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Data analysis for 'Smarter Energy Use' project

Confidential Report

Dairy Australia

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1 Background

1.1 Background

'Smarter energy use' is a project managed by Dairy Australia and funded by the Australian Government Department of Industry and Science and Dairy Australia. The project will conclude in May 2015. The purpose of the project is to reduce energy consumption on dairy farms by providing dairy farmers with Energy Efficiency Plans. The project team have undertaken 1,400 on-farm energy assessments (900 from Round 1 and 500 from Round 2) during the period January 2012 to April 2015.

The energy efficiency plan provided to each participating dairy farmer included:

- An assessment of energy use
- Breakdown of energy use by activity (water heating, milk harvesting, milk cooling, cleaning and effluent, stock and dairy water, feeding, shed/workshop/miscellaneous, lights)
- An action plan to reduce energy use including an estimate of potential annual energy savings.

Dairy Australia populated an Excel workbook with the assessment data, the 'national database'. The database includes the following:

- Date and location (region) of assessment
- Power bill data (kWhr/year, $/year, $/kWhr average for year of assessment)
- Farm data (type of dairy, number of clusters, average milking herd size, kL milk/year)
- Benchmarks (energy $/kL of milk, kWhr/kL milk)
- Estimates of % of kWhr/year breakdown for each activity (see list of activities above)
- Estimates of % of $/year breakdown for each activity
- Electricity savings identified (kWhr/year and Co2e/year).

The data should be viewed with care due to the following:

- Some of the data was estimated e.g. if not all power bills were available.
- A team of 31 energy assessors undertook the assessments (15 of these undertook less than 10 assessments). It is likely that assessors had different approaches and different levels of skills.
- Two different tools were used that used different approaches to calculating identified savings. The two tools provided quite different results for identified savings (see section 7.1.1).

Although a large team of assessors undertook the audits, in round one the more experienced assessors mentored others. In round two a core team of 13 ongoing approved assessors were used and they had ongoing mentoring and training opportunities (Alison Kelly, pers. comm.).

While two tools were used that gave different results for identified savings, we expect that they would provide similar results for energy consumption and cost component data.

The collection of the data provides an opportunity to 'value add' to the project by analysing the data further.

1.2 Purpose of this report

RMCG was engaged by Dairy Australia to conduct an independent analysis of the national database to:

- Develop information for industry and dairy farmers. This will be used by Dairy Australia to produce fact sheets for each Regional Dairy Program (RDP)
- Inform the Smarter Energy Use final project report including any policy implications.

This report summarises the key findings from the data analysis and desktop research.

2 Key findings

Key findings from this data analysis were:

Energy use:

- There was an enormous range in energy use in Australian dairy sheds. Average energy use was 48kWhr per kL milk (excluding automatic, small rotary and large walk through dairies). Two-thirds of properties fell into the range 31 to 66kWhr per kL milk.
- Automatic, small rotary (herd size <150) and large walk through (herd size >300) dairies all have higher energy use compared to others with a similar herd size
- There is very little difference between regions except in Queensland more energy is used for milk cooling and less energy is used for hot water. In Tasmania with a cooler climate, less energy is used for milk cooling
- Scale is important. Energy use per kL milk declines with herd size, by about 14% from herd size 100 to 200 and then by about 4% for every 100 cows up to 500 cows.

Energy costs:

- The simplest and most important measure is cost per 100 cows
- Average energy cost per 100 cows was $6,566 per year. Two-thirds of properties were in the range $3,969 to $9,164. Most regions were relatively similar except for NSW where energy costs were greater due to higher average energy prices (i.e. cost per kWhr).
- Therefore a good national benchmark for energy use is:
  a) $6,600 per 100 cows is average
  b) $4,000 per 100 cows is low
  c) $9,200 per 100 cows is high.

Cost components:

- The three main cost components are hot water, milk cooling and milk harvesting
- These three cost components total about 81% of energy use and represents about 40kWhr per kL of milk for all dairies except the automatic, which typically totals 60kWhr.

Indicative savings:

- Across the two tools used, for just over half (55%) of properties there were small savings (<$2,000 per year) identified. About 40% of properties had potential to save a modest amount ($2,000 - $10,000). Substantial savings (up to $29,000) were identified for a small (5%) proportion of the assessments
- There is an opportunity to provide information for those farmers who do not have energy efficiency plans. Extension information could include supporting information on how to assess the costs of the three main cost components and how to assess energy use against benchmarks.

Collection of information:

The two assessment tools gave very different results for identified savings, and the way the data was recorded in the database also differed. Both methods are useful and valid because one shows what can be done by tweaking existing equipment and the other shows the maximum possible with investment.

Data collection should consider any differences in the tools used and consider the best way to record data so that it can be analysed.

Data recorded should include:

- A consistent way of recording dollar value of savings, regardless of which tool is used
- An indication of what level of investment is required for recommended upgrades
- Existing technology used on each property, particularly those that relate to efficiency gains e.g. VSDs, solar hot water. This would provide insights into the characteristics of each property and how that relates to efficiency
- The types of recommendations provided to farmers and which cost component they relate to e.g. milk cooling. This would provide insights into which technologies or cost components were most often identified for energy efficiency gains.

The best way to collect and record the above data needs further consideration.

Dairy farm business costs are often benchmarked per kgMS. Therefore consideration should also be given to collecting farm data for kgMS produced, to allow benchmarking of energy costs per kgMS.

3 Data analysis method

The data, as recorded in the national database, is shown at Appendix 1.

Dairy Australia contracted an energy assessor to clean-up the database to remove any entries that were incomplete and to check for errors. Therefore we expect that the data provided for this analysis was acceptable.

We performed the following entries / calculations within the database:

- Tidying up entries for two columns, Regional Development Program (RDP) and dairy type. This was required for consistency so that the data could be filtered
- Adding the following columns:
  - Average milking herd range, using the standard ranges of <150, 150-300, 301-500, 501-700 and >700. This allowed grouping and filtering of data
  - Range of average kWhr/kL. This allowed grouping of data by average energy consumption
  - Assessment tool used. We could determine from the type of data entered in 'Electricity savings identified' which tool had been used, AgVet or Bullock
  - kWhr/kL for each cost component, by multiplying the % for each component by the total use per kL
  - Savings in kWhr/kL, by dividing identified savings (kWhr/year) by kL of milk produced
  - Energy savings as a % of usage
  - Indicative dollar savings per year, by multiplying savings (kWhr/year) by the average price per kWhr.

Our analysis of the database was developed to reflect what was possible and to obtain the maximum benefit. Thus we have been able to include the following main components:

- Total energy use kWhr per kL of milk (Excel pivot tables for each region, herd size and dairy type)
- Energy use for different cost components (Excel pivot tables for each region, herd size and dairy type)
- Analysis of savings:
  - Analysis of savings in kWhr per kL, % of total energy use, $ per year
  - Pivot tables were developed to assess identified savings by dairy type, and herd size. This was undertaken separately for the two different tools used by energy assessors (noting that each tool used a different approach to assess/identify savings)
  - Histogram of savings to illustrate the skewed nature of the savings data
- Data for each region by Regional Development Program (RDP) that can be used in fact sheets for dairy farmers and industry.

In addition to the information in the database referred to above our analysis also included some quantitative data based on assessors findings. Three assessors were interviewed to confirm:

- The types of technology / issues typically found in use, and if possible any regional differences or observed trends
- Typical energy saving actions identified and if possible any differences between regions or shed types

- Their view on where the focus should be for future programs to support increased energy efficiency.

We also reviewed the ‘Phase 1 evaluation report’ and the ‘Draft final project evaluation report’ to obtain further information on the types of savings identified and the proportion of farmers who had implemented the recommended changes.

We used excel statistical ‘data analysis’ to assess the correlation for herd size and energy use per kL of milk produced. Otherwise, it was not appropriate to statistically analyse the data due to the nature of the data (e.g. non-continuous) and the design of the data collection (it was not designed for statistical analysis) and the scope of our analysis.

Therefore in undertaking the analysis we adopted standard methods such as generation of pivot tables to summarise the data, percentiles and standard deviation (SD) to indicate the variability of the data.

Some of the data was skewed (such as identified savings) and therefore not a normal distribution. Although SD should generally only be used when data is normally distributed, we chose to use SD to provide an indication of variability and to aid interpretation of charts.

All data was included in the analysis except where otherwise stated.

We developed some ‘simple’ benchmarks for energy costs per 100 cows including total costs and costs for each of the three main cost components. The average minus and plus one standard deviation was used to develop benchmarks for “low” and “high” energy use/costs. This range represents two-thirds of the assessments. Total energy costs were rounded to the nearest 100 and the costs for each component were rounded to the nearest 10.

Benchmarks were also developed for energy use and energy cost per kL of milk, using the same method i.e. minus and plus one standard deviation.

4 Demographics of farms assessed

The following two tables show the demographics of the assessments included in the database. Table 4-1 shows the number of assessments by dairy type and herd size across **all RDPs** and Table 4-2 shows the breakdown **by RDP**. We have not checked if the dataset is representative of the industry in each RDP.

Table 4-1: Total (all RDPs).

	Herd size					
Dairy type	**<150**	**150-300**	**301-500**	**501-700**	**>700**	**Grand Total**
Automatic	2	13		1		16
Double Up	58	184	41	4	3	290
Rotary	2	63	174	81	86	406
Swing-over	142	369	137	13	7	668
Walk Through	13	2	1			16
Grand Total	**217**	**631**	**353**	**99**	**96**	**1396**

Table 4-2: By RDP.

	Herd size					
RDP & dairy type	**<150**	**150-300**	**301-500**	**501-700**	**>700**	**Grand Total**
DairyNSW	**26**	**49**	**21**	**6**	**10**	**112**
Double Up	5	22	4		1	32
Rotary			12	4	8	24
Swing-over	12	25	5	2	1	45
Walk Through	9	2				11
DairySA	**21**	**67**	**31**	**11**	**10**	**140**
Automatic	1	1				2
Double Up	7	34	4	1		46
Rotary		11	16	9	10	46
Swing-over	12	21	11	1		45
Walk Through	1					1
DairyTas	**15**	**66**	**67**	**19**	**38**	**205**
Automatic		4		1		5
Double Up	2	8	2			12
Rotary		1	12	12	32	57
Swing-over	13	53	53	6	6	131
GippsDairy	**14**	**76**	**40**	**8**	**7**	**145**
Automatic	1	4				5
Double Up	3	15	5			23
Rotary		4	22	7	7	40
Swing-over	10	53	13	1		77
MurrayDairy	**38**	**129**	**77**	**19**	**6**	**269**
Automatic		1				1
Double Up	20	35	10	1	1	67
Rotary	1	12	43	18	5	79
Swing-over	17	81	24			122

	Herd size					
RDP & dairy type	**<150**	**150-300**	**301-500**	**501-700**	**>700**	**Grand Total**
QDO	**61**	**65**	**10**	**3**	**1**	**140**
Automatic		3				3
Double Up	10	19	4	2	1	36
Rotary		2	1	1		4
Swing-over	48	41	5			94
Walk Through	3					3
WesternDairy	**13**	**39**	**12**	**3**	**8**	**75**
Double Up	8	28	3			39
Rotary		2	8	2	8	20
Swing-over	5	9	1	1		16
WestVic Dairy	**29**	**140**	**95**	**30**	**16**	**310**
Double Up	3	23	9			35
Rotary	1	31	60	28	16	136
Swing-over	25	86	25	2		138
Walk Through			1			1
Grand Total	**217**	**631**	**353**	**99**	**96**	**1396**

5 Energy consumption

We suggest that the best way to compare energy consumption is by production basis e.g. 'per kL of milk' because this takes into account variation in herd size and litres per cow.

This section examines energy consumption, which is the amount of energy used regardless of the price paid per kWhr. So it covers energy used not energy costs (although costs are related to usage).

5.1 Energy use per kL milk produced

5.1.1 Herd size

There was a significant correlation (P<0.001) between herd size and energy use per KL of milk produced.

Figure 5-1 shows the average energy use in kWhr per kL of milk produced, by herd size category. Energy use per kL milk is highly variable particularly for dairies with smaller sized herds. There is a trend for better energy use efficiency with larger herd size, which is most likely due to economies of scale. However, amongst dairies with smaller sized herds, some were relatively energy efficient. The data also indicates that average energy use per kL milk is similar for herds of 501-700 and herds >700, suggesting a limit to economies of scale for energy efficiency.

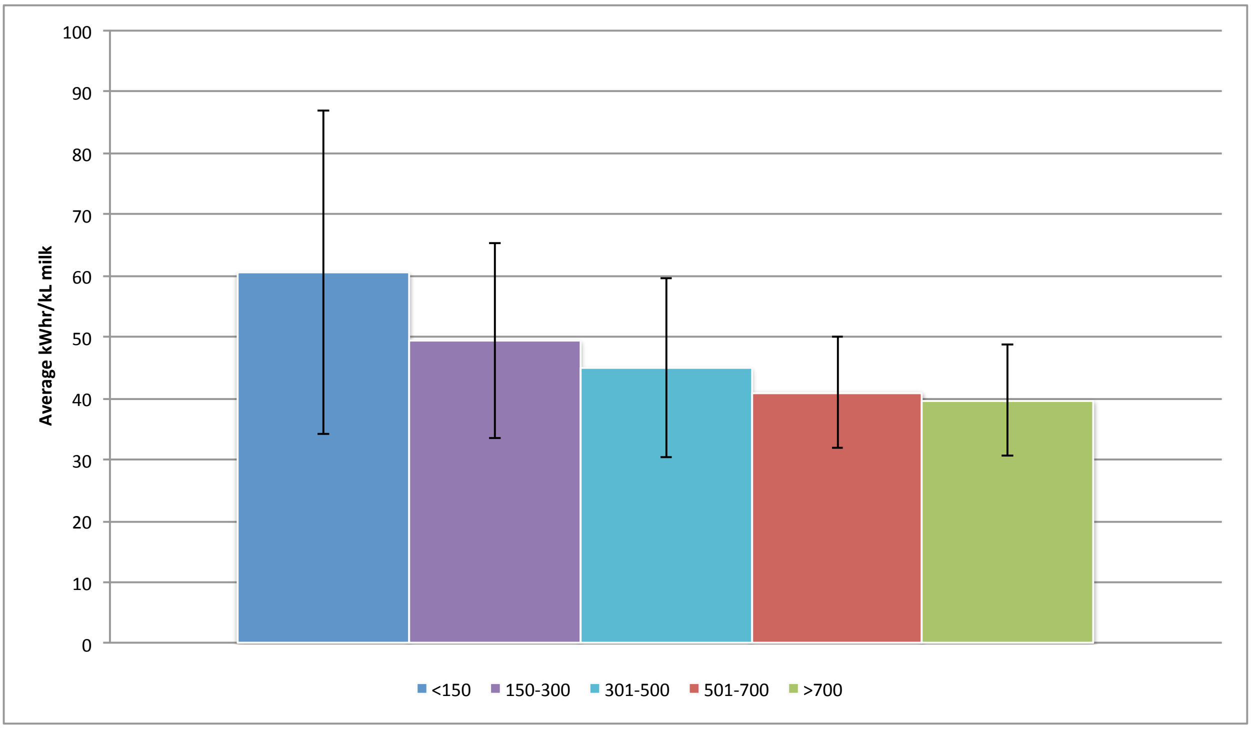


Figure 5-1: Energy use per kL milk, by average herd size. Error bars represent +/- standard deviation. (Herd size <150 n= 217, 150-300 n=631, 301-500 n=353, 501-700 n=99, >700 n=96).

5.1.2 Type of dairy

Figure 5-2 shows energy use per kL of milk for each type of dairy by herd size. There were only 16 automatic/robotic sheds and only 16 walk through sheds. Therefore data for these shed types should be viewed with care, and have been included here for interest.

