SUBMISSION TO

SENATE SELECT COMMITTEE ON CLIMATE POLICY

John Davidson

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SUMMARY AND CONCLUSIONS:

1. The aim of this submission is to demonstrate that there is at least one alternative for driving down net carbon pollution (NCP) that is significantly better than both emission trading or carbon tax based schemes.
2. In order to demonstrate this, the following alternatives were compared:
    a. The use of a single, grand emission trading scheme (ETS) as the central policy for driving down net carbon pollution (NCP).
    b. The use of a single, grand carbon tax scheme (CTS) as the central policy for driving down NCP.
    c. The use of a multiple scheme approach (MSA) as the central policy for driving down NCP. MSA involves the simultaneous use of a number of separate schemes each of which will deal with a specific aspect of driving down NCP; e.g., a *case specific scheme* aimed at driving down NCP from electricity generation.
3. The comparison included both a general comparison and a comparison of the effectiveness of each alternative for two specific cases:
    a. Driving major investment in clean-electricity. And
    b. Reducing the average fuel consumption of new cars.
4. MSA was demonstrated to be clearly superior to both ETS and CTS for driving investment in clean-electricity. In particular, MSA would:
    a. Avoid the potential for destabilizing the economy as a result of:
        i. The price shocks that both ETS and CTS depend on to justify investment.
        ii. Instabilities in the price of carbon permits flowing through to both prices and the relative competitive position of competing products.
    b. Have a much lower impact on prices.
    c. Give far more predictable rates of change.
    d. Provide more certainty for investors, dirty-electricity producers customers and government.
    e. Give the government more direct control over specifics if required.
    f. Have a more positive effect on world wide efforts by demonstrating that it is possible to reduce NCP at the rates required to meet 2050 targets without putting the economy and jobs at risk.
5. MSA was demonstrated to be clearly superior to both ETS and CTS for driving down the average fuel consumption. The proposed alternative does not depend on increasing the price of fuel and provides more certainty to car manufacturers.
6. It is reasonable to suggest that MSA would be clearly superior in many other specific cases. It is worth noting that MSA always allows the option of using case specific versions of ETS or CTS if this proves to be the best alternative for a specific case.
7. Single grand ETS or CTS schemes:
    a. Will put the same price on carbon for all industries instead of using the optimum price for each industry.
    b. Are less likely to deal effectively with the specific issued associated with particular industries than a case specific approach.
    c. Will tend to create more uncertainty than smaller schemes that deal with a specific issue.
8. Australia will make a major contribution to worldwide NCP reduction if it can demonstrate that it is possible to drive down emissions at the required rate without destabilizing the economy.

RECOMMENDATIONS

It is recommended that:

1. MSA be used as the central policy for driving down NCP.
2. A pragmatic approach be used during scheme development. Developers should be permitted to think outside the *"we must put a price on carbon"* mindset.
3. Over the next few years:
    a. Continue or accelerate existing programmes, at least until they have been reviewed.
    b. Focus initially on a limited number of relatively simple, cost effective actions that will give a predictable reduction in NCP without the need for new technology: e.g., electricity generation and cars.
    c. Periodically issue a call for expressions of interest to help identify potential investment opportunities.
    d. Add additional opportunities to the programme and/or accelerate current action until the rate of NCP reduction reaches target.
    e. Run a first review of other opportunities to reduce NCP to:
        i. Identify action that should be taken in the short term.
        ii. Start the development of a long term plan.
    f. Initiate new specific action schemes.
    g. Monitor rate of change of NCP and act to increase the rate if required.
    h. Revise and extend programmes to encourage community action.

CONTENTS

1.0 INTRODUCTION:

The aim of this submission is to demonstrate that there is at least one alternative for driving down net carbon pollution (NCP) that is significantly better than both emission trading or carbon tax based schemes.

Both emission trading schemes (ETS) and carbon tax schemes (CTS) share the following characteristics:

1. They are grand schemes that set out to provide a complete system for driving down NCP, apart from any specific exclusions, such as those in the governments proposed scheme.
2. They depend on "*putting a price on carbon*" as the sole mechanism for driving down NCP.

