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TecEco Submission to the Prime Ministers Task Group on Carbon Trading

Introduction

The climate during the Holocene has been remarkably stable compared to earlier epochs and has been a major factor in the evolution of civilization as we know it. We are however agents of our own downfall as emissions since the beginning of the industrial revolution are having a major greenhouse effect on climate first brought to the attention of the world by Arrhenius (Arrhenius 1896) and now confirmed by thousands of scientists.

“We have a climate crisis which is a planetary emergency. We have to respond. This is a crises defined by the relation between the human species and the ecological system of the planet. We will solve it. We can solve it.”(Al Gore at the opening of the Live Earth. (See **http://liveearth.msn.com/**)

“Our climate crisis affects everyone. This is really about all of us. Not affects every one here not just people in Africa or India, it affects all of us. It just effects all of us.” (Kevin Wall at the opening of the Live Earth. (See **http://liveearth.msn.com/**)

Some governments are in fear of change. They are wrong. Modern economic theory (evolutionary economics in particular) is based on the fact that change is the major driver of economic growth. This process, called creative destruction by Schumpeter (Schumpeter 1954), is whereby new innovation destroys old and less efficient process and is the drive engine of modern economies.

The Australian and US governments in particular are pariahs in the global community because they have failed to recognise the urgency of global warming and other environmental impacts, the economic truth that that change is a driver not a brake and in so doing they have denied innovative Australian businesses like members of the Global Sustainability Alliance the opportunity to participate in the growing international market for carbon credits. Yet Australia will be one of the countries most affected (See recent CSIRO reports)

As custodians of the future it is the responsibility of governments to do something about anthropogenic forcings of climate and other issues affecting earth systems. The paper discusses policy misunderstandings and basic failures in the political and economic system in the way of the vital role of planetary maintenance.

The role of governments is to add value to change that maintains homeostatis in planetary systems and for the same reasons that we require a national system for carbon trading in

Australia we need a global system. As there is only one atmosphere, one sea one earth and all are connected there is strong argument for a broad based system.

Earth Systems

The Earth is a complex system of interacting physical, chemical and biological processes, and provides a natural laboratory whose experiments have been running since the beginning of time.

It was probably Buckminster Fuller[1] who got us all thinking of earth as a connected independent entity requiring maintenance. His story is a fascinating one as throughout his life he was concerned with the question "Does humanity have a chance to survive lastingly and successfully on planet Earth, and if so, how?"

James Lovelock[2] in his various books on Gaia theory brought to the attention of many the importance of viewing earth in such a holistic way. Lovelocks books are forerunners of what we now call earth systems science.

More recently Tim Flannery, an Australian scientist has been writing on the subject of climate in an easily understandable way. The titles of his two books, The Weathermakers (Flannery 2005) and We Are The Weathermakers (Flannery 2006) make it clear that we are in fact now planetary engineers as envisaged by Buckminster Fuller. This is spaceship earth and we have to take care of it. We have choices.

Earth systems science treats the entire Earth as a system in its own right, which evolves as a result of positive and negative feedback between constituent systems and is being confirmed by computer models which are giving scientists the tools to develop and test hypotheses that explain past and possible future behaviour.

[1] Richard Buckminster ("Bucky") Fuller (July 12[1], 1895 – July 1, 1983) was an American visionary, designer, architect, poet, author, and inventor. Fuller devoted his life to the question as to whether humanity had a chance to survive lastingly and successfully on planet Earth, and if so, how. Pursuing this lifelong experiment, Fuller wrote twenty-eight books, coining and popularizing terms such as "spaceship earth".

[2] Dr James Ephraim Lovelock CH CBE FRS, was born on July 26, 1919 and is an independent scientist, author, researcher, environmentalist and futurist who lives in Cornwall, in the south west of Great Britain. He is most famous for proposing and popularizing the Gaia hypothesis, in which he postulates that the Earth functions as a kind of super organism (a term coined by Lynn Margulis)

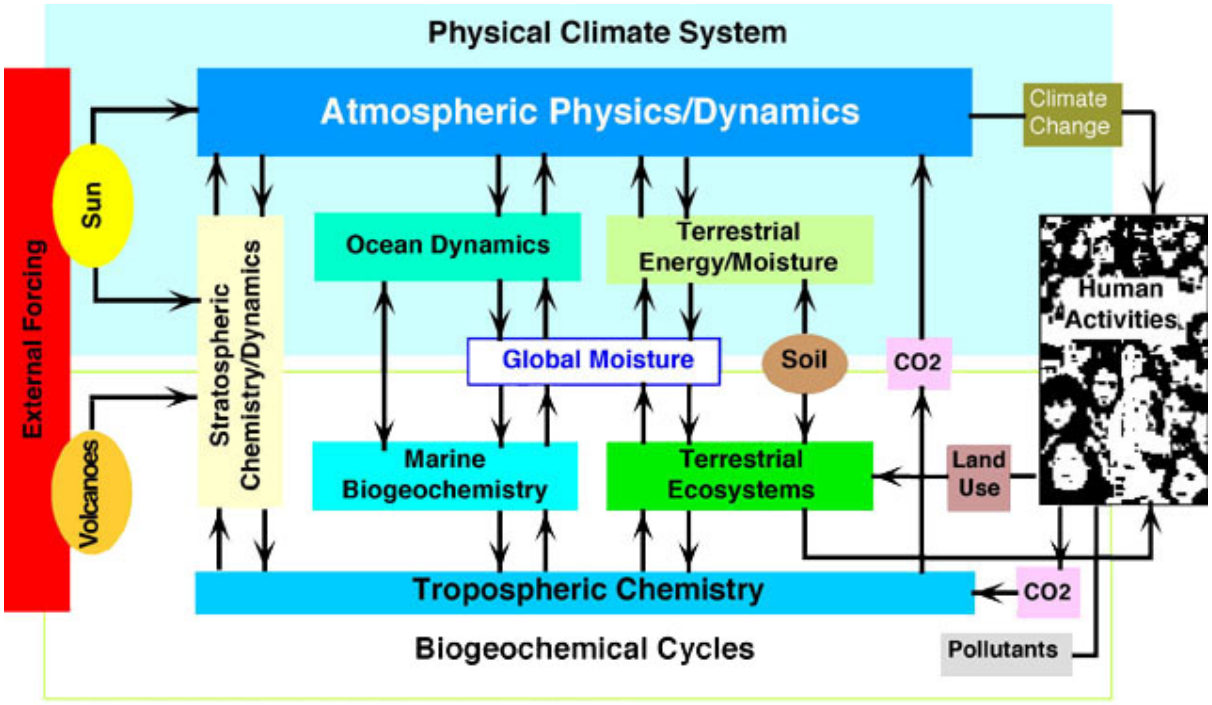
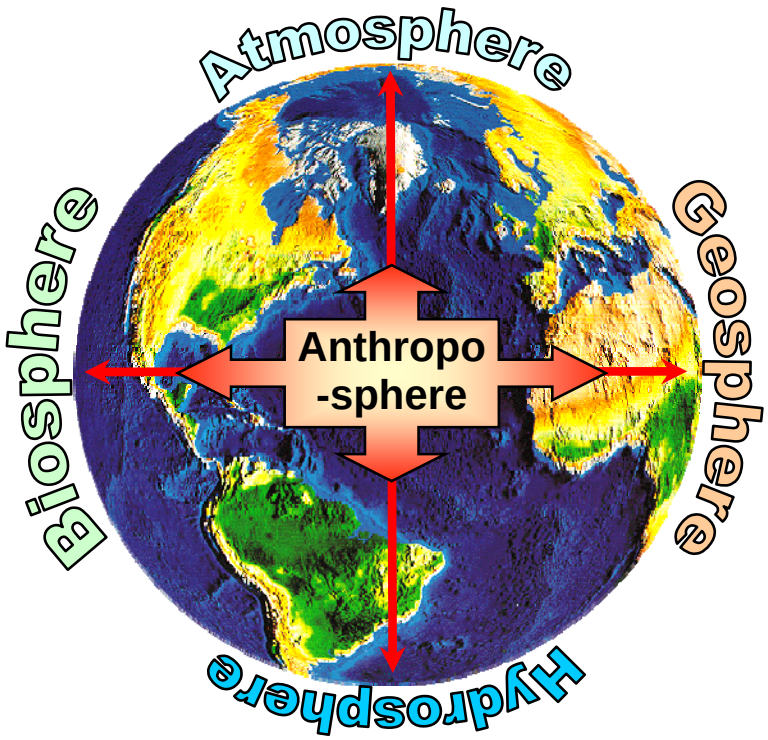


Figure 1 - Earth Systems Science (NASA website

Earth Systems Science

The Earth system is often represented by interlinking and interacting "spheres" of processes and phenomena. The atmosphere, hydrosphere, biosphere and geosphere form the simplest collection, though some would add the cryosphere as a special element dealing with polar regions and processes, and others would add the anthroposphere emphasizing human dimensions and impact on the planet.



The earth system consists of positive and negative feedback loops.
Small changes caused by man such as CO_2 and other climate forcing as well as pollution impact right across all interconnected systems throughout the global commons

Figure 2 - A Simplistic Representation of Earth Systems (Harrison)

The difficulty with simplistic representations such as the one above is that they divide the system artificially continuing a deconstructed perception of what is in reality a more holistic total Earth system in which no part should be considered in isolation from any other part.

Chemistry, physics, biology, mathematics and applied sciences are all drawn upon in our attempts to understand Earth as an integrated system.

There is a risk of the total collapse of earth systems and the weather is certainly changing very quickly. Do we want to end up like Mars which is an example of a planet that lost its atmosphere? We have a choice. As Tony Blair says about the planet in the preface to Tim Flannery's second book "it is this generation that must protect it"

The recently issued STERN review makes it clear that the cost of not doing something will far exceed the cost of action. At TecEco we maintain that paradigm shifts in technology such as we offer can actually make the changes required profitable.[3] See Appendix 1 - Gaia Engineering and Appendix 2
Eco-Cement

[3] The Stern Review on the Economics of Climate Change was released to the British government on the 30 October 2006 by Sir Nicholas Stern, Head of the Government Economics Service and Adviser to the Government on the economics of climate change and development. It advises that not taking action will cost a lot more than taking action. A summary is included in Newsletter 64 available for download from the TecEco web site at www.tececo.com

The Problem of Externalities

“For that which is common to the greatest number has the least care bestowed upon it. Every one thinks chiefly of his own, hardly at all of the common interest; and only when he is himself concerned as an individual.” (Aristotle 350 BC)

The issue of looking after and therefore valuing the commons, first discussed by Plato, Aristotle’s teacher, continues as one of the main topics for debate amongst modern political philosophers and is far from resolved. A more recent book “The Tragedy of the Commons” by Garrett Hardin (Hardin 1968) raised the problem in relation to the population debate. He argued that the "invisible hand" (laissez-faire) approach to resource problems does not always provide optimal solutions. In Hardin's hypothetical commons, the action of self-interested individuals cannot promote the public good. A more recent book by John Ralston Saul (Saul 2005) discusses globalism and highlights the current inadequate response to issues of the common good.

As sustainability issues become more urgent, studied and understood by the masses a cultural drift is noticeable resulting in a will to embrace change. The legal, political and institutional mechanisms are however lacking to bring about change on a timelier basis, thereby matching the urgency of the problem.

The major problem today is not so much one of use but of degradation of the commons, on a global rather than village green scale.

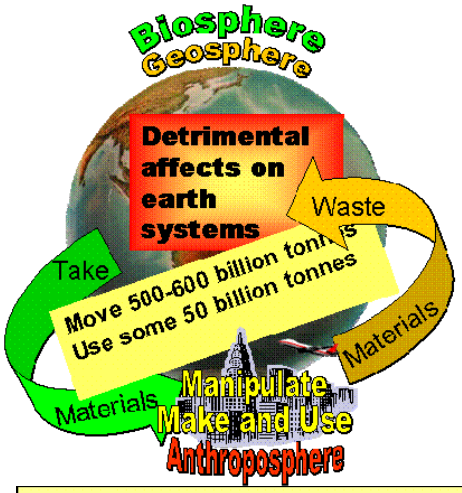
Defining Externalities

Economists like me call the costs associated with pollution (some of which cannot easily be measured in monetary terms) externalities. Definitions abound but a good one from About: Economics[4] is that an externality is an effect of a purchase or use decision by one set of parties on others who did not have a choice and whose interests were not taken into account.

Pollution, generated by productive enterprises affects others who had no choice and were probably not taken into account. Emissions are a classic externality that a carbon tax would legally factor into the cost of energy, but which can be traded out by the purchase of credits. A carbon tax would bring the externality (emissions) into the market place whereby the forces of supply and demand once given value, can modify the quantity.

[4] http://economics.about.com/cs/economicsglossary/g/externality.htm

The Techno-Process



Underlying the techno-process that describes and controls the flow of matter and energy through the **supply and waste chains** are molecular stocks and flows. If out of synch with nature these moleconomic flows have detrimental affects on earth systems.

To reduce the impact on earth systems new technical paradigms need to be invented and cultural changes evolve that result in materials flows with underlying molecular flows that mimic or at least do not interfere with natural flows and that support rather than detrimentally impact on earth systems.

Figure 3 – The Techno-Process (Harrison 2005)

Underlying the vast 600 billion tonne flow of materials through our take-make-use-waste techno-process (see Figure 1), 70 % of which is the construction industry, are molecular flows that are damaging the planet such as too much CO_2 in the air or heavy metals released to our common waters (See Figure 2). These impacts are external to our economic system and not costed.

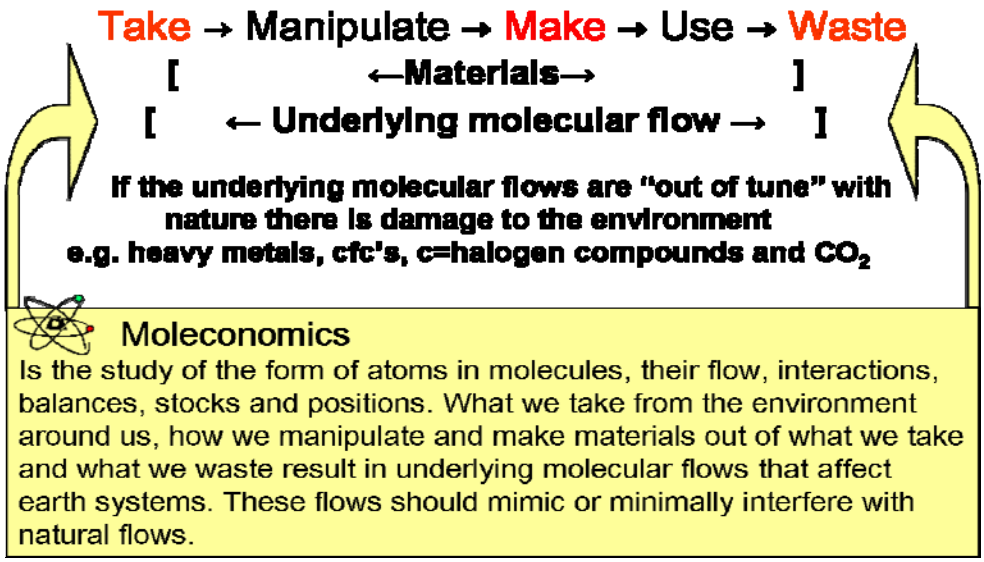


Figure 4 - Moleconomic[5] Flows that are Damaging Underlay Materials Flows (Harrison 2005)

[5] Moleconomics Is the study of the form of atoms in molecules, their flow, interactions, balances, stocks and positions. What we take from the environment around us, how we manipulate and make materials out of

We will all however feel the brunt of global warming as the climate changes, as individuals we do not consider ourselves responsible, but with 6.5 billion of us all collectively polluting we are changing the planet. To prevent this continuing a system of putting a cost on detriments to the global commons is essential

Externalities related to the techno-process are characterised by causes and effects in different time and geographical scales. The causes take place essentially in market places and have a cost of 'causing' and a value from having 'caused' Unfortunately many of the effects or consequences of 'causing' do not take place locally or in the same short time frame and are thus disassociated from market places and do not have a cost or value to individuals in the shorter term as Aristotle so astutely observed.

