Submission to the Inquiry into the National Market Driven Energy Efficiency Target Bill 2007

Summary

The National Market Driven Energy Efficiency Target Bill 2007 appears to be based on a prevalent non sequitur regarding efficiency improvements and environmental outcomes. I put it to the committee that:

a) Improving energy efficiencies is a dead-end strategy for addressing environmental issues.

b) The driving of efficiency improvements should be left to the normal market forces of the economy and not subject to potentially distorting contrivances.

c) The environmental future of society will be better served by parliamentary efforts being directed towards debating issues such as the sustainability of population growth and a consumption growth driven economy.

Energy Consumption

Energy consumption can be broken down into two components:

1. The basic work to be done; e.g. heat 10 litres of water from 10^{o}C to 60^{o}C.
2. The efficiency losses; being the difference between the work done and the energy used.

For any amount of work demanded, the available opportunity for improving efficiency is absolutely finite. As an example, most electricity consumption across industry in general is consumed by squirrel cage electric motors. The efficiency of a moderately sized squirrel cage motor is in the order of 96 percent. No amount of technology can do better than that next 4 percent. Yet electricity consumption in Australia is growing at more than 2 percent per annum.

Sources of Consumption Growth

If consumption is growing at 2 percent then in 35 years the rate of consumption will double. Where does this growth come from? Consumption growth can come from only two sources:

1. Increased utilisation of existing points of consumption.
2. Creation of net new points of consumption which didn't previously exist.

Basic economics dictate that existing points of consumption will be sized to efficiently match demand. The potential for energy consumption growth from increasing utilisation of existing points of consumption is limited. The doubling of the rate of consumption will not come from merely increased utilisation of existing points of consumption.

Clearly the main driver of consumption growth is the creation of new points of consumption – new houses, new buildings, new factories, installation of air conditioning into old buildings etc.

Drivers of Consumption Growth

This growth through new points of consumption is in turn essentially driven by two factors:

1. Population growth – growth in the total number of people.
2. Increasing affluence – growth in the amount consumed per person.

These two factors are multipliers in the overall increase in consumption.

Environmental Impact of Consumption

There are various environmental factors which arise from energy consumption, however two stand out:

1. Pollution – being the release from containment of harmful materials.
2. Depletion of finite non-renewable resources.

Virtually all energy consumption, even that which is derived from renewable energy sources, contributes to these impacts when the entire life-cycle is taken into account.

Growth Versus Efficiency Improvements

What should be clear from the above is that the drivers of consumption growth are open-ended and exponential. On the other hand the opportunities for efficiency improvements are absolutely finite and limited. (Except that, somewhat perversely, the magnitude of opportunity for efficiency improvements increases as overall consumption increases.) Efficiency improvements can never ultimately compete with underlying demand growth from the continual creation of new points of consumption. So long as basic demand continues to grow, efforts aimed at addressing environmental issues through efficiency improvements are akin to one step forward and ten steps back – a dead-end strategy.

Commercial Imperatives

There are already commercial imperatives that drive efficiency improvements; there always have been. One jet engine manufacturer will have an edge over its competitors if its engine is more fuel efficient. An airline choosing its next purchase will consider fuel efficiencies on the basis of hard dollar economics. There is no need to invoke environmental considerations. Be it aircraft, ships or producing aluminium or steel, efficiencies have always been increasing because businesses which don't improve efficiencies don't stay in business.

If government is to intervene heavily and attempt to create structures to drive the rate of efficiency improvements beyond that naturally dictated by market forces then there has to be a good reason. If the reason is not economics and is ostensibly environmental, then the question needs to be asked whether this is an effective approach and if more effective approaches are available to deal with the issues.

More Effective Approaches

If consumption drives major environmental problems then the objective must be to reduce consumption. Reducing consumption is the same as negative consumption growth. Increasing absolute consumption rates to a level above present but below some theoretical 'alternative scenario' is not reducing consumption – it is increasing consumption.

If energy consumption growth is currently positive, then it cannot become negative without first becoming zero. Achieving zero energy consumption growth would only be achievable if the creation of overall net new points of consumption approaches zero. Without creating an endlessly deteriorating average standard of living, this is only possible if population growth is zero.

It is not the purpose here to press strategies for dealing with environmental issues. The purpose is to point out the logical basis of the matter. Arguing for efficiency improvements as a means of addressing environmental issues while at the same time saying nothing about population growth, is illogical. There is much to debate about the sustainability or otherwise of continuous population growth and continuous consumption growth (driven by new points of consumption). These are the key issues which need to be debated and resolved.

Further Discussion

Included here is the transcript of a public lecture entitled Consumption Growth 101 which covers the subject in more depth. A PowerPoint presentation automated with an audio recording of the lecture is available at consumptiongrowth101.com.

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CONSUMPTION GROWTH 101

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Introduction

Most of us have at least some interest in the prevailing environmental debates: Climate change; energy sources – (e.g. fossil fuels versus nuclear versus renewable); pollution; environmental degradation and so forth. We are consuming too much and need to consume less we are told. Consumption – and particularly consumption growth – is at the root of these issues. So it is important to have some common understanding and agreement on the basics of consumption and growth.

