Capturing savings and value

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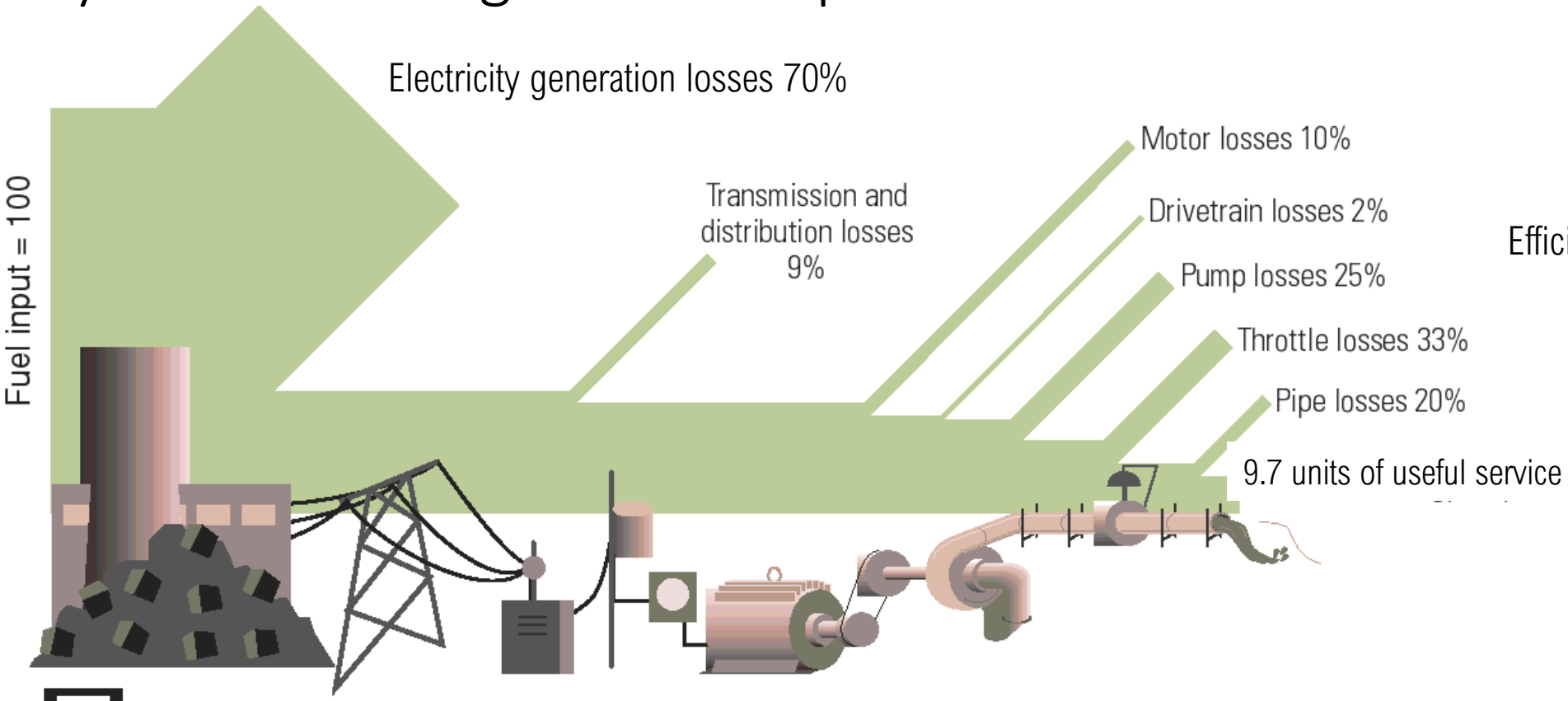
From Victorian program – common measures

- Improving pre-cooling
- Refrigerant treatment (de-fouling, changing refrigerant type, etc)
- Installing variable speed drives on pumps (and fans); fan, pump replacement
- Lighting updates
- Heat recovery systems
- Control systems for hot water and chilled water and refrigeration
- Maintenance (fixing air leaks, regular maintenance, cleaning lines, etc)
- Solar (and heat pump) hot water systems
- Solar PV (after completion of efficiency upgrades to reduce the amount required to be installed)
- Replacement of inefficient equipment – vats, pumps, compressors