'Causes' affecting the global commons take place with the here and now benefit or loss being measured in market places but the long term consequence being ignored as not being condensable to present value.

This is where putting a legal cost on emissions is so useful, it bring cause and effect into he same market place so that quantities can be dealt with.

The main aim of the National Emissions Trading Taskforce should be to address the complex and as yet unsolved problem of externalities first enunciated by Aristotle and now threatening to annihilate us with irreversible climate change.

Doubters should stop for a moment to consider the consequences of not addressing the issue of climate change.

Solution Multipliers and Connectivity

A relatively congenial climate during the Holocene is what has allowed the development of civilisation as we know it. Stable climate has allowed us to evolve to what we are. The climate is an important factor supporting civilisation and we are changing it.

The fundamental message of earth systems science is that everything is connected. Not just earth systems. Everything.

Tackling climate change by curbing CO2 emissions will help resolve a number of other problems and the reason is because all our major problems affect each other.

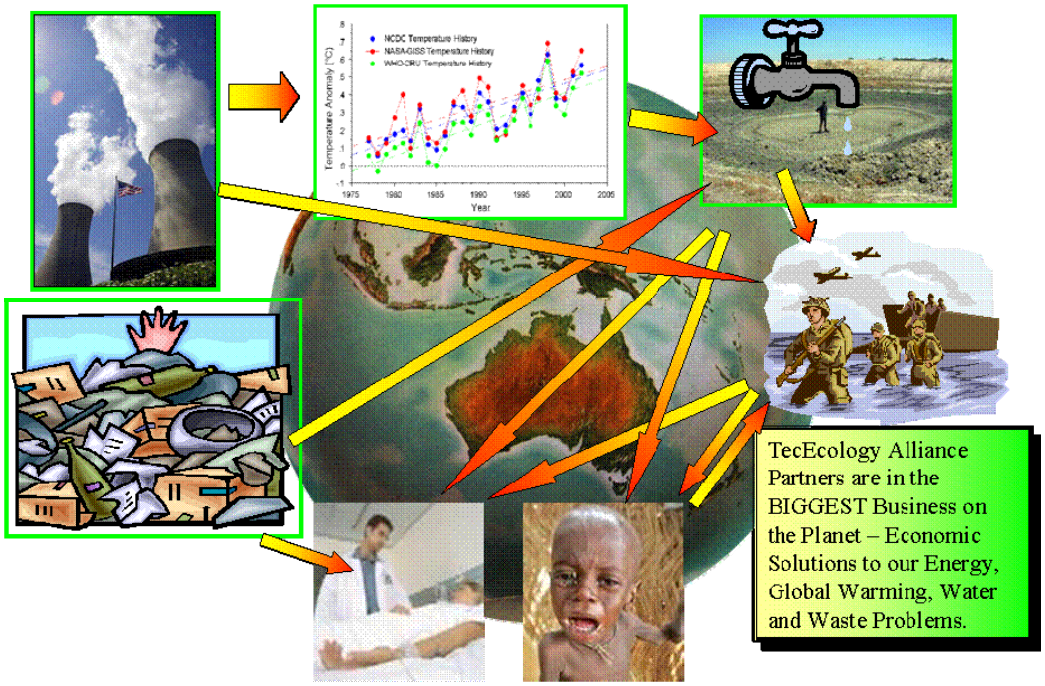


Figure 5 - Climate Change has Major Connectivity with Other Global Issues

Climate change will not just affect sea level and polar bears. It is already having an affect on health, agriculture and many other global issues due to this interconnectivity.

It follows that ideally not only should emissions be tackled by the taskforce, but sustainability issues generally.

De-Politicising the Planetary Custodian Role – Towards a Charter?

Governments are elected for short terms and under pressure to deliver short term outcomes to the electorates of each member - a process not conducive to long term planetary maintenance.

To solve problems of the global commons such as too much CO_2 it is essential to take a wider, longer term view, wider than that of regional governments and longer than that of successive short term power plays. Contrary to the parochial political view held by the Australian government this is best achieved on a global rather than national scale, however on a national scale better than no scale at all. We are therefore making some progress that we are considering a trading scheme at all.

The key to solving the problem of externalities is to make doing so an economic process. It will not happen because it is the right thing to do.

There are two basic steps in this. Attaching costs to wastes such as CO2 and encouraging new technology paradigms that convert waste to resource in accordance with Pilzer's law. (See The Role of Governments on page 16). We argue that with a strong mandate these important interventionist roles are best performed separately to the political process which is subject to election related fluctuation.

The author made a submission to the Committee of Enquiry into a Sustainability Charter that would have enshrined fundamental postulates or principles that translate as means to deliver valuation of the natural capital not only of Australia but the world (as much of it is "common") and thereby facilitate incorporation into our value exchange system that we call accounting.

A charter would define policies whereas a trading scheme is a tool to bring about these policies, and supported by a legal price on carbon emissions would have the function of bringing into the market place externalities. Whether a charter should address issues of the global commons because it is the right thing to try to do or for some other reason such as satisfying human survival needs is not determinable as all of these currents are flowing. By facilitating mechanisms that enshrine value for externalities a charter, at the very least, will help address the problem of accounting for them enunciated by Aristotle. One very important tool for this new way of thinking and acting is a trading scheme supported by taxes on carbon and other externalities.

The political process in western democracies is too short term in outlook to adequately address solutions to problems like global warming and this is a good reason to consider a charter which just as the reserve bank sets out to regulate the economy would strive to achieve global homeostasis. A charter supporting a trading scheme would de-politicise and give dimension to the urgency of response to the problem and could be a way forward for the Australian government on climate change.

To adequately consider wider impacts than carbon alone there remain questions as to whether a charter should spell out values, a process for arriving at the values required or act a mere guide to legislation that does so on a more flexible basis. Our initial view is that defining the urgency, principles and process for addressing the problem will more likely ensure that a national emissions trading scheme survives and that those trading in such a scheme prosper and grow. As for most good ideas there is otherwise a danger a charter if adopted is little more than rhetoric warming the air. Processes like a real money here and now trading scheme are also generally better than prescriptions as they are less adversarial and more flexible.

There are few scientists in government and more lawyers than any other profession. Lobbyists abound. They are the largest group of short term gainers and sadly governments listen to them instead of the grass roots. But there is change afoot, the mischief of their false economic arguments designed for their own profit is becoming understood and even energy companies like Santos are saying we need to join Kyoto or its successor.

Beyond Globalisation - Addressing the Common Good

Globalisation implies that commerce will lead civilizations, that every activity, once released from government interference will find its own natural balances and that nation states would become irrelevant and the power of markets would determine the course of human events.

According to John Ralston Saul, globalism is "an inevitable form of internationalism in which civilization is reformed from the perspective of economic leadership." Saul then argues that AIDs, the African debt, the return of fundamentalism and terrorism, and many

other common problems are not disappearing in spite of a theoretical resulting rise in global prosperity (Saul 2005).

According to Karl Polanyi “the idea of a self-adjusting market implied a stark utopia” (Polyani 1944). Amongst other failures of globalism, the failure to address issues of the commons is paramount. Evidence of this is the rise of more nationalistic approaches to environmental and societal problems and the collapse of globalism.

Many countries have fallen into the false belief that globalism will solve problems in markets, yet markets do not address common needs as clearly pointed out in this document. The way forward may be to cherry pick globalism, maintaining free trade (the why Australia should not grow rice argument) but take into account social and sustainability values. If nothing else, a charter, local carbon trading scheme and eventually joining Kyoto or its successor will reinforce this process of understanding that we live in one world and the capacity of that world to support us is rapidly diminishing.

The Economics of Imperfect Markets and Innovative Change

Modern economic theory (evolutionary economics in particular) is based on the fact that change is the major driver of economic growth. This process, called creative destruction by Schumpeter (Schumpeter 1954), is whereby new innovation destroys old and less efficient process, is the drive engine of modern economies.

This explanation for growth, first espoused by Schumpeter, is more important today than ever as the level of sustainability in a society is economically related to the cultural demand for sustainability and the technology used.

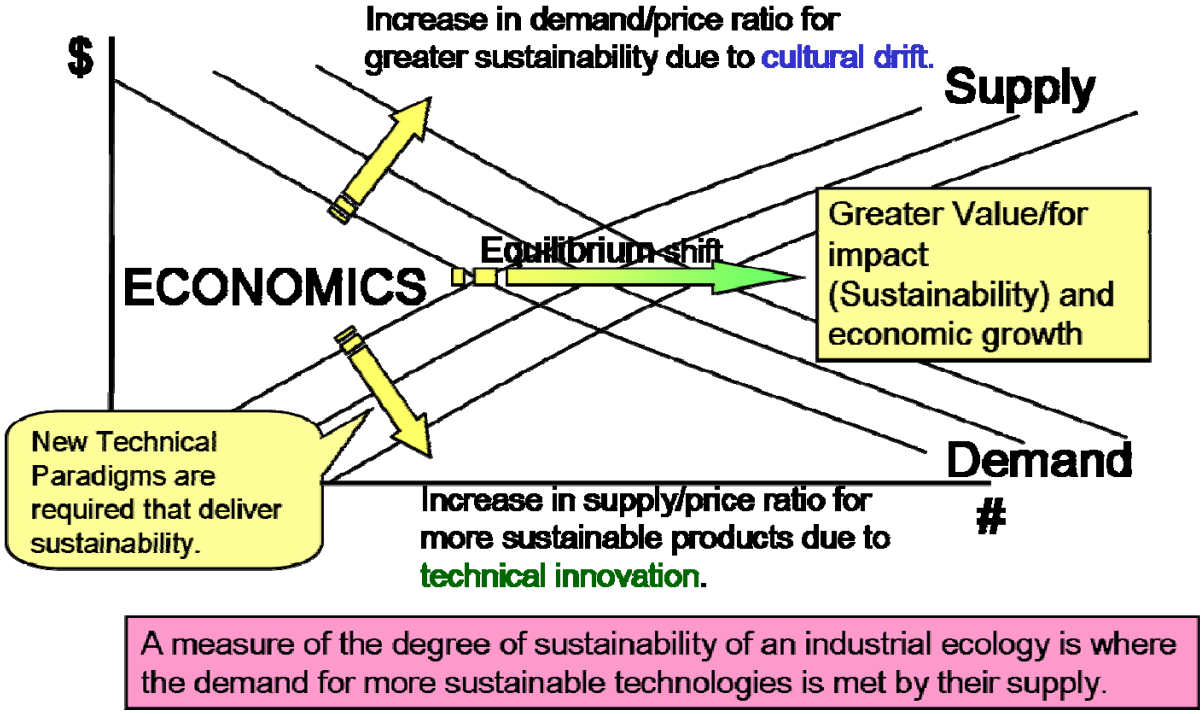


Figure 6 – Sustainability is a Direction defined by the Intersection of Cultural Change and Innovation moving towards greater Supply and Demand

Throughout history, economic growth and the level of sustainability of a society has been connected to the level of innovation and cultural demand or acceptance of that innovation.

Through innovative change we not only grow our economies in the manner enunciated by Schumpeter but as demand shifts through cultural change, move towards greater sustainability through changes in the technological basis of our economies by a combination of innovative paradigm shifts and slower evolutionary development.

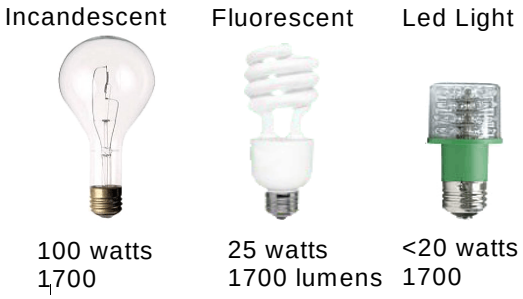
Examples of paradigm shifts include the invention of the bow and arrow, wheel, metals, glass and gunpowder whilst the development of cooking recipes, crops, breeds of cattle and sheep and many minor inventions are examples of slower, more evolutionary change.

The need for innovation delivering greater sustainability has never been greater. Specific examples of recent innovation that are also more sustainable include the development of neon light globes, the recent breakthrough in solar technology and the materials that are being developed by TecEco including Eco-Cements.

Governments do not back their rhetoric by purchasing innovative new sustainable products. Whilst the Federal government may give grants to develop and commercialise a promising technology when it comes to support in the market place they are lacking. A more broadly based trading scheme would tend to address this problem by negatively burdening less sustainable technologies with price.

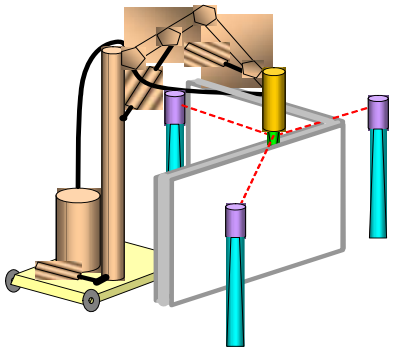
Given the volume of materials and hence moleconomic flows associated with the built environment it is essential that more sustainable buildings and infrastructure are recognised and encouraged by a trading scheme. The emissions savings from a large building with a significantly lower annual footprint over a lifetime are very significant and such improvement should therefore gain credits to drive sustainability in the built environment. Price penalties through carbon and other sustainability taxes will also improve the connection between performance and price in the market place for structures.

Unfortunately many economists do not understand that change and economic growth are compatible. Our imperfect markets do not optimise sustainability. They are short term and the value of sustainability is hard to recognise in them. Larger established businesses based on older technologies such a the power and coal industries have evolved means to maintain market share such as political clout and are scared of innovation and change. Countries (including the U.S and Australia) have not ratified the Kyoto protocol on the false presumption that restricting carbon emissions would be a burden for their economies. These governments have been badly advised. Change and economic growth are compatible.



