The Energy Paradoxes

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Introduction.

1. Professor Charles Handy of the London Business School, in *The Age of Paradox* (1994)1, identified nine paradoxes in his studies in the field of management. These paradoxes arise from the unintended consequences of the management of modern organizations. Peter Larson, of The Public Policy Forum, prepared a synopsis that appeared in The Ottawa Citizen (December 17, 1994)
2. The list of paradoxes that follows was taken by Mr. Larson from Professor Handy's book and appears here in abridged form:
3. *The paradox of intelligence*. Intelligence is the rising form of property; yet such assets never appear on company balance sheets.
4. *The paradox of work*. Because the economic system discourages people from working for free, simultaneously we have work crying out to be done (from helping the elderly to environmental cleanup) and people endlessly searching for work. Modern organizations cannot seem to bridge this gap.
5. *The paradox of productivity*. At the organizational level, productivity improvement means more work from fewer people. At the social level, more people become inactive or enter the underground economy. The result is organizations become more productive and society less so.
6. *The paradox of time*. The application of modern technology means less time is needed to make and do things. People should have more spare time. But time has become a competitive weapon and getting things done quickly is imperative. As a result, many of those who work have less time than ever before.
7. *The paradox of riches*. Economic growth depends upon more people wanting more things. But increasingly, the things people want most (clean air, safe environment) are collective and cannot be bought by individuals at any price. And because there is no customer, organizations cannot produce them.
8. *The paradox of organizations*. Today, organizations need to be local and global at the same time; to be small in some ways but big in others; and to be centralized some of the time and decentralized the rest. Managers are expected to be more entrepreneurial and more team-oriented at the same time. No one knows what is needed to run organizations now.
9. *The paradox of ageing*. People never learn very much from the previous generation because their experiences were so different. The result is most organizations are led by people whose experiences do not equip them to lead in today's environment.
10. *The paradox of the individual*. Managers are urged to challenge old ways. At the same time they are asked to remember that they are a part of a larger group – a team. The tension between individual rights and collective will has never been more explosive.
11. *The paradox of justice*. People want the organizations they work for to treat them fairly. But being treated fairly means different things to different people. To some it means treating different people identically, but to others it means compensating for their differentness. Either way, the manager will be accused of being unjust.
12. Many aspects of the energy system are also becoming more paradoxical. In this note, a number of the more evident of these paradoxes are explored in the same style as employed by Professor Handy in his book which has now become widely recognized as a major contribution to the understanding of some of the more important dilemmas of our time.

Paradoxes in the Energy System

In classical terms, energy is consumed in an economy to provide comfort, to aid in transport, and to generate wealth. But when well-being is more widely defined, paradoxes arise. When the adequacy of the supply of oil was a national concern in the 1970's, this author noted that one of the fastest growing segments of the market at that time was the consumption of gasoline in cars driven by teenagers. From a global economic prospective, the situation was potentially serious; but to have less gasoline available for some driving purposes was not.

1. *The paradox of world oil supply*. Oil is currently supplied to world markets at margin from the producers with the lowest costs and the largest resources. As long as the present political tensions persist in the Middle East, this remarkable situation will continue. This is the reverse of the normal pattern for the extraction of natural resources. This inverted production pattern probably explains why, for the past thirteen years, world oil consumption per capita has been effectively constant at 4.43 barrels per capita (standard deviation – 0.079 barrels) irrespective of

price changes, local wars, and economic conditions generally.

