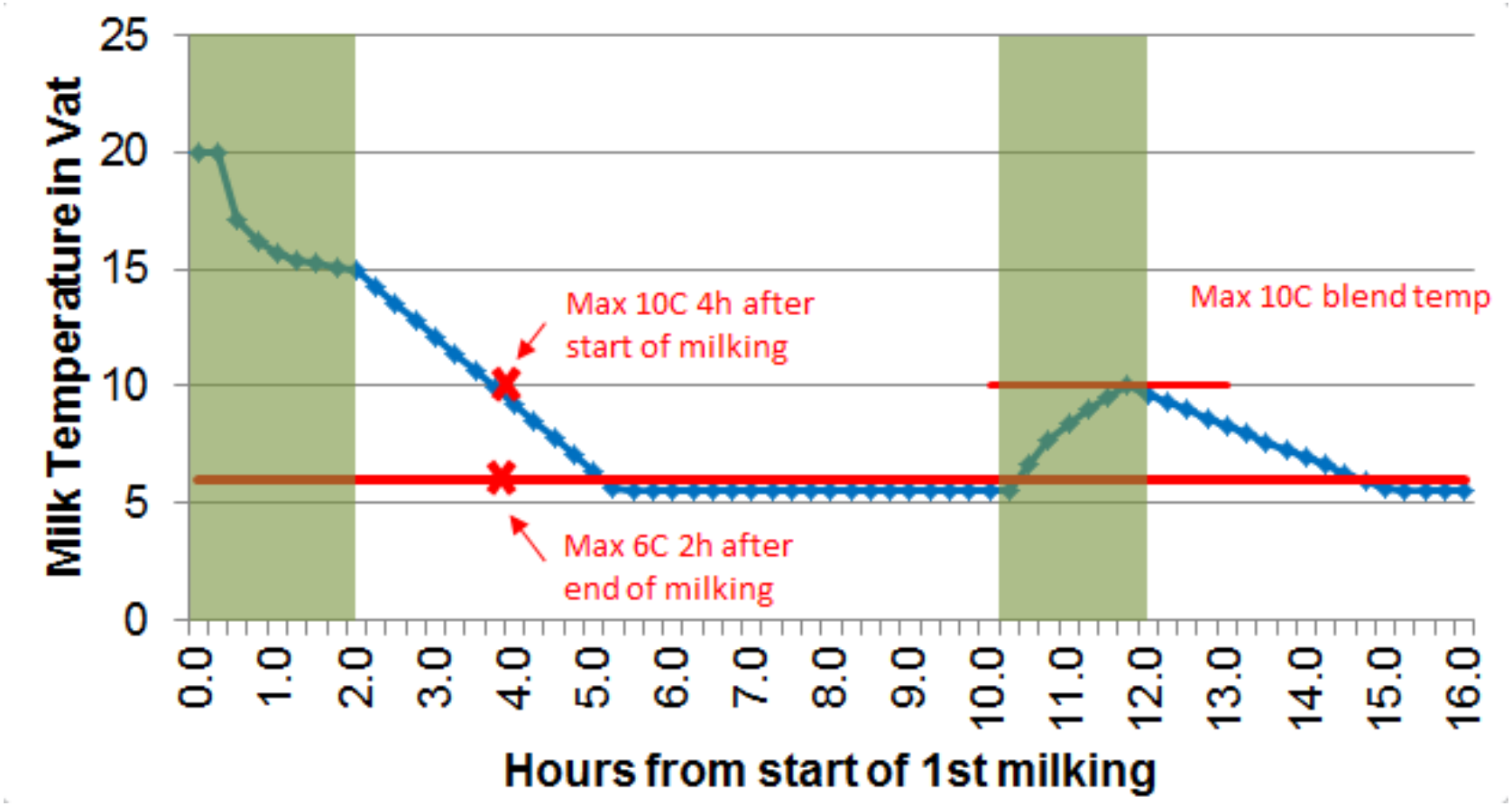

What does it mean?

