

Agriculture Energy Investment Plan: Analyses of 'Round 1' farm energy assessments and grants



Author

Adriana Robaina
Agriculture Victoria

Contributing analysts

Rodney Pugh and John van Rooden
Sustainability Victoria

CONTENTS	Page
Executive Summary	3
Background	4
Objectives	4
Method	4
Farm Classifications	5
Assessments and Grants	6
Classification of Opportunities	7
Calculations	7
Results	8
Farming sectors in assessments and energy costs	8
Sources of energy	11
Locations	12
Opportunities from the assessments	13
Farmer adoption through the AEIP grants	16
Adoption trends by sector	18
Adoption trends by region	20
Project costs and savings for adopted actions	22
Payback and co-benefits	23
Greenhouse gas emission savings	24
Learnings	26
Appendix 1. Number of farm energy assessments analysed, by sector and sub-sectors	27
Appendix 2. Range of annual energy costs (\$/year) per business, by sector and sub-sector	28
Appendix 3. Location of participants in farm assessments	29
Appendix 4. Categories for energy opportunities in the on-farm assessments	30
Appendix 5. Number of opportunities in the 680 on farm energy assessments	31
Appendix 6. Adoption rates for recommended actions	32
Appendix 7. Actual expenditure for adopted actions	33
Appendix 8. Annual energy cost savings (estimated) for adopted actions by Category	34

Executive Summary

- There were 680 on-farm energy assessments reports analysed from the 794 assessments completed in the 2018 AEIP program, also referred to 'Round 1' of the program. The next step of the program offered grants to implement the recommendations in the assessments. The actions for 320 successful grant recipients were analysed from the 2018 program.
- The largest group of participants in the on-farm energy assessments were Dairy farmers at 48% followed by Horticulture growers at 29%.
- Dairy represented 43% of the approved grants analysed and Horticulture 30%.
- Horticulture growers collectively had the greatest energy costs and potential for savings. The high energy costs and potential for opportunities in horticulture are driven by irrigation systems and many businesses operating their own cool rooms.
- Pigs, poultry and cropping businesses also had high energy costs per business.
- The top grower sub-sectors in Horticulture for potential energy savings, are vegetables (outdoors), grapes, stone fruits, apple & pear.
- Cropping and grazing (Meat and Wool) sectors had low participation in the program. These sectors also had a greater reliance on diesel for energy than electricity.
- Overall, there was good representation from all regions of Victoria, although there were more farmers from North Victoria participating in this program than from other regions.
- The items that were recommended the greatest number of times in the energy assessments were solar photovoltaics, variable speed drives and upgrade to more efficient equipment. Sector differences existed, for example, heat recovery was high on the list for Dairy, while timers/operational controls and insulation were recommended more in Horticulture.
- Solar energy also had the greatest adoption rate.
- Recommendations with relatively low adoption were heat pumps, heat recovery, timers/operational controls, and insulation.

The adoption of low-cost items such as behaviour change and tariff management were not captured through the grants, with farmers sometimes citing doing these quickly on their own, rather than including them in the grant process.

- Farmers in the Metro Melbourne areas had the greatest adoption rates, closely followed by farmers from North Victoria. Barwon South-West farmers had the lowest adoption rates.
- Assessments and adopted actions included a simple payback estimate. This is a simple calculation of the actual or estimated cost of implementation divided by the expected annual savings. It does not include ongoing maintenance costs or a discount rate on the cost of money.
- The 320 grants analysed represented \$42.9 million invested in total on farm energy upgrades. The energy savings estimated from these actions translated into an estimated 27,552 tonnes of CO₂ equivalent in greenhouse gas emissions savings per year. The total from the program is greater than this.

Several projects relied on co-benefits to be considered an attractive investment and may or may not have been associated with considerable energy savings too. Co-benefits included productivity, water savings, labour savings, product quality, animal welfare and reduced chemicals.

Background

The Agriculture Energy Investment Plan Extension (AEIP) supports farm businesses to reduce energy costs, improve energy efficiency and explore alternative energy options. Potential co-benefits include productivity improvements, energy and water efficiency gains, emission reduction and waste reduction, helping to sustain Victoria's adaptable and internationally competitive agriculture sector.

The Assessment component of the Program provides On-Farm Energy Assessments performed by energy experts to assist farmers identify opportunities to reduce energy costs. These assessments were free to farmer participants. The Grants component then provides a cash contribution to help farmers invest in some, or all, of the energy efficient upgrades and own-generation technology that were recommended in each assessment.

Objectives

This report is an independent document, for the purpose of evaluation by the governance committee of the Agriculture Energy Investment Plan (AEIP) and Energy Smart Farming (ESF) projects.

The analyses undertaken in this report provides insights that contribute to the evaluation of AEIP, as well as delivering learnings to guide the planning of extension activities under the ESF project.

The objectives of this research are:

- To analyse information collected from the AEIP farm energy assessments and approved grants to estimate potential energy savings
- To extract insights from the AEIP data into farm energy opportunities and adoption that will inform AEIP evaluation and the Energy Smart Farming delivery.

This study is a collaboration between Sustainability Victoria and Agriculture Victoria.

Method

The AEIP assessments and grants program was conducted in two rounds. Round 1 (AEIP 2018, AEIPe 2018) and Round 2 (AEIP 2020, with slightly different guidelines).

This data mine is focused on the results from 'Round 1', also referred to as the AEIP 2018 program.

From the 794 AEIP on-farm energy assessments that were completed in 'Round 1', 680 completed reports were randomly selected for analysis.

Key pieces of information were identified from these text reports to compile a database with relevant categories that could be analysed. The information of interest was manually extracted from reading individual reports and entered into Excel. Several weeks of data entry, validation, testing and re-design followed.

The completed database contained the following categories per stakeholder or business:

- Stakeholder application no.
- Stakeholder business name
- Farm description
- Farming category and sub-sector
- Annual energy costs (\$/year) and energy use (GJ/year) by different sources (electricity, gas, LPG, diesel, other)

- List of opportunities, that is, recommendations by assessors for energy upgrades or improvements, and the estimated costs and savings per opportunity

The amount of detail written about each business was highly variable. Some categories such as farm size (ha) were initially selected and recorded, but later found to be unavailable for many reports.

Farm Classifications

Farms were grouped into broad industry categories that generally align with Agriculture Victoria business units and industry organisations, such as Dairy, Horticulture, Meat & Wool.

Farms were then classified into sub-sectors, based largely on a shorthand of ANZSIC code descriptions, however some sub-sectors were created to highlight features of interest or mixed enterprises.

For example, the Dairy sub-sectors were set as:

- Dairy: refers to Dairy farm only
- Dairy & other: Dairy farms with another farming enterprise, such as beef or potatoes
- Dairy & manufacturing: Dairy farms making their own Dairy product(s), such as cheese

The 'Meat & Wool' sector represents beef cattle and/or sheep farming, while 'Other Livestock' includes pigs, poultry, goats, and other animals not listed elsewhere.

Goats were recorded under 'Other Livestock', with 'and manufacturing' added where farmers are producing Dairy products from goat milk.

Horticulture is a multi-faceted industry with many types of plant products, so this group comprised the most sub-sectors. Sub-sectors for Horticulture were defined by produce type and groupings for example, Tree Nuts.

Based on feedback from the Agriculture Victoria Horticulture team, viticulture was divided into growing wine grapes or table grapes and identifying which farms also have a winery or '& other' horticulture enterprise. Wineries not growing their own vineyards are classified as 'Other Production' for sector and 'Wine & Other Alcoholic Beverage Manufacturing' for the sub-sector.

Potato growing was unique as it appears under Vegetables (sub-sector) in Horticulture (sector), when grown alone or with other horticulture crops. However, potatoes also exist as one of the crops grown in 'Livestock & Crops'. There were several farms around the Ballarat area with mixed enterprises that involved growing potatoes as well as sheep, beef cattle and/or cereal and fodder crops.

The 'Crops' sector are cropping farms typically growing grains (cereal crops), legumes, canola and/or fodder. The 'Livestock & Crops' sector includes meat and/or wool enterprises that also grow some type(s) of crops. A few unique mixes exist such beef cattle and a vineyard.

'Other Production' includes onshore aquaculture, agricultural wholesaling and the manufacture of oils, fats and alcoholic beverages where the raw ingredients are sourced and not grown.

The complete list of sectors and sub-sectors is shown in Appendix 1.

Assessments and Grants

Some assessments involved multiple farms combined in a single report, therefore conclusions are made per business rather than per farm. As not all applications were analysed, we cannot report how often this occurred, but it did not seem to be a large portion from what we observed. However, where there were multiple grants applied for the same business, these were combined into one, as they represent the same opportunities implemented at different times.

The assessor's recommendations and estimates of the potential energy strategies were then categorised as follows:

- Opportunity description
- Opportunity type, for example, solar,
- Opportunity category for broader grouping of related recommendations
- Estimates of the implementation costs of each opportunity (\$ required to invest)
- Potential savings in energy use (GJ/year),
- Energy cost savings (\$/year)
- Co-benefits value (\$/year), if relevant
- Payback
Simple payback only, not a discounted payback. See the Payback section for more details
- Emission savings (tCO₂/year)

Although often provided by the assessors, this was standardised with our selected formula applied to the assessors estimate of the reduction in energy use, in GJ/year per energy source (electricity, diesel etc.)

The following terms and measures were used from the assessment reports:

- Energy Costs (\$/year)
This is the actual annual spend on energy. Tables and charts showing total energy costs refer to the collective totals for a sector or sub-sector. Averages for an individual business are reported as Energy Cost per business.
- Potential Costs Savings (\$/year)
This refers to the estimates made of the potential savings on energy costs that may result from implementing the recommendations. Again, totals refer to collective group totals, and average per business refers to the average potential saving for an individual business.
- Implementation Cost (\$)
These are estimates of the required investment to implement the recommendations provided in the assessments.
- Potential Emission Savings (tCO₂/year)
This is the potential savings in greenhouse gas (GHG) emissions, calculated as a reduction in tonnes of carbon dioxide produced per year (tCO₂/year), that is estimated to result from adopting the recommendations provided in the assessments.

Analyses of the database information were conducted in Excel using pivot tables and general analyses across multiple worksheets.

Classification of Opportunities

Opportunities were itemised in the recommendations and identified as to which were adopted via the grants. These itemised opportunities or energy solutions were classified into 20 categories, listed with examples in Appendix 2.

Farm improvements that were not energy related and therefore not eligible for grants were excluded. As were options that were investigated by an assessor but deemed unviable or not a good investment.

Calculations

Annual savings in greenhouse gas emissions was calculated from energy savings GJ/year as:

$$\text{Tonnes CO2 equivalent savings (tCO2)} = \text{Electricity savings (GJ)} \times 0.272 + \text{Gas savings (GJ)} \times 0.0514 + \text{LPG savings (GJ)} \times 0.0602 + \text{Diesel savings (GJ)} \times 0.0699$$

Source: Australian National Greenhouse Accounts October 2020

The values for gas, LPG and diesel are already expressed in GJ in the Australian National Greenhouse Accounts (on page 16) and converted to tonnes from kg by dividing by 1,000.

The equivalent Emission Factor (EF) for electricity in kWh is 0.98, as the latest estimate available in October 2020 for electricity purchased from the grid in Victoria (on page 19).

