Carbon Ready Dairy Demonstration Project

MDF Carbon Emissions Reduction Plan

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Australian Government

Department of Agriculture, Fisheries and Forestry

BACKGROUND

In May 2009 the Macalister Demonstration Farm (MDF) made a successful application to the Department of Agriculture, Fisheries and Forestry under the Farm Ready Program for a project known as the 'Carbon Ready Dairy Demonstration' to identify the source and size of carbon emissions generated by normal operations and then to use this information to develop a Carbon Emissions Reduction Plan. The Plan includes strategies to minimise and offset carbon emissions as well as an analysis of the financial impact of the plan on the farm business. A key to the project is to gather and interpret information in a practical way so that farmers can then make informed decisions about their investment in carbon emissions reduction or offset.

At the time the application was made the proposed Carbon Pollution Reduction Scheme (CPRS) was on the table and that framework guided much of the early work on the project. In December 2009 the Government announced that Agriculture was to be excluded from the Carbon Pollution Reduction Scheme indefinitely. Further announcements in April 2010 deferred the introduction of the CPRS until 2013 at the earliest subject to the legislation passing through the Parliament. As this report is being prepared the Government has announced the introduction of a Carbon Tax to begin in July 2012 to be followed by a trading scheme a few years further on. At this stage there has been no indication of the rate at which the Carbon Tax will be applied nor the detail of the trading scheme. The Carbon Farming Initiative (CFI) is in the Parliament now and sets a framework where farmers can trade emission reductions or emission offsets into both regulated and voluntary markets. At this stage the market is in its infancy and there is uncertainty about the benefits available to farmers.

The government has made it clear that there is an expectation that the agriculture sector will make an equivalent contribution to emission reduction at about the same cost as the other sectors that are included in any trading scheme. This might be in the form of incentives to encourage agricultural businesses to invest in emission reduction technologies or practices or in the form of regulation where the government may make certain actions compulsory.

In the absence of a detailed framework for Australia to reduce its carbon emissions it is very difficult to provide advice on emission reduction measures within the context of the farm business. However, for the purpose of the exercise, this discussion is built on the assumptions included in the proposed CPRS on the basis that the future will include a carbon trading scheme of some kind. Whilst the financial impact on the farm is likely to be different, the application of the concept will be similar.

Like all new policy settings there are risks and opportunities that farmers will need to be aware of. This project attempts to walk farmers through the sort of thinking needed to maximize the benefits and minimise the cost of these changes to build a stronger farm business.

CONTEXT

GLOBAL WARMING

Since the industrial revolution in 1750, carbon dioxide (CO_2) levels have increased by 30%, methane (CH_4) levels by 150% and nitrous oxide (N_2O) levels have risen by 18%. These gases have been identified as key in trapping a layer of warming air around the Earth. Whilst temperature variability has been a normal part of the Earth's history, the decade 1998 - 2007 was the warmest on record and is seen as evidence of the impact of human activity with Victoria 1.2°C warmer than the long term average. Temperature changes have been slow in coming and will take time to turn around. Under global warming we are already committed to a further increase in temperature of 0.6°C by 2030. Even under a low emissions scenario carbon dioxide levels will be at double the 1750 level by 2100 resulting in a 1.8°C increase in temperature relative to the average temperature in 1990. To put this in perspective, during the last Ice Age (20 000- 100 000 years ago) the global average temperature was only 5°C cooler than the current global average of 15°C - at this time Mt Kosciusko was covered in a small ice cap and glaciers covered Tasmania.(Ref 4)

Agriculture and Global Warming in Victoria

Temperature rise will be greatest in spring and summer, there will be more hot days and the hot days will be hotter. The number of frosts will fall and runoff reduced by up to 30%.(Ref 4) There will also be an increase in extreme events - storms, floods and drought.(Ref 1)

Agriculture and Global Warming in Gippsland

By 2030:

- Maximum and minimum temperatures will increase by 0.5-1.4°C;
- Spring will start two weeks earlier;
- Autumn will finish two weeks later;
- Rainfall will decrease by 2% in summer and autumn, 3-4% in winter and 7% in spring.

Negative impacts:

- Greater evaporation and a longer season will stretch demand for water;
- Reduced water runoff means less water security;
- Quality and quantity of feed grains may be reduced but at an increased price;
- Increased temperature may make low productivity tropical grasses and weeds more competitive at the expense of the more nutritious C-3 species like ryegrass, cereals, fescue.

Positive impacts:

- Higher pasture growth rates in winter;
- Summer crops sown earlier to shorten maturity and harvest time;
- Long growing season allows use of drought tolerant perennial pasture species;
- Earlier boost in pasture production following Nitrogen application.(Ref 5)

By adapting to climate change the economic impact for livestock industries can be halved when compared to doing nothing. This can be achieved by adapting the production cycle to better match feed production by altering grazing rotation and modifying grazing times; altering forage and animal species or breed; provide supplementary feeding; and change or improve feed concentrates.(Ref 1) Responding to the challenge of change is what farmers have always done.

NOTE: whether you believe in global warming or not the political momentum is at a point where action will be taken at a national and global scale. Farmers who ignore this new reality run the risk of being left behind and their business viability threatened.

THE KYOTO RULES

Greenhouse Gases

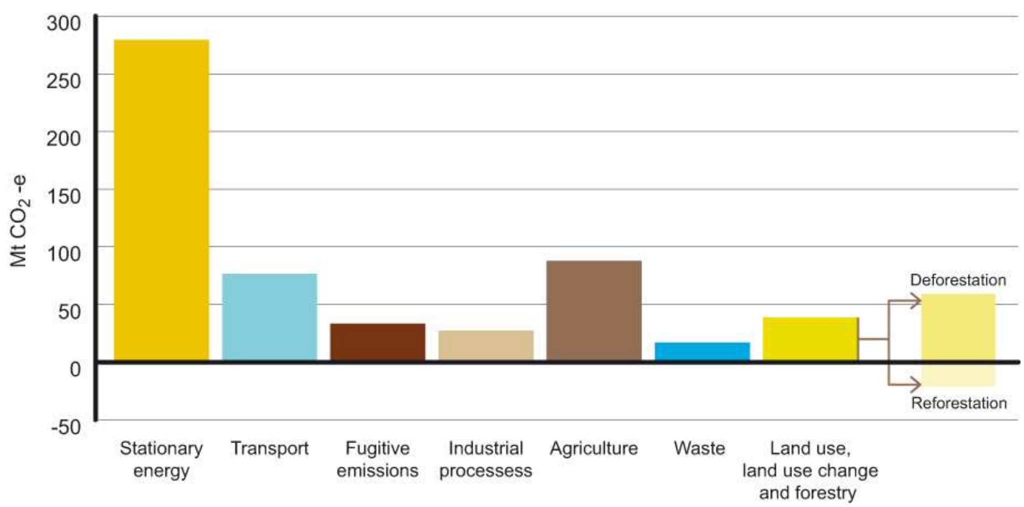
Under the Kyoto rules a number of greenhouse gases are identified:

- Carbon dioxide (CO_2) is produced by the combustion of fossil fuels - power industry, heavy manufacturing, and transport.
- Methane (CH_4) is generated from breakdown of waste in landfills and effluent treatment; from coal mining and ruminant digestion.
- Nitrous oxide (N_2O) is generated by the breakdown of nitrogen fertilizers in the soil.
- Sulphur hexafluoride (SF_6) is generated by the electronics and the power industry.
- Hydrofluorocarbons (HFCs) are generated in industrial processes.
- Perfluorocarbons (PFCs) are generated in industrial processes. (Ref 1)

Carbon emissions are measured in carbon dioxide equivalents (CO_2-eq) with the 'Global Warming Potential' of each gas measured against the impact of carbon dioxide. One tonne of carbon dioxide (CO_2)represents 1 CO_2-eq, one tonne of methane (CH_4) is 21 CO_2-eqs, each unit of nitrous oxide (N_20) is 310 CO_2-eqs. This means that one unit of nitrous oxide is 310 time more powerful at warming the atmosphere than one unit of carbon dioxide. For agriculture, emissions of interest are methane and nitrous oxide; carbon dioxide produced by animals is not included.

Around 80% of global emissions are generated by 15 countries (EU is counted as one country).(Ref 3, p 12-84)

Fig 1. Australia's Emissions Profile 2006 *(Ref 3, p 6-3)*



At 16% of Australia's carbon emissions Agriculture is the second largest source of greenhouse gases behind the burning of fossil fuels (Fig 1). But it is responsible for 60% of Australia's methane emissions and 84% of nitrous oxide emissions.(Ref 1) Livestock are responsible for 70% of agricultural emissions which is equivalent to 11% of total Australian carbon emissions. (Ref 2)

CARBON EMISSIONS AT THE MDF

The calculation of emissions at the MDF has used the Dairy Greenhouse gas Abatement Strategy (DGAS) calculator developed in partnership between Dairy Australia, the Tasmanian Institute of Agricultural Research at the University of Tasmania and the Dept. of Agriculture, Fisheries and Forestry. This calculator is available on the Dairying for Tomorrow website (www.dairyingfortomorrow.com).

The farm data needed to make the calculation is not too difficult to find and is shown in Tables 1 and 2 for the past four years.

Table 1: Carbon Emissions Calculator - Farm Inputs

Whole Farm Details				
Trees planted since 1990 (Ha)	0	0	0	0
Farmland (excluding tree area)	**2006-07**	**2007-08**	**2008-09**	**2009-10**
Irrigated pasture (Ha)	65	68	68	68
Electricity (kwh per annum)	172905	111710	135829	137265
Diesel/Unleaded (litres per annum)	6010	6039	5025	6413
Chemicals				
Glyphosate (litres per annum)	12	10	11	10
Fertiliser				
Nitrogen (tonnes ELEMENT/yr)	16.0	19.5	19.6	22.4
Phosphorus (tonnes ELEMENT/yr)	2.0	1.5	0.4	0.0
Potassium (tonnes ELEMENT/yr)	5.4	5.2	1.8	3.7
Sulphur (tonnes ELEMENT/yr)	1.7	0.9	0.6	0.0
Purchased Feed Inputs				
Pasture hay (tonnes DM/yr)	413	0	40	29
Grain/concentrates (tonnes DM/yr	806	678	566	609
PKE (tonnes DM/yr)	186	124	219	184
Grass silage (tonnes DM/yr)	0	27	5	0
Seed Inputs				
Grass seed (kg per annum)	100	100	100	100
Milk Yields				
Farm milk solids (t/yr)	164.0	161.2	156.9	145.5
Av lactation (days)	305	305	305	305
Av production (l/cow/day)	18	23	24	22
Av production (% MS/day)	7.55%	7.62%	7.84%	7.79%
Herd				
Milker numbers	350	305	290	280
Milker av weight (kg)	550	550	550	550
Milker weight gain (kg)	50	0	0	0

Table 2: Carbon Emissions Calculator – Dietary Inputs

Nutrition								
Cattle Type	**Season**	**Feed Type**	**Digesti-bility %**	**Protein %**	**2006-07 Kg DM/ cow/dy**	**2007-08 Kg DM/ cow/dy**	**2008-09 Kg DM/ cow/dy**	**2009-10 Kg DM/ cow/dy**
Milkers	Spring	Pasture	79	22	9	12	14	13.5
		Concentrates	84	13	4.5	5.5	4.5	4.5
		Silage	65	15				
		PKE	55	16			0.5	0.5
	Summer	Pasture	79	22	3	8	11	12
		Concentrates	84	13	6.5	7.5	6	5.5
		Silage	65	15	6.5	2		
		PKE	55	16			1.5	1.5
	Autumn	Pasture	79	22	4	8.5	9	9
		Concentrates	84	13	6	6.5	5	7.5
		Silage	65	15	4	0.5	1.2	
		PKE	55	16			1	1
	Winter	Pasture	79	22	5	6	9	11
		Concentrates	84	13	7	7.5	4.5	4
		Silage	65	15	2			1
		PKE	55	16		3.4	1.5	1.5
Dry cows	Annual	Pasture	79	22	6	6	6	6
		PKE	55	16	3	3	3	3

How big are the carbon emissions at the MDF?

