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# A Challenge to current Sustainability Directions

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## ABSTRACT

This paper investigates how organisations define and approach sustainability, our excessive consumption, the root causes, what has been done, how effective it has been and finally, holistic solutions to becoming sustainable.

Abundant energy is core to our modern civilisation and has allowed us to experience a high standard of living. However, general consensus indicates that our current practice of consumption and resource exploitation is not sustainable and if left unchecked will ultimately result in self-destruction.

In order to be sustainable a clear and objective definition is essential, yet current definitions include subjective terms that are difficult to measure or are contrary to the very notion of sustaining.

Many acclaimed projects and technologies, in which engineers have played a major role, have resulted in negative environmental and social impacts as a direct consequence of the economic drivers that have led to excessive consumption and energy resource depletion. A life cycle assessment has been used to evaluate energy use, and derive a new concept of 'process reversed' energy. This process makes it possible to account for waste management, rehabilitation, community disruption and resource depletion and derive a 'true' price. By so doing, market forces would make renewable energy, efficiency and recycling economically viable. Furthermore, products would be designed to last, be reusable and repairable, thereby reducing consumption and increasing sustainability.

Engineers Australia has produced a Code of Ethics that requires us to 'use our knowledge for the benefit of the community and for a sustainable future ahead of sectional interests'. To adequately address this, engineers need to take a leadership role in redefining sustainability and overhauling our economic system such that it allows the engineering profession to operate in a sustainable environment for the benefit of society at large.

Finally, as a global community we have to rethink our values and lifestyle, move away from short term economic behaviour, and change direction to long term sustainability.

## 1. INTRODUCTION

The question "Who believes that our way of life will be much the same in 1000 years, or maybe 100 years?" elicited typical responses of "no", "way off", "not even 50 or 20 years". This was the result of the author's adhoc survey, which supports the view that intuitively people recognise the high degree of unsustainability of our current way of life.

Being unsustainable ultimately will lead to widespread crises or even collapse if left unchecked. Some civilisations have disappeared as a direct result of their excessive consumption of resources and it appears that we are heading this way. What makes us unique is that the capacity of the environment to absorb our waste is at its limit, and we have nowhere else to go (space travel to new planets being unrealistic).

Sustainability was recognised internationally as a major problem over 40 years ago, yet since this time, the problem has become larger. There is no real global consensus on balancing the three key dimensions of the economy, ecosystem and society, and the aim of this paper is to assist in this endeavour.

## 2. DEFINITION OF SUSTAINABILITY

The Oxford Dictionary definition of sustainability is:

- "able to be maintained at a constant level"

This definition is consistent with "steady state", which is achieved when the system being observed – in this case Earth - is unaffected by time. In other words, if observed now, in 100 years or 1000 years, there is no net change, even though there is internal dynamic activity.

Under the direction of the United Nations, the Brundtland Commission published 'Our Common Future' in 1987, where they defined sustainable development as:

- "Development that meets the needs of the present without compromising the ability of future generations to meet their own needs".

This is the most widespread definition and is adopted by Engineers Australia in its Sustainability Charter. Other organisations have developed their own definitions such as:

- "Improving human well-being without damaging nature" and,
- "Balance between lifestyle and preserving nature and economic growth".

Terms such as "economic growth", "improving well-being", or "meeting the needs" may be desirable, (and should form part of a vision or objective) but can be misinterpreted or allow organisations to feel they are doing something when they fulfil the non-sustainable part of their definitions. These terms are also largely subjective and open to interpretation. It is easy to argue for example that "future generations can still meet their needs" regardless of what we do. Furthermore, "growth", "development", and "improve" suggest an increase, whereas "sustain" suggests a constancy or neutral position. The above definitions have, in the author's opinion, confused the meaning of 'being sustainable' and allowed it to become a misused catch phrase.

It has been stated many times that a problem well defined is a problem half solved. In the case of sustainability, the lack of a clear, accurate, measurable and generally agreed definition, has contributed to a lack of progress in this arena.

## 3. ENERGY AND CONSUMPTION

Perhaps one of the defining characteristics of our modern civilisation is the massive global consumption of energy. This has arisen as a direct consequence of elements of society striving to meet their perceived needs.

A review of energy flows in Australia in 2007 reveals that 17,000 PJ of energy was produced or extracted. Of this, 60% was from coal, 25% Uranium, 14% hydrocarbons and 1.5% renewable energy [1]. This energy balance also reveals that we consume 5500 PJ (including thermodynamic losses), export 13000 PJ and import 1800 PJ. Of the 5500 PJ of energy used internally, 34% is used in transport, 46% industry, 10% residential and 7% commercial. If the energy used in 'off-road' vehicles and other conveyance mechanisms is included in transport, it is estimated that nearly half of Australia's energy is used in simply moving products and people around.

