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Energy and Agriculture in Australia and New Zealand: Politics, Prices and Economic Outcomes[1]

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Energy is a significant agricultural input in both Australia and New Zealand. Likewise agriculture in NZ Australia has the potential to produce significant energy sources – the extent to which depends on the price of competing energy sources – particularly oil. Higher energy prices, resulting in changes in land use in North America also have the potential to significantly impact the demand for, and prices received, for Australian and New Zealand agricultural commodities. This paper analyses recent statistics on agricultural energy consumption in both Australia and New Zealand and considers the relationship between energy prices and aggregate economic activity and economic activity in the farm and farm processing sector. It explores the impact of alternative energy price scenarios on Australian and NZ agriculture. It is informed by both CGE analysis of the NZ economy and results of international studies. The evolution of outcomes is sensitive to both global energy prices and the policy responses of the Australian and New Zealand Governments.

[1] Invited paper, 51st AARES Annual Conference, Queenstown, February 2007.

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Introduction

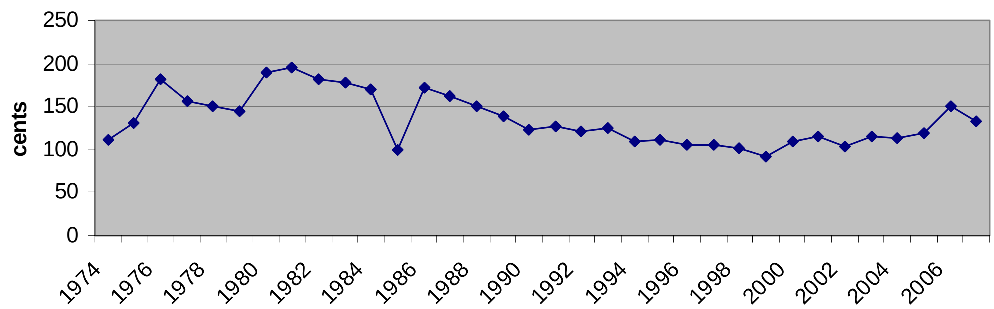
The last few years have been a great opportunity for energy economists to use their analytical skills to address issues of significant public interest. Attention has focused on reducing greenhouse gas emissions, ensuring reliable energy supply, and the cost of energy and its impact on economic activity (energy markets and their regulation). This paper takes a different path and back to consideration of the very direct links between agricultural economics and energy economics. It begins with consideration of the place of energy in the NZ and Australian economy. It then considers energy consumption on farm and the potential for energy production on farm. The focus then moves off farm to consider energy consumption off farm with a focus on activity in the farm processing sector. Consideration is then given to the impact of higher energy prices on agricultural commodity prices. Clearly changing commodity prices impacts agricultural production choices and hence energy production and consumption.[2]

The subtitle of the paper indicates something of the tenor of the paper. Energy production and consumption is determined by the interplay of market and political forces. The institutional frameworks and associated policies are critical determinants of the opportunities and constraints facing farmers, farm processors and those who trade in agricultural products. Given the range of stakeholders and complexity of issues participants in energy policy debates often argue from assumptions that are not carefully scrutinised. This paper seeks to focus consideration on what are feasible

[2] The paper ignores transmission issues (both negative externalities and obligations to supply) and electricity pricing issues.

possibilities during the next decade as opposed to possibilities that only exist with extreme assumptions. The expectation is this consideration will help analyst determine their priorities for research in the next period of time.

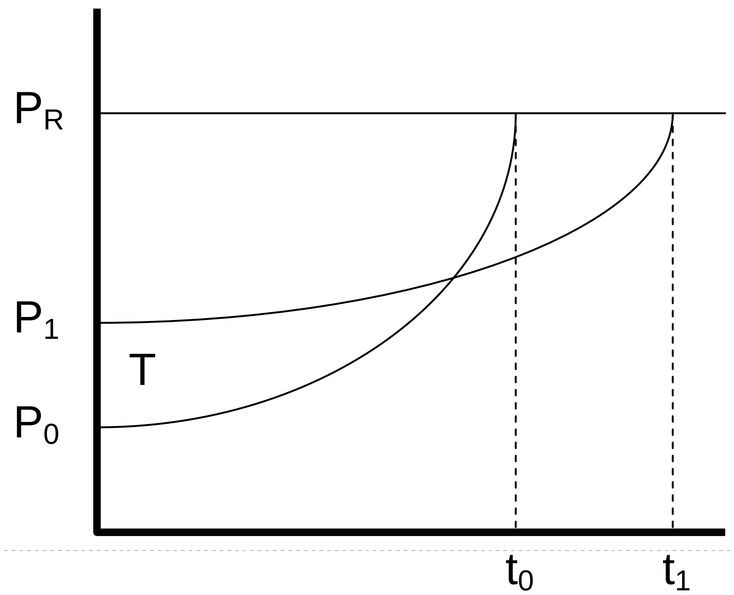
Figure 1
Real NZ Petrol Prices (91 octane)
(2005 Base)