Based on the level of production and management system in place, the MDF generated between 1,677 and 2,070 tonnes CO_2-eq per year over the past four milking seasons (Fig. 2). A typical breakdown of these emissions is shown in Fig. 3.

Fig. 2 Annual Carbon Emissions at the MDF 2006-2010

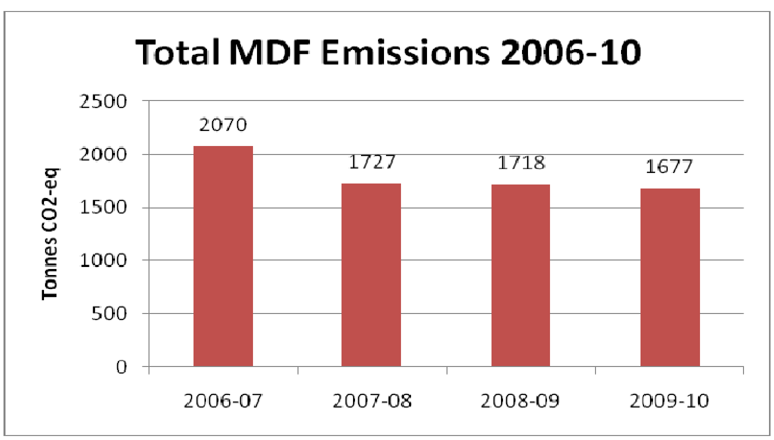
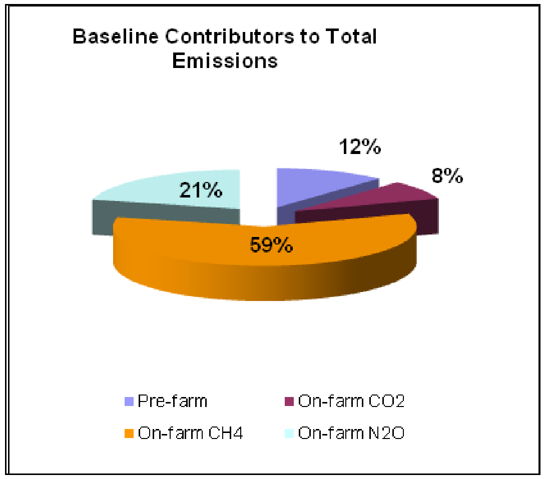


Fig 3: MDF Total Carbon Emissions by sector (2008-09)



Less than 12% of emissions are generated in products or feedstuffs before reaching the farm. Under the current proposals these emissions will be the responsibility of the business that generated them and will result in higher prices if they are required to pay a Carbon Tax or if they are caught up in a carbon trading scheme. On-farm carbon dioxide emissions are made up of electricity and diesel emissions – this 8% of farm emissions will also be counted against refinery and power generation emissions and will certainly result in higher costs. So that's 20% of emissions generated before the farm gate leaving 80% generated on-farm.

Of the on-farm emissions, more than 72% are from methane generated by rumen digestion, 14% by indirect losses of nitrous oxide, 10% generated by losses of nitrous oxide in dung and urine and less than 3% generated by nitrous oxide loss from fertiliser (Table 3 & Fig.4).

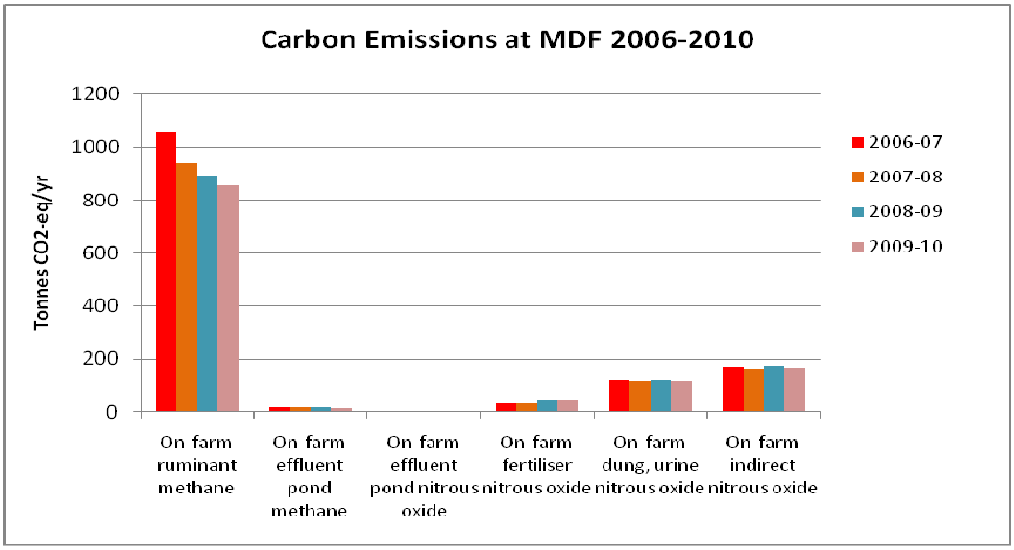
Table 3: MDF Carbon Emissions Breakdown 2006-10 [1]

	Tonnes CO_2-eq/yr			
Pre-farm emissions	**06-07**	**07-08**	**08-09**	**09-10**
Fertiliser	34	48	47	44
Grain & Other feed sources	279	241	223	225
CO_2 –Energy – Electricity & Diesel	264	177	207	214
On-farm emissions				
CH_4 - Ruminant	1055	937	890	854
CH_4 - Effluent ponds	17	16	16	15
N_2O - Effluent ponds	1	1	1	1
N_2O - N Fertiliser	33	32	43	44
N_2O - Dung, Urine, Spread	117	113	118	113
N_2O – Indirect [2]	170	162	173	167
Tree plantings	**0**	**0**	**0**	**0**
TOTAL EMISSIONS	**2070**	**1727**	**1718**	**1677**
Total Emissions Intensity (t CO2-eq/t MS)	**12.6**	**10.7**	**10.9**	**11.5**
On-farm Emissions Intensity (t CO2-eq/cow)	**4.3**	**4.1**	**4.3**	**4.3**

[1] Calculation is based on cows on the milking area and does not include young stock and bulls on agistment.

[2] Indirect emissions include later or off-site losses following runoff, loss to the air and leaching of dung, urine and fertilizer; it also includes estimates of loss following soil cultivation.

Fig. 4: Comparison of MDF Carbon Emissions 2006-2010 (tonnes CO_2-eq)



The 23% difference between the years with the highest and lowest emissions over the past four years is a good illustration of the sort of variability that takes place in emissions in the dairy industry as a result of changes in input prices, milk price and seasonal variability. With ruminant emissions the most significant it may be useful to compare the feed ration in each year. Details of inputs for each season are presented in Table 4 but can be summarized as follows:

- 2006-07 was a very dry year; milkers were fed a low level of pasture that was supplemented with up to 7 kg/day of concentrate (2.3 tonnes/cow) and 6 kg/day of silage at the peak of the season.
- 2007-08 was a year of high milk prices so purchased feed was used to push production. Milkers were fed a moderate level of pasture that was also supplemented with up to 7 kg/day of concentrate at the peak of the season (2.2 tonnes/cow).
- In 2008-09 the milkers were fed a high level of pasture with up to 6 kg/day of concentrate at the peak of the season but a lower overall intake of concentrates (1.95 tonnes/cow).
- In 2009-2010 the milkers were fed a high level of pasture with up to 7.5 kg/day of concentrate at the peak of the season (2.2 tonnes/cow).

Analysis of the diet (Table 2 and summarized in Table 4) shows that the biggest difference between years was in dry matter intake but, when balanced against a fall in cow numbers, the impact of changes to what is already a very good diet on per cow emissions is negligible (Table 3). Higher fibre levels in 2006-07 would have raised methane emissions/cow but this would have been balanced to some degree by the high grain intake; higher crude protein levels in 2008-09 and 2009-10 would have raised nitrous oxide emissions/cow in dung and urine. Increased nitrous oxide emissions in 2008-09 and 2009-10 have also come from an increase in the use of nitrogen fertilizer but this still represent less than 3% of the farm's carbon emissions.

The greatest impact on total emissions comes simply from the falling cow numbers - from 350 in 2006-07 to 280 in 2009-10. Whilst the level of total emissions has fallen the pressure on per cow production rises as overhead costs are spread over a smaller herd. In the development of this plan this has emerged time and again as a critical element – there are many ways to reduce carbon emissions but decisions about emissions reduction must have a strong business focus so as not to compromise farm viability. At current milk prices there is a point beyond which a continued fall in cow numbers cannot be sustained; variability in milk prices makes it even more risky. This also needs to be balanced against the demand for food from a growing world population and it would seem that fewer cows will not provide a solution to the problem.

Table 4: Diet Analysis 2006-2010

	06-07	**07-08**	**08-09**	**09-10**
Average Total Intake (Kg DM/cow/day)	14.4	16.9	17.2	18.1
Average Digestibility (%)	76.9	78.9	78.6	78.8
Average Crude Protein (%)	16.5	17.7	18.8	18.8

IMPACT OF A CARBON PRICE ON FARM COSTS

The Government has undertaken extensive modeling to determine the impact of a carbon trading scheme on input costs. According to the DPI (Vic) [Ref. 6], under the previously proposed carbon trading model the impact of a trading scheme or tax at a carbon price of \$20/t CO_2-eq will see a rise in feed costs by 1.5%, fertiliser and farm chemicals by 2% and electricity by 16%. Based on these assumptions the financial impact using 2009-2010 input costs is summarized in Table 5.

Table 5: Anticipated financial impact at the MDF of a carbon tax or trading scheme at \$20/t CO2-eq

	Pre-carbon tax costs/year 2009-10	**After-carbon tax costs/year**	**Increase in costs/year**
Electricity	\$21,086	\$24,460	\$3,374
Supplementary Feed	\$241,332	\$244,942	\$3,610
Fertilizer	\$36,734	\$37,469	\$735
Farm Chemicals	\$1,679	\$1,713	\$34

The total increase in costs as a result of the introduction of a carbon price of \$20/tonne CO2-eq is likely to be around \$7,753. Compared to the 2009-10 farm operating costs of \$614,134 this is equivalent to an increase in costs of 1.2% and is consistent with an ABARE[Ref. 8] analysis that suggests an increase in the cost of production for dairying at \$20/tonne CO2-eq by 1.1%. As the price on carbon increases the cost of all of these inputs will increase further.

Under the previous proposal for a CPRS a fuel tax adjustment was proposed whereby there will be a 'cent for cent' reduction in fuel excise to compensate for any rise in fuel price due to the sale of carbon permits. Agriculture will be able to access this fuel tax adjustment and this means that there will be no increase in diesel price as a result of the scheme for three years from the start of the scheme. There has been no discussion about any change to this proposal to date and there has been little information available to estimate the impact of the removal of this adjustment on diesel prices as any carbon tax or scheme matures.

There is also likely to be a fall in milk prices as a result of processors being drawn into the scheme, however, milk processors are likely to be classed as Emission Intensive Trade Exposed (EITE) and will be compensated to protect their competitiveness in international market. Under the previous CPRS proposal they would receive 95% of their permits for free and that would continue until comparable carbon markets were developed internationally. Current discussions indicate that this or similar compensation will remain. The MDF is a Murray Goulburn supplier. Murray Goulburn reports its 638,000 tCO_2-eq per year of emissions to the National Greenhouse Energy Reporting Scheme. For the 31,900 tCO2-eq or 5% of output that will require permits at, say, a carbon price of $20/tCO2-eq spread over its 2700 suppliers, this represents an average cost of $240/supplier/year. As the carbon price increases so will the cost to farmers but at $40/tCO2-eq the average cost becomes less than $480/supplier/year. Of course, bigger suppliers will pay more and smaller suppliers will pay less in proportion to their milk production.