The formula is adjusted to convert from kWh to GJ (1kW = 0.0036 GJ) and kg CO2 equivalent to tonnes, that is, $0.98/0.0036/1,000 = 0.272$

For example:

100,000 kWh of electricity $\times 0.98$ (EF)/1,000 = 98 tonnes CO2 equivalent

Same as

360 GJ of electricity $\times 0.272$ (EF) = 98 tonnes CO2 equivalent

A 'Simple Payback' estimate was calculated as implementation cost divided by estimated financial benefits. In some businesses, co-benefits such as productivity improvements or labour savings were noted.

No interviews or additional details were collected of actual savings or economic case studies for this report.

Results

This data mine is focused on the results from ‘Round 1’, also referred to as the AEIP 2018 program.

There were 680 assessments randomly selected and analysed from the 794 free on-farm energy assessments completed in ‘Round 1’ of the AEIP program, which ran from May 2018 – December 2020. From this group there were 320 businesses identified that progressed to receiving grants and these were analysed for the actions chosen to be implemented.

As the program was extended, there were additional assessments and grants completed following these analyses (Table 1). This raises potential for extended adoption of opportunities recommended in Round 1, in addition to this report.

Table 1. Number of assessments and grants

	Round 1	Round 2	Total
No. of free on-farm energy assessments completed	794	575	1369
No. of assessments analysed	680		
No. of grants	480	171	651
No. of grant analysed	320		

Farming sectors in energy assessments and energy costs

The largest group of participants in farm assessments were Dairy farmers at 48% followed by Horticulture growers at 29% (Table 2, Fig 1). ‘Other Livestock’ was dominated by Poultry farms, followed by Pig farms.

Note the assessments analysed represent 85% of all the assessments completed, yet the results indicate that Dairy and Poultry had the greatest representation for their sector, with at least 10% of their farms in Victoria participating in these assessments, followed by Horticulture with at least 6% (Table 2).

Participation by cropping and livestock farmers (Crops, Meat & Wool, Livestock & Crops) was comparatively low (Table 2). Whether this was due to lack of awareness of the AEIP program or perceived lack of opportunities for energy improvements, or both, is unknown. However, with targeted extension for Round 2 of the AEIP program, preliminary analyses indicate greater engagement by crop growers.

The complete list of sectors and sub-sectors is shown in Appendix 1.

While Dairy represented the largest group of participants, the Horticulture growers represented the greatest total energy costs and potential for savings (Fig 2, Table 3). This is due to a combination of moderate participation and relatively high energy costs.

On average, Other Production had the highest energy cost per business. This was not surprising as this category consists of businesses with manufacturing processes. For the traditional farming sectors, Other Livestock had the highest energy costs per business, followed by Horticulture and Crops (Fig 3, Table 4). For Horticulture participants, energy costs seemed to be driven by irrigation and cool rooms according to their descriptions in the assessments and also reported in the behavioural research.

Table 2. Number of businesses assessed per sector, from Round 1 AEIP program

	No. of farm energy assessments analysed	No. farms in Victoria*	% of Victorian farms*
Crops	38	5,900	1.3%**
Dairy	326	3,088	10.6%*
Horticulture	188	2,850	6.6%
Livestock & Crops	39		
Meat & Wool	36	18,600	0.4%**
Other Livestock	37		
• Pigs	7	341	2%
• Poultry	24	234	10.3%
Other Production	16		
TOTAL	680		

* Data from Dairy food Safety Victoria Annual Report 2020-21, Agriculture Victoria Industry Fast Facts.
 **The numbers for Livestock & Crops were included with Crops, as well as Meat & Wool, for calculating % of Victorian farms

Fig 1. Participants by Sector in farm energy assessments

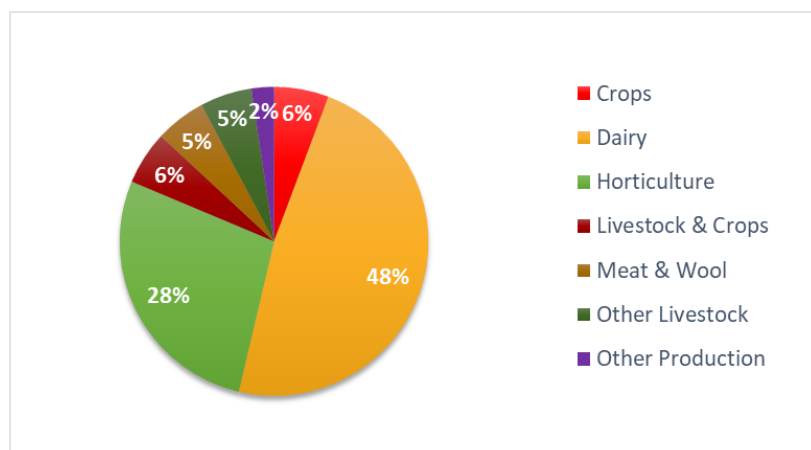


Fig 2. Total energy costs per sector from assessments

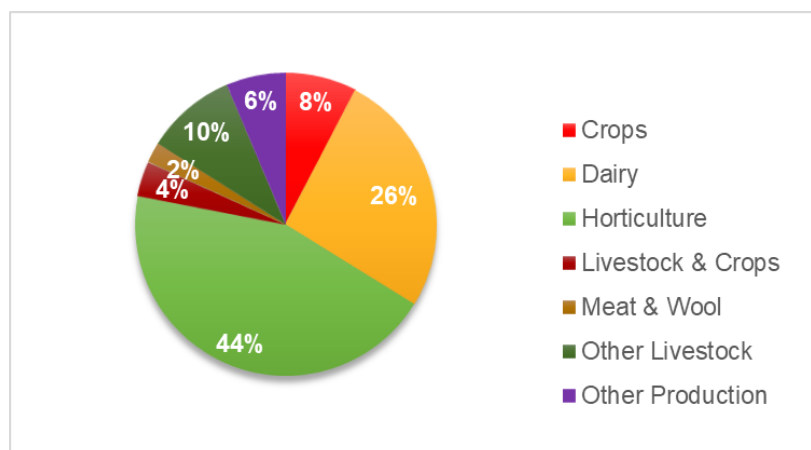
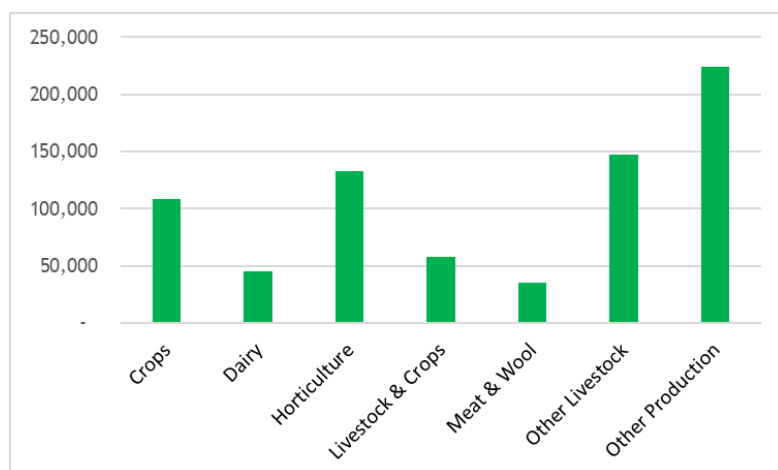


Fig 3. Average annual energy costs (\$/year) per sector.



* Other Livestock comprised mainly poultry and pig farms

Table 3. Total sector energy costs and potential savings for the 680 assessments

	Total Energy Cost (\$/yr)	Potential		
		Total Energy Cost Savings (\$/yr)	Total Energy Savings (GJ/yr)	Total Emissions Savings (tCO2/yr)
Crops	4,113,342	1,250,745	32,265	4,700
Dairy	14,726,977	6,062,508	107,910	26,215
Horticulture	24,901,253	10,580,567	340,311	46,383
Livestock & Crops	2,267,703	865,755	21,974	2,450
Meat & Wool	1,250,102	679,204	16,904	2,330
Other Livestock	5,432,459	2,103,344	52,574	6,793
Other Production	3,579,999	1,755,643	55,109	12,414
Total	56,271,835	23,297,766	627,046	101,285

Table 4. Average energy cost and potential savings per participant (per business)

	Average Energy Cost (\$/yr)	Potential		
		Average Energy Cost Savings (\$/yr)	Average Energy Savings (GJ/yr)	Average Emissions Savings (tCO2/y)
Crops	108,246	32,914	849	124
Dairy	45,175	18,597	331	80
Horticulture	132,453	56,280	1,810	247
Livestock & Crops	58,146	22,199	563	63
Meat & Wool	34,725	18,867	470	65
Other Livestock	146,823	56,847	1,421	184
Other Production	223,750	109,728	3,444	776
Total	82,753	34,261	922	149

The spread of total energy costs within sectors was greatest for Other Production and Horticulture. This is demonstrated by the standard deviation for these sectors, which represents how much the data varied from the average. The higher the standard deviation, the greater the spread of results. (Appendix 2)

All sectors showed a skew towards businesses with high energy costs, having outliers with high costs, but more so for Horticulture with several operations having energy costs in excess of \$500,000. Remember that some businesses only provided a combined total cost for multiple farms in their assessments.

The Meat & Wool group show the lowest annual energy costs and the narrowest spread (Appendix 2). Dairy also shows a tight distribution of energy costs for most of their participants but with more outliers than the Meat & Wool group.

Sources of energy

Cropping and grazing sectors (Crops, Meat & Wool, Livestock & Crops) rely on diesel for over 50% of their energy use and costs (Fig 4 & 5). Barriers to diesel alternatives might influence their lower participation, such as lack of confidence in diesel alternatives or lack of interest in upgrading machinery until end of life of the equipment. It is interesting to note that the electricity costs for cropping and Dairy were similar although Dairy farmers seemed more aware and likely to undertake energy audits.

Over 30% of LPG is used by Other Livestock. Gas or LPG are used in Horticulture and Other Production. The proportion of energy sources below are on an annual basis, no seasonal data is available.