(Source, MED)

It is appropriate to remember some recent history of energy analyses in this part of the world. Many influential NZ analysts in the 1970s failed to recognise economic agents respond to changes and projected energy prices so high as to make various State investments profitable and left the legacy of "think big" projects which were severely critiqued with the benefit of hindsight. Chudleigh et al (1979?) reported that from 1968-76 fuel, vehicle and wages rose between 250 and 300% but transport costs only increased by 100%. It is appropriate to note the extent of energy price fluctuations within recent decades. Figure 1 show real petrol prices in NZ since 1974. It indicates that the higher prices experienced during 2006 do not look particularly extreme. Further, firms make immediate choices in response to both shocks and longer term decisions based on their expectations. Part of these expectations depends on expectations as to possibilities of transition to new energy sources as per Figure 2 which highlights the significance of changing reservations prices and the impact of government choices with respect to both research and energy taxes.

Figure 2: Technical Change and energy transitions



Recent NZ policy has focused on reducing greenhouse gas emissions and the enhancing the performance of energy markets. The NZ Ministry of Economic Development (MED 2006a) identifies key indicators pertaining to security, access, efficient use, fair pricing and adverse effects. Overall the current NZ government is willing to be more interventionist than recent governments as it seeks to resolve tensions in the energy sector but as it does so it faces great challenges with regard to policy coherence. Likewise this tension is apparent in Australia when one considers State initiatives such as Queensland’s Energy Policy (Queensland Government, 2000) or the debates about mandatory renewable energy targets (Kent and Mercer, 2004).

Energy and the Economy

Energy prices impact agriculture in many ways. The obvious impact is in higher on farm and processing costs and the adverse impacts on farm households via increasing costs of non farm activity. However as we all know energy markets are both global and local and higher energy prices impacts the wealth of different economies in different ways depending for instance if they are a net energy exporter or a net energy importer. Further dynamics are important and how well adjustment occurs. The so called "Dutch disease" is a reminder that the challenge is critical for energy exporters as energy importers.

During the last two decades there have been surprises in the performance of our respective economies. The Australian economy has become less energy intense (energy consumed/$GDP) despite the relatively low energy prices for much of this period (Akmal, et al, 2005). However what is not surprising is consumers and firms adjust their consumption patterns in the light of changing relative prices. Recent projections in both NZ and Australia show ongoing increases in energy consumption during the next 2 decades despites expectations of higher energy prices (Akmal et al 2006 and MED, 2006b).

Two fundamental questions arise. What is the likely impact of higher energy prices on our economies? And what is the likely impact of policy interventions on both energy prices and consumption and the economy more generally? Our CGE modelling of the NZ economy shows a sustained 1% increase in energy efficiency could increase the GDP trajectory by 0.8% per annum and real wages by more than 1% (Fatai et al,

2003) but it is appropriate to step back and consider existing energy consumption patterns.

Energy consumption by NZ agriculture is significant being 8% of total industrial consumption and when combined with dairy and meat processing it becomes more than 20% of total industrial consumption or nearly 10% of total energy consumption (Table 1). The situation is different in Australia with Agricultural energy consumption closer to 2% of total energy consumption (Table 2).

Table 1: NZ energy consumption 2004

Sector	Consumption MWh	%	Energy $m	Lines $m	c/kWh
Agriculture	1,284,620	8.0	107.6	67.7	13.65
Dairy	752,980	4.7	38.2	28.2	8.82
Other food	621,975	3.9	40.3	21.2	9.89
Meat	643,370	4.0	42.3	17.2	9.25
Tot Industrial	16,151,006	100	953.6	354.8	8.10
All Sectors	35,794,819				11.22

Source: MED, 2005

Table 2: Australia primary energy consumption by sector 2003-04

	PJ	%
Agriculture	87	1.60%
Mining	221	4.07%
Petroleum refining	90	1.66%
Manufacturing & construction	942	17.33%
Electricity generation	2462	45.30%
Transport	1282	23.59%
Commercial & services	71	1.31%
Residential	216	3.97%
Other	64	1.18%
Total	5435	100.00%

Source: Akmal, et al, 2005

It is also appropriate to note the significance of lines charges for agriculture in NZ and the important place of infrastructure costs as opposed to energy costs.