Marvellous and Insidious – *Exponential growth*

We are going to start off by looking at the amazing phenomena of exponential growth. At the outset I must point out that real-world phenomena rarely, if ever, vary in a purely exponential fashion for very long. The purpose here is to explain the general principle – not predict the future.

It is a useful fact of simple exponential growth that a value which is growing at a fixed rate will repeatedly double at a fixed interval. If $1,000 could be put on deposit at a fixed rate of interest for a long enough period of time, in a certain length of time it would grow to $2,000. In the same length of time that it took to grow from $1,000 to $2,000 the balance would grow from $2,000 to $4,000. The length of time would be the same again to grow from $4,000 to $8,000 and so on. This is marvellous. If the interest rate was 5 percent then the interval would be around 14 years. If one were fortunate enough to earn a rate of 10 percent that interval would be around seven years.

Before moving on, an explanation of a rule of thumb by which periods of doubling can be calculated is useful. This rule of thumb is widely referred to as *the rule of seventy*. How many years a value will take to double at a particular percentage growth rate can be worked out by dividing seventy by the annual growth rate in percent. Thus a 2 percent growth rate results in doubling every thirty-five years; a 1 percent growth rate results in doubling every seventy years. A growth rate of 0.1 percent results in doubling every 700 years.

To find out the interval at which the value will triple, divide 110 by the growth rate. Such is exponential growth.

The second important fact to know about exponential growth, or geometric progressions, is what happens to the result as the number of doubling intervals increases. Take a strip of paper and fold it in half. The thickness has now doubled. Fold it again. You will probably find that it can be folded six times, and with some effort perhaps seven times. (By the way: The world record for paper folding is twelve times.) After the second fold the thickness is four times the original thickness and so on. The thickness of the original sheet is probably around one tenth of a millimetre. If you could hypothetically fold a piece of paper 42 times what would you discover? The answer to life the universe and everything? No, not quite. Would it be the width of the room? Perhaps it might be the length of the block? We are not even close. The thickness of the sheet folded in half 42 times would reach further than from the earth to the moon. It is no exaggeration then to say that ongoing exponential growth eventually leads to astronomical results, and in a shorter time than one might naturally expect.

Another popular illustration of exponential growth is the water lily, of which the following is a slight variation. Imagine a small lake, the size of a football field. One day a man notices an unusual water lily growing in the middle of the lake. He rows out to investigate and measures the size of the lily. In area it is roughly the size of a football. (Round or oblong variety – take your pick). The next day at the same time he rows out and measures it again. The lily has doubled in area. The same observation is made on the third day. The lily is now four times the size it was on day one.

The man realises that if the lily continues to grow it will eventually cover the entire lake and cut off all light to everything else beneath. How much time does he have to take action? Give or take a day the lily will cover the entire lake in twenty days. The man is curious to observe the lily grow and decides to wait until it covers half the lake before dealing with it. The problem is the lily is doubling in size every day. This is insidious. The interval between when it covers half the lake to when it covers the entire lake is only one day.

In the above case the interval of doubling is one day. If the rate of growth is different the interval of doubling will be different. However the fact that the last half of the lake is covered in a single period of doubling remains the same. No matter how long it took to cover the whole lake, however long the lily takes to double will be how long it takes to cover the last half of the lake. If from start to finish is twenty intervals of doubling then the last half will be covered in one twentieth of the total time – regardless of what the total length of time is.

There is something else to note in this illustration which is of interest. Each time the lily doubles in size it grows by an amount equal to all of the growing that has occurred up until that time. Regardless of whether it was ten or ten thousand times, how many times the lily has doubled to reach that size is irrelevant. The eleventh or ten thousand and first period of doubling will equal all that has occurred before. This is the nature of exponential growth.

Now consider the water lily illustration in terms of the lake as being a finite resource that is being irreversibly consumed at an exponentially growing rate. Instead of asking how long it takes for the last half of the resource to be consumed, what about how much of the resource is remaining in half the time that it takes to consume the total? That is: how much of the lake is covered at Day 10? The total amount of resource that has been consumed at the end of each period, (in this case one day), doubles each period, and the total resource is consumed in twenty doubling periods. In half the elapsed time the amount of resource remaining is over a thousand times as much as has been consumed already. Notice how deceptive this situation is. The resource has been consumed for ten periods and there is over a thousand times as much left as the total of that which has already been consumed. Yet the amount of *time* left is only equal to the amount of *time* already elapsed – ten periods, not one thousand or ten thousand.

Consider the statement that the hot rock energy resource in Australia is 7500 times the annual energy consumption of the nation. This tends to give one the impression that the resource will last 7500 years or thereabouts. If the rate of consumption was not growing then that impression would be correct. Surely one would expect that a small rate of consumption growth wouldn't have too much of a dramatic effect on that 7500 year figure? That depends on how small is *small*. At a 1 percent annual consumption growth rate this resource would run out in 433 years.