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- Approximate 35% increase in theoretical peak refrigeration load
- But many farms already have some excess capacity, either due to good precooling or conservatively sized vat and/or refrigeration
- Over NZ, a little over half of farmers shouldn’t need to do anything while the rest need anything between a small tweak and a major upgrade.

A plan of attack

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- Work through your options systematically:

  a) How much, if any, increase in cooling capacity do I need?

  b) What can I achieve with some minor tweaks, which will generally also save some energy?

  c) If I need some prechilling, what option is best for me?

Knowing where you are now

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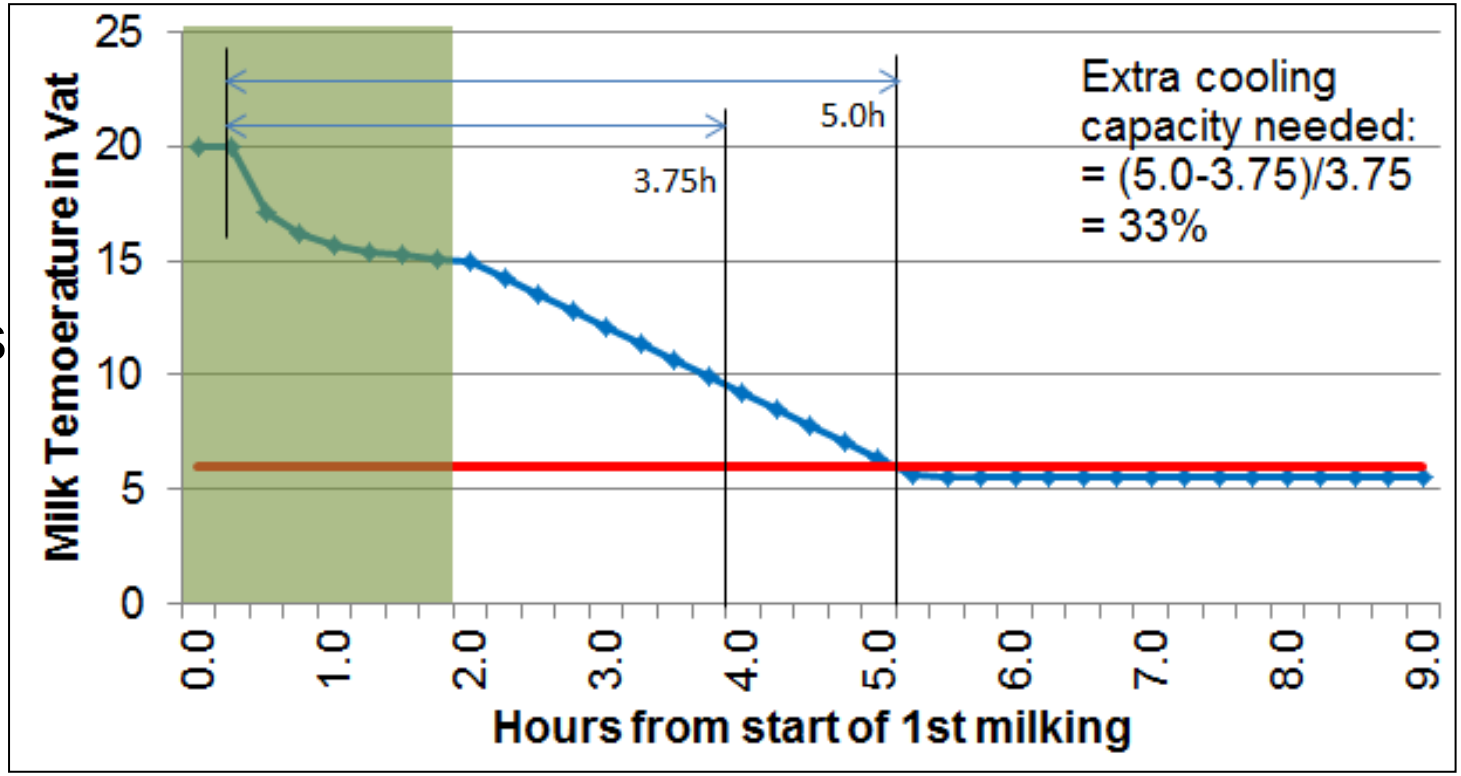
- Number of ways you can do this:

