

## "Jobs, Natural Capital and Economic Growth - What's Next?"

Notes for a presentation  
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The questions I want to talk about today are big - where is our world going and, if we don't like our human direction, what we can do about it?

Our entire world is going through transformations that offer much hope but also unprecedented challenges to continued progress and world peace.

The upside comes from the global growth dynamic and the expanding realms of human knowledge. The risks come from factors that threaten to pull the props out from under the growth dynamic. These include new forms of international competition, the persistence of mass poverty, and above all, climate change which is part of a broader human assault on the viability of global ecosystems.

The choices our societies make in the next few years about how to deal with these risks will determine if the world's peoples evolve towards cooperation or towards great human suffering and conflict on a degraded planet.

In simple terms, we are going to have to decide, and decide quickly, whether to share our world or fight over it.

To help zero in the nature of this challenge and actions that will lead us towards a more stable and peaceful future, I am going to steal a page from business planning and approach these conflicting issues in the way the CEO of a major corporation might approach the launch of a new enterprise.

The first thing the CEO would do is create a Mission Statement that clearly defines the business of his company. We are dealing with societies, so we need to define the nature of the business our societies are in. Is it, for example, to become more productive so we can out-compete the Chinese or to shape

citizens into self-absorbed consumers whose fantasies of luxury and status keep the economy afloat? What business are we in?

Second, we need to create a Vision statement, - something that defines our market ambition or, for our purposes, a vision that sets out what we think our societies should be working to achieve - and perhaps do this in relation to different time frames.

Then, when we have this clear purpose in mind, we can design the organizational units and implementation strategies - the products, services and actions - that will enable us to achieve the Vision.

**So, what is the business of societies?** To get a handle on this we need a bit in history - well, actually we need to go back some 4 billion odd years to when chemical reactions of increasing complexity started to self-replicate and life began on Earth. Since then, some 30 billion - some say as many as 1 trillion species, all evolutionary descendents of these original life forms, have risen and perished.

Most died out in 5 “Great Extinctions” - the last one caused by a comet that ploughed into the earth about 65 million years ago killing off about half the then-living species, including the dinosaurs.

From a human perspective, that comet was a fortuitous event. Without it,

- we humans would not be around to share the world with some 1.8 million other known species including our evolutionary predecessor, the chimpanzee, with which we share a remarkable 96% of our genetic make-up, and
- we would not be well into the 6<sup>th</sup> great extinction, this one caused by humans - by us. We are knocking off species at about a thousand times the natural rate.

Well, all that by way of suggesting that species are in the business of survival. As a rule of thumb, they either adapt to changed environmental conditions or die.

Now the human species and the societies we create are pretty much in the same mould. We are of nature and entirely dependent on what we derive from natural systems. Everything we consume comes from nature. Our cities are all built and operate on the basis of what we draw from nature. Everything in this

room comes from nature. So do our cars, our hairdryers and our Blackberries and our waste streams are all eventually accommodated by natural systems.

Of course we know that. What we also know but seldom pay enough attention to is the fact that all societies, whether consciously or not, are organized around the task of drawing what we need from nature - of meeting our provisioning needs.

And, like species that fail to adapt, untold thousands of earlier cultures and peoples have come and gone over the millennia, leaving only those faint markers of their passing that we now puzzle over.

In Toynbee's phrase, many of them became "arrested societies", bound in by belief systems and practices that constrained their ability to visualize alternatives. They exhausted provisioning options or they were overwhelmed by more innovative peoples ruthlessly intent on provisioning themselves.

Thus the rule of thumb for the survival of human societies is also "adapt or die" - or, more precisely, organize to meet provisioning needs or die. **The core business or mission of our societies is to meet the provisioning needs of citizens.** Other things may be important, but if societies fail to do this, they die.

Societies organize their provisioning functions around available energy sources, technological innovation and trade. When these prove inadequate they resort to migration to more favoured locations and with depressing frequency to war in order to take what they need from others.

This figure illustrates the manner in which past societies organized these five tools of outreach to meet their provisioning needs.

Old hunter-gather societies changed little over many millennia. That was because their energy systems - reliance on muscle-power and the burning of wood - provided a slim basis on which to innovate. In the absence of innovation, the only way they could augment their provisioning capability was through migration to more favoured locations or by taking what they needed by waging war on neighbouring tribes.