The key differences between ETS and CTS are:

1. ETS depends on a carbon permit market to set the price of carbon. The price of carbon for CTS is set by the government in the form of a carbon tax.
2. For ETS, the government ramps down total NCP by reducing the number of carbon permits sold each period. CTS has no mechanism that will automatically limit total NCP.

However, there is no inherent reason that demands that:

1. NCP must be driven down by a single grand scheme.
2. Action must be taken to reduce all sources of pollution at the same time.
3. The system must depend on "putting a price on carbon" to drive down NCP.

Logic suggests that we may come up with better answers if we are allowed to think outside the "one grand scheme" and "putting a price on carbon" mindsets. It may also make sense to focus on a limited number of actions at one time, particularly in the shorter term.

With the above logic in mind, the third approach considered will be a multiple scheme approach (MSA). Key features:

1. A number of schemes will operate at the same time.
2. Some of these may be *case specific* schemes designed to take account of the specific issues associated with a particular industry or opportunity to reduce NCP.
3. Others may be *action specific* schemes designed to drive specific actions such as the harnessing of community support.

The comparison of these three alternatives went through three stages:

1. A comparison for the specific case of driving investment in clean-electricity.
2. A comparison for the very different issue of driving down the average fuel consumption of new cars.
3. A general comparison based on issues that go beyond those considered for the specific cases.

NOTES:

1. The term net carbon pollution is used in recognition that NCP can be reduced by either reducing emissions or adding to the carbon stored in soil, vegetation etc.
2. Carbon taxes may also be used primarily as a source of revenue with any effect on emissions as a bonus.

2.0: CASE 1: DRIVING MAJOR INVESTMENT IN CLEAN-ELECTRICITY

This case considers alternatives for driving major investment in clean-electricity. (Note that a completely different approach may be appropriate for driving minor investment such as the installation of rooftop solar cells.)

2.1: Background:

Electricity generation accounts for approx. 50% of Australian greenhouse emissions. In addition, some proposals for cleaning up other sources of emissions will be more effective when cleaner electricity is available; e.g., the use of plug-in hybrid cars. Some of the reduction in electricity related NCP will come from reductions in per capita consumption of electricity. However, serious investment in clean-electricity will be required in order to meet 2050 NCP targets. This investment may include investment to reduce NCP for existing dirty-electricity generation as well as the construction of new, clean generating capacity.

Special features of the electricity industry that may influence the design of schemes for driving major investment in clean-electricity include:

1. The total investment will be so large that it will need to be spread over decades.
2. Years will elapse between a decision to build extra capacity and this extra capacity coming on line.
3. It will take many years to pay back investment in power generation.
4. The cost of cleaning up electricity is expected to continue dropping as a result of new technology and improvements to existing technology.
5. Generating plant life can be over 20 years.
6. Almost all existing dirty-electricity production will have to shut down or be cleaned up by 2050 if NCP targets are to be met.
7. The order in which dirty-electricity capacity is shut down will not simply depend on emissions/kWh or costs. The choice may need to take account of:
    a. Impact on transmission losses and grid investment requirements.
    b. Vulnerability to localized failures.
    c. Ability to complement the future mix of clean power sources. There is often a trade-off between efficiency and ability to respond to variation in demand.
8. **Location** of new plant may have to take into account factors other than investors' return on investment including:
    a. Overall cost effectiveness, not just cost effectiveness of the new plant itself.
    b. Impact on transmission losses and grid investment requirements.
    c. Vulnerability to localized failures.
    d. Benefits of geographic spread on variation in total wind, solar and/or tidal power output.
9. **Technology** selection may have to take into account factors other than investors' return on investment including:
    a. Potential impact on what happens in other parts of the world; e.g., many countries would welcome a low cost way of reducing NCP from coal fired power stations.
    b. Overall cost effectiveness.
    c. Minimizing transmission losses and grid investment requirements.
    d. Vulnerability to localized failures.
    e. Matching time and seasonal variation of total clean-electricity output to consumption patterns.

f. Benefits of trialling new technologies such as combinations of heat storage with solar thermal.
a. Potential impact on emissions from other sources; e.g., CO_2 sequestration offers the best chance of serious reductions of emissions from cement and steel production.
g. Impact on the Australian coal industry.

