The Economics of Nature

- FOLLOW THE GREEN LINE -

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WENTWORTH GROUP OF CONCERNED SCIENTISTS

One year ago today, I was aboard the Akademik Ioffe – a converted Russian research vessel – steaming towards the sub-Antarctic Island of South Georgia en route to the Antarctic mainland.

It has been one of my lifelong dreams to visit Antarctica, but I wasn't just content to visit this remarkable land, I was determined to use this opportunity to explore the history of Antarctica in the context of today's great challenges of climate change and the destruction of nature.

I even made a film of the journey. It's called 'One Summer Dream', and it uses Antarctica as a powerful visual and historical metaphor for how we can manage planet earth in the 21st century - the heroic era of Shackleton, the power of the industrial revolution, the giant 19th century whaling stations, the melting glaciers and the icebergs, and nature at its most beautiful and pristine.

For those of you who haven't seen the film – it's being screened again here at the Library on Wednesday 20th February.

My premise in this film and in tonight's lecture is that we don't need to destroy the machines of the industrial revolution, but we do need to change the way we power them.

That premise is based on hard core economic modelling that's been conducted around the world over the past few years. And it is from this premise, that comes a fundamentally new way of managing nature in the 21st century, which is the subject of my talk tonight.

How on earth did our civilisation explode so quickly and with such force, to allow me to fly half way round the world, board a gigantic ship, and visit a land that 200 years ago had not been touched humans?

It is because the machines of the industrial revolution changed the course of human history. They advanced our civilisation to unimaginable heights.

But we have now discovered that the fossil fuels that are powering the machines that are creating our wealth are changing our world's weather. Carbon pollution from these machines has the potential to seriously damage the very civilisation they helped to create.

But mine is not a gloom and doom story – far from it – it's a story of heroic proportions. You see, the people who built the power stations, the steam engines, and the motor cars were not evil, they were actually heroes of their generation.

You're about to discover that we don't need to destroy the machines to protect our natural world. But we do need a revolution in our thinking.

The industrial revolution built the machines that liberated humanity. They freed us from subsistence and they lifted us above nature.

The industrial revolution also drove the green revolution allowing us to produce and store vast quantities of food. Our population exploded. In 1800 there were one billion people on this planet. Two hundred years later, there are 6 billion and we expect that number to grow by another 3 billion within the lifetime of most people here today.

The industrial revolution was built on the harnessing of fossil fuels – the energy embedded in the vast oil, gas and coal reserves that were laid down millions of years ago, when the earth was a very different place. It has given us health care, aged pensions, fast cars, shops full of food, schools, 4 weeks annual leave, sick leave, television, the internet, coffee shops, dress shops, the list goes on and on.

We are, without doubt, the wealthiest, healthiest and most educated generation. We have more choices and more opportunity than any generation in history.

But this success has been at the cost of something else. That something else is our natural world. We have already cleared half of the world's rainforests, we've degraded vast river basins, and we stand to lose half of all species on earth.

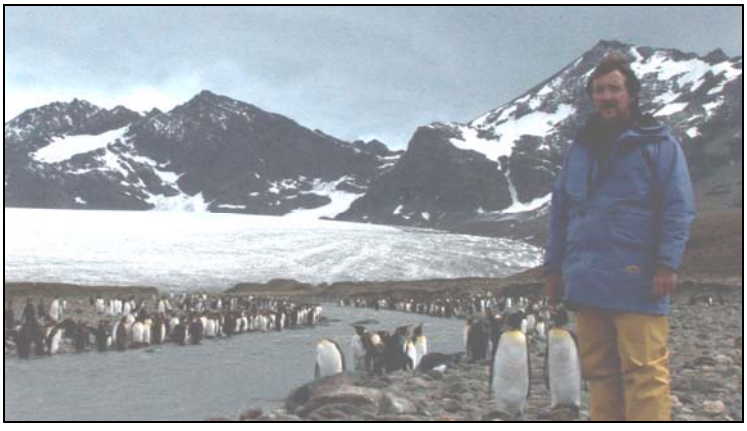
And now, on top of all this, we have discovered that the fossil fuels that are powering our machines that created all this wealth are changing our world's weather. We are burning one million years of prehistoric plant growth in the form of fossil fuels every year and releasing it into our atmosphere, and it in turn is causing carbon pollution, which is heating up our planet.[1]

We are in uncharted territory, where the earth's climate may respond dramatically and suddenly and we are not prepared. We have no idea what damage we might be causing.

We are already witnessing dramatic signs that our world is warming – it's on our TV news bulletins nearly every week. Just this week an article in Nature by the University College of London Hazard Research Centre said that their models predict that a 0.5°C increase in Atlantic sea surface temperature will result in a 40% increase in hurricane frequency[2].