Optimising business and energy productivity

- Apply ‘systems and services’ thinking to process efficiency
- Identify where energy goes with dynamic modelling of processes based on fundamental physics and chemistry (eg EEO ‘Energy-Mass Balance’, AS/NZS 3598 etc)
  - transients, part-load efficiencies, standby losses matter!
  - Predictive modelling for benchmarking can avoid loss of production
- Ensure data systems provide ACTIONABLE advice where and when useful, and in a form the operator or control system can apply
- Incorporate all business benefits and overall system outcomes into project evaluation
- Align the human, financial, incentive systems with information and process systems
- Transform ‘wastes’ into value
- Consider new business models that capture more of Value Chain, and/or diversify

Systems thinking – an example



Efficiency within plant 35.5%

Can level of 'useful' service be reduced – eg water efficiency measures?

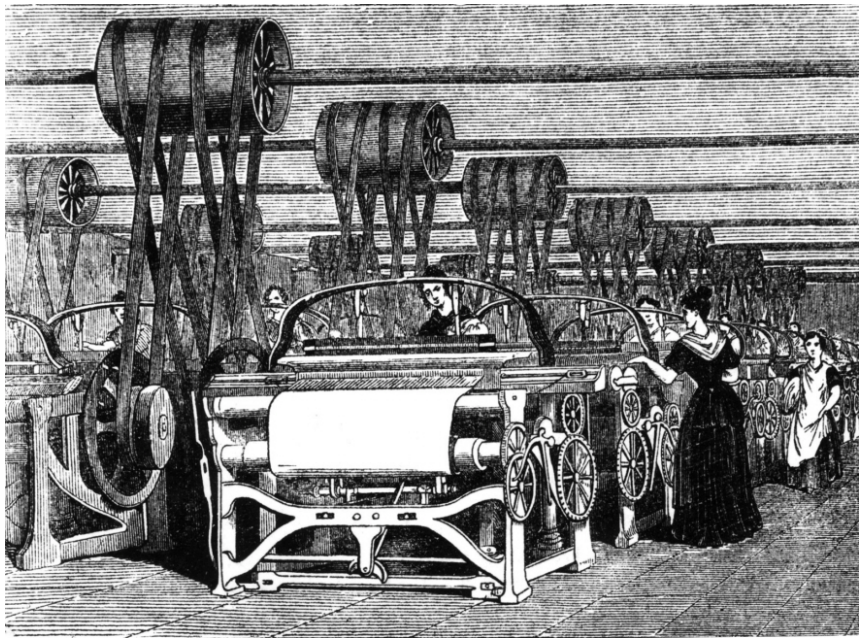
From the *Drivepower Technology Atlas*.
Courtesy of E SOURCE, www.esource.com.

To calculate efficiency: (1-0.7)x(1-0.09)x(1-0.1)x(1-0.02)x(1-0.25)x(1-0.33)x(1-0.2) = 0.097 (9.7%)

To check pump system efficiency: measure or estimate flow rate in litres/second needed for 'efficient' service. Calculate or estimate vertical height from source to outlet in metres. Watts(flow)=(Litres/sec)x9.8x(height difference from inlet to outlet). System efficiency=(Watts(flow))/Watts(electric)x100. Ideally also check Power Factor.

If pump system efficiency is less than 65% and/or Power Factor is less than 0.9, there may be savings potential