The situation remained much the same in early agricultural societies. They eventually added animal power and hydrology (irrigation) to the energy mix.

But they still migrated in search of new land and managed to eradicate most earlier societies from all areas in the world that are suitable for farming

Cities, of course, are totally dependent on what they derive from elsewhere and their arrival had to wait until sufficient agricultural surpluses were available to feed urban peoples. Innovation was stimulated by the necessity of trading to meet provisioning needs and by the sharing of knowledge between societies that trade produced. A major development was the harnessing of wind power for sailing. However, almost from the beginning, cities also relied on colonization and war to reach out to more distant sources of natural capital.

This situation persisted through the early years of nation-hood and it wasn't until after the mid 1700s that innovation really took off. The trigger for this was the exhaustion of forest resources in England where the shift to coal was followed quickly by the invention of the steam engine and the on-set of the first Industrial Revolution.

The impact of this Revolution was enormous.

- The mechanization of agriculture saw productivity increase by over 300%. Populations surged. People poured into cities to work in new manufacturing plants.
- Advances in sailing technologies furthered imperial ambitions.
- The railroads and telegraph stitched countries together and created access to the vast, untapped resources of the Americas and elsewhere.
- The place of trade in national economies led Adam Smith to publish his works that laid the basis for present-day neo-classical economics.
- The rise of the merchant classes eroded the power of Kings and helped lead to the introduction of democratic systems of government.
- All this because of coal

The Second Industrial Revolution then began to take shape in the latter half of the 19<sup>th</sup> century. Again, energy technologies were the cause.

First came oil and the internal combustion engine followed quickly by electricity and the seemingly endless potential to electrify all things mechanical. The combination sparked waves of innovation and employment based on the production and mass marketing of consumer products. By the turn of the century, large MNE's were operating, R&D labs were being established and innovation was becoming the basis on which further growth would soon be "created".

Our global economy is the beneficiary of all of these earlier transitions. The international business networks that now scour the globe for essential natural capital are tied together by advanced information technologies. Innovation underpins the growth dynamic and the entire global enterprise is enabled by the diversity of energy systems now we now enjoy.

Throughout this long process a fairly consistent pattern was followed - despoil or exhaust the provisioning capacity of the local and reach out to more distant or novel sources of natural capital.

The extensions of provisioning capability also had a persistent ugly side in terms of human conflict. Some argue there may be a peace dividend associated with global economic integration. If you can trade for what you need, they argue, why go to war? I think the jury is still out on that.

But whatever the downsides in these transitions might have been they are vastly outweighed by the overall benefit to human well-being.

- Each advance in energy systems created a broader base on which to innovate.
- Technological advance led to the vast diversification of skill requirements and specialized job functions that now help modern, urban societies create mass employment.

Above all, these transitions have steadily increased the power of our provisioning arrangements to tap natural realms. We have gotten steadily richer because we have been able to extend our provisioning reach.

If all we had to meet our needs were the simple tools and sophisticated knowledge of local ecosystems that ancient hunter-gather societies relied on, the habitable portions of the entire world could probably only support about 20 million people.

In contrast, the provisioning arrangements of the global economy now directly meet the provisioning needs of over 2 billion people, partially meet the provisioning of 1-2 billion more and offer hope for a better life to several billion others.

The principles of neo-classical economics that now underpin the operation of the global economy can be summarized very simply in the notion of “the virtuous circle of growth.”

Growth, the theory says, together with democratic systems of government and open, transparent arrangements for encouraging trade and foreign investment will eventually produce a virtuous circle of wealth creation, social advance and increased investment in social and environmental issues.

And, of great importance, it seems to work! In the last couple of decades hundreds of millions of people have been raised above the poverty line - over 400 million in China alone. Hundreds of millions more are expected to do the same in the next couple of decades.

So, it is not surprising that almost all political leaders are committed to participation in the global economy and rely with more or less precision on neo-classical economic principles to help manage their national economies.

But all is not well within our world or the global economy. Despite stellar performance there are disturbing trends within patterns of global growth that are, to say the least, unnerving. The most critical issue is growing constraints on our ability to meet global provisioning requirements. I will return to this theme in a minute. But first, let's take a quick look at the growth of inequity and competitive tensions within our integrated world.