ABARE also suggests that Earnings Before Interest and Tax (EBIT) is also sensitive to the price of carbon permits with EBIT falling by 1c/kg MS for every $10/tonne CO_2-eq.

IMPORTANT NOTE:

Both the DPI (Vic) and ABARE figures assume that farms make no attempt to reduce emissions and will bear all costs from the introduction of a carbon tax or carbon trading scheme. This is highly unlikely as farmers are very good at manipulating and investing to minimise input costs when margins are under threat. This Emissions Reduction Plan will explore the options available to dairy farmers to reduce carbon emissions at the same time as minimising the impact of a price on carbon emissions on the farm business.

OPTIONS TO REDUCE CARBON EMISSIONS

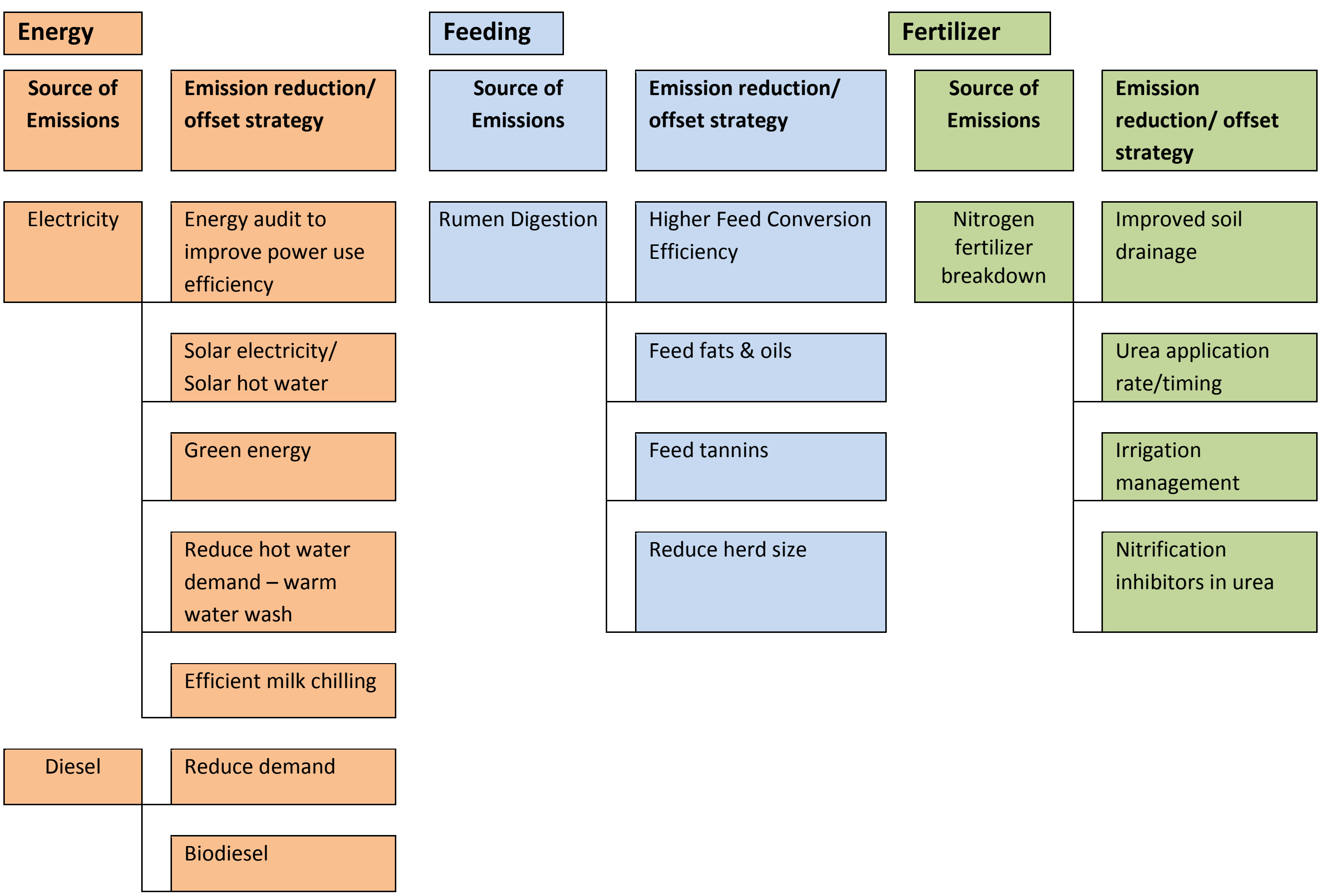
Every farmer will approach the reduction of carbon emissions on their farm in a different way. There will be those who readily make changes, even if it costs them money, because it will be good for the environment (and they will possibly benefit sometime in the future); there will be those that will choose to invest in modest changes as long as they will be better off in the short to medium term; and there will be those that will only make changes if there is a return on the investment.

When considering what approach to take for the MDF as part of this review the first priority was to protect the immediate viability of the farm business in the face of potential input cost rises. The second priority was to find strategies that would generate the greatest reduction in emissions for the least cost, including any investments that would generate a production benefit for a positive return. This probably places the MDF somewhere in the middle of the action scale above.

Australia has committed to a reduction in carbon emission of 5% by 2020. This project has set that same 5% target as a minimum for emissions to be reduced. A higher level of emission reduction will be sought if there is a good business case to do it.

Strategies under consideration are either emission reduction strategies or emission offset strategies that essentially fall into three main groups: energy strategies, feeding strategies, and fertilizer strategies. (Fig. 5)

Fig. 5: Emission Reduction/Offset Strategies



In making an assessment of the options the production figures, costs of production and carbon emissions for 2008-09 have been used as a typical season to allow a comparison of costs and benefits of new strategies with a no action strategy.

ENERGY STRATEGIES

Reduction in the use of energy, like electricity or fuel, makes good business sense with or without a price on carbon emissions so should always be front of mind. If there can be savings or productivity gains as a result of any action to reduce emissions then these can be invested in further emission reduction activities and are an important motivator.

A series of Information Sheets produced for Dairy Australia covering energy efficiency in the dairy are available from the Dairying for Tomorrow website (www.dairyingfortomorrow.com./upload/documents/file/ then click on SA BMP Info Sheets. These were and titles include: A1: Getting Started, A2: Thermal Efficient Design, A3: Construction Materials, A4: Renewable Energy Sources, B1: Dairy Lighting, B2: Dairy Pumps & Motors, B3: Heating Water, B4: Cooling Milk, and C1: Water at the Dairy

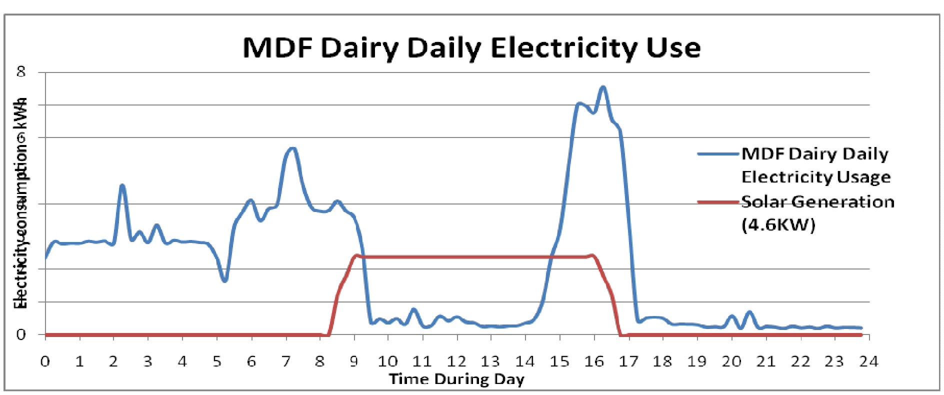
Electricity

A review of electricity use at the farm showed that there are three point sources – the dairy, the pump for fixed spray irrigation, and the pumps at the irrigation bore. All three have different demands and will be considered separately.

Electricity is used in the dairy to run the milking plant, for refrigeration and to heat water. The milking plant includes a plate cooler that reduces milk temperature by 10°C that is further reduced by refrigeration in the vat to 2.8°C in 80 minutes. Milk is picked up once a day so the longest period that milk is refrigerated is 18 hours and the vat is empty for the remaining six hours of each day.

The electric hot water system is large enough to hold enough hot water for two milkings. It has a night switch and only operates on off-peak power which makes no difference to carbon emissions but keeps the costs down. The tank is held half full during the day as cold water doesn't refill the tank until 11pm when the off-peak rate begins and the heating element is switched on. This means that water is heated for only eight hours in each day. The pattern of electricity use at the dairy can be seen in Fig. 6. You can see the peaks around milking and the increased power consumption after 11pm for hot water heating.

Fig. 6: Dairy Daily Electricity Consumption

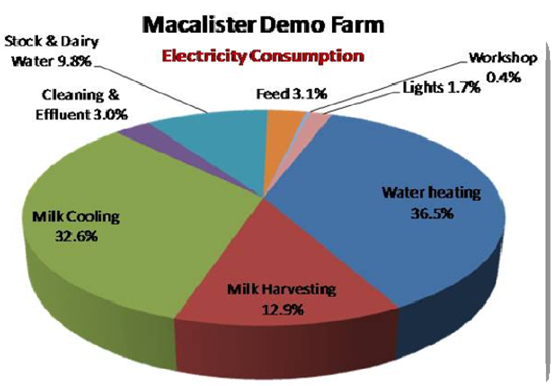


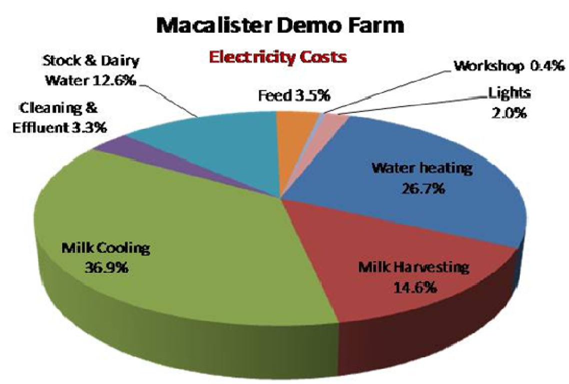
To assess the worth of any investment in emissions reduction it is important to make estimates of the future cost of electricity to compare any change in costs as a result of action taken. Treasury estimates that under the proposed but now shelved CPRS the cost of power as a result of a price on carbon would rise by 3.4% per year until the emissions reduction target has been reached. This represents a doubling of the cost of power used at the MDF dairy over a twenty year period. This assumption has been used in all of the following scenarios where only the increased cost as a result of the introduction of a carbon price has been included. No other rises have been accounted for. It has also been assumed that any Renewable Energy Certificates issued for any solar system are sold for $30 each even though this will vary up and down in price as carbon trading develops. This cost is built in to the adjusted capital cost (Appendix 2). While power costs at the dairy represent only a small proportion of total production costs, any increase in electricity costs will come directly from the farm profit so doing nothing is not really an option.

1. Options to improve the power use efficiency of your current system

Energy use is not an area that we at the MDF have any expertise in so we invested in an energy audit for the dairy. However, it took some time to find someone who not only knew about energy use but was also very familiar with dairy plant operation. AgVet Projects in Warragul met the standard we had set and were excellent to work with. The audit report is included in the appendix but highlighted that milk cooling and water heating are the biggest energy users and should be the focus of our energy saving plan (Fig. 7).

Fig. 7: Electricity consumption and electricity costs at the MDF dairy





Electricity consumption is directly related to the carbon emissions generated so milk cooling and water heating must be the target for emissions reduction. Of course, electricity costs are not exactly the same as electricity consumption because some of the consumption, like hot water, is only at off-peak power rates.

Milk should be cooled as it passes through the plate cooler to within 2^{o}C of the incoming water temperature. The audit revealed that milk was entering the vat at a temperature 4^{o}C or more than was expected. This was put down to either a plate cooler that is too small (check with milking machine dealer), deposit inside the plate cooler that impedes flow (check and clean annually), or insufficient water flow to remove the heat.