From the above, Australia's energy consumption per capita is 76000 kWh, which is about 10 times the average direct personal consumption of electricity and gas. The major difference between the per capita value and the direct home energy use is attributed to 'embodied energy' (the energy required to make products). Mackay estimates embodied energy in the UK as 5 times direct use [7]. As an example, the embodied energy contained in an average house is equivalent to 15 years of energy used in the house [2]. Similarly, the energy used to make a computer is about 15 times what the computer uses in 1 year. In other words, we use far more energy in making and transporting our material goods than in direct home use.

It may be better from an energy perspective to keep old equipment and housing longer than replace with the new efficient equivalent. Retailers however use the 'green' image of selling new products based on direct energy only.

*3.1 'Process Reversed' and 'Embodied' Energy*

The author proposes a new means of evaluating the energy usage of products, where the total energy is considered holistically using a Life Cycle Assessment methodology. The assumption is that a sustainable (steady state) system should have no net change. To achieve this, it would be necessary to calculate the sum of energies that return everything in the product cycle back to its original state. The entire process from primary industry, to manufacture, to shop, to user, to waste dump, transport and reparation is considered.

This method to restore everything to its original state is termed "Processed Reversed" (PR) energy and is derived as follows:

PR Energy = embodied energy +
energy to dismantle +
energy to rehabilitate (land and toxins) +
end user energy (eg. shopping)

The "process reversed" concept allows us to convert all the problems of pollution, waste, power, transport and land usage into a common unit of energy. From this perspective, for example, it could be said that there is no water crisis, but rather a lack of available energy.

With so much of our energy from non-renewable natural resources (hydrocarbons), which are themselves also continuously increasing the pollution on the planet, we are indeed in an unsustainable situation.

## 4. THE ENGINEERS ROLE

Assets such as skyscrapers, dams, oil rigs, ocean liners, aircraft, mass production and process plants, to name but a few, are now considered essential to our current way of life. Engineers and scientists can take great credit for the impressive array of material artefacts and economic progress they have brought.

However, this progress has brought with it the widespread water contamination, ground toxicity, greenhouse gas emissions (GHG) and general waste, threatening the very systems that support all life and activity on Earth. In short, this material success has inadvertently come at a cost.

Engineering has also improved humanity by means of water provision, sanitary systems, security against the elements and renewable energy sources. It could be said therefore that engineers are part of the problem as well as part of the solution!

Many products or projects undertaken have had the unfortunate consequence of contributing to unsustainability, either through their inherent nature, external circumstances or large scale accidents. Despite there always being a good reason (lessons learnt), they do continue to happen.

Many manufactured products suffer from an ever increasing trend towards shorter life through designed obsolescence in an attempt to accelerate economic activity. This practice occurs, because the company has repeat business knowing that the products will fail even though this results in dissatisfied customers and increased damage to the environment. While engineers may have been the original designers of products and the means of mass production, these products can be unscrupulously copied. In most of these cases, the product quality suffers in the quest for a lower price, which increases consumption and unsustainability.

Engineers Australia has a Code of Ethics that requires us to 'use our knowledge for the benefit of the community and for a sustainable future ahead of sectional interests' [4]. The vast majority of engineers work ethically and would not undertake or sign-off on work if it could cause undue harm to the community or environment, yet as mentioned above, engineering has been at the heart of many such occurrences.

This situation can arise because engineered projects typically involve cross organisational teams that focus on their specific component without regard to the overall outcome. This approach is necessary to deliver project outcomes, however this can leave the individual unaware of the big picture or powerless to effect any significant change to the broad company objectives.

## 5. THE CORPORATION

Company directors are required by law to act in the best interests of the company and its shareholders, which fundamentally means achieving financial returns. There is much reference to the 'triple bottom line', however there is little legislation to ensure sustainable practices.

Directors of oil, gas and mining companies would be remiss in their fiduciary duties if they did not maximise profits and adhere to good governance. Part of good governance involves sustainability, yet these industries are by their very nature not

sustainable as the product is extracted once and takes millions of years to be replenished. It is thus imperative that society consider the best use of these resources as they rapidly become depleted.