Inequity is growing within and between countries. Across the industrialized world, the wealth gaps between upper and lower income earners have increased dramatically in the last 2 decades. The Middle Classes are being squeezed. Labour markets are being hollowed out as smaller numbers of high paying jobs are being created at the top while most new jobs are being created at the bottom. These conditions can be socially destabilizing and they are not going away.

And the same thing is happening around the world. Spectacular growth rates over several decades in major 3<sup>rd</sup> World economies have been accompanied by equally startling increases in the gaps between those living in wealthy enclaves linked to global provisioning networks and the almost 3-billion strong under-half of the world's people that survive on less than \$2 per day.

The face of international competition is also changing. All peoples and all nations are beginning to compete for the same jobs as populous countries become more technologically sophisticated. The integration of production across national borders is driving all countries to adopt similar technologies.

But populous countries are also now becoming centres of innovation in their own right.

India and China are now churning out orders of magnitude more scientists and technologists each year than Western economies. And it is not just the big, emerging economies that are doing this. Viet Nam, for example, is now producing almost three times the number of information technology grads each year than Canada.

The growing technological capacities of populous countries, combined with their abundant pools of low wage workers, are beginning to confer a lethal competitive advantage across all areas of advanced technology - an advantage that will last for decades.

And the directions of present technological advance are complicating the picture. Things like faster chips and computer speed, nanotechnologies, artificial intelligence and robotics - may be combining to presage an era of jobless growth. These all increase productivity and efficiency: they are technologies that replace human labour. This may be desirable from a competitiveness perspective but it is unsettling when billions of people are queuing up to find jobs in market economies.

So, the race for technology-based jobs is on. There is no finish line for this race, no guarantee of likely winners, and competition at the front of the pack will intensify. The benefits and durability of aimless growth are increasingly ephemeral. The treadmill of endless competition is propelling all of us towards an uncertain future that seems to lack coherent social purpose.

Thus, it could be argued that technology is turning against us. But if it is, it is just the tip of an iceberg of change barring the route of further progress.

At some point during the big transitions since the onset of the Industrial Revolution leading economies have shifted their gaze from provisioning and survival to competing for growth. We now view the world through the prism of neo-classical economics and are pre-occupied with organizing for competitive advantage. As a result, we no longer consciously organize to meet our provisioning needs.

We ignore this requirement at our peril.

The tensions associated with technology-based competition are coming on top of a sharp decline in the utility of our dominant energy systems and the erosion of global ecosystems on which growth depends. It is not just technology that is turning against us. All of these factors are beginning to work against the continued betterment of humankind.

So, there you have a brief look back at the history of human provisioning efforts and our current situation. To move our business planning forward, we now need to scope the coming provisioning challenge - to profile the iceberg that threatens to stop further progress.

We all know we are doing vast harm to the viability of global ecosystems.

- I noted the 6<sup>th</sup> Great Extinction of species that we are now inducing.
- The global wild fishery is in disrepair and decline.
- Within 20 years the full effects of the stealthy spread of pollutants on both human and ecosystem health will be known.
- We are pushing the edges of significant depletion of physical resources, notably water.

Now water seems like an impossible thing to run out of. But we are depleting and polluting vital aquifers, draining rivers dry and turning vast areas of formerly productive land into desert. In the process we are undermining the social well-being of hundreds of millions of rural and urban peoples and straining the relations between nations that share common water resources.

- We spend an inordinate amount of time navel-gazing around the issue of “peak oil”, and to some extent with cause as sooner or later fossil fuels will be exhausted. But in many respects this is a false issue that I want to avoid discussing. Running out of fossil fuels is not one of the issues we should be concerned about. The only issue of importance is the effects of CO<sub>2</sub> that result from the burning of these fuels.

Obviously the key concern here is climate change. But we also have to address the impact of these emissions on our oceans, which have been absorbing up to 20% of all the CO<sub>2</sub> we produce. This has now increased

the acidity of the world's oceans to the point where the production of plankton, the basic source of nutrients that support all ocean life, is being impaired.

Moreover, about 3 billion people still rely primarily on their muscles and the burning of bio-mass to meet their energy needs. If they are to join the global economy, they have to increase their energy intensity. Whether from the supply side or from the environmental side, it would be wrong for them to do this through reliance on fossil-fuels.

I will return to these energy issues later. But first, let's be clear about the consequences of not taking global warming seriously.

