Published in *Future Justice* in 2010 by Future Leaders (www.futureleaders.com.au)

What Do We Owe to Future Generations?

Peter Doherty

Although steps have been taken over the past 150 years or so to protect 'heritage areas' of great natural beauty, the idea that we have some long-term obligation to future generations has not resonated in the human discourse and is rarely, for example, enshrined in any substantial body of behavior, practice or law. Now, though, we face the irrefutable fact that many natural resources have been massively depleted, from fish populations to tropical rainforests. We are currently living through the sixth great biological extinction in the history of the planet, and we are the cause. In less than two centuries our species has consumed much of the readily accessible oil and we are now forced to tap deep resources where, as we are seeing off the West Australian coast, there is a great risk of major environmental damage. Modern electronics has a massive requirement for the 'rare earth' metals: just the name should tell us something about scarcity and the need for recycling. Then there's the issue of anthropogenic climate change that will lead inexorably to the flooding of most of our coastal cities and the loss of irreplaceable assets like the Great Barrier Reef.

Despite the fact that most thinking people understand this, it seems that taking any meaningful action is extraordinarily difficult. The standard cop-out is that technology will solve all our problems, but ultimately that just can't be true. How do we change this? How do we protect the plants and animals that

make our world so extraordinary? How do we ensure that our descendants will have a bright future? How do we begin to live in ways that are sustainable in the very long term? We might start this discussion by looking at who we are and where we have come from.

Pre-History and the Beginnings of Us

On best estimates, modern human beings (*Homo sapiens sapiens*) have been around for some 120,000–200,000 years, and our smaller-brained ancestors for millions of years before that. Current thinking is that the human and chimpanzee (*Pan troglodytes*) lineages diverged about 5 million years back. We know from recent analyses that we share about 99% of their genome. Both species form into communities but also act as individuals. At least until weaning, mothers nurture and care for their young. Mating occurs with much greater frequency than is required for reproduction. Males and females can be more or less promiscuous and, like humans, chimps are known to kill individuals who are foreign to their group. Their latest gift to us is the human immunodeficiency virus (HIV), which probably transmitted to humans when someone cut his hand while butchering a chimpanzee for bush meat, an interaction that pretty much summarises much of the traditional interface between other species and us.

Unlike *Homo sapiens,* however, *Pan troglodytes* remained in Africa, continuing the part arboreal part ground-based lifestyle that was also followed by our ancient ancestors. Also, chimp numbers are declining, with there being recent (2008) evidence of a rapid, massive drop in the count of 8–12,000 for *Pan troglodytes verus* (estimated to be about half the world's total numbers) found previously in the Cote d'Ivoire. Few would be in doubt that this is a result of human activity, related directly to the extraordinary expansion of human populations and the ever greater economic and other pressures that are being further exacerbated by the unpredictability of rainfall, drought and progressive desertification that many accept is a consequence of anthropogenic climate change. Add to that the polit-

ical turmoil, corruption and murder in those developing countries where an abundance of natural resources leads to a dominance by local criminals with the full complicity of the international 'extraction' industries, and we have a situation that is as lethal for chimpanzees as it is for human wellbeing.

Africa is the birthplace of humanity and, as we contemplate the 'worst-case' scenarios for what is happening in some African states now, it is just possible that we are looking at the shape of the future for a world devastated by the consequences of over-population, unsustainable development and global warming. Of course, that may have limited relevance to those in my generation (I was born in 1940) who live in the developed world, or even for our children and grandchildren. Unlike the other primates, all but the most degraded of us care permanently about what happens to our children and, with our big frontal cortex, we are even able to take that further to our children's children.

But how smart are we if we are unable to extend such concern beyond the next couple of generations to the future of humanity itself? How do we ensure that Homo sapiens will still be around in 120,000-200,000 years time and, because we have a duty of care to the planet as a consequence of our uniquely developed capacity to reason, how do we guarantee that will also be true for *Pan troglodytes*? At a minimum, we need to change much of what we do and how we utilise the resources available to us. We also have to rethink the way that we look at the natural world and our place in it. That process has to begin now.