Similarly, directors of manufacturing and transport companies have a fiduciary duty to maximise returns for shareholders overshadowing sustainable practices. For example, due to global competitiveness, designers choose materials to meet the criteria at the lowest cost possible, which often results in a throw away or disposable product. Likewise, transport consumes immense energy (nearly 50% of Australian energy consumption) to move goods including bottled water, drinks, food and other basics around the globe.

In many cases, company directors and CEOs are overseeing highly unsustainable practices, while seemingly adhering to good corporate governance, in their attempt to meet the needs of their clients and shareholders using economic principles.

## 6. THE ECONOMIC SYSTEM

Society does not look favourably on the children of wealthy families who inherit large sums of money only to squander it on a lavish lifestyle – in essence depleting the capital. Are the leaders in society doing just this with our planet? Similarly, the CEO of a company who sells all the production assets, depletes all stockpiles without replenishing them and fires staff, may see the immediate benefit of improved cashflow and profits, but this is not sustainable and certainly not prudent. Often, the CEO benefits personally by implementing such measures through performance based bonuses.

The economic system allows and indeed rewards behaviour that is clearly damaging to society and the environment, yet these are the pillars propping up the economy. Money does not have intrinsic value, but rather reflects perceived value. By current economic analysis though, a 100 year old tree has more value as paper pulp used to produce 'junk' mail. Realistic economic valuation has been compromised because of the blind and unquestioned faith in 'economic growth'.

Drivers of the economy are GDP, share price and productivity, yet are these reliable KPIs? The share price should reflect the company potential to earn, but in reality is a vehicle for speculators. The GDP reflects how much money is spent. These measures do not accurately reflect true value. As an example, a well-built product (road, phone, fridge, building) may not generate as much GDP as a product that breaks and needs replacing, causes environmental disasters that need clean up, damages health that requires medical treatment and other expenses such as travel. All this purchasing is good for GDP and possibly shares, but not for society or environment.

As derived from GDP figures, 97% of what the average Australian spends is on consumption, leaving 3% for investment purposes [4]. Much of this is in capital equipment which has a fixed life, and ultimately is scrapped. This is a further indication that for all our spending (GDP) there is very little to show for it and roughly correlates with the claim that less than 1% of all produce is still around 1 year later [6].

Advertisements appear on buildings, bill boards, letterboxes, computer screens and even bus windows, applying peer pressure and false hope to increase company sales. Increased sales, combined with decreasing costs, does increase profits, but leads directly to our high rate of consumption.

'Western' society is highly unsustainable as a direct result of our economic system, yet the developing world by and large is aspiring to this system of material wealth and capitalism. Given that we are on a finite sized planet, capital growth has been likened to a pyramid scheme because at some point the last to join cannot gain economically from further growth. A risk analysis clearly reveals that combined with population increases, economic growth and externalised costs, business as usual for the global community is not an option.

## 7. POLITICAL SYSTEM AND SOCIETY

Australia can be proud of having a stable democratic society and political system; however this could be under threat as resources become depleted. Politicians are responsible for the laws that govern society and which produced our economic system. This system was instrumental in strengthening our society many years ago, but the system as described above is instrumental in causing unsustainability.

In a democratic society, governments are elected by the people. People are influenced by our leaders, and thus it is the leaders who need to initiate this change. Currently it appears that it would require a major catastrophe directly attributed to our lack of sustainability before people would accept drastic policy measures designed to sustain our civilisation.

From the aforementioned sections, there is proportioned responsibility attributed to the engineer, builder, businessman, politician and ultimately the people for the current situation. As Einstein said, "a new type of thinking is required if mankind is to survive and move toward higher levels".

## 8. WHAT HAS BEEN DONE

Many elements of society appreciate the dilemma that we are in, and over the past 25 years have initiated and implemented many sustainable projects.

### *8.1 Renewable Energy*

5.2% of energy consumed in Australia in 2007 is considered as renewable energy, made up of 4% bagasse, wood and biofuel, 1% hydro and 0.2% wind and solar [1]. These figures are rounded and have been adjusted to account for energy lost as a result of thermodynamic processes.

There has been a threefold increase in wind energy production since 2007; nevertheless wind, solar, geothermal, wave and tidal energies accounted for less than 1% of energy consumed in Australia in 2011. As these are considered the big renewable growth areas (as bagasse and hydro are near their limits), there is cause for concern.

### *8.2 Energy Efficiency*

The Government introduced a compulsory Energy Efficiency Opportunity program (EEO) to encourage large organisations to reduce energy consumption. However, from the author's experience, only a small proportion of identified savings are economical or sufficiently risk averse to become projects. As an example, around 10% of the energy used in an old plant was identified as a saving potential and about 1% on a new mine. Less than 10% of these projects identified were seriously considered for implementation. At low industry energy prices of around 8c/kwh for electricity, energy efficiency programs may only have achieved a 1% reduction in total energy usage.