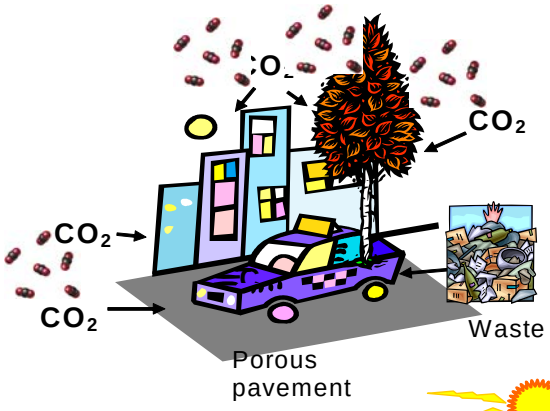
Light Globes - A Recent Paradigm Shift in Technology Reducing Energy Consumption

Light Globes in the last 10 years have evolved from consuming around 100 watts per 1700 lumens to less that 20 watts per 1700 lumens. As light globes account for around 30% of household energy this is as considerable saving.



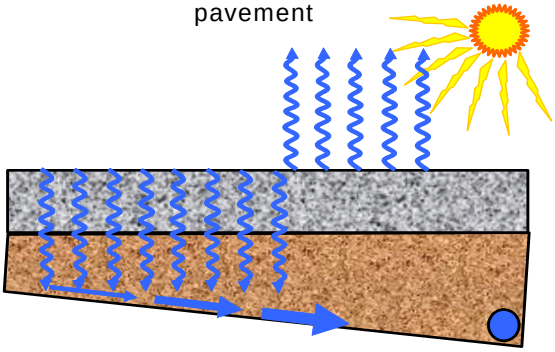
Robotics - A Paradigm Shift in Technology that will fundamentally affect Building and Construction

Construction in the future will be largely done by robots because it will be more economic to do so. Like a color printer different materials will be required for different parts of structures, and wastes such as plastics will provide many of the properties required for the cementitious composites of the future used. A non-reactive binder such as TecEco tec-cements can supply the right rheology, and like a printer, very little will be wasted.



TecEco-Cements - A Paradigm Shift in Technology that will fundamentally affect Building and Construction

Eco-Cements set by absorbing CO_2 out of the air and are suitable for the Pareto proportion (80%) of materials used for construction in the built environment. Coupled with the capture of CO_2 during manufacture the resulting sequestration is significant



TecEco Porecocrete - A Paradigm Shift in Technology that will solve our city water and coastal pollution problems

Porous pavements mimic nature cleansing and potentially capturing water. They decouple pollution from rain water, provide safer roads and cooler cities.

Global Sustainability Alliance Gaia Engineering - A Tececology that sequesters CO_2, delivers fresh water, carbonate building components and magnesium cements as well as other commodity products

Porous pavements mimic nature cleansing and potentially capturing water. They decouple pollution from rain water, provide safer roads and cooler cities.

Figure 7 - Recent Paradigm Shifts in Technology

Fortunately many processes have been forced to change because of their impact on the "common" environment. The result has often been the substitution by more efficient processes, even on a purely economic basis (e.g. since the ban of CFCs, fridges have become more efficient, although manufacturers warned that nothing could effectively replace them). However the shift toward more efficient and sustainable technologies does not always happen naturally and must be encouraged by policy initiatives of government. This is explained, using an evolutionary framework, by Mulder & van den Bergh (Mulder and van den Bergh 2001) who emphasizes that: "One of the most important insights of evolutionary thinking is that current systems are not necessarily optimal from an efficiency perspective, even if prices are "correct" (I.e. prices reflect externalities, are based on perfect competition, etc.).

The reason is that systems can be locked-in, that is to say that they are the result of unique, historical, path-dependent processes. …… Present inefficient technologies may be locked in as a result of network externalities and sunk costs. Well-known examples are systems which require a significant amount of private and public investment and network support such as transport and infrastructure, energy generation and provision."

Biomimicry/Geomimicry

An overriding principle that must be adhered to is that of biomimicry. Sustainable processes are more efficient and therefore more economic. Natural ecosystems can be 100% efficient. If we wish to survive in harmony with nature for the longer term, what is needed are new ideas for policies that foster the development of processes and technologies that allow material and energy flows to more closely mimic and support flows in natural ecosystems. We have lost the connection with the planet and live in a surreal techno-world. Our air conditioned homes and offices leave nature outside and we have been lulled by such comfortable 'civilised' surroundings that all is well. It is not. Nature is a living library of wisdom and we must learn by connecting and evolving more harmoniously.

Economic rationality and an emissions trading scheme are harmonious with the principle of biomimicry as nature is the most frugal economist of all. "Restructuring the global economy according to the principles of ecology represents the greatest investment opportunity in history. In scale, the Environmental Revolution is comparable to the Agricultural and Industrial Revolutions that preceded it.(Brown 2006)"

Encouraging the Development of Tececologies - What if industry were working together?

An industrial ecology is a localised or regional network of partnered organisations benefiting from an exchange of resources, information and/or expertise. Even if we colour this definition green as Tom Graedel [2] and others have done and say industrial ecologies involve actions taken to reduce the impact of industrial systems on the environment; in particular creating a closed industrial system, analogous to a natural ecosystem, where waste from one industry can be used as input for another.

To change global flows such as that of CO2 relentlessly going into the atmosphere we need more than industrial ecologies; we need new technologies designed to economically

substantially reverse damaging moleconomic flows outside the system. We have called this new class of ecology a tececology[6].

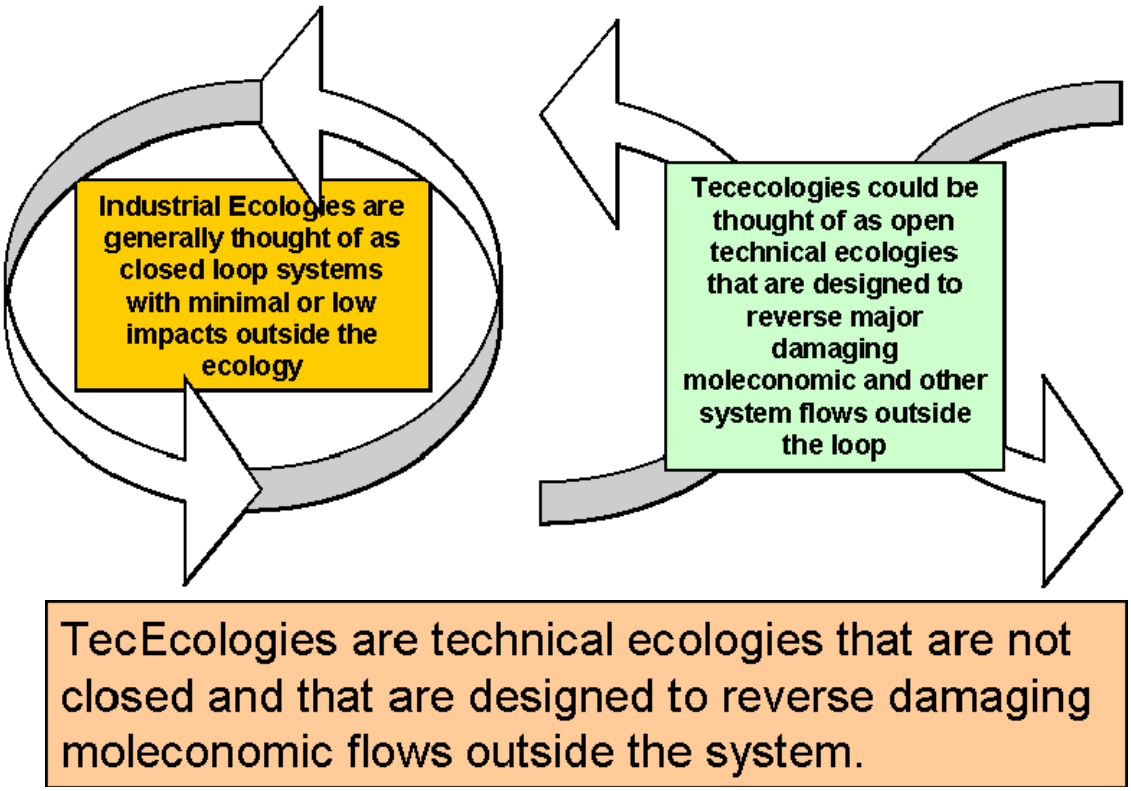


Figure 8 – Tececologies – Global System Pumps Reversing Damaging Moleconomic Flows.

An example of a tececology that if supported by Carbon Trading could solve the problem for us all is Gaia Engineering from the Global Sustainability Alliance. Modelled on the thinking of Sir James Lovelock and geomimicry principles Gaia Engineering Tececologies reverse the flow of CO_2 and waste redefining both as resources.

Tececologies are technologies work together that substantially reverses damaging moleconomic flows going on mostly in the global commons. Tececologies are different to industrial ecologies because they are deliberately designed to economically reverse damaging moleconomic flows outside what were generally thought of as closed industrial systems. They go much beyond what the concept of an industrial ecology embraces and could be likened to ecological pumps. Industrial ecologies recycle but do not reverse flows outside what could be considered as a closed system with a flow greater than required for their own inputs.

The Global Sustainability Alliance partners have developed Gaia Engineering Tececology that can lead the world, economically reversing damaging moleconomic flows such as that of CO_2 into the atmospheric global commons and wastes into the commons generally.

[6] Tececologies are technical ecologies that are not closed and that are deisgned to reverse damaging moleconomic flows outside the system.

The initiation of carbon trading in Australia would help foster this exciting new Australian Tececology as an exemplar as to how we can solve the problem to the rest of the world.

The Gia Engineering Tececology is explained in detail in Appendix 1 The Gaia Engineering Process on page 22.

Energy Sustainability and Emissions

The electricity debate is to some extent an argument between centralized, large generating organizations and localized small producers and is currently raging in many countries. The centralists argue for base load power, usually from coal but in Australia recently at the instigation of the Prime Minister, nuclear, and smaller local producers are generally advocating more sustainable sources such as solar or bio power. The writer has nothing against fusion or nuclear, however is rightly concerned about nuclear waste.

The terms of reference indicate a foregone conclusion by the Prime Minister and presumably his advisors. The Terms of Reference are limited thus "Australia enjoys major competitive advantages through the possession of large reserves of fossil fuels and uranium. In assessing Australia's further contribution to reducing greenhouse gas emissions, these advantages must be preserved."

Given the fact that Australia has some of the best geology on the planet to enjoy free geothermal energy, the most sun to take advantage of solar energy, large bays with narrow entrances to use tidal energy and in some areas strong winds that can be harnessed, so called cleaner fossil fuel or nuclear are options and that is all.

Clean coal is just not possible without high expense and the risks associated with geo sequestration immense. So much so that we have attached as appendix

We further believe that the decision should be made by rational scientists not politicians with at best law or economics degrees and little understanding of the issues.

We are not necessarily against nuclear for base load generation but the sudden overwhelming interest from the Prime Minister may well result in actions that our descendents will regret. Considering that a 13 billion dollar fusion reactor funded by six nations is to be built and tested in France it would seem more appropriate to wait and see the outcome of this experiment as if successful it would open the door to clean and abundant energy.

The International Thermonuclear Experimental Reactor, is being built to demonstrate that nuclear fusion, which harnesses the same energy that heats the sun to generate electricity, can wean the world off pollution-producing fossil fuels. Nuclear fusion also produces no greenhouse gas emissions, which many scientists tie to global warming, and compared to fusion, only low levels of radioactive waste.

In the context of our strong objection to the terms of reference which point towards a forgone conclusion that carbon trading would give credit to power companies that invest in so called clean coal and to the larger manufacturers of nuclear fission reactors keen to get rid of old technology, although perhaps futile in the current political debate we nevertheless submit this paper in the faint hope that is educates the minds of our decision makers.

Because of power transmission losses, at some point, the generation of electricity on a decentralized basis is more efficient than generation from large power plants. This point will only be crossed by innovation encouraged by the right institutional support.

Many countries have privatized transmission and this has been a grave error as it will stand in the way of the evolution of more efficient forms of power such as recently announced by Los Alamos National Laboratory in the US[7].

Unfortunately, sustainable energy other than from hydro so far does not suit large centralized power generation power plants and is therefore discredited by them further slowing their introduction.

Policies are therefore needed to encourage more sustainable generation of electricity such as a more broad based system of eco credits and debits discussed below as which is broader even than carbon trading.

The Role of Governments

Governments must consider externalities or who else will? The people have had enough of the avoidance of this responsibility for short term political gain.

What is needed is a return to the fundamental role of government for the common good; an efficient attempt to govern by action as well as legislation.

We argue under the heading De-Politicising the Planetary Custodian Role – Towards a Charter? On page 8 that the key to solving the problem of externalities is to make doing so an economic process. It will not happen because it is the right thing to do. We also argue that there are two basic steps in this. Attaching costs to wastes such as CO2 and encouraging new technology paradigms that convert waste to resource in accordance with Pilzer's law (See below)

Governments must take the lead in maintaining earth system homeostasis and to perform this function it is essential that they:

- Consider de-politicising the planetary custodian function.
- Bring to account externalities through mechanisms such as legal cost and trading of exchangeable credits earned through mitigating action against such cost and taxation policy.
- Infuse public good needs into their procurement policy.
- Foster change by for example:
    - Improving the connection in the built environment between performance and the price of structures
    - Supporting environmental rating systems with real benefits and costs such as in the broad based trading system suggested.
    - Improving education about sustainability

[7] More than one electron for each photon of light.

To get over the short term outlook of successive governments mentioned earlier we suggest a charter coupled with commitment to long term binding international agreements such as Kyoto or its successor is appropriate.

We see no sense in isolating a purely Australian trading system from wider international markets. Australia was an active participant in GATT and its replacement treaties so we cannot understand parochial attitude. Neither can many of our trading partners.

A charter in conjunction with a trading scheme preferably internationally connected as the main tool would de-politicise the process. As externalities are connected and the need urgent a broadly based system would be better than one merely based on carbon trading.

We have a reserve bank board to look after our financial system so why not a charter and board of governors charged with maintaining the environment. It's a big step but by depoliticising the role the problem of short term politics and long term need is to some extent obviated. Can one imagine what would happen to the price of carbon for example very time there is an election. Every small minded politician would be seeking a local exemption or relaxation trading a seat in parliament for the common good.

Many would also argue that the power of economics will the most quickly improve Australian and global sustainability. By invoking Pilzer's first law (Pilzer 1990) which states that the technical paradigm defines relative resource values, it follows that to convert waste to resource new technical paradigms are required. To initiate this process a legal cost to detrimental externalities such as CO_2 emissions would be extremely helpful. Technical paradigms are evolving to economically utilise CO_2 like the Australian developed Gaia Engineering on offer by Global Sustainability Partners or which TecEco are one. Technologies that are much greener and convert waste like CO_2 to resource need to evolve a lot more quickly to prevent further rises in temperatures.