Given the importance of greenhouse gas emissions we have modeled the impact of alternative taxes on the economy. The simulations undertaken included the introduction of an energy tax, a carbon tax and a petroleum tax. The rate of taxation is set so that each type of tax collects revenue equivalent to 0.6 percent of GDP in the base-case. The results are of significance both in terms of what they tell us for greenhouse gas policies but also what they tell us about the impact of higher energy prices on the NZ economy. The key thing to note is the adverse impact on the export sector. However when considering the case of higher market prices for energy as opposed to the tax case we must take account of the impact on export prices.

Table 3: Effect of taxes on selected NZ macro variables

	Energy tax	**Carbon tax**	**Petroleum products tax**
Income tax rate	-0.62	-0.68	-0.82
HH consumption	-0.09	-0.10	-0.20
Working K	-1.12	-1.26	-0.82
Fixed K	-1.58	-1.62	-0.75
Investment	-0.51	-0.54	-0.32
Volume X	-1.54	-1.70	-1.62
Volume M	-0.78	-0.89	-0.91
GDP	-0.38	-0.39	-0.29

Source: Scrimgeour, et al., 2005.

Different tax specifications impact different economic sectors to a significant degree. For agriculture an energy tax is less costly whereas a carbon tax or a petroleum product tax is more costly in contrast to the mining sector were an energy tax or a carbon tax is twice as costly as a petroleum tax. These results are reported in Table 4.

Table 4: Effects of alternative taxes on NZ sectors

	Energy tax	Carbon tax	Petroleum prod tax
Petrol products	-1.52	-1.34	-1.62
Construction	-0.93	-0.80	-0.62
Mining	-4.12	-4.51	-2.00
Transport	-0.55	-0.50	-0.71
Wood products	-0.43	-0.52	-0.41
Electricity	-3.21	-3.62	1.27
Metal products	-3.66	-3.92	-3.12
Agriculture	-0.31	-0.42	-0.40

Source: Scrimgeour et al, 2005.

Given the preoccupation with energy forecasting it is appropriate to note that estimates by Owen (2006) indicate that if the true price of externalities were included in energy pricing we would see a substantial shift towards renewable energy production and consumption. If this were to occur we would not be surprised to see further reductions in renewables costs as the technologies and their commercial applications evolve.

Energy Consumption on the Farm

Energy use on farm varies significantly between farm types. Energy use on arable farms has been dramatically declined where no-till agriculture or reduced till agriculture has been adopted. Wood et al (2006) examine energy consumption on organic farms versus conventional farms and conclude that although organic farms use more energy on farm they are more efficient if you take account of energy consumption along the length of the production and supply chain. This paper however focuses on dairy farming where ether is considerable data available concerning energy use. For NZ dairy farms there is considerable variation in energy use depending on the location and size of the unit. Table 5 report energy use for Canterbury and Waikato farms and highlights the significance of energy costs associated with irrigation.