It was identified that the water flow rate in the plate cooler was too low (the Westfalia plate cooler prefers 2.5 times the milk flow rate) and it was suggested that we replace the dairy pressure pump with a dedicated pump matched to the task that delivers high flow under low pressure. Bringing milk into the vat up to 4^oC cooler will generate significant savings in refrigeration costs.

While there are now much more efficient vats and refrigeration units around than the one installed at the MDF, the capital cost of replacing it before its time is hard to justify. When the vat is due for replacement energy efficiency will be a high priority.

It goes without saying that all hot water pipes should be insulated and hot water systems should only run during off-peak hours to generate the savings for investment in other emission reduction/cost reduction technologies. There was some suspicion that the temperature loss over the peak hours in a day in the 1000 L HWS was higher than the expected 15%. Investigation showed that the HWS was located directly onto a metal frame that was secured to the concrete floor. Over the years the tank has probably settled inside the casing and is now resting on the base of the service and virtually in direct contact with the frame. It was suggested that a timber slats or a heavy plywood sheet be inserted between the bottom of the HWS and the top of the stand as a way to better insulate the tank and maintain water temperature.

To make sure that the system continues to work properly a number of regular checks are required (Table 6).

Table 6: Milking system performance monitoring schedule

Area of Focus	Description
Milk Cooling	• Monitor plate cooler performance once a week • Service plate cooler annually • Clean fins on condensing unit once a month • Service refrigeration unit annually
Hot Water	• Check thermostat setting once a month • Check condition of anodes every six months. If there is rapid corrosion of anodes, increase checking frequency.
Vacuum Pump	• Ensure belts are correctly tensioned and pulleys correctly aligned • Ensure belts match pulleys
Lighting	• Quickly repair defective lights • When replacing globes selected the most efficient lighting for the task. Refer to fact sheet on lighting.
General	• Quickly attend to and repair water leaks. • Introduce natural lighting where possible (e.g. in bore pump area) and in the pit.

2. Options to reduce electricity consumption

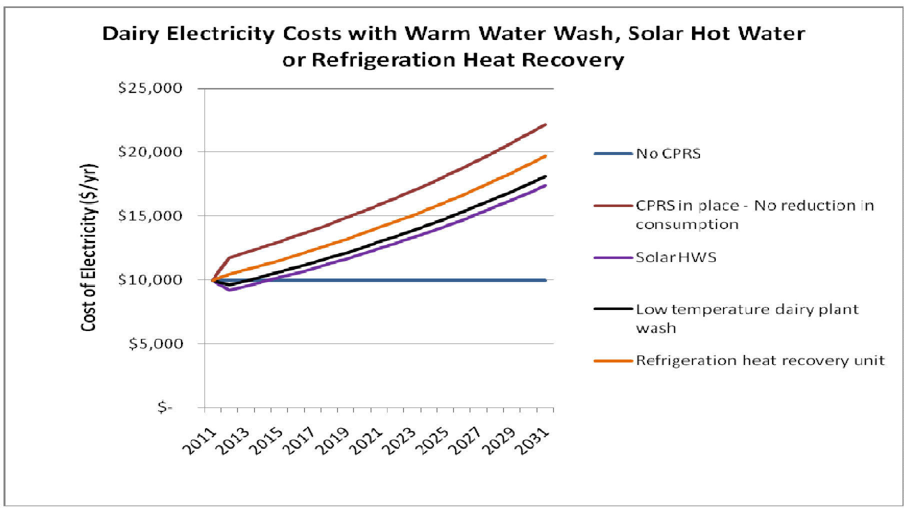
Apart from making sure that the plant is running efficiently and energy is not being wasted through poor practices, there are a number of investments that might be considered to reduce electricity consumption.

It was suggested during the dairy energy audit that improved cooling performance in the vat could be achieved by installing a heat recovery unit on the refrigeration unit to lower the temperature of refrigeration gases and improve their cooling efficiency. Performance data suggests that the gain from a heat recovery unit may be equivalent to lowering the temperature of milk entering the vat by 2-3°C while the heated water could be used as a feed for the hot water services. In both instances this is an energy saving.

In all of the graphs following, the 'No CPRS' line is flat and indicates that no other influences on electricity price have been taken into account, even though we know that prices will increase for other reasons anyway over the twenty year period. The 'CPRS in place – No reduction in consumption' line represents the change in costs if a carbon tax or trading scheme is in place but assumes that the farm does nothing to reduce emissions and continues with business as usual. This is an extreme position that is not viable.

Two other new options were considered at the dairy – solar hot water and a low temperature dairy plant wash system - and assessed as measures to reduce electricity consumption. In each case the system assessed was designed to replace or integrate with the current system at the MDF. In a low temperature dairy plant wash system water is required at only 40°C and is used with a new range of recyclable chemicals. This system is almost ready for market release and early trials indicate that it works very well, although it comes at a higher price than originally anticipated. In this calculation it has been assumed that a small hot water service is retained to provide hot water for wash up of other than the milking plant. Fig. 8 provides the details.

Fig. 8: Projected Dairy Electricity Costs 2011 – 2031: Reduced Energy Consumption Alternatives



You can see that an investment in any of a solar hot water unit, refrigeration heat recovery unit or a low temperature dairy plant wash system will reduce the cost of electricity by reducing carbon emissions but the cost trend is still tracking upwards. In 20 years time, even with such an investment, the cost of electricity will be at least 80% higher than it is now with a saving of only 19 tCO_2-eq per year (or 1% of farm emissions) for solar hot water and 29 tCO_2-eq per year (or 1.4% of farm emissions) for a low temperature dairy plant wash system. We need to do better than that to achieve the target of 5% reduction in total farm emissions.

However, as each of the low temperature dairy wash and solar hot water systems reduces the demand for electrically heated hot water they should be viewed as alternatives – either invest in one or the other because there is little benefit in lots of cheap hot water if you only need water to 40°C - there are much cheaper ways to do this. However, the refrigeration heat recovery unit can be combined with either to maximize milk cooling and minimise water heating costs (Figs. 10 &11).

3. **Options for alternative sources of electricity**

Another approach is to look at alternative sources of electricity. The two most practical and available options are to invest in solar electric cells yourself or to purchase through an energy retailer electricity that has been generated from renewable sources like wind and hydro, with the possibility of solar and tidal energy in the future.

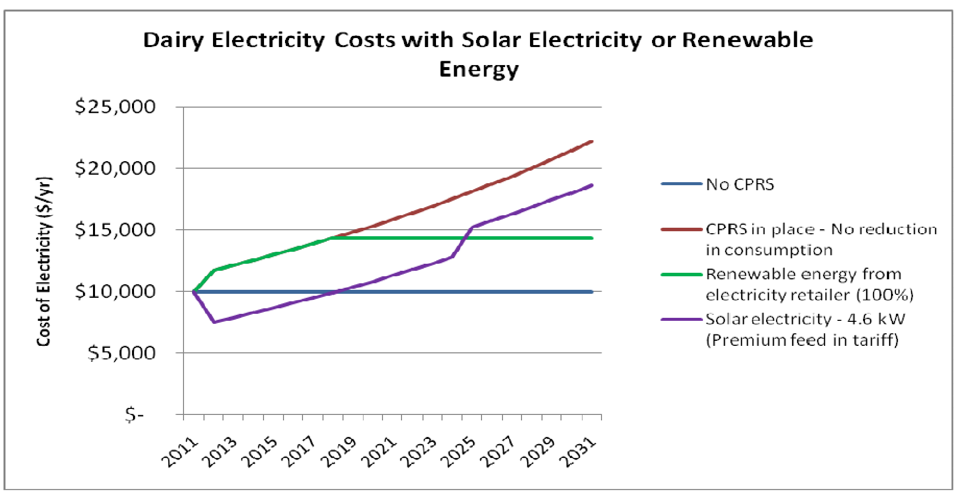
In Victoria the government offers a premium to households and businesses for any electricity that is generated and fed back into the supply grid. The payment of this premium will continue until 2024 and is limited to systems up to 5kW, with a limit of 100 MW for the state before the price paid falls to a standard rate of about 80% of the price consumers pay for their power. At the MDF this is a fall from 68c/kWh to 20c/kWh for the power generated. Without the premium feed-in tariff the payback period for solar electricity more than doubles. It is likely that the state limit of 100 MW will be reached in the second half of 2011 so there is some incentive to consider the option sooner than later.

The payback period for solar cells is largely determined by its initial cost and how much power is consumed during the day when the solar panels are generating electricity. The cost of solar systems has dropped considerably since the beginning of this project in 2009 – as much as 30% for comparable systems. If such a drop in price continues, this option will become increasingly viable.

Consider the installation of solar cells at the dairy to generate electricity. You can see in Fig. 6, with the largest solar system in place, the power generated is in excess of what is being used during the day and will be fed back into the grid for five hours between 9.30am and 2.30pm, and power drawn from the grid is reduced for 3.5 hours during the morning and afternoon milkings. Overnight power consumption remains unchanged. The payback period for each of the systems considered (1.5kW, 3 kW and 4.6 kW) ranges from just over six years to just over seven years. This means that the cost of a unit and its generating capacity are closely linked.

Another option is to buy renewable or 'green' power generated by power companies and not go to the expense of buying solar panels. The impact on total electricity cost for these two options is shown in Fig. 9.

Fig. 9: Projected Electricity Costs 2011 – 2031 with Solar or Renewable Energy Options



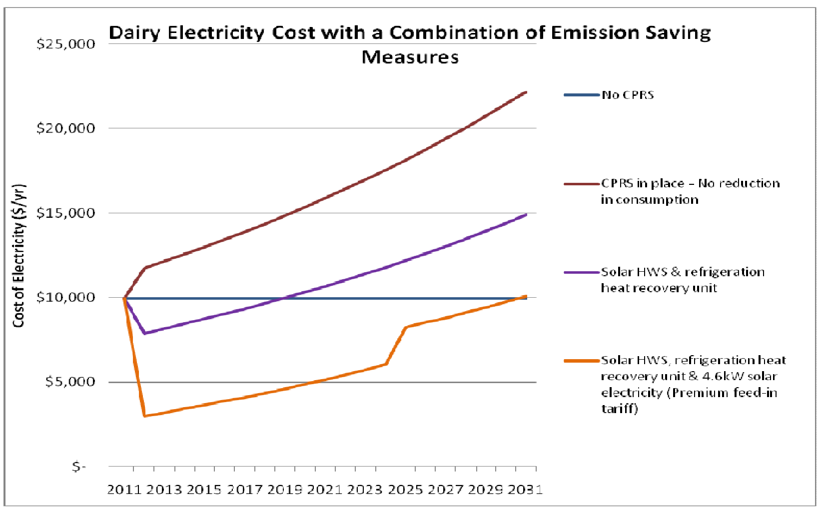
Note that installing a solar electric system reduces power costs but the cost trend is still upwards because the majority of the power used still generates emissions and comes with a price on carbon. The jump in the curve at

2024 occurs because the premium feed-in tariff finishes so the credit for power generated moves from 68c/kWhr to about 80% of the peak tariff which is estimated to be 33c/kWhr. Emissions saved are less than 10 tonnes CO_2-eq/year or about 0.5% of farm emissions.

On the other hand, by buying renewable energy from the electricity retailer there is a jump in power costs of more than 40% but the advantage is that there is no capital outlay and power costs are capped at that increased level because the price of renewable energy is not affected by a carbon price (other than to possibly become cheaper as more and more investment in renewable energy is made). The purchase of renewable energy from the electricity retailer should happen when the price of renewable electricity is the same as coal generated electricity.

Of all of the individual options considered, only electricity from renewable sources achieves a reduction in total farm emissions of 5% to meet the emissions reduction target. So let's consider a combination of alternative power sources and reduced consumption options to bring power consumption and power costs down. (Fig. 10).