There is a possibility that our estimate of this resource size could be completely wrong. What if the resource is actually one hundred times as large? Surely now it will last practically indefinitely? Not quite. If consumption keeps growing at just 1 percent per annum, even this now seemingly huge resource will only last 892 years. That might seem like a while, but it is a long way from the three quarters of a million years implied by quoting the resource size as a multiple of present annual consumption.

Resources such as oil, gas and coal are often quoted using the term *reserve-to-production ratio*. This is a figure of how many years the reserve would last at current production rates. There is nothing intentionally sinister or conspiratorial in that. Figures which on their own are essentially meaningless make more sense when expressed as a ratio. Ratios are used extensively in industry and business for this reason. Reserve-to-production is a useful ratio. What it is not useful for is indicating how long a resource will *actually* last.

The geothermal energy from hot rocks is of course used to make electricity. Electricity can be visualised as analogous to water streaming from a garden hose. The water pressure which is felt when you put your finger over the end of the hose is analogous to voltage; the speed of the water flowing is analogous to current; the rate at which the water will fill up a bucket, in litres per minute, is analogous to power measured in kilowatts; and the total amount of water in the bucket is analogous to the total energy measured in kilowatt-hours. An electricity bill will be predominantly a function of kilowatt-hours, i.e. how many buckets-worth were used. The cost of getting a new connection to a premises, be it a house or factory, is generally a function of the maximum demand in kilowatts, i.e. the rate at which the owner might want to fill buckets. The voltage, like water pressure, is set by convention or regulation and the appliances are matched to suit. Current is a function of power and voltage.

Large power stations are expensive and take years to bring on line. For that reason, (among others), much work goes in to trying to accurately forecast what demand will be in the future. The experts at the Australian Bureau of Agricultural and Resource Economics, whose job it is to make such projections, have forecast in a 2006 report that from 2004 to 2030 electricity consumption in Australia will grow at an average rate of 1.9 percent per annum. In some states and in some years the growth will be more and in others less, but for the nation as a whole and over that time frame that is the predicted average outcome.

Compared to the water lily the rate of growth of electricity consumption in Australia is small. However the growth is still exponential growth and has some similarly surprising outcomes when extrapolated. No-one can accurately predict what the *actual* electricity consumption will be at a given point in the distant future, but some what-if calculations can be performed very easily. Simplifying the calculation slightly by rounding the 1.9 percent to 2 percent: What if growth continued at an average of 2 percent for a while further than 2030, through to around 2040 say? Consumption would then be more than double what it was in 2004. At a growth rate of 2 percent, consumption doubles every thirty-five years. Thus most Australians will likely see electricity consumption doubling in their lifetime. Those my generation or older will have seen it double at least once already.

The effect of exponential growth is even more dramatic than that. At present, electricity consumption in Australia accounts for approximately 1.4 percent of the world total. That doesn't seem like much. However what if the growth of electricity consumption in Australia continued at a rate of 2 percent; not just until 2030, but for the next 200 years after that? By that time, at an average 2 percent growth rate, Australia would be consuming as much electricity as is presently being consumed by the entire world!

If, hypothetically, demand for electricity is growing at a constant rate of 2 percent then the demand is growing in an exponential fashion and doubling every thirty-five years. Using the garden hose analogy, at the end of year thirty-five twice as many buckets were filled that year than were filled in a year thirty-five years before. At the end of seventy years the demand is four times what it was at year one. Simply stating the fact like that sounds innocuous. However when considering how many new power stations this equates to building in the span of one lifetime, that fact in itself is staggering.

But it gets worse.

In the time that the water lily took to double in size the increase in area equalled the total area it covered for all of the previous intervals of doubling. Electricity consumption is no different. The total kilowatt-hours consumed in the thirty-five year doubling period equal all of the electrical energy that was consumed for all previous time. Putting it another way: *One generation can consume as much energy as was consumed by all previous generations put together*.

An Inescapable Conclusion – *Growth in a closed system*

Apart from sunlight, the earth is essentially a closed system. The inescapable conclusion of combining exponential growth in a closed system is that perpetual growth of anything tangible within a closed system is impossible – growth will stop. This is hardly surprising.

Despite projections that the world population growth might cease sometime this century, the rate of population growth at the moment of around 1.1 percent is still very high in historical terms. One commentator to make such an observation as far back as 1949 was none other than M. King Hubbert. (We'll meet him again later.) The following is an adaptation of Hubbert's comments.

Calculating a historical average of population growth is simply a matter of starting with the present population and choosing a time frame for human history. The shortest estimate of human history comes from a *young earth* assessment of Biblical chronology: 6,000 years. Setting aside the perennial arguments regarding the veracity or otherwise of this estimate, it is a starting point because it will produce the largest possible average population growth rate for human history. That average growth rate is 0.36 percent. Choose 100,000 years and the average is 0.02 percent. There are very good reasons why these average rates are so low and why the present rate can be judged as unsustainably high by a long shot.