Human Migration and the 'Hunter Gatherers'

Human beings are thought to have begun the move 'out of Africa' less than 100,000 years ago, travelling north into Europe and Asia and around the rim of the Mediterranean and beyond. Australia's indigenous people represent the far eastward march of that southern migration, and their 40–60,000 year history of isolation on this dry continent provides a too-often undervalued time capsule of what life was like before the discovery of metals and the development of plant-based agriculture. The fact

that agriculture did not emerge here likely reflects the lack of plant varieties that were suitable for domestication as grain crops. There is evidence, however, that at least some aboriginals in the south of Australia developed techniques for eel farming and built more permanent houses but, again, the mammalian and avian species they encountered were not suitable for domestication. As a consequence, though different tribal groups maintained some territorial boundaries, aboriginal culture maintained a hunter/gatherer lifestyle, together with the animistic belief systems that pre-date the accumulation of people into fixed agricultural and larger communities.

We may be mistaken, though, if we think that the original immigrant population that had grown to a size of 350-750,000 by the time Captain Arthur Philip and the first fleet arrived in1788 was innocuous in the environmental sense. Did the disappearance of the giant marsupials around 50,000 years back reflect that they were hunted to extinction? How much does the life cycle of those eucalypts that need fire to initiate seeding reflect periodic burning to drive kangaroos and other species onto the spear points of indigenous hunters? Perhaps human beings have always had a significant impact on their environment though, until very recently, at levels that are minimal when we go beyond the local situation.

Also, it's reasonable to assume that, while nomadic tribal groups moved to follow food supplies, they would return repeatedly to the same sites as the seasons changed. Those that lived in the drier parts of the country must have been very careful to protect their water sources. While much of any traditional, animistic culture is likely to contain a strong element of ancestor worship, societies that persisted under such conditions can only have done so if they acted in ways that ensured their own, long-term survival. We seem to have lost that awareness or, if this happened without any real consciousness of what they were doing, the code of behaviour developed from practical experience that allowed people to continue living in reasonable harmony with harsh environments.

Facile speculation can, for example, lead to the idea that the fields full of rusted cars, the devastation we see in older American cities as the factories, the dilapidated shopping malls and so forth that are past their 'use by date' and left to decay in favor of new 'developments', simply reflects a deeply ingrained culture of progressive abandonment that we inherit from our 'hunter gatherer' past. But surely that is unfair to the hunter/gatherers, who were very dependent on what nature could provide for them. The roots of this contemporary disgrace and great ugliness lie in what contemporary human beings value, or fail to value, not in the practices of our distant ancestors. The problem is with us, and it's just too easy to pass off our worst behavior as reflecting something that is inbuilt and basic to Homo sapiens sapiens. Of course laziness, greed and selfishness are very human, with the latter two being enshrined in the 'neocon/economic rationalist' philosophies that have been so attractive to many in the political and business communities and so lethal for our long-term wellbeing.

The Holocene: Agriculture, Mining, Towns, Writing, Religion, Civilization, Infection

Through the past 12,000 years we have lived through the relatively mild (in the climate sense) era of the Holocene. The geologists classify the Holocene as interglacial, though there have been interspersed warmer (eg the mediaeval warming) and cooler (e.g., 16th–19th century little ice age) periods, many of which may have been local rather than global. Early in the Holocene, ocean levels are thought to have increased by about 35 metres. By contrast, particularly in the far north of the world, removing the enormous weight of ice allowed some of the landmass to come up by more than 100 metres. Compare that 35 metre figure with the 8–12 metre rise that would follow the complete melting of the Greenland Ice and the West Antarctic Ice Sheet (WAIS), two regions that the climate scientist believe are particularly vulnerable with progressive climate change. Estimates of heightened sea levels through the remainder of this century range from about a 0.5–1.5 metre increase,

but history will hopefully continue after 2100! What will the world look like in 2300?