  - datalogging (expensive,)
  - calculating from the milk temp in vat at end of milking and refrigeration nameplate capacity (less accurate), or
  - simple monitoring over a couple of milkings



Options

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- Option 1: Get the best out of what you already have
- Option 2: Increase vat refrigeration capacity
- Option 3: Add prechilling
  a) Cooling tower
  b) Chilled water/glycol
  c) Ice-bank

Improving precooling

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- A 1^0C drop in milk temperature to the vat reduces refrigeration load by 8% and saves energy
- Maximise precooler performance
  - use coldest water you can
  - concrete tanks better than plastic, light colours better than dark
  - once through water flow, don't return to the same tank
  - keep water side of plates clean
  - should cool to within 2-3C of water temp
  - link water supply to milk pump

Insulating outside vat

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- Vat insulation on an outside vat will increase cooling capacity by around 10% on a hot afternoon
- Do get a properly fitted one - cost $2,000-$3,500

Other Tweaks

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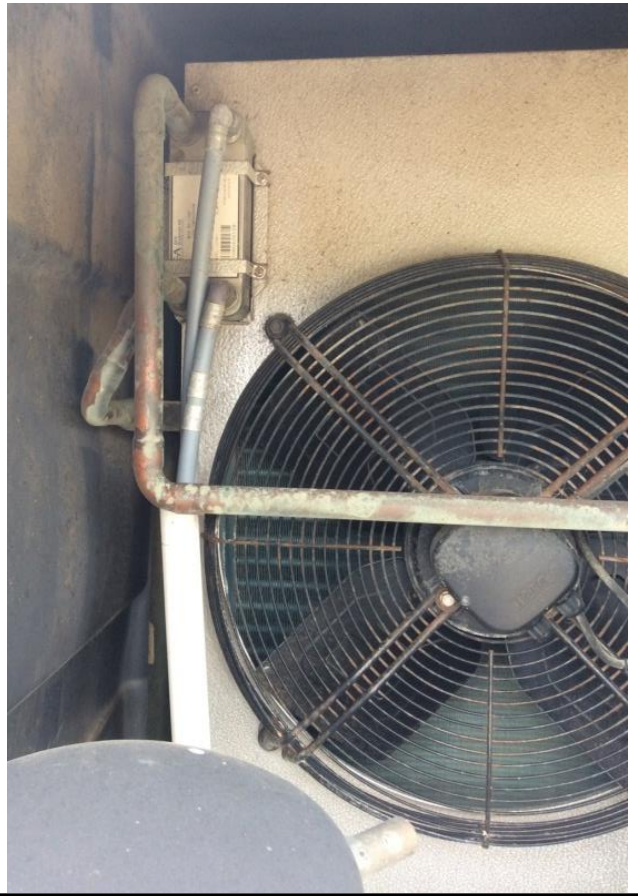
- Ensure refrigeration units are well maintained and have good unimpeded airflow around the condenser
- Measures which save energy and probably improve cooling capacity but difficult to predict by how much:
  - desuperheaters & heat recovery systems (particularly if condenser already struggling)
  - electronic expansion valves



Install a larger refrigeration unit

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- If you have good precooling but still need extra capacity, this may be your best option
- Vats have a maximum pad capacity - beyond that adding more refrigeration gains nothing in terms of cooling rate
- Standard 4,500-9,100 litre vat pads can handle 23.5 kW which is about the output a 9hp refrigeration unit.
- The condition of the present refrigeration unit, electricity tariff structure, and any quality concerns will also need to be considered.
- Consider installing heat recovery along with any new unit as it is the cheapest time to add it