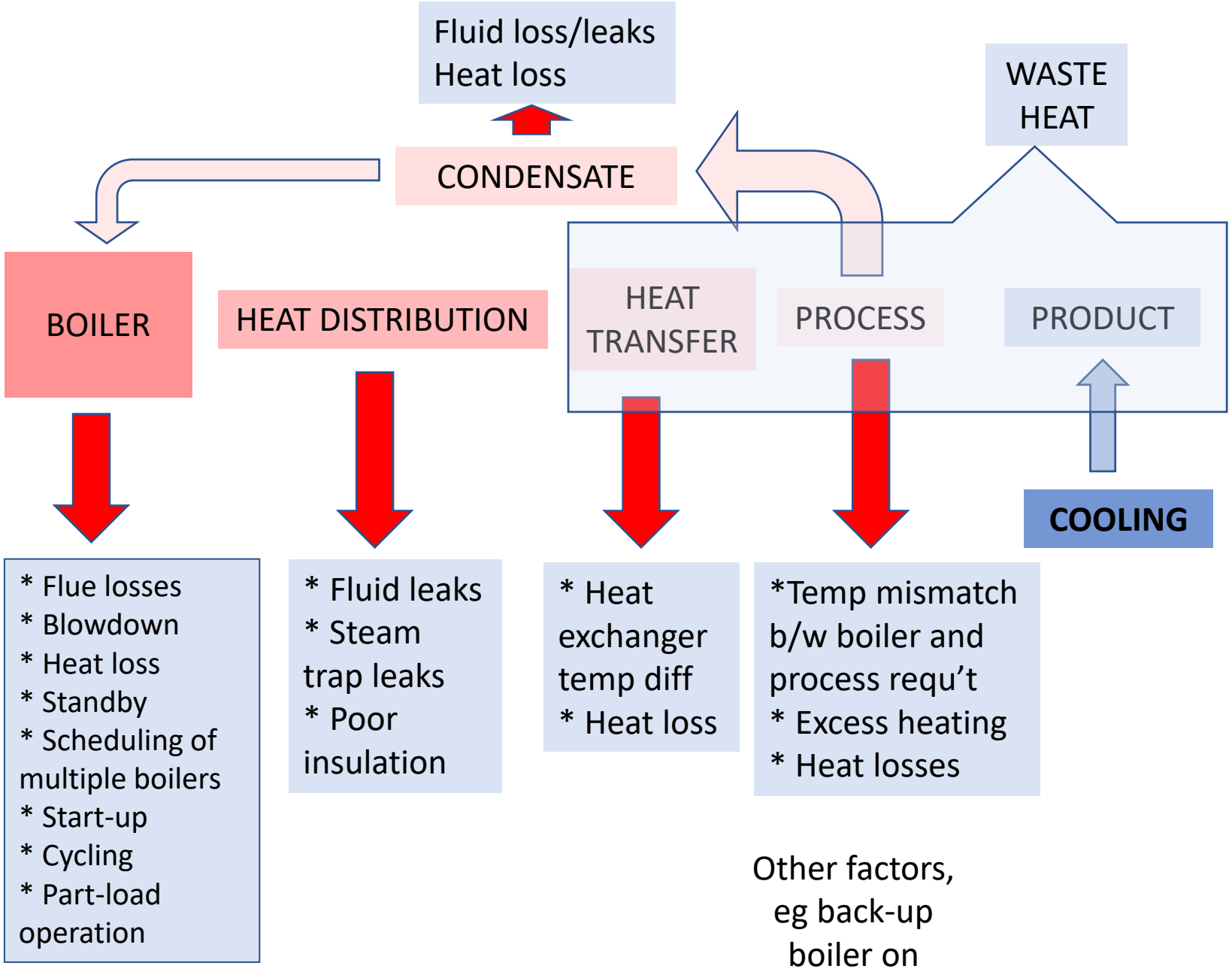
Steam Boiler System



http://www.core77.com/posts/58982/How-Did-Factories-Get-Power-to-Their-Machines-Before-Electricity

Scientific American (1991):

"..At the turn of the century, a typical workshop or factory contained a single engine that drove dozens or hundreds of different machines through a system of shafts and pulleys. Cheap, small, efficient electric motors made it possible first to give each tool its own source of motive force, then to put many motors into a single machine."