The data highlights that:

- More energy is used per kL of milk in automatic systems compared to others. This is largely due to greater energy use for milk harvesting (see section 5.2), and we would expect higher energy use for milk harvesting in this type of system. Note that the data for automatic dairies is for only 16 farms, so the data should be viewed with care
- Larger (>300) walk throughs and smaller (<150) rotaries consume more energy per kL of milk compared to other similar sized dairies
- Otherwise, there are no obvious differences between dairies.

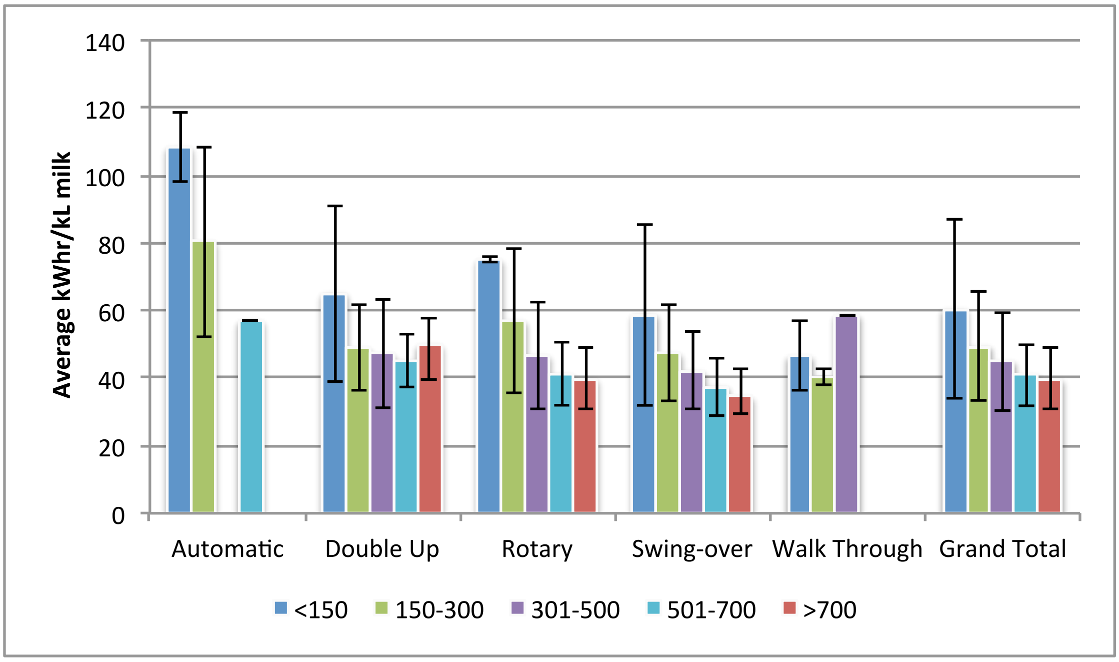


Figure 5-2: Energy use per kL of milk, by dairy shed type. Error bars represent +/- standard deviation. (Automatic n=16, double up n=290, rotary n=406, swing-over n=668, walk through n=16).

5.1.3 Region

Figure 5-3 shows the energy use in kWhr, per kL milk, for each RDP region by average herd size. Note that this chart **excludes** automatic, small (<150) rotary and large (>300) walk through dairies so that the sample was uniform. The chart shows no obvious difference between regions but economies of scale with lower energy use per kL milk for larger herds. The herd size trend generally holds across regions. Note that there were only a small number of assessments for some of these values so data should be viewed with care. The number of assessments is listed in Table 5-1.

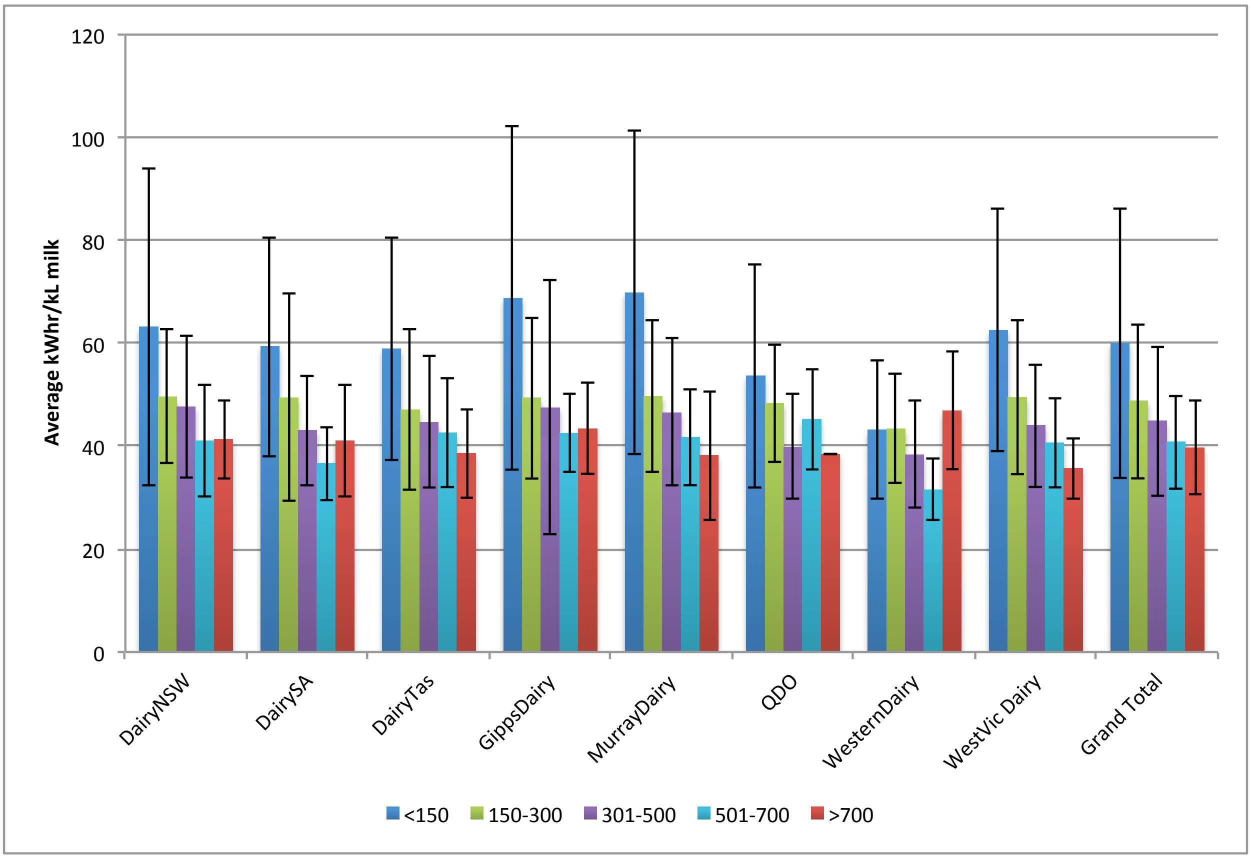


Figure 5-3: Energy use per kL milk produced for each RDP by average herd size – <u>excluding automatic, small rotary and large walk through dairies</u>. Error bars represent +/- standard deviation. (n ranges from 1 to 140. See table of n values below).

Table 5-1: Number of assessments.

	DairyNSW	DairySA	DairyTas	GippsDairy	MurrayDairy	QDO	WesternDairy	WestVic Dairy	Total
<150	26	20	15	13	37	61	13	28	213
150-300	49	66	62	72	128	62	39	140	618
301-500	21	31	67	40	77	10	12	94	352
501-700	6	11	18	8	19	3	3	30	98
>700	10	10	38	7	6	1	8	16	96
Total	**112**	**138**	**200**	**140**	**267**	**137**	**75**	**308**	**1377**

Figure 5-4 illustrates energy use per kL of milk and average herd size for each region.

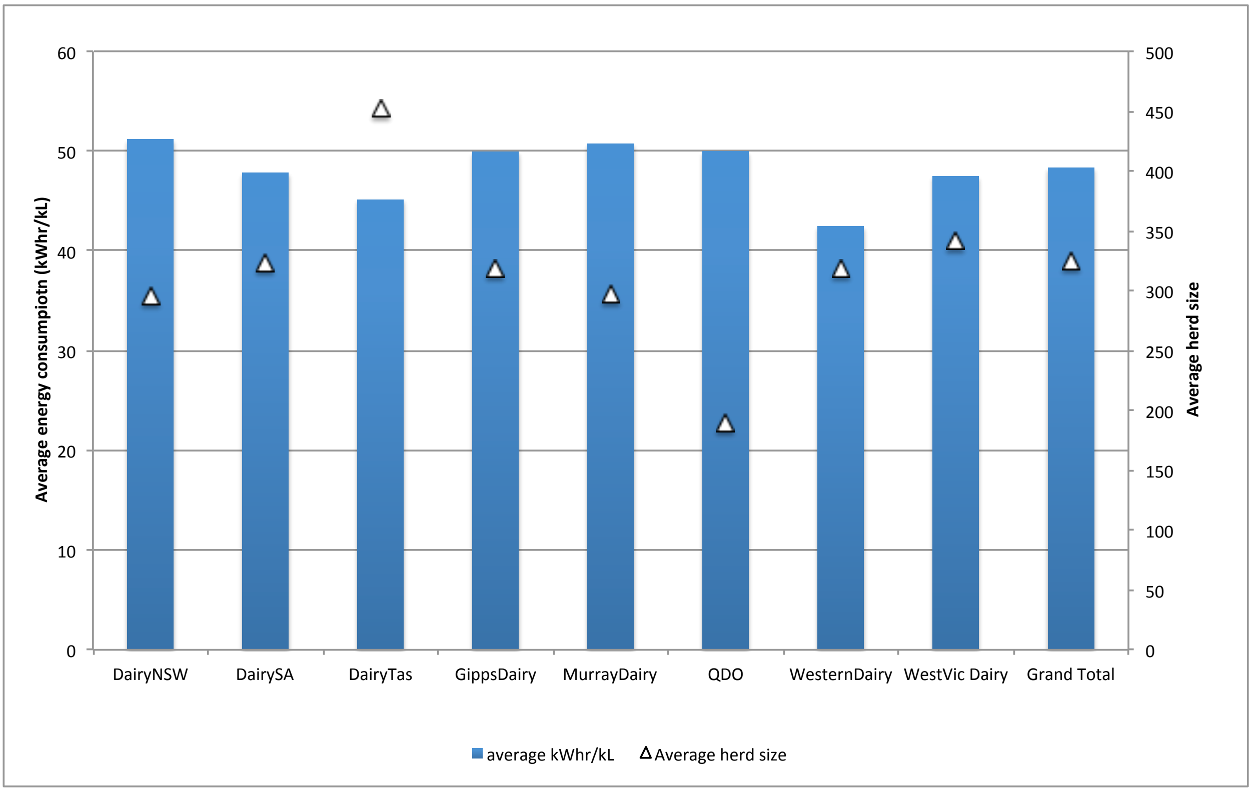


Figure 5-4: Average energy consumption kWhr/kL milk and average herd size, for each region. <u>Excluding automatic, small rotary and large walk through dairies.</u> (NSW n=112, SA n=138, Tas n=200, Gipps n=140, Murray n=267 Qld n=137, Western n=75, WestVic n=308).

5.1.4 Variability and data range

Whilst the national average energy consumption is 48 kWhr/kL of milk, the data is highly variable. The 10 percentile was 32 kWhr/kL and 90 percentile was 68 KWhr/kL.

Therefore because of the high variability the data, in particular the 'mean' or 'average' figures should be viewed with care, especially for calculations with a small number of assessments.

5.1.5 Conclusions on energy use per kL of milk produce

We can conclude from the analysis of energy use per kL of milk, that:

- There is a significant, slight herd size impact i.e. dairies with larger herd sizes have lower energy use per kL milk
- Type of dairy does not affect energy use except for automatic, small rotaries (<150) and large walk throughs (>300) which all have higher energy use compared to others with a similar herd size
- The national average was 48 kWhr/kL of milk (excluding automatic, small rotary and large walk through dairies)
- A majority of properties fell within the range 32 to 68 kWhr/kL
- There is no regional impact per se except that there is a different mix of sizes in the regions.

5.2 Energy use for different cost components

5.2.1 Type of dairy

Figure 5-5 shows energy use per kL milk for different cost components for each dairy type. It highlights the following:

- Across all dairy types, a majority of energy used is for hot water, milk cooling and milk harvesting. Totalling about 81% of energy use and represents about 40kWhr per kL of milk for all dairies except the automatic which typically totals 60kWhr
- As described in the previous section, energy use is greater in automatic systems compared to others. This is largely due to greater energy use for milk harvesting, and we would expect higher energy use for milk harvesting in this type of system. Note that the data for automatic dairies is for only 16 farms, so the data should be viewed with care.

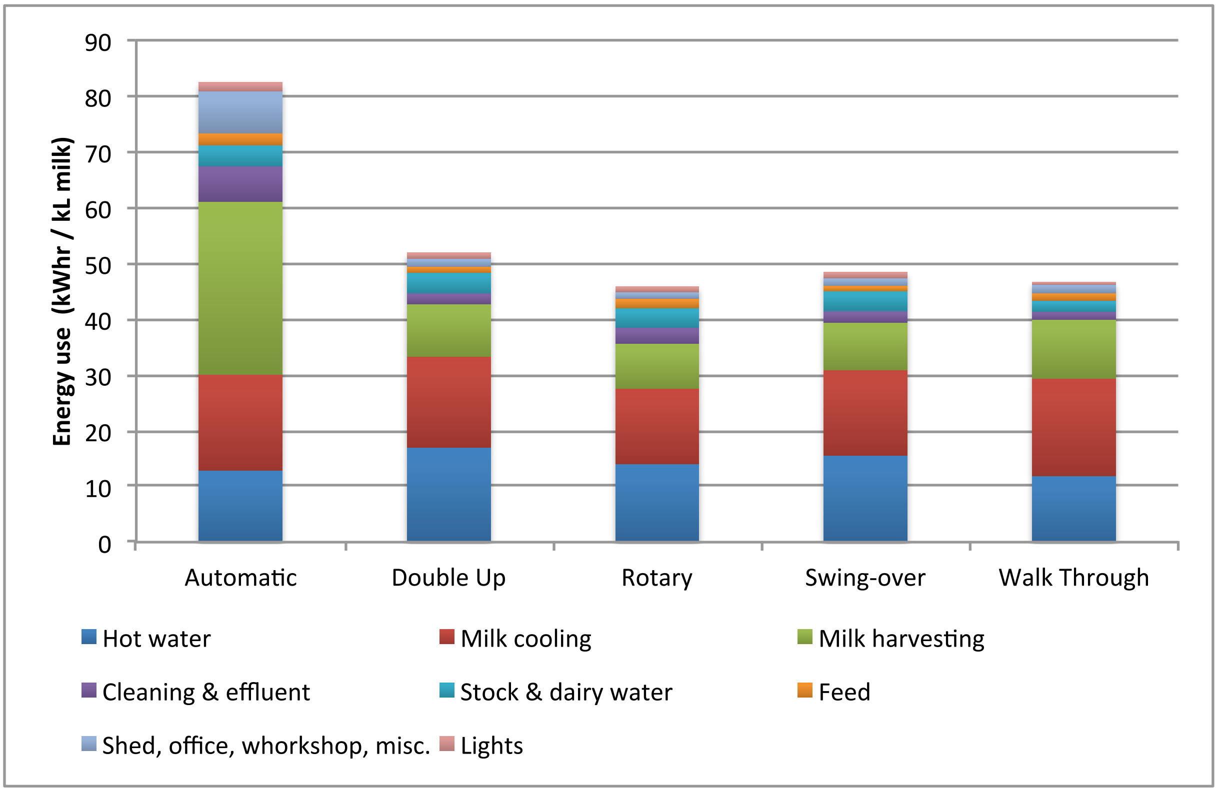


Figure 5-5: Energy use for each cost component, by dairy type. (Automatic n=16, double up n=290, rotary n=406, swing-over n=668, walk through n=16).