There are many obvious factors that would inevitably bring a halt to otherwise unchecked population growth. For the purposes of this exercise an extreme case will be taken: water. Not just drinking water, but the water we are made of. Since humans are predominantly made of water it can be safely assumed that the volume of water contained in people on earth can never exceed the total volume of water that there is on earth. This amount is fixed and for all intents and purposes will never change. The scenario is a ridiculous one: that all other obstacles are overcome and human population growth is halted only because there is no longer enough water to make any more people. It's ridiculous, but it is useful for the purposes of this discussion.

Fix either growth rate or elapsed time and the other value can be calculated. A useful way of dealing with these two variables is to calculate the number doubling periods and then use the rule of seventy in reverse for different cases. For this particular scenario the number of doubling periods is thirty-two. Various outcomes can now be worked out using simple arithmetic.

What would happen if present population growth rate continued unchanged? At a population growth rate of 1.1 percent, within roughly 2,000 years there would be more water in humans than water in the world. This isn't going to happen.

For reasons of measurement error, common statistical uses, practical purposes and other reasons there will be a finite value below which growth would generally be recorded as zero. That value might typically be 0.1 percent. If growth is less than 0.1 percent, say 0.08 percent, then for day-to-day purposes it is zero. But what if it really was mathematically 0.08 percent? Would the time frame to reach this unalterable water limit be so long as to be irrelevant? That depends if 28,000 years is regarded as an irrelevantly long period of time. Regardless of the answer to that subjective question, the characteristics of population dynamics are bound by the types of limits described in these examples – and most certainly much less in reality.

There is one inescapable conclusion of all this: *whether anyone likes it or not, human population growth will effectively cease, and in a time frame that is of relevance.*

Having established that human population growth will cease, if for no other reason than finite water resources, what about energy consumption? Mankind is always finding new and previously undreamt of ways of consuming energy. From the perspective of 200 years ago the scale of industrial society today would surely seem improbable. How could anyone have imagined the astronomical amounts of energy that today would be consumed per head of population? This is important to keep in mind when various growth rate scenarios are extrapolated into the future.

Just the same as farms convert things we can't eat into things we can, power stations convert one form of energy into another type of energy which is more flexible. The original primary source of energy can take various forms. However it is important to distinguish between what is a primary energy source and what is merely an intermediate means of storage, or secondary fuel. When considering questions of energy sources it is important to get right back to the primary source that occurs naturally.

There are five basic forms of primary energy that are of relevance: three renewable and two non-renewable. They are: solar energy; geothermal energy; tidal energy; fossil fuels and nuclear fuels.

Solar energy. Every year the disc of the earth intersects the same amount of energy flowing from the sun. This figure is easily calculated and not open to conjecture. Wind energy, hydro power, wave energy and biofuels are all derivatives of solar energy. Any quoted amount of annual energy production from these sources can only ever be less than that total sum of energy which hits the upper atmosphere each year.

The total amount of energy, of all types, marketed in the world in 2004 is quoted in *International Energy Outlook 2007* as 447 quadrillion Btu. It is not necessary for the purposes of this discussion to attempt to equate that figure to anything recognisable; the number simply represents the energy consumed. The energy density of sunlight falling on the solar panels of earth-orbiting satellites is 1300 watts per square meter. From this figure and the diameter of the earth the total kilowatt-hours of solar energy intersected by the earth each year can be calculated. From there kilowatt-hours can be converted into Btu (or vice-versa) and the two figures divided.

The outcome of this calculation is that the amount of energy from the sun that is intersected by the earth is 11,514 times the amount of energy marketed in the world in 2004. This appears to be a large number. But how many doubling periods does it equal? The answer is less than fourteen doubling periods.

What if one conducts the hypothetical thought experiment that society moved over to only using energy derived from solar power, and derivatives of solar energy such as wind power? Is such energy endless? Is it so abundant that there will be sufficient for energy consumption growth for a very long time? While any prediction of timing is purely hypothetical, the maximum upper limit of the number of doubling periods for such a scenario is not hypothetical. There is no upside uncertainty. Double present consumption no more than fourteen times and the absolute limit will have been reached. If energy consumption growth over a long period of time were to average just 0.5 percent, the limit would be reached in less than 1960 years; or 980 years at 1 percent; or 490 years at the presently forecast 2 percent. If, as a result of a widespread belief that this energy was boundless, clean and environmentally friendly, consumption grew to 4 percent, the limit would be reached in less than 245 years.

In summary: A*t present typical rates of global energy consumption growth, not even literally all the solar energy in the world would be sufficient to meet requirements in 500 years time.* And that conclusion is drawn using an extremely conservative basis. Whether the period of time is 200 years or 2000 years, it is still only a fraction of the length of recorded human history. When measured on that scale it is not a long time.

Apart from solar energy and its derivatives there are only two other sources of renewable energy on earth: geothermal and tidal-related. Both of these are a tiny fraction of the energy intersected by the earth from the sun. Adding them into the above consideration makes no material difference to the outcome. Even if together they were equal to the amount of solar energy, (and they are not), the difference would be only a single doubling period. For the 2 percent case simply add another 35 years.