There is a sort of scientific consensus that if the global average temperature increases by over 2 degrees, it will precipitate our worst nightmares about rapid global warming. The problem with the idea of thresholds is that no one really knows when we might reach them, or, indeed, if we have already exceeded them.

What is clear is that at a certain point, global feedback mechanisms that now help to temper global warming will all begin to turn the other way setting off a chain reaction of parallel events. Warmer then begets warmer and we will have to deal with runaway climate change.

As these feedback mechanisms kick in, unstable weather will create havoc for agricultural producers causing disruptions in food supply. People will be forced to migrate to escape from intolerable heat. As the polar ice caps melt, coastal cities and communities will be forced to abandon their locations or resort to huge public works programs to hold back the rising oceans. Insects and disease will migrate. Markets will surely collapse. The global economy will implode. Chaos will ensue.

So, how close are we to the tipping point?

I don't know, but a growing number of scientists believe we have already passed the point of no return and that all we can do is try as best we can to adapt to whatever changing weather patterns are forced upon us.

To support this conclusion they point to signs that the big negative feedback mechanisms are taking hold. For example,

- the polar ice covers are melting and huge amounts of solar heat that were reflected back into space off the white surfaces are now being caught and retained by the dark ocean waters.
- northern climates are warming faster than other regions and the great volumes of ancient carbon sequestered in Arctic permafrost are starting to be released
- the death of huge tracts of forest caused by altered weather patterns and climate-related pest infestations, along with more frequent forest fires, are producing large, incremental volumes of climate-forcing carbon dioxide.
- The great ocean currents that mix the Southward flow of cold Arctic waters with warm tropical flows are showing signs of slowing.
- The oceans are warming. Hotter tropical waters are fuelling more violent weather patterns. Similar events are also occurring elsewhere as the entire Earth begins to breathe more deeply.

Many also suggest the tilt towards chaos is already evident in what we now tend to see as isolated events - a drought here, the collapse of a fishery there, a violent storm somewhere else - the sort of things we are familiar with. The consequences will become more severe as these events begin to overlap.

Others point to Darfur and other examples of ethnic cleansing - which are nothing more than cold-blooded contests for the control of limited land and water resources - and to the growing numbers of ecological refugees that are now beginning to join the streams of economic migrants seeking better lives for their families. These, they say, are precursors of what might await the world. Conflict, is latent in the growing competition between economically advanced and rapidly emerging economies for access to global sources of natural capital, including, but not limited to oil and gas.

Now, while climate change is the “Mother” of all environmental issues, there are also a lot of pretty big sons and daughters that we have to deal with. It is the totality of these strains on global ecosystems that are undermining our ability to meet global provisioning needs.

The report of the UN's Millennium Ecosystem Assessment puts the overall picture into perspective. In simple terms it says that we are drawing more from nature each year than nature can regenerate and we cannot keep on like this, let alone increase the draw without suffering serious consequences.

Yet we show little evidence of tempering the growth of our demands on ecosystems.

If we project ahead just a couple of decades the picture that results is scary. We all seem to expect the global economy to keep on growing at 3-4% per year. (It grew by 5% in 2005) If this happens, in just 25 years total world output - global GDP - will be 2 or 3 times as big as it is now.

Looking at this in a slightly different way, there are roughly 2 billion full participants in the global economy. Another 1.5 billion are now in the wings. If we then take the reduction of poverty seriously, we have another 3 billion people whose better life-styles must be provisioned. And then another 2 billion people will soon join us.

We are already impairing our world. Yet the continued pursuit of global growth and the reduction of poverty could soon require, each year, the ecological equivalent of 2-3 Earths, maybe even 4.

Clearly, the choice before us is to either figure out how to share our world - or to act as discreet ethnic, religious or national groupings intent on exerting dominance in an increasingly resource-starved and unstable world.

If we choose to share, we have to reorganize our societies to meet our provisioning needs.

If we are soon going to need the ecological equivalent of 2 to 4 earths - let's settle on 3 - then we have to find ways of reducing the demands we make on natural systems to about 1/3<sup>rd</sup> of the levels in 2000. We then have to maintain the draw at that level indefinitely.

So, lets recap.

The Mission is to provision societies.

The Challenge is to reduce the demands we place on natural systems to about 1/3<sup>rd</sup> of present levels.