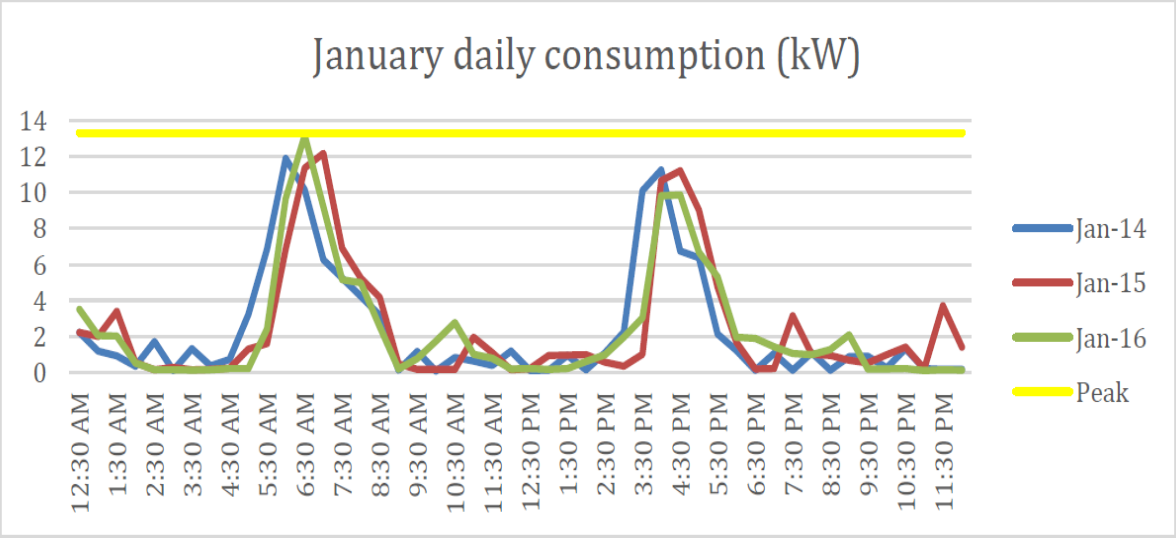


Indicative efficiencies?

60-90%	X	70-90%	X	80-95%	X	??%	=	??-30-75%

Dairy farm electricity load profile can stress local SWER network capacity

Milk harvesting and cooling contribute most to peaks
(Irrigation excluded from this study)
Expansion of herd increases peak load to exceed SWER line or local network capacity – unless peak demand is reduced

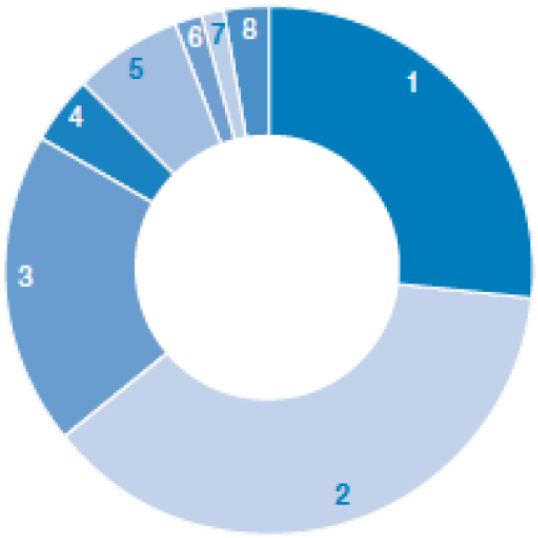


The hourly load (kW) across 24 hours for a representative dairy farm we visited and analysed.

Options include:
* high efficiency milk cooling
* thermal (cold) storage or electricity storage
* Power Factor correction
* improved vacuum pump and compressor efficiency
* high efficiency hot water system and water efficiency

Robotic milking could smooth demand BUT milking energy consumption higher unless smart, high efficiency vacuum pumps, compressors etc used

Figure 2 Breakdown of energy costs average for herringbone sheds – Western Victoria



1	Hot water	26.7%
2	Milk cooling	37.6%
3	Milk harvesting	19.2%
4	Cleaning and effluent	4.0%
5	Stock and dairy water	6.8%
6	Feed	1.7%
7	Shed, office, workshop, misc.	1.3%
8	Lights	2.7%

Breakdown of energy costs average for herringbone sheds – Western Victoria

Source: *New Energy Options for the Victorian Dairy Industry* (2017) Negotiaction and United Dairyfarmers of Victoria

Egs of energy use – piggery and piggery feed mill Power Factor(!) (from *Establishing Energy Usage on Australian Piggeries to enable Implementation of Energy Reduction Strategies (2014)* FSA Consulting, Toowoomba)

Major energy use components in piggeries include:

- Tunnel Ventilated Sheds (Fans) – High Usage
- Heat Lamps – High Usage
- Lighting – Low Usage
- Manure Management (Effluent Pumps, Agitators, Flushing System) – Low Usage
- Feed Delivery – Low Usage Feed milling on-site can also use a lot of energy
- Cleaning/Drinking Water (Bore) Pumps and Hoses – Low Usage
- Office Facilities – Low Usage

50-350kWh/y per tonne live weight

TABLE 4 – ENERGY USE COMPONENTS AT FOUR PIGGERIES

Units: kWh/day	Piggery A	Piggery B	Piggery E	Piggery F
Production System	F2F*	F2F*	F2F*	Breeder
Farrowing	150	1169	123	753
Bore Pump	39			
Finishing	36	1383	10	
Feed mill			45	
Dry sow Sheds				27
Workshop / Amenities	145	156	9	121
Total Site	371	2809	187	900
% Farrowing of Total Site	40%	42%	66%	84%

