THE ENERGY ENIGMA OR COMMENTS ON A RECENT VISIT TO SOUTH AFRICA OF AMORY LOVINS

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INTRODUCTION

There is a prevalent perception that like diamonds, "energy is forever". Energy is that ephemeral entity which is necessary (but insufficient) condition for survival and development. Modern civilisation was founded on the utilisation of fossil fuels, which has established technology to advance to the extent that the employment of nuclear fission and the direct conversion of sunlight to electricity is now common place. Our grand-parents were reliant on horses for transport, yet now-a-days man has sent several manned expeditions to the moon and unmanned expeditions to other planets. Nevertheless, not-with-standing the advancements made over the past few decades, the major source of energy remains the exo-thermic chemical reactions of fossil fuels. But these energy sources are finite, and also unduly impact on the environment at local and global scales.

The current imperative in energy is efficiency; whereby the life time of fossil fuel reserves may be extended and the impacts on the environment may be limited and controlled South Africa recently hosted one of the world's most developed lateral thinkers on energy matters, Dr Amory Lovins, co-Director of the Rocky Mountain Institute in Colorado, USA. It is Dr Lovins' premise that we do not need to unduly worry limitations on greenhouse gas emissions, the required results can be obtained through addressing the efficiency paradigm. The following sections of this note will present some of the stimulating ideas presented by Dr Lovins during his recent visit to South Africa.

NEGAWATTS

The issue of environmental pollution can be addressed through efficiency considerations and to this end coined the term *negawatts.* Lovins states that "abating urban smog, acid precipitation, global warming, and other results of air pollution is commonly assumed to require costly technological investments or inconvenient life style changes or both." He goes on further to state that "new developments in efficient end-use of energy can now reduce emissions even more at zero or negative net internal cost, while providing unchanged or improved services to consumers."

The term negawatts was coined to illustrate that instead of requiring more electricity generating capacity, it is possible to do with less generating capacity for the same functions through efficient practices. Although this may not be entirely applicable to South Africa where fast-tracking of development is a national policy, lessons can be learned so as to defer the requirement for extra electricity generating capacity thereby releasing capital for other development purpose and to minimise negative impacts on the environment.

In this regard, Lovins sites inter alia the case of compact fluorescent lights (CFL). An 18 W CFL (equivalent to a 75 W in condescend lamp) over its 10 000 hour life-time will avoid approximately 8 kg of CO_2 from a coal-fired power station. Moreover, a CFL industrial plant required to produce a virtual 100 megawatt is less complex and much less expensive than a 100 megawatt electricity generator.

HOLISTIC APPROACH

One of the unfortunate aspects of modern technology is specialisation and division of elements of a project into small and to a large extent independent tasks. It is too often the case that the specialists involved in design operate independently resulting in a less than optimum solution. For example, the environment could be regarded as a large leaky balloon. Plugging one hole merely places increased pressure on the other holes.

Lovins cites the case of moving a fluid in a pipe, where the pipe engineers do not communicate. Too often he has observed installations with small pipes and large pumps, a case where the pump uses energy to overcome the high friction in the small pipes. A more efficient solution, he proposes, would be to use large pipes and small pumps. As the friction along the length of a large diameter pipe is less than for a small diameter pipe, a smaller and less expensive and less running cost pump is required. The essence is to "optimise the whole system, not the parts."

THE HYPERCAR

Transportation is the key to freedom. Remember the thrill and feeling of liberation when you took ownership of your first car. However the proliferation of cars is placing a strain on the environment, especially in the inner city areas. Motor car manufacturers are looking to develop electric vehicles for two reasons, they are thought to be more energy efficient than current petrol engines, and to address environmental issues for example in efforts to meet California's *zero-emission-vehicle* requirements. The current perceptions regarding the *zero-emission-vehicle* are of course a fallacy - electric vehicles merely displace the pollution to a place where the electricity is generated.