2.2: Criteria for a Good Scheme:

Features of a good scheme for driving major investment in clean-electricity include:

1. **Investors** will be seeking certainty re future sales and prices.
2. **Customers** will be looking for:
    a. No large, sudden jumps in the price of electricity.
    b. Low average prices.
    c. Price certainty.
    d. Reliable supply:
        i. Additional capacity sufficient to meet growing demand.
        ii. Enough surplus dirty-electricity capacity retained to provide a capacity safety margin.
2. **Dirty-electricity producers** will be looking for:
    a. Certainty re:
        i. Order in which dirty-electricity generators will be shut down.
        ii. Approx timing of these shutdowns.
        iii. The extent to which a plant would have to reduce NCP/kWh to delay or avoid the need for shutdown.
    b. Reasonable profits during the running down of dirty-electricity production.
3. **The government** should be seeking a system that would:
    a. Not have the potential to destabilize the economy.
    b. Have a positive effect on employment and economic growth.
    c. Have a positive effect on NCP reduction efforts outside of Australia.
    d. Give government control of the rate of clean up.
    e. Give government the option of putting limits on technology, location, ownership, operation etc if required.
    f. Provide a reasonable compromise between the needs of customers, investors and dirty-electricity producers.
    g. Include provisions for ongoing planning, research and development.

2.3: One *Case Specific* Alternative*:

The following suggestion would satisfy most, if not all of the above requirements. This particular alternative assumes that private enterprise would build, own and operate clean-electricity production*. Details:

1. The government would control the rate of cleanup by periodically issuing competitive tenders for the supply of clean-electricity.
2. If required, tender documents would put limits on technology, location, capacity etc as well as the extent to which this might be achieved by clean up of dirty-electricity.
3. The pricing formulae and sales guarantees would be agreed to during tender negotiations. Note that:
    a. The agreed pricing formulae may be different for different contracts.
    b. Sales guarantees and pricing formulae may hold for only a limited amount of time or cumulative power output.

4. New regulations would require that preference normally be given to clean-electricity, provided that it was offered at the agreed price.
5. A similar approach may be used if the proposal involved a partial cleanup of an existing dirty-electricity plant.
6. A plan would be developed for the running down of dirty-electricity production.
7. Pricing formulae and sales guarantees may be negotiated for **part** of the production from dirty-electricity producers. Prices may also be negotiated for standby time and maintaining the option of restarting a plant.
8. It may be necessary to modify the existing marketing and pricing system to fit in with the above changes.
9. Ongoing planning, research and development might be financed by a small electricity levy or simply be part of a larger system.

The above suggestion provides a satisfactory way of dealing with the issues raised in section 2.2 above. In particular:

1. It avoids the need for destabilizing price shocks.
2. Preference is given to clean-electricity.
3. Prices will only ramp up slowly in line with the average cost of production.
4. Prices will be kept low because:
    a. Competitive tenders are used.
    b. Future price agreements can take advantage of improving technology without affecting earlier price agreements.
5. It provides certainty to potential investors.
6. Power shortages will be avoided.
7. It has the potential to provide a reasonable deal for dirty-electricity producers.
8. It gives government control of the rate of cleanup and the option of placing limits on location, technology etc.
9. It will stimulate the economy by providing steady investment opportunities and green jobs.

***NOTE:** No claim is made that that the above is the best case specific alternative for driving investment in clean electricity.