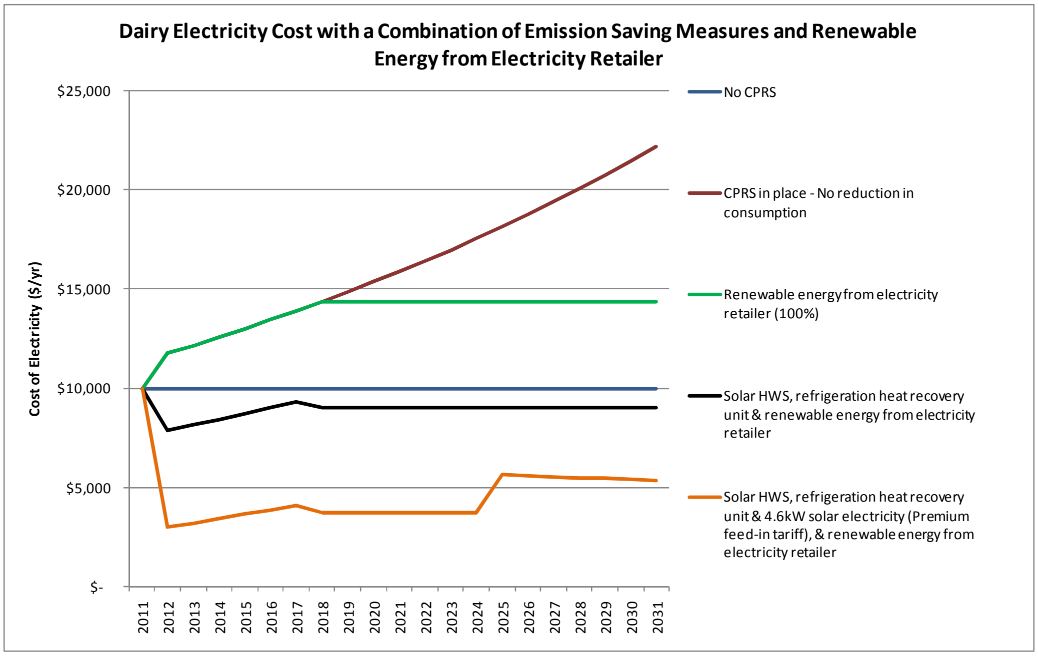
Fig. 10: Projected Electricity Costs 2011 – 2031: Alternative Energy & Reduced Energy Consumption Alternatives



Again, you can see the impact of reducing electricity consumption alone – costs are reduced but are still tracking upwards because purchased power attracts an extra cost because of the carbon tax/emissions scheme. Of course, the further emissions are reduced the lower the total cost increase. For each combination the cost of power initially falls below current costs for a time, extending through to twenty years for the combination of solar hot water, refrigeration heat extraction unit and 4.6 kW solar electric system, but the electricity price continues its upward trend.

However, by reducing consumption and then purchasing renewable energy from the electricity retailer power costs are capped, and the more emissions are cut the lower the cap will be (Fig. 11). In fact, by investing in a range of emission reduction strategies proposed and then purchasing renewable energy the cost of power can be capped at a level lower than the current level. The assumptions predict that the change to renewable energy will be worthwhile in about 2018 where the curves flatten off. The curve that includes the solar electricity option also includes a rise in 2024 when the premium feed-in tariff finishes. The best part of this combination of options is that each element can be installed independent of the others as funds allow. This requires a longer term vision.

Fig. 11: Projected Electricity Costs 2011 – 2031: Alternative Energy & Reduced Energy Consumption Alternatives with Renewable Energy from Retailer



All of this depends on the introduction of a price on carbon emissions and a check on the assumptions behind any new scheme to see how similar they are to the assumptions that have been used in these calculations. Any change in assumptions will impact mostly on the payback period.

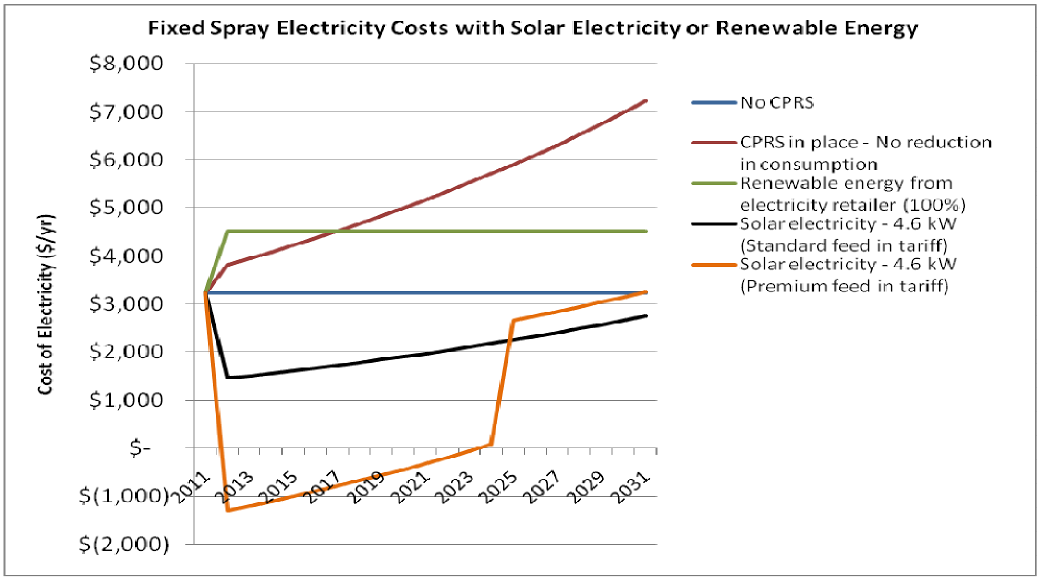
Pumping Electricity Use

Apart from improving the efficiency of irrigation pumps, that is, making sure that the right pump is installed to do the job at hand, for electric pumps solar electricity may also be worth considering when most of the pumping occurs overnight. This ensures that a high proportion is returned to the grid and estimates indicate that at the MDF 90% or more of the power generated will be returned to the grid.

Consider the options for the lateral spray system with overnight pumping in Fig. 12.You can see the significant impact the premium feed-in tariff has on total costs with costs dropping into the negative. A 4.59kW solar electricity system will drop the power cost from just over $3,000/year to a credit of just under $1,000/year as soon as it is installed. This means that at the rate paid under the premium feed-in tariff the amount paid for the power generated is greater than the rate charged for the pump use. This credit balance on the account can be negotiated with the electricity retailer to be paid or credited against other electricity accounts on the farm. This credit situation arises when there is relatively low power use on a meter with high rates of feed back into the grid because most consumption is at night.

With the anticipated rise in prices as a result of a carbon emissions scheme, it is not until twelve years later that any payment would be made for power and even twenty years after installation the price paid is short of what is currently being paid and well short of the renewable energy cost. Even a 3kW solar electricity system has a similar payback period and meets the cost of renewable energy in about twenty years time. This is an example where the investment in solar energy can save both emissions and cost but, at the scale of the farm operation, it’s not a lot of money. For a smaller system it is important that it is linked to the purchase of renewable energy from the electricity retailer to cap the price.

Fig. 12: Projected Electricity Costs 2010 – 2030: Alternative Energy for Irrigation Pump



If the premium feed-in tariff is not available, by accessing renewable energy from the electricity retailer when the price of renewable and non-renewable sources is the same will cap costs under the standard feed-in tariff at about $1,675 and for the premium feed-in tariff at a credit of about $875 per year.

This forces us to have a close look at the future of the old diesel motor at the re-use dam. Maintenance costs are high and it is likely that it will suffer a major breakdown very soon. Assuming the pump itself remains in place (although it may be more efficient to replace it), the replacement cost for the motor of $5,500 and diesel running costs of about $4.47/hr (2.5 litres per hour at $1.50 c/l plus a maintenance allowance of $500/yr) against the cost of power supply at $28,000, an electric motor and adaptor plate at $4,700 and running costs of $3.19/hr (12 kW/hr at 23c/kW plus a service charge of $300) makes for an interesting decision. This is a decision that many farmers face as they have to replace aging pumps and motors. In this case the payback period for a change to electric pumping with the addition of solar electric panels and access to the feed-in tariff is just over 10 years. It depends on whether you take a long or short term view. If the diesel motor was not due for replacement then the business case isn't good enough to retire the motor early. However, timing her could be just right.

One concern is the security of the solar system. It may not be wise to install it at a site remote from the farm buildings close to a road unless the structure can be installed in such a way that it cannot be moved or dismantled. This practical element will be part of the consideration.

The reduction in energy costs is worth pursuing whether there is an emissions trading scheme or not. The first step is an energy audit to identify potential savings in electricity consumption.

Diesel

The amount of diesel used on the farm is split between the tractor for general farm operations and the diesel driven pump at the re-use dam. The option of replacing the diesel motor with an electric motor at the pump has been discussed. Tractor use is generally at a low level and only when necessary. A switch to bio-diesel could be considered. Bio-diesel contains a proportion of vegetable oil which is a renewable fuel source so overall emissions are reduced. However, bio-diesel there was no easy source of bio-diesel near Maffra so it is not really an option for such low consumption.

FEEDING STRATEGIES

Feed Quality

One way to deal with the high level of methane production in the rumen is to increase feed conversion efficiency by feeding high quality supplements with pasture. While this increases methane production per cow it means that fewer cows can be milked for the same production and perhaps introducing the option of bringing the yearlings home to reduce rearing and agistment costs.

In each of the three years where emissions were analysed each cow generated up to 4 tonnes CO2-eq in each season. At the same time, EBIT/cow varied from a loss of $539 in the drought year of 2006-07 to $899/cow in 2007-08 when the milk price was high. If a mid-point EBIT of $320/cow was selected then to compensate for a deliberate strategy to reduce cow numbers the carbon price would need to reach at least $80/tonne CO2-eq, a figure not anticipated for many years yet. Given how difficult it is to make a dollar in agriculture and the need to feed a growing world population, it is hard to imagine farmers reducing herd numbers when the extra cows could add significantly to profit. Besides, digestibility is already high (> 70%) so the return on a further improvement in feed quality and feed conversion efficiency is not likely to be great. The uncertainty of response at high levels of digestibility also represents a risk.

Fermentation of cereal supplements creates a hostile environment for methane-producing microbes so methane production per cow is reduced. Energy that would have been lost in the methane is diverted to milk production but this is a complex process and the extent of any production increase is not clear. In 2008-09 the cows at the MDF were fed grain and pellet at 6.4 kgDM/day during lactation. Unless there is a significant rise in milk price or dramatic drop in grain price (or both) then it is unlikely that there is a margin in increasing the rate fed.

Another option to reduce methane production in the rumen is to feed a supplement high in fats and oil. The fat content of the diet can be increased up to 7% before appetite is suppressed. For every 1% increase in fats or oil fed, methane emissions are reduced by 3.5%, again with the displaced energy from methane production going to an increase in milk production. In a trial at Ellinbank dairy cows fed on a ryegrass silage, lucerne hay and grain (3kgDM/day) diet over the summer season were supplemented with whole cottonseed fed at 2.7kgDM/day. Researchers measured a reduction in methane emission of 12% at the same time as an increased milk yield of 15%, with an increase in fat by 19% and protein by 16%. However, dietary fat levels in spring pasture can be as high as 5%, dropping to 1.5% in summer pasture so there is a definite opportunity for dry land dairy farmers. For irrigation farmers the opportunity is more modest.