In the last 4 years, the combined increase in renewable energy and improvements in energy efficiency are only just keeping up with the increase in energy demand. With all the effort and programs in place, only 2% of energy is still truly renewable.

*8.3 Other Energy Sources*
Uranium nuclear power is not a GHG emitter, but is still a polluter. Other technologies such as nuclear fusion and thorium nuclear energy have been continuously developing for 20 years however, no tangible results have been achieved.

*8.4 'Green' Initiatives*
There have been numerous noble and successful green projects undertaken using thermal mass, natural ventilation, recycling, water treatment using wetlands and aquifer storage, organic farming, pyrolysis, tri-generation and many others, however they have not made substantial inroads into alleviating the resource demands of our modern society. Some initiatives have even been counterproductive because the embodied energy in the projects exceeded the energy saving potential, or introduced unforseen hazards.

*8.5 Carbon Tax*
The carbon tax is aimed at reducing emissions in the interest of climate sustainability. Critical as this is, it's bigger benefit may be that it attributes a tax (or cost) directly on non-renewable energy resources (currently 'free' from the ground) which in turn are the major cause of all types of pollution. The tax will make little difference to global energy use or emissions, likewise though, it won't much affect spending. Its main value is that it allows Australia to take a lead in initiating a model toward a sustainable environment and society. As an aside, in order to level the playing field, an import duty on countries with no carbon tax should be implemented.

So with all the effort to date, solutions have not been very effective on a macro scale. This conclusion correlates with Mackay [7] who analyses renewable energy and consumption in the UK. So how do we become sustainable?

## 9. SOLUTIONS

We firstly need to recognise the problem, then understand the root causes and drivers. The author proposes redefining the current definition of sustainability to be more accurate, objective and measurable. In addition, it is essential to rethink the political and economic systems (the rules of the game) as they are the root cause. It is beyond the scope of the current paper to propose comprehensive solutions, however some ideas are presented.

A specific solution is to ensure the price of goods and services reflects all the costs associated with producing it. The 'process reversed' method could assist in deriving the costs by assigning a total energy for each product, and then applying a dollar rate per kWh for this energy. This cost adjustment could be achieved by introducing a scheme such as WEEE 2002/96/EC, as implemented in Europe, which requires all waste electrical and electronic equipment to be returned to the seller for appropriate disposal. This concept could be extended to all products and industries, not just electrical. Currently these externalised costs are ultimately borne by the taxpayer.
The consequences of the above re-costing could mean that food prices would increase slightly to that of organics, whereas imported cheap low quality products would substantially increase due to higher externalised costs. Market forces would make buying local produce a logical choice, as transport costs are less than for imported. It would also make financial sense to become more efficient, implement large scale renewable energy projects; and reuse, repair and recycle products. Designers and manufacturers would see the benefit of producing quality products that may cost 3 times more, but could last 5 times longer, thus reducing shopping, traffic congestion and frustration with poor quality products.

By including the total cost in the price, we can then decide to purchase (or not) knowing that the full life cycle cost of the item has been included in the price. We could thus reduce bureaucracy and legislation associated with special programs, sustainability reporting, incentives and levies. It has to be expected that some industries like retail, resources and transport would have to adjust, but the net employment rate would be expected to remain the same.

Economic growth must be dropped as an imperative. It is not possible to continue to expand the economy on a finite planet with a finite capacity. GFCs will continue, until it is realised that natural resources and people underpin the economy.

Ultimately though, we need to rethink our values and needs. The fear of losing our standard of living is one of the inhibiting factors in becoming sustainable, partly because of equating well-being with material wealth. Increased well-being could result from cycling or walking to work, home grown produce, local markets, caring and sharing; activities that would also reduce energy use and lead to sustainability.

## 10. CONCLUSIONS

In conclusion, we need to work toward a framework in which the system is set up to reflect the values of society and the environment, and does not require individual sacrifice while others continue down the path of consumption. As engineers, we need to take a leadership role in reforming the systems so that we can work to the Code of Ethics.

The author proposes a measured transition plan be implemented to avoid instability, but there is no choice - we have to become sustainable. We need to recognise this and change our lifestyle rather than learning the hard way as nature unleashes her fury.

By society addressing these issues, it is possible to have a sustainable society and also improve well-being!

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