Fig 4. Average costs per energy source, for each sector

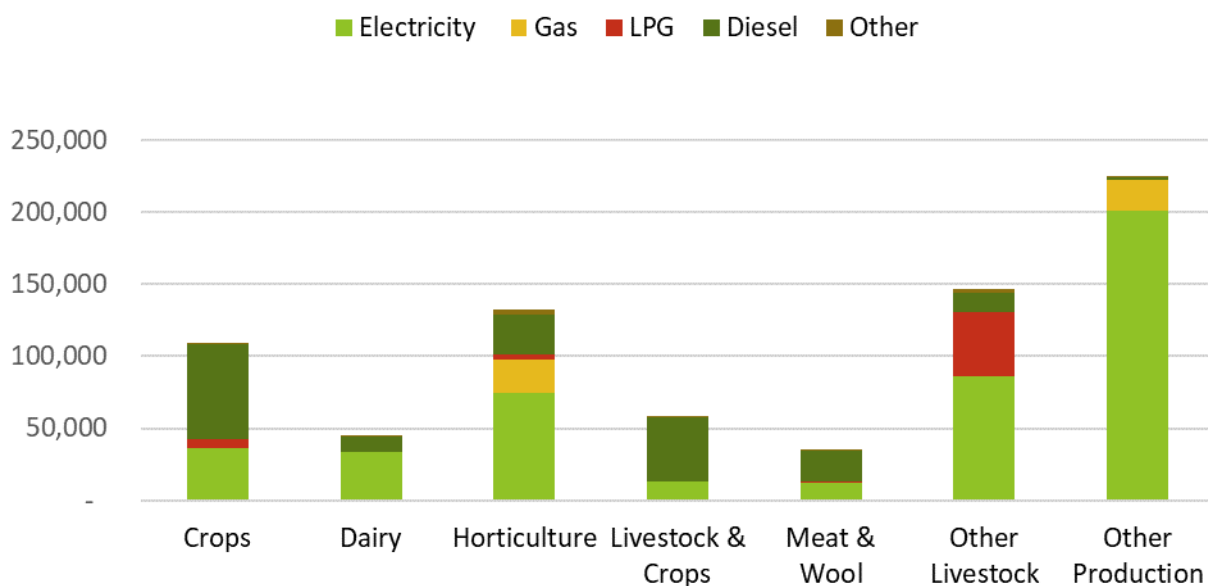
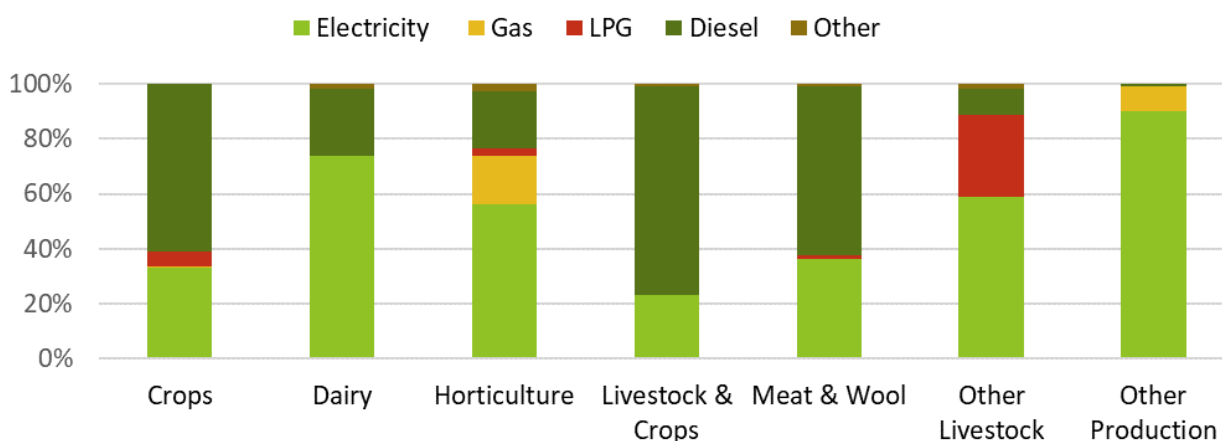


Fig 5. Percentage of costs by energy source for each sector



Locations

Farmers from Northern Victoria dominated the assessments (Table 5). Anecdotally, there was possibly more promotion or word of mouth in northern Victoria. For example, the dairy irrigation team promoted the AEIP program in their irrigation events and seminars in this region. The popularity of solar solutions and greater solar radiation in northern Victoria is another potential influence.

Dairy farms were spread through the typical regions of Barwon South-West, Gippsland, and Northern Victoria. Horticulture growers were mostly from Northern Victoria, but they were also the largest sector in the Metro area.

Metro businesses include Horticulture, Other Livestock, and Other Production. This area includes Werribee, the Dandenong Ranges, Yarra Valley and the Mornington Peninsula where boutique ‘farmhouse’ type businesses exist that like to market their products as environmentally friendly, or possibly perceive a greater need to reduce their environmental impact to appease urban neighbours. Additionally, Metro farmers are likely to have better access to suppliers and services.

Table 5. Region by sector participation in the farm assessments analysed

	Barwon South-West	Gippsland	Grampians	Northern Victoria	Metro	Total
Crops		1	6	30	1	38
Dairy	82	106	4	129	5	326
Horticulture	5	12	12	129	30	188
Livestock & Crops	4	0	23	12	0	39
Meat & Wool	7	10	4	15	0	36
Other Livestock	3	2	5	13	14	37
Other Production	3	0	3	7	3	16
Total	104	131	57	335	53	680

Northern Vic region is Loddon-Mallee plus Hume LGA

Opportunities from the assessments

The most common opportunities across sectors were (Fig 6 a to g, Appendix 4 and 5):

- 1 Solar PV <50 kW
- 2 Variable speed drives
- 3 Upgrade, more efficient equipment
- 4 System Reconfiguration
- 5 Lighting
- 6 Maintenance & low-cost repairs
- 7 Heat Recovery
- 8 Tariff Management
- 9 Timers/Operational controls
- 10 Upgrade to different technology

Solar items were reflected through 962 opportunities and were broken down into four categories (Table 6).

The category 'Solar, other' includes solar pumps and thermal solar.

Solar PV< 50kW was the most popular opportunity across all sectors (Appendix 4, Fig 6a to g).

Other renewable energies (Renewables, non-solar) were not popular, except in Other Production (Fig 6g) plus a few recommendations in Other Livestock (Fig 6c) and Horticulture (Fig 6b).

Dairy and Horticulture shared the same top three opportunities: Solar PV<50kW, Variable speed drives and Upgrade to more efficient equipment, but differed after this. Heat Recovery appeared in Dairy's top five recommendations (Fig 6a), while Timers/Operational controls and Insulation were rated more highly by the assessors for Horticulture (Fig 6b).

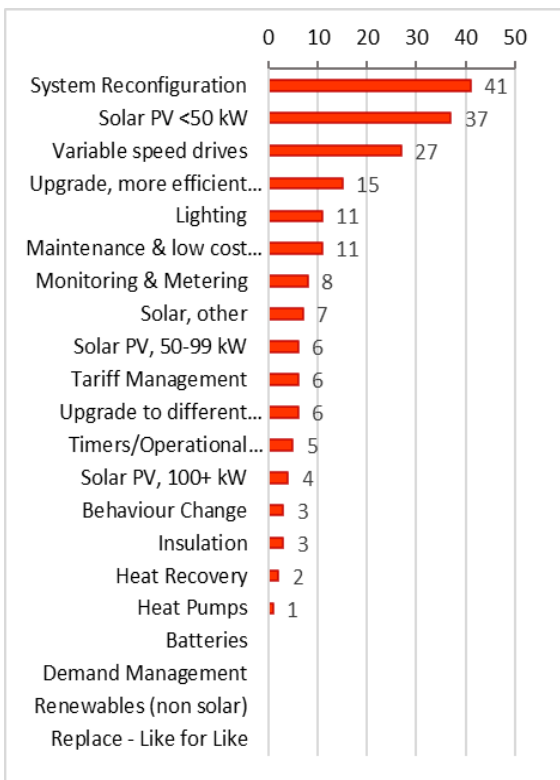
System reconfiguration was in the top three recommendations for the cropping and grazing sectors (Fig 6c to f).

Table 6. Solar opportunities

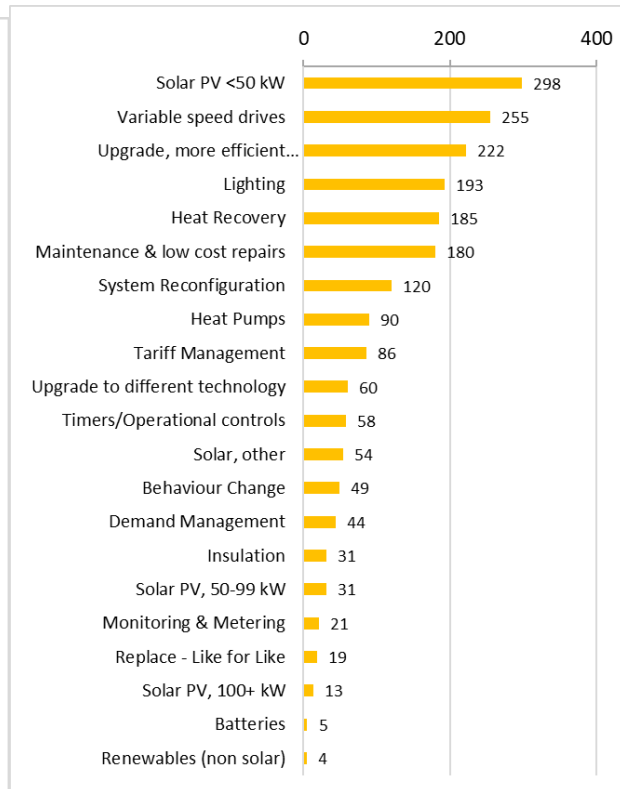
Solar Category	No. of opportunities
Solar PV <50 kW	631
Solar PV, 50-99 kW	93
Solar PV, 100+ kW	77
Solar, other	125
Total	962

Fig 6. Most recommended to least recommended opportunities in assessments, by sector.
The following bar charts show the number of times the category items were recommended in the assessments analysed.