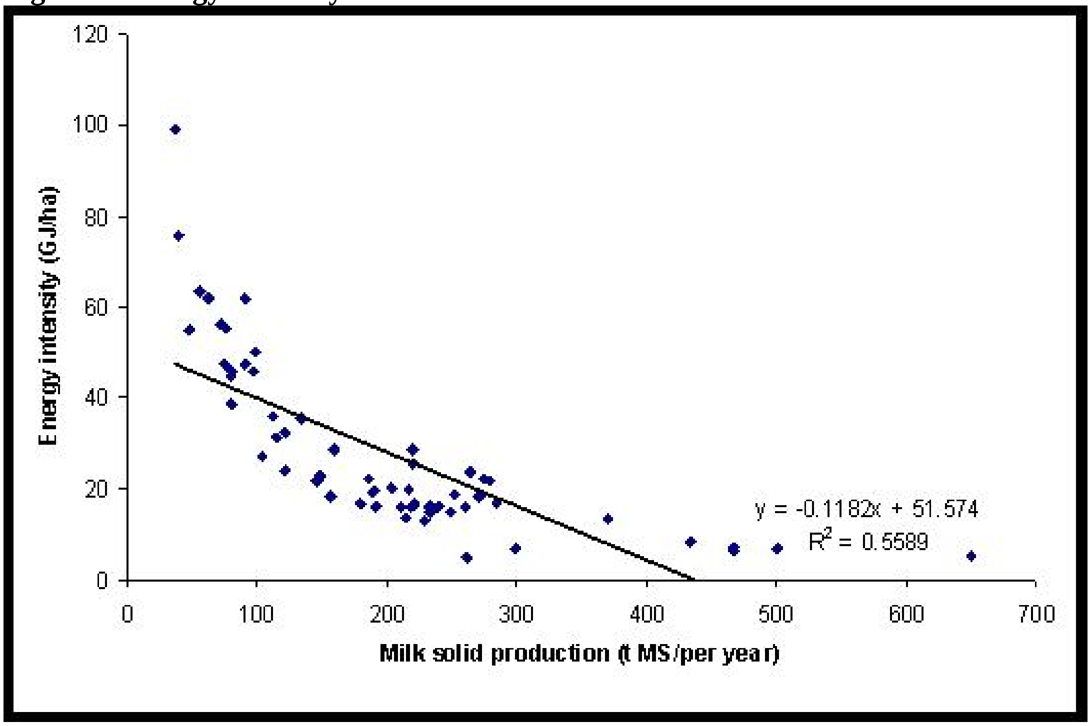
Table 5: Energy Use on NZ Dairy Farms (MJ/kgMS)

	Waikato	Canterbury
Fertilizer	18	19
Electricity	17	15
Liquid Fuels	12	13
Irrigation		16
Total	47	63

Source: Sims et al., 2006

Figure 1 highlights the significance of farm size for energy intensity and shows how small farms are much more inefficient users of energy. This indicates higher energy prices will be another pressure reinforcing the ongoing increase in average farm size. However the farm size effect is arguably in large part caused by framer knowledge and investment choices. Table 6 reports evidence on energy consumption on typical farms and compares this with energy use on energy efficient commercial farms. The evidence indicates her is substantial potential for many dairy farms to increase the efficiency of their energy use.

Figure 1: Energy Intensity and Farm Size



Source: Sims et al., 2006

Table 6: Energy Use per cow (kWh)			
	Typical Farm	Energy Efficient Farm	Difference %
Water heating	32	23	28
Milk chilling	26	19	27
Milking machine	24	15	38
Water pumping	23	18	22
Miscellaneous	18	15	17

Source: Sims et al., 2006

The potential for reducing electricity consumption on farm is considerable and involves straightforward technical adjustment such as: insulating water cylinders and milk vats; use of heat exchanges for pre-cooling milk and preheating water; optimal sizing of water heaters and vacuum pumps; the use of variable speed pumps; and the use of just in time water heating. These technologies would not impact farm practice. However if it was perceived to be economic further gains could be achieved by reduced fertilizer use; more efficient vehicle use; once a day milking; and optimising the time of milking and irrigation. Given that the average farm dairy is 20.75 years with milking equipment 10.85 years old and the average dairy farmer is over 50 it would seem there is significant potential for reducing on farm energy consumption patterns. That could be further supplemented on the supply side by the use of biogas digesters, windmills and solar panels.

Energy Production on the Farm

Significant research has been done in the last 30 years exploring the energy potential from agricultural production. Lyn Wright documents worldwide development of commercial energy from energy based crops (Wright, 2006). He highlights the fact that bioenergy consumption is greatest is countries with heavy subsidies or tax incentives and notes the potential of agricultural residues in Australia and pine forest residues in NZ. Pimental and Patzek (2005) have done significant work researching ethanol production from corn, switchgrass and wood and biodiesil production from soybean and sunflower and their work has shown contrasting results to those published by the USDA. They report that producing a litre of ethanol requires 29% more fossil energy than is produced as ethanol and costs 42 cents per litre. Further ethanol has a low energy comment and 1.6 litres of ethanol has the same energy content as 1 litre of petroleum. Table 7 present some key results from Pimental and Patzek.

These results show how ethanol and biodiesil are uncompetitive and dependent on subsidies. However they also show that if oil prices were to substantially increase ethanol from agriculture and biodiesil could become competitive. Pimental and Patzek suggest the fundamental challenges are the low fraction of sunlight captured by plants; the low percentage of ethanol derived from carbohydrates (with corresponding energy cost of removing the 92% water); and the low energy yields from oil crops and the energy intensive extraction processes.