F2F – farrow to finish

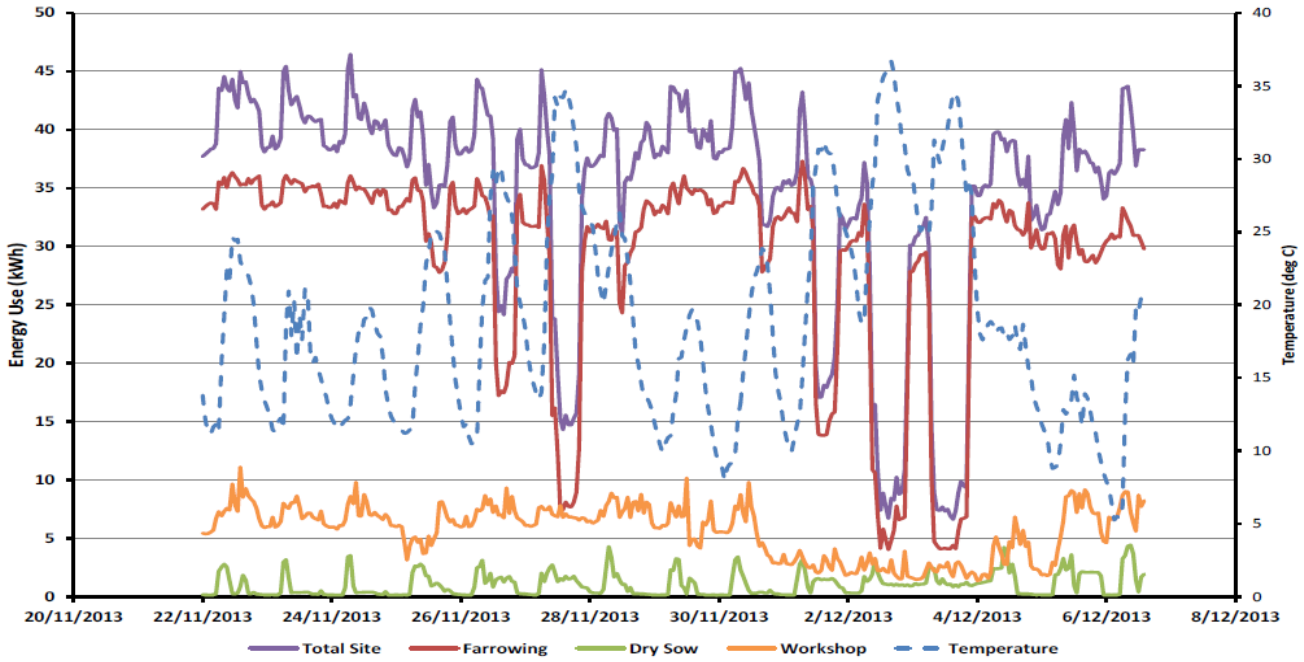
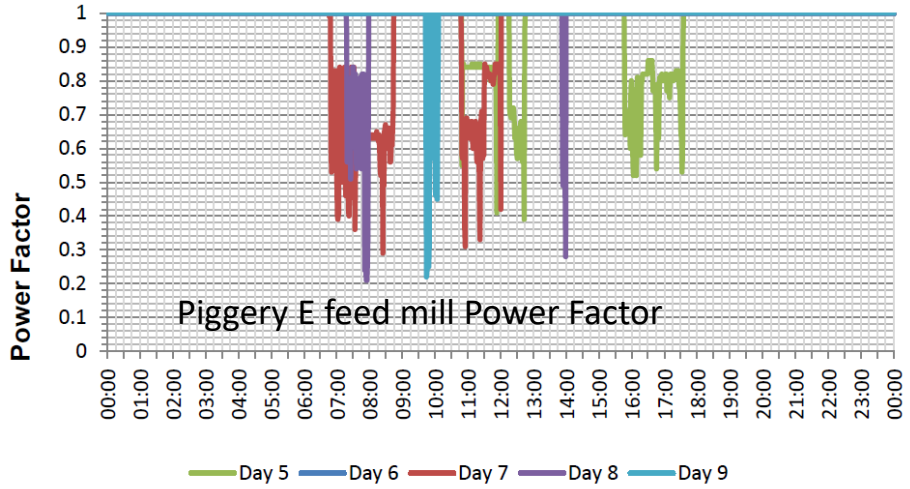