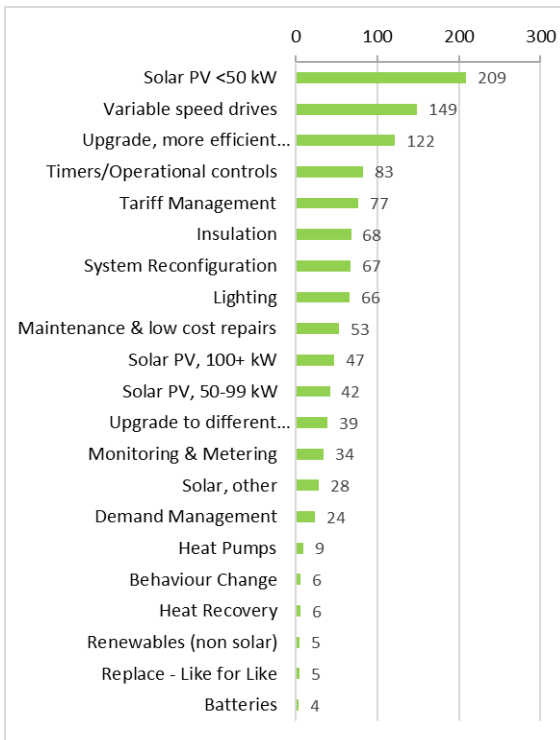
a) Crops



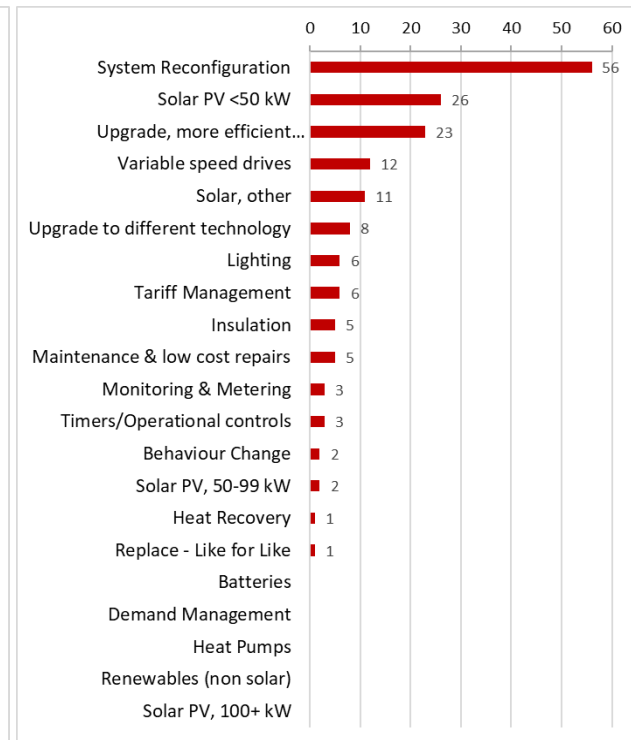
b) Dairy



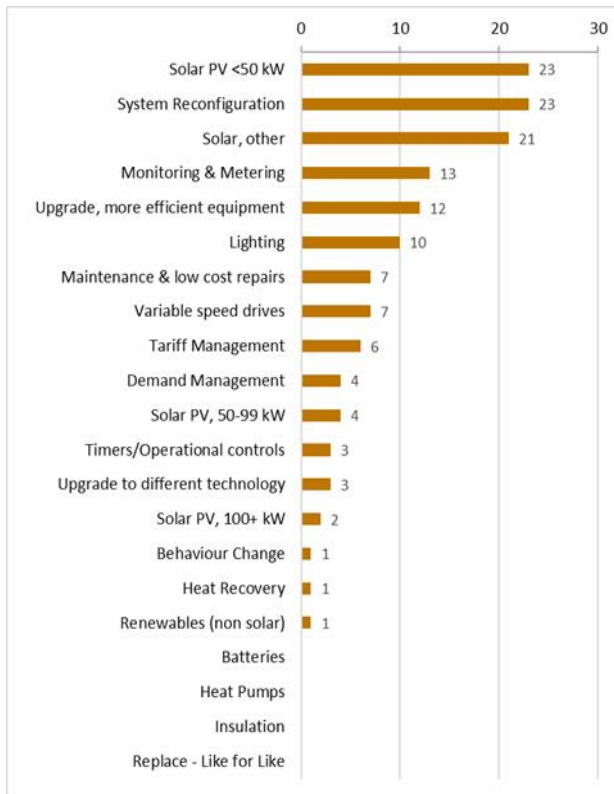
c) Horticulture



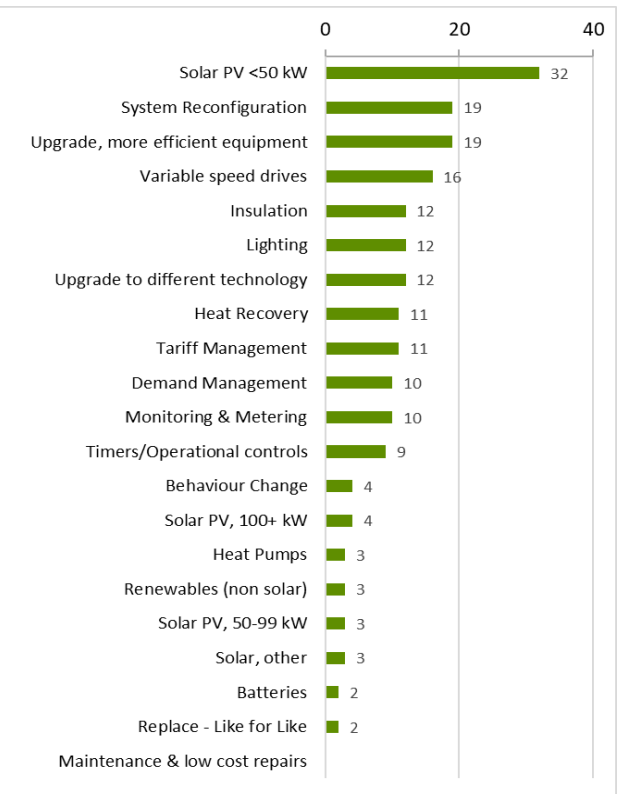
d) Crops & Livestock



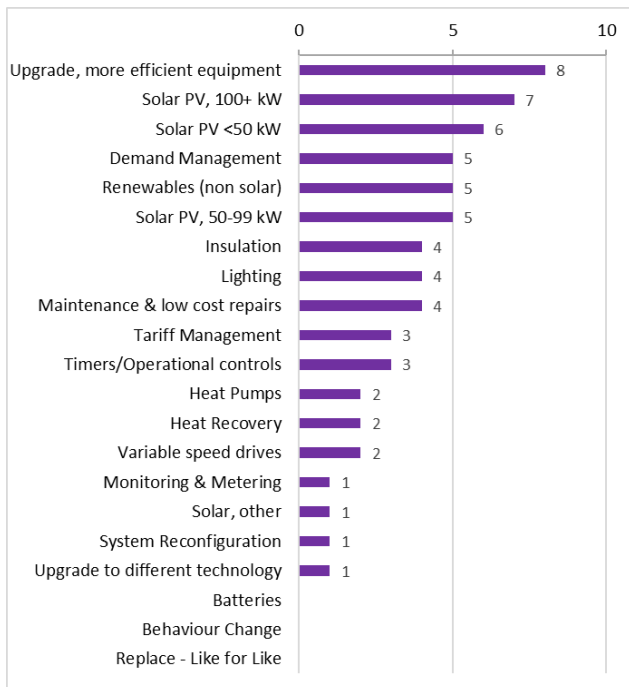
e) Meat & Wool



f) Other Livestock



g) Other Production



Farmer adoption through the AEIP grants

The 320 grant holders analysed showed a similar distribution of sectors as in the assessments (Fig 1), with slightly increased representation in the grants by Horticulture and Crop growers (Fig 7).

Not surprisingly the recommendations that were adopted the most generally followed the pattern of what was recommended the most, since one of the conditions of the grants program was that farmers could only nominate energy upgrades that were listed in their assessments.

Hence, all solar solutions topped the list (Fig 8). Even when considering the adoption rate, that is number of times adopted divided by number of times recommended, there was still a strong preference by farmers for solar energy, particularly the larger photovoltaic units (Appendix 6). Reading through applications, some farmers adopted larger photovoltaic systems than recommended, including funding any difference in costs for themselves, usually citing future growth as the reason.

Variable speed drives, upgrading to more efficient equipment and system reconfiguration followed solar in popularity.

Items with a moderate number of recommendations but relatively poor adoption rates included heat pumps, heat recovery, timers or operational controls and insulation.

Feedback from dairy field reps suggest that bad experiences reported with heat pumps in dairies has resulted in hesitation among farmers. A recent installation of a heat pump at the Ellinbank SmartFarm proved that the customisation required to install heat pumps into a dairy can indeed be challenging.

For timers or operational controls there are two possible reasons, one being that some simple timers and controls are low cost and potentially adopted outside of the grants. The other reason being they probably did not rate as highly for the farmer as did other recommendations.

The grants seemed to capture moderate to high-cost capital items only. Adoption of low-cost actions while likely, were not requested through the grants. Some farmers wrote about making these smaller changes themselves and quickly, rather than through the grant process. Therefore, the adoption of actions under behaviour change, lighting, maintenance and low-cost repairs and tariff management are largely unknown and not reported.

Fig 7. Distribution of the 320 grant holders by sector

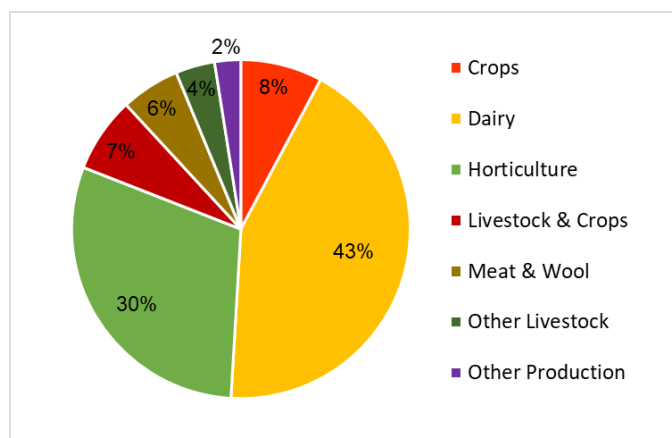
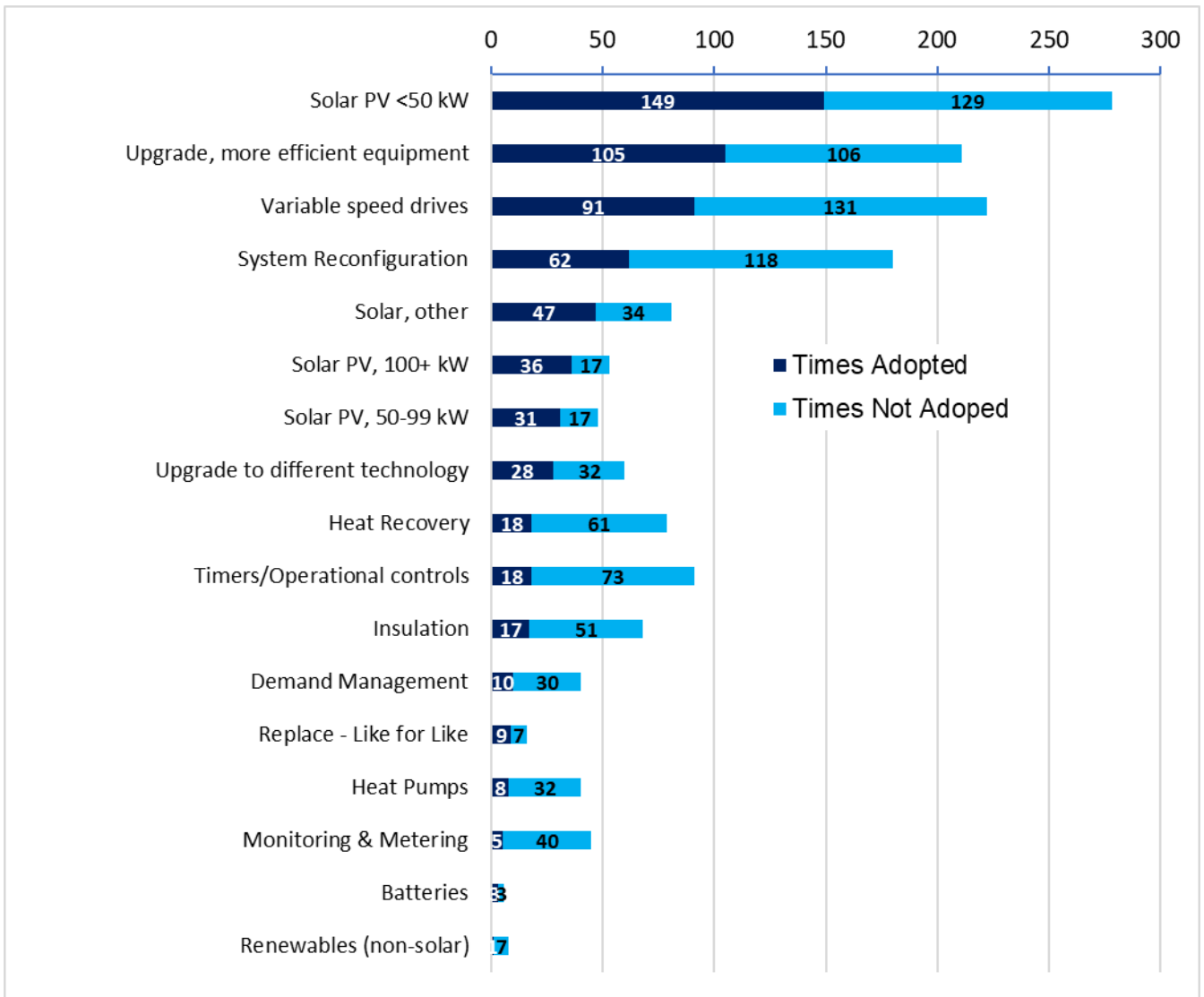


Fig 8. Number of times that recommendations were adopted in grants versus not adopted.