We predict that the grassroots now want action on global warming and other environmental issues and it follows that governments can no longer remain complacent. They must take a longer term view and encourage new greener technologies not just by lifting the rate of support for research development and deployment but by active procurement policy.

Culture shift is leading us a way from heavy consumerism, but is not happening quickly enough and a further role of governments should therefore be education about the environment and the planet[8]

The challenge is to harness human behaviours which underlay economic supply and demand phenomena. This can occur through innovation. By changing the technical paradigm in favour of making, for example, carbon dioxide and other wastes resources new materials with lower take and waste impacts and more energy efficient performance will emerge. Putting a legal value of carbon will initiate this process.

Unfortunately sustainability will not happen because it is the right thing to do, it will only happen if forced by legislation and brought into our value system of exchange by the imposition of a legal cost.

A carbon trading scheme is a first step, however governments need to think beyond, and with the replacement of Kyoto a few short years away, consider a broader based scheme of eco-credits and debits as discussed in Appendix 3 A Broad Based System of Eco-

[8] Interestingly NASA is taking a lead role funding universities to teach the subject.

Debits and Credits on page 35 and also the implementation of supporting tax policy.

The cultural shifts required to demand new greener technologies are being generated by the media to the point where action on climate change is likely to become a major election issue in Australia and many other countries overseas.

Figure 9 - The Role of the Media

The rate of cultural change has been growing exponentially with Al Gore (An Inconvenient Truth), CSIRO reports regarding draught, the STERN Report, IPCC report and the Branson prize which Global Sustainability Alliance members have entered to win. Live Earth with be run on the 7th July this year and will be the final nudge that will change the minds of millions. (See **http://liveearth.msn.com/**). Governments need to be aware of the rate of change.

Conclusion

The great task of the future will be that of global maintenance as we are now planetary engineers as Tim Flannery (Flannery 2005) puts it so well. The problem of the future will be that of maintaining the common good and the scene it will be staged on is the global commons.

Governments are the structure with the mandate and the power to direct the behaviour of individuals in particular directions unfortunately the need for government to drive programs to overcome problems such as global warming is not well understood and perhaps better focus could be achieved through the adoption of a charter. The first major tool would be that of attaching costs to externalities starting with emissions trading.

One way of reducing the political one-upmanship that seems to have stolen the stage is to depoliticise the process and our responses to it and a charter could also have this role. A Sustainability Charter as considered by another enquiry should set Australian governments the target of implementing programs that discourage undesirable externalities and encourage behaviour that results in commonly enjoyed benefits.

We need to start somewhere as we are lagging behind the rest of the world and a National Carbon Trading scheme is a good start. We can then consider broadening the markets

and joining Kyoto or its replacement. Australia cannot stay out of global sustainability treaties forever. The market is less likely to fail if it is international (Kyoto or its successor) and broadly based (eco credits and debits).

Our natural capital, vital to sustain life and all economic activity is becoming seriously diminished. Virtually all improvements in sustainability have associated reductions in energy and reductions in energy are associated with reductions in emissions and for this reason if no other, any new global system to replace Kyoto should be broadly based. A broad based scheme of eco-credits and debits is discussed in Appendix 3 on page 35.

There should also be serious consideration as to how to assist new and emergent technologies that are more sustainable and resource efficient so they can compete with existing technically paradigms that have the advantage of economies of scale and procurement policy is an easy tool to adjust.

The Eco Credits and Debits Scheme that we are proposing is an example of a tax on behaviour that we wish people to avoid; namely, manufacturing or building using unsustainable technologies. Energy reductions pay and are low hanging fruit. An objective of a broader based scheme would be to try and also improve sustainability generally. The scheme could be extended on a global scale to encourage adoption of a wider range of sustainable technologies in a diverse range of industries. Eco Credits and Debits could conceivably attach to energy generation, transport systems, manufactured goods, food and services that embody or result in low levels of GHG emission, embodied-energy and embodied-water, or which have any other positive impact on the environment, such as improved biodiversity or waste utilisation as well as overall greater sustainability.

The more general system of debits and credits proposed coupled with appropirte changes in taxation policy (see Appendix 5 – Tax Instruments and Sustainability Policy on page 48) would harness the huge energies that Australians employ towards paying less tax and direct it towards solving our common problems. In this way, much of the change towards sustainability would occur with a minimum of government intervention.

In the meantime we give our wholehearted support to a carbon trading scheme being the first small step of many required to guarantee survival in the future. Otherwise climate change will hit us with more force than of many atomic catastrophes. The proof is in the paleo climate record.

Summary Conclusion

General

1. We are now earth system maintenance engineers
2. The weather is certainly changing much more rapidly that it has in the past and there is a risk of the total collapse of earth systems.
3. The cost of not maintaining earth systems is likely to far exceed the cost of doing so. (STERN Report)

4. Governments are the focal point for action to maintain the homeostasis of earth systems
5. The fear the Australian and US government have for change is misguided.
6. Paradigm shifts in technology such as Gaia Engineering offered by Global Sustainability Alliance Partners (TecEco and Greensols) can make the maintenance function profitable.
7. The key is in to convert waste including CO2 gas to resource. In this manner we can economically solve the problem.
8. The guide to all our actions is nature. We must learn to live with and mimic her.

A Blue green print for Action

We seem to be in a situation where pride is getting in the way of statesmanship and common sense. The government appear at least however sizing up the situation and below follows the steps we think they should take.

1. Initiate a National carbon trading scheme in Australia as soon as practicable.
2. Establish a non political sustainability charter and board to administer the system with a clear mandate to broaden and expand it to cover all externalities.
3. Link the Australian trading system with the global community as quickly as possible by ratifying Kyoto.
4. Take a proactive role in the global debate for the replacement of Kyoto to broaden the base of trading.
5. Recognise the large contribution the building and construction industry has to global and national greenhouse emissions. According to the Stern Report "Buildings account for 8% of greenhouse gas emissions, or 20% if upstream emissions are included."
6. Proactively support research, development and deployment of new blue green technologies at all levels including procurement policy and education.
7. Properly consider energy and sequestration technologies in an open debate involving the public.
8. Consider not just taxing externalities such as by using a carbon tax but other taxation instruments including income tax and subsidies which could provide a shift in consumption and investment expenditure towards more sustainable outcomes.

John Harrison B.Sc. B.Ec. FCPA

July 2006

Appendix 1 - Gaia Engineering

"The economic solution to global warming and waste"

www.gaiaengineering.com

Gaia engineering is being undertaken by Global Sustainability Alliance Partners - TecEco Pty. Ltd and Greensols Pty. Ltd.

- Our mission is to develop Gaia Engineering that substantially reverses damaging molecular flows that are a consequence of materials flows on the planet
- As the built environment is man made and involves large flows it is the obvious place to permanently fix CO2 and other wastes
- Gaia engineering is potentially profitable as it results in the production of valuable commodities including fresh water and building materials

Humanity has unprecedented powers to damage planet earth and affect the well-being of present and future generations. Few people realise the extent to which existing technical paradigms driven by fossil fuels are causing havoc. Global Sustainability Alliance partners believe that in order to live more sustainably we need to make our economic consumption behaviours work for the planet, instead of against it. We can do this by changing the technical paradigms of our many industries. Technical paradigms define what energy and matter are valued as resources and what is emitted or discarded as a waste and thus the underlying molecular flows that are so damaging.

Cultural change has increased the demand for more sustainable products. To meet this increasing demand new innovative technical paradigms are evolving. Gaia Engineering is not a single process or paradigm but a tececology which embraces a number of new technical paradigms and processes designed to solve global warming and waste problems by changing the underlying moleconomic flows involved. Gaia Engineering will work because combined correctly these new processes will allow people to make money using them.

Even if the annual flow of emissions was frozen today, the level of greenhouse gas in the atmosphere would still reach double its pre-industrial levels by 2050. In fact, emissions are increasing rapidly and the level of 550ppm could be reached as early as 2035.(Stern 2007)

We therefore need to support Gaia Engineering. Carbon trading is a good way to start.

If adopted on a large scale the Gaia Engineering tececology would sequester significant amounts of atmospheric CO2 and convert significant volumes of waste to resource. Gaia Engineering is an group of new technologies including TecEco's Tec-Kiln technology and Eco-Cements, bioreactor technologies, carbon dioxide scrubbing technologies, a seawater separation technology from Greensols Pty. Ltd. that can produce fresh water, and a number of industrial commodity products including gypsum, sodium bicarbonate and various other salts as well as building materials based on magnesium carbonates.

Gaia Engineering

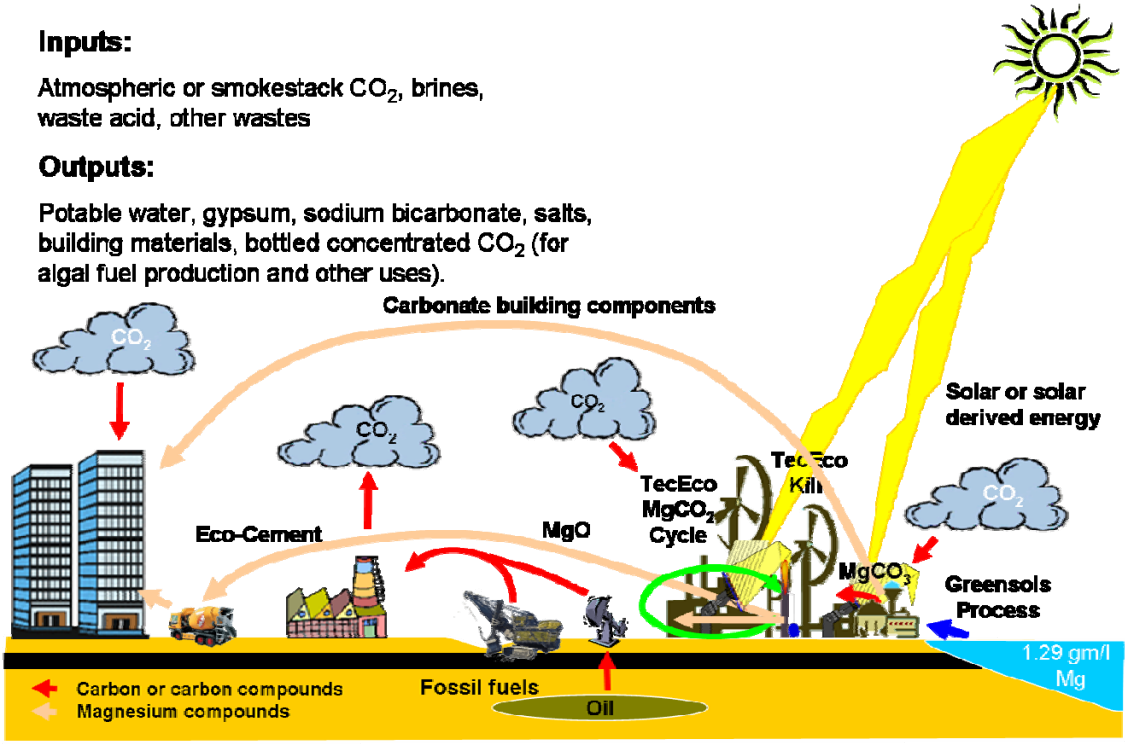


Figure 10 - Graphic Illustration of the Gaia Engineering Process for Seawater

The Gaia Engineering process starts with the Greensols process which used carbon dioxide from for example power stations and waste acid to extract magnesium carbonate and valuable salts from seawater or suitable brines and produce potable water as a by-product. The magnesium carbonate from this process can then be used directly as building products such as bricks or block or calcined in the TecEco Tec-Kiln which removes and captures carbon dioxide (ready for incorporation into cellulose, other compounds or for other uses and produces magnesium oxide. The magnesium oxide can either be used to make TecEco cements which utilise other wastes and in the case of eco-cement absorb more atmospheric CO2 as they harden or alternatively can be used to sequester more CO2 in a hydroxide/carbonate slurry capture process.

The hydrated carbonates produced by the hydroxide/carbonate slurry process can be de carbonated and cycle around that process indefinitely as in the diagram below.

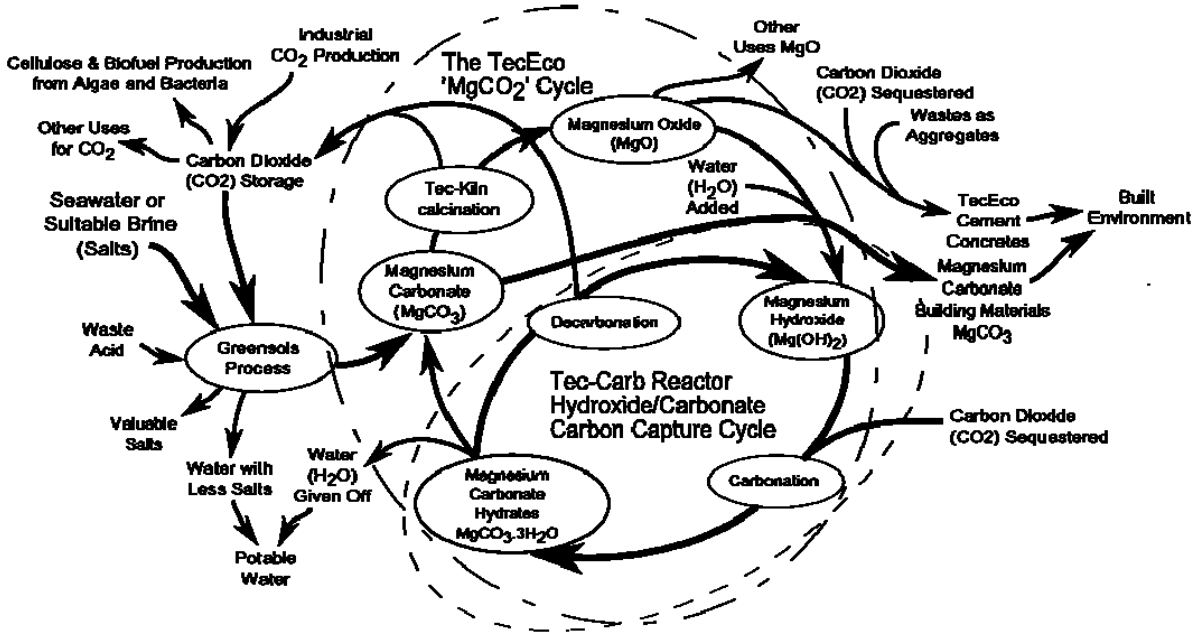


Figure 11 - Gaia Engineering Process Vector Diagram

Technologies are still evolving to use the CO2 produced by Gaia Engineering. A particular future use that we are monitoring is to force rapid growth of algae able to convert CO2 and water into oxygen and energy rich biomass.