Following a hunter/gatherer lifestyle, our ancient ancestors may not have noticed the inexorable, gradual change as they slowly retreated from the encroaching sea. In Australia, the land bridge that linked Tasmania (Wilson's Promontory is the northern end) was inundated and any early archeological sites were lost forever. What was human culture like at the beginning of the Holocene? We know that the hunter/gatherers talked to each other, at least within their own tribal groups. Australia alone had more than 200 indigenous languages at the time of European settlement. Cave and rock paintings from the prehistory era can be seen in regions as distant as Arnhem Land and the Dordogne. They utilised available products like wood, stone, bone, horn, skins, grasses and reeds to make weapons, fish hooks, musical instruments, baskets, nets, cloaks, shelters and small boats. Such societies are thought to have been relatively egalitarian, with a great deal of mutual independence. The need for mobility kept numbers low. A woman could only carry one child, while the frail elderly were, of necessity, abandoned.

Beyond those early beginnings, civilisation as we know it starts with the cultivation of grasses to produce grain crops, then the need to found permanent settlements to benefit from, and protect, those resources. This great advance in the human condition must have been initiated by the 'gatherers', the women of the tribe, while the male 'hunters' may have been more involved in the domestication of sheep, goats, cattle, pigs and horses. The story is covered wonderfully well in Jared Diamond's *Guns Germs and Steel*, a 'must-read' for anyone who wants to understand the human condition. Follow that with *Collapse*, his later book that details small-scale examples of what happens when we fail to maintain a stable and sustainable environment.

Over the 10,000 plus years of the Holocene, we started to mine minerals and extract metals from ores. Living at close quarters with livestock led to at least one animal disease

(bovine rinderpest) being established in humans (measles). Writing begins about 5,000 years back, providing a permanent record rather than a fallible, oral tradition. That facilitates the emergence of the great religions with their moral and ethical rulebooks, a development that helped people to live together in larger and more complex communities. Even today, some religious fundamentalists continue to confuse the acquisition of writing with the beginning of time, bringing them into direct and absurd conflict with evidence-based reality. Then, with the Egyptians and the Greeks, we see the emergence of mathematics, engineering, and experimental and observational science, practices that were to lose momentum during the dark ages.

Having continuous food supplies allowed the human population to increase dramatically in size. By the time of Christ, there are thought to have been about 300 million of us. Social hierarchies had emerged and labor had become increasingly specialised. The Christian Bible mentions farmers, laborers, merchants, soldiers, carpenters, fishermen, politicians, priests and moneylenders. Politics took a great step forward with the development of Greek democracy, or was it a return to the more egalitarian model that existed in a hunter/gatherer world? With the beginning of formal politics, we also see political satire being recorded in plays and other writings.

Athenian democracy was, of course, quite different from our own. The spectrum of eligible voters was very limited and decisions were made by direct participation, not through the actions of elected representatives. Democracy has been molded to the realities of our time, although that is not necessarily true for all forms of religion. Those who believe that the ultimate guidelines for how we should behave now are enshrined in religious writings from 2,000 or more years back might, however, think a little of the differences between life then and now.

Farming requires a constant labor source, so the injunction to 'be fruitful and multiply' made sense. Furthermore, there could be catastrophic loss of life when various plagues attacked people living in close proximity. Death rates of 30-50% were

commonly recorded, figures that seem almost incomprehensible today. The Black Death of 14th century England (caused by the rat/flea-borne *Yersinia pestis*) created labor shortages and killed many of the monks and administrators who lived in close communities. The result was the relative empowerment of working people and the emergence of that complex mix of French, Latin and Anglo-Saxon that we now call the English language.

Even in the 19th century when we were beginning to understand contagion and the need for sanitary conditions, Charles Darwin could write that human mortality in disease outbreaks rarely exceeds 10%, a level that would cause massive fear and outrage in any developed country today. Like most families, the Darwin's lost at least one child (to tuberculosis) and both infant and maternal mortality were commonplace. Contrast that 10% figure with the catastrophic 1918–19 influenza pandemic where about 2% (40–100 million people) died worldwide, in an era where public health practices had become widespread, though there were no vaccines to block the influenza virus at point of entry or antibiotics for treating secondary bacterial infections. That's why scientists like me make the seemingly paradoxical argument that one solution to the overpopulation problem is to protect children against the major infectious diseases, removing the need for large families to generate the 'farmer's insurance' that has traditionally provided continuity and 'social security' in very poor communities. Where that argument falls apart, however, is with religious groups, who continue to believe that producing large numbers of children is a God-given right and even a duty. Then too, many economists and politicians can think only in terms of ever-increasing human numbers, the consumers that drive what passes for progress.