The lumping of geothermal energy with renewables is actually somewhat simplistic. It can be renewable or non-renewable depending on where you are and what technology is used. Geothermal heat comes from radioactive decay inside the earth which produces a constant output flow of heat. This is the energy that drives volcanos. Since rocks will conduct heat at a limited rate, if the heat built up over a long period of time and is drawn off in a short period of time then the energy source is essentially non-renewable.

Setting aside the problem of the rate of flow of heat through rocks, just how vast is geothermal energy? It is smaller than that arriving from the sun; but how much so? Estimates of the total energy flowing continuously from the interior of the earth vary in a range of around 5 to 60 terawatts. (As with 'quadrillion Btu', it is not important here to understand what a terawatt is.) Remember, this is the total energy flow. How much could conceivably be converted into electricity will be some tiny fraction of that total. Even if it was all recoverable, freezing the earth from the inside might not be a good idea.

To put geothermal energy into perspective with world energy consumption one needs to work out what worldwide energy consumption is in terawatts. As a comparison the *International Energy Outlook 2007* figure for worldwide marketed energy in 2004 of 447 quadrillion Btu can be used. This converts into an average instantaneous power of 15 terawatts.

Whichever way it is analysed, geothermal energy is far from being a vast resource when compared with total global energy consumption – even right now. At the lower end of the estimates the world is already using several times the total theoretically possible geothermal energy available. Even at the most wildly optimistic projections of what proportion of total geothermal energy could be extracted, the higher limits would still not be sufficient. Even if the upper estimates are wrong by some large amount, exponential growth will not take long to overtake such upward revisions.

The last form of renewable energy is tidal power. Since this is a smaller fraction again compared with geothermal energy it is not necessary to do any analysis to conclude that tidal power will be of little help when it comes to dealing with global energy demand. Besides, tidal power is related to the spin of the earth and interfering with that might not be a good idea either.

Unlike determining the solar energy intersected by the earth, estimating total fossil fuel reserves is not at all straightforward.

Most famous among the forecasters of fossil fuel production is M. King Hubbert. In a paper published in 1949 Hubbert noted that the age of oil would, on the scale of recorded human history, be rather brief. He presented a graph of fossil fuel consumption in the context of tens of thousands years of human history. More importantly than a concrete prediction of when fossil fuels would run out, Hubbert predicted the general profile of production over time. Hubbert reasoned that production of a finite resource would start at zero, increase to one or more peaks and, at some stage in the future, return again to zero. In between would be a profile of production versus time. From principles of basic calculus the area under that shape could be no greater than the total reserve to start with. The generalised form of this profile is a bell shape curve. The higher the peak, the narrower the bell will be. Hubbert also explained how the corresponding profile for a renewable resource such as hydro power was an S-curve, (also called a *logistic curve*).

In 1956 Hubbert presented a paper to a meeting of the American Petroleum Institute. This paper was actually hailing the prospects of nuclear power but it ultimately made him famous for quite different reasons. There has been so much discussion of peak oil in the media that I'm not going to elaborate further on the subject here.

Of all fossil fuels, coal is the most abundant. Realistic projections for coal, by those whose job it is to make such projections, involve much shorter time frames than those discussed here for solar energy. For example, on page 51 of *International Energy Outlook 2006,* worldwide recoverable reserves of coal were quoted as being: "enough to last approximately 180 years[9] at current consumption levels" [their footnote reference]. There is a reference footnote at the bottom which states the following:

> *"Based on the IEO2006 reference case forecast for coal consumption, and assuming that world coal consumption would continue to increase at a rate of 2.0 percent per year after 2030, current estimated recoverable world coal reserves would last about 70 years."*

What will most certainly occur is that a point will be reached where overall production will not be able to be increased. Remember Hubbert's peak. For any finite resource, eventually at some point the production rate has to start its inevitable descent to zero. Supply will continue for some time but no new additional demand will be able to be met. What this means in practical terms is that *no net additional coal fired power stations would be able to be built.* This is true regardless of any progress in carbon sequestration technology. The owners would not be able to secure a supply of coal without shutting down a power station elsewhere. Furthermore, for the purposes of the discussion here: even if it had been up until that point, coal would no longer be able to be used as a substitute to meet growing demand for oil products. At this point the fossil fuel age is all but over. Growth in consumption of fossil fuel energy will stop forever.

Taking the above figures at face value, this halting of growth in supply of coal would occur earlier than 2076. Alternate and larger figures than the 180 quoted above abound in various quarters. The key point to remember however is that so long as consumption is growing exponentially, multiplying the resource estimate two, three or even four times, will – on the scale of human history – make little difference to the overall outcome.

All of this might seem a powerful argument for nuclear power, but it is not. Nuclear power is a non-renewable energy source. As was demonstrated earlier, even seemingly vast non-renewable energy sources are no match for society's appetite for exponential consumption growth. To make matters worse, whether it is coal, gas, nuclear fission power or even nuclear fusion power, all these non-renewable energy sources produce harmful waste. The amount of waste produced is a function of how much electrical energy is produced. More energy equals more waste.