2.4: Emission Trading Scheme:

A comparison of ETS with the case specific scheme described in section 2.3 led to the startling conclusion that ETS would be inferior to the case specific scheme for all of the criteria listed in section 2.2 above. In some cases, the extent of this inferiority was very significant. In particular:

1. **ETS depends on "putting a price on carbon"** to drive change. As a consequence:
    a. There must be a potentially destabilizing jump in the price of electricity before investment in clean-electricity can be justified
    b. Decisions re location, technology etc. will be made by investors on the basis of return on capital.
    c. Decisions re the shutting down of dirty-electricity capacity will be determined on the basis of intense competition between these producers. The result may not be optimal in terms of the total electricity supply system.

2. **The price of carbon is determined by the price of carbon permits traded in a carbon permit market**. As a consequence:
    a. Potential investors in clean-electricity would be exposed to future price related risks due to:
        i. Short term variations in carbon permit prices resulting from:
            - Problems matching supply and demand for clean-electricity.
            - Speculator activity and the normal vagaries of the permit market. The price of EU carbon permit prices had dropped from a 2008 high of €30 down to only €8 per metric tonne CO_2 by 25 Feb 2009 (1). This is equivalent to a drop from 6.4¢ to 1.7¢/kWh* ex generation plant. See attachment A1 for details.
        ii. Drops in longer term average permit prices due to the development of more cost effective ways of producing clean-electricity.
    b. Investment in clean-electricity will tend to follow economic cycles due to the price of permits dropping during periods of lower than average growth. (It would be better if investment was counter-cyclic.)
3. **The government limits the number of new permits issued each period to match a NCP cap that ramps down to the 2050 target.** As a consequence, there is a risk of artificial power shortages or restraints on growth if the investment in cleaning up electricity has not been large enough.

***NOTE:** The World Business Council for Sustainable Development (2) commented recently that "European carbon prices are now far below levels which can, on their own, make expensive, low-carbon energy technologies competitive with fossil fuels such as coal, gas and oil."

The effect of some of these problems might be reduced or avoided by special arrangements; e.g., passing laws that allow governments to specify the location of new wind farms. However, the potentially destabilizing price jumps, uncertainty re the price of carbon and high level of investor uncertainty are fundamental features of ETS.

2.5 Carbon Tax Scheme:

A carbon tax based scheme (CTS) will avoid the problems that arise with ETS as consequence of depending on markets to set the price of carbon and the use of a NCP cap. However:

1. The problems associated with "putting a price on carbon" will be the same as for ETS.
2. The price of carbon (tax rate) is set by the government. If set too low, there will be no investment in clean-electricity. Too high and the price of electricity will be higher than necessary.
3. CTS provides no mechanism for controlling the rate of clean-up.
4. Carbon taxes might be reduced in response to the development of lower cost methods of clean power production. However, the threat of future tax reductions would be seen as an additional risk by investors. (Unless compensation for the effects of tax reductions was agreed to before the investment was made.)

2.6 Conclusions – Driving Investment in Clean-electricity:

The case specific scheme described in section 2.3 was clearly superior to both ETS and CTS for driving major investment in clean-electricity.

3.0: CASE 2: DRIVING DOWN THE AVERAGE FUEL CONSUMPTION OF NEW CARS

This case considers alternatives for driving down the average fuel consumption/km of new cars.

3.1: Background:

Passenger vehicles accounted for 62% of transport fuel consumption in 1995 (3) with total transport responsible for 14% of total CO_2 emissions in 1999 (4). Based on these figures, passenger vehicles would account for 9% of total greenhouse emissions. The average fuel consumption of passenger vehicles was 11.5 litres/100km in 2007 compared with 11.4 litres/100 km in 1963 (5).

Part of the problem is that most Australians would consider the loss of their cars as a major attack on their quality of life. To some extent this concern is due to practical considerations such as trip times, delays waiting for public transport, comfort and security. These issues are of particular importance to those who live away from the most congested parts of large cities. In addition, for many people, cars are linked to psychological factors such as status and image. The action required to reduce NCP from people transport will need something more complex than the availabilty of low NCP alternatives.