In order from the most adopted actions to the least. The two bars together extend to show the total number of recommendations for each category, for example solar PV V < 50kW was recommended 278 times to the 320 grant holders.



Excludes Behaviour Change, Lighting, Tariff Management, Maintenance & low-cost repairs due to lack of capital costs.

Adoption trends by sector

It is interesting that the sectors which seemed to participate the least in the free on-farm assessments had the highest adoption rates overall in the grants process, that being the crop growers and the meat and wool farmers (Table 7). Potentially the smaller numbers that did participate from these sectors were more committed to making changes, or perhaps the dairy and horticulture sectors had more people that were not yet ready to implement changes simply due to a greater population of farmers involved.

Table 7. Number of actions recommended and adopted for the 320 grant holders.

Excludes categories of zero or low cost, i.e., behaviour change, lighting, maintenance and low-cost repairs, and tariff management.

	No. of actions adopted	No. of actions not adopted	Total no. of recommendations	Adoption Rate, %
Crops	54	56	110	49%
Dairy	271	388	659	41%
Horticulture	213	289	502	42%
Livestock & Crops	36	59	95	38%
Meat & Wool	31	35	66	47%
Other Livestock	23	43	66	35%
Other Production	10	18	28	36%

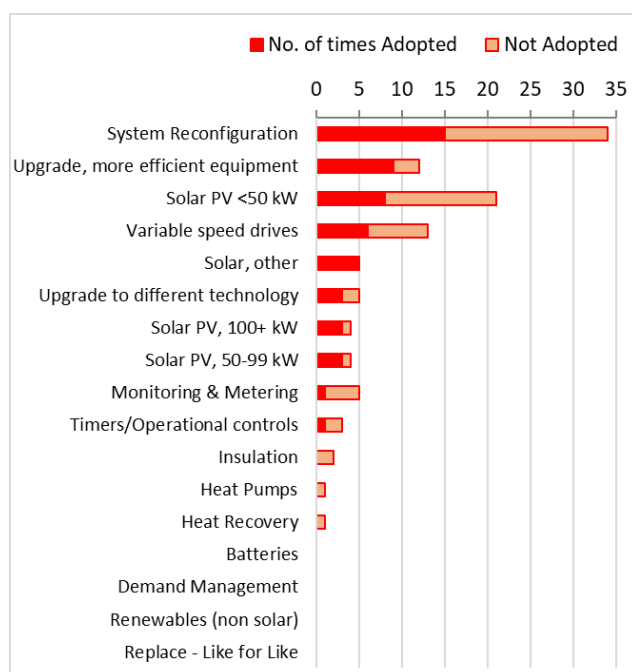
The adoption of specific categories by each sector is presented below in Fig 9a to 9g.

Fig 9. Number of times that recommendations were adopted versus not adopted, by sector.

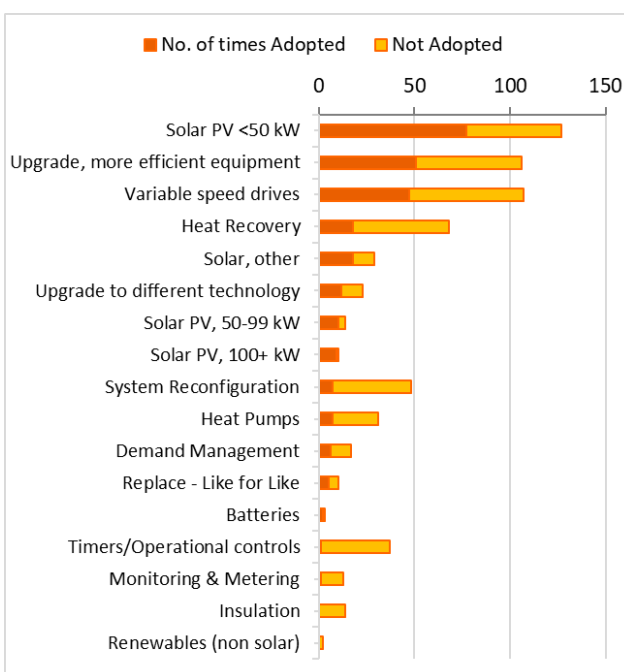
In order of the categories that were adopted the most times to the least times.

The dark bars show the number of times adopted, while the light bars show the number of times recommended but not adopted. The two together extend to the total number of times that category was recommended to the grant holders.

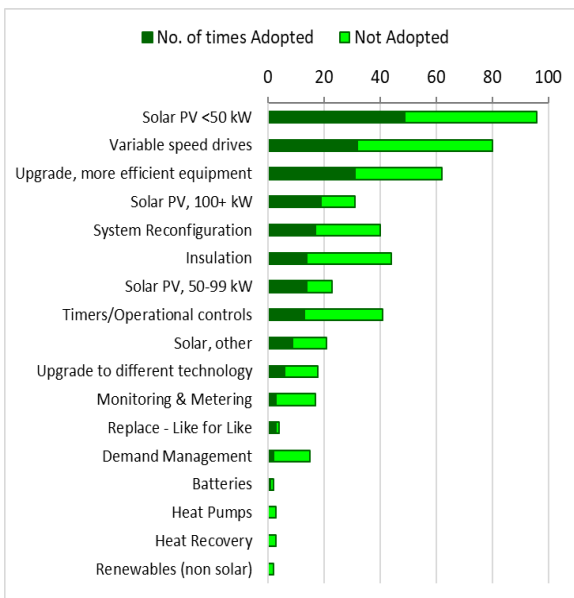
a) Crops



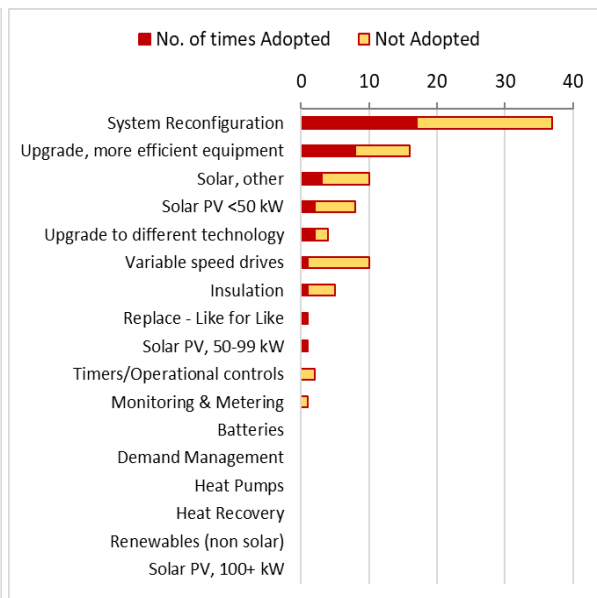
b) Dairy



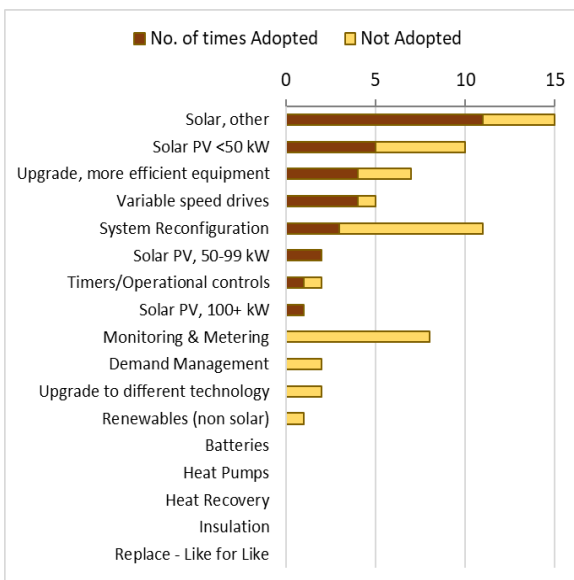
c) Horticulture



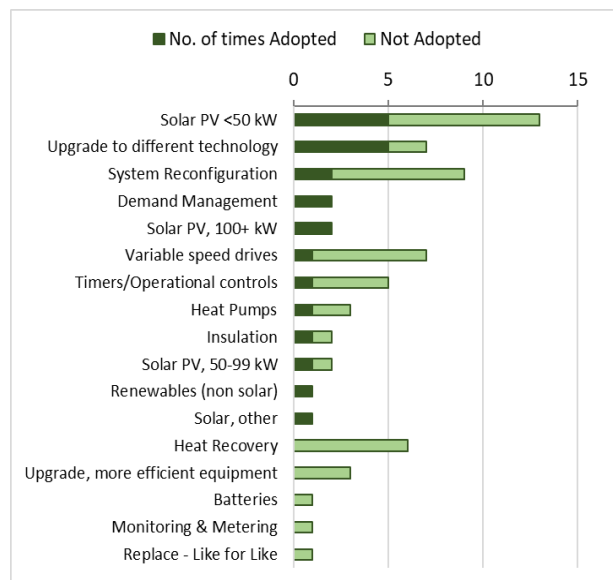
d) Livestock & Crops



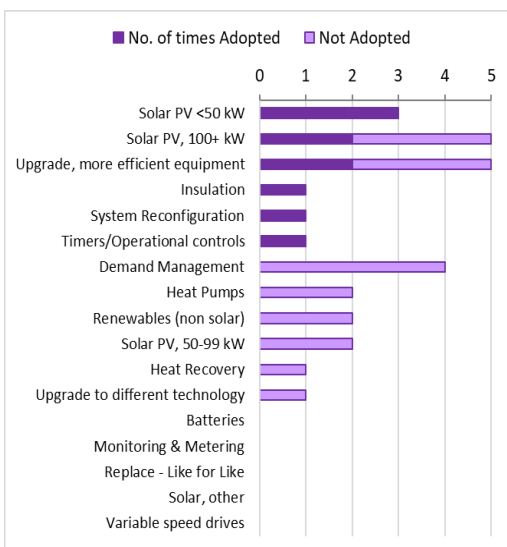
e) Meat & Wool



f) Other Livestock (pigs, poultry, goats, other)



g) Other Production (aquaculture, oils & fat manufacturing, alcoholic beverage manufacturing)



Adoption trends by region

The Metro grant holders adopted the most of their recommendations and were the greatest adopters of solar energy. The Metro area includes Werribee, the Dandenong Ranges, Yarra Valley and the Mornington Peninsula. Barwon South-West farmers had the lowest adoption rates, whether low-cost categories were excluded or not (Table 8). Metro farmers are likely to have better access to new technologies and services, or possibly motivated by other influences.

In regional Victoria, solar energy solutions were popular in North Victoria and Gippsland. Upgrading to more efficient equipment was popular throughout all of regional Victoria. Heat recovery had better uptake in Barwon South-West (Fig 10a to 10e).

