"Many of these practices are so ill judged that they could do lasting damage to the health of science and its efficacy as a social institution." (p. 252) The litany of modern science policy - accountability, evaluation, selectivity, priorities, competition and management, are subject to critical attack as too often representing little more than the application of generalised bureaucratic principles without regard to the special creative character of the research process. For Ziman, this amounts to killing the goose that lay the golden eggs.

This last argument deserves serious consideration. It is possible to see at least some of the responses to the significant changes in the perceived value of scientific knowledge that Ziman has characterised by his steady state metaphor as representing an excessive and over-enthusiastic application of managerialism.

Indeed, it is quite remarkable. Currently, general management principles are moving away from 'command- control' models, and towards a more decentralised approach to decision-making, with cohesion maintained by a supportive organisational culture. But at the same time , an exemplar of this approach, the science system, with its quality control maintained by a subtle social dynamic, is being moved in the direction of bureaucracy. Whatever the resource limitations, and the economic potential, means must be found to pursue both efficiency and directedness without threatening individual and institutional creativity.

Ziman has catalogued the changes in the environment of modern science with a clarity and insight that will make this book immensely appealing to those scientists struggling to come to grips with the rationale, and the rhetoric, of science policy. Which is not to say that many of course have not been quite adept at this already.

One could not dispute the magnitude of the changes that have occurred to science in this one generation, or that resource limitations themselves are a factor in this change. However it seems the far greater shift in the conception of knowledge as the central component in generating economic activity, itself a resource which is not subject to conventional depletion, and the evolution of new approaches to its effective management, which is driving the new revolution in ideas. And that revolution has only just begun!

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Energy Research and Technology in Australia *by Australian Science and Technology Council* . ASTEC Occasional Paper No. 28, (Australian Government Publishing Service, Canberra, 1994) pp. 81, ISBN 0-644-29665-8,$7.95

This report by the Australian Science and Technology Council [ASTEC] is a serious and considered review of energy research and associated technology. Much of the discussion of energy-related issues in Australia focusses on the economic contribution from the mining and export of energy minerals. While that cannot be ignored, energy plays a much more important role in maintaining the basic fabric of industrial society. If sufficient energy is available, it is possible to rectify shortages in most other areas. Land can be farmed more intensively, poorer grades of ore can be worked for minerals, sea water can be distilled to produce potable water and housing can be allowed to spread further from the centres of urban areas, if energy is plentiful. Without adequate supplies of energy, however, our soci-

ety would literally grind to a halt. There are therefore few areas in which research and the development of new technology is so important.

ASTEC argue that more government funds should be allocated to energy research and technology in Australia and more of the R&D budget should be targeted toward those energy technologies likely to be needed in Asian countries in the foreseeable future. Those are the key recommendations of this report. The call for more money is backed by international comparisons. As a share of total R&D spending, energy in Australia gets about half the average for Europe and north America. This report recommends an extra $25 million a year for energy-related research, arguing that the allocation for energy R&D is "remarkably low", given the energy intensity of the economy. This is a good point. Suggestions of a carbon tax have been greeted with howls of outrage on the grounds that energy is crucial to our economy in general and our competitiveness in particular. Leaving aside the question of whether economic considerations should prevail over such issues as the future of the planet, that argument suggests that we should see energy supply and end-use efficiency as very high priorities. As long as some of our governments remain committed to a pre-industrial model of development based on exploitation of our mineral wealth, energy will remain of vital importance. We should expect to see research and development spending at a high level by comparison with other OECD countries. To the contrary, our research expenditure remains at a low level. When Malcolm Fraser introduced world parity pricing for oil, he said that some of the revenue would be used to boost energy research. The oil levy brings in several billion dollars each year, of which about $50 million is spent by the Commonwealth on energy research. Thus the Fraser promise was honoured in literal terms, but it would be hard to make a case that the Fraser government or any of its successors have been serious about applying the oil revenue to securing our energy future.

The report also notes that a remarkably small share of the energy research budget is allocated to improving the efficiency of energy use. Funding of work on energy conservation is only about a quarter of the average level for other OECD nations. Australia is among the very highest users of energy per capita, so improving energy efficiency should be a very high priority. As this report reminds us, we are simply not doing the groundwork that would allow us to improve the efficiency of energy use. For the OECD as a whole, energy use per unit of economic output has been cut by 30% in the last twenty years, mainly by efficiency gains. The figure for Australia is only 5%, showing how far we lag behind other industrial nations in the improvement of performance. Much of Australian industry is still using old technology. Our failure to adopt minimum energy standards means that we are still being sold hardware that does not meet the level of performance expected in northern hemisphere industrial nations.

Given the rapid economic development in the Asia-Pacific region, ASTEC concludes that industry and government should cooperate to identify and fund the energy technologies which are likely to be required later this decade. If this recommendation were to be adopted, it would give increased emphasis to renewable energy technologies. These supply systems are more suitable for small isolated communities with little technical support than the old technologies that literally belong to the steam age. There is every prospect that Australia could do well out of doing good if we set the goal of assisting the Asia-Pacific region to have access to clean, small-scale energy supply systems and efficient end-use devices. Pre-occupied with the traditional approach of selling coal and gas, we ignore the economic opportunities represented by growing energy demand on our doorstep. Meanwhile in Indonesia, German companies are selling solar technology and US firms are installing wind turbines. The report gives data on the distribution of research effort, showing the bizarre result of continuing historical patterns of funding. More than twenty years after the cancellation of the last serious proposal to use nuclear power in Australia, the Commonwealth government

still spends about $18 million on research related to nuclear energy. This is defended by ASTEC as being our responsibility as a major seller of uranium; in other words, it is effectively a massive subsidy from the public purse of the politically contentious activity of mining and exporting uranium. It is not clear that this policy would command widespread support in the community.

There is more food for thought in the report's conclusions about coal research. In the 1970s the government set up a research trust account, funded by a levy on coal production. This was a key factor in modernising the industry. A few years ago, the coal industry successfully lobbied to be left to organise its own research. This report concludes that the industry's short term view means it is failing to invest in R&D. ASTEC concludes that funding bodies should give a higher priority to coal research. But it seems odd to reward the industry for its myopia by giving it more public funds. The coal industry defends its short-term approach by saying its first priority is to remain viable. While that is an understandable concern, there has never been a time when there has been such a great need for the industry to look ahead. The growing concern about global climate change means that it is simply not rational to assume that increasing amounts of coal will be burned and turned wastefully into electricity. The industry already receives very generous public support; it should not expect further hand-outs as a reward for putting its collective head in the sand.

ASTEC makes a case for restoring the effective value of the tax deduction for private sector research and development. The change to the corporate tax rate has reduced the public subsidy of research, thus making it more expensive for tax-paying companies to invest in R&D. Like most such recommendations from advisory bodies concerned with the real world of industry and commerce, it will have to run the gauntlet of the government's house ideologues in the Industry Commission. The Commission's draft report on research and development exhibits