2. *The paradox of the new technologies for the discovery of oil.* New techniques developed by the exploration industry are leading to the discovery of more oil than previously expected. The question is whether this oil would have been found by the older methods given enough time or whether this oil would never have been discovered at all without the new approaches. The truth is likely to lie between the two possibilities but no one knows the proportion at present. In consequence, the ultimate resource potential for conventional oil is again uncertain.
3. *The paradox of fighting inflation with monetary techniques when the rise in prices is caused by increases in the price of oil imposed unilaterally by external producers.* Increasing the interest rate to combat such externally-imposed price increases only makes it harder to undertake measures to replace the imported oil by such approaches as conservation and substitution. This is because nearly all such technical measures to replace oil have a higher first cost. The application of these measures to mitigate the situation will thus be discouraged even though in some instances, the life-cycle costs may even be lower than before.
4. *The paradox of oil revenues.* Provinces such as Alberta, which derive a large share of their financial requirements from the oil industry, will see a increase in revenue as their oil production declines. This is because the price will likely increase faster than the decline in production. But if there were a free market in world oil, its price would likely be substantially lower than it is now. Some experts say between .US $10–12 a barrel and some say even less. Though Canada should keep the money in the family, it is true all Canadians are in effect paying a large share of Alberta's provincial revenues.
5. *The paradox of current governmental policies to control emissions of greenhouse gases.* Currently, the Canadian government is simultaneously trying to limit carbon dioxide emissions and encourage the fossil fuel industry, notably the expansion of the oil sands industry and the development of off-shore petroleum resources in Eastern Canada. An obvious contradiction exists except when the additional production merely replaces the decline in the production of oil expected from conventional sources in western Canada.
6. *The paradox of using energy more efficiently when carbon dioxide emissions must be controlled.* Increasing efficiency in the conversion and application of energy is generally recommended as the first step in the reduction of carbon dioxide emissions. Invariably, however, such measures result in economic efficiencies that in turn promote growth and thus the consumption of more energy. Similarly, measures such as privatization, downsizing, and deregulation, when implemented to promote greater efficiency, have the same result. An individual company may reduce emissions by increasing efficiency but the emissions increase for the economy as a whole.
7. *The paradox of deregulation.* Industries that are deregulated enter a more competitive business atmosphere which in turn requires a different managerial attitude often with new people in charge. Few leaders can be expert in everything and rarely are the new managers deeply conversant with the technological issues concerning the industries they are managing. The consequence is that the only industries that can be deregulated safely are those that have reached a technological dead end. When it became clear that supersonic passenger flight was not the future in aviation (the Concorde was the exception that proved the rule), that industry could be deregulated. But the electric power industry is likely to enter a new technological phase in part due to complex environmental issues: it remains unclear whether the industry will be able to adapt to operations in a deregulated framework.
8. *The paradox of responsibility.* If an industry is deregulated, who is responsible for its integrity? In the case of electrical power, is it the power generator, the operator of the main transmission lines, or the local power distributor? If a utility is compelled to deliver energy from a distant supplier selected by the customer, what is its responsibility for supply?
9. *The paradox of the level playing field.* It is commonly said a level playing field is required to improve the efficiency with which energy is consumed and thus lower emissions. Only then will the renewable and other benign technologies come into their own. But if the consumption of fossil fuels fall as a result of increases in price caused by the elimination of direct or hidden subsidies, so will their rate of extraction, and their price will thus fall in compensation.
10. *The paradox of lower fossil fuel prices when emissions of carbon dioxide must be reduced but with no capture and sequestering of this greenhouse gas.* If emissions of carbon dioxide were reduced without the application of capture technologies, less fossil fuel would be consumed and the price would be lower.

Expressed another way, the life of the fossil fuel era would be extended by the imposition of controls on emissions of carbon dioxide.

11. *The paradox of increases in the consumption of energy when carbon dioxide is captured and sequestered.* If carbon dioxide is captured from processes consuming the fossil fuels and then sequestered from the atmosphere, primary energy consumption will rise as emissions decrease. It requires more energy to capture this gas from the fossil fuel conversion processes and for the subsequent sequestering operation. The efficiency of conversion of the fossil fuel to useful forms of energy thus decreases. This must be compensated by the consumption of still more fuel to produce an equal output of useful energy. Given the same demand for useful energy, more fossil fuels will be consumed at a higher price than without this control technology.

12. *The paradox of the increased use of natural gas when carbon dioxide must be controlled.* Natural gas tends to replace the other fossil fuels for two quite different reasons in this circumstance: not only is it the fossil fuel with the lowest carbon intensity but it also lends itself to conversion at higher efficiencies because it is a gas and thus easier to apply in most process applications. Nevertheless, natural gas presents the most difficulty for the application of processes for the capture of carbon dioxide. This is because the concentration of carbon dioxide in combustion exhausts is the lowest of the fossil fuels. Consequently, the unit costs of its capture are higher.

13. *The paradox of the application of gas turbines to the generation of electricity from natural gas when carbon dioxide must be controlled.* The use of gas turbines generally results in higher conversion efficiencies but the exhaust gas stream is always lower in carbon dioxide concentration than other combustion processes. Though less in total quantity, the cost of separating a unit of this gas for capture is higher than from conventional methods of generation. Two reasons account for this: first, natural gas, the fuel of the lowest carbon intensity is generally employed in gas turbines; and second, greater quantities of excess air must be used than in other combustion processes to lower the temperature of the combustion gases entering the turbine stage. (The operating limits are set by the metallurgical requirements to protect the blades of the turbine).

References

1. Charles Handy, *The Age of Paradox*, Harvard Business School Press, 1994 (ISBN 0- 87584-425-1).

2. Peter Larson, The Ottawa Citizen, December 17, 1994.

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