In Australia, CSIRO have estimated that global warming could result in a decline in rainfall in the southern Murray Darling Basin by up to 10 percent[3] within the next 25 years, and a consequential fall in runoff into our river systems of up to 40 percent[4]. These worst case projections have immense implications for water supplies, for irrigation, for farming and for our biodiversity.

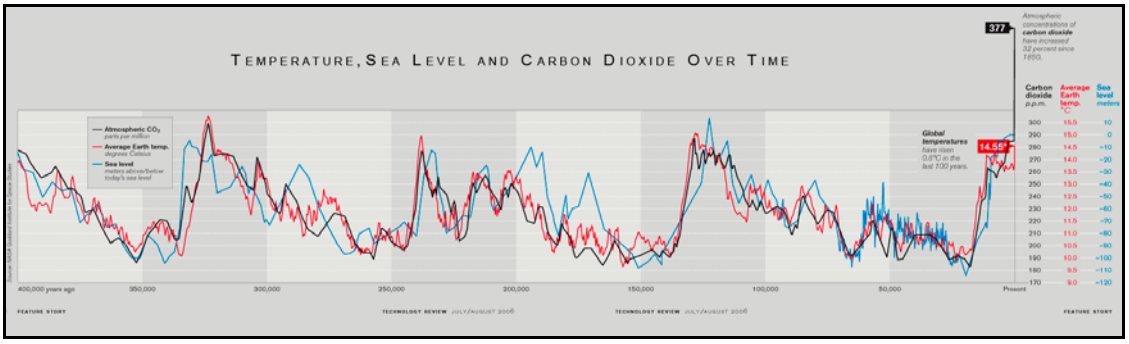
Climate change is no longer a theory, it has already begun. On my visit to South Georgia I saw the reality of climate change in person. There I was, amongst colonies of hundreds of thousands of King Penguins, doing what King Penguins do. I stood beside this stream which was flowing out from the melting Heaney Glacier.



100 years ago, at the beginning of the industrial revolution, this glacier terminated into the Atlantic Ocean as a 30 metre high wall of ice. Then around 1920 it started retreating and the retreat has accelerated. Since 1970 it has retreated inland by 750 metres, and the vast 30m wall of ice that was once on the edge of the South Atlantic Ocean has disappeared into the far distance behind me[5]. With the water of the stream rushing over rocks, I could actually hear the sound of climate change.

Yet the warming we are experiencing now is nothing compared to what we can expect with run away climate change. The world's climate scientists estimate that by the end of this century, our world could warm between 1.8 degrees, even if we act now, and by 4 degrees if we do nothing[6]. This doesn't sound much, but they are terrifying numbers.

The world has gone through many climate shifts in the past. Ice cores in Antarctica dating back 800,000 years show these cycles, and the science on why they occurred is well understood. For example, 120,000 years ago the earth's average temperature was about the same as it is today, but 20,000 years ago it was about 4 degrees cooler[7].



The past 10,000 years or so, the time when humans created agriculture, developed our cities, built the industrial revolution, the earth has experienced a peak of relatively warm weather.

Ok, so the world has been 2, 3 or 4 degrees cooler several times over the past million years, but when was it 2, 3 or 4 degrees warmer? The answer is astounding. The last time our earth was just one degree warmer than today was about 300,000 years ago, but that pales into insignificance when you discover that the last time our world was 4 degrees warmer than today is not measured in thousands of years or even hundreds of thousands of years.

The last time it was 4 degrees warmer was 40 million years ago. That's right, 40 million years[8].

If we don't take action to address climate change now, climate scientists are telling us that our civilisation could be faced with levels of warming in the next 100 years that our planet has not experienced for 40 million years.

What will our world be like then? I don't know, but I can tell you what it was like the last time our world was 4 degrees warmer. Large mammals had not yet evolved, the human species did not exist, Antarctica was free of ice and covered in rainforest, alligators swam in swamps in the Arctic and global sea levels were 70 metres higher than today.