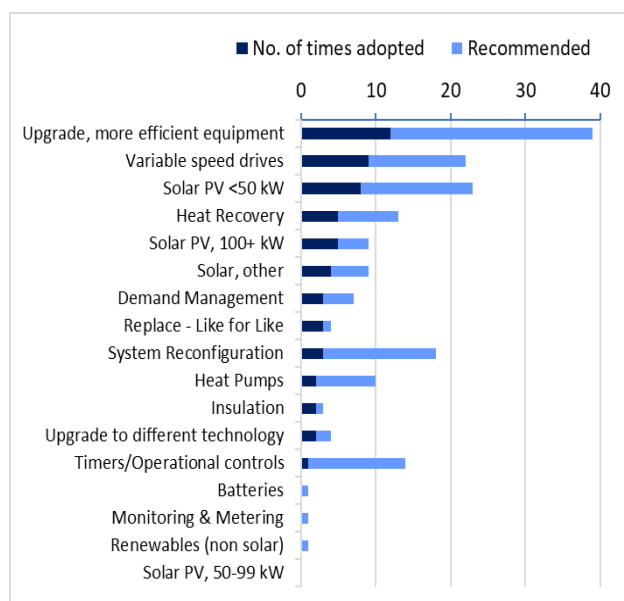
Table 8. Number of recommendations and adopted actions for 320 grant holders, by region

	Barwon South-West	Gippsland	North Victoria	Grampians	Metro	Total
All categories						
No. of recommendations	241	369	988	173	116	1887
No. adopted	62	125	380	61	46	674
% Adopted	26%	34%	38%	35%	40%	36%
Excluding low-cost categories						
No. of recommendations	119	291	803	157	97	1526
No. adopted	59	117	358	60	44	638
% Adopted	33%	40%	45%	38%	45%	42%
Total solar categories						
No. of recommendations	41	95	252	47	25	460
No. adopted	17	56	154	17	19	263
% Adopted	41%	59%	61%	36%	76%	57%

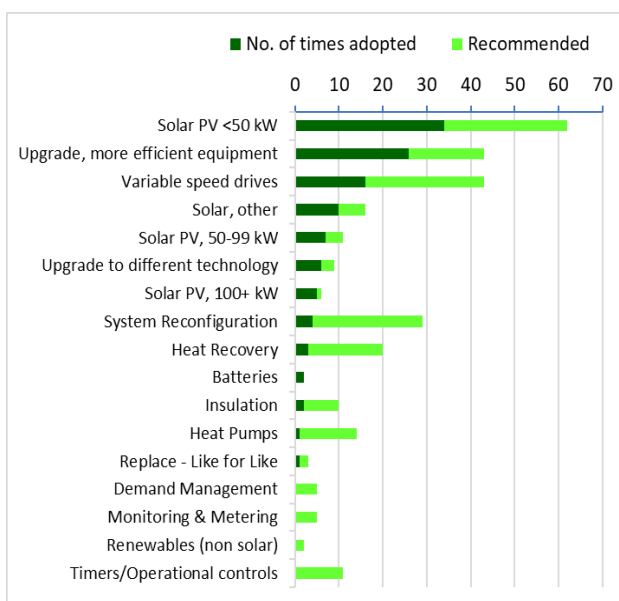
North Victoria region is Loddon-Mallee plus Hume LGA (Local Government Authority)

Fig 10. Adoption trends by region (excluding low-cost items)

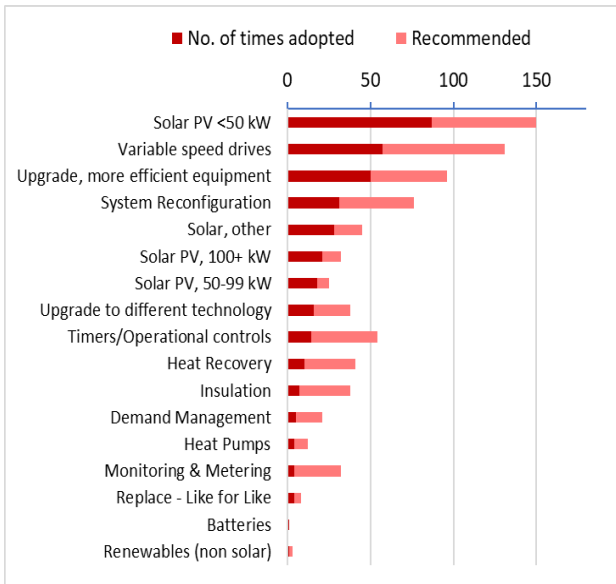
a) Barwon South-West



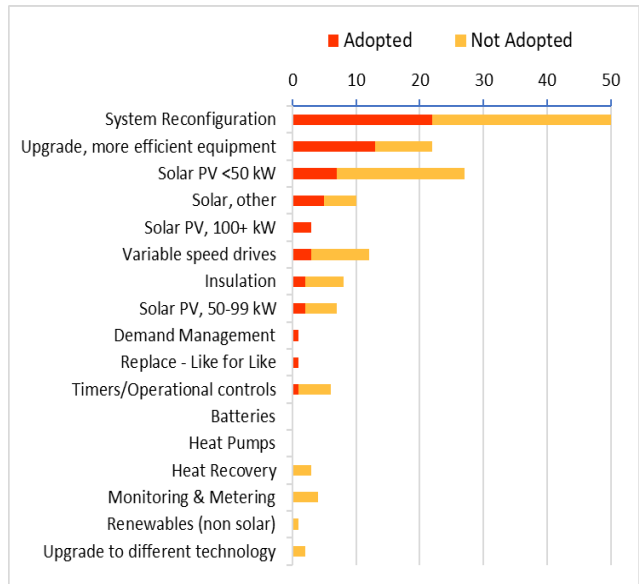
b) Gippsland



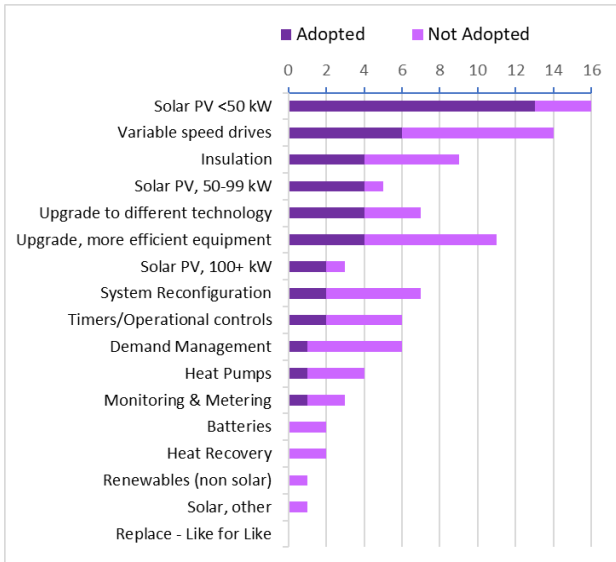
c) North Victoria



d) Grampians



e) Metro



Project costs and savings for adopted actions

The actual project costs for adopted actions was on average overall \$134,171. Projects costs were greater on average for Other Production and Other Livestock owing to intensive farming (pigs and poultry) and manufacturing processes in these sectors (Table 9). Actual expenditure based on the type of adopted action are shown in Appendix 7.

While Dairy had relatively lower costs involved in their upgrades on average, collectively they represented the second greatest total investment, after Horticulture.

In total, the 320 grants analysed represent \$42.9 million invested in farm energy upgrades, with the total program investment being greater than this.

The costs savings for energy were expected to be on average \$19,620 per business with the 320 grant holders expected to total an annual saving of \$6.3 million (Table 10). Note these are well-considered estimates but not confirmed by any measurements or follow up. The estimated energy cost savings based on the type of adopted action are shown in Appendix 8.

Table 9. Actual projects costs (\$) for adopted actions

	Actual Project Costs (\$)	
	Total	Average
Crops	4,066,751	162,670
Dairy	11,285,261	81,777
Horticulture	17,818,545	185,610
Livestock & Crops	3,407,014	148,131
Meat & Wool	1,655,361	91,965
Other Livestock	2,870,378	239,198
Other Production	1,831,472	228,934
Total	42,934,782	134,171

Table 10. Estimated annual energy costs savings (\$/year) for adopted actions.

	Annual estimated energy costs savings for adopted actions (\$/year)	
	Total	Average
Crops	399,703	15,988
Dairy	1,426,249	10,335
Horticulture	3,331,003	34,698
Livestock & Crops	264,430	11,497
Meat & Wool	230,894	12,827
Other Livestock	329,345	27,445
Other Production	296,774	37,097
TOTAL	6,278,398	19,620

Payback and co-benefits

Farm energy assessors provided estimates of savings and a simple payback, that is payback calculated simply as the estimated implementation cost divided by the estimated cost savings. No allowance for annual operating or maintenance costs, or discounting of interest, is included in this. Although rudimentary, simple payback is a common indicator used in energy assessments.

Where actions were adopted, the simple payback estimate was updated with actual costs. Co-benefits, in addition to energy savings, were identified for many businesses, but described in varying levels of detail.

The value of co-benefits were analysed where available for grant holders, being the cases with known adopted actions. Average payback per sector is shown in Table 11, both for energy costs savings only (Simple Payback1) and including the co-benefits where provided (Simple Payback2).

The energy savings (GJ/year) in Table 11 differs from Table 4 as this is the data for 320 grant holders, while Table 4 is based on the initial 680 farm energy assessments.

Table 11. Simple payback, with and without co-benefits, and average energy savings, for the 320 grant holders.

	Simple Payback1 (without co-benefits), years	Simple Payback2 (with co-benefits), years	Average Energy Savings per business (GJ/year)
Crops	> 15	6.3	147
Dairy	6.4	5.5	57
Horticulture	11.0	6.1	434
Livestock & Crops	> 15	6.9	168
Meat & Wool	8.4	5.6	158
Other Livestock	5.8	5.7	248
Other Production	6.9	4.2	1197

Co-benefits had a significant impact on payback in Crops, Horticulture and Other Production. This is because co-benefits were largely associated with insulation and irrigation upgrades. There were also moderate co-benefits with some new technologies and upgrades to more efficient equipment.

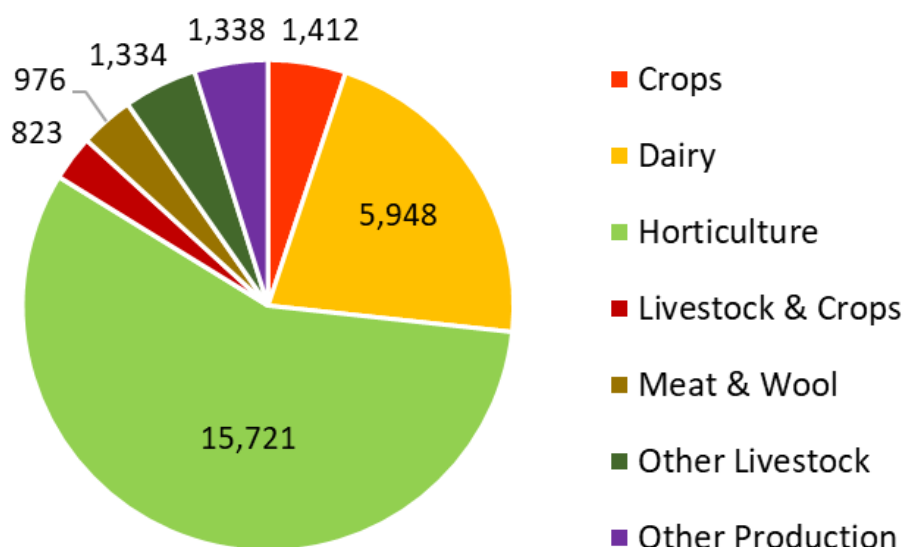
Co-benefits associated with irrigation upgrades include productivity gains and water savings. Other co-benefits included product quality, animal welfare, reduced maintenance costs, reduced use and cost of chemicals and labour savings.