5.2.2 Region and herd size

Figure 5-6 illustrates energy use per kL milk for different cost components for each RDP. The three figures after that (Figure 5-7, Figure 5-8, Figure 5-9) shows the same data, focussing on the three main cost components, by herd size for each region. Note that the data for automatic, small rotary and large walk through dairies has been excluded. These charts highlight the following:

- Energy use for heating and cooling can vary depending on climate, for example:
  - More energy is used to cool milk in dairies in warmer climates e.g. in Queensland. Less energy is used for milk cooling in Tasmania, which has a cooler climate (this may also relate to the average herd size in Tasmanian assessments)
  - Less energy is used to heat water in dairies in warmer climates e.g. in Queensland
- There may be some regional differences in energy use for stock and dairy water, which would probably relate to climate and topography e.g. depending on how much pumping is required. However, this is not a major cost component
- As discussed earlier, there may be some slight differences in total energy use per kL of milk but this probably relates to the different mix of assessments by herd size, rather than a regional effect per se.

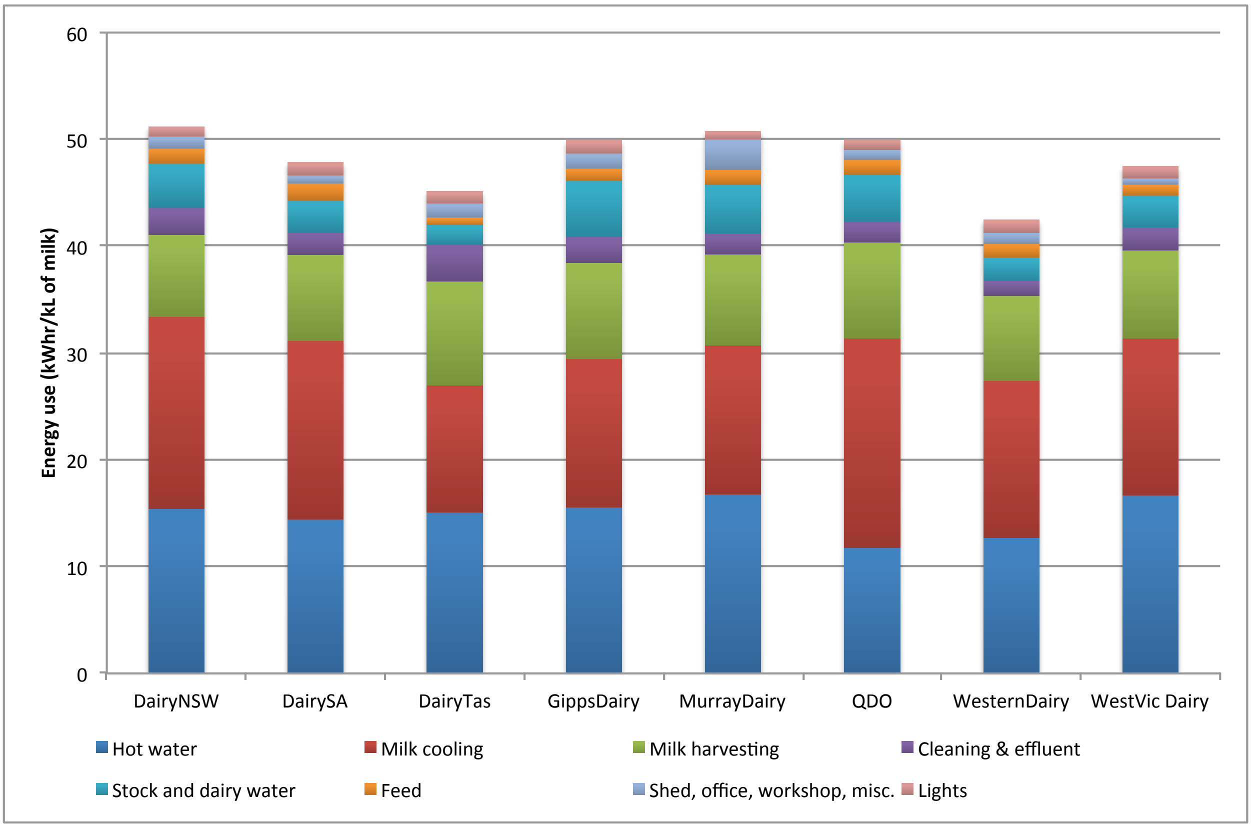


Figure 5-6: Energy use for each cost component for each RDP. <u>Excluding automatic, small rotary and large walk through dairies.</u>

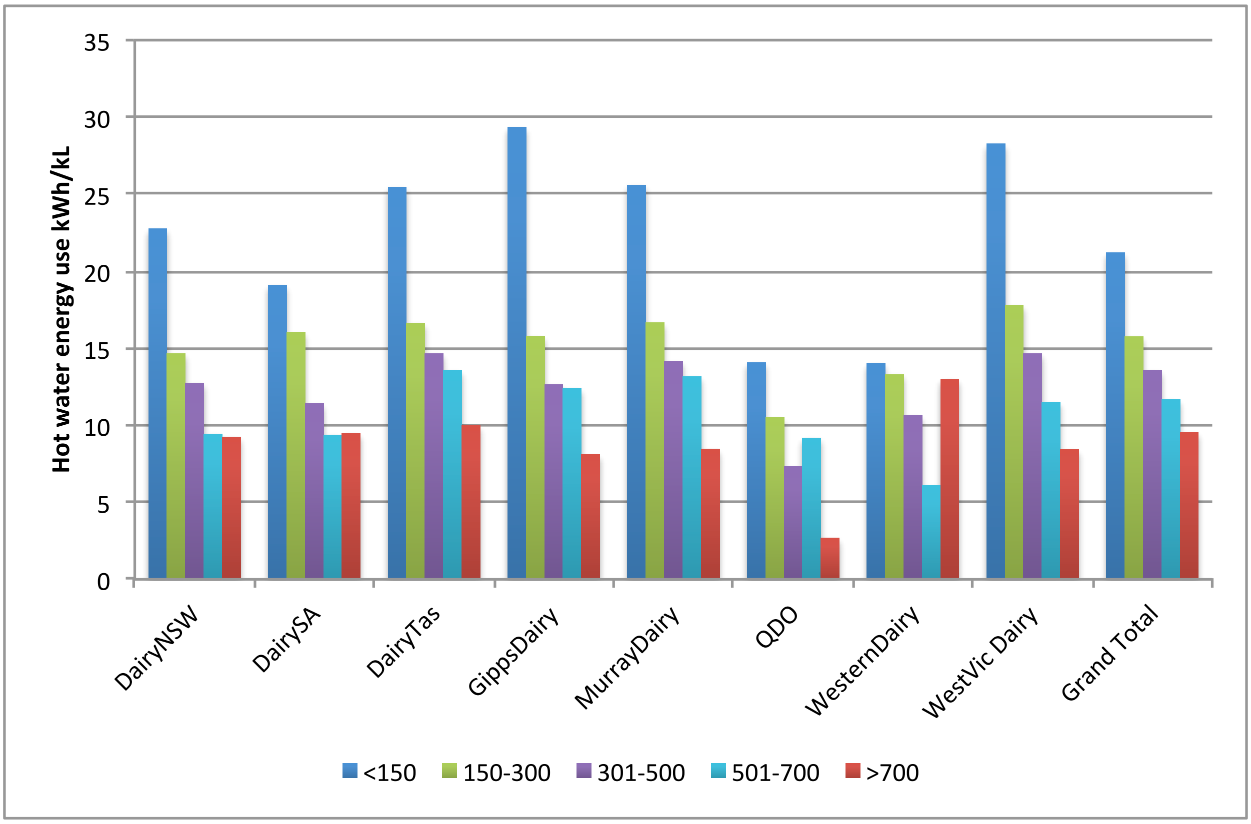


Figure 5-7: Hot water energy use per kL of milk. <u>Excluding automatic, small rotary and large walk through dairies.</u>

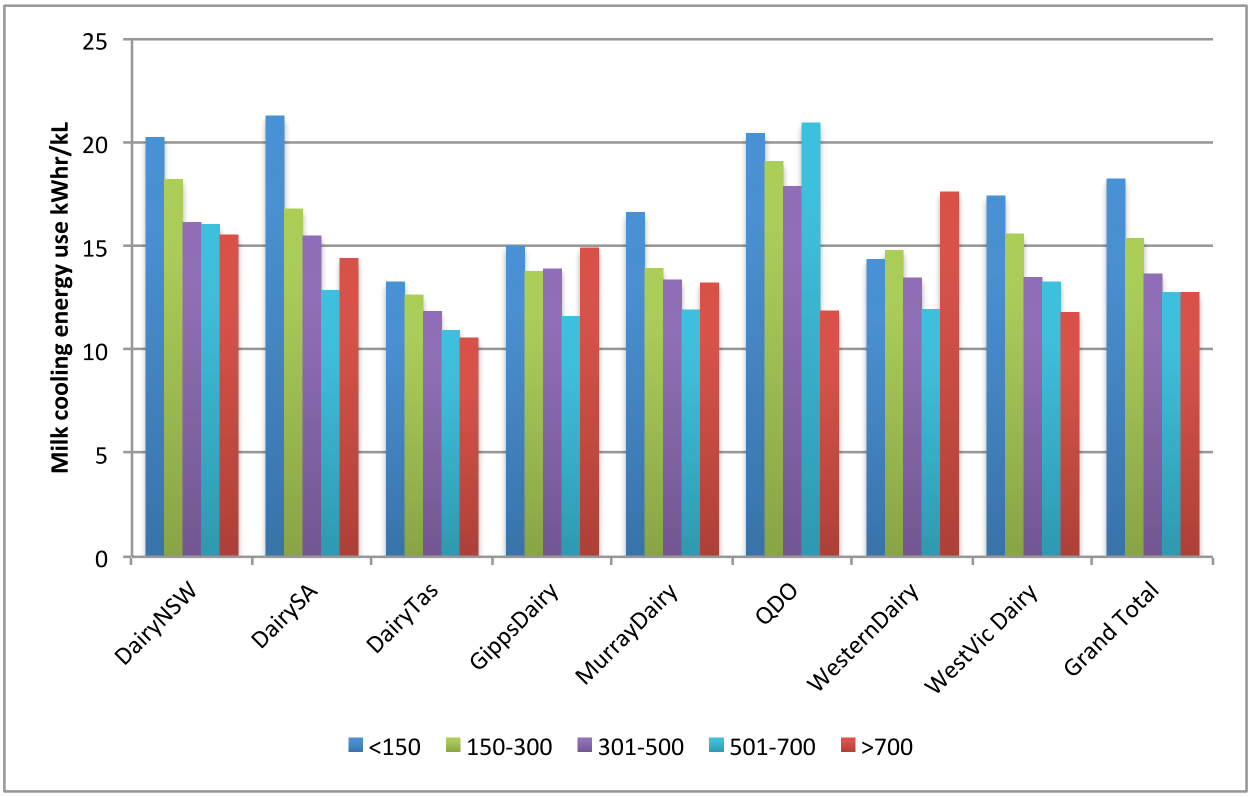


Figure 5-8: Milk cooling energy use per kL of milk. <u>Excluding automatic, small rotary and large walk through dairies.</u>

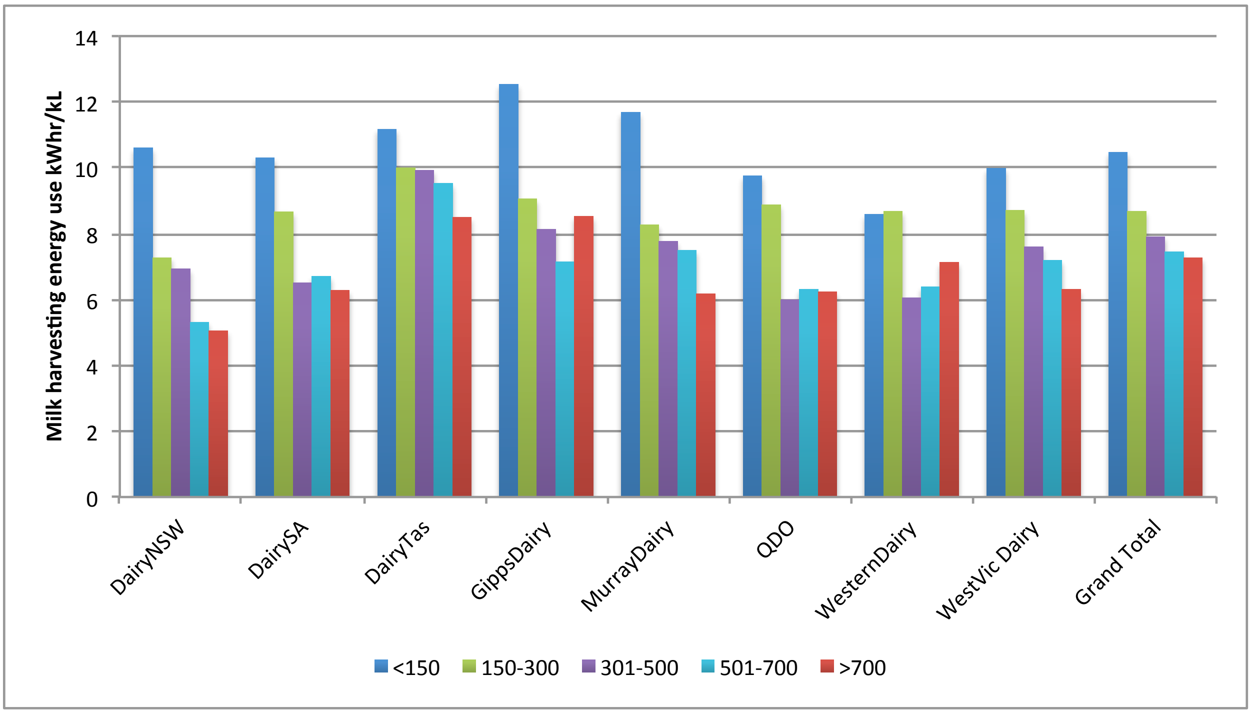


Figure 5-9: Milk harvesting energy use per kL of milk. <u>Excluding automatic, small rotary and large walk through dairies.</u>

Figure 5-10 shows energy use for the three main cost components by herd size. This illustrates the trend for less energy use in larger herds.

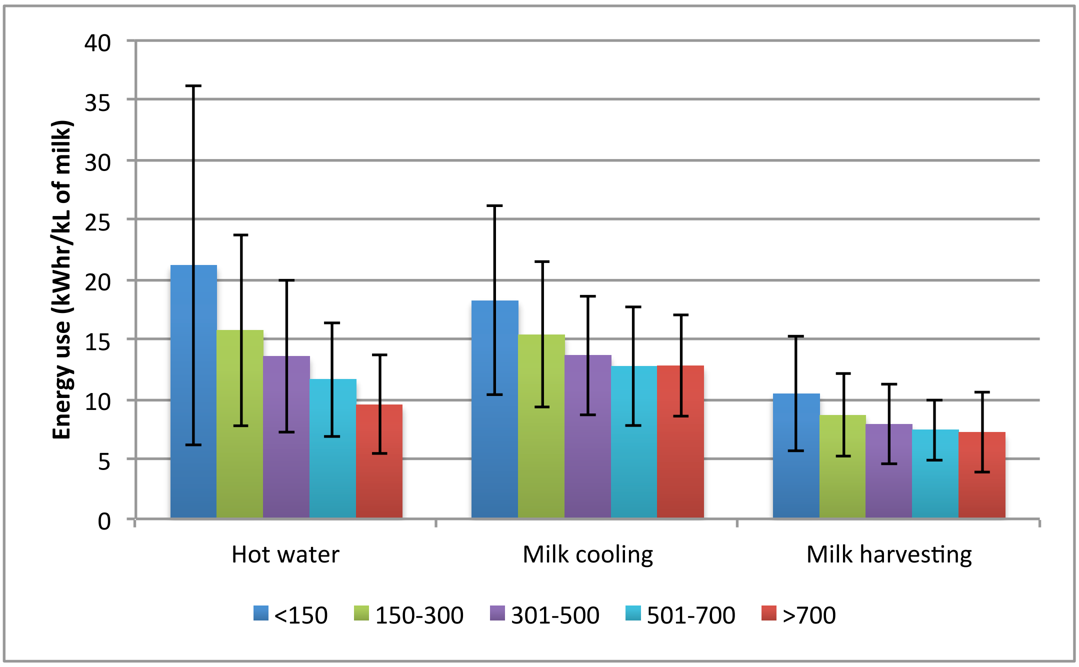


Figure 5-10: Energy use for the three main cost components by herd size. Excluding automatic, small rotary and large walk through dairies. Error bars represent +/- SD.