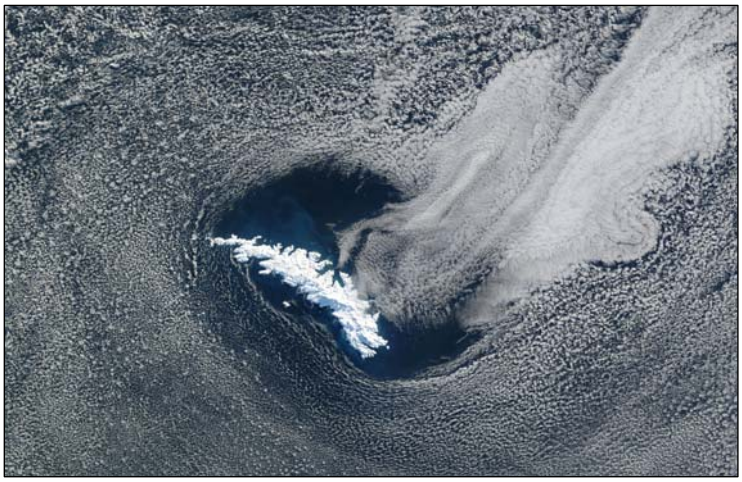
The industrial revolution has bought us wealth and opportunity, but it has also resulted in the destruction of nature at unprecedented rates and, on top of all this, it is now changing the world's weather.

Quite simply this planet cannot support our civilisation if the developing nations reach our standard of living, at our levels of consumption. Our golden age cannot last forever – or can it?

I believe there is an alternative path, and that the answers to this challenge of our generation can be found in the laws of nature: the same laws that have driven life on earth for billions of years. The same laws that allow some species to survive and prosper, but have also seen the extinction of 99% of all species that ever existed.

If we get it right, our civilisation will advance to unimaginable heights. If we get it wrong, eventually what we understand as civilisation, will collapse. And if we only get it half right, we will probably survive, but we will destroy our inheritance, the great gift of life on earth.

This magical, remote island of South Georgia is a massive paradox. It is 100 km long and 40 km wide, and over 1,000 km from the nearest land.



It carries the romantic history of the explorers like Ernest Shackleton, and it is a place of indescribable beauty. But is also a place of great tragedy where millions upon millions of penguins, seals and whales were slaughtered for their oil.

Do we need whales, fur seals and penguins for our civilisation to survive? Of course not. We could probably destroy most of the species on earth and still hold on to our civilisation.

After all, only four species of plants - wheat, corn, rice and potato - provide over half of plant based calories in the human diet, and around a dozen animal species provide 90 per cent of the animal protein[9]. Europe wiped out most of its biodiversity centuries ago.

If our survival depended on extinguishing half the diversity of life then that's probably what would happen – for this is now the power of man.

But what a tragedy if we destroyed all this life – this miracle of evolution. What would we be left with – cappuccinos on the street corner or more so-called "reality" shows on TV? Wheat, corn, rice and potato, sheep and cows? Is that what life is all about?

It was machines that made us the luckiest generation in history. But we are not machines. We touch and feel, we love and hate, we laugh and cry. Machines can make our life easier, but they are not the reason for living.

The world's most famous painting, the Mona Lisa, is valued at over 500 million dollars. We don't need great artworks to survive either, but we place value on them nonetheless, because they enrich our lives.

For countless generations, we have also enjoyed the benefits and beauty of life on earth, for free. But now, as our planet becomes more congested, the free ride is over. 200 years ago nature ruled man. We now dominate it. This sounds heroic and once it was, but it's not anymore and in a minute I'll show you why.

No-one can predict the future, but we do know what humans are designed to do. We will – individually and in groups – exploit our resources to maximise our personal wellbeing and comfort. That's what we do – it's what all living things do – it's built into our genes.

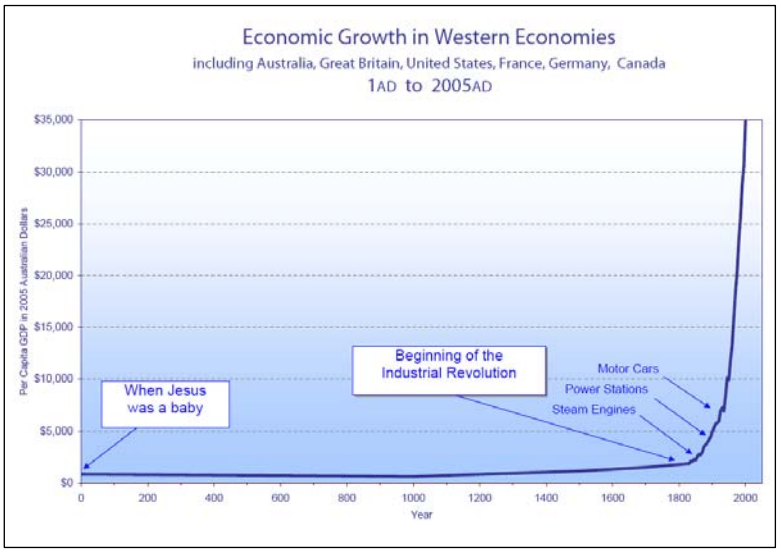
Nothing will stop our urge to develop, so we must find another way.