Any credible plan for reducing the fuel consumption of cars to the levels required to meet 2050 targets must include strategies for reducing average fuel consumption/km. Reducing the average fuel consumption of new cars would have to be part, if not all of this effort.

Small cars are already available in Australia with fuel consumptions below 4 litres/100 km. There are no technical reasons why further reductions cannot be made without radical changes to the car as we know it.

For example, existing plug-in hybrid technology would allow most car owners to significantly reduce petrol consumption without having to wait for technical breakthroughs or new infrastructure; e.g., an owner with the writer's *typical-working-week trip* pattern would achieve a petrol consumption of less than 0.8 litres/100 km by retrofitting a 4 litres/100 km car with a plug-in hybrid able to go 35 km on battery power alone – See attachment A2 for details.

Special features related to the use of cars that may influence the design of schemes for driving down the average fuel consumption of new cars include:

1. The relative fuel consumption of different types of car may vary considerable depending what they are used for. (For example, conventional cars may actually have better fuel consumption than plug-in hybrids if they are being used for long trips in flat countryside.)
2. Some people would be satisfied with a car designed for the efficient transport of one or two people.

3. Other people, such as large families, workmen, etc. may have regular need for vehicles that can carry more people and/or bigger loads. However, there is a danger that special arrangements for these people will be used to allow others without these practical needs to indulge in their desire for gas guzzling luxury.
4. Using a simple cap on the fuel consumption of new cars to drive down average fuel consumption will increase the pressure to make special exceptions.

NOTE: The fuel consumption record for an internal combustion driven car is better than 0.03 litres/100 km (5). It may be worth asking what would need to be done to convert a car of this type into a practical means of people transport.

3.2 Criteria for a Good Scheme:

1. **Car manufacturers** will be seeking certainty re:
    a. Future changes in average fuel consumption requirements.
    b. Method(s) to be used for measuring fuel consumption.
2. **Car buyers** might be looking for:
    a. No increase in the price of fuel.
    b. Low prices for fuel efficient cars.
    c. No limit on the number of fuel efficient cars.
    d. Fuel consumption measurement that reflects their usage pattern.
    e. A mechanism that provides at least some option of continuing to buy cars with fuel consumptions above target.
    f. Special provisions for those who really need vehicles that can carry more people and bigger loads.
3. **The Government** should be seeking a system that would:
    a. Not require any potentially destabilizing jumps in the price of fuel.
    b. Have a positive effect on employment and economic growth.
    c. Have a positive effect on NCP reduction efforts outside of Australia.
    d. Give government the option of controlling:
        i. Future values for the average fuel consumption of new cars.
        ii. The method(s) use for measuring fuel consumption.
        iii. Special exceptions and acceptable ways of meeting these needs.
    e. Measures fuel consumption in a way that:
        i. Recognises the benefits of plug-in hybrids
        ii. Encourages reduction of both oil imports and contribution to total NCP by making an allowance for the future effect of plug-in hybrid electricity consumption on total NCP.
    f. Include provisions for ongoing planning, research and development.

3.3: One *Case Specific* Alternative:

The following suggestion is one example of a case specific alternative that would satisfy most, if not all of the above requirements:

1. All imports would be considered to be “new cars” for the purposes of this scheme.
2. Regulations would be introduced to:
    a. Specifying future average fuel/NCP requirements for new cars.
    b. Specify the method(s) to be used to calculate fuel consumption/NCP including NCP allowance for electricity consumption.
    c. If appropriate, detail separate schemes for different classes of vehicle, location or use.

3. Set up an offset credit trading system; e.g., registration of a vehicle consuming two litres/100 km above target might be offset by purchasing a credit from the registration of two vehicles both one litre/100 km below target.
4. Ongoing planning, research and development might be financed by fuel taxes or simply be part of a larger system.