While several investments required co-benefits to have an attractive payback, the energy savings involved were often, but not always, considerable. Co-benefits played a larger role in grant eligibility in Round 2 of the program.

Greenhouse gas emission savings

From the adopted actions of the 320 grant holders in Round 1 of AEIP grants, there is a total estimated 27,552 tonnes of CO₂ equivalents greenhouse gas (GHG) emissions saved per year. This is an average of 86 tonnes per grant holder. Totals by sector are shown in Fig 11.

Fig 11. Greenhouse gas emission savings achieved from grant actions, group totals



The traditional food growing sectors in Round 1 realised 44 - 57%, on average, of potential GHG emission savings (Table 12, Fig 12). 'Other Production' is the exception, capturing only 15% of their potential GHG emission savings through this grant program. We don't know the reasons, whether these businesses encompassed their energy plans into other manufacturing projects and/or business grants.

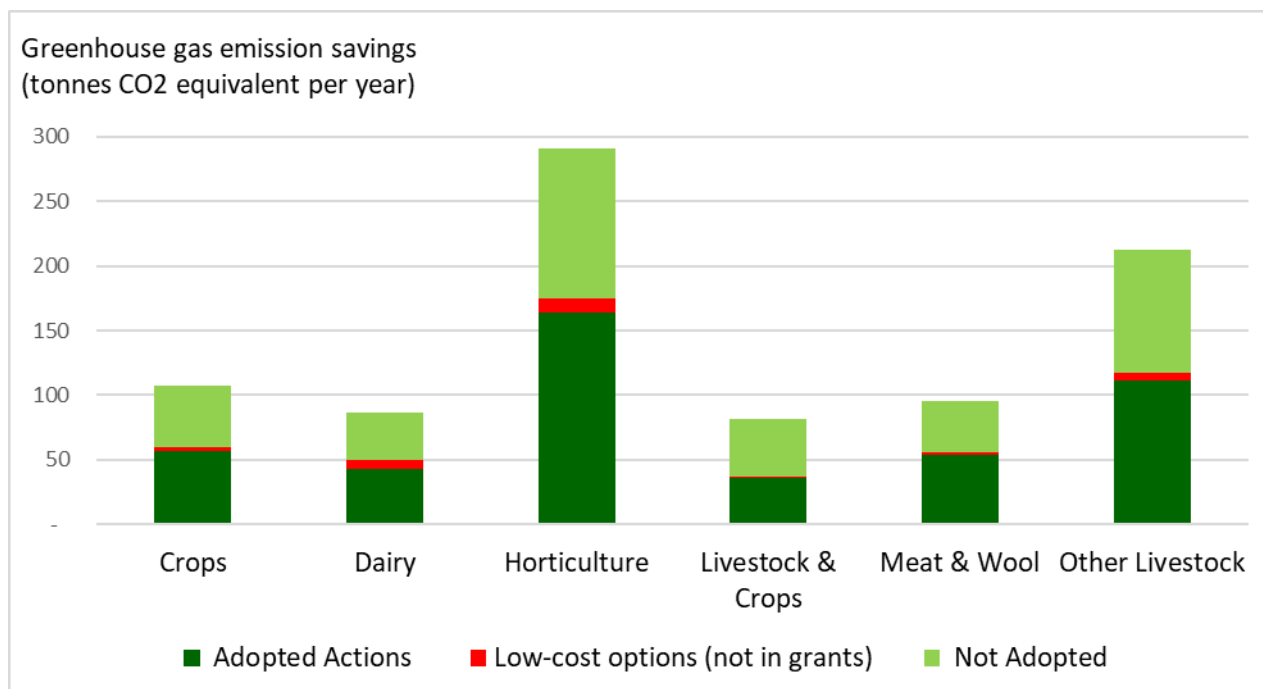
Table 12. Greenhouse gas emissions savings, achieved versus potential, average per grant holder

	Average estimated GHG emission savings (tonnes CO2 equivalent per year) for:					
	Adopted Actions	Not Adopted	1. Low-cost options (not in grants)	2. Other not adopted	Total Potential	% of Potential
Crops	56	51	3	47	107	53%
Dairy	43	44	7	37	87	50%
Horticulture	164	127	11	116	291	56%
Livestock & Crops	36	46	1	45	82	44%
Meat & Wool	54	41	2	39	96	57%
Other Livestock	111	101	6	95	213	52%
Other Production	167	986	3	983	1,153	15%

* Total Potential GHG savings is the sum of estimated GHG emission savings from adopted actions and not adopted actions in grants. The savings from not adopted actions are broken down into (1) low-cost options not captured in grants, and (2) the remaining not adopted actions.

Fig 12. Greenhouse gas emission savings (tonnes CO2 equivalent per year), average per business.

The chart shows the greenhouse gas emissions savings calculated from the adopted actions in grants (in dark green), against the additional potential savings from actions not adopted (in light green). The impact of zero or low-cost options that are not captured in the grants but were possibly adopted by farmers are shown in red. 'Other Production' is excluded from this chart due to data not in same range.



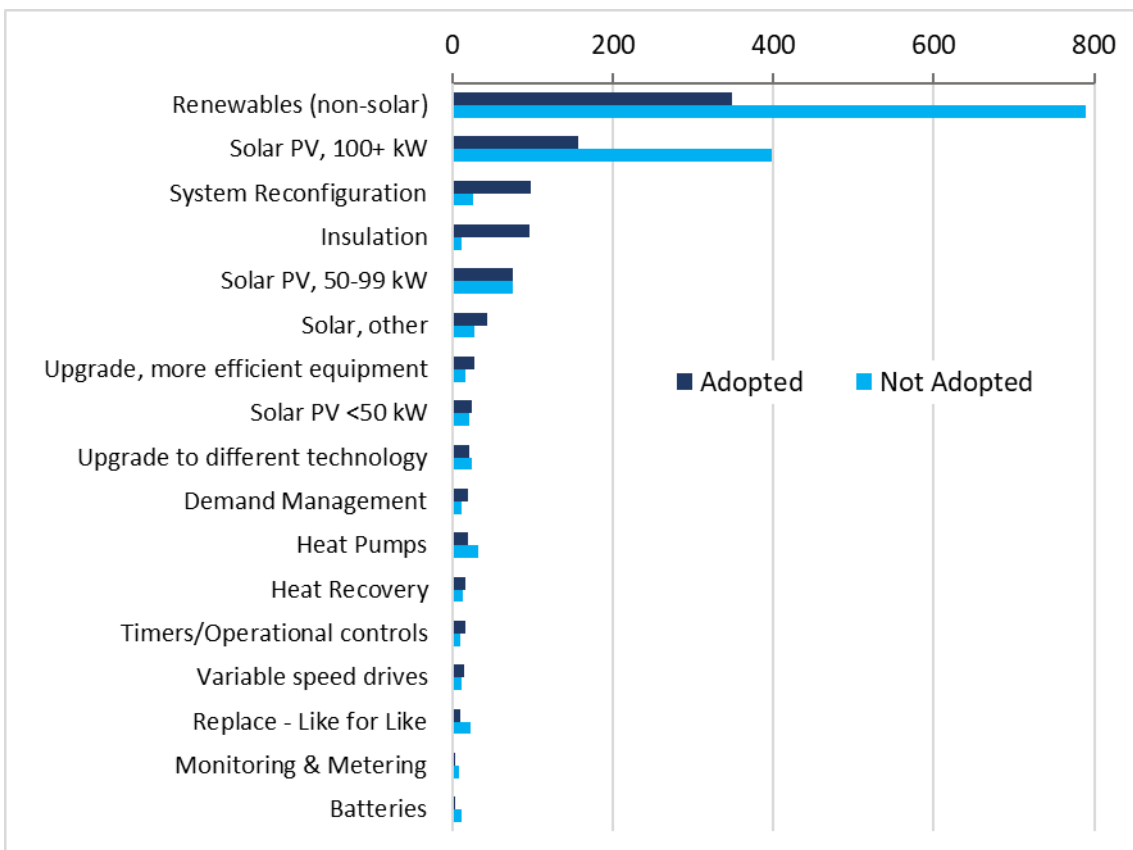
Renewable energies naturally showed the greatest savings in greenhouse gas emissions (Fig 14), whether adopted or not. However, like Solar PV 100+kW, there were larger, and more expensive, projects in these categories not yet realised, as indicated by the larger emission savings of the not adopted items. Renewables (non-solar) included biogas and wind turbines. These suggested technologies were few, innovative and expensive.

For ‘System Reconfiguration’ and ‘Insulation’, the adopted actions had a greater average emission saving than the items not adopted in the same category, suggesting that farmers either proceeded with the larger projects in these categories, or the ones with greater impact.

For ‘Solar, other’ and ‘Upgrade to more energy efficient equipment’, the adopted actions had slightly higher emission savings than the ones not adopted.

For remaining categories, such as ‘Solar PV 50-99kW’, the impact on emission savings was fairly similar between the adopted and not adopted actions within each category.

Fig 13. Average greenhouse gas emission savings (tonnes CO2 equivalent/year) estimated per category, for adopted versus not adopted actions for grant holders. Zero or low-cost options are excluded as these were not captured in the grants (that is, behaviour change, lighting, maintenance and low-cost repairs and tariff management).



Learnings

As a result of these findings, actions were taken, including more promotion to other sectors and changes to grant guidelines, leading to an increase in participation by other sectors such as cropping and livestock in Round 2.

Appendix 1. Number of farm energy assessments analysed, by sector and sub-sectors.

Randomly selected from a total of 794 assessments completed in the 2018 and 2018e program.

Sector	No. of assessments	Sector	No. of assessments
Crops	38	Livestock & Crops	39
Grains	5	Beef Cattle, Crops	5
Grains & other	14	Sheep, Beef Cattle	1
Other Crops	19	Sheep, Beef Cattle, Crops	15
Dairy	326	Sheep, Beef Cattle, Horticulture	2
Dairy	322	Sheep, Crops	14
Dairy & manufacturing	1	Sheep, Crops, Dairy Cattle	1
Dairy & other	3	Sheep, Crops, Pigs	1
Horticulture	188	Meat & Wool	36
Apple & Pear	19	Beef Cattle	11
Berry	3	Sheep	13
Citrus	5	Sheep, Beef Cattle	11
Citrus & avocados	1	Sheep, Pigs & meat sales	1
Floriculture (outdoors)	1	Other Livestock	37
Floriculture (under cover)	5	Camels	1
Forestry	1	Goats & manufacturing	4
Fruit & Vegetable Wholesaling	1	Goats & other	1
Grapes	8	Pigs	7
Grapes & other	2	Poultry (eggs)	4
Grapes (table)	22	Poultry (meat)	20
Grapes (wine & table)	1	Other Production	16
Grapes (wine)	13	Beer Manufacturing	1
Grapes (wine) & winery	10	Oil & Fat Manufacturing	1
Grapes (wine), winery & other	1	Onshore Aquaculture	7
Mixed Fruits	12	Other Agricultural Wholesaling	2
Mushrooms	2	Scientific Testing & Analysis Services	1
Nursery	10	Spirit Manufacturing	1
Olive Growing	1	Wine & Alcoholic Beverages M'facturing	3
Other Fruit	1	Total	680
Packing & storage	2		
Stone Fruit	24		
Tree Nuts	2		
Tree Nuts & Fruit	6		
Turf	1		
Vegetables (outdoors)	25		
Vegetables (under cover)	9		

Appendix 2. Average and standard deviation of annual energy costs (\$/year) per business, by sector and sub-sector. From the 680 assessments analysed. Single farm data are not shown but included in the sector average.