This graph shows the explosion of personal wealth in western economies since the invention of machines[10].

It also provides the pathway for us to address our long-term environmental problems as well.

Let me explain - here is when Jesus was a baby.

And here is the beginning of the industrial revolution, stream engines were invented here, power stations here, motor cars here. Just look at the explosion in our wealth since the invention of the machines.



When Shackleton set out for Antarctica in 1914, the average income in Australia had reached 6,000 dollars, in today's money. But even that was just the beginning.

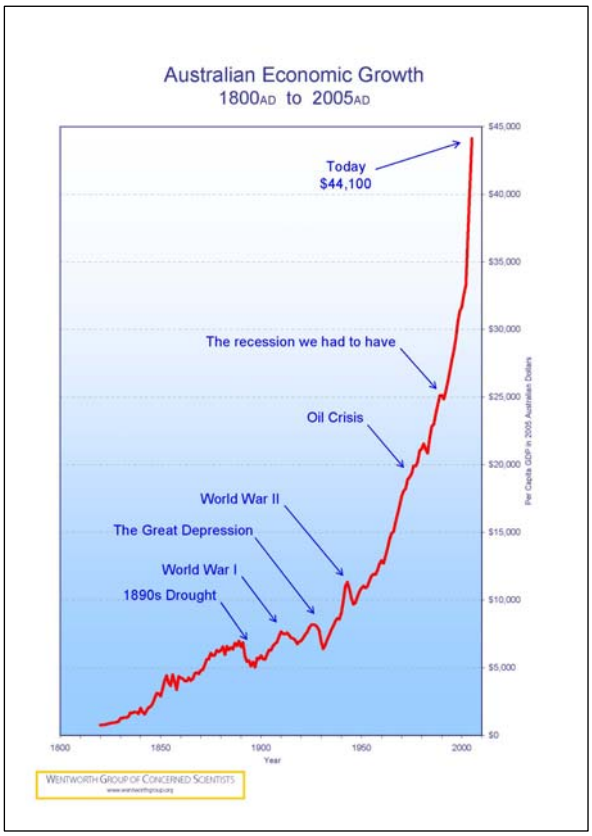
Today, less than 100 years later, it is over 44,000 Australian dollars for every man, woman and child.

We are eight times more wealthy than our grandparents and we live in a world beyond their wildest imagination. All because of machines. They freed us from subsistence and lifted us above nature.

Climate change is not an economic problem: it's a political and institutional problem.

It is a political conflict between short term self interest and long term responsibility, and it is an institutional challenge to create economic incentives that will drive down the cost of carbon pollution free energy systems.

But before we can act on the technical solutions, we need to solve the political problem. We need to let the world see that it's in everyone's self interest to stop playing games.



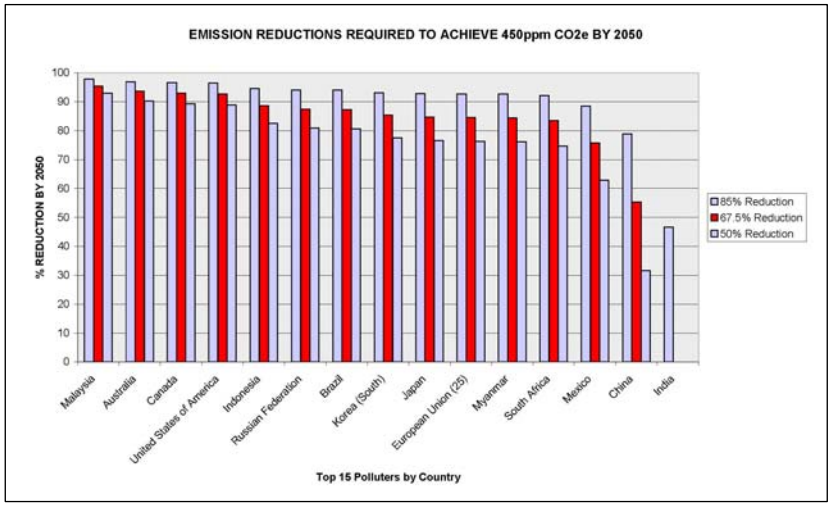
The worlds climate scientists tell us that we need to keep greenhouse gas concentrations in our atmosphere below 450ppm if we are to have a 50% chance of keeping global warming below a critical threshold of 2 degrees above pre-industrial levels[11]. Pre-industrial levels were about 280ppm. It has already reached 380ppm of CO2 and this is rising at an accelerating rate of 2ppm per year[12].