Table 7: Energy costs and yields from USA crops

	Energy Input/Output	Cost/litre
Ethanol		
Corn	1:3.8	$0.45
Switchgrass	1:14.4	$0.54
Wood cellulose		$0.58
Biodiesil		
Soybeans	1:2.6	$1.21
Sunflower	1:0.76	$1.66

Source: Pimental and Patzek

The Australian Biofuels taskforce (2006) and Von Lampe(2006) at the OECD has presented useful summaries of recent research as has the Pacific Economic Cooperation Council (see Armbruster and Coyle, 2007). Sugar has a lot of potential as can be seen by developments in Brazil. Edye et al. (2006) explore the potential of sugar cane biorefineries and see their work leading to a sustainable sugar industry in Australia. They predict disruptive technical change will significantly improve the economics of bi-refining. Enthusiasts will be hoping for rapid progress on this front for as Kirby (2003) reports under current practice it is not economically viable. Tribe (2005) notes the rapid progress in Brazil and the advances in enzyme science and predict rapid progress in this space.

Alzate and Toro (2006) develop balance sheets to show the energy potential from lignocellulosic biomass. This highly technical analysis undergirds the argument of Davidson (2004) who claims “perennial deep rooted plantations of trees and woody shrubs” are an important future energy source. He claims “much of the rationale for a transition to a carbohydrate economy will rest on new issues such as jobs for rural Australians and refurbishing degraded farm landscapes.” In New Zealand work is proceeding in the same space with AgResearch and Scion working with North American partners on relevant enzyme research (Eng, 2007). Raison (2006) provides some words of caution to enthusiasts in this space noting the impact of large coal reserves, uncertain renewables policies, the lack of proven small scale technologies and distribution systems, controversy over forest use and the lack of relevant markets.

Energy Consumption off Farm

Energy consumption off farm is currently an area of significant interest. The work on “Food miles” by Saunders et al (2006) attracted wide publicity and revealed how less energy intensive much of NZ agriculture is compared to Europe. This paper focuses on transportation costs prior to processing and on processing costs. The consideration of transportation focuses on sugar cane and milk.

Higgins (2004)researches the optimal scheduling of sugar cane transport. The research was motivated by the opportunity to reduce capital and operational costs. The new meta heuristic applied to an integer programming model achieved the result and at the same time would have reduced the energy intensity of cane transport. This approach is similar to the work done by Basnet et al. over a number of years (eg

Basnet et al (1999)). They researched tanker milk collection activity. This research has contributed to processing site selection and the optimisation of milk collection for a given set of sites. The creation of a limited set of so called mega sites for milk processing means milk is hauled long distances. During the last decade this has resulted in limited use of rail for long haul. Currently university staff are exploring the potential for reducing volume before transport from a few minor locations.

Energy efficiency ex the factory is difficult to manage. However the establishment of an inland port in the Waikato to improve logistics is one example of evolution that can occur. The continued consolidation of international shipping is likely to play a major role in shaping developments in this area.

Prasad and Pagan (2006) report on energy use in milk processing in Australia. They report significant gains in energy efficiency with the move to larger processing plants and higher levels of efficiency compared to UK plants (see Table 8)

Table 8: Total energy use (GJ/kL raw milk intake) - electrical and thermal

	Median	Variance	* plants	UK ave
Milk only	0.47	17%	5	0.82
Cheese and whey products	0.63	92%	3	1.44
Mainly powders	1.32	531%	9	2.18

Source: Prasad and Pagan (2006)

Dairy processing is energy intensive given the challenge of ddehydration from 97% water to 3% water. The problem is exacerbated by industry practice of plant construction in a hurry with energy design being one of the last margins for optimisation. Better utilization of waste heat is coming with greater awareness of the cost of energy consumption (Kamp, 2006). Prasad and Pagan identify the scope for improved energy efficiency by optimising the scope of energy consuming equipment, recovering eat energy, optimising plant load requirements with electricity supply exploring alternative sources of energy and co-generation.

Each year in NZ Fonterra uses about 10% of NZ's total gas consumption (18 PJ of gas); about 6% of NZ's total coal consumption (330,000 tonnes) and about 1% of NZ's electricity consumption (960GWh less 400GWh produced in cogeneration plants) (MED, 2006b). Cogeneration capacity is even larger being 275GWh at Te Rapa, 477 GWh at Hawera and 203 GWh at Te Awamutu.