5.2.3 Variability and data ranges

Table 5-2 illustrates the variability in the data for the three main cost components. The table lists the mean, 10%ile and 90%ile for each component.

Table 5-2: Variability in the three main cost components.

Cost component	10%ile (kWhr/kL)	Mean (kWhr/kL)	90%ile (kWhr/kL)
Hot water	6.62	15.32	25.91
Milk cooling	9.18	15.03	22.35
Milk harvesting	4.59	8.58	13.14

For nine assessments, hot water energy use was zero. These properties are probably using solar hot water for example, which would explain zero energy use as the assessments were based on power bills. However data on types of energy used was not collected and therefore we can not be sure from the database which properties were using renewable energy. Therefore, we are not sure what the lower end of the energy use range is for hot water if using mains electricity. Regardless, the above data highlights the variability.

5.2.4 Conclusions on cost components

We conclude from the above analysis that:

- The three main energy cost components are hot water, milk cooling and milk harvesting. Totalling about 81% of energy use and represents about 40kWhr per kL of milk for all dairies except the automatic which typically totals 60kWhr
- Energy use for the three main cost components was highly variable:
  - Hot water: a majority (80%) of properties fell within the range 7 to 26 kWhr/kL (the mean was 15)
  - Milk cooling: a majority (80%) of properties fell within the range 9 to 22 kWhr/kL (the mean was 15)
  - Milk harvesting: a majority (80%) of properties fell within the range 5 to 13 kWhr/kL (the mean was 9)
- Automatic dairies have substantially higher energy use for milk harvesting
- There is a difference in Queensland where more energy is required to cool milk and less energy is required to heat water, which would be due to the warmer climate in Queensland. Less energy is used for milk cooling in Tasmania, which has a cooler climate (but this may also relate to the average herd size in Tasmanian assessments)
- Energy use for all three main cost components decline with herd size.

6 Total business energy costs

This section examines total business energy costs i.e. dollars per farm.

Average total annual energy costs per business are shown in Table 6-1.

Table 6-1: Average total energy costs per business ($/year). Excluding automatic, small rotary and large walk through dairies.

Herd size	Dairy-NSW	Dairy- SA	Dairy- Tas	Gipps- Dairy	Murray Dairy	QDO	Western Dairy	WestVic Dairy	Total
<150	8,916	9,781	7,673	8,045	8,034	6,980	9,243	6,990	7,916
150-300	21,440	16,458	13,651	13,339	14,196	14,382	17,683	12,681	14,753
301-500	38,276	32,118	20,937	21,572	23,217	25,203	29,919	20,689	23,888
501-700	51,350	45,438	29,906	32,494	32,683	47,147	35,359	33,612	35,541
>700	81,698	72,826	34,832	57,281	51,731	54,404	55,478	45,520	50,070
Total	**$28,672**	**$25,403**	**$21,131**	**$18,491**	**$18,103**	**$12,886**	**$22,916**	**$18,352**	**$19,972**

As expected, total energy costs increase with herd size. The national averages range from $7,900 for herds <150 to $50,100 for herds >700. However, the average cost varies between regions due to different power prices as well as the mix of herd sizes. Refer to section 8 for more information on costs per kWhr in each region.

Within each herd size and region combination, costs were highly variable. Table 6-2 lists the minimum, maximum, mean and standard deviation for each herd size in dollars.

Table 6-2: Variability of total energy costs per business ($/year). Excluding automatic, small rotary and large walk through dairies.

Total energy costs per business ($/year)				
Herd size	**Min**	**Max**	**Mean**	**Standard Deviation**
<150	$1,663	$23,867	$7,916	$3,448
150-300	$3,586	$55,778	$14,753	$6,154
301-500	$3,985	$63,106	$23,888	$9,521
501-700	$18,510	$76,419	$35,541	$11,995
>700	$14,906	$121,722	$50,070	$23,942
Total	**$1,663**	**$121,722**	**$19,972**	**$14,518**

Table 6-3 lists the energy costs per 100 cows for each RDP. This provides a good simple benchmark for each region for energy costs per 100 cows.

Table 6-3: Energy costs per 100 cows.

Energy Cost per 100 cows				
Row Labels	**Mean**	**Standard Deviation (SD)**	**Mean minus 1SD**	**Mean plus 1SD**
DairyNSW	$9,687	$3,142	$6,545	$12,829
DairySA	$8,066	$2,486	$5,580	$10,552
DairyTas	$5,299	$1,849	$3,450	$7,148
GippsDairy	$6,073	$2,310	$3,763	$8,383
MurrayDairy	$6,413	$2,086	$4,327	$8,499
QDO	$6,883	$2,562	$4,321	$9,444

WesternDairy	$7,650	$2,565	$5,085	$10,216
WestVic Dairy	$5,534	$1,968	$3,566	$7,503
Total	**$6,566**	**$2,598**	**$3,969**	**$9,164**

Note the extremes of energy use were between $1,000 and $20,000 per 100 cows.

Total annual energy costs per business increase with herd size and were highly variable.

Nationally, the average cost was $6,566 per 100 cows and two-thirds of properties (i.e. +/- 1 SD) were between $3,969 and $9,164.

Energy costs per 100 cows can be used as a simple benchmark.

7 Potential energy savings

7.1 Data limitations

7.1.1 Audit tools used

Energy assessors used either the AgVet tool or the Bullock tool to undertake the assessments. The two tools differed in their approach to the components that were included for calculating identified savings. The AgVet tool considered options using the existing equipment while the Bullock tool also included upgrades (e.g. variable speed drives (VSDs) on vacuum pumps) but only those that with a payback period of less than 4 years (energy assessors pers comms).

Therefore, the magnitude of potential savings differs depending on the tool used. So, while the results from the Bullock tool are generally greater, it does not necessarily mean that these farms have greater potential savings compared to other farms that were assessed with the AgVet tool.

In DairyTas and GippsDairy RDPs the AgVet tool was used exclusively (Table 7-1). In QDO, WesternDairy, WestVic Dairy and Dairy SA the Bullock tool was used exclusively and in DairyNSW 97% of assessments used the Bullock tool. In the MurrayDairy region, both tools were used.

Both tools are useful - they answer different questions.

Table 7-1: Number of assessments using each tool, by RDP.

	AgVet	Bullock	Total
DairyNSW	3	109	112
DairySA		140	140
DairyTas	205		205
GippsDairy	145		145
MurrayDairy	171	98	269
QDO		140	140
WesternDairy		75	75
WestVic Dairy		310	310
Total	**524**	**872**	**1,396**

7.1.2 Data recorded

The database includes a breakdown of energy consumption by cost component e.g. hot water, milk cooling, milk harvesting etc. However the identified savings are not broken down or identified by cost component. Therefore, although we know what the main types of recommendations were (based on the project evaluation report and feedback from the assessors) it was not possible to determine from the database where the largest savings were identified.

7.2 Potential energy savings

We have provided a separate analysis for each of the two tools, given that the data will vary according to the tool used. The identified savings should be viewed as indicative only due to inconsistency in the database records.

The following sub-sections assess identified savings as % of energy use and savings in kWhr/ kL of milk. Section 7.2.3 illustrates the spread of the data using histograms and section 7.2.4 looks at the indicative dollar value of savings per business.

7.2.1 Identified savings (% of energy use)

The AgVet tool, which only included savings that could be made through improvements to existing equipment (and not equipment upgrades), identified farm savings on average of 4.3% of total energy use (data not shown). The Bullock tool, which considered equipment upgrades as well as improvements to existing equipment identified farm savings on average of 21% of total energy use.

We examined the data by herd size, and savings as a percentage of total energy use were relatively similar across herd sizes.

Identified savings were very variable. There was a large number of assessments with nil or small savings and a small number of assessments with larger savings. Therefore averages are not indicative of typical savings.

Even though for a large number of properties there were nil or small savings identified. Feedback from participating farmers suggests that they appreciated the one-on-one service and valued the audit process, as it was useful for benchmarking against others. Regardless of the amount of savings identified, the audit and energy assessment process was useful for increasing understanding and awareness of energy efficiency.

In the AgVet assessments:

- Nil or small savings i.e. savings of up to 4%, were identified on more than half of the assessments (i.e. 58% of assessments identified savings of 0% to 4% of energy use)
- Substantial savings i.e. >16% were identified on 11 farms (i.e. 2% of assessments identified savings greater than 16% of energy use)
- The median savings identified was 3.3% of energy use.

In the Bullock assessments, there was a trend for greater % savings for the higher energy users per kL of milk. We would expect this because the systems that are operating efficiently would use less energy and have smaller potential savings, if any.

In the Bullock assessments:

- Nil or small savings i.e. savings of up to 4% were identified in 10% of the assessments
- Savings of up to 20% were identified in about half of the assessments
- The median savings identified was 20.7% of energy use.

7.2.2 Identified savings (kWhr/kL)

We calculated average savings in kWhr/kL of milk for the three main dairy types (double up, rotary and swing-over) and by herd size (data not shown). There were no obvious differences between dairy type or herd size. Mean savings were 2.1 kWhr/kL using the AgVet tool and 10.7 kWhr/kL using the Bullock tool. Based on a national average for total energy use of 48.3 kWhr/kL, these savings represent about 4.3% and 22.2% respectively. This data for mean savings should be viewed with care due to the skewed nature of the data and high variability.

7.2.3 Histograms of identified savings

As described earlier, the data included a large number of assessments with nil or small savings. Figure 7-1 and Figure 7-2 illustrate the potential savings as histograms for the AgVet and Bullock tools respectively.

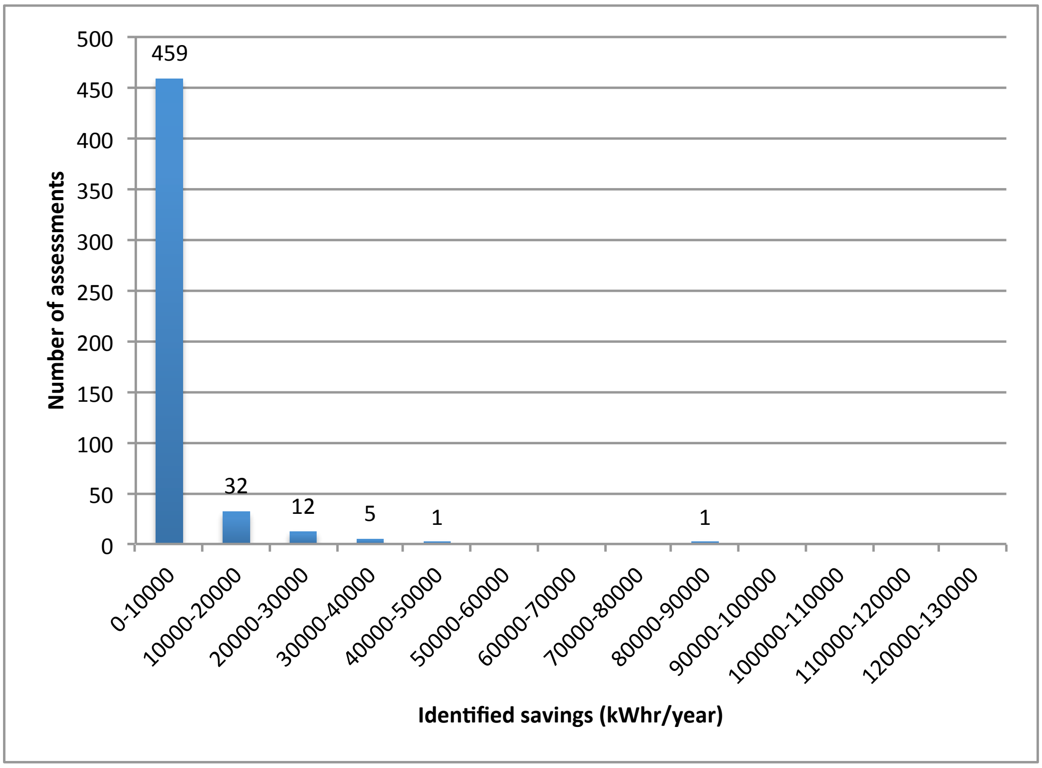


Figure 7-1: Histogram of identified savings (kWhr/year) - AgVet tool. Excluding automatic, small rotary and large walk through dairies.

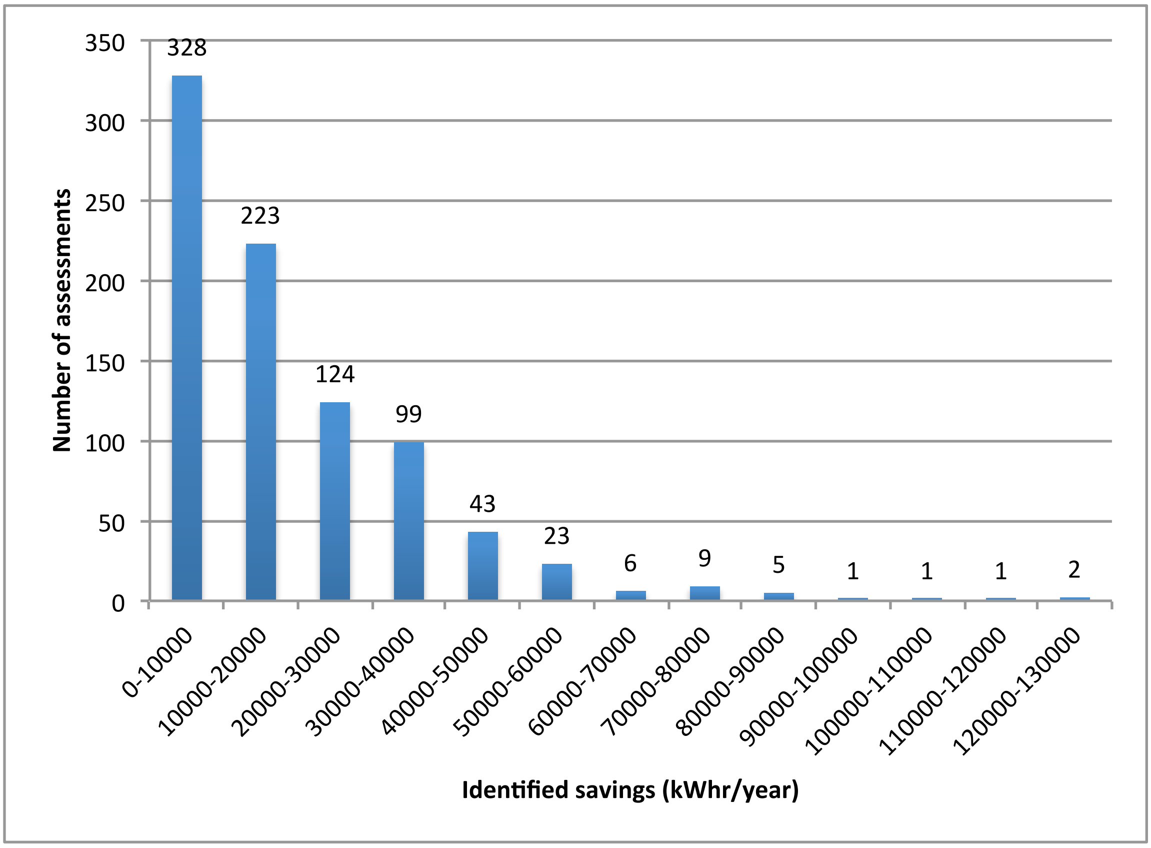


Figure 7-2: Histogram of identified savings (kWhr/year) - Bullock tool. Excluding automatic, small rotary and large walk through dairies.