In simple terms that gives us less than 35 years before we exceed that critical threshold, but in reality we don't even have that. High levels of air pollution, such as we are experiencing now in Asia, are actually masking the real figure.

If you discount 'global dimming' as developing nations mobilise to reduce the human health problems caused by air pollution, we have already crossed the 450ppm threshold[13].

Let me explain what a long term global stabilisation target of 450ppm means for Australia.

According to the best available science, Australia will have to reduce its greenhouse gas emissions by 94 percent. Europe will need to reduce by 85%, the United States by 94%, Japan by 85%. Indonesia and Brazil will need to reduce emissions by 88%.[14]



We will need to completely decarbonise our energy production technologies.

But in every conversation I have had in the past 6 months, people say to me, oh yes I know that, but what about China.

Well indeed, what about China?

As the Chinese economy powers on into the 21st century, even they will need to massively reduce their existing per capita emissions.

No matter which phase in the industrial revolution countries are in, there is hardly any difference. If we are to stabilise the world's climate system, just about everybody will have to accept a similar target by 2050 anyway. We will need to completely decarbonise our energy production technologies.

And these figures are based on a 50% probability of keeping climate change below 2 degrees above pre-industrial levels[15]. If you take a more conservative risk assessment and use a 15% probability, the numbers get even closer (and higher). Australia will need to reduce its emissions by 97%, the USA 97%, Europe 93%.

China will need to reduce its current per capita emissions by 79%.

How do I get these figures? Really simple: Achieving stabilisation at 450ppm CO2e requires a global reduction in the order of 70 percent by 2050[16,17,18]. Current global emissions are 44 Gigatonnes per annum[19]. A 70% reduction of 44 billion tonnes equals 13 billion tonnes (Table 1).

The world population will reach 9 billion people by 2050. This gives every human a greenhouse pollution permit of just 1.7 tonnes per annum. Australians currently produce 26 tonnes per person – China produces 4.

Table 1
Total Global Greenhouse Gas Emissions in 2000
(CO2, CH4, N2O, PFCs, HFCs, SF6 - includes land use change & intl. bunkers)

						Reductions to achieve 450ppm by 2050		
						Probability		
						15%	50%	85%
Country	MtCO2	Rank	% World Total	Tons Per Person	Rank	85% Reduction	67.5% Reduction	50% Reduction
Malaysia	861	9	1.94%	37.4	1	98	95	93
Australia	509	14	1.15%	26.6	2	97	94	90
Canada	751	10	1.69%	24.4	3	97	93	89
United States of America	6,611	1	14.91%	23.4	4	97	93	89
Indonesia	3,068	4	6.92%	14.9	5	95	89	83
Russian Federation	1,991	6	4.49%	13.6	6	94	88	81
Brazil	2,333	5	5.26%	13.4	7	94	87	81
South Korea	547	12	1.23%	11.6	8	93	85	78
Japan	1,406	8	3.17%	11.1	9	93	85	77
European Union (25)	4,982	2	11.23%	11	10	93	85	76
Myanmar	521	13	1.17%	10.9	11	93	84	76
South Africa	455	15	1.02%	10.3	12	92	83	75
Dem. Republic of Congo	408	17	0.92%	8.2	13	90	79	68
Mexico	682	11	1.54%	7	14	89	76	63
Iran	435	16	0.98%	6.8	15	88	75	62
China	4,850	3	10.94%	3.8	16	79	55	32
India	1,574	7	3.55%	1.5	17	47	-13	-73
World	44,347		100.00%	7.3				

The problem is we all know the world is not fair. If it was, we would have solved world poverty. In the real world, each nation is fighting for its own self interest - it's a game - to get a small advantage over our economic competitors and to make sure they don't get one over us. That's why we are at a stalemate, stuck in an absurd and dangerous game.

This is no game. Would you go for a swim in Bondi beach if you were told there is a 15% chance of being eaten by a shark? Of course you wouldn't. Well that's the risk we are now taking with runaway climate change.

It's like a farmer driving past a small grass fire in a paddock, with the weather forecast on the car radio saying "hot, dry northerly winds", and the farmer thinking – "oh, it will probably burn itself out, I'll come back tomorrow".

The challenge to secure the world's climate system is gigantic. If the world's energy growth is higher than currently predicted by the IPCC models (as more recent analysis suggests), then the policy choice is stark.

Even under the fairest possible scheme – where every human is eventually given the same pollution permit, this table effectively means that we are going to have to decarbonise the world's energy systems and we have 40 years to do it.