Cooling Towers

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- Cooling Tower
  - need to store large amount of water,
  - can replace precooler water or be a 2nd stage cooling
  - will give you water at around 3C above overnight minimum temperature,
  - unlikely to be a good or reliable option in Northland

Prechilling

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- What type – icebank, glycol, or chilled water?
- What size ?
  - 100,000 kg ms farm with precooling to 18C will need:

    All cooling in vat - 5 hp unit
    Icebank or stored chilled water system - 2 hp
    In-line chiller - 9 hp
  - You don't have to cool the milk to 6C into the vat – can share the cooling load between precooler and vat
  - Take into account the age and condition of your present refrigeration unit, demand constraints, cost, whether you have heat recovery on the existing refrig.
- All these options require a two-stage milk cooler

Ice-banks

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- Stores “cold” in form of ice on coils
- Advantages:
  - run with smaller refrigeration unit,
  - take advantage of cheaper off-peak power

- Disadvantages:
  - slightly more energy use than vat refrigeration
  - can blow out electricity use if ice sensor fails
- Wide range in price and complexity

Chilled Water or Glycol systems

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- Glycol systems are basically chilled water systems but with a compound added to lower the freezing point
- Glycol needs extra measures to ensure the glycol cannot contaminate the milk in the event of a plate failure.
- Both have options of either a storage system or direct in-line cooling.
- Storage systems allow for a smaller refrig unit, important if you have capacity constraints, but overall will be more expensive unless you have a spare concrete tank and will use a little more energy

Heat Recovery

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- Units generally come with integral heat recovery to preheat water to the cylinder
- Worth considering these but they don’t always deliver as much hot water as promised
- With in-line prechiller it takes a bit of juggling to get maximum heat recovery and have 85C hotwater in time for washup, particularly if you do two hot washes a day.

Chilled Water & Glycol systems

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Simple systems

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- If you have a decent sized calf milk vat or a spare concrete tank, and comfortable with a bit of manual input, you could make you own chilled water system.
- Won’t be able to get down to 6C milk into the vat and not as efficient as a package unit but a lot cheaper
- Still need two-stage cooling and an extra pump
- Should be able to get a 10C temperature drop with 1.5 litres of chilled water storage for every litre of milk cooled.
- The chilled water should be a closed loop otherwise you will waste too much energy