In the AgVet assessments:

- For 23% of properties there were nil savings identified (included in the 0-10,000 category)
- In the vast majority of properties i.e. 90% of the assessments, there was less than 10,000 kWhr savings or <$2,200 (based on national average of $0.22/kWhr) to be saved from "tweaking" the system
- About 10% could save up to 5 times that amount which, whilst a significant amount, is for a few properties.

In the Bullock assessments:

- For 6% of properties there were nil savings identified (included in the 0-10,000 category in Figure 7-2)
- About 64% of the assessments were less than 20,000kWhr savings and a relatively large proportion of those were between 0 and 10,000kWhr savings
- There were a small number of assessments with more substantial annual savings identified i.e. about 10% of assessments were savings of 40,000 to 130,000kWhr savings
- Using an average price of $0.22 per kWhr, a majority of the assessments identified annual savings of between zero and approximately $4,400 per farm.

7.2.4 Dollar value of savings per business

We calculated the dollar value of savings by multiplying the savings in kWhr/year and the average cost per kWhr. Therefore this data for value of savings should be viewed with care because the data is indicative only.

For the AgVet assessments, by "tweaking" the system:

- Indicative annual savings identified ranged from $0 to $13,918
- In 89% of properties assessed savings were between $0 and $2,000 per year
- In 11% of properties assessed savings were between $2,000 and $9,000
- For 1 property savings were $14,000.

For the Bullock assessments, by both "tweaking" and spending capital:

- Indicative annual savings ranged from $0 to $28,267
- In 61% of properties assessed savings were between $0 and $4,000 per year
- In 36% of properties assessed savings were between $4,000 and $15,000
- In 3% of properties assessed identified savings were between $15,000 and $28,267.

7.3 Most common recommendations

Feedback from assessors

Based on feedback from the three energy assessors interviewed, the most commonly identified savings were:

- Pre-heating hot water for hot water systems

- Installing VSDs on vacuum pumps
- Improved functioning of equipment for milk cooling – including function of the plate-cooler and the compressors on the vats. One assessor said that about 60-80% of plate coolers were less effective than optimum and this ranged from a couple of degrees up to 10^{o}C.

Assessors felt that the savings depended largely on each individual dairy and there were no obvious trends or differences by region, herd size or dairy type - apart from different climatic factors.

The database shows that this is correct with the exception of automatic dairies, small rotary and large walk through dairies. Otherwise, options to reduce energy consumption were based on individual farms and for example, how well their equipment was maintained.

Further, the actions recommended have nothing to do with regions or type of dairy but you can see how scale would influence the cost and ability to install upgrades.

Dairy Australia evaluation

The phase 1 evaluation (Dairy Australia, 2014) found that amongst evaluation survey respondents the most common recommendations to reduce energy consumption were:

- Milk cooling, including installation of more efficient equipment, using cooler water sources, etc. (recommended in 64% of dairies)
- Water heating, including installation of more efficient equipment, lowering water temperatures where possible, using heat exchange units, etc. (54%)
- Vacuum pumps, including installation of more efficient equipment (26%).

This accords with the feedback from assessors and our analysis.

7.4 On-farm implementation of recommendations

The Draft Final Evaluation report (Dairy Australia, 2015) shows the proportion of evaluation respondents who have already made the changes or plan to made changes in the future that were recommended in their energy reports.

Evaluation data is shown in Table 7-2 for the types of changes to reduce energy consumption / improve efficiency.

Table 7-2: Changes made as a result of the program for the types of changes to reduce energy consumption / improve energy efficiency.

Type of change recommended	Change recommended in plan (% of total responses)	Change already made (% of total responses)	Change planned in the future (% of total responses)
Milk cooling, including installation of more efficient equipment, using cooler water sources, etc.	61%	21%	24%
Water heating, including installation of more efficient equipment, lowering water temperatures where possible, using heat	60%	24%	29%

exchange units, etc.			
Vacuum pumps, including installation of more efficient equipment	30%	5%	21%
Lighting, including changing to more efficient globes, etc.	24%	8%	9%
Increase equipment maintenance	13%	10%	1%

This evaluation data suggests that a majority of respondents had either already made the recommended changes or plan to do so in the future. Most of these changes would have been made within a relatively short timeframe, i.e. within a year or two of receiving their energy plans, suggesting that farmers rated the advice highly.

In addition to the above energy efficiency actions, changing energy supplier or tariffs were recommended in 26% of plans. Although these actions do not directly relate to energy efficiency they can represent substantial financial savings for some farms.

The data does not provide any indication of the expected magnitude of energy savings from the actions taken and some of these actions may be relatively minor e.g. changes made to lighting or minor adjustments to equipment.

7.5 Barriers to implementation of recommendations

Based on the evaluation feedback (Dairy Australia evaluation report, 2015), the main barrier for farmers was 'cost/unable to afford'. This was mentioned by 55% (out of 65 responses) of those who had not implemented all changes yet. Other barriers were 'existing equipment still working' (31%), 'don't believe change will affect consumption' (20%), and 'payback time too long/unrealistic' (5%).

When asked "*What sort of support, if any, would you need to implement changes?*" responses included:

- Nothing further required/don't know (mentioned by 62%)
- Grants/financial assistance (25%)
- Checklist/costs for purchasing equipment (11%)
- Better return on solar power contributions to the grid (5%).

55% mentioned cost as the main barrier. 25% mentioned grants/financial assistance would support them in making the change. Although cost may be a barrier at a point in time, some had decided to hold-off equipment replacements until the existing equipment failed.

In addition, we believe that cost barriers can relate to any combination of:

- Cash flow limitations
- Not being convinced of the cost to benefit ratio, and
- In dollar terms the total savings may not be worth the time and effort and/or other issues may be more important.

It is not clear from the evaluation report if the cost barriers were associated with:

- Smaller herd sizes
- A particular phase of the business e.g. those who are unable to expand, or

- Types of recommendations.

We recognise that this may not have been possible due to the size of the dataset.

Further, those who cited cost barriers may still be planning to implement the changes in the future. However, for a majority of properties the recommended changes are not worth a lot of money. In these cases there is less incentive to implement the changes. For most of the business the savings are small but a few are significant.

> Although cost was the main barrier, farmers often have other legitimate reasons for not making recommended changes.

7.6 Conclusions on identified savings

The data analysis highlights that:

- The two tools gave very different values due to their different approach but this was to be expected given that one method was tweaking the current system and the other involved capital expenditure on equipment upgrades – both methods have their place because they are answering different questions
- For 169 of the dairy farms assessed (12% of total assessments), there were **nil** savings identified
- The AgVet and Bullock tools identified median savings of about 3.3% and the 20.7% respectively, but the data was very variable
- Most of the assessments lie in the saving range of 0 to 20,000 kWhr per year. For more than half of the properties the savings were less than $2,000 per year and the number of assessments decreased with greater identified savings (Figure 7-1 and Figure 7-2)
- It appears that there are three general groups of farmers in terms of energy savings:
  - In more than half of businesses regardless of the method used, the savings identified amount to less than $2,000 per year and whilst all savings are important are relatively modest
  - Based on the savings identified in the Bullock assessments, a significant number i.e. about 30% of properties, identified savings where $5,000 to $29,000 per year
  - There is a small number who could make substantial savings i.e. greater than $20,000
- Average identified savings as a percentage of total power bills are relatively consistent across herd sizes and dairy type. It was not possible to examine potential regional differences due to the different tools used in each region, however given that there is no significant difference in energy bills between regions they would not expect a difference anyway
- Total potential energy savings per farm are greater in larger herds due to greater total energy use. It follows that potential dollar savings per year increase with herd size
- It is not possible from the database to fully understand the characteristics of the more efficient dairies. For example we don't know what technology they were already using such as pre-heating water, solar panels or using VSDs.

8 National summary

The information provided in this section has been developed to include in industry fact sheets. Therefore, it has been written with a farmer audience in mind.

We suggest that Dairy Australia could supplement with additional data from the Dairy Farm Monitor dataset - on energy costs as a percentage of total costs.

8.1 Background

The Smarter energy use program will close in June 2015. Since 2012 this project has successfully delivered 1,400 energy assessments, covering ~21% of dairy farms across Australia.

This information sheet is benchmarking data from those assessments. The energy assessments involved: review of 12 months of power bills; shed visit for energy efficiency assessment and follow up visit/communication with farmers with recommendations. All figures below are inclusive of GST.

This data only relates to dairy shed use and any other loads connected to the dairy metering point. So it does not include irrigation, which is typically the biggest part of the power bill for irrigated farms, depending on the season.

The data excludes automatic, small rotary (herds <150) and large walk through (herds >300) dairies which all have higher energy use compared to others with a similar herd size.

8.2 Key findings of study

Energy costs per 100 cows

Energy costs per 100 cows can provide a simple benchmark. These benchmarks can indicate if you have a problem and therefore are a good indicator of potential savings. If your energy use were similar to the 'high' benchmark it would be worthwhile undertaking an assessment of your energy use to identify where efficiencies can be made. See table below.

Energy use and cost per kL milk

For benchmarking energy use, the best comparison is kWhr per kL because that accounts for variations in L per cow and MS per cow. The amount of energy used largely depends on the volume of milk physically harvested and cooled. See table below for benchmarks per kL milk.

Table 8-1: National benchmarks.

	National benchmarks		
	Low	**Average**	**High**
Total energy costs per 100 cows	$4,000	$6,600	$9,200
Hot water costs per 100 cows	$560	$1,590	$2,610
Milk cooling costs per 100 cows	$1,170	$2,290	$3,400
Milk harvesting costs per 100 cows	$690	$1,280	$1,860
Energy use per milk production kWhr per 1000L	31	48	66
Energy cost per milk production $ per 1000L	$6	$11	$15
Energy cost per kWhr (average for year of assessments from 2012 to 2015)	$0.18	$0.22	$0.26

Scale is important

Dairies with larger herd sizes have lower energy use per kL milk. Energy use for all three main cost components is lower for larger herds.

Energy use per kL milk declines by about 14% from herd size 100 to 200 and then by about 4% for every 100 cows up to 500 cows.

Identified savings

Typically, more than half (55%) of the assessments identified savings of less than $2,000 per year. About 40% of properties had potential to save a modest amount ($2,000 - $10,000). Substantial savings (up to $29,000) were identified for a small (5%) proportion of the assessments.

8.3 Energy use

There was a herd size impact i.e. dairies with larger herd sizes have lower energy use per kL milk (Figure 8-1).

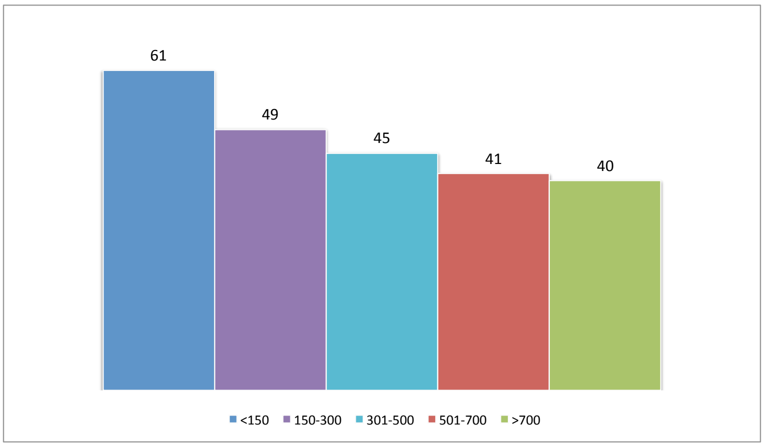


Figure 8-1: Energy use per milk production, by herd size kWhr per 1000L.

8.4 Total costs per farm

Annual power bills per business were highly variable and ranged from $1,663 to $121,722. As expected, annual power bills increase with herd size.

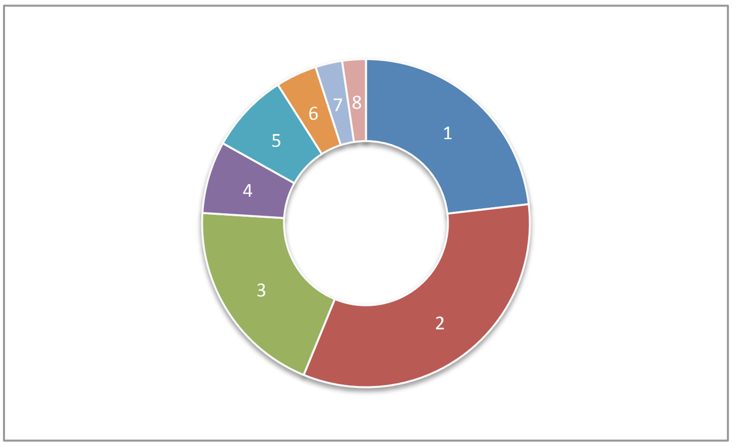
Table 8-2: Variability of total energy costs per business ($/year). Excluding automatic, small rotary and large walk through dairies.

Herd size	Min	Max	Average (Mean)
<150	$1,663	$23,867	$7,916
150-300	$3,586	$55,778	$14,753
301-500	$3,985	$63,106	$23,888
501-700	$18,510	$76,419	$35,541
>700	$14,906	$121,722	$50,070
Total	**$1,663**	**$121,722**	**$19,972**

8.5 Cost components

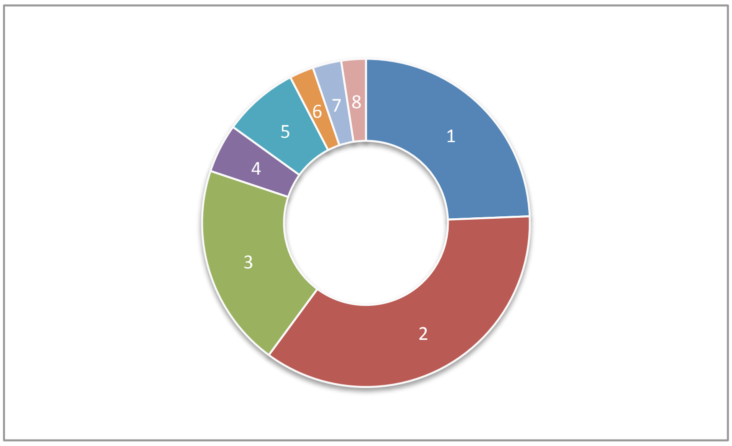
The following chart shows the breakdown of energy costs for the most common dairy types, rotary and herringbone.

The three main energy cost components are hot water, milk cooling and milk harvesting totalling about 79% of energy costs. To reduce energy consumption and costs, focus on the three main cost components.



Breakdown of energy costs average for rotary sheds

1 Hot water	**23.2%**
2 Milk cooling	**33.1%**
3 Milk harvesting	**19.8%**
4 Cleaning & effluent	**7.1%**
5 Stock and dairy water	**7.9%**
6 Feed	**4.1%**
7 Shed, office, workshop, misc.	**2.6%**
8 Lights	**2.3%**



Breakdown of energy costs average for herringbone sheds

1 Hot water	**24.4%**
2 Milk cooling	**35.7%**
3 Milk harvesting	**20.0%**
4 Cleaning & effluent	**4.8%**
5 Stock and dairy water	**7.4%**
6 Feed	**2.4%**
7 Shed, office, workshop, misc.	**2.8%**
8 Lights	**2.4%**

Energy use for all three main cost components decline with herd size (Figure 8-2)

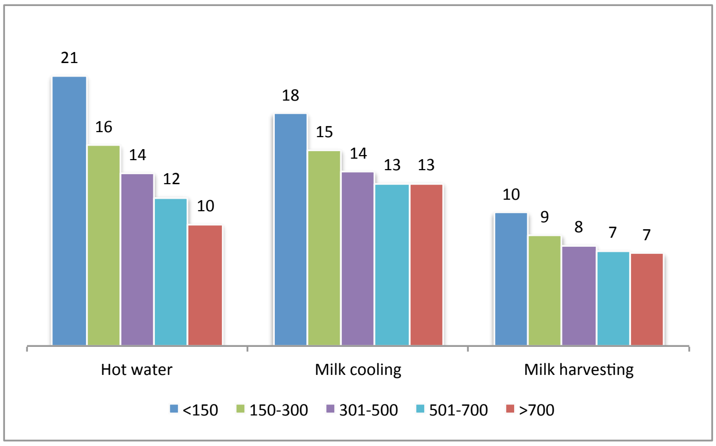


Figure 8-2: Energy use for the three main cost components, by herd size kWhr per 1000L.