A rough calculation (March 2010):

- *If cows are currently fed 5.5kg/cow/day of a ration of wheat with 0.5kg/cow/day of a mineral pellet with Rumensin, and limestone along with 1 kg PKE per cow per day then feed cost averages $275/tonne or$1.65/cow/day*

Change to:

- *Feed 6kg/cow/day of a ration of 30% Canola meal with added canola oil, 60% wheat with Rumensin, minerals and limestone along with 1 kg PKE per cow per day. At a feed intake of 18 kg DM intake/day the cows are getting an extra 450g oil/cow/day or 2.5% of diet, well within the limits. Feed costs go to $345/tonne or $2.07/cow/day;*
- *Assume a milk response of 15% increase in fat (10,550 kg) @ $2.48/kg and a 12% increase in protein (6,270 kg) @$6.21/kg*

Feed costs increase by 42c/cow/day for a return of $0.50/cow/day or a margin of 8c/cow/day and a saving of 0.5 kg CO2-eq/cow/day.

At a carbon price of $20/tonne CO2-eq this adds 1c/cow/day for a net return of 9c/cow/day.

The MDF typically feeds a supplement of grain (usually crushed wheat) along with a grain-mineral mix pellet and PKE so substitution of a high oil ration of up to 2.5% is possible to supplement the natural oil content of pasture (see Box adjacent). The margins are slim but 9c/cow/day equates to an extra $7,950 over the course of a season. At a reduction of 10% of methane emissions or 6% of farm emissions (44 tCO2-eq), exceeding the 5% target, is it worth the risk? At least it is a cash positive investment and not a cost. As the carbon price rises or the feed price falls this may become even more attractive. The farm would have to have confidence in the science to make this investment. This opportunity is likely to develop with the introduction of the Carbon Farming Initiative that is in the Parliament at the time of writing.

Rumensin is a commercial product in the Monensin family of antibiotics. In part, it suppresses the activity of methane producing microbes however, methane suppression is not for long periods and it loses its effectiveness with repeated application. As an added issue, there is the risk of losing consumer confidence in milk as a safe, pure product if the use of Monensin becomes widespread. The farm will monitor this debate and continue to monitor its effectiveness in lifting production.

A further option is to feed a ration high in tannins, as is found in feed products made from wine making waste like skins, seeds and stems. Tannins bind with protein to promote better digestion and reduce methane emissions, and divert some of the nitrogen from a volatile form in the urine to an organic form in the manure that is less likely to break down to N_2O. Some of these products have reached the market but are not readily available. This is a part of the feed market to watch in the future.

This discussion really indicates that current feeding options to reduce rumen generated emissions are unlikely to provide the sort of emission reductions necessary to meet national targets. With the money currently invested in research it is more likely that a high-tech solution, like a vaccine (NZ has developed something they think will be ready for release in 2018) or biological control agents like predatory microbes against methane producing organisms, will be a more effective solution.

With agriculture currently excluded from any carbon trading scheme there is a risk that this sort of solution will become compulsory with any increase in costs at least partly balanced by production benefits.

Also on the horizon is an animal breeding solution – finding animals that naturally produce lower levels of emissions as the base for a future breeding program – and a plant breeding option – breeding of ryegrass that has higher fats and tannins and therefore a lower capacity to produce methane emissions. Both of these offer long term possibilities.

FERTILIZER STRATEGIES

Just as feeding management can reduce methane emissions, fertilizer management can reduce nitrous oxide emissions from paddocks following the application of nitrogen fertilizer. Strategies to reduce nitrous oxide emissions are really a summary of fertilizer best management practices, with the saved nitrogen available for increased plant growth and productivity. The MDF fertilizer practices were checked against the following:

- Add nitrogen fertilizer only if it's needed – use soil tests to determine fertilizer needs and use effluent strategically;
- Apply nitrogen in regular small doses, for example, straight after grazing, and match to pasture growth requirements;
- Limit nitrogen fertilizer rates to 50-60 kg N/ha in an application;
- Wait 21-28 days of the last application before applying more nitrogen fertilizer;

- Adding nitrogen fertilizer to waterlogged soils dramatically increases nitrous oxide losses – allow 3-4 days after flood irrigation;
- Don't graze cows on waterlogged paddocks – if waterlogging is a persistent problem consider installing and using a feed pad to avoid pugging;
- Maintain soil pH at or below 6.5 to minimise volatilization (losses to the air when urea is applied to dry ground).

Apart from the occasional grazing of cows on waterlogged paddocks following a very wet spell, the MDF follows best practice when it comes to fertilizer application so there are few opportunities for emission reduction gains by adjusting management.

However, there are products on and coming onto the market that can reduce the loss of nitrogen to nitrous oxide. One product, Agrotain, is used as a coating used on nitrogen fertilizer to reduce volatilization, the loss of nitrogen to the air. It works to slow the action of the naturally occurring enzyme, urease, that begins to break down urea within days of application and is most effective in the warmer months. Some recent work at the MDF by Incitec Pivot shows that their product Green Urea (that is treated with Agrotain) can generate a 16% increase in dry matter production from November to March when applied at 25 kg N/ha. This provides the opportunity to reduce the application rate of Green Urea by 15% to 21.25 kg N/ha to achieve same pasture growth. Calculations show that at the lower rate of Green Urea application five applications of Urea costs $76/ha while Green Urea costs about $77/ha and reduces farm emissions by 4 t CO2-eq or 0.2%. The MDF applies nitrogen at about 45 kg N/ha so presumably there are further gains to be made. This will be tested in an MDF/Incitec Pivot partnership in 2011-12 where pasture production at different rates of Green Urea will be compared to Urea.

Other products that incorporate a nitrification inhibitor work by slowing the conversion of urea to nitrous oxide and ammonia by the bacteria in the soil. These products are not yet readily available and are likely to generate greater emission reductions. Product cost could not be determined at this stage. It is possible that when these products prove their worth and hit the market that they could also become compulsory as part of the national emission reduction strategy.

SOIL CARBON

The potential to sequester soil carbon to offset emissions has also been considered. The rate of soil carbon increase is largely determined by the amount of plant matter above the ground. Environmental factors governing plant growth like rainfall, temperature, and length of growing season are important in adding to soil carbon as are management practices such as fertilizer application, improved rotation of crops and stock and irrigation. The rate of soil carbon decline or loss is largely determined by climate, soil clay content, as well as management practices of cultivation and over grazing.

In a review of Australian agriculture and its potential for carbon sequestration in soils the CSIRO found that past clearing and conversion of native land to agricultural production has depleted soil organic carbon by 40-60% and that pasture improvements have generally resulted in gains of 0.1-0.3 tonnes carbon/ha/yr. Active management to increase soil carbon results in improved levels in the first 5-10 years which then diminish over time. Adding organic material has the potential to increase soil carbon levels but this comes at a cost likely to be higher than the value of the added carbon if traded and higher than could be achieved using conventional fertilizers sustainably.

What does this mean for dairy farming? At the MDF pasture productivity is high at 12-14 tonnes DM/ha/yr with the climate and irrigation assisting to boost organic matter in the soil. A good cover remains on the surface after grazing with the residue kept at 5 cm. Cultivation for pasture renovation is infrequent. This probably accounts for the already quite high organic carbon levels in the soil (MDF 5.5 – 7.2%) and so, like many dairy farms, there is very little to gain in an intensive, high productivity system using improved pasture in higher rainfall areas. For this reason, building soil carbon as an offset strategy is not considered as a viable option.

TREE PLANTING

Tree planting is seen as one of the activities most likely to be undertaken by farmers because the rules around Kyoto compliant plantings are already set and because of the multiple benefits of trees on farm. However, the earning potential of highly productive land currently used for dairying makes it hard to imagine a wide scale change in land use to trees. Of course, every farm has some land that is underutilized or is less productive (such as steep hillsides in the Strzeleckis) that might be suitable but, in the MID, these areas are likely to be small and compliance costs will consume a higher proportion of the earnings from stored carbon (see Box below).

The Economics of Planting Trees for Carbon Sequestration:

- The growth rate of trees in the MID is likely to take up about 500 tonnes CO2-eq/ha over 60 years
- This is equivalent to an average of 8.3 tonnes/ha/year
- If EBIT is about $800/ha/year the carbon price needs to be $96/tonne CO_2-eq excluding establishment costs to make the change to land use worthwhile.

AUSTRALIA'S CARBON FARMING INITIATIVE

The Carbon Farming Initiative (CFI) was developed by the Gillard Government in response to calls from the farming sector to recognize the contribution that agriculture can make to a reduction in carbon emissions. Legislation is in the parliament at the moment and has been praised by some for the opportunity it gives farmers to get a return on investment in emission reduction and roundly criticized by others who think the rules are so tight that it's not worth the effort.

Participation in the CFI is voluntary so farmers have the choice between doing nothing and taking the price rise hits, taking action to minimise the impact but not seeking any return from the scheme on their investment, or taking action and selling the carbon credits in the appropriate market. It is important to note that diesel and electricity consumption is not covered by the CFI; investment to reduce electricity consumption is already covered by tradable renewable energy certificates and we are waiting to see what possibilities will emerge for reductions in diesel use.

As a signatory to the Kyoto Protocol Australia has agreed to international standards as to how carbon emission reductions are counted. While the rules may seem a bit strange, they have to be broad enough to cover all circumstances. In the CFI these rules have been interpreted as follows. Emissions must:

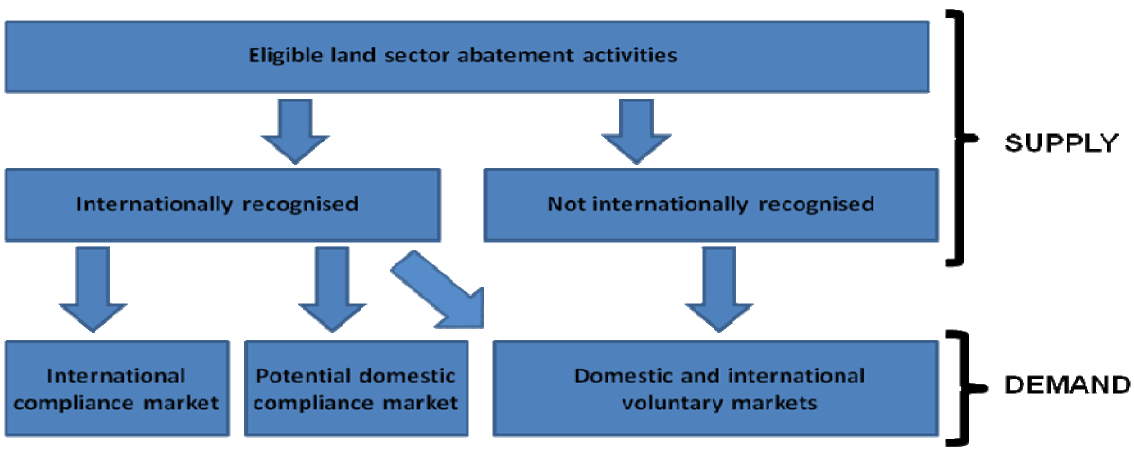
- Be additional – more than under 'business as usual', activity must be new to the industry – there will be a list of approved initiatives, some of which dairy farmers will already be doing.
- Be permanent – for carbon emissions offset like tree growing or soil carbon capture it must be for at least 100 years. For tree planting if you sell your farm then the obligation passes to the next owner. Will that be attractive to buy?

  For emissions avoided the permanence rule does not apply but you will have to prove that the reduction in emissions is real.

- Avoid leakage – must not cause an increase in emissions elsewhere. For example, moving young stock off the farm will reduce farm emissions but transfer the obligation elsewhere – this can't be claimed as a reduction in emissions.
- Be measurable and verifiable by a qualified third party – this is one of the costs – you can only sell what you have captured and if the amount of carbon captured falls and you have already sold it you will have to buy the difference from someone else at the current market price. May be risky.
- Be conservative so claims are not over-estimated – this is good risk management.
- Be consistent with international rules and conventions; and
- Be measured by techniques based on science – an agreed set of measuring techniques are being developed that everyone will have to use.

What makes the CFI an advance on what was previously available is that there will now be two types of carbon credits available for farmers to claim – one for the highly regulated, Kyoto compliant market (mostly for tree planting), and one for the more flexible local market. The Kyoto carbon credits can be traded on the world market or used by local manufacturers to comply with their obligations so prices will eventually follow world prices; the domestic carbon credits can be traded to companies who see a marketing advantage to being carbon neutral and will probably be worth less although your obligations remain the same. In particular, the domestic trading market is still in development but will be in place quickly once there is something to trade.