Simple systems

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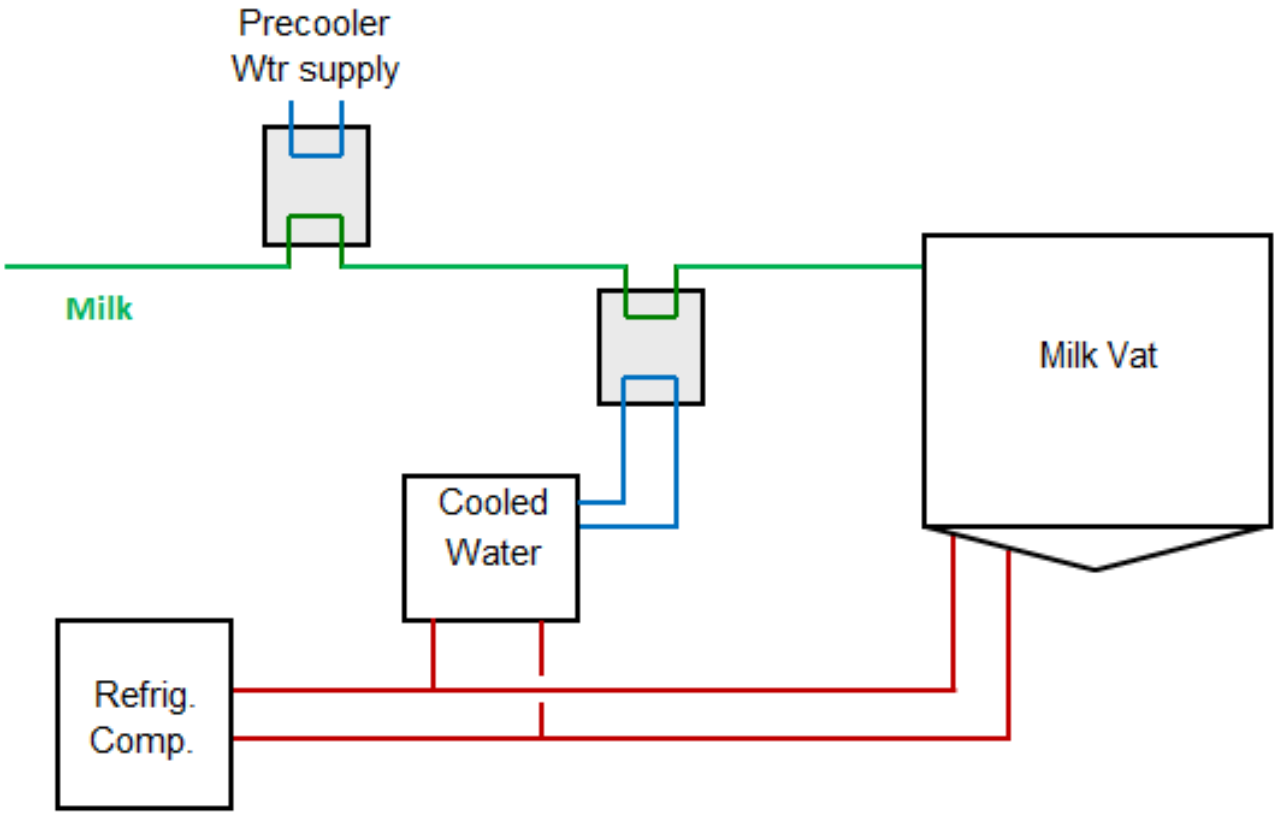

In conclusion

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- First figure out what if any increase in cooling capacity you need for tougher milk cooling standards
- First look at efficiency measures which free up cooling capacity before upgrading of the refrigeration plant
- Consider all options and do the sums for your own circumstances, challenge all assumptions
- Don’t be afraid to seek assistance

- And now, a few words on energy efficiency in general ….