8.6 Savings for farmers

Typically, more than half (55%) of the assessments identified savings of less than $2,000 per year. About 40% of properties had potential to save a modest amount ($2,000 - $10,000). Substantial savings (up to $29,000) were identified for a small (5%) proportion of the assessments.

The most commonly identified savings were associated with:

- Improved functioning of equipment for milk cooling, including function of the plate-cooler and the compressors on the vats and using cooler water sources

- Pre-heating hot water for hot water systems, using heat exchange units (where appropriate) and using correct water temperatures
- Installing variable speed drives (VSDs) on vacuum pumps.

In addition to energy savings, for some farms there were further dollar savings to be made with electricity billing arrangements and changeover to time of use contracts. Although these do not reduce energy use, they can substantially reduce total bills.

By considering these opportunities, farmers might be able to reduce energy use, lower the costs (through changes in electricity billing arrangements and/or changeover to time of use contracts), and have fewer greenhouse gas emissions.

The energy use data and legacy resources from this program will be available to the dairy industry well beyond the life of this program. See http://frds.dairyaustralia.com.au/events/smarter-energy-use/

9 Regional summaries

The information provided in the following sub-sections has been developed to include in industry fact sheets. Therefore, it has been written with a farmer audience in mind.

We suggest that Dairy Australia could supplement with information with additional data from the Dairy Farm Monitor dataset - on energy costs as a percentage of total costs.

9.1 Gippsland

9.1.1 Background

The Smarter energy use program will close in June 2015. Since 2012 this project has successfully delivered 1,400 energy assessments, covering ~21% of dairy farms across Australia.

This information sheet is benchmarking data from 140 energy efficiency assessments conducted in Gippsland dairy sheds, representing 9% of dairy farms in the region, from 2012 to 2015. The energy assessments involved: review of 12 months of power bills; shed visit for energy efficiency assessment and follow up visit/communication with farmers with recommendations. All figures below are inclusive of GST.

This data only relates to dairy shed use and any other loads connected to the dairy metering point. So it does not include irrigation, which is typically the biggest part of the power bill for irrigated farms, depending on the season.

The data excludes automatic, small rotary (herds <150) and large walk through (herds >300) dairies which all have higher energy use compared to others with a similar herd size.

9.1.2 Key findings of study

Energy costs per 100 cows

Energy costs per 100 cows can provide a simple benchmark. These benchmarks can indicate if you have a problem and therefore are a good indicator of potential savings. If your energy use were similar to the 'high' benchmark it would be worthwhile undertaking an assessment of your energy use to identify where efficiencies can be made. See table below.

Energy use and cost per kL milk

For benchmarking energy use, the best comparison is kWhr per kL because that accounts for variations in L per cow and MS per cow. The amount of energy used largely depends on the volume of milk physically harvested and cooled. See table below for benchmarks per kL milk.

Table 9-1: Gippsland benchmarks.

	Gippsland benchmarks		
	Low	**Average**	**High**
Total energy costs per 100 cows	$3,800	$6,100	$8,400
Hot water costs per 100 cows	$660	$1,580	$2,500
Milk cooling costs per 100 cows	$1,080	$1,810	$2,550
Milk harvesting costs per 100 cows	$690	$1,200	$1,720
Energy use per milk production kWhr per 1000L	29	50	71
Energy cost per milk production $ per 1000L	$6	$11	$15
Energy cost per kWhr (average for year of assessments from 2012 to 2015)	$0.18	$0.21	$0.24

Scale is important

Dairies with larger herd sizes have lower energy use per kL milk. Energy use for all three main cost components is lower for larger herds.

Nationally, energy use per kL milk declines by about 14% from herd size 100 to 200 and then by about 4% for every 100 cows up to 500 cows.

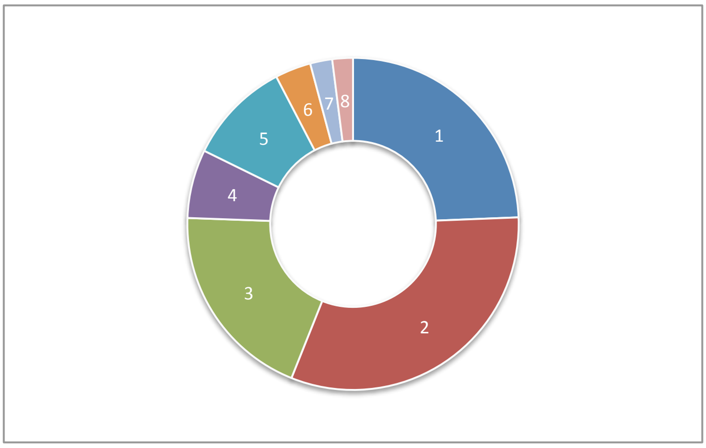
Identified savings

In Gippsland, typically 90% of assessments had indicative identified savings of between $0 and $2,000 per year. Others were between $2000 and $9000 indicative savings per year.

Refer to the national summary for information on most common recommendations.

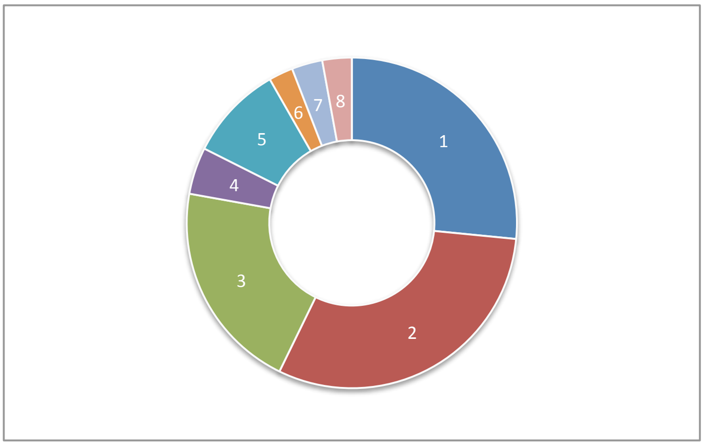
Cost components

The three main energy cost components are hot water, milk cooling and milk harvesting totalling about 77% of energy costs in Gippsland. The following charts show the breakdown of energy costs for the most common dairy types, rotary and herringbone.



Breakdown of energy costs average across rotary sheds - Gippsland

1 Hot water **24.4%**
2 Milk cooling **31.7%**
3 Milk harvesting **19.5%**
4 Cleaning & effluent **6.7%**
5 Stock and dairy water **10.1%**
6 Feed **3.5%**
7 Shed, office, workshop, misc. **2.1%**
8 Lights **2.0%**



Breakdown of energy costs average across herringbone sheds - Gippsland

1 Hot water **26.6%**
2 Milk cooling **30.7%**
3 Milk harvesting **20.6%**
4 Cleaning & effluent **4.6%**
5 Stock and dairy water **9.3%**
6 Feed **2.4%**
7 Shed, office, workshop, misc. **3.0%**
8 Lights **2.9%**

To reduce energy consumption and costs, focus on the three main cost components: hot water, milk cooling and milk harvesting.

9.2 Western Victoria

9.2.1 Background

The Smarter energy use program will close in June 2015. Since 2012 this project has successfully delivered 1,400 energy assessments, covering ~21% of dairy farms across Australia.

This information sheet is benchmarking data from 308 energy efficiency assessments conducted in Western Victorian dairy sheds, representing 22% of dairy farms in the region, from 2012 to 2015. The energy assessments involved: review of 12 months of power bills; shed visit for energy efficiency assessment and follow up visit/communication with farmers with recommendations. All figures below are inclusive of GST.

This data only relates to dairy shed use and any other loads connected to the dairy metering point. So it does not include irrigation, which is typically the biggest part of the power bill for irrigated farms, depending on the season.

The data excludes automatic, small rotary (herds <150) and large walk through (herds >300) dairies which all have higher energy use compared to others with a similar herd size.

9.2.2 Key findings of study

Energy costs per 100 cows

Energy costs per 100 cows can provide a simple benchmark. These benchmarks can indicate if you have a problem and therefore are a good indicator of potential savings. If your energy use were similar to the 'high' benchmark it would be worthwhile undertaking an assessment of your energy use to identify where efficiencies can be made. See table below.

Energy use and cost per kL milk

For benchmarking energy use, the best comparison is kWhr per kL because that accounts for variations in L per cow and MS per cow. The amount of energy used largely depends on the volume of milk physically harvested and cooled. See table below for benchmarks per kL milk.

Table 9-2: Western Victoria benchmarks.

	Western Victoria benchmarks		
	Low	**Average**	**High**
Total energy costs per 100 cows	$3,570	$5,500	$7,500
Hot water costs per 100 cows	$450	$1,450	$2,440
Milk cooling costs per 100 cows	$1,200	$1,940	$2,680
Milk harvesting costs per 100 cows	$600	$1,080	$1,560
Energy use per milk production kWhr per 1000L	32	47	63
Energy cost per milk production $ per 1000L	$5	$9	$13
Energy cost per kWhr (average for year of assessments from 2012 to 2015)	$0.16	$0.20	$0.23

Scale is important

Dairies with larger herd sizes have lower energy use per kL milk. Energy use for all three main cost components is lower for larger herds.

Nationally, energy use per kL milk declines by about 14% from herd size 100 to 200 and then by about 4% for every 100 cows up to 500 cows.

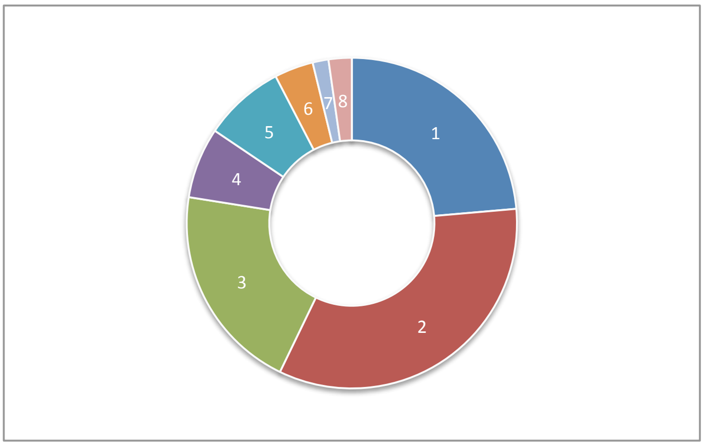
Identified savings

In Western Victoria, typically 60% of assessments had indicative identified savings of between $0 and $4,000 per year. About 35% had indicative savings of between $4000 and $9000. Others were between $9000 and $26000 indicative savings per year.

Refer to the national summary for information on most common recommendations.

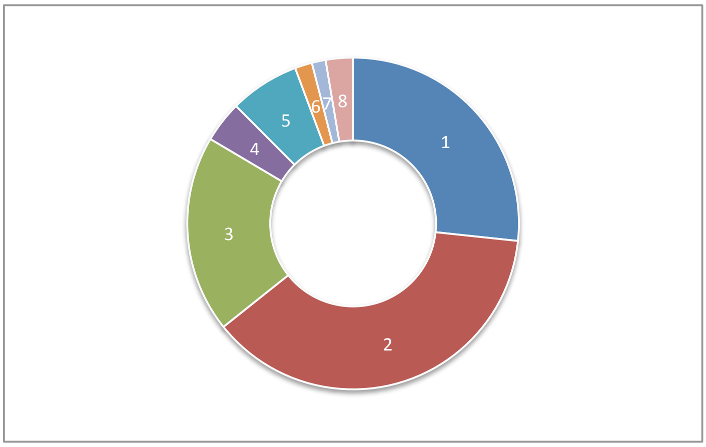
Cost components

The three main energy cost components are hot water, milk cooling and milk harvesting totalling about 81% of energy costs in Gippsland. The following charts show the breakdown of energy costs for the most common dairy types, rotary and herringbone.



Breakdown of energy costs average across rotary sheds – Western Victoria

1 Hot water **23.6%**
2 Milk cooling **33.6%**
3 Milk harvesting **20.4%**
4 Cleaning & effluent **6.9%**
5 Stock and dairy water **7.9%**
6 Feed **3.8%**
7 Shed, office, workshop, misc. **1.6%**
8 Lights **2.3%**



Breakdown of energy costs average across herringbone sheds – Western Victoria

1 Hot water **26.7%**
2 Milk cooling **37.6%**
3 Milk harvesting **19.2%**
4 Cleaning & 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%**

To reduce energy consumption and costs, focus on the three main cost components: hot water, milk cooling and milk harvesting.

9.3 Murray Dairy

9.3.1 Background

The Smarter energy use program will close in June 2015. Since 2012 this project has successfully delivered 1,400 energy assessments, covering ~21% of dairy farms across Australia.

This information sheet is benchmarking data from 267 energy efficiency assessments conducted in Murray Dairy sheds, representing 16% of dairy farms in the region, from 2012 to 2015. The energy assessments involved: review of 12 months of power bills; shed visit for energy efficiency assessment and follow up visit/communication with farmers with recommendations. All figures below are inclusive of GST.

This data only relates to dairy shed use and any other loads connected to the dairy metering point. So it does not include irrigation, which is typically the biggest part of the power bill for irrigated farms, depending on the season.

The data excludes automatic, small rotary (herds <150) and large walk through (herds >300) dairies which all have higher energy use compared to others with a similar herd size.

9.3.2 Key findings of study

Energy costs per 100 cows

Energy costs per 100 cows can provide a simple benchmark. These benchmarks can indicate if you have a problem and therefore are a good indicator of potential savings. If your energy use were similar to the 'high' benchmark it would be worthwhile undertaking an assessment of your energy use to identify where efficiencies can be made. See table below.

Energy use and cost per kL milk

For benchmarking energy use, the best comparison is kWhr per kL because that accounts for variations in L per cow and MS per cow. The amount of energy used largely depends on the volume of milk physically harvested and cooled. See table below for benchmarks per kL milk.

Table 9-3: Murray Dairy benchmarks.

	Murray Dairy benchmarks		
	Low	**Average**	**High**
Total energy costs per 100 cows	$4,300	$6,400	$8,500
Hot water costs per 100 cows	$840	$1,650	$2,460
Milk cooling costs per 100 cows	$1,180	$1,970	$2,760
Milk harvesting costs per 100 cows	$710	$1,200	$1,680
Energy use per milk production kWhr per 1000L	31	51	70
Energy cost per milk production $ per 1000L	$6	$10	$14
Energy cost per kWhr (average for year of assessments from 2012 to 2015)	0.17	0.20	0.23

Scale is important

Dairies with larger herd sizes have lower energy use per kL milk. Energy use for all three main cost components is lower for larger herds.

Nationally, energy use per kL milk declines by about 14% from herd size 100 to 200 and then by about 4% for every 100 cows up to 500 cows.