Global electricity consumption is quoted in the *Energy Information Administration / International Energy Outlook 2007* report as growing at 2.4 percent over the outlook period to 2030. However in this case the lower figure of 2 percent typical for overall energy consumption growth will be used. If electricity consumption continued to grow at 2 percent for the next one thousand years, what multiple of non-renewable energy resource would be required to meet those cumulative requirements? The answer is *over 24 billion times*. There are various figures quoted for the amount of uranium and thorium reserves in the world as a multiple of present annual electricity requirements. None are in the order of 24 billion. Taking different price scenarios into account some optimistic figures might be in the order of 10,000 times smaller than that: 2.4 million. At that rate the world might just scrape through one thousand years at 1 percent per annum growth rate before the resources are totally exhausted. Even give or take a very large error in these estimates, one thing is certain: *at typical consumption growth rates, uranium and thorium cannot see society further than a fraction of recorded human history.*

Inevitably all this leads us to the question of fusion power. All I will say about fusion power is that 40 years ago fusion power was considered to be achievable within 40 years. Forty years later fusion power is still regarded as being 40 years away. I wonder what the pundits will be saying in 40 years time?

It can be concluded that whichever way the problem is cut, getting past the next thousand years with exponential energy consumption growth is difficult to arrange from a resource supply point of view – let alone from a waste management perspective. None of the options – fossil fuels, renewable energy or nuclear power – will sustain growth of any significance. There is only one inescapable conclusion that can be drawn: *growth in the rate of energy consumption will stop.*

For all practical purposes, everything tangible consumed in modern society requires the consumption of energy somewhere. If growth in human population will stop, and growth in energy consumption will stop, by extension one can readily appreciate that growth of consumption of everything tangible in society with stop. This will be true no matter how ingenious mankind may be.

A useful analogy to demonstrate the inevitably of a halting of growth is the Petri dish. To understand where the world is heading with a continuous growth paradigm one only needs to understand what happens to the bacteria in the Petri dish. For a while the bacteria are happily multiplying, consuming food and generating waste in the process. The culture is growing, and at an astounding rate – a fast-forward version of society. But the party doesn't last. Eventually the resources start to run out and waste products build up to toxic levels. The bacteria may or may not then proceed to die off completely, but with absolute certainty it *will* stop growing.

The Missing Link – *The critical ingredient in addressing growth*

Not strictly, but in general, economic growth equates to consumption growth. Growth oils the wheels of the economy. Solid growth provides strong employment, makes (some) people wealthier and generates more taxes which can be used to build infrastructure, protect the country and so forth. Non-growth is called *recession* and is regarded as something to be avoided at all cost. And so we have a dominant paradigm of continuous growth.

There is a theoretical possibility that growth, of its own accord, could taper off to zero in an orderly fashion and stay there. However this is unlikely because it is at odds with the prevailing paradigm, (both in terms of policy and natural behaviour), of continuous economic growth.

So, is the issue about a choice between perpetual growth and zero growth? If it is accepted that eventually growth will stop regardless, then the answer is surely no. What is the issue then?

The issue is that the only choice society has is whether the transition to zero growth is to be a controlled or an uncontrolled transition. If global warming causes the sea level to rise significantly then consumption and economic growth in vast low-lying regions of the world will stop. That is an example of an uncontrolled transition to zero growth and is a reflection of the whole system.

One day society will stop growing. The world population will stop growing; the consumption of energy and resources will stop growing. The rate of growth will permanently, on average, fall to zero or less. Whether we like it or not, this is certain. When it will happen is an immaterial guess. What is important is *how* it happens and what the end result looks like afterwards.

Consumption is the flow of energy and materials through society. On a planetary scale, the materials at least don't really go anywhere – we just re-arrange and transform them within the closed system that is the earth. It is generally agreed that not all, but certainly the most vexing environmental problems are driven by consumption. The problem is that our consumption is re-arranging the composition of everything in the earth in a way that has undesirable side-effects.

In the long run it is consumption itself that is the problem, not just the waste streams that are inherently generated; which become pollution when they are released from containment. If that is the case then it should be self-evident that we can't effectively deal with the problems associated with consumption unless we can first deal with the *growth* of consumption.

This re-arranging or transformation we call consumption must occur at some location – a point of consumption. The same concept is used whereby greenhouse gases are accounted for at the point of emission. Consumption growth occurs in one of two ways: either through increasing utilisation of existing points of consumption or through the addition of new points of consumption.

Environmental solutions in the category of reducing consumption and waste can be broken down into the following loose sub-categories:

- Efficiency improvements
- Reducing per-capita consumption
- Clean energy
- Recycling
- Technology improvements and breakthroughs, and
- Market-driven systems

Can these measures resolve environmental issues if they were just sufficiently applied? Well; yes and no. Yes they will, but not if there is a key ingredient missing. That key ingredient is dealing with consumption growth at its source. The drivers of consumption in society are essentially population and affluence. The effect of those drivers is not merely more consumption but *new* points of consumption that never previously existed. The primary source of consumption growth is *new points of consumption*.