Fig. 13: Australia's Carbon Farming Initiative – Markets (Ref. 9)



Under the CFI there are a number of eligible activities that farmers can do to become involved in the scheme. Whatever you do has to go through a process to be approved in advance. You can't just go and do something and expect to get paid. Some of the opportunities will be more applicable to some industries more than others. For example, increasing soil carbon will be more achievable for a cereal cropper where base soil carbon levels are low than to a high producing dairy farmer who will typically have soils with a high carbon content.

The approved activities are:

- Reforestation and revegetation – There are some tight rules around tree plantings that you must be aware of to comply – at least 10 metres wide and at least 2ha for a start. Apart from tree belts and on turnout paddocks, it's hard to imagine dairy farmers turning over productive land to trees. My calculation says that you would need to get near \$100/t CO_2-eq to make it worthwhile in the Macalister Irrigation District growing 13-14 tDM/ha/yr.

The carbon price will be less for less productive land to make that change in land use worthwhile. Talk at the moment is for an opening price for carbon of $20-30/t CO2-eq.

- Reduced methane emissions from livestock – This is the biggest source of emissions on farm. Highly digestible feed and cereal supplements, along with products like Rumensin, are the best way to minimise emissions at the moment. Many dairy farmers are already doing this. There is a lot of research going on to develop a product that can be introduced to the rumen to change the way the microbes work and reduce methane production. The good news is that any reduction in methane production will result in an increase in milk production. Wait for that one.
- Reduced fertiliser emissions – Products are being developed to add to urea to slow the conversion to nitrous oxide. The upside is that will less lost to the atmosphere there will be more N available to the pasture to boost growth rates. Also worth waiting for but in the meantime follow best practice to reduce emissions by adding fertiliser only when it is needed and never when paddocks are waterlogged.
- Effluent management – Emissions released from dairy effluent are very low from a whole-farm point of view. There may be opportunities to cover ponds to collect methane and then burn it off to the less dangerous carbon dioxide to claim a credit. You will have to do the sums to know if it is worth it.
- Reduced emissions from soil or increased soil carbon sequestration –for many farmers believe that this is the great hope but for dairy farmers it is the most risky. Normal farming activity like cultivation and drying off paddocks over summer will bring a fall in soil carbon, as will overgrazing. Many dairy soils, particularly in irrigated/summer growing areas, already have high levels of organic matter (soil carbon) so opportunities are very limited. The best way to raise soil carbon is to under-utilise grown pasture – at the carbon price suggested it is far from worth it.

Farmers and landholders can participate by:

- Obtaining the necessary approvals and managing and reporting the project themselves;
- Using a specialist service provider to assist with project reporting and management; or
- Allowing other companies, known as offset aggregators, to undertake the offset activity on their land. They will manage offset projects on a number of farms, possibly each with a different deal. By joining a group of farmers who, together, guarantee a minimum level of emission reduction, there can be some flexibility to move in and out as, for example, seasons change or circumstances change.

This is explained in the Box below.

As it stands, the CFI has the potential to encourage some farmers along to reduce emissions and receive a benefit for it. However, for dairy farmers there is unlikely to be significant benefit until there is a high-tech way to reduce methane emissions from our cattle and, to a lesser extent, until the fertiliser inhibitors are developed.

As carbon trading is introduced it is likely that new opportunities will emerge as a wider range of activities are recognized for their potential to reduce emissions and more players are actively operating in the marketplace. It is also conceivable that in the future private companies will approach dairy farmers with incentives to invest in a range of emission reduction measures in order to pick up the carbon credits for any emissions saved. For this reason it is critical that you stay informed so that you can make the best decisions for your business.

Participating in the Carbon Farming Initiative

Example 1:

Farmer A chooses to undertake a project to reduce fertiliser use on his farm. He finds the appropriate CFI methodology to use, becomes a recognised offsets entity and gets his project approved by the CFI scheme administrator.

Farmer A undertakes the project, using less fertiliser on his farm, and each year completes a report, has it audited and submits it to the administrator.

At the end of each year, some credits are issued into Farmer A's account in the Registry based on the amount of emissions reduced, which he can sell to another entity that trades in CFI credits.

Example 2:

Farmer B has decided she wants to grow a carbon sink forest on her farm, but doesn't want to have to worry about the paperwork, so appoints an agent to look after this on their behalf.

Farmer B plants the trees and looks after them. The agent takes care of the project application, reporting and auditing.

The agent may charge a fee for their services and all carbon credits are issued to Farmer B which she can sell to another entity that trades in CFI credits. Alternatively, Farmer B can hand over the rights to the CFI credits to the agent who will pay the farmer a fee for growing the trees (this fee may not be related to the value of the credits). (Ref. 9)

Where to from here for dairy farmers?

There is already a market to trade savings in energy consumption through Renewable Energy Certificates (RECs) so it is well worthwhile getting an energy audit at the dairy to know in advance where the best gains might be made. Very often emission reduction results in cost savings, although some changes will require investment first. Some activities will be cheap and easy and worth doing straight away.

In the meantime, reduce farm emission by following best practice in irrigation, fertiliser application and energy use, but think very carefully before you get too involved in generating and selling carbon credits. There may well be a sting in the tail for the unwary.

Having worked through this process on a fairly typical dairy farm in the Macalister Irrigation District, there are a number of recommendations that can be made:

- Spend time considering your options but invest to protect the farm business first;
- Wait for clearer policy signals from the Government before making big investments;
- Implement low cost actions first – they are usually best management practices that will make you money anyway;
- Invest in other emission reduction strategies as you can afford them;
- Be ready to absorb the cost of any compulsory actions;
- Stay informed and watch out for snake oil salesmen – they are usually selling snake oil.

EMISSIONS REDUCTION STRATEGY AT THE MDF

The strategy proposed for the MDF is based on a number of key elements:

- The initial target is for a 5% reduction in farm emissions by 2020 but opportunities for good and strategic investments that reduce emissions further will not be ignored;
- Because of uncertainty moving into a carbon restrained economy, a medium term view has been taken with a payback target for any investment at five years. Investments that have a longer payback period will be considered in the light of other incentives or cross subsidies to bring the payback period back to five years;
- The strategy includes a combination of emissions reduction actions and emissions offsets for greatest flexibility;
- The risk involved in investing in the Carbon Farming initiative are seen as too high to be worth the investment when other lower risk actions are available.

The plan to reduce carbon emissions at the MDF is as follows:

	Adjusted capital cost (Less incentives & RECs) $ (excl. GST)	**Payback period Yrs**	**Emissions saved tCO2-eq/yr**	**% of farm emissions saved**
1. Improve insulation of HWS at the base	$50	0.3	2	0.1
2. Improved plate cooler performance with new pump	$1,800	2.1	7.75	0.15
3. Heat recovery unit	$6,800	2.9	17.7	0.9
4. Solar electricity at one pump site – 1.5 kW as long as the **premium** feed-in tariff can be accessed.	$7,370	4.7	3.1	0.2
5. Solar HWS	$17,190	6.2	34.0	1.7
6. Renewable energy from electricity retailer when price difference is 3.5c/kWhr	0	0	108.8	5.4

The highest priority investments, even though the emissions savings are low, are those that are the easiest and least expensive that also has milk quality benefits.

The heat recovery unit is seen as a less expensive option to reducing water heating emissions than the more expensive warm water wash system. If we were building a new dairy and the price of the wash unit comes down we should consider it as an option but in an established dairy there is little incentive at the price for both the electricity cost savings and emission savings.

The solar electricity array at a pump site saves little in emissions but by accessing the feed-in tariff it generates a significant saving in power costs that can be used to cross-subsidise more expensive actions like the installation of solar hot water at the dairy. This is a key to a strategic approach – whilst the focus is on emissions reduction, any investment must improve or at least maintain the viability of the business. This action has the added benefit that once access to the feed-in tariff has been approved extra panels can be purchased and added to the system (up to 5kW) at any time and still access the higher tariff and further reduce emissions (up to 2.2% of total farm emissions).

Investment in solar hot water is recommended because it is a known technology that easily integrates into our current system. This is also an important element of this strategy – we don't like surprises! It is a low cost investment for each tonne of emissions reduction and represents good value from an environmental point of view.

One of the greatest challenges faced by all businesses is to control costs. Because renewable energy will not be subject to any carbon tax or carbon permit costs it will not be affected by any trading schemes, other than perhaps to come down in price as it becomes more mainstream. By choosing renewable energy at the time when the difference in price between renewable and non-renewable power is closer together we will effectively cap the impact of any carbon scheme on electricity costs. This generates greater financial certainty and lower risk as we move into an unknown future.

This strategy achieves a total farm emission reduction of 8.45%, in excess of the national target. Whilst all of these actions reduce emissions they also generate cost savings that means that an investment in the next 18 months will have them all paid for by the 2020 target date.

At this stage, any further reduction in carbon emissions come at considerably greater cost with longer payback periods. We consider it wise to wait for the development of rumen modifiying actions that can reduce methane emissions and additives to urea to reduce breakdown to nitrous oxide as the next big step in emissions reduction. In the meantime, we will continue to feed our cows well and use best-management practices for fertilizer application to minimise our emissions.

Ref No.	Reference
1	ABARE, *Australian Commodities* (Sept 07)
2	Dept of Climate Change, Fact Sheet *Agriculture Emissions* (May 09)
3	Dept of Climate Change, White Paper *Carbon Pollution Reduction Scheme: Australia's Low Pollution Future* (Dec 08)
4	Dept of Sustainability & Environment, *Climate Change in Victoria: 2008 Summary*
5	GippsDairy *What does climate change mean for dairy in Gippsland* (Feb 08)
6	Dept of Primary Industries (Vic), Issues Brief *Impact of Emissions Trading on Farm Costs* (Mar 09)
7	Dept of Treasury, *Australia's Low Pollution Future: The Economics of Climate Change Mitigation*, 2008
8	ABARE, *Issues Insights Agriculture & the CPRS: Economic issues and implications* (Mar 09)
9	Dept of Climate Change & Energy Efficiency, *Carbon Farming Initiative Consultation Paper* (Nov. 10)

APPENDIX 1: MDF DAIRY ENERGY AUDIT

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Energy Assessment Action Plan

Macalister Demonstration Farm

Energy Efficiency for Your Farm

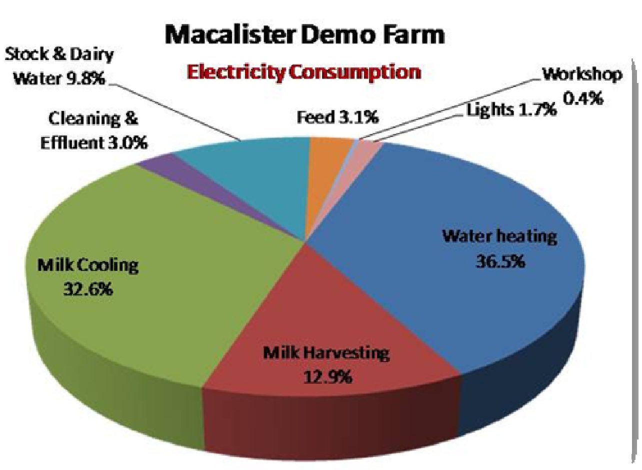
Thanks for electing to conduct an energy audit on your dairy. This is a good opportunity to examine energy use and indentify where improvements can be made.