Lovins stated that, when considering that the purpose of a vehicle is to transport a person from A to B, the current average vehicle on the road is only 1% efficient in its use of the energy contained in the liquid fuel. The rest of the energy is used to transport the mass of the car and the fuel, engine inefficiencies and to overcome friction forces. Moreover, the worst thing one can put in an electric vehicle is a battery. His alternative approach is an ultra-light ultra-slippery vehicle. The technical

feasibility of these vehicles has already been demonstrated. Using technologies which are already about ten years old, it is possible to reduce the mass of a 4-5 seat electric vehicle to less than 500kg. This is possible by making use of polymers and composites, and dispensing with heavy components such as transmission, and because the vehicle is light it does not need power steering, heavy ABS brakes etc. Such vehicles can be designed with a drag coefficient of Cp = 0.2. It has been ascertained that such a vehicle travelling at 120 km/h would need approximately 10 kW to overcome rolling resistance and aerodynamic drag. One can envisage a vehicle being powered by a 15 kW petrol engine with a storage device (for example battery, capacitor, flywheel) to deliver the momentary higher powers when required for acceleration. The petrol, operating at a constant rotational speed, can be made very efficient and low polluting.

Such a car could be expected to increase the efficiency of the average family car's by a factor of 4-10, reduce the emissions by 10-1000 fold, and at the time preserve current standards of safety and comfort.

Lovins also predicted that we would see new players in the vehicle industry. With the large scale introduction of electric vehicles, the technology base shifts from a mechanical bias to an electronic bias. With their proven short (and ever shortening) lead times to deliver new products to the market, it may be possible for computer and related companies to enter this market. This is already manifest by the partnership between Mercedes and Swatch to produce a small car. It is interesting to note that Toyota is launching a hybrid vehicle late 1997, and that this vehicle may come to South Africa for the 1998 World Clean Air Congress in Durban.

PASSIVE HOUSE DESIGN

If one addresses a house or a commercial/industrial building as an appliance which uses energy/electricity, a new perspective can be obtained on energy efficiency. It is well known that appropriate insulation of a dwelling can save energy. But the passive solar design of a house can make it cooler in summer and warmer in winter.

Dr Lovins resides in a passive solar designed house located in the Rocky Mountains, that includes commercially available and super efficient lighting and appliances. The location is subject to snowfalls during winter, yet the total electricity requirements are only about a tenth of existing houses. There are no cooling or heating systems, yet the inside environment of the house is comfortable year round. Moreover, a banana tree is grown in the conservatory.

DISTRIBUTED ELECTRICITY GENERATION

The development of large electricity generation stations and their associated transmission and distribution networks followed the industrial development of the post World War II era Lovins proposes that it is now time to re-examine our assumptions which lead to the *bigger is better* policy. Lovins proposes that small is profitable. He proposes that the concept of *mass production* should replace *unit size*. "Centralised electricity generation is based on the reasonable-sounding proposition that the bigger the power plant, the cheaper the capital cost per kilowatt and the higher the efficiency. Unfortunately, a few big plants can easily prove more expensive to build than a lot of smaller ones, because they require more customized design, are prone to higher cost overruns, take longer to build, entail premium siting costs, attract stronger opposition, and are often less reliable."

He goes on further to present that mass production can reduce the cost of say photovoltaic systems and fuel cells to the extent that they would be a cost effective alternative to grid electricity. These distributed sources would be especially beneficial to the rural areas in South Africa. Notwithstanding the above, he admits that it would be unviable "to run a smelter with a bunch of wind turbines." The essence is that the "..energy sources should be of a scale appropriate to their end uses".

CONCLUSION

Dr Lovins is one of the world's more mature lateral and holistic thinkers. His field of work includes energy, resource, water, environmental conservation and sustainable development, and he has published extensively on these topics. His visit to South Africa has already ignited a spark of awareness in many areas and should bear fruit in policy development. The essence of his message may be summed up by the title of a paper by him; "If You Think Education is Expensive, Try Ignorance."

FURTHER INFORMATION

Further information may be obtained from the Rocky Mountain Institute via Internet address http://ww.rmi.org.

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