The above suggestion provides a satisfactory way of dealing with most of the issues raised in section 3.2 above. In particular:

1. **It will work no matter what happens to the price of fuel.**
2. Allows the government to control the future average fuel consumption of new cars.
3. It will provide certainty for car manufacturers.
4. Gives the government the power to deal with special needs and different usage patterns.
5. The cost of fuel efficient cars will be reduced by the effect of the offset trading system.

It is difficult to predict the net effect on employment. However:

1. Any system that reduces the need for oil imports will cost jobs in the oil related industries.
2. Avoiding the need to increase fuel prices low will help other parts of the economy.

3.4: Emission Trading and Carbon Tax Schemes:

The key problem with both these schemes are:

1. The price they put on carbon will increase the price of fuel for both cars and the general transport industry.
2. In the short to medium term the price of carbon will reflect the price required to drive investment in clean-electricity, not the value needed to reduce the fuel consumption of cars.
3. Provides manufacturers with no certainty re future average fuel consumption requirements for new cars.

It can be argued that increasing the price of fuel may have the added benefit of driving down total car kilometres. However:

1. We are comparing schemes for driving down the average fuel consumption/km of new cars. Reducing kilometres travelled is a separate issue.
2. Large movements in fuel price over the last few years had little effect on total fuel consumption.

3.5 Conclusions – Driving Down Average Fuel Consumption of New Cars:

The case specific scheme described in section 3.3 was clearly superior to both ETS and CTS for driving down average fuel consumption of new cars.

4.0 GENERAL DISCUSSION

4.1 Contribution to Global Reduction of NCP

Behind the rhetoric there is a widespread reluctance to start reducing NCP at the rate required to meet 2050 targets. To some extent, this reflects the uncertainties and unnecessarily high price increases associated with ETS. These factors have become even more important in the light of the current financial crisis. "Wait and see" might be close to what most countries really want.

It can be argued that Australia should show leadership and forge ahead with ETS. However, even if this approach does reduce Australian NCP, there is a real risk that the perception will be that ETS has caused considerable damage to the Australian economy. This perception may encourage other countries to defer serious action.

MSA offers a way for Australia to demonstrate that it is possible to reduce NCP without damaging the economy. If Australia does this, the pressure on other countries to act will be much stronger.

4.2 "Grand Scheme" Issues:

The "grand scheme" versions of both ETS and CTS have, in theory, the attraction of allowing governments to set caps or carbon taxes and then be able to leave it to others to sort out the details. However, key problems with this approach include:

1. The government has very limited options for ensuring that the decisions made are in the country's interests.
2. The "carbon price" will be the same for all opportunities to reduce NCP*. As a consequence:
    a. Some industries will decide that it makes more sense to pay the carbon price, do nothing at all about reducing NCP, and pass the price of carbon on to their customers. The result is the pain of price increases with no NCP reduction gains.
    b. For some other industries, the price of carbon will be much higher than what is required to drive NCP reduction. The result will be higher than necessary price increases.
    c. Industries that cannot pass on cost increases or economically reduce NCP will suffer from reduced profits or be forced to shut down their Australian operations.

***NOTE:** The government has dealt with some of these problems by offering selected industries some carbon permits for free and/or entering into compensation deals. However, all this added complication fails to address the fundamental flaws of both ETS and CTS.

4.3 Will a Case Specific Approach always be Superior for Dealing with Specific Industries?

In both cases considered above, a case specific approach that did not depend on "putting a price on carbon" was clearly superior. This doesn't automatically mean that case specific must always be superior. However, the case specific approach allows for the use of targeted case specific versions of ETS or CTS where these are the best options. For this reason, **case specific must always be at least equal** to ETS and CTS.

It would not make sense to reject the case specific approach when it has been demonstrated to give better results for something as important as driving investment in clean-electricity and reducing the fuel consumption of cars.

4.4 What About "Action Specific" Schemes as Part of the Multiple Scheme Approach?

An MSA that is nothing more than a collection of case specific schemes has its limitations. There is also a need for actions that cover more than one specific case. Examples include:

1. Overall strategy development.
2. Overall data collection and monitoring.
3. Issuing and processing competitive tenders that seek the "reduction of NCP" instead of the "supply of clean-electricity".
4. Harnessing community support.