The tools around which we have to organize our business plan are limited and not all of them are desirable. For example, we can no longer migrate en mass to more favoured locations. Trade can change the distribution of access to natural capital, but it cannot increase the volume of ecological goods and services available for all of humanity. And we want to avoid war if at all possible.

So, as happened many times in the past, it looks as if we are left with reorganizing our societies around new energy systems and technologies.

To further clarify intent - to help us shape a vision of what we hope to achieve - let's put a name to this next transition in human organization. Let's say we are seeking to bring about a new Age of Global Provisioning.

If we take all these considerations together, we end up with the following Vision Statement:

**By 2030, the Age of Global Provisioning has arrived as human societies have re-organized around energy systems and technologies that equitably meet provisioning needs while simultaneously reducing human demands on natural systems to 1/3rd of present levels.**

OK. We have our Mission and Vision Statements. We now have to figure out our corporate structure - the specific business units that will have prime responsibility for achieving our Vision.

Because we are in a business-planning mode, we can't be all things to all people. We have to be sensitive to the span of control and we want to concentrate our resources on activities that will produce the greatest impact.

Thus, I would suggest only five business units. Each unit must in turn be charged with achieving specific, clearly-defined goals and with taking the actions that will achieve them.

Let's have a quick look at these business units, starting with energy systems.

## 1. Energy Systems

Energy is unique. We can't survive without it and we can't make the transition to global provisioning without abundant energy supplies. That's not a problem, as long as the energy we use is environmentally benign. If it is, there are almost no limits to how much we can use.

So, to be clear, the goal is not to cut energy use but to reduce the energy-related demands we make on nature. If we take CO<sub>2</sub> as a proxy for these demands, then the goal is to cut CO<sub>2</sub> emissions by 2/3rds by 2030.

There are lots of options for doing this.

- For sure, the transition must involve the total embrace of solar and renewable energy options, especially solar power and wind.
- Bio-gas has a vital role to play. In Brazil, where sugar cane is plentiful, a barrel of ethanol now costs half as much as a barrel of oil. Overall, the UN estimates that bio-gas could account for a quarter of world energy consumption within 2 decades.
- If hydrogen can be produced using wind, tidal or off-peak power, then do it. Nuclear power might also be used on a limited basis if energy forecasts predict shortfalls.
- If, and only if, coal can be cleaned up or gasified to produce low carbon fuel and the carbon off-gasses can be sequestered, then the use of coal is defensible. But that's a big IF!
- On the other hand, the goal of cutting carbon emissions puts a dark cloud over further exploitation of fossil fuels, especially non-conventional forms. To the extent that we do continue to exploit fossil fuels - and we could still be using them several hundred years from now - we have to reduce their role in accordance with the CO<sub>2</sub> target. We might also consider channelling allowable fossil fuel use to activities that cannot easily be diverted from oil dependence, such as agriculture, or to higher, value-added uses such as petrochemicals.

Achieving energy goals is more than just an energy industry challenge. In fact, as we will discuss, the biggest contributions to cutting CO<sub>2</sub> emissions may actually come from our other business units - from changes made by industry, through the redesign of our cities and the adoption of new agricultural practices.

Finally, there is a need to invest more heavily in the development of new energy technologies. The IEA estimates that \$17 trillion will be needed over the next 25 years for new energy development, with the vast majority being spent on the quest to expand the use of fossil fuels.

Well, what could we accomplish if we forget about the notion of “peak oil” or finding and utilizing additional fossil fuel resources and, instead, put the bulk of these monies into developing and installing renewable energy systems.

Take solar panels. Their conversion rate - sun to electricity - is now about 12-14%. At around 18% they become as efficient as most forms of electrical power. Proto-types of solar panels are now available that achieve over 30%. Now, think of the further gains that might accrue if some smart young kid working in a nanoscience lab - perhaps here in Calgary, or in India or Spain - figures out a way to accelerate the photoelectric effect. If these advances also cut production costs, we can look forward to cladding our houses and buildings with solar panels that will meet all our home energy needs and provide enough surpluses to endlessly power-up our electrical or hydrogen vehicles.

The dream of everlasting, essentially free and clean energy is there for our taking. But we have to choose to seek it!

## **2. Industrial Ecology**

The huge international corporations that tie our global economy together represent a quantum leap in our capacity to organize around a shared purpose. We now have to fully mobilize that remarkable organizational capacity to help achieve the Vision.