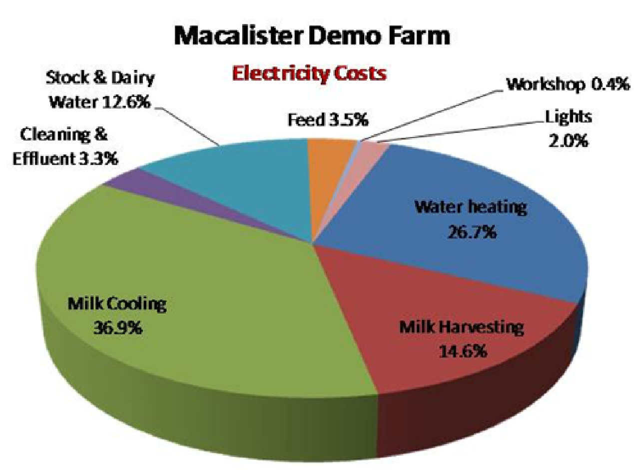
Often just small changes like improving plate cooler performance can make a big difference to the cost of your electricity bills over a year and the amount carbon pollution produced. Over the long term, significant energy and financial savings can be achieved by operating existing equipment more efficiently or replacing outdated/less efficient equipment.

Becoming more energy efficient saves money, improves your operational performance and enhances your reputation among customers, staff and the community.

Your Current Electricity Use

Based on the energy bills you supplied the annual electricity costs for the dairy total $11,953.02 for the 2010 financial year. Greenhouse gas emissions for that year's electricity use equated to 107 tCO_2e.





Using these bills together with the audit undertaken at the dairy on 12/11/2010 I have calculated following breakdown for electricity use and costs:

The audit has identified that heating water & cooling milk account for almost 70% of the electricity used at the dairy. In terms of costs milk cooling was the largest contributor; representing 36.9% of the total.

These two areas; water heating and milk cooling should be the focus of your energy saving action plan.

Your Energy Efficient Action Plan

The following table lists the actions that will improve energy efficiency and help you to save money. Preference should be given to implementing these actions in the order of priority listed.

Priority	Area of Focus	Description	Estimated cost for priority	Potential Annual Savings	Payback (years)
1	Milk Cooling	Need to confirm bore water temperature. Confirm plate cooler is correctly sized (contact your local milking machine dealer) and plates are clean. Improve the pre-cooling performance by increasing the water flow rate through the plate cooler. Aim for at least twice the peak flow rate of the milk pump (the Westfalia plate cooler prefers 2.5 x the milk flow rate). Milk pump flow rate can be established during milking by catching milk into a bucket. Milk should be cooled to within 2 degrees of the incoming water temperature. A dedicated pump may be required. Be sure to select a pump designed for this purpose. A good example is the Calpeda 10A water pump (rrp $896 ex GST). This pump can deliver up to 20,000 l/hr and is well suited as a plate cooler pump.	$1,800	$842	2.1
2	Hot Water & milk cooling	Improved cooling performance could be achieved by installing a heat recovery unit. The heated water could be used as a feed for either (or both) of the hot water services. The performance gain from a heat recovery unit may be equivalent to lowering the temperature of milk entering the vat by 2-3^{o}C.	$5,500	$1,922	2.9
3	Milk Cooling	Investigation of the average wet bulb temperatures, from the nearest weather station (see below); suggests there could be an opportunity to further reduce cooling costs by installing a draft force cooling tower. These are a very efficient way to lower the milk temperature prior to entering the vat. However, detailed partial budgets are required to ascertain the worthiness of this option.	$5-10k	Depends on assumptions used and capital invested.	

Wet Bulb Temperatures and Cooling Towers

In theory, the lowest water temperature available from a cooling tower is the wet bulb temperature of the ambient air, which depends on the air's relative humidity.

In practice, the water temperature can be reduced to within about 5°C of the wet bulb temperature. The table below provides local monthly average wet bulb temperatures.

Mean wet bulb temperature (°C) for years 1943 to 2010*	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
9am	15.3	15.5	14.1	11.7	9	6.6	5.8	7.2	9.3	11.3	12.7	14.1
3pm	17.2	17.6	16.4	14.2	11.7	10.3	9.6	10.1	11.4	13	14.5	15.8

Source: Bureau of Meteorology – East Sale Airport

Worthwhile Low Cost Energy Saving Actions

Area of Focus	Description
Milk Cooling	• Monitor plate cooler performance once a week • Service plate cooler annually • Clean fins on condensing unit once a month • Service refrigeration unit annually
Hot Water	• Check thermostat setting once a month • Test the temperature loss of the 1000 L HWS. If greater than 15% (in 24hrs) then identify ways to better insulate. This may involve inserting wooden slats between the bottom of the HWS and the top of the stand. • Check condition of anodes every six months. If there is rapid corrosion of anodes, increase checking frequency.
Vacuum Pump	• Ensure belts are correctly tensioned and pulleys correctly aligned • Ensure belts match pulleys
Lighting	• Repair defective sensor light at milk room entrance • When replacing globes selected the most efficient lighting for the task. Refer to fact sheet on lighting.
General	• Quickly attend to and repair water leaks. • Introduce natural lighting where possible (e.g. in bore pump area) and in the pit.

Further Information

A series of InfoSheets covering energy efficiency related to building and operating a dairy (produced for Dairy Australia) is available from the Dairying for Tomorrow website:

Titles include:

A1: Getting Started

A2: Thermal Efficient Design

A3: Construction Materials

A4: Renewable Energy Sources

B1: Dairy Lighting

B2: Dairy Pumps & Motors

B3: Heating Water

B4: Cooling Milk

C1: Water at the Dairy

If you would like additional information or assistance to implement these actions do not hesitate to contact me.

Disclaimer

This report documents the results of preliminary observations and analysis of material presented to AgVet Projects by the Customer. The findings, conclusions and recommendations and all written material contained in the report represents our best professional judgement based on the information made available.

The analyses have been based on estimated data and based on visual inspection where appropriate. Recommendations are based on average conditions and generic data. AgVet Projects warrants that our services have been performed in a professional manner & in accordance with applicable professional standards.

Gabriel Hakim

AgVet Projects

19th November 2010

APPENDIX 2: OPTIONS FOR MDF EMISSIONS REDUCTION

Alternatives at the Dairy	Adjusted capital cost (Less incentives & RECs) $ (excl. GST)	Lifetime	Power production saving kWh/yr	Payback period Yrs [1]	Emissions saved tCO2-eq/yr	% of farm emissions saved	Cost of action $/tCO2 -eq	Value of REC to bring payback to 5 yrs $/tCO2-eq	Comment
Improve efficiency of dairy energy use									
Improve insulation of HWS at the base	$50	15	1400	0.3	2	0.1	$1.70	No RECs for this action	After 4 months this action saves $145+ each year. Essential.
Improved plate cooler performance with new pump	$1,800	15	7,525	2.1	10.5	0.5	$11.40	No RECs for this action	Has the added benefit of lowering risk of milk quality decline. Essential
Heat recovery unit	$6,800	15	8,227	2.9	11.5	0.6	$39.40	No RECs for this action	Immediate benefits and reasonable payback period. Worth considering as a cheap source of hot water along with milk quality benefits.
Renewable power from electricity retailer									
All electricity comes from renewable sources purchased from an electricity retailer beginning in 2012. Cost of renewable power in 2010 is 28% higher than non-renewable tariff.	0	**Indefi-nite**	77,244	0	108	5.4	0	No RECs for this action	Timing of switch depends on the proportion of peak: off-peak power use. At MDF 41% of power used in the dairy is peak power. The higher the use of peak power to off-peak power the sooner a switch to renewable energy will be viable. A switch to renewable energy is not viable for about the first five years until carbon price increases to about $28/tCO2-eq or when the peak tariff is about 3.5 cents/kWh higher than the renewable energy tariff.
Solar power fed back to the grid									
Solar electricity - 1.5 kW; Assume 70% of power generated is fed back into the grid at the **premium** feed-in tariff [2] and remainder used to reduce power use.	$7,370	20	2,223	5.2	3.1	0.2	$118	$33	Start saving immediately and maximise the period on the premium feed-in tariff to minimise payback period.
Solar electricity - 3 kW; Assume 70% of power generated is fed back into the grid at the **premium** feed-in tariff and remainder used to reduce power use.	$12,900	20	4,447	4.5	6.2	0.3	$104	Payback calculation based on $30	Start saving immediately and maximise the period on the premium feedin tariff to minimise payback period.

Solar electricity - 4.6 kW; Assume 70% of power generated is fed back into the grid at the **standard** feed-in tariff and remainder used to reduce power use.	$19,370	20	6,672	8.3	9.3	0.5	$104	$92	Start saving immediately but payback period extended by missing out on premium feed-in tariff.
Solar Hot Water									
Solar HWS (three x 300 litre Solarhart)	$17,190	15	24,279	6.2	34	1.7	$34	$72	
Low Temperature Dairy Plant Wash									
Westfalia low temperature dairy plant wash and recycling system with reduced hot water heating	$50,000	15	20,615	17.4	28.9	1.4	$115	$520	
Combination of Emission Reduction Measures									
Solar HWS & renewable energy from electricity retailer	$17,190	15	24,279	6.2	34.0	1.7	$34	$72	When electricity source is switched to renewable energy then 5% of total farm emissions is saved.
Solar HWS, refrigeration heat recovery unit, & renewable energy from electricity retailer	$17,190	15	36,924	4.2	51.7	2.6	$22	Payback calculation based on $30	When electricity source is switched to renewable energy then 5% of total farm emissions is saved.
Solar HWS, refrigeration heat recovery unit, 4.6kW solar electricity (Premium feed-in tariff), & renewable energy from electricity retailer	$42,010	20	43,596	4.6	61	3.0	$34	Payback calculation based on $30	When electricity source is switched to renewable energy then 5% of total farm emissions is saved.

Notes:

[1] No provision has been made for inflation or interest on borrowed fund in the calculation of payback period.

[2] Solar systems of greater than 5kW cannot access the premium feed-in tariff in Victoria. There is also a cap of 100MW of installed generation capacity for solar installations which is expected to be reached in 2011. Once this is reached the feed-in tariff will drop to about 80% of the peak power rate. Only one meter on each property can access the premium feed-in tariff.

Alternatives for water pumping	Adjusted capital cost (Less value of incentives & RECs) $ (excl. GST)	Lifetime	Power production /saving kWh/yr	Payback period Yrs	Emissions saved tCO_2-eq/yr	% of farm emissions saved			Comment
Renewable power from electricity retailer									
All electricity comes from renewable sources purchased from an electricity retailer beginning in 2011	**0**	**Indef-inite**	22,192	0	31	1.5		No RECs for this action	Timing of switch depends on ratio of peak:off-peak power use. At MDF 58% of power used to pump for fixed sprays is peak power. The higher the use of peak power to off-peak power the sooner a switch to renewable energy will be viable. A switch to renewable energy is not viable for about the first five years until carbon price increases to about $28/$tCO_2$-eq or when the peak tariff is about 3.5 cents/kWh higher than the renewable energy tariff.
Solar power fed back to the grid									
Solar electricity - 1.5 kW; Assume 90% of power generated is fed back into the grid at the **premium** feed-in tariff and remainder used to reduce power use.	$7,370	20	2,223	4.7	3.1	0.2	$118	Payback calculation based on $30	Start saving immediately and maximise the period on the premium feed-in tariff to minimise payback period.
Solar electricity - 3 kW; Assume 90% of power generated is fed back into the grid at the **premium** feed-in tariff and remainder used to reduce power use.	$12,900	20	4,447	4.1	6.2	0.3	$104	Payback calculation based on $30	Start saving immediately and maximise the period on the premium feed-in tariff to minimise payback period.
Solar electricity - 4.6 kW; Assume 90% of power generated is fed back into the grid at the **premium** feed-in tariff and remainder used to reduce power use.	$19,370	20	6,672	4.0	9.3	0.5	$104	Payback calculation based on $30	Start saving immediately and maximise the period on the premium feed-in tariff to minimise payback period.
Solar electricity - 4.6 kW; Assume 90% of power generated is fed back into the grid at the **standard** feed-in tariff and remainder used to reduce power use.	$19,370	20	6,672	7.8	9.3	0.5	$104	$44	Start saving immediately but payback period extended by missing out on premium feed-in tariff.