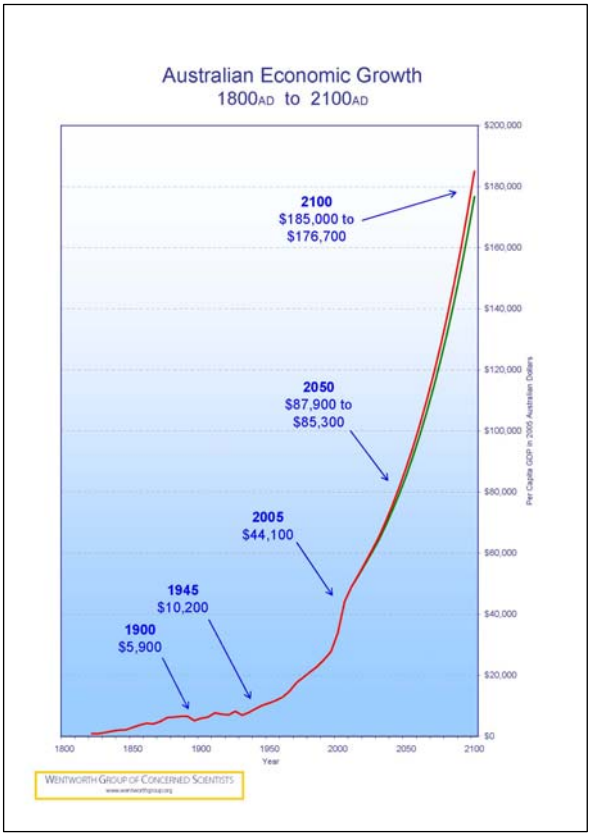
While the political and technical challenges are enormous, what amazes most people is that this is economically feasible.

Just about every economic model suggests that hitting a 450ppm (50 percent probability) target by 2050 will cost no more than 1 to 2 % global GDP by 2050. When seen in the context of projected global economic growth, delaying setting targets for short term economic advantage now, is simply absurd.

The following graph shows you what a 1 to 2% reduction in global GDP really means.

The Intergenerational Report prepared by the Australian Treasury, predicts that, short of any unexpected shocks, the explosion in wealth will continue between now and 2050, in the order of 1.5 per cent of GDP per capita per annum[20].

If this rate is projected over the following 50 years, at the end of this century, living standards in Australia will rise from $44,000 per person today, to over $185,000 per person (the red line)[21].



The green line is based on the best available international modelling[22] of the economic impact of deep cuts in global emissions, involving high income countries reducing their greenhouse footprint by at least 60% by 2050[23,24].

This graph should be on t-shirts because it is a most hopeful message.

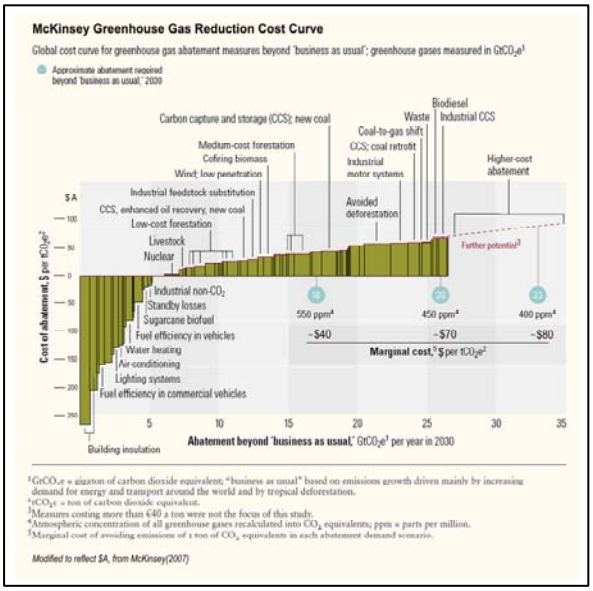
It shows that we don't need to destroy the machines of the industrial revolution, but we do need to change the way we power our machines.

What on earth are we arguing about: to fix the problem, we simply need to follow the green line.

So how is this possible?

We've been told for years that to give up the machines means we have to give away our civilisation – that the only way to save the world is to turn off the lights.

This cost curve for greenhouse gas reduction produced by the international accounting firm McKinsey helps explain this apparent paradox. It shows us two things.



Firstly, we can achieve the 450 target without wrecking the economy – because in the early years business can make a profit and households can save money when they invest in those technologies on the left hand side of the graph – building insulation, fuel efficiency, solar water heating.

The second thing this graph shows is that as you move along the curve costs do increase, but, with the exception of currently unproven carbon capture and storage technologies, we actually have all the technologies in place today to fix the problem.