The Greensols process is very efficient because it does not work against the hydrogen bonding of water and it can deliver massive sequestration at low energy cost. The magnesium thermodynamic cycle (the MgCO2 cycle) and Tec-Reactor hydroxide/carbonate slurry process mimic photosynthesis using the same central atom (magnesium). They can go around and around like a bicycle wheel as together, mass and energy are neither created nor destroyed, energy is only lost outside the system through inefficiencies. There is an exothermic part of the MgCO2 cycle where heat is required and an endothermic part where heat is released. To make the process as efficient as possible it is desirable to capture the heat from the exothermic parts and as efficiently as possible transfer it to the endothermic parts of the cycle.

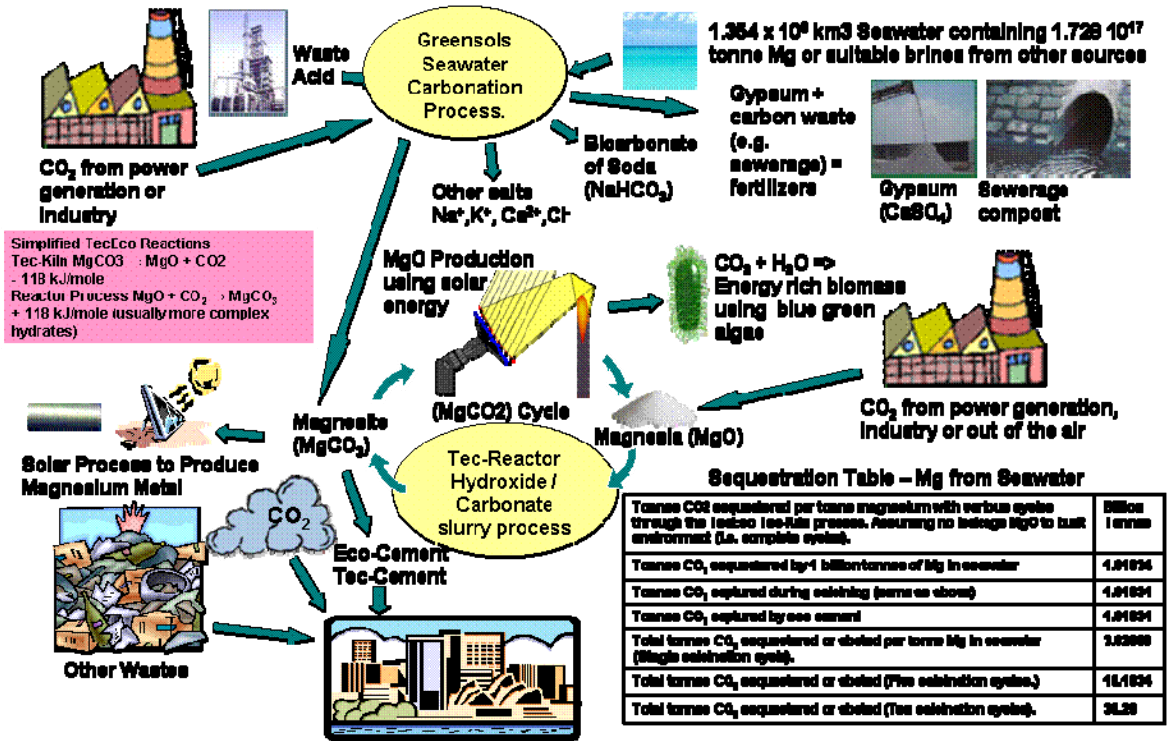


Figure 12 - The Gaia Engineering Process Diagram for Seawater

The efficiencies of the various sub-processes are important to making the Gaia Engineering tececology economic and minimizing the amount of energy required overall. An important area of research we are engaged in is to develop technologies for the efficient collection, concentration and transfer of heat energy and more follows about this (See Transferring Heat from the Exothermic Part to the Endothermic Part of the MgCO2 Cycle).

We call the Gaia Engineering process geo-photosynthetic because it mimics the way that plants, algae and some bacteria capture and store carbon using photosynthesis. Basing our tececologies on Gaia Engineering will result in sustainable cities that store carbon and are constantly recycled.

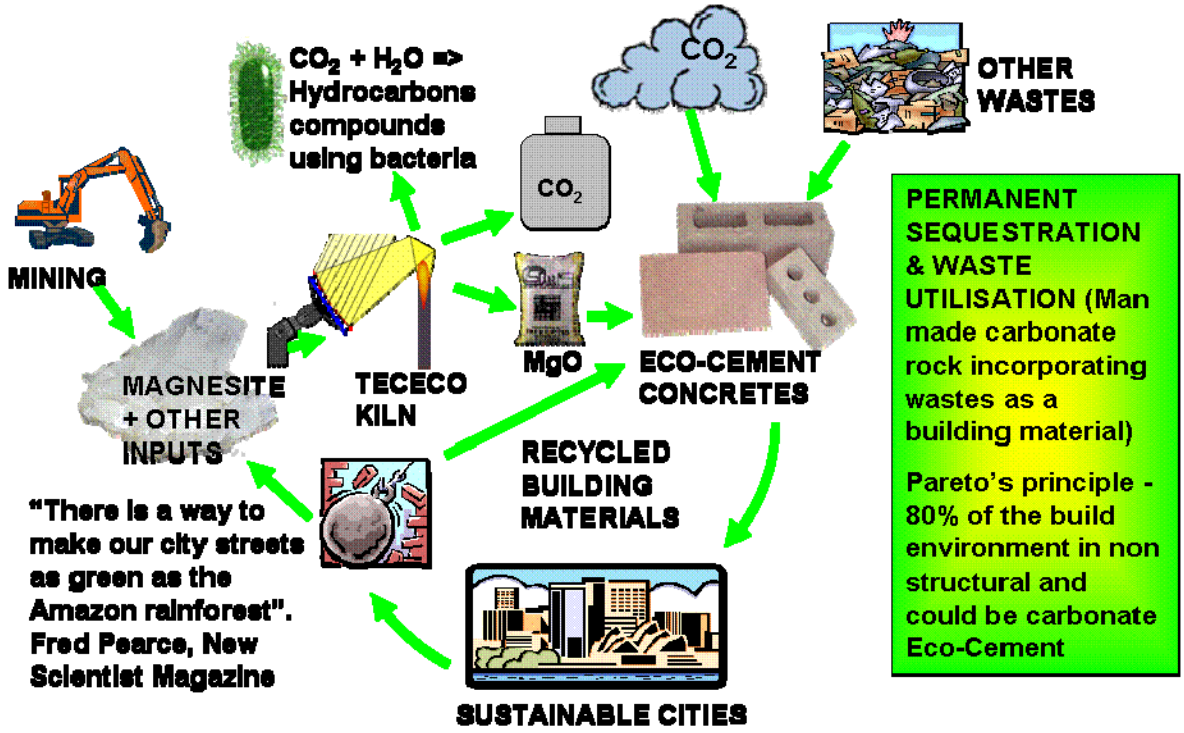


Figure 13 - Sustainable Cities

The TecEco Model of the Gaia Engineering Process

TecEco have developed a crude Excel model of the Gaia Engineering process to work out the plant and process requirements to sequester enough CO2 to avoid reaching a concentration of 450 parts per million in the atmosphere, considered by many as an upper limit to avoid the most dangerous effects of global warming and irreversible change. It relies on several assumptions, including a forecast for magnesia sales for use in concrete and the extent to which global abatement programs will be successful,. Outputs include the number of plants of a given capacity that will be required as well as the costs and revenues involved in running the process. The model still needs a lot of work however if you would like to review it please go to the TecEco web site at www.tececo.com and look under tools.

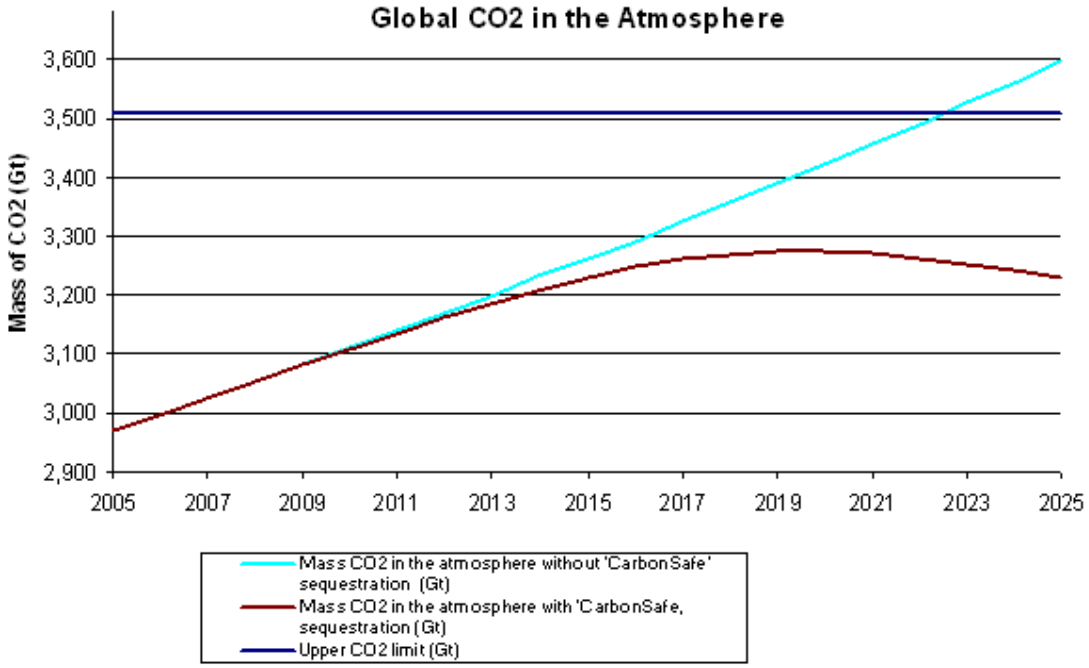


Figure 14 - Gaia Engineering (formerly CarbonSafe) Sequestration

Transferring Heat from the Exothermic Part to the Endothermic Part of the MgCO2 Cycle

In a continuous cyclic process such as the MgCO2 (magnesium thermodynamic) cycle sub-process of the Gaia Engineering tececology it is important to be able to transfer the heat produced in the exothermic sub-processes in the system to the endothermic sub-processes or at least transform it into a useful form such as electricity with minimal losses.

There are several exciting new technology contenders for capturing low grade heat including a pyroelectric process being promoted by CANMET in Canada and various modified liquid/vapour pressure processes including the Newcomen engine and non water Rankine engines. As the liquid used in the latter is normally an organic compound they are often referred to as Organic Rankine Energy Cycle engines or ORCE's. The Newcomen engine is particularly attractive to TecEco as one of the outcomes is potentially the production of potable water.

Power stations waste a lot of low grade heat and should consider retrofitting the Newcomen or Non Water Rankine engines discussed under Newcomen Engines.

How the MgCO2 cycle in Gia Engineering TecEcology is Geo-Photosynthetic (mimicking Photosynthesis)

In nature respiration consumes organic molecules and oxygen to produce energy and CO2. Before the industrial revolution this process was essentially balanced by photosynthesis, which combines CO2 and water to create molecules such as glucose and oxygen. We burn fossil fuels for energy in a manner similar to respiration but we provide no process to remove the damaging amounts of CO2 that we introduce into the air. The Gaia Engineering tececology was designed for this purpose and could therefore be likened to an ecological pump with many features analogous with photosynthesis.

The diagram below summarises photosynthesis in terms of inputs and outputs. The explanation of the complex reactions that take place is for the purpose of comparison simplistic.

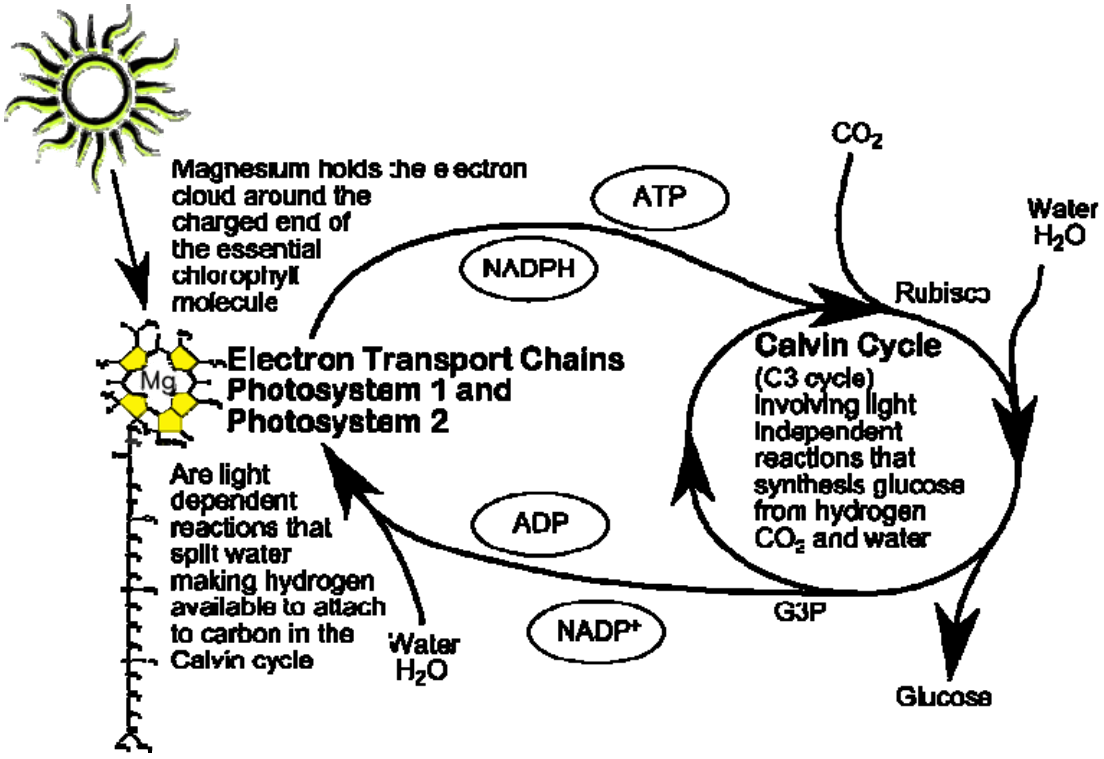


Figure 15 - The main Processes of Photosynthesis

Magnesium ions are important in the chlorophyll molecule as their strong charge holds an electron cloud around a porphyrin ring that supplies electrons to the process. PSII as it is referred to is a photosynthetic process that splits water thereby supplying hydrogen ions and electrons to this cloud. These electrons pass through the process powering the Calvin cycle via NADP<=> NADPH in the PS1 process. The hydrogen ions are incorporated in glucose via the (ADP<=>ATP) cycle.