FIGURE 8 – HOURLY ELECTRICAL ENERGY USE PROFILE (KWH) IN SUMMER FOR PIGGERY F



Example of Benefits of Digital Transformation

FONTERRA

(https://www.thinxtra.com/2019/03/dairy_company_fonterra_iot/)

- IoT/Industry 4.0 supports compliance, sustainability, productivity and animal health/welfare through **measurement, monitoring, traceability and informed action**
- Milk temperature in farm vats, trucks: heat from road issue solved with spray-on coating
- Equipment condition monitoring: underpinned maintenance planning, predictive and preventive action
- Supply chain tracking of location, temperature, humidity, light: manage condition, wear-and-tear, damage, theft

Metering and monitoring

- Get utility historical data – review and analyse
- Multiple regression analysis that combines multiple data streams can be useful – eg Coles approach (Energy Efficiency Best Practice case study)
- Add-on techs can provide detailed data – eg WattWatcher, PV suppliers, Freestyle Technology (http://freestyletechnology.com.au/)
  - Generally need an electrician to clip around a cable – unless you use add-on units that track pulses, flashing light, display changes
- Data analytics and machine learning can be very powerful tools, especially if linked to multiple data streams for relevant variables (weather, production, transport logistics, etc)

Business case and financing Demand side investments

- Use Internal Rate of Return and Net Present Value – not 'Payback Period' (see http://www.energytools.com/calc/EnerEcon.html for a useful calculator to compare)
- Consider net cash flow for financing options, eg BOOT (Build Own Operate Transfer), longer term loans, equity, use of government incentives
- Consider all significant costs and benefits eg productivity, OH&S, reduced risk of loss of production, product quality/consistency, reputation, climate risk, increased asset value, etc

Simple Payback Period: time required for cash inflows to equal original cash investment, i.e. how long it takes to get your money back

Net Present Value: project value today, factoring in changing value of money over time

Internal Rate of Return: discount rate at which the benefits equal the costs (i.e. NPV = 0) – compare with returns on other investments and cost of capital

Taking control in a more variable, extreme climate

Murray Goulburn: conversion of low value waste to higher value product

Murray Goulburn worked with CSIRO's Food Innovation Centre to develop and commercialise continuous ion exchange processing technology (CSEP) to manufacture high value dairy protein ingredients such as whey protein isolates and the bioactive, lactoferrin. Prior to this the company was producing approximately 35,000 tonnes of cheese per year but were only using 10-15% of the residual whey, as mainly pig feed.

With the chromatographic system developed with the help of CSIRO, the company was able to treble its cheese production each year and commercialise protein ingredients from the by-product streams.

These ingredients are now used in valuable manufactured products such as the billion dollar sports foods, beverages and meal supplement markets in North America and in infant formula.

Sundrop Farm, SA (Source: https://www.eco-business.com/news/6-water-saving-innovations-to-celebrate-this-world-water-day/?google_editors_picks=true)