The current HIV/AIDS pandemic is killing about 3 million people a year and is having a disastrous impact on some societies in the developing world. However, unlike the situation BCE or, for that matter, before Louis Pasteur and Robert Koch

in the second half of the CE 19th century, we understand the science of HIV, know how to avoid catching the disease by behaving appropriately, and have a spectrum of drugs for treating the condition. Viruses, bacteria and other pathogenic microorganisms still constitute a major threat, but not since the plague of the middle ages and the control of smallpox by vaccination, have we seen the type of infectious disease 'cull' of human numbers that characterized the 'pre-science' era. Even so, there is no absolute guarantee that a rapidly-spreading, highly lethal respiratory infection might not do just that. That's why scientists and authorities were (and are) so worried about the H5N1 'bird flu', which killed 60% of those few who presented with symptoms (less than 400 worldwide), but has so far failed to mutate in ways that allow human to human spread.

Apart from the population issue, some of the other ideas enshrined in writings from two millennia back may not be particularly helpful when it comes to thinking in terms of the human future. Although the Christian Bible, for example, contains injunctions to practise good husbandry and care for the land, it also states that every other species on the planet has been put here solely to serve our needs. Regrettably, although no reasoning human being can have continued to believe that since Charles Darwin and the 1859 publication of *On the Origin of Species*, the ultimately malevolent interaction between humanity and the natural world that is implicit in such statements continues to dominate so much of what we do. Following the view that everything on or in this planet is ours to exploit and that there is no penalty as a consequence, has led to our present, and what may be increasingly precarious situation. Fortunately, the more thoughtful religious groups are coming to the same conclusion as the scientists, that we have 'duty of care' and are responsible when it comes to protecting the magnificence of the Creation, although the two groups may differ on the nature of that Creation. I wish we could say the same for most economists and many politicians.

The Rise of Science, Fossil Fuels, the Industrial Age and Air Pollution

The intellectual momentum that began with the Egyptians and the Greeks had largely been lost by the time that the Great Library of Alexandria, the primary repository of written knowledge until that time, was destroyed around the 7th century CE. Aspects of mathematics and science prospered for a while in the Islamic world then, beginning in the 11th century, we start to see the emergence of the first of the ancient European universities at Bologna, Paris, Oxford, Padua, and Cambridge. Padua was particularly important in the medical sciences, as it was here that Andreas Versalius did the dissections that were basic to his definitive anatomy text, while William Harvey completed the experiments that lead to the 17th century understanding of the human circulatory system. It was important to understand that the blood does not ebb and flow!

When science started to re-emerge in the 16th and 17th century, with the philosophy of Francis Bacon and the foundation of the earliest of the great scientific societies, The Royal Society of London and the French Academy of Science, the stage was set for what was to become the industrial revolution. The contributions of physical scientists (Isaac Newton, Robert Boyle, Antoine Lavoisier, William Faraday, Joseph Priestly), mathematical philosophers (Rene Descartes), engineers (James Watt and Robert Stevenson) and many others, ensured that this revolution proceeded with increasing speed.

The Industrial Revolution began in 18th century England. By 1750 the world population had grown to about 800 million, a number that was to rise to about a billion by 1800. This increased to 1.6 billion by 1900 then 4-fold to 6.4 billion by 2000. Current, optimistic predictions are that human numbers will stabilise somewhere about 9 billion. Through that time we experienced the steam/coal-driven growth of light, then heavy industry in Britain, the transport of goods and people in screw-driven ships, the oil-fuelled American Industrial Revolution, the development then mass production

of the automobile, and the beginnings of international flight that have led to global mass tourism. All this happened because we were able to access seemingly limitless sources of cheap, abundant energy by burning fossil fuels, the cleanest of which is natural gas (methane, CH_4), though it's only clean if the CO_2 that escapes concurrently at the wellhead is captured and returned back into the ground. The dirtiest source of energy is, of course, coal.