The MgCO2 and hydroxide/carbonate slurry process cycles in the Gaia Engineering tececology depicted above similarly use magnesium compounds to fix CO2 as carbonates.

Both the Gaia Engineering and photosynthesis processes are powered by light and hence photosynthetic. Common to both are energy transfer mechanisms. In photosynthesis electrons move around the process whereas in the MgCO2 and hydroxide/carbonate slurry process cycles it is intended to use heat transfer technologies such as Newcomen engines.

Summary of the Gaia Engineering Process

The scientists behind Gaia Engineering are Chris Cuff and Stephen Blake from Greensols Pty. Ltd. and John Harrison from TecEco Pty. Ltd.

Gaia Engineering is a combination of new technologies including:

- A seawater separation technology from Greensols Pty. Ltd.
- TecEco's Tec-Kiln technology and cements
- Carbon dioxide scrubbing technologies
- TecEco' Eco-Cements

Gaia engineering profitably **geomimics** past planetary geological processes and adopted on a large scale will:

- Sequester significant amounts of atmospheric CO2 in the built environment
- Add value to the salts recoverable from sea water
- Convert large volumes of waste to valuable resource
- Produce and capture fresh water.

Gaia Engineering works like a giant ecological pump.

Inputs include:

- Seawater or suitable brine
- CO2
- Waste acid
- Other wastes of all kinds
- A small amount of energy

Outputs include:

- Gypsum, sodium bicarbonate and various other valuable salts.
- Magnesium carbonate building components.
- TecEco Tec, Eco and Enviro-Cements.
- Waste utilisation.
- Fresh water.

Gaia Engineering **http://www.tececo.com/simple.tececology.php**starts with the Greensols process which uses carbon dioxide from for example power stations and waste acid to extract magnesium carbonate from seawater or suitable brines which can be cast as panels, blocks or other building components. As there is 1.29 grams of magnesium in every litre of seawater there is enough of it to last a billion years at current needs for sequestration. With natural replenishment the resource will last indefinitely. As by products

Gaia Engineering produces valuable salts such as sodium bicarbonate as well as fresh water. The process does not work against the hydrogen bonding of water like reverse osmosis and is therefore very low energy.

The calcium and magnesium carbonates produced are then calcined in the TecEco Tec-Kiln which removes and captures the gas for incorporation into cellulose, fuel or other useful compounds and produces magnesium oxide the main ingredient of TecEco Tec, Eco and Enviro-Cements and input for the Tec-Carb Reactor hydroxide-carbonate CO2 capture process. Eco-Cements utilise other wastes and absorb more atmospheric CO2 as they harden and are used to bind together building components produced in the Greensols process.

Appendix 2
Eco-Cement

Eco-Cement is a new more environmentally sustainable type of cement developed by TecEco which incorporates reactive magnesia and wastes that is more environmentally sustainable. Eco-Cement used to make porous concretes absorbs CO2 from the atmosphere to set and harden and in this way mimic nature (See geomimicry). Eco-Cement can also be recycled. Wastes such as fly and bottom ash, slags etc. can also be included for their physical properties as well as chemical composition without problems from delayed reactions.

The Global Sustainability Alliance plan to make the magnesia that is used in Eco-Cements using solar energy in a new kiln that combines heating and grinding and captures CO2 known as the Tec-Kiln. Given this production scenario Eco-Cement concretes have the capacity to become a huge carbon sink and they will be used in the Gaia Engineering tececology to bind wastes and the carbonate building components made using Greensols technology.

As stated by Fred Pearce in the article on Eco-Cements published in the New Scientist magazine (Pearce 2002[2]) “There is a way to make our city streets as green as the Amazon Forest. Almost every aspect of the built environment from bridges to factories to tower blocks, and from roads to sea walls, could be turned into structures that soak up carbon dioxide – the main greenhouse gas behind global warming. All we need to do it is the change the way we make cement.”

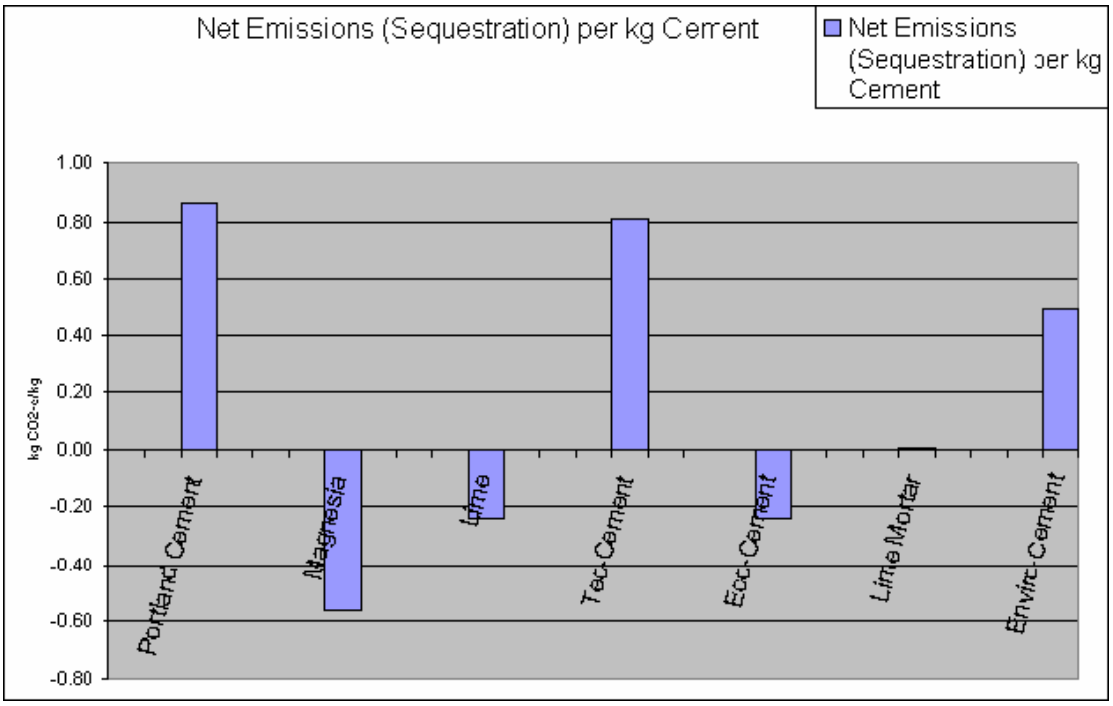


Figure 16 - Sequestration Typical Eco-Cement (Assuming Capture during Manufacture)

Making the built environment a repository for recyclable resources (referred to as waste) as well as a huge carbon sink is an alternative that is both politically and economically viable.

We got the idea of using carbon and wastes in building materials from his observations of nature. During earth's geological history, large tonnages of carbon were put away as limestone and coal by the activity of plants and animals. Shellfish build shells from it and trees turn it into their wood. These same plants and animals wasted nothing, the waste from one was the food or home of another. I concluded that the answer to the problems of greenhouse gas and waste was to use them both in building materials. (See geomimicry)

Eco-Cements are made by blending reactive magnesium oxide with conventional hydraulic cements like Portland cement. They are environmentally friendly because in porous concretes the magnesium oxide will first hydrate using mix water and then carbonate forming significant amounts of strength giving minerals in a low alkali matrix. Many different wastes can be used as aggregates and fillers without reaction problems. The reactive magnesium oxide used in Eco-Cements is currently made from magnesite (a carbonate compound of magnesium) found in abundance and that in the Gaia Engineering tececology will be produced from seawater.

When added to concrete reactive magnesia hydrates to magnesium hydroxide, but only in porous materials like bricks, blocks, pavers and porous pavements will it absorb CO2 and carbonate. The greater proportion of the elongated minerals that form is water and carbon dioxide. These minerals bond aggregates such as sand and gravel and wastes such as saw dust, slags, bottom ash etc.

Eco-Cement can include more waste than other hydraulic cements like Portland cement because it is much less alkaline, reducing the incidence of delayed reactions that would reduce the strength of the concrete. Portland cement concretes on the other hand can’t include large amounts of waste because the alkaline lime that forms causes delayed and disruptive reactions.

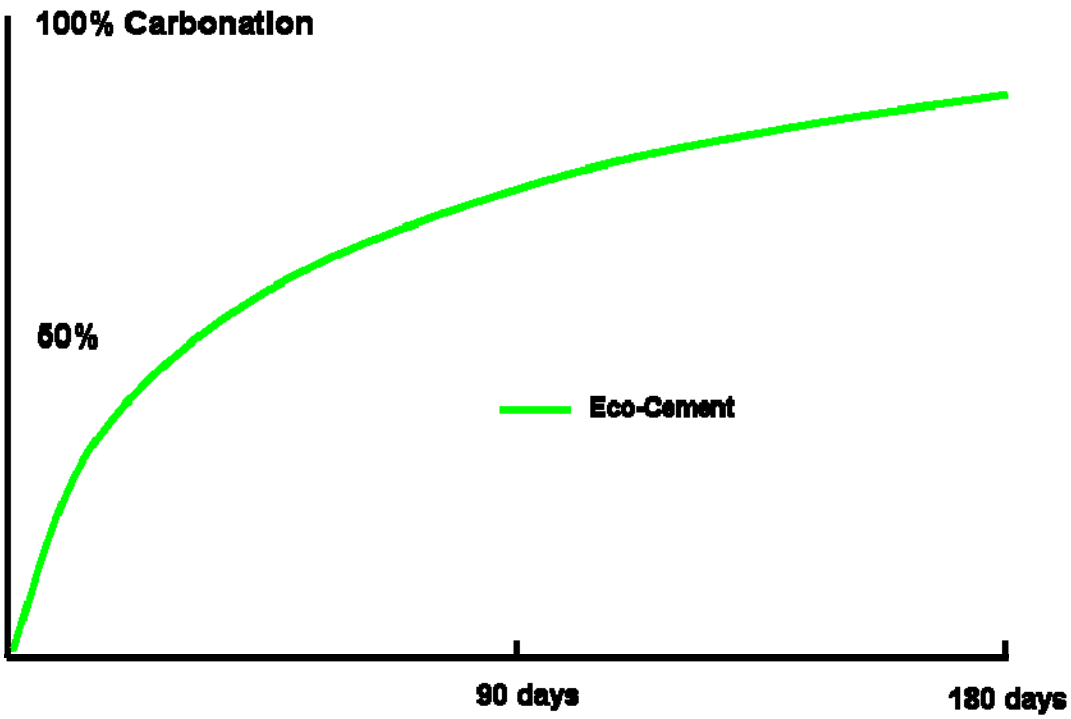


Figure 17 - Eco-Cement Carbonation

The more magnesium oxide in an Eco-Cement and the more porous it is, the more CO2 that is absorbed. The rate of absorption of CO2 varies with the degree of porosity. Carbonation occurs quickly at first and more slowly towards completion.

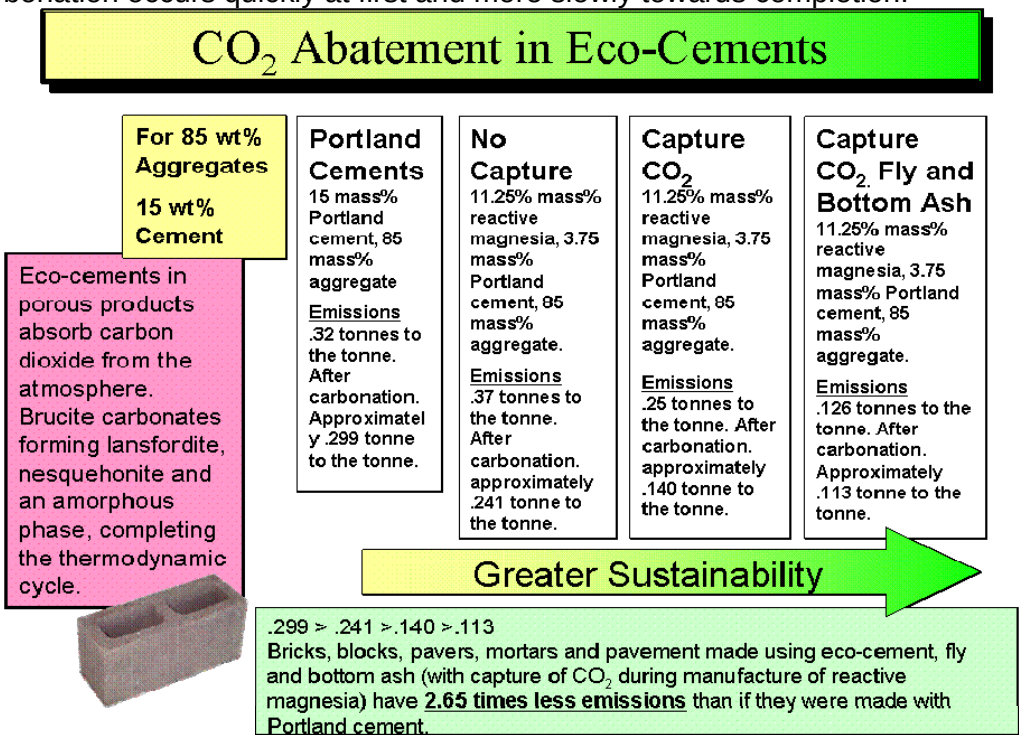


Figure 18 - Sequestration in a Typical Eco-Cement Product

A typical Eco-Cement concrete block would be expected to fully carbonate within a year. Eco-Cement also has the ability to be almost fully recycled back into cement, should the concrete structure become obsolete.

Appendix 3
A Broad Based System of Eco-Debits and Credits

Carbon Trading is an important precursor enabling process for a wider based system necessary in the longer run. What follows are the main elements of a previous submission to the House Standing Committee on Environment and Heritage Inquiry into a Sustainability Charter

Sustainability Auditing and "Eco Credits"

We mention earlier that sustainability tools need to be broadened because of their connectivity and multipliers on each other and that there should be factors other than CO2 with institutionalised value in relation to the well being of the global environment.

This broadening of cost tools should be associated with a re examination of all taxation and subsidy instruments many of which, perhaps as a legacy of the past encourage activities that result in greater sustainability.

We therefore propose a Sustainability Charter run by a Commission or Board that includes enabling clauses for the establishment by the Commission of a process of "Sustainability Assessment" to determine the allocation of broad based "Eco Credits" or "Eco-Debits" and advise on taxation policy generally.

A Sustainability assessment process should be used to determine the overall environmental impact of a process or development, based on a wide range of factors. The results of the assessment would then be used to determine the number of Eco Credits or Debits that are granted upon completion of a project. It differs from Environmental Impact Statements (EIS) in that it relates to any business undertaking or construction and the process should be more simple and informal – codified yet flexible. For example systems for determining the relative sustainability merits of structures already exist. What is proposed is a mechanism for putting a value on these ratings.

Initiating carbon trading is a good start towards a broader based Sustainability Assessment Scheme and finer tuning of taxation and subsidies which could focus initially on just building construction as we already have current rating systems. In time a broadening is envisaged to include landscaping, subdivisions, utilities etc.