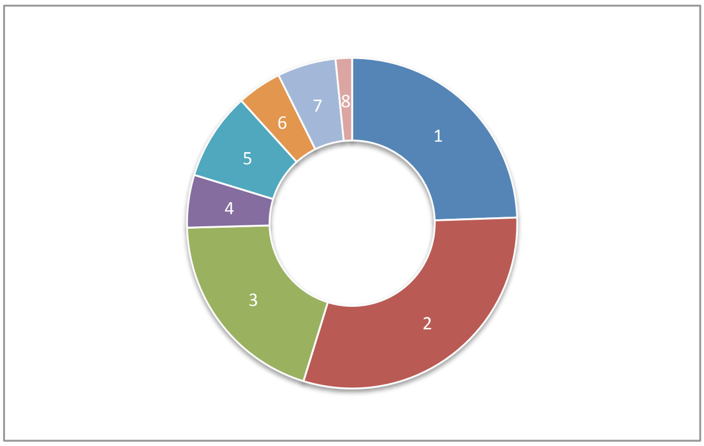
Identified savings

In the Murray Dairy region, typically 58% of assessments had indicative identified savings of between $0 and $1,000 per year. About 33% had indicative savings of between $1000 and $5000. Others were between $5000 and $16000 indicative savings per year.

Refer to the national summary for information on most common recommendations.

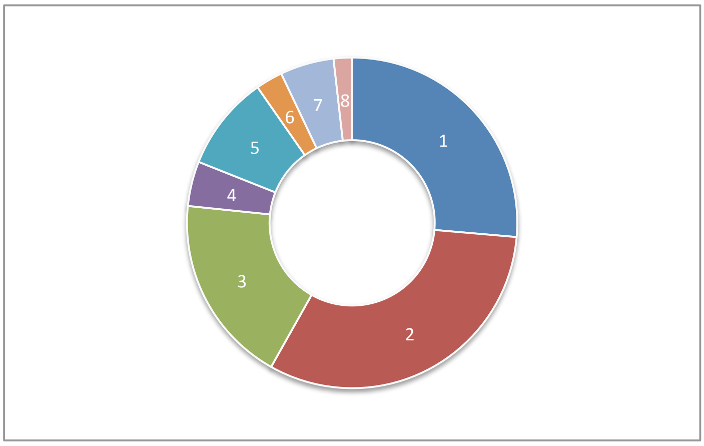
Cost components

The three main energy cost components are hot water, milk cooling and milk harvesting totalling about 76% of energy costs in the Murray Dairy region. The following charts show the breakdown of energy costs for the most common dairy types, rotary and herringbone.



Breakdown of energy costs average across rotary sheds – Murray Dairy

1 Hot water **24.5%**
2 Milk cooling **30.3%**
3 Milk harvesting **19.8%**
4 Cleaning & effluent **5.2%**
5 Stock and dairy water **8.6%**
6 Feed **4.4%**
7 Shed, office, workshop, misc. **5.7%**
8 Lights **1.6%**



Breakdown of energy costs average across herringbone sheds – Murray Dairy

1 Hot water **26.4%**
2 Milk cooling **31.8%**
3 Milk harvesting **18.5%**
4 Cleaning & effluent **4.4%**
5 Stock and dairy water **9.3%**
6 Feed **2.6%**
7 Shed, office, workshop, misc. **5.3%**
8 Lights **1.8%**

To reduce energy consumption and costs, focus on the three main cost components: hot water, milk cooling and milk harvesting.

9.4 Tasmania

9.4.1 Background

The Smarter energy use program will close in June 2015. Since 2012 this project has successfully delivered 1,400 energy assessments, covering ~21% of dairy farms across Australia.

This information sheet is benchmarking data from 200 energy efficiency assessments conducted in Tasmanian dairy sheds, representing 49% of dairy farmers in Tasmania, from 2012 to 2015. The energy assessments involved: review of 12 months of power bills; shed visit for energy efficiency assessment and follow up visit/communication with farmers with recommendations. All figures below are inclusive of GST.

This data only relates to dairy shed use and any other loads connected to the dairy metering point. So it does not include irrigation, which is typically the biggest part of the power bill for irrigated farms, depending on the season.

The data excludes automatic, small rotary (herds <150) and large walk through (herds >300) dairies which all have higher energy use compared to others with a similar herd size.

9.4.2 Key findings of study

Energy costs per 100 cows

Energy costs per 100 cows can provide a simple benchmark. These benchmarks can indicate if you have a problem and therefore are a good indicator of potential savings. If your energy use were similar to the 'high' benchmark it would be worthwhile undertaking an assessment of your energy use to identify where efficiencies can be made. See table below.

Tasmania had the lowest average energy costs per 100 cows. This would be due to the larger average herd size in Tasmanian assessments.

Energy use and cost per kL milk

For benchmarking energy use, the best comparison is kWhr per kL because that accounts for variations in L per cow and MS per cow. The amount of energy used largely depends on the volume of milk physically harvested and cooled. See table below for benchmarks per kL milk.

Table 9-4: Tasmania benchmarks.

	Tasmania benchmarks		
	Low	**Average**	**High**
Total energy costs per 100 cows	$3,500	$5,300	$7,100
Hot water costs per 100 cows	$600	$1,350	$2,100
Milk cooling costs per 100 cows	$940	$1,600	$2,250
Milk harvesting costs per 100 cows	$690	$1,290	$1,890
Energy use per milk production kWhr per 1000L	31	45	60
Energy cost per milk production $ per 1000L	$7	$10	$14
Energy cost per kWhr (average for year of assessments from 2012 to 2015)	$0.20	$0.23	$0.26

Scale is important

Dairies with larger herd sizes have lower energy use per kL milk. Energy use for all three main cost components is lower for larger herds.

Nationally, energy use per kL milk declines by about 14% from herd size 100 to 200 and then by about 4% for every 100 cows up to 500 cows.

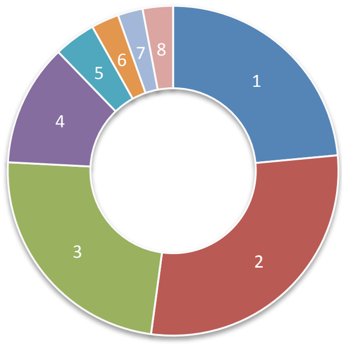
Identified savings

In Tasmania, typically 57% of assessments had indicative identified savings of between $0 and $1,000 per year. About 37% had indicative savings of between $1000 and $3000. Others were between $3000 and $8000 indicative savings per year.

Refer to the national summary for information on most common recommendations.

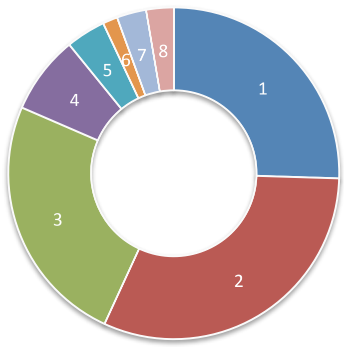
Cost components

The three main energy cost components are hot water, milk cooling and milk harvesting totalling about 80% of energy costs in Tasmania. The following charts show the breakdown of energy costs for the most common dairy types, rotary and herringbone.



Breakdown of energy costs average across rotary sheds - Tasmania

1 Hot water **23.5%**
2 Milk cooling **28.6%**
3 Milk harvesting **23.7%**
4 Cleaning & effluent **12.0%**
5 Stock and dairy water **4.1%**
6 Feed **2.7%**
7 Shed, office, workshop, misc. **2.4%**
8 Lights **3.0%**



Breakdown of energy costs average across herringbone sheds - Tasmania

1 Hot water **25.5%**
2 Milk cooling **31.4%**
3 Milk harvesting **24.6%**
4 Cleaning & effluent **7.6%**
5 Stock and dairy water **3.9%**
6 Feed **1.5%**
7 Shed, office, workshop, misc. **2.9%**
8 Lights **2.7%**

To reduce energy consumption and costs, focus on the three main cost components: hot water, milk cooling and milk harvesting.

9.5 Subtropical

9.5.1 Background

The Smarter energy use program will close in June 2015. Since 2012 this project has successfully delivered 1,400 energy assessments, covering ~21% of dairy farms across Australia.

This information sheet is benchmarking data from 137 energy efficiency assessments conducted in subtropical region dairy sheds, representing 21% of dairies in the region, from 2012 to 2015. The energy assessments involved: review of 12 months of power bills; shed visit for energy efficiency assessment and follow up visit/communication with farmers with recommendations. All figures below are inclusive of GST.

This data only relates to dairy shed use and any other loads connected to the dairy metering point. So it does not include irrigation, which is typically the biggest part of the power bill for irrigated farms, depending on the season.

The data excludes automatic, small rotary (herds <150) and large walk through (herds >300) dairies which all have higher energy use compared to others with a similar herd size.

9.5.2 Key findings of study

Energy costs per 100 cows

Energy costs per 100 cows can provide a simple benchmark. These benchmarks can indicate if you have a problem and therefore are a good indicator of potential savings. If your energy use were similar to the 'high' benchmark it would be worthwhile undertaking an assessment of your energy use to identify where efficiencies can be made. See table below.

In the subtropical region, more energy is used for cooling milk and therefore costs for cooling milk are higher than for some other regions.

Energy use and cost per kL milk

For benchmarking energy use, the best comparison is kWhr per kL because that accounts for variations in L per cow and MS per cow. The amount of energy used largely depends on the volume of milk physically harvested and cooled. See table below for benchmarks per kL milk.

Table 9-5: Subtropical benchmarks.

	Subtropical benchmarks		
	Low	**Average**	**High**
Total energy costs per 100 cows	$4,300	$6,800	$9,400
Hot water costs per 100 cows	$180	$1,370	$2,560
Milk cooling costs per 100 cows	$1,690	$2,850	$4,010
Milk harvesting costs per 100 cows	$710	$1,280	$1,840
Energy use per milk production kWhr per 1000L	33	50	67
Energy cost per milk production $ per 1000L	$7	$11	$16
Energy cost per kWhr (average for year of assessments from 2012 to 2015)	$0.20	$0.23	$0.25

Scale is important

Dairies with larger herd sizes have lower energy use per kL milk. Energy use for all three main cost components is lower for larger herds.

Nationally, energy use per kL milk declines by about 14% from herd size 100 to 200 and then by about 4% for every 100 cows up to 500 cows.

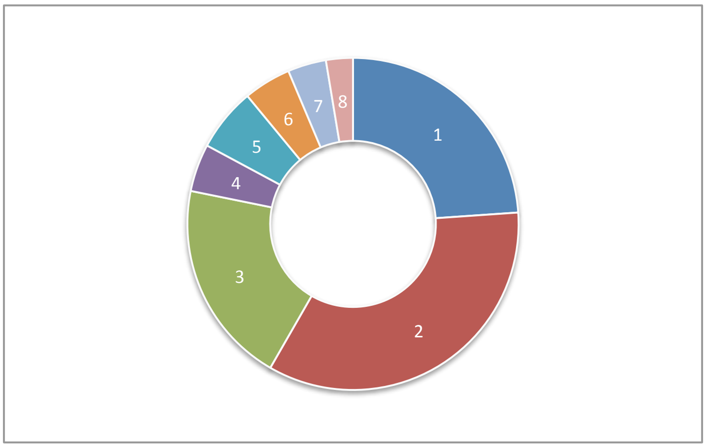
Identified savings

In the Subtropical region, typically 54% of assessments had indicative identified savings of between $0 and $2,000 per year. About 34% had indicative savings of between $2000 and $5000. Others were between $5000 and $12000 indicative savings per year.

Refer to the national summary for information on most common recommendations.

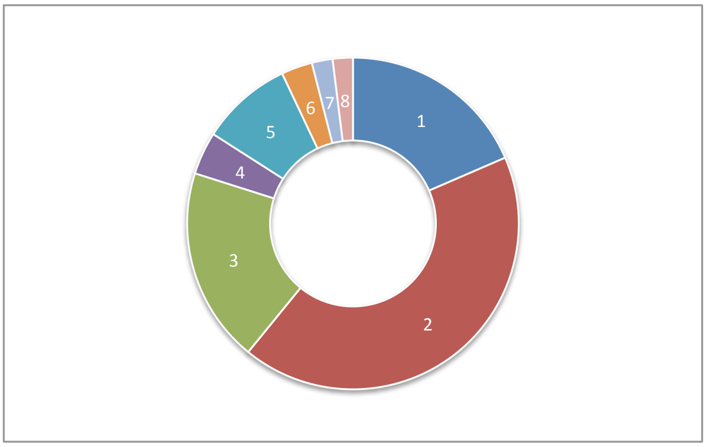
Cost components

The three main energy cost components are hot water, milk cooling and milk harvesting totalling about 80% of energy costs in the subtropical region. The following charts show the breakdown of energy costs for the most common dairy types, rotary and herringbone.



Breakdown of energy costs average across rotary sheds - Subtropical

1 Hot water **23.9%**
2 Milk cooling **34.4%**
3 Milk harvesting **19.9%**
4 Cleaning & effluent **4.6%**
5 Stock and dairy water **6.2%**
6 Feed **4.6%**
7 Shed, office, workshop, misc. **3.7%**
8 Lights **2.6%**



Breakdown of energy costs average across herringbone sheds - Subtropical

1 Hot water **18.5%**
2 Milk cooling **42.4%**
3 Milk harvesting **19.0%**
4 Cleaning & effluent **4.2%**
5 Stock and dairy water **8.9%**
6 Feed **3.0%**
7 Shed, office, workshop, misc. **2.0%**
8 Lights **2.0%**

To reduce energy consumption and costs, focus on the three main cost components: hot water, milk cooling and milk harvesting.

9.6 New South Wales

9.6.1 Background

The Smarter energy use program will close in June 2015. Since 2012 this project has successfully delivered 1,400 energy assessments, covering ~21% of dairy farms across Australia.

This information sheet is benchmarking data from 112 energy efficiency assessments conducted in Dairy NSW region dairy sheds, representing 23% of dairy farms in the region, from 2013 to 2015. The energy assessments involved: review of 12 months of power bills; shed visit for energy efficiency assessment and follow up visit/communication with farmers with recommendations. All figures below are inclusive of GST.

This data only relates to dairy shed use and any other loads connected to the dairy metering point. So it does not include irrigation, which is typically the biggest part of the power bill for irrigated farms, depending on the season.

The data excludes automatic, small rotary (herds <150) and large walk through (herds >300) dairies which all have higher energy use compared to others with a similar herd size.

9.6.2 Key findings of study

Energy costs per 100 cows

Energy costs per 100 cows can provide a simple benchmark. These benchmarks can indicate if you have a problem and therefore are a good indicator of potential savings. If your energy use were similar to the 'high' benchmark it would be worthwhile undertaking an assessment of your energy use to identify where efficiencies can be made. See table below.

In NSW, average energy costs are higher than all other regions due to higher cost per kWhr.

Energy use and cost per kL milk

For benchmarking energy use, the best comparison is kWhr per kL because that accounts for variations in L per cow and MS per cow. The amount of energy used largely depends on the volume of milk physically harvested and cooled. See table below for benchmarks per kL milk.

Table 9-6: New South Wales benchmarks.

	New South Wales benchmarks		
	Low	**Average**	**High**
Total energy costs per 100 cows	$6,500	$9,700	$12,800
Hot water costs per 100 cows	$780	$2,180	$3,570
Milk cooling costs per 100 cows	$2,370	$3,710	$5,100
Milk harvesting costs per 100 cows	$960	$1,600	$2,240
Energy use per milk production kWhr per 1000L	32	51	71
Energy cost per milk production $ per 1000L	$9	$15	$20
Energy cost per kWhr (average for year of assessments from 2012 to 2015)	$0.24	$0.29	$0.33

Scale is important

Dairies with larger herd sizes have lower energy use per kL milk. Energy use for all three main cost components is lower for larger herds.

Nationally, energy use per kL milk declines by about 14% from herd size 100 to 200 and then by about 4% for every 100 cows up to 500 cows.