When you put the McKinsey cost curve with my GDP growth curve, the bottom line is that over the next 40 years, of course electricity and petrol prices will rise, but the rise will be so small, the extra price will be considerably lower than the increase in wages[25].

Put another way, a new report prepared by Steve Hatfield Dodds for the Climate Institute, showed that if Australia joined with other leading nations and became completely carbon neutral, our GDP will still grow from a $1 trillion economy today to over $3 trillion in 2050[26].

With a price signal on carbon and innovative government policies, we will create the opportunity for our industries to get us to the '450 by 2050' target, and lead us to a carbon pollution free, 21st century economy.

A price on carbon will drive the next industrial revolution.

We went to the moon with a machine with 10 times less computing power than in your mobile phone. If we can go to the moon for an adventure, surely we can build new ways to power our machines to save the world.

But as our world gets smaller and nature's resources get scarcer, the implications of my graph go well beyond climate change – it goes to the heart of what humanity is capable achieving in the 21st century – an opportunity to create an economic system that is profoundly different to that of the 19th and 20th centuries.

Let me explain. The solution to climate change has three components:

1. Energy technology (energy production will need to be carbon pollution free) – this needs to provide 50% of the solution.
2. Energy efficiency (we need policy settings to use less energy and in the process also save money) – that's 25% of the solution.
3. Landscape management (let nature help us, because trees and soils absorb carbon) – that's also 25% of the solution.

It is in this last component that lies at the heart of driving the economic revolution of the 21st century. This is what I call the economics of nature, because it is a giant step towards putting an economic value on the services that nature provides us.

By reducing carbon pollution in the atmosphere, we can also create an economic system that will conserve the world's biodiversity, because rainforests and restored river basins store vast quantities of carbon, so healthy landscapes will become more valuable than cleared ones.

Many would argue that this opportunity was not available to earlier generations, as economic growth at the beginning of the industrial revolution was produced primarily by converting nature into products for human consumption.

Because landscapes absorb vast quantities of carbon, we can design the carbon economics so that for the first, and possibly the only time in human history, we can grow the world economy without destroying nature.

Let me give you two examples: the world's tropical rainforests and our own Murray Darling Basin.

Tropical rainforests cover only7% of the world's land surface[27], yet they contain almost half of the world's terrestrial biodiversity. Over half of these forests have already been cleared, and current clearing rates are staggering - 13 million hectares of tropical rainforest is cleared every year.[28]

But tropical deforestation is not only destroying nature, it is also directly releasing the equivalent of 2 gigatonnes of carbon dioxide into the atmosphere every year. This represents a staggering 20% of all global carbon emissions.[29]

Land clearing throughout the vast archipelago nation of Indonesia, Australia's nearest neighbour, has resulted in it being the world's third highest greenhouse emitter, behind only the United States and China. Clearing of the vast Amazon Basin makes Brazil the fourth.[30]

TABLE 1. GHG EMISSIONS SUMMARY ($MtCO_2e$)[1]

Emissions sources	United States	China	Indonesia	Brazil	Russia	India
Energy[2]	5,752	3,720	275	303	1,527	1,051
Agriculture[3]	442	1,171	141	598	118	442
Forestry[4]	(403)	(47)	2,563	1,372	54	(40)
Waste[5]	213	174	35	43	46	124
Total	**6,005**	**5,017**	**3,014**	**2,316**	**1,745**	**1,577**

Note: (1) The table excludes EU from the comparison as EU comprises 25 countries. If EU as a block enters the calculation, Indonesia stands 4th, and the ranking are US, EU, China and Indonesia. (2) The data for energy emissions are from 2003. The energy data used IEA's 2005 annual statistics except for Indonesia where PIE 2005 statistics are used. (3) The data for agriculture emissions are from 2005, from US EPA 2006. Biomass combustion is included in the calculation. (4) The data for forestry (LULUCF) emissions are from 2000, from Houghton, 2003. (5) The data for waste emissions are from 2005, from US EPA 2006.

Tropical forest nations, such as Indonesia and Brazil, are calling for action. If the western industrial economies of Europe, Australia and America are prepared invest, it will not only help the world address climate change, it will for effectively no additional cost, also finance the conservation of vast tracts of tropical landscapes, and, in the process, open up new economic opportunities for people in the developing world.

It will be one of the great legacies of our generation.

Carbon pricing also has the potential to fundamentally change the pricing signals in rural Australia because properly designed, is capable of creating a self funding mechanism to restore degraded landscapes, such as in the Murray Darling Basin and south west Western Australia, at a scale that would have been unimaginable 20 years ago.