Land Titles Offices

In many cases causes tend to be localised and could be considered with land whereas the effects tend to be regional or even global.

By localising the economic impact of global effects, costs and benefits can be incorporated as values in an economic system providing strong incentive or disincentive as required for making more sustainable decisions in what are short term markets

On possibility is that more broadly based Eco Credits or Debits attach to the title of the land. The formal registration of credits would be conducted via the respective State Land

Titles Offices, similar to the way that a mortgage or covenant may be registered so that it attaches to the registered title, under the Torrens system. The Eco Credit or Debits would be able to be:

- Left registered on the title,
- If Credits offset against the payable stamp duty and other government charges, or
- Traded on a market.

Just like with carbon trading market trading of Eco Credits would be a useful way to establish a mechanism for charging developers who are responsible for significant environmental impacts. If a developer wants to build a resort in an environmentally sensitive area or with unsustainable technologies then, if it is to be approved, the developer can be required to purchase a certain number of Eco Credits as part of the approval conditions to meet the Debits he would be penalised with. This would tend to drive up the price of Eco Credits and thereby provide further incentive for more sustainable construction. The idea is to make the adoption of sustainable construction techniques the most cost effective way to build.

Determinations by the Sustainability Commission

The ambit of an Eco Credit/Debit ought to be as wide as possible, and flexibility should be built in to the system such that the definitions can expand. The Sustainability Commission would have a role to play in establishing the system and in the ongoing determination of what factors can count towards Eco Credits and how such factors are measured. People would be able to appear before the Commission seeking a determination on any matter in relation to the Sustainability Audit or Eco Credits and Debits. Home owners and builders should be able to argue their case for more Eco Credits and developers of new construction materials and technologies should be able to petition the Commission requesting that their product be registered as a source of Eco Credits when used in construction.

The range of factors that would attract Eco Credits or Debits could be very broad. They would include an assessment of the source of the materials used, their embodied energies, embodied water and any Greenhouse Gas (GHG) emissions that result from their manufacture and transport to the construction site. Use of waste materials would be viewed positively, as would aesthetic factors such as sensitivity to the surrounding natural environment. The correct management of stormwater and grey-water, use of solar-passive design techniques, insulation, renewable energy systems and native plants are further examples of factors that would attract Eco Credits or Debits.

The sustainability commission could also advise governments how to co-ordinate tax and subsidy policy.

Measurement by Designers

The actual measurement of the factors that count towards Eco Credits could be undertaken by architects, building designers or other authorised contract assessors.

Auditing by Inspectors

The system should be as insulated as possible against graft. The auditing of assessments could be undertaken by municipal council building inspectors or some other government agency. As municipal councils already undertake routine inspections and assessments of new constructions they would be well placed to service this aspect of the job.

National Database

The collation of this information into a National Database will provide useful and detailed metrics of industry. Once a picture of the sustainability of the industry is constructed the data can be analysed in detail to identify areas for improvement and refinement. Areas that are identified as in need of improvement can be ascribed a higher rate of Eco Credits.

The database will also be a useful resource for the administrators of the system to determine what each factor is worth in terms of Eco Credits at the time of the assessment.

Software tools could be designed to hook into the designer's CAD software and calculate the number and value of the Eco Credits or Debits that relate to the factors registered within the system.

Factors

The term 'factors' is the suitably vague term used to describe the properties that count towards the allocation of Eco Credits or Debit for a project. Rather than using 'products' as the primary measure, the term 'factors' can include the way that the huge variety of different products are used. Solar-passive heating is a simple example, where standard construction products can be used in a way that dramatically lowers the heating and lighting requirements of buildings. Once a standard product has an Eco Credit/Debit rating then that rating can be used by the designer in the assessment.

Trading

The Sustainability Commission in parallel with establishing a value system would need to consider the establishment of a trading system so the value attached to Eco Credits or Debits can be realized in the marketplace. We consider that Debits as well as credits are required otherwise trading will not occur.

Advantages of a Sustainability Value System

Information Leveraging

The promotion of sustainable materials in construction is usually hampered to a large extent by a lack of information. The people making the purchasing decisions within the

housing market are generally uneducated about the environmental impacts of their decisions.

The environmental situation we are faced with today, particularly with reference to global warming, requires high quality decision making. We simply cannot afford to leave decisions with large cumulative environmental impacts in the hands of non-experts without any form of guidance.

The classical conception of a market with an 'invisible hand' has broken down with respect to sustainability in construction because of our failure to account for the externalisation of costs to the environment. The generation of wastes that are not correctly re-integrated into natural systems has in the past been free when it should have been a cost. The result is that the 'invisible hand' of Adam Smith has been 'blind', as well as invisible; having no idea as to what activities to avoid, because it can not see the cost.

We need to discover new ways of incorporating those costs into our accounting systems. Costs are very useful as people prefer to avoid them. They much prefer benefits.

By framing the Sustainability Auditing Scheme primarily in terms of benefits and costs – Eco Credits and Debits – we can structure the economics of the construction industry in a way that takes advantage of the best information that we have about the hidden and distributed costs of environmental impacts.

Self-Interest Leveraging

The idea of Eco Credits and Debits is also designed to harness the motivational power of tax avoidance. The theory is: if people were to direct as much effort towards sustainability as they do towards minimising their taxation bills then the problem would soon vanish.

Flexibility

The Sustainability Commission will make determinations in relation to the Scheme in much the same way that a court makes its decisions, based on rules of precedent to ensure a balance between certainty and flexibility. Owners, builders and construction technology vendors will have the ability to seek determinations from the Commission as to their eligibility to register with the Scheme. Legal representation ought to be permissible only on appeal, in order to keep the determinations short and informal.

The system should be as flexible as possible so it can be readily adapted to an international system should one be adopted.

Recycling of Government Instrumentalities

The proposed Sustainability Auditing Scheme would need to ensure that the sort of unnecessary duplication of roles that has plagued the Australian federal system in the past is avoided. Whilst we see the role of the Sustainability Commission as being crucial in terms of establishment of the Scheme and ongoing arbitration, the actual machinations of it can best be performed by existing government instrumentalities that already perform similar tasks; namely, municipal councils and the state land titles offices. There will likely

be roles for the AGO9, ANSI10, ABGR11, AASMIC12 and various other government and non-government organisations.

The Sustainability Commission will be in a position to determine other possible connections and synergies that can be utilised in a similar manner.

Industry Standards and a Sustainability Value System

As an adjunct to the Scheme, a review of the various construction industry standards will be useful. This is an area in which a lot of ink has already been spilt, as there are difficult issues involved. There is a general consensus that a move towards performance-based standards is far preferable to maintaining formula-based standards, which tend to act as barriers to innovation. The question is how to do this in a cost-effective manner, as the cost of performance testing can be prohibitive.

The mechanisms of the Sustainability Auditing Scheme may be able to help solve this dilemma.

The main issue is the delayed effect of any new problems. When problems only present after several decades from the date of construction, the original owner will most likely have sold the property to a third party. If the original owner/builder used a technology that was outside of the formula-based standard, perhaps in order to gain more Eco Credits under the Scheme, then subsequent purchasers of the building need to understand that they are accepting the attendant risks.

Innovation Caveats

A condition of the granting of Eco Credits on innovative technologies that fall outside of formula-based standards ought to be the registration of a caveat against the title that specifies that the innovative technology that was used. The caveat will provide specific details of the technology, what level of performance is expected of it and the results of any subsequent testing that has been performed during the period of registration. This will give the third party purchaser notice of the risk and will be a prompt to find out whether the risk is likely to impact in any way on his or her enjoyment of the property.

In effect, the costs associated with possible risk remain with the original owner/builder. In return for taking the risk, the original owner/builder has the right to redeem any Eco Credits or choose to leave them on the title for the benefit of the purchaser who may then agree to take on the risks.

[9] Australian Greenhouse Office
[10] Australian National Sustainability Initiative
[11] Australian Building Greenhouse Rating scheme
[12] Association for the Advancement of Sustainable Materials in Construction

Appendix 4. - Geosequestration

Recognizing the fact that we are now “The Weather Makers” (Flannery 2005) becoming skilled as planetary maintenance engineers (Lovelock 1979) as quickly as possible is essential.

Australians have correctly concluded that technology will give us the tools to moderate our own impacts, the question remains as to what tools at what price and what profit. The pumping of vast amounts of CO2 underground has been proposed as one such tool. We believe this may be useful in a few circumstances but that insufficient research has been done into lower risk, more profitable alternatives.

The Global Sustainability Alliance have proposed an alternative that is safer, potentially profitable and capable of sequestering vast quantities of CO_2 directly from the air as well as from power stations indefinitely.

The Global Sustainability Alliance

The Global Sustainability Alliance (See **www.gaiaengineering.com**) comprises businesses and individuals that see the solution to global warming in profitably finding uses for carbon and other wastes. At present the group consists of two companies. TecEco Pty. Ltd. (TecEco) specializing in economic solutions to global problems including energy, water, waste and pollution, loss and degradation of topsoil and global warming and Greensols Pty. Ltd., (Greensols) formed to develop and deploy a method of extracting magnesium and calcium carbonates from seawater.

The managing director of TecEco, John Harrison is well known as a materials scientist, and economist, inventor of Eco-Cement, speaker and writer about sustainability issues relating to materials. (See **www.tececo.com**). The managing director of Greensols Pty. Ltd., Prof Chris Cuff, is a private consultant in chemical mineralogy and crystallography. Prior to this he was Dean of Science at James Cook University. Over the last 30 years Chris has served on numerous national and international committees including the Council of the Australian Council of Nuclear Science and Engineering (see **www.greensols.com.au**).

Global Warming and CO_2 Sequestration

Excess atmospheric CO_2 created by the burning of fossil fuels is believed to be a major cause of global warming. To counter this, industries directed towards the uptake and sequestration of atmospheric CO_2 are being promoted through a system of Carbon Credits that can be traded with CO_2 producing industries. Major carbon exchanges currently exist in Brussels, Chicago and more recently NSW and potential opportunities still exist in Australia dependent upon legislative changes by State and Federal Governments.

A common form of carbon sequestration currently supported financially by Carbon Credits is the planting of biomass such as in tree plantations. Alternatively ocean nourishment is proposed as process for stimulating the sequestration of atmospheric carbon dioxide in the

deep ocean by providing the nutrients needed to enhance the biogenic production of phytoplankton of calcium carbonate. Both have problems. The sequestration of CO_2 through the planting of biomass (e.g. tree plantations) is relatively short term in geologic and climatic time frames as the sequestered carbon is released as the biomass decays. Fertilising the oceans to the south of Australia with iron could have countless unforseen consequences and should not be done prematurely without much more research.

A solution is required that is safe, has other environmental benefits and that is profitable because it converts CO_2 into a resource. Such a solution has been created by the Global Sustainability Alliance and members are concerned with the over emphasis on a particular form of geosequestration, that of pumping liquefied CO_2 into underground storage reservoirs.

The term geosequestration is a jargon word derived from the Latin root “geo” meaning earth (geography, geology etc.) and sequester (ation) from the Latin for a depositary. The term was originally used generically for technologies for geologically sequestering CO_2 and included what is today referred to by many as mineral sequestration. The fossil fuel industry have attempted to take over the word to add credibility to pumping gaseous or liquid CO_2 into underground “storage” usually with the pecuniary advantage of also forcing up more oil.

During the cold war extensive work was carried out to determine the practicality of storing gas underground and the general conclusion was that doing so was not feasible. Pumping liquid CO_2 deep underground is a short term, risky and temporary solution to the now urgent global carbon dioxide concentration problem. The technology should only have a limited role to play in what should be a more holistic approach to the issue. The reality is that compressing carbon dioxide and pumping it long distances and eventually underground is a risky, high cost waste of an as yet unrecognised resource. The technology would not have gained any credence at all if it was not promoted by the oil industry because it is also a useful technology for forcing oil out of the ground under pressure from dwindling reserves.

As distinct from pumping liquid CO_2 underground, permanent carbon dioxide (CO_2) fixation (‘sequestration’) is defined as the permanent immobilisation of CO_2 from the atmosphere by precipitation as solid carbonate mineral phases, typically calcium carbonate ($CaCO_3$) and magnesium carbonate ($MgCO_3$).

We therefore question the manner in which the Australian government has focussed only on depositing liquid CO_2 underground and examined none of the safer, more logical and more economic alternatives available. Are we exchanging dirty coal for dangerous coal?

What we should be doing is mimicking nature and finding uses for CO_2 as TecEco has done. The permanent fixation of carbon dioxide accomplished by the Global Sustainability Alliance process is an entirely different form of permanent sequestration with as yet no known downsides.

The Science Underpinning Geosequestration Technologies

There are many different types of geosequestration technologies. A short description of the main contenders follows.

Pumping CO_2 Underground

Australia has 24 large power stations supplying 80% of our electricity burning coal and producing a quarter of a million tonnes of CO_2 every day (Horstman 2006).

Pumping CO_2 underground has been proposed so we can keep using oil and coal and has been given the name “clean coal” as green wash. It involves capturing the gas at power stations, compressing it into liquid CO_2, piping it to a suitable location (usually an oil well) and then injecting it deep underground where it is hoped it will remain trapped for thousands of years.

The concept of putting CO_2 back into the ground from whence it came is rock solid. Some 7% of the crust is carbonate sediment and along with oil and coal originated as atmospheric carbon through natural sequestration. My concern is that, as a rule nature has not buried carbon dioxide as a gas in sediments, although it occasionally emerges in a concentrated form in volcanic areas causing loss of life. If we are to learn from nature’s 4 or 5 billion year old experiment, then geomimicry principles require the burial of CO_2 by first making it a non reactive solid as has occurred naturally during the formation of carbonate sediment during previous periods of global warming including the Carboniferous and late Permian.

The earth is highly fractured and holding compressed liquid CO_2 at depth and preventing escape, adverse reactions and other catastrophes occurring is problematical. During the effluxion of time, unless the gas is converted to a chemically stable solid, it will naturally migrate to regions of lower pressure such as at the surface, or as has been demonstrated, combine with salt and react with country rock thereby migrating in this manner (Kharaka 2006). We submit that true geomimicry alternatives such as precipitating magnesium carbonate from seawater and using it to construct the built environment with Eco-Cements and other alternatives (not discussed here as they are not geo or of the earth) such as using genetically modified blue green algae to produce ethanol or cellulose, are more exciting and a much more economic and appropriate use of taxpayer funds.

Mineral Sequestration

Mineral sequestration is a term generally used in reference to using serpentines, olivines or peridotites to sequester CO_2. The technology was first mentioned by (Seifritz 1990) and discussed further by Dumsmore (Dunsmore 1992). However, Lackner and his associates (Lackner, Wendt et al. 1995) were the first to provide the details and foundation for current research into the technology.