Consider a new suburb which has been developed with the latest in green technology housing. All the houses contain super-efficient appliances, have solar hot water systems, photovoltaic solar panels and so forth. All of the occupants drive the latest in super-efficient hybrid vehicles.

Now consider the vacant land that was there before. How much electricity was being consumed by that vacant land? How much greenhouse gas was being emitted as a result of the consumption occurring there?

The new houses are the source of consumption growth. This is where consumption growth comes from. The level of efficiency is irrelevant. The base case that the environment is accounting against is not an inefficient new house. The base case is what was there before – nothing.

If basic demand continues to grow at an exponential rate, then no amount of efficiency improvements will be able to compete and bring about a reduction in overall consumption. Efficiency improvement is a dead-end strategy for combating consumption growth.

It is of course true that improving efficiencies will make a permanent difference if demand growth is zero – but only if growth is zero. And that is the point. It is also true that efficiency improvements are good business – but it won't save the earth.

In the face of an exponentially growing population: If the *per-capita reduction* approach is taken to its logical conclusion then eventually everyone ends up with less and less, and ultimately effectively nothing. This is not a comforting prospect.

One illustration of this situation is as follows: In the interests of "saving the planet", in one suburb families are being asked to invest in energy-efficient lights and appliances, adjust the thermostat and use less water. All the while down the road a field is being subdivided and will soon have many lights, heaters, air conditioners and bathrooms where previously there were none. This doesn't add up.

Clean energy. Drying clothes outdoors is an emission-free totally clean use of energy. This is because the energy is not converted into an intermediate secondary form before its final application.

There is simply no way that electricity can be produced or consumed in a totally clean and waste-free manner when the entire lifecycle is taken into account. Clean energy is a misnomer and to a large extent does not exist. If renewable energy is cleaner than non-renewable, then we have already seen how limited the scope is in the face of ongoing exponential growth. Renewable energy is an admirable idea, but it won't do the trick.

Much the same applies to recycling. Recycling is a good thing, but even at relatively high levels it doesn't make much of an impact on overall consumption demand growth. The huge sums being invested around the world in alumina and aluminium production capacity expansion are testament to this fact.

Technology. Before the advent of the motor car, concerns were being raised in large cities of the prospect of drowning in a sea of horse manure. Like the children's story of *The King the Mice and the Cheese* by Nancy and Eric Gurney, society managed to fix with technology one problem limiting growth but replaced it with another with unforseen downsides that are even more problematic than the first. The pollutants released in the making and driving of vehicles are irretrievably dispersed throughout the atmosphere. Excess horse manure looks like a simple problem in contrast to climate change. If we've gone from horse manure to climate change, and climate change is tough, what might be waiting over the horizon? Besides: *Expecting technological breakthroughs to somehow resolve global environmental issues is a bit like a retirement plan based on winning the lottery. It is a risky proposition*.

Paradoxically, (and in some ways perversely), self-interest and the very forces of growth economics that are driving global destruction are sometimes held up as being the solution to environmental problems. The logic is sometimes presented for example that farmers wouldn't be responsible for environmental degradation because it is inherently in their interest to look after the land; or the fishing industry would never destroy fish stocks beyond recovery for the same reason; or the old economics argument that when a resource becomes scarce then the price will increase and therefore the resource will be valued and protected. The facts of reality prove otherwise. Yet, by extension this is the same logic that is behind the concept of carbon trading. Rather than address the problem head-on, the underlying theory is to contrive and manipulate the drivers of destruction to somehow bring about the opposite of the natural tendencies of a consumption growth economy.

In the 1960's and 70's the level of toxic waste being dumped into rivers in the western world was much worse than it is today. How was the situation improved? Not by developing a contrived market system trading in toxic waste and allowing the high price of toxic waste to drive behaviour. What is the incentive today that dissuades the manager of an industrial complex from dumping toxic waste into a river? It is not market forces. It is not a tax on dumping toxic waste. The incentive is avoiding being sent to jail. Yes, toxic waste does occasionally get dumped into rivers. Yes also occasionally do individuals get sent to jail for doing so. For the shareholder there is also the risk that the regulatory body will use powers at their disposal to simply shut down the operation. These are extreme cases; but the point is that it is government regulation, mandates and sanctions that drive the behaviour – not market forces or financial rewards.

It is true that the proposed systems of carbon trading do involve a combination of both market forces and regulatory control. The problem is that the underlying focus and emphasis is on the market forces, not the regulatory controls as being the driver of behaviours.

Land clearing stops when governments enact and enforce legislation to stop it (except where there is no land left to clear). Unsustainable fishing stops when governments step in. Developments don't proceed when the regulating authority says 'no'. Conservation reserves and national parks are created and sustained by governments, not markets. No matter how contrived, market forces are as likely to save the world as they were to save the dodo, thylacine or Newfoundland cod stocks. It is just the wrong tool for the job.