	Annual Energy Costs, \$/year			Annual Energy Costs, \$/year	
	Average	StdDev		Average	StdDev
Crops	108,246	121,166	Livestock & Crops	58,146	48,088
Grains	52,330	34,969	Beef Cattle, Crops	49,140	33,840
Grains & other	142,005	123,741	Sheep, Beef Cattle, Crops	50,925	52,173
Other Crops	98,085	130,323	Sheep, Beef Cattle, Horticulture	33,535	36,148
Dairy	45,175	66,557	Sheep, Crops	66,357	49,018
Dairy only	42,509	53,848	Meat & Wool	34,725	37,935
Dairy & other	342,009	347,318	Beef Cattle	33,371	25,856
Horticulture	132,453	284,168	Sheep	44,581	49,321
Apple & Pear	112,745	130,645	Sheep, Beef Cattle	26,765	34,430
Berry	25,452	7,680	Other Livestock	146,823	252,595
Citrus	96,592	57,280	Goats & manufacturing	216,810	255,802
Floriculture (under cover)	121,251	167,954	Pigs	74,618	56,662
Grapes	22,967	12,091	Poultry (eggs)	494,712	602,427
Grapes & other	284,699	355,002	Poultry (meat)	102,028	140,636
Grapes (table)	78,862	80,873	Other Production	223,750	327,404
Grapes (wine)	65,412	82,296	Onshore Aquaculture	408,195	422,753
Grapes (wine) & winery	54,407	41,892	Other Agric. Product Wh'saling	104,434	133,159
Mixed Fruits	230,167	434,364	Other Alcoholic Bev. M'facturing	38,776	23,515
Mushrooms	268,417	326,975			
Nursery	29,048	26,649			
Packing & storage	87,285	1,577			
Stone Fruit	83,197	86,120			
Tree Nuts	19,805	14,496			
Tree Nuts & Fruit	273,905	281,934			
Vegetables (outdoors)	145,295	211,556			
Vegetables (under cover)	610,397	951,369			

Appendix 3. Location of participants in assessments.

From the 680 assessments analysed.

Sector	No. of assessments
Crops	38
Gippsland	1
Grampians	6
Hume	11
Loddon Mallee	19
Metro - Southern	1
Dairy	326
Barwon South-West	82
Gippsland	106
Grampians	4
Hume	69
Loddon Mallee	60
Metro - Melbourne	1
Metro - Southern	4
Horticulture	188
Barwon South-West	5
Gippsland	12
Grampians	12
Hume	60
Loddon Mallee	69
Metro - Eastern	15
Metro - Southern	13
Metro - Western	2
Livestock & Crops	39
Barwon South-West	4
Grampians	23
Hume	7
Loddon Mallee	5
Meat & Wool	36
Barwon South-West	7
Gippsland	10
Grampians	4
Hume	9
Loddon Mallee	6
Other Livestock	37
Barwon South-West	3
Gippsland	2
Grampians	5
Hume	4
Loddon Mallee	9
Metro - Eastern	1
Metro - Northern	1
Metro - Southern	12
Other Production	16
Barwon South-West	3
Grampians	3
Hume	6
Loddon Mallee	1
Metro - Southern	2
Metro - Western	1
Total	680

Appendix 4. Categories for energy opportunities identified in the on-farm assessments.

In alphabetical order

Category	Description and examples
Batteries	Batteries for storing energy from solar
Behaviour Change	Do things differently. Low-cost options. Examples include turn off lights, use lower water temperature.
Demand Management	Includes changing from 2 to 3 phase power
Heat Pumps	Purchase heat pump(s)
Heat Recovery	Add heat recovery or heat reclaim system.
Insulation	Add insulation, seal gaps etc.
Lighting	Change from halogen, high bay and/or fluorescent lights to LED
Maintenance & low-cost repairs	Includes checking and cleaning equipment, small fixes such as replacing valves. Multiple small items may include check tariff rates as a generic maintenance activity.
Monitoring & Metering	Add monitoring and metering controls.
Renewables (non-solar)	Renewable energies, not including solar. Includes wind turbines, biogas, and hydro systems
Replace – like for like	Replace old equipment with new, but same
Solar (non-PV)	Solar that is not photovoltaic panels for electricity, includes thermal solar and solar pumps.
Solar PV <50 kW	Solar photovoltaics, less than 50 kW
Solar PV < 100 kW	Solar photovoltaics, 50 to 99 kW
Solar PV > 100+kW	Solar photovoltaics, 100 kW or more
System Reconfiguration	Examples include add an icebank, electrify pumps. Install soil moisture monitoring. Change irrigation system, mostly from gun sprayers to laterals.
Tariff Management	Changing activities to off peak. Negotiating or shopping for a better price or supplier
Timers/Operational controls	Any form of automation and adding timers.
Upgrade, to more efficient equipment	Replace old equipment with a new, more efficient model, such as replace a milk vat, plate cooler, water pumps, improved irrigation lines
Upgrade, to new technology	Replace old equipment with new equipment that uses different technology. Includes changing the type of fans, heaters, refrigerant, and compressors. Unique examples include picking platforms.

Appendix 5. Number of opportunities in the 680 on-farm energy assessments.

In order from most to least popular recommendations.

	No of opportunities
Solar PV <50 kW	631
Variable speed drives	468
Upgrade, more efficient equipment	421
System Reconfiguration	327
Lighting	302
Maintenance & low-cost repairs	260
Heat Recovery	208
Tariff Management	195
Timers/Operational controls	164
Upgrade to different technology	129
Solar, other	125
Insulation	123
Heat Pumps	105
Solar PV, 50-99 kW	93
Monitoring & Metering	90
Demand Management	87
Solar PV, 100+ kW	77
Behaviour Change	65
Replace - Like for Like	27
Renewables (non-solar)	18
Batteries	11

Appendix 6. Adoption rates for recommended actions.

Excludes low-cost categories not captured in grants.

a) From most to least adopted action recorded in the grants

	No. of Times Recommended	No. of Times Adopted	Adoption Rate %
Solar PV <50 kW	278	149	54%
Upgrade, more efficient equipment	211	105	50%
Variable speed drives	222	91	41%
System Reconfiguration	180	62	34%
Solar, other	81	47	58%
Solar PV, 100+ kW	53	36	68%
Solar PV, 50-99 kW	48	31	65%
Upgrade to different technology	60	28	47%
Heat Recovery	79	18	23%
Timers/Operational controls	91	18	20%
Insulation	68	17	25%
Demand Management	40	10	25%
Replace - Like for Like	16	9	56%
Heat Pumps	40	8	20%
Monitoring & Metering	45	5	11%
Batteries	6	3	50%
Renewables (non-solar)	8	1	13%

b) In order of highest to lowest adoption rate (%)

	No. of Times Recommended	No. of Times Adopted	Adoption Rate %
Solar PV, 100+ kW	53	36	68%
Solar PV, 50-99 kW	48	31	65%
Solar, other	81	47	58%
Replace - Like for Like	16	9	56%
Solar PV <50 kW	278	149	54%
Batteries	6	3	50%
Upgrade, more efficient equipment	211	105	50%
Upgrade to different technology	60	28	47%
Variable speed drives	222	91	41%
System Reconfiguration	180	62	34%
Insulation	68	17	25%
Demand Management	40	10	25%
Heat Recovery	79	18	23%
Heat Pumps	40	8	20%
Timers/Operational controls	91	18	20%
Renewables (non-solar)	8	1	13%
Monitoring & Metering	45	5	11%
Total for all solar categories	460	263	57%

Appendix 7. Actual total expenditure for grant actions (\$).

Note some expenditures may involve multiple purchases for multiple farms.

	Average Expenditure \$	Std Dev
Batteries	44,323	27,176
Behaviour Change	20,322	2,599
Demand Management	67,663	86,489
Heat Pumps	28,204	17,613
Heat Recovery	22,199	23,235
Insulation	39,573	39,621
Lighting	3,702	2,947
Maintenance & low-cost repairs	10,888	19,251
Monitoring & Metering	22,681	16,801
Replace - Like for Like	16,358	7,179
Solar PV <50 kW	32,798	25,128
Solar PV, 100+ kW	207,980	151,418
Solar PV, 50-99 kW	85,809	28,321
Solar, other	71,135	64,308
System Reconfiguration	152,610	228,416
Timers/Operational controls	48,181	48,078
Upgrade to different technology	65,244	58,934
Upgrade, more efficient equipment	73,397	85,014
Variable speed drives	13,737	13,117

Appendix 8. Estimated annual energy cost savings for adopted actions by category

	Average energy cost savings \$ per year
Batteries	1,232
Behaviour Change	2,656
Demand Management	5,254
Heat Pumps	3,200
Heat Recovery	3,152
Insulation	13,605
Lighting	746
Maintenance & low-cost repairs	1,089
Monitoring & Metering	2,736
Renewables (non-solar)	71,293
Replace - Like for Like	2,570
Solar PV <50 kW	5,929
Solar PV, 100+ kW	30,160
Solar PV, 50-99 kW	18,123
Solar, other	11,305
System Reconfiguration	21,406
Timers/Operational controls	3,976
Upgrade to different technology	5,684
Upgrade, more efficient equipment	8,048
Variable speed drives	3,999
TOTAL	19,620

We acknowledge and respect Victorian Traditional Owners as the original custodians of Victoria's land and waters, their unique ability to care for Country and deep spiritual connection to it.

We honour Elders past and present whose knowledge and wisdom has ensured the continuation of culture and traditional practices.

DEECA is committed to genuinely partnering with Victorian Traditional Owners and Victoria's Aboriginal community to progress their aspirations.



© The State of Victoria Department of Energy, Environment and Climate Action March 2024.

Creative Commons

This work is licensed under a Creative Commons Attribution 4.0 International licence, visit the [Creative Commons website](http://creativecommons.org/licenses/by/4.0/) (<http://creativecommons.org/licenses/by/4.0/>).

You are free to re-use the work under that licence, on the condition that you credit the State of Victoria as author. The licence does not apply to any images, photographs or branding, including the Victorian Coat of Arms, and the Victorian Government and Department logos.

ISBN 978-1-76136-643-7 (pdf/online/MS word)

Disclaimer

This publication may be of assistance to you but the State of Victoria and its employees do not guarantee that the publication is without flaw of any kind or is wholly appropriate for your particular purposes and therefore disclaims all liability for any error, loss or other consequence which may arise from you relying on any information in this publication.

Accessibility

To receive this document in an alternative format, phone the Customer Service Centre on 136 186, email customer.service@delwp.vic.gov.au, or contact National Relay Service on 133 677. Available at [DEECA website](http://www.deeca.vic.gov.au) (www.deeca.vic.gov.au).