4.5 MSA Implementation:

It is suggested that, at any one time, MSA would be focussed on a limited number of opportunities for reducing NCP. In addition, parallel action may be taken on other potential opportunities in order to:

1. Avoid the situation getting worse; e.g., insist that any expansion be in a form that would make it easier to drive down NCP at some later date.
2. Do the planning, research and development on other potential opportunities so that action can be started when required by the overall plan.

4.5.1 Short-Term Action over the Next few Years:

Over the next few years:

1. Continue or accelerate existing programmes, at least until they have been reviewed.
2. Focus initially on a limited number of relatively simple, cost effective actions that will give a predictable reduction in NCP without the need for new technology, such as electricity generation and cars.
3. Periodically issue a call for expressions of interest to help identify potential opportunities.
4. Add additional opportunities to the programme and/or accelerate current action until the rate of NCP reduction reaches target.

5. Run a first review of other opportunities to reduce NCP to:
    a. Identify action that should be taken in the short term.
    b. Start the development of a long term plan.
6. Initiate new specific action schemes.
7. Monitor rate of change of NCP and act to increase the rate if required.
8. Revise and extend programmes to encourage community action.

5.0 REFERENCES:

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6.0 BIODATA - John Davidson:

John Davidson is a semi retired chemical engineer who has spent most of his life in the construction and mining industries. His work has ranged from formal research through to design, commissioning and operations management. He is interested in both the technology and management of emissions reduction. In addition, he has also worked for AMIRA (The Australian Minerals Industry Research Association - An organization that facilitated joint funding by mining companies of research in Universities, CSIRO and other research organizations.) He also served on the ACARP coal preparation sub-committee. – Which recommends the allocation of research funds from the coal industry levy.)

A ATTACHMENTS:

A1 Calculation of the Effect of Changes in Price of EU Carbon Permits on the Price of Electricity:

The following calculates the impact that EU carbon permit prices would have had on Australian electricity cost:

Currency conversion:

$AUD/€EUR = 0.5292 ("The Australian" 3 April 09)

Greenhouse emissions per kWh:

The following data came from an Australian Uranium Association Publication (6)

TYPE	G CO2/kWh			% OF COAL MEDIAN
	HIGH	LOW	MEDIAN	
Coal fired	1306	966	1136	85 to 115
Gas fired	688	439	537	39 to 61
Hydro	236	4	238	0.3 to 21
Solar PV	280	100	190	9 to 25
Wind	48	10	29	0.9 to 4.2
Nuclear	21	9	15	0.8 to 1.9

NOTE: IAEA was UK based – figures assumed to be European, not Australian

Price EU permit (€EUR /tonne CO2)*	Cost of permit/kWh ($AUS/kWh)	% of Davidson Family Average Price*
€8	$0.017	13
€22	$0.047	36
€30	$0.064	49

***NOTES:**

1. The Davidson family paid an average $0.13/kWh for quarter to Jan 09.
2. By 25 Feb 2009, EU carbon permit prices dropped from a 2008 high of €30 down to only €8 per metric tonne CO_2 (1)
3. Calcs based on coal median of 1136 g CO2/kWh.

A2: Fuel Consumption Calculation for Plug-in Hybrid Cars:

The following shows calculated petrol consumption savings resulting from the conversion of a conventional car to a plug-in hybrid:

Assumptions:

1. Savings are based on a "typical working week trip pattern" of 6x30 km and 1x100 km trips with full battery recharge before the start of each trip.
2. Petrol consumption would be 15% lower when the car is being driven by generator only because of energy recovery during braking.

Table: A2 – Effect of Conversion to Plug-in Hybrid

Battery range km	70	**35**	17.5
Petrol consumption before conversion (litres/100 km)	4	**4**	4
Petrol consumption after conversion (litres/100 km)	0.36	**0.79**	1.91