Benchmarking electricity use

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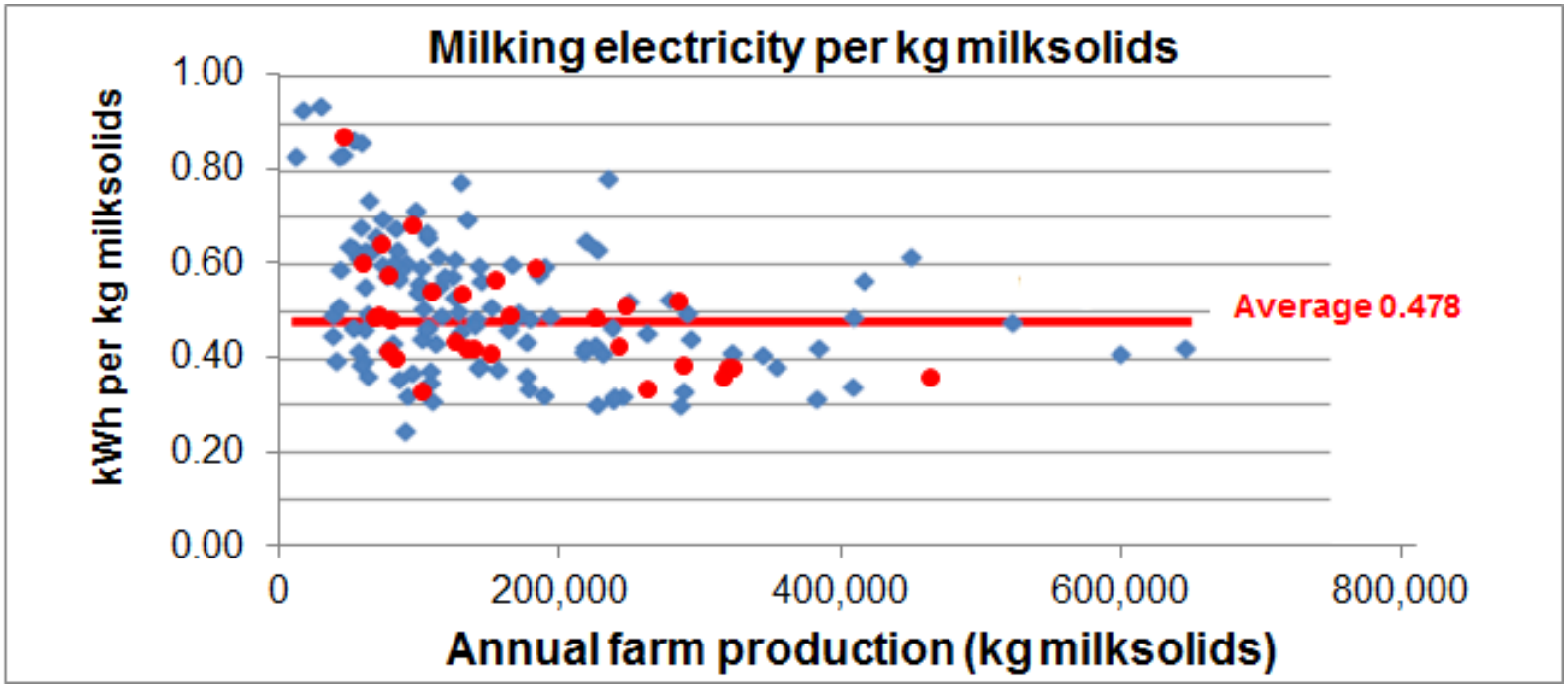

- There is more variability in the smaller farms but small farms can be just as efficient as the large farms with new sheds

Where is electricity used?