It is our opinion that permanent sequestration as a solid stable carbonate mineral is much safer than pumping CO_2 as a liquid into underground reservoirs and to this extent support mineral geosequestration as suggested by the above authors and others.

The main problem with this technology is the high cost which no useful products or by-products are created to offset.

Gaia Engineering

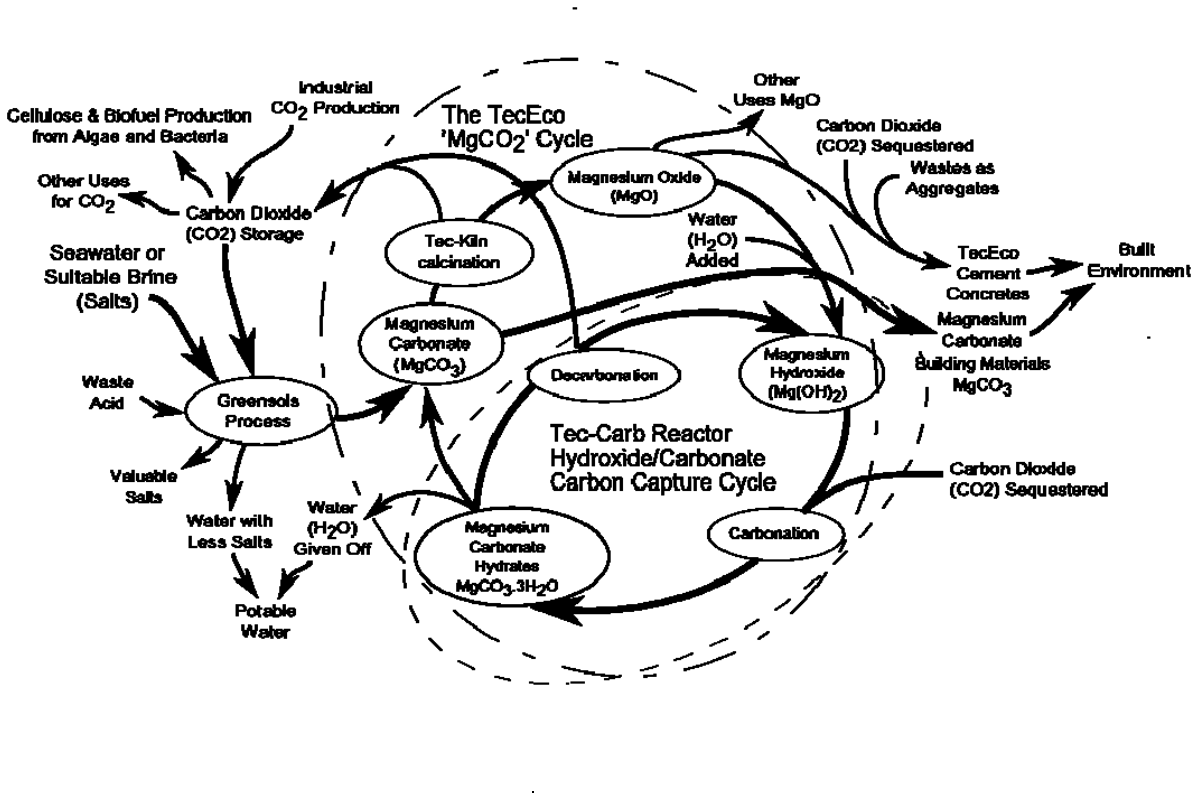


Figure 19 - Global Sustainability Alliance Process Vector Diagram for Seawater

The Global Sustainability Alliance believe that to be successful in the long run any sequestration process must convert CO_2 into a resource. To do this we have developed an economically viable tececology we call “Gaia Engineering” that mimics nature. This biomimicry-geomimicry process includes a number of components that together will make sequestration profitable. Valuable by-products are created as result of the process, include potable water[13], sodium bicarbonate, mineral salts, carbonate building components and Eco-Cements, which themselves utilize waste and set by absorbing CO_2.

Gaia Engineering is geo-photosynthetic in the way it mimics photosynthesis by reversing carbon flows from fossil fuel consumption. Most components are driven by non-fossil energy and working together, consume rather than produce wastes.

Gaia Engineering comprises an evolving number of key sub-processes, which as they are as of May 2006 are depicted in Figure 19 above. They are:

[13] Water is a scarce resource in Australia and many other parts of the world.

- The Greensols Process, for precipitating magnesium carbonate, sodium bicarbonate, gypsum and other salts and potable water from seawater.
- TecEco's Tec-Kiln, for low-temperature, non fossil fuel calcination of magnesium carbonate converting it to magnesium oxide, and
- A Hydroxide Carbon Capture Cycle (The HCCC) for additional CO2 capture.
- TecEco Eco-Cement sequestration.

The concept of using CO_2 as a resource to build the built environment is without equal, that this can be achieved whilst at the same time utilising wastes to produce other valuable product including much need fresh water is an outstanding, yet unrecognised Australian achievement.

If adopted on a large scale the CarbonSafe process would sequester significant amounts of atmospheric CO_2 and convert significant wastes to resources. All of the outputs from the process uniquely provide revenue to help make the overall process economic.

The Potential Environmental and Economic Benefits and Risks of the Various Methods of Sequestering CO2 that will be Encouraged by Carbon Trading

Pumping CO_2 Underground (incorrectly geo sequestration)

The crust of the earth is always prone to tremors and earthquakes and there is a high probability that pumping liquid CO_2 underground will not always work as expected. Should the technology fail the consequences will be significant.

Consider the Costs and Risks.

Costs

The International Panel on Climate Change estimate burial costs of between 15-75 dollars per tonne of CO_2, depending on the method (Metz and Loos 2005). The actual figure is still a guess. The point is that pumping liquid CO_2 underground will be very expensive. Much more expensive than our Gaia Engineering proposal as no useful product is involved other than in the remote possibility in Australia that it may be used to extract previously economically unviable oil deposits, further compounding the problem.

Energy Usage

Estimates abound of up to a third as much energy would be required to capture compress, pump and store the CO_2. Regardless of the exact extent of this unknown energy cost, it will be high.

Risks

The earth is highly fractured and compressed gases have a habit of wanting to migrate to zones of lower pressure and once again become gases. During the cold war extensive research concluded that storing gas underground was too risky – has anything changed?

CO_2 has escaped before as in the 1986 Cameroon disaster that killed some 1700 people and the consequences would be disastrous if it happened on a large scale as a result of underground storage of massive amounts of the gas.

There are many geological reports outlining the risks such as recently reported by New Scientist (Kharaka 2006) and it is not our intention to reiterate them further.

Mineral Sequestration

The main problem so far recognised with mineral sequestration is that of cost. The Global Sustainability Alliance think that this will only get worse with the rising price of fuels as the process involves mining and transport.

Cost and Energy

Cost estimates for the industrial-scale implementation of current mineral carbon sequestration processes range from $60-100/ton CO_2 avoided for the direct carbonation of olivine to several hundred dollars per ton of CO_2 avoided for the direct carbonation of serpentine. (Krevor and Lackner 2005)

Risk

Calcium or magnesium carbonate solids are the thermodynamic ground state of carbon and to this extent there is very little risk of catastrophic failure. The problem is more a risk that in spite of continued research viable chemical processes for reacting magnesium silicates with CO_2 sufficiently rapidly will not be found.

Gaia Engineering Sequestration

To John Harrison and other members of the Global Sustainability Alliance, adding value to carbon dioxide by developing uses for it is by far the most sensible option. Pilzer's "first law" stated simply is that the technology paradigm defines what is or is not a resource (Pilzer 1990). Uses are found by changing technology paradigms and to this end John Harrison has invented Eco-Cement whereby carbon is used to bind together other wastes to create the built environment.

Eco-cements are a perfect example of geomimicry whereby material that is indefinitely stable is created out of carbon dioxide in the air.

Costs

The long run costs of making carbonate components that are held together by Eco-Cements for use in constructing the built environment in accordance with Gaia Engineering should be very low, especially since other valuable product is also produced. The process temperatures are low, the energy efficiency high and the source of

magnesium is abundant, universally available in sea or groundwater and cheap. Given current emissions, only around 23 billion tonnes of man made magnesium carbonate (magnesite) are required to be deposited a year to reverse global warming. This is in the same order of mass as the concrete we already make. The key is to use some of that magnesite to replace concrete. Our calculations show that magnesium in sea water would last over a billion years with natural replenishment. With replenishment – probably indefinitely.

Risk

As stated earlier, magnesium carbonate is very stable. As the Eco-Cement technology has already been proven there is no risk. The Greensols process has been laboratory tested and will work.

The Skill base in Australia to Advance the Science of Geosequestration Technology

Skills acquired are somewhat proportional to the money spent to acquire them and what is occurring in Australia is that so much money is being literally thrown at the concept of pumping liquid CO_2 underground that all sorts of experts are emerging from the CSIRO to universities and jumping on what is rapidly becoming an academic “gravy train”.

This seems obvious to most thinking persons except those involved. There was some justifiable concern that those recommending this technology also stood to benefit from taxpayer investment in it however this did not prevent the announcement of considerable government funding to a small number of major industry players.

We agree money has to be thrown at a solution. It is just that the smell of the fossil fuel industry lobbying for money is overpowering.

What is needed is a solution that is safe, permanent and can not only sequester concentrated CO_2, but CO_2 out of the air. Our Global Sustainability Alliance are offering such a solution with the added advantage that it is potentially profitable. Unlike the fuel industry we have no lobbyists, nor axe to grind, just an altruistic desire to solve the problem because it is the right thing to do. We know we will not achieve this goal unless doing so is profitable and that is why we have invented new technology paradigms that are potentially profitable, especially if Australia exploits the competitive advantage of becoming an early adopter.

Regulatory and Approval Issues Governing Geosequestration Technology and Trials

Pumping CO_2 Underground

The regulatory regime will be a mine field. There are inherent dangers in pumping a gas that is lethal to human and other life underground in a crust which is always moving, sometimes slowly and sometimes more rapidly as evidenced by earthquakes. As a result

of this movement gases do not in the long term remain underground and there is as a consequence proportionally not much gas in the crust.

Who will be responsible? Will it be considered an act of god if the CO_2 gets away as a gas or into ground water and we end up with giant soda fountains all over the place near which nobody can live?

We know that in the long run the gas will escape. Will people (if they are still around) in a millions years blame us for their woes?

It is in our interest as a species to survive and in the short term pumping CO_2 underground may increase the probability of doing so. In the medium or long term however there are substantial risks we should not be burdening our successors with.

The Global Sustainability Alliance do not consider that a potential life threatening technology such as pumping CO_2 underground should be funded without extreme legally enforceable precautions. Other methods have no obvious risk and thus would not require the same scrutiny.

How to Best position Australian industry to capture Possible Market Applications.

Unfortunately other countries are well advanced with technologies to pump CO_2 underground so we do not consider there are significant opportunities other than in niche allied technologies.

On the other hand the opportunities with Gaia Engineering are significant. All components of the technology are patented and Australian or public domain.

The know how is also Australian and even though it can be used to sequester more concentrated gases at power stations, unlike pumping CO_2 underground concentration is not required for either the hydroxide carbon capture cycle or Eco-Cements to work.

The most relevant saleability factor is that the Gaia Engineering process is potentially profitable.

Summary

It is my considered view that the government should not have allocated over half a billion dollars of taxpayers money to a special interest group (the petroleum and coal industries) without having made proper enquiry into other alternative forms of geosequestration.

We believe a much more economic proposal is to develop tececologies that use CO_2 and wish to draw to your attention that for some time now our Global Sustainability Alliance have been promoting Gaia Engineering processes to do just that.

Appendix 5 – Tax Instruments and Sustainability Policy

Taxes and subsidies are powerful weapons for the implementation of policy but must be much more carefully monitored than they have been in the past to prevent distortions and the inadvertent encouragement of unsustainable economic activity

It is important to try and use taxation and market instruments together to create a strong positive investment incentive for sustainability. Most prior endeavours have focused on cost offsets such as carbon trading, not the possibility of more generous incentives.

Incentives as well as tax costs should be part of the toolkit for sustainability.

By harnessing the energy Australian put into reducing their tax liabilities we can solve the problem.

Direct and Indirect Taxes

“Australia's taxation system is predominantly federal rather than state-based. In national discussions this decade about a shift from income-based taxation to consumption-based tax, the concept of ecological tax reform that has come to the fore in Europe has not had broad exposure in Australia, with the exception of the carbon tax debate. Ecological tax reform is the shifting of the tax base from value adding activity such as employment, enterprise and saving, to compensating for resource depletion and the creation of wastes and pollution.”(EPA(NSW))

There is no doubt Tax incentives/disincentives can bring about outcomes some of which in retrospect have not been so desirable. This is because taxation instruments are very good at redirecting our economic behaviours.

One of the reasons income taxes have been retained in Australia and many other countries is that they are a powerful weapon for implementation of government policy objectives. Unfortunately the weapon is large and cumbersome, slow and difficult to aim. Income taxes are however very useful for redirecting our purchasing behaviour. If there is a taxation deduction or write-off to purchase something not available for alternatives then our purchasing decision is strongly influenced.

On the other hand non progressive but directed taxes such as excise and duties, taxes on single streams such as payroll tax or carbon taxes add costs to purchasing decisions redirecting buyers in the market elsewhere.

Examples abound of both good and bad tax policy decisions. As an example of what is generally considered as good income tax policy Charities are largely funded by tax breaks for contributions. Unfortunately there appears to be at least as much bad as good policy and I suspect this is because of the time it takes to redirect such a large cumbersome instrument. Before sustainability became an issue land clearing was supported by tax breaks and subsidies and in many cases was undesirably pursued with vast tracts of marginal land turned over to broad acre farming and now cursed by salinity as a direct

result of the removal of deep rooted species. Culturally and scientifically we moved away from such practices long before the slow cumbersome aim of tax policy was shifted.

Another less obvious example is the per kilometre deduction for private vehicle usage whereby larger less efficient vehicles still attract a bigger deduction. It would be amazing how quickly we could actually reduce our consumption of fossil fuels if tax breaks including depreciation, one off deductions, running costs and other deductions were more appropriately aimed.

Given the power of the income tax instrument and the cultural change that has occurred it would now seem appropriate to redirect aim to encourage expenditure that results in greater sustainability and discourage obviously bad farming and agricultural practices.

We believe that the shear size of the legislation which is our tax law has caused some of its poor aim. Part of the changes required has to be simplification so users can actually figure out where the aim is.

Subsidies

Subsidies are an alternative for government when true pricing cannot be achieved for social or economic reasons. Examples included subsidies on public transport

Subsidies can have negative environmental effects if they result in distortions or inadvertently encourage the maintenance of unsustainable production practices. Examples included politically motivated subsidies to water which have led in places to overuse of water for irrigation and associated problems including salinity. In a similar way subsidies for land clearing have led to the deforestation of large areas of unsuitable land.

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