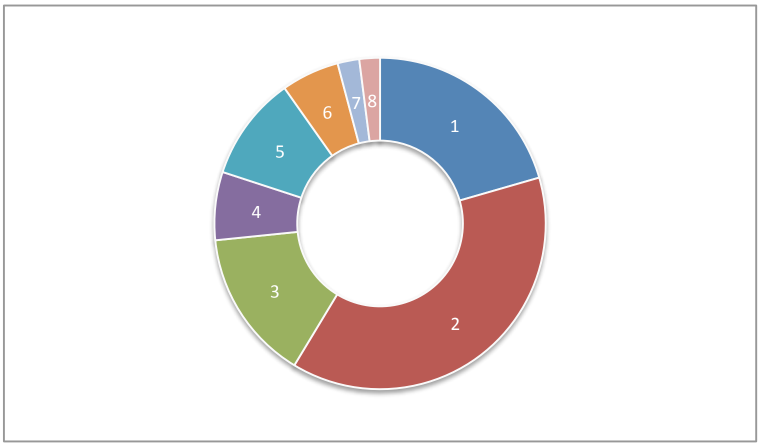
Identified savings

In the DairyNSW region, typically 65% of assessments had indicative identified savings of between $0 and $5,000 per year. About 25% had indicative savings of between $5000 and $12000. Others were between $12000 and $25000 indicative savings per year.

Refer to the national summary for information on most common recommendations.

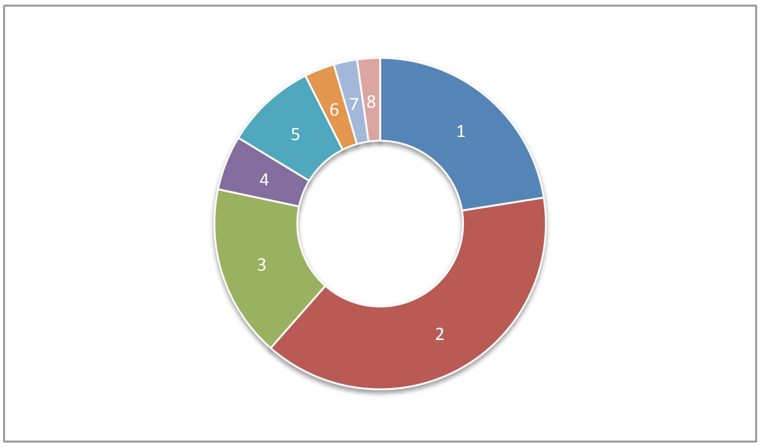
Cost components

The three main energy cost components are hot water, milk cooling and milk harvesting totalling about 77% of energy costs in NSW. The following charts show the breakdown of energy costs for the most common dairy types, rotary and herringbone.



Breakdown of energy costs average across rotary sheds - NSW

1 Hot water **20.5%**
2 Milk cooling **38.1%**
3 Milk harvesting **14.7%**
4 Cleaning & effluent **6.6%**
5 Stock and dairy water **10.2%**
6 Feed **5.7%**
7 Shed, office, workshop, misc. **2.1%**
8 Lights **2.0%**



Breakdown of energy costs average across herringbone sheds - NSW

1 Hot water **22.5%**
2 Milk cooling **39.0%**
3 Milk harvesting **16.8%**
4 Cleaning & effluent **5.3%**
5 Stock and dairy water **8.9%**
6 Feed **2.9%**
7 Shed, office, workshop, misc. **2.3%**
8 Lights **2.2%**

To reduce energy consumption and costs, focus on the three main cost components: hot water, milk cooling and milk harvesting.

9.7 South Australia

9.7.1 Background

The Smarter energy use program will close in June 2015. Since 2012 this project has successfully delivered 1,400 energy assessments, covering ~21% of dairy farms across Australia.

This information sheet is benchmarking data from 138 energy efficiency assessments conducted in DairySA region dairy sheds, representing 50% of dairy farms in the region, from 2012 to 2014. The energy assessments involved: review of 12 months of power bills; shed visit for energy efficiency assessment and follow up visit/communication with farmers with recommendations. All figures below are inclusive of GST.

This data only relates to dairy shed use and any other loads connected to the dairy metering point. So it does not include irrigation, which is typically the biggest part of the power bill for irrigated farms, depending on the season.

The data excludes automatic, small rotary (herds <150) and large walk through (herds >300) dairies which all have higher energy use compared to others with a similar herd size.

9.7.2 Key findings of study

Energy costs per 100 cows

Energy costs per 100 cows can provide a simple benchmark. These benchmarks can indicate if you have a problem and therefore are a good indicator of potential savings. If your energy use were similar to the 'high' benchmark it would be worthwhile undertaking an assessment of your energy use to identify where efficiencies can be made. See table below.

South Australia has the second highest average cost per 100 cows. This is probably due to a combination of factors such as cost of energy per kWhr and possibly higher energy use for milk cooling in the region.

Energy use and cost per kL milk

For benchmarking energy use, the best comparison is kWhr per kL because that accounts for variations in L per cow and MS per cow. The amount of energy used largely depends on the volume of milk physically harvested and cooled. See table below for benchmarks per kL milk.

Table 9-7: South Australia benchmarks.

	South Australia benchmarks		
	Low	**Average**	**High**
Total energy costs per 100 cows	$5,600	$8,100	$10,600
Hot water costs per 100 cows	$660	$1,750	$2,830
Milk cooling costs per 100 cows	$1,900	$3,110	$4,310
Milk harvesting costs per 100 cows	$880	$1,530	$2,170
Energy use per milk production kWhr per 1000L	30	48	66
Energy cost per milk production $ per 1000L	$7	$11	$16
Energy cost per kWhr (average for year of assessments from 2012 to 2015)	$0.20	$0.24	$0.28

Scale is important

Dairies with larger herd sizes have lower energy use per kL milk. Energy use for all three main cost components is lower for larger herds.

Nationally, energy use per kL milk declines by about 14% from herd size 100 to 200 and then by about 4% for every 100 cows up to 500 cows.

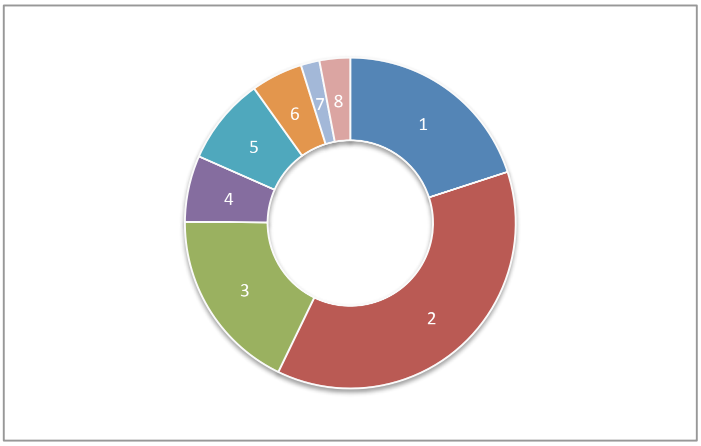
Identified savings

In the DairySA region, typically 81% of assessments had indicative identified savings of between $0 and $8,000 per year. About 13% had indicative savings of between $8000 and $14000. Others were between $14000 and $29000 indicative savings per year.

Refer to the national summary for information on most common recommendations.

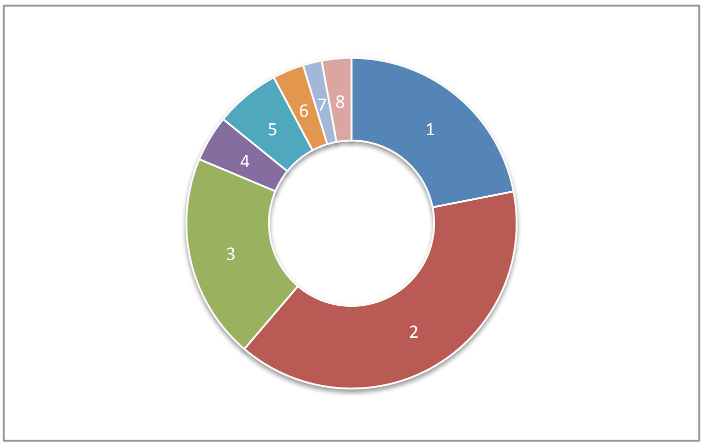
Cost components

The three main energy cost components are hot water, milk cooling and milk harvesting totalling about 79% of energy costs in the DairySA region. The following charts show the breakdown of energy costs for the most common dairy types, rotary and herringbone.



Breakdown of energy costs average across rotary sheds - SA

1 Hot water	**20.0%**
2 Milk cooling	**37.2%**
3 Milk harvesting	**17.9%**
4 Cleaning & effluent	**6.5%**
5 Stock and dairy water	**8.5%**
6 Feed	**5.1%**
7 Shed, office, workshop, misc.	**1.8%**
8 Lights	**3.0%**



Breakdown of energy costs average across herringbone sheds - SA

1 Hot water	**21.9%**
2 Milk cooling	**39.3%**
3 Milk harvesting	**20.1%**
4 Cleaning & effluent	**4.5%**
5 Stock and dairy water	**6.4%**
6 Feed	**3.1%**
7 Shed, office, workshop, misc.	**1.8%**
8 Lights	**2.9%**

To reduce energy consumption and costs, focus on the three main cost components: hot water, milk cooling and milk harvesting.

9.8 Western Australia

9.8.1 Background

The Smarter energy use program will close in June 2015. Since 2012 this project has successfully delivered 1,400 energy assessments, covering ~21% of dairy farms across Australia.

This information sheet is benchmarking data from 75 energy efficiency assessments conducted in Western Australian (WA) dairy sheds, representing 47% of WA dairy farms, from 2012 to 2014. The energy assessments involved: review of 12 months of power bills; shed visit for energy efficiency assessment and follow up visit/communication with farmers with recommendations. All figures below are inclusive of GST.

This data only relates to dairy shed use and any other loads connected to the dairy metering point. So it does not include irrigation, which is typically the biggest part of the power bill for irrigated farms, depending on the season.

The data excludes automatic, small rotary (herds <150) and large walk through (herds >300) dairies which all have higher energy use compared to others with a similar herd size.

9.8.2 Key findings of study

Energy costs per 100 cows

Energy costs per 100 cows can provide a simple benchmark. These benchmarks can indicate if you have a problem and therefore are a good indicator of potential savings. If your energy use were similar to the 'high' benchmark it would be worthwhile undertaking an assessment of your energy use to identify where efficiencies can be made. See table below.

Energy use and cost per kL milk

For benchmarking energy use, the best comparison is kWhr per kL because that accounts for variations in L per cow and MS per cow. The amount of energy used largely depends on the volume of milk physically harvested and cooled. See table below for benchmarks per kL milk.

Table 9-8: Western Australia benchmarks.

	Western Australia benchmarks		
	Low	**Average**	**High**
Total energy costs per 100 cows	$5,100	$7,700	$10,200
Hot water costs per 100 cows	$720	$1,850	$2,980
Milk cooling costs per 100 cows	$1,920	$2,860	$3,800
Milk harvesting costs per 100 cows	$820	$1,540	$2,250
Energy use per milk production kWhr per 1000L	31	42	54
Energy cost per milk production $ per 1000L	$6	$10	$13
Energy cost per kWhr (average for year of assessments from 2012 to 2015)	$0.19	$0.23	$0.27

Scale is important

Dairies with larger herd sizes have lower energy use per kL milk. Energy use for all three main cost components is lower for larger herds.

Nationally, energy use per kL milk declines by about 14% from herd size 100 to 200 and then by about 4% for every 100 cows up to 500 cows.

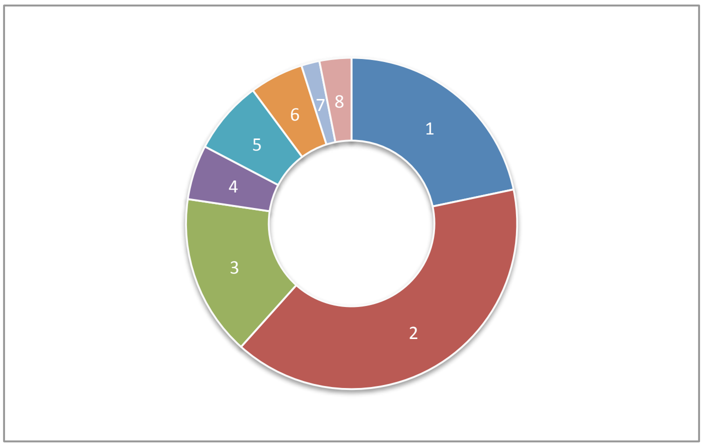
Identified savings

In WA, typically 52% of assessments had indicative identified savings of between $0 and $5,000 per year. About 35% had indicative savings of between $5000 and $10000. Others were between $10000 and $26000 indicative savings per year.

Refer to the national summary for information on most common recommendations.

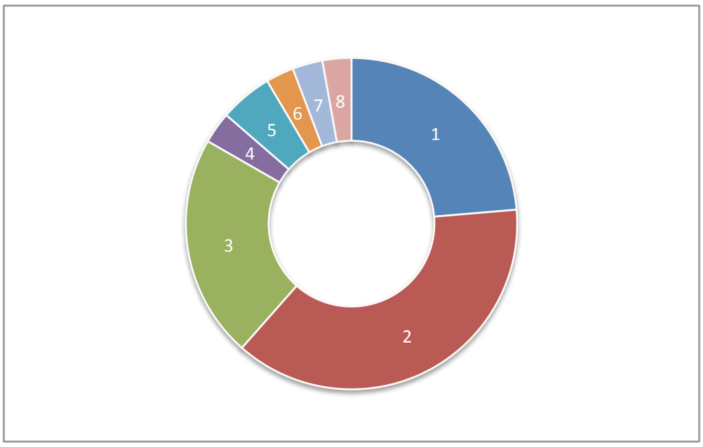
Cost components

The three main energy cost components are hot water, milk cooling and milk harvesting totalling about 82% of energy costs in WA. The following charts show the breakdown of energy costs for the most common dairy types, rotary and herringbone.



Breakdown of energy costs average across rotary sheds - WA

1 Hot water	**21.7%**
2 Milk cooling	**39.9%**
3 Milk harvesting	**15.7%**
4 Cleaning & effluent	**5.3%**
5 Stock and dairy water	**7.2%**
6 Feed	**5.3%**
7 Shed, office, workshop, misc.	**1.8%**
8 Lights	**3.1%**



Breakdown of energy costs average across herringbone sheds - WA

1 Hot water	**23.7%**
2 Milk cooling	**37.8%**
3 Milk harvesting	**21.8%**
4 Cleaning & effluent	**3.1%**
5 Stock and dairy water	**5.1%**
6 Feed	**2.7%**
7 Shed, office, workshop, misc.	**2.9%**
8 Lights	**2.8%**

To reduce energy consumption and costs, focus on the three main cost components: hot water, milk cooling and milk harvesting.

References

Dairy Australia (2014) Smarter Energy Use Program Phase 1 Evaluation

Dairy Australia (2015) Smarter Energy Use Program 2013-2015 Evaluation (unpublished DRAFT)

Appendix 1: Assessment data recorded in the national database

	A	B	C	D	E	F	G
1		Assessment data					
2	Number	Date of Assessment	RDP	sub-region	State	Assessor name	Farm business name

	H	I	J	K	L	M	N	O	P
1	Power bill data			Farm data				Benchmarks	
2	Total kWhr/ year	Total $/ year	$/ kWhr average for year of assessment	Type of dairy	Number of clusters	Average milking herd size	kL milk/ year	$/ kL	kWhr/ kL

	Q	R	S	T	U	V	W	X
1	ESTIMATES % of kWhr/ year							
2	Hot water	Milk cooling	Milk harvesting	Cleaning & effluent	Stock and dairy water	Feed	Shed, office, workshop, misc	Lights

	Y	Z	AA	AB	AC	AD	AE	AF
1	ESTIMATES % of $/ year							
2	Hot water	Milk cooling	Milk harvesting	Cleaning & effluent	Stock and dairy water	Feed	Shed, office, workshop, misc	Lights

	AG	AH	AI
1	Electricity Savings identified		
2	kWhr/ year	CO2e/yr	Scope or Est $ savings/yr