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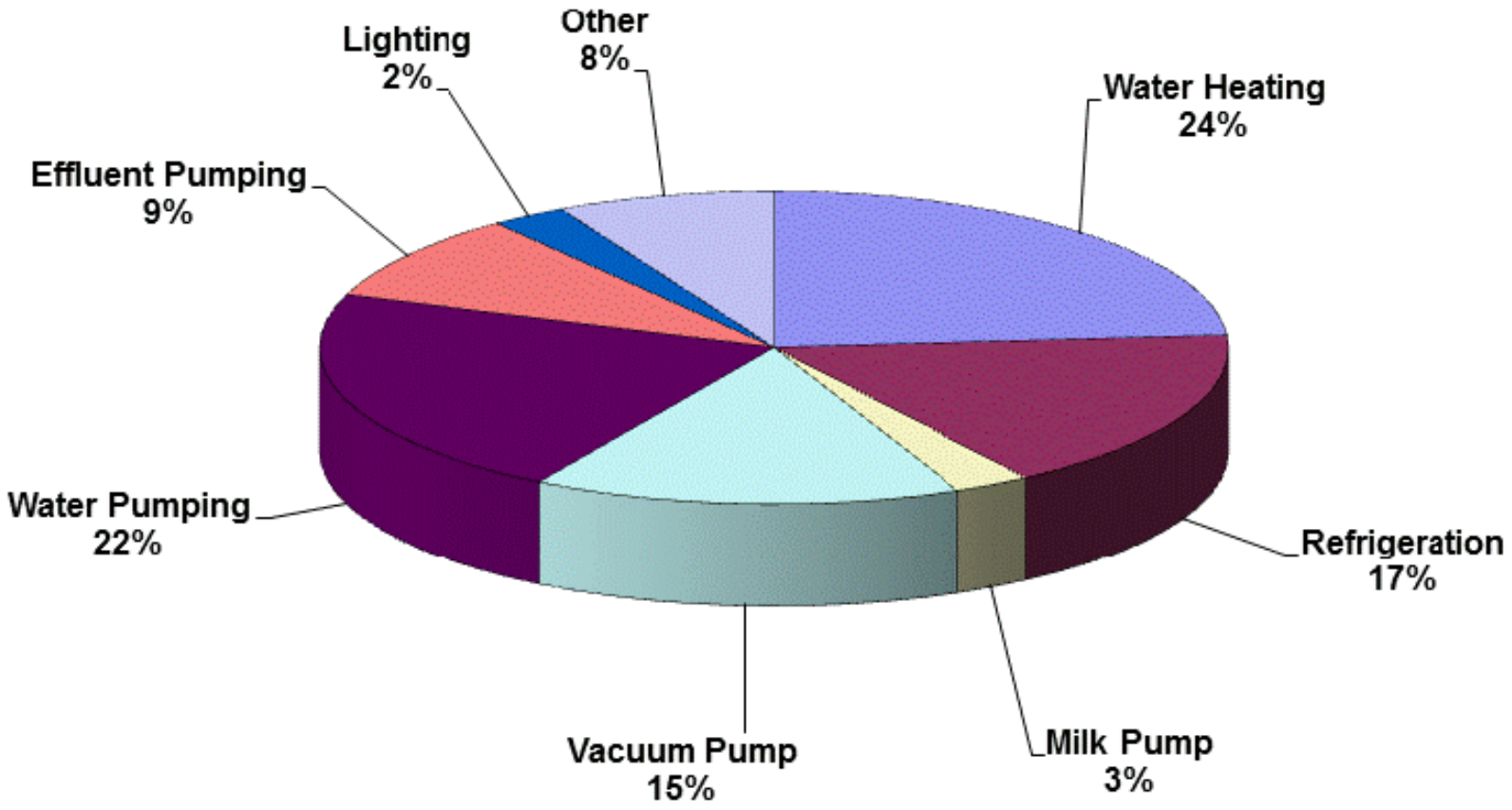
- Typical split:



Water heating opportunities

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- First minimise the amount of hotwater heating needed:
  - once a day hotwash if you can
  - fix any leaks
  - no hotter than necessary
  - have volume measurement on cylinder or washtub
  - keep cylinder cladding in good nick,
  - jacket older cylinders
- Fit timer control, especially if doing once-a-day hotwashing and/or you have a day/night tariff.

Water heating opportunities

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- Many options to recover heat from the refrigeration plant to preheat water:
  - recovery from precooler
  - simple refrigerant desuperheater
  - recirculating desuperheater
  - heat pump (e.g Mahana Blue,Eco Boost)
- Which option is best depends on tariffs, how much hot water you use, and how much you are prepared to spend.
- Solar hot water, ground- or air-source he even bottled LPG are also options

Milking plant

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- Vacuum pump variable speed drives (VSDs)
  - The vacuum pump is generally the main load in the milking plant itself
  - VSDs match the speed of the pump motor to the vacuum requirement
  - As a general rule, the larger the vacuum pump and the more cows being milked, the quicker the payback
  - Benefit does depend on vacuum pump type – greatest savings with liquid-ring pumps

- Milk pump VSD - normally small and the real benefit is in getting a uniform flow through the precooler

Effluent and water pumping

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- This is becoming an increasingly large component of the milking shed electricity
- See some grunty pumps and agitators on effluent systems
- If you reduce water use you will reduce electricity used in pumping water to and effluent away from the shed
- Look at ways to minimise hosing down time
  - concrete in good order,
  - pre-wetting,
  - dungbusters, etc.

Evaluating efficiency options

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- Don’t get sucked in by sweeping payback claims - work out the payback for your particular situation
- Beware the blatant snake-oil offers – e.g. power factor correction units
- Don’t hesitate to ask for help

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Thank you.

Questions?