The conceptual frameworks for doing this are now well known. They begin with the application of eco-design principles to products, industrial processes and downstream markets. The results encompass closed loop and zero-emission production processes and life cycle materials management systems.

Many international companies are now far out in front of governments and the public in terms of their understanding and response to energy and climate change issues. Their efforts are impressive. However, further substantive progress is unlikely without major regulatory incentives and the international coordination of market effects.

### **3. Urban Design**

We also need to pro-actively redesign our cities to become vastly more efficient users of natural capital. Aggregate estimates suggest that cities account for around 3/4s of human natural capital consumption and 3/4s of all pollution. Thus, it is in cities where by far the greatest potential for resource and energy efficiency gains are possible. These can be achieved in two ways.

The first goal is to transform urban areas into cities of sustainable villages

To accomplish this we need to redesign and rebuild our cities in ways that create denser populations that live and work in “green buildings” concentrated around stops on mass transit lines. Think cities where people live close to where they work and where people think walking, not driving. And above all, think of energy self-sufficiency and the use of decentralized energy technologies like solar, geo-thermal, co-generation using bio-fuels and then hydrogen.

The reductions in human demands on natural systems that will result are huge. High density housing, for example, uses about 2.5 times less energy and materials in construction than low density units. Mass transit can minimize car use, lower GHG emissions and even cut city budgets.

Green buildings can already cut energy and water consumption in half and emerging technologies can virtually eliminate the need for fossil fuel use to heat and operate buildings. Eventually the production of surplus energy to feed back into regional grids will be possible.

The second goal is to transform entire cities, like industry, into closed loop processors of natural capital.

Eco-industrial parks provide a model for doing this. These encourage industries whose waste products are inputs into other production processes to locate adjacent to each other. Ramping this concept up to the city or regional

level is also possible. The starting point is the conduct of city-wide materials flow analysis to clearly identify possible synergies.

The redesign of cities to achieve higher densities will also make it easier to efficiently collect and re-use waste products. Decentralized or point of use waste separation and even recycling technologies (many exist) can break the practices of channelling waste materials, and pollutants into poison-laden dumpsters and inseparable slurries that present unmanageable recovery problems at centralized waste treatment plants.

All it takes to initiate this new urban agenda is to change the zoning rules and building codes. It's as simple as that, and as difficult!

Once the rule changes are made, or even in anticipation of their coming into effect, all further urban expansion should be frozen until minimum density targets are met.

Random urban redevelopment should also be stopped and new investment directed towards projects designed in accordance with the new rules for sustainability. If all urban redevelopment is forced into large enough blocks, the creation of energy self-sufficient communities becomes possible.

Making progress along these lines will require significant investment in new resource recovery and reprocessing technologies and market mediation mechanisms to create outlets for recycled materials and products.

Without long-range urban development plans that are assembled around this Vision, little progress will occur. These plans need to take a global view of the requirements for change.

The plans also need to redirect market forces and provide a reasonable phase-in period to allow developers and property owners time to adjust their investments to accord with the new rules.

#### **4. Agriculture**

Agriculture now accounts for about 70% of human withdrawals of water. It is also a huge consumer of fossil fuels (approximately 2 quarts of oil per 2 lbs. of breakfast cereal), the world's worst polluter and the source of almost 25% of human-generated greenhouse gasses.

Thus, efforts to increase agricultural productivity must be done in ways that also bring about dramatic reductions in the use of fossil fuels and water and that cut pollution and the sector's contribution to climate change.

The key to achieving all of these objectives is the use of technologies that reduce water use. Examples of these technologies exist. Precision agricultural practices using drip irrigation and computer-aided applications of fertilizer and pesticides can dramatically reduce run-off and water pollution while cutting fossil fuel requirements and the release of greenhouse gasses. These practices could also solve the world's water problem by releasing huge quantities of water for other uses.

The agricultural sector can make additional contributions to reducing climate forcing in two ways. First, there is evidence that shallow tillage practices could help slow the release of greenhouse gasses from agricultural soils. Second, there is great scope for converting agricultural waste into relatively clean-burning bio-gas. Indeed, one estimate suggests that if all of the food waste from farm to home in the US could be captured and converted this way, the resulting gas could meet all of the country's transportation needs. (And won't we soon capture all of this material in our closed loop cities?)