Until very recently the United States, with about 300 million people, was the largest producer of greenhouse gases like CO_2, CH_4 and N_2O. American may still hold the record for individual, mindless, conspicuous consumption, but the 1.2 billion plus Chinese have now taken the greenhouse gas record away from them. What is happening, of course, is that China, along with Korea, Japan and more recently India, is recapitulating the European and American industrial revolutions. China, in particular, is burning massive amounts of coal, a practice that is increasing greenhouse gas levels at an alarming rate. And the Chinese and the Indians have not even begun to approach the consumption patterns that dominate economic activity in Western societies. Soon we will achieve atmospheric CO_2 levels that were last seen early in the Pleistocene, a geological era characterized by massive climate variation over the course of more than a million years.

As anyone who has visited any mainland city in Asia knows, most urban (and many rural) Asians now live much of their lives under a 'brown cloud' of pollution. Hong Kong and Seoul may be serious about cleaning up the air, but the cloud drifts across from mainland China, and, if we go west, down from India as far as Mauritius. Much of the brown cloud is comprised of particulate matter that may serve to limit global warming as it blocks incoming energy from the sun. However, raindrops form around air-born particles and, if there is too much material in the atmosphere, rainfall patterns, like the seasonal monsoons, can be seriously disrupted. We may also be experiencing some of this effect in Northern Australia.

If we were to stop burning fossil fuels tomorrow, particulate air pollution would soon clear and our planet would probably become just a little hotter. Even methane is broken down reasonably quickly. Water vapor, which also has a potent greenhouse effect, will return to the earth as rain. What will remain up there for thousands of years is, however, CO_2. Furthermore, as the oceans continue to warm, they will take up less CO_2 in the form of the 'weak' (H_2CO_3) carbonic acid. Ocean acidification is, of course, one of the topics that the fossil fuel industry hacks and has-been (or never-been) scientists who make up most of the 'climate change denier' group prefer to ignore.

Some scientists who are in despair about getting any meaningful action on reducing greenhouse gas emissions are talking seriously about developing engineering approaches for taking CO_2 out of the atmosphere. The application of such technology would, of course, be enormously expensive, but then the cost would fall largely on future generations. The discussion is still muted, as the great fear is that even mentioning the possibility of a technical fix will provide ammunition for the idea that those of us who are alive now don't really need to do take any steps to modify our behavior. Surely we can be better than that. Fortunately, other, contrary themes are building in human society and, as they have considerable resonance with the young, may give us some reason for optimism.

Emigration, Colonisation and the Beginnings of Conservation

Prior to the industrial revolution, the idea that humans could have any serious impact on the health of the planet would have seemed absurd. People in the main led God-oriented lives, much as they do today in parts of the Islamic world. Cataclysmic events were generally attributed to the actions of the Deity. The idea of a benevolent God must, though, have taken something of a hammering with the continuing episodes of plague in mediaeval Europe and beyond. That, together with the separation of

Church and State that is basic to Christian teaching: 'Render to Caesar the things which are Caesar's and unto God the things that are God's' (Mark 12: 17), is likely to have been a significant factor in the rise of science and secularism.

By not acknowledging responsibility, or even realising that there might be an emerging problem, there would have been no obvious reason to promote conservation or to protect the natural world through the first seven centuries of the last millennium. Some protections were, however, put in place. Apart from the practices of responsible agriculturalists, the English aristocracy, for example, conserved large tracts of native forest for hunting, and forbade the killing of wildlife for other than their own purposes. The British rule of primogeniture, where the eldest son inherited the estate intact, ensured that such holdings were not infinitely divided, as happened in some parts of continental Europe. Britannia ruled the waves with wooden sailing ships, so steps were taken to protect the tall pines that provided the masts and the oaks that were used to form the sturdy hulls.