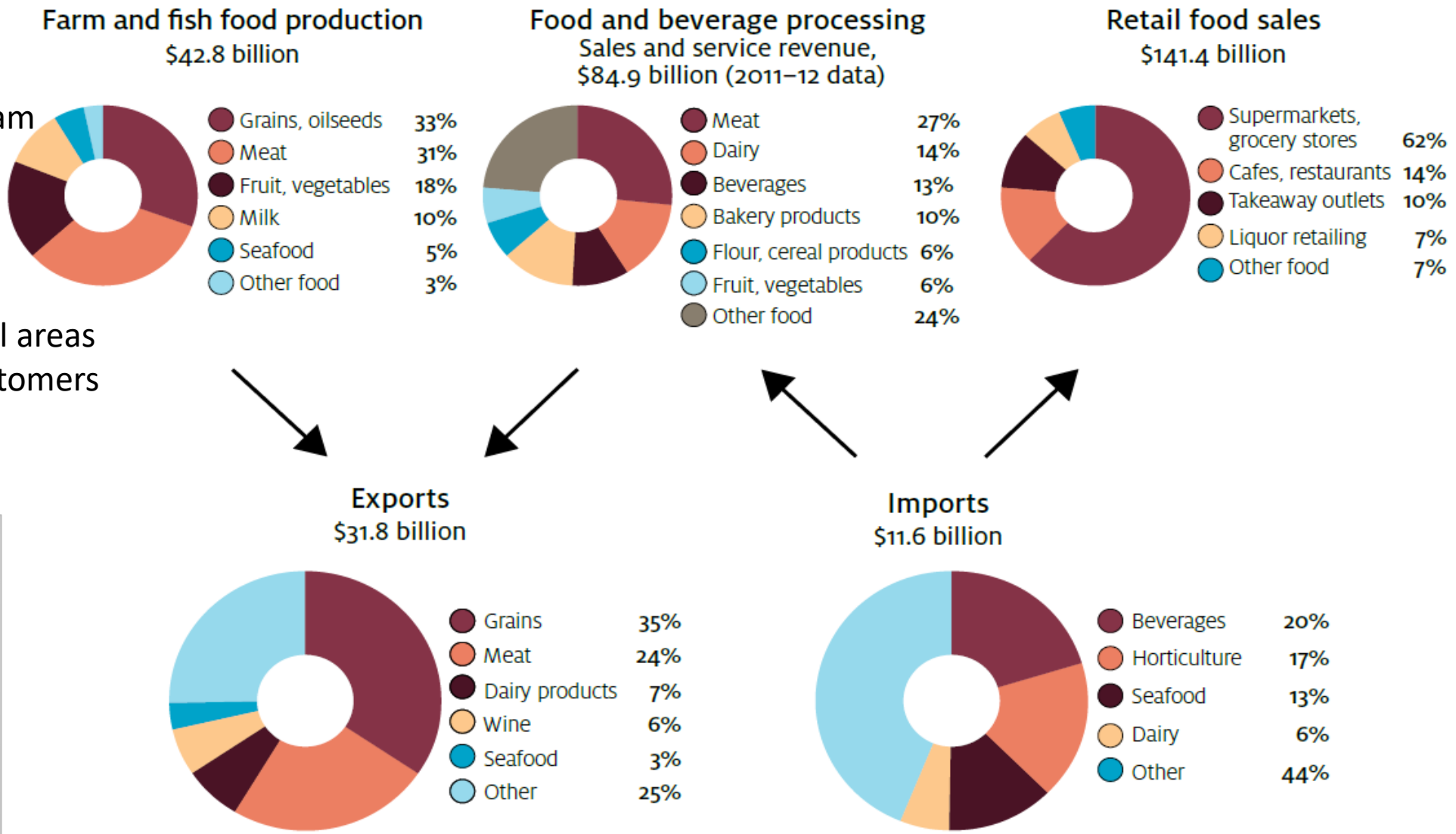
Australian developed Biogill wastewater treatment at Binnorie dairy – up to 80% energy saving through gravity-driven aeration: modular, compact, odour reduction

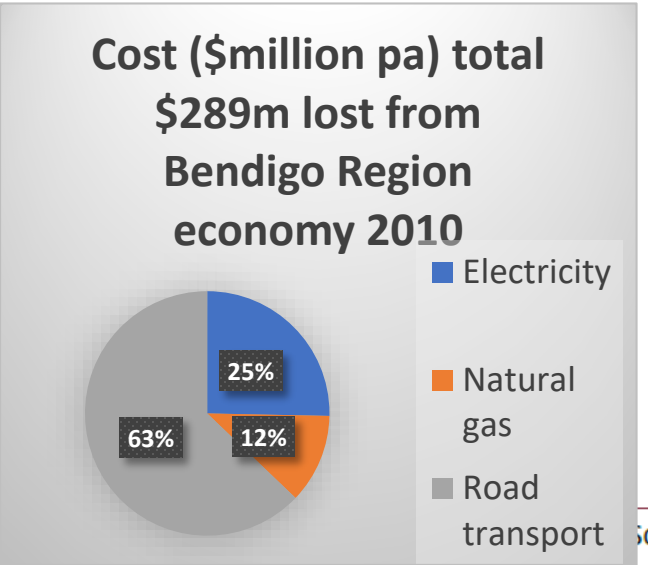
https://www.biogill.com/projects/food-beverage/binnorie-dairy/

How do regional areas increase their share of Value Chain $, sales and turnover?

Source: http://www.agriculture.gov.au/SiteCollectionDocuments/ag-food/publications/food-stats/australian-food-statistics-2012-13.pdf

- More value adding
- Diversify
- Shift activity from downstream
- Cut input costs
- Reduce food waste
- Develop alternative paths to customers
- Attract customers to regional areas
- Add 'perceived value' so customers pay more
- ??





Source: Australian Bureau of Statistics (2013abc; 2014abc)