Investments for storing carbon in terrestrial landscapes can be targeted to produce multiple environmental and economic benefits:

- restoring native vegetation along the nation's rivers, wetlands and estuaries, which would produce two landscape benefits: improved water quality, and re-connecting native vegetation across our vast, fragmented landscapes;
- expanding habitat to create viable populations of threatened species, which is a foundation stone for their long-term survival; and
- improving soil carbon in agricultural landscapes, which helps address both climate change and improve the condition of our agricultural soils, which have been in slow decline over the past two centuries.

There is a one other great economic reform that we must embrace, one that on face value seems a little mundane and tame compared to the other two of decarbonising the world's energy production systems and putting an economic value on the services that nature provides us, but it is one that actually lies at the very heart of our current environmental problems.

"Over the past 50 years, humans have changed ecosystems more rapidly and extensively than in any comparable period of time in human history. This has resulted in a substantial and largely irreversible loss in the diversity of life on Earth"[31]

That statement was made in a landmark report by leading international scientists, titled the Millennium Assessment.

So, why is it that the latest speculation on a 0.25 per cent increase in interest rates receives front page coverage in our daily newspapers, yet a little over a year ago, the most comprehensive assessment of the health of the world's ecosystems ever undertaken by science was largely ignored?

The reason is that our accounting systems evolved at a time when the natural world seemed endless and our focus was on managing the industrial revolution, not our natural environment.

It is an issue that has led me to question whether all the environmental science produced in the past generation has had any influence at all on influencing the trajectory of humanities ecological footprint. So what can we do about it?

We are now aware that our future prosperity is linked to effective stewardship of nature: our land and water, a stable climate, clean air, healthy coasts, and marine resources.

We now know that without stable functioning natural systems, our economic prosperity is transient and intergenerational financial security is a mirage. So what can we do about it? We need to build national environmental accounts so that we can monitor the health of our natural world.

There are parallels to this environmental dilemma with the rapid industrialisation of our economy in the early part of the 20th century. It was not until 1945 that Australia produced its first set of economic accounts[32]. It took nearly a century of the industrial revolution to pass before we recognised the value of a systematic collection and reporting of economic statistics and developed the capacity to do so. In doing so, they fundamentally changed the way we manage the economy by improving the stability of our economic system.

Environmental accounts are fundamental to successfully dealing with the 21st century challenges of stabilising the world's climate systems and managing nature. Today we wouldn't dream of managing the economy without rigorous accounting standards for our personal accounts, for business dealings and for managing the national economy.

Our place in history, now demands we do for our natural capital, what earlier generations did for our economic development. We need to build a greater understanding of how to live in harmony with nature.

With these reforms - decarbonising the world's energy production systems; putting an economic value on the services that nature provides us; and building environmental accounts - our generation has the opportunity to transform the economics of the 21st century and in doing so transform the management of nature and with it, our place in history.

Rather than being the generation that condemned humanity by its mistakes, history will record our generation as the generation that transformed from the industrial revolution into a civilisation that became true custodians of life on this blue planet.

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Acknowledgement

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[15] Table TS.5. (reference 1 above) gives the 'best estimate' for holding global temperature increases to below 2.1 degrees over pre-industrial levels, by keeping CO2e concentrations below 450 ppm, and Table SPM.6. (reference 2 above), which gives probabilities of achieving the 450ppm (445-490) CO2e target by 2050 based on the future emissions scenarios used by the IPCC.

[16] This is an approximation of the IPCC Table SPM6, which states that a reduction in global CO2 emissions in 2050 (as a percentage of 2000 emissions) in the range of -85% to -50% is required to achieve a CO2e stabilisation in the range of 445 to 490ppm by 2050. The figures correspond to the 15th and 85th percentile of the IPCC's Third Assessment Report (2001) scenarios distribution, which was also used for the 2007 analysis. It is also consistent with Table 8.2 in the Stern Review (p227), based on work by Meinschausen et al, 2006.

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The impact on Australia is assumed to be three time the world average, implying a GDP of -3% by 2050, rising to -4.5% by 2100. This ratio is more conservative than the impact ratios suggested by ABARE (Ahammad *et al.,* 2006), which generally indicates impacts on Australia that are around twice the average world impact.

The Stern Report finds that temperature increases are likely to have non-linear impacts on living standards, with increases on 2°C above pre-industrial levels reducing per capita economic income by around 1.5%, and increases of 4°C reducing incomes by around 6%. Applying these estimates to Australia suggests GDP per capita with policy action with be higher than without action from around 2080 – if we assume Australian policy action is three times more costly than the world average. If we assume policy action is 1.5 times as costly, policy action results in higher incomes from 2055.

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