Halting consumption growth at its source is the key ingredient in resolving global environmental problems. Imagine trying to make a fruitcake without fruit? Perhaps because fruit mix was too costly or hard to obtain. No amount of flour, eggs, sugar or butter will make up for the lack of fruit. Yet this key ingredient seems to be widely ignored or overlooked in the mainstream debates on environmental issues. There seems to be to be a great deal of effort going in to trying to make a fruitcake while studiously avoiding using any fruit.

As if to purposely demonstrate this point, in early 2007 a group of 21 environmental groups issued a joint *Climate Change Policy Agenda* statement for Australia. Agenda item 4 on energy states:

> *Stabilise total energy consumption by 2010 and achieve 1.5% annual reductions to 2020 ...*

(So far so good. But the means of achieving this are stated as being...)

> *... through world's best energy efficiency standards for appliances, buildings, vehicles and industrial equipment.*

No suggestion is made of the possibility that in order to stabilise total energy consumption it might in fact be necessary to stop building new houses, buildings etc., and stop growth in the population. Instead the suggestion is made that "*Solar hot water systems [...] should be made compulsory for all new homes built after*

2008." The fact that the vacant land to be occupied by the new homes consumed no energy at all seems to have been overlooked. No link is made between the physical expansion of society and growth of consumption. No suggestion is made of the correlation between increasing population and increasing energy consumption. No suggestion is made as to how to stop total energy consumption growth after all new efficiency gains possible have been fully exploited. No suggestion is made of what to do after 2020, while the population continues to grow, new (even super-efficient) buildings continue to be constructed and the number of vehicles continues to grow.

The joint policy agenda covered a number of topics besides energy consumption. None of the proposals are inherently bad; it is just that they won't solve the overall problem.

The blind spot with regards to the relationship between development-related growth of society and consumption growth can be seen in other documents representative of large numbers of people. In February 2007 the Senate Standing Committee on Rural and Regions Affairs and Transport published its final report on an inquiry entitled *Australia's future oil supply and alternative transport fuels*. The inquiry received 194 submissions from various individuals and organisations, and held nine hearings.

The senate report was overall reasonable and balanced. It is interesting to note however that the section on demand side responses failed to mention some obvious relationships. For example: if the population of the nation grows by say one million, then one million more people will require transport of some description, along with all the goods that they consume. Unavoidably, some of that transport must involve fossil fuel. If the population does not grow by one million then the nation will not have to be concerned with how those one million people and all their consumption will be transported. If one million new houses are constructed then all the materials for one million new houses will need to be transported from one place to another. On the other hand: if one million new houses are not constructed ... . Perhaps these facts go without saying. However if the topic of discussion is how to reduce national transport fuel demands, one would think that some mention of the main drivers of consumption demand growth would be in order. Growth of basic consumption and population, it seems, is taken as a given.

This fixation with efficiency and all manner of measures except actually addressing the fundamental drivers of demand growth is somewhat reminiscent of the anti-whaling slogan: *Nothing is wasted except the whale*. It is similar to the case whereby an army of volunteers are spending a weekend planting trees. All the while in the same region there is a bulldozer clearing more land and knocking down trees by the thousand. If it is for intensive farming, urban development, highways or other development, the land will most likely never ever be rehabilitated. Yes, planting the trees is useful. But it won't keep up with the bulldozer. Yes, the more efficient buildings will consume less than would otherwise have been the case. But all those efficiency gains and more are simply consumed by the next new development. Yes, there are major gains to be achieved from improving average vehicle efficiency. But in the long run these can never compete with exponential growth in the underlying demand for transport, driven by a variety of factors including overall material consumption growth multiplied in turn by overall population growth.

Growth will stop; but it won't be stopped by the popularly advocated means of saving the earth which don't address the real sources of growth. *Whether it be relating to electricity, transport fuels, water, arable land or the climate change contribution of flatulent sheep, any plan of action which fails to address the infinite problem of continuous growth is doomed to failure and is only postponing the inevitable.* It is worse than that though because the misplaced virtue masks and diverts attention away from the real source of the problem.

A simple illustration of the postponement effect is increasing Minimum Renewable Energy Targets. National minimum renewable energy targets might be increased from say 8 percent to 25 percent. If the target is instantaneously met, yet overall demand continues to grow at 2 percent, in a little over ten years the sum total of the non-renewable component is back to square one. The timetable has been shifted out by a mere ten years. That is the overall effect of applying all the strategies that fail to address the underlying drivers of consumption growth.

So, on the one hand we have the supposed ‘inevitability’ and desirability of perpetual economic growth driven by consumption growth. On the other hand is the immutable impossibility of ad-infinitum perpetual growth.

I am not suggesting for a moment that there should be a sudden and ill-conceived dramatic change in the way society functions. That would bring about great unnecessary hardship. What I am suggesting is that we need to stop and ask whether we really are any smarter than bacteria in a Petri dish. If we are, then we need to have some sort of a workable plan. Any plan that fails to deal with the fundamentals of consumption growth will not be workable.

What is at issue are questions of simple reality. It is not an ideological battle to be won or lost; it is a case of having a good fix on the map of reality that will ultimately determine the collective destiny of everyone. After all, while the debates will continue, in the end it is reality that will have the final say.