Then we see the first of the protected, national parks that are a particular feature of Australia and the United States. The initial legislation to set aside what is now Yellowstone National Park was signed in 1864 by President Abraham Lincoln. Of course, that 'permanent resource' for future generations could be lost anytime if Yellowstone, where the hot, molten larva of the inner-earth bubbles very close to the earth's surface, blows its top. About 2.1 million years ago, the explosion of the Yellowstone 'supervolcano' covered vast areas of North America with ash. Yellowstone is thought to erupt every 600,000 years or so, and is about 40,000 years overdue. Shouldn't we be conserving at least some of our non-renewable energy resources (particularly uranium) in case a major volcanic event, or a dust cloud thrown up by a massive asteroid hit, blocks out much of the light and heat of the sun for decades or more?

Through the 19th century, though, the idea of conservation other than to protect areas of great natural beauty was

hardly at the forefront of people's minds. So far as Europe was concerned, there was always more land available, although it meant the colonisation and dispossession of indigenous people on other continents. Europeans brought the Christian Bible and progress to 'native' peoples, leaving an extraordinary legacy of disruption, degradation, exploitation, arrogance and bitterness. Given the political and economic imperatives of the time, there was no way that this could not have happened and, as such 'races' were considered to be morally and intellectually incompetent, the process seemed to be completely justified.

Now, with advances in molecular biology, the idea that any particular human population could be classified as intellectually superior or inferior on the basis of genetic makeup does not hold up, although racial groups may differ culturally as a consequence of belief systems and their historical situation over the preceding few hundred years. Any over-population problems for Europe through the 18th and 19th centuries and the first half of the 20th century were simply solved by emigration. Today, the emigration streams have reversed in direction.

With the exception of Australia, the mass migrations are from the poor countries of the south to the wealthy north. Again, there is the potential for massive social disruption and a fear of the re-emergence of fascism, or something worse, lurks at the back of (particularly) the European consciousness. In general, the United States, which at times teeters on the edge of right-wing extremism but has so far been protected by the checks and balances built in to the separation of powers by the founding fathers, is less culturally aware of that problem. America can be more obsessed with a 'libertarian' ideal that denies the necessity for state regulatory controls and taxes. The proposition that the 'right to bear arms' guarantees freedom in the absence of the rule of law makes me think of the social model that prevails now in Northern Pakistan and Afghanistan.

Technical Fixes and the Need for Recycling

In the absence of any consideration of anthropogenic climate change, the justification used today for burning progressively

through the easily accessed fossil fuel stores of coal, oil, and natural gas, or consuming all the readily mined uranium and thorium, is that future generations will have plenty of time to develop new technologies for exploiting renewable energy at the levels required to maintain our type of civilisation. Given the unpredictability of climate through the ages and the possibility of some catastrophic and unpredicted event, can we really justify the complete depletion of these reserves?

Australians are told, for example, that we have 800 years of coal available. But, even if we ignore the environmental cost, at what level of usage and what happens after that? Major doubt has been thrown recently on similar claims of continued coal access in the United States. Human beings have been around for at least 120,000 years, and our more ape-like ancestors for millions of years before that. Is the human future to be measured in terms of a few thousand years?

What possible justification can there be for not moving now with all possible speed to promote energy conservation and tap renewable energy resources? Those of us who are alive today will rightly be regarded as having plumbed the lower moral and intellectual depths if future generations have reformulated the Easter Island question, 'Who cut down the last tree?' as, 'Who burned the last drop of oil?' We can't continue to let the future be directed by the short-term interests of CEOs and the Boards of the major non-renewable energy companies! Any continued use of fossil fuel should be regarded as a limited, interim measure with a very definite phase-out period.

One suggestion for the colder countries of the northern hemisphere is that there could be a massive expansion in electricity generation by nuclear fission, with the proviso that any facilities built now will be shut down after 20 years. Even if we extend that to 50 years, I find it hard to believe that, unless we achieve the ever-elusive nirvana of limitless energy supplied by nuclear fusion, it would be politically feasible to take such fission generators off-line. Furthermore, even if the decision was

taken now to greatly expand the construction of nuclear fission plants, the capacity just isn't there, at least in the short term.