## **5. The Interface with Natural Systems**

Looking forward, if we are to cut our demands on nature by 2/3rds, our societies must develop a greatly enhanced capacity to monitor and control human interactions with natural systems. We are also going to need this enhanced capacity to help us anticipate and respond to both short-term and systemic changes in the operation ecosystems.

At present most jurisdictions have only a limited capacity to manage these functions. Our resource management practices are held hostage to the tyranny of the installed political and administrative base inherited from earlier eras of few people and abundant resources. Over hundreds of years of random growth, political jurisdictions sprang up around agricultural villages, then towns and cities. State and national governments were added on top and each established their own administrative and regulatory regimes.

The result, in most jurisdictions, is highly fractured, inconsistent decision-making. We need to restructure these ineffective management systems to reflect the present era of few resources and abundant people.

Doing this will require the creation of binding political accountability for controlling the totality of demands on natural systems.

Because political change is slow, this transition will have to be facilitated through the development and use of effective monitoring and forecasting technologies and decision-making tools that help evaluate and control all planning and investment decisions by all jurisdictions within an integrated bio-region management framework.

### **Support Actions - the Corporate, or headquarters role**

In addition to the actions of the five business units, there are a number of support functions that must be taken up by corporate headquarters. The corporate role includes communicating the Vision, setting the energy and innovation agendas, global marketing and overcoming major obstacles.

#### **i. redirecting the innovation agenda**

The redirection of the innovation agenda is of central importance.

This chart compares the dominant fields of present innovation with the requirements for provisioning the world's peoples.

On a very broad basis existing patterns of innovation must be redirected towards meeting the world's provisioning needs. This applies especially to expenditures on military technologies and conventional energy systems.

This does not mean that all other innovation must be stopped. In fact, things like nanotechnology, agro-biotechnology and advanced communications and computer capability - are essential to our ability to change course: they can help fight pollution, contribute to finding new energy solutions and improve our environmental monitoring and forecasting abilities. However, to be useful, they have to be specifically directed to these purposes.

#### **ii. creating jobs**

When it comes to selling the vision, particularly on a global scale, a key obstacle to overcome will be concern over jobs.

As noted earlier, past transitions in the core technologies and energy systems around which societies are organized have always been times of great gains in employment and wealth.

If this happened with coal and the steam engine - with oil and the internal combustion engine - with the electrification of everything - and with information technologies - then surely we can expect the same result from the broad restructuring we must now induce.

Think about it. We are looking at reconfiguring the totality of existing energy infrastructure, transforming global agriculture, redesigning our cities and making enormous investments to protect our societies against unstable environmental conditions. These requirements can productively engage all of humankind for the next hundred years.

Jobs are an issue if we continue down our present track. They are not an issue if we choose to shift course.

So, it comes down to this. We must all choose, and choose quickly, whether to fight our neighbours for access to the remaining pockets of natural capital on a degraded planet or unite as a single species on the battlefields of energy and technological innovation to equitably provision the people's of the world.

But can we shift course? Can we make the transition to this new Age of Global Provisioning if our societies continue to be organized around the notion that well-being is equated with material wealth and if the economic principles that guide us are aimed at maximizing individual welfare and consumerism?

I don't have the answer. I do know that when the signals are right, market forces are the most powerful agents of change available to us. However, we appear to be locked into "compete-mode" in the pursuit of patterns of growth that are aimless and opportunistic. Without direction, it is highly unlikely that market forces will take us where we have to go. And this I do know, they won't take us there in time frames that matter.

If the dominant beliefs that now shape our human direction cannot quickly accommodate the provisioning imperative, then our societies, like so many

before us, will collapse, and we, in turn, will leave behind only crumbling reminders of our passing to be discovered and puzzled over by others in the long future.

Ultimately, our course will be determined by what people like you and I think of these issues and what we are prepared to do about them. Our politicians can't get too far out in front of their constituents and still get re-elected and there seems to be only so much fear or disruption that people like you and I are prepared to contemplate. So, we remain indecisive.

A poem by Yeats captures this conundrum quite nicely. He was referring to the drums and rattle of impending war, but his words could just as easily refer to the Sixth Great Extinction of species or to the beginning of nature's revenge.

“... we wonder, and we wait, and we go about our business, even as the sound of something terrible slowly approaches across the hills.”

That is not adequate!

Thank you for listening.