Further developments are possible with whey to ethanol plant operating at Hawera but this is not generating any significant economic return.

Energy Prices and Agricultural Commodity Prices

Chudleigh et al. (1979?) concluded a 50% increase in oil prices could reduce farm gate prices for non dairy agriculture products in the order of 2 to 13%. However the increase in oil prices in the first decade has tended to lead to more claims that it will result in higher farm product prices in Australia and NZ. For instance Stringleman (2007) writing in the *National Business Review* argues biofuel production in the USA will accelerate global protein demand which will benefit Australian and NZ beef producers. This argument is supported by numerous North American analysts. FuturePundit (2006) writes "The growing use of corn to produce ethanol is expected to drive up the price of corn by about 25% within a single year". Corn prices in the USA are projected to be average $2.90-$3.30 per bushel compared to $2.05 in

2004/05 and $2.03 in 2005/06. This increase and related projections lead Iowa professors Wisner and Baumel (2004) to worry “Will there be enough corn?”

Danielson argues that concerns about high corn prices are unfounded (Danielson, 2007). He builds his case around three arguments. Firstly he argues there are increasing corn yields per hectare; there is flat corn use in the export and sweetener market and increased use of distillers dried rains with soluble (DDGS) by the livestock and poultry sectors.

Fanin (2007) quoting Henry Bryant sees significant land diversion to corn resulting in pressure on other crops. If this were to occur the demand for corn could be filled without the predicted corn price increases predicted by some analysts. What is interesting is that to the extent ethanol or biodiesil production does take off in North America it does have potential to impact grain and livestock markets. The extent of that impact will partly be determined by choices made in North American poultry and livestock industries and changing production and consumption patterns in other countries, especially the European Union.

It is tempting for analysts to focus their attention on the impact of higher energy prices directly on agricultural markets. However we have long known that energy consumption is strongly correlated with economic growth. This raises the obvious question of whether economic growth lead to higher energy consumption or higher energy consumption leads to higher economic growth. Granger causality analysis sheds some light. Australia and NZ are different from India and the Philippines

Previous work by Fatai et al. (2004) found evidence of a unidirectional link from real GDP to final energy consumption and a unidirectional link from real GDP to industrial and commercial energy consumption in New Zealand and Australia. By way of contrast for India and Indonesia, there was unidirectional link from energy to income and for Thailand and the Philippines a bidirectional link. This suggests great caution when it comes to predicting the impact of higher energy prices on individual economies.

In the long run all kinds of changes can occur as people respond to higher energy prices. This includes changing consumer choices about where and when they consume food. However before economists invest too heavily in seeking to understand these choices it is appropriate to complete core economic analysis on the impact of energy prices in our macroeconomic analyses and the impact of higher energy prices in core agricultural commodity markets.

Conclusion

Consideration of fluctuations and trends in energy prices suggests that energy concerns will continue to bean important policy challenge even though there is little evidence of dramatic economic transformation as was often discussed during the period of high oil prices in early 2006. Shocks will continue to occur and policy makers will act but from an agricultural perspective the bigger issue is how Governments' respond to green house gas emission challenges. This and efforts to regulate energy markets are likely to be the major factors which interact with exogenous shocks to impact agricultural performance and welfare.

Higher energy prices are likely to have an adverse impact on the agricultural sector unless there is offsetting increase in product prices. Given the probability that governments' will continue to pursue greenhouse gas emission reduction strategies it is important to evaluate the evolving policy mix as policy details have a major impact. Farm energy consumption is very responsive to changing energy prices. Evidence from dairy farms suggests there is substantial potential to reduce energy savings associated with technical advance and increased understanding. The agricultural sector has significant potential to produce energy as another commodity. However the low rate of energy capture by plants, the low level of ethanol produced and the high energy costs in extraction suggest that there will not be a dramatic increase in ethanol or biodiesil production quickly unless there are significant technical breakthroughs. Higher energy prices have the potential to positively impact prices for Australian and New Zealand beef exports but analysts should be cautious in their predictions given the lack of robust economic modelling behind any of the current projections.

This review of energy and agriculture in Australia and New Zealand tends to support the view that major change in the short term is unlikely. However analysts would be foolish to lose interest given how close ethanol and biodiesil production is to being economically viable; the significant government involvement in energy markets; and the potential for biofuel production to impact agricultural product prices. The NZ Royal Society (2006) recommended the government be more proactive on this front but it appears that the next decade will primarily be focused on research rather than commercial production.

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