Surely, with Australia's small population, massive land mass and extraordinary levels of sunlight, we should be able to function using solar collectors, with the add-on of hydrogen generation to provide back-up, base-load power. Then there's also the possibility of tapping geothermal energy. That would, of course, require the development of a more sophisticated economic model, depending on something beyond the idea of 'extraction' and shipping stuff out. By functioning as little better than a large mine, we paint ourselves into an increasingly limited corner!

Mining is, of course, about a great deal more than exploiting fossil fuels. As pointed out by the former mining executive Hugh Morgan, building those big windmills uses lots of metal! Any battery/electric technology requires nickel, cadmium, platinum and so forth, metals that are not in unlimited supply. It's essential that they should be recycled so far as that is possible. The same is true for the tantalum used in mobile phones and the like.

The ever-expanding use of electronic technology that, among other things, will likely operate to decrease the need to take long-distance flights, requires enormous amounts of energy. Google, for example, is already accessing 30% of it's power usage from solar energy. How feasible would it be to distribute most of the 'hard facilities' that service our web-based world to locations where there is ready access to geothermal energy? While we need enlarged electric grids to disseminate AC power from regions where there are, for example, major resources of geothermal, wind and tidal energy, most of our small electronic devices utilize low-voltage DC electricity. Why can't this be supplied locally from solar collectors, solar 'paint' and so forth, generated at the level of the household or even the car parked in the street? At this stage, if we sell home-produced solar electricity to a power company, it is first 'inverted' to AC for transmission, then often back to DC

again by the myriad of small transformers we find for cell phones portable computers at any 'end-user' site.

There are many possibilities, but we first have to convince governments to promote the necessary tax and regulatory structures needed to unleash the entrepreneurial spirit that drives true innovation. How do we break Australian political leaders, in particular, out of the view that our future is inextricably linked to fossil fuel extraction? What will our situation be, for example, if the rest of the world concludes that the continued burning of coal is unacceptable?

Economics, Politics, the Law and Us

Even if we don't take the obvious measure of writing a will, the law generally protects the inheritance of assets within families. We conserve some parts of the landscape and seascape in land and marine national parks from the viewpoint that these will be available for the use of future generations, but what about the other resources that sustain life? Is it possible to develop a body of law that requires us to take some account of the needs of future generations? Is it possible to evolve effective economic models that promote sustainability?

Whenever we initiate some action that promotes economic growth, increases GDP and so forth, there is no formal value put on the resources that may be degraded to achieve that purpose. In simplest terms, each time we concrete over a hectare of prime agricultural land, the possibility of using that earth to produce food is lost to subsequent generations. Such losses are not listed as debits, but that's what they are if we're talking about the human future. Much of our agriculture and the green world that delights us depends on pollenation, but do we ever cost the massive contribution that bees make to our economic and social well-being or consider how they might be affected by any proposed development? There are already causes for real concern about the overall health of bee populations globally.

The basic question is, 'How do we develop sustainable economic models, and how do we put in place the political and

legal frameworks that ensure their application and continuity?' Some economists, namely Nicholas Sterne and Ross Garnaut, have pointed out that our failure to act now on anthropogenic climate change will have enormous social and financial implications for future generations. Many fail to find those arguments compelling. Are there other economists who are trying to develop an 'economics of sustainability'? I know that people like Jim Mirlees (Economics Nobel 1996) are taking this issue seriously, but are the politicians taking them seriously?

Scientists and engineers can do everything in their power to develop the necessary clean and green technologies but, unless we get the financial and political settings right, nothing useful will happen. This is an issue for each and every one of us who cares about what sort of a world our children's children, and their children and grandchildren, will inherit. We have to act, and we have to make our voices heard.

If you're a young person reading this, think about how you should train and what sort of a career path you might follow to help make the necessary changes. Everyone has a part to play, from engineers, to lawyers, to builders, to teachers, to bankers and so on. We need fresh minds and new, adventurous but well-informed voices. Could there be any better use for a life? Great changes are driven by individual effort. Be part of that process. When you reach the age your grandparents are now, make sure that you can say: 'I tried: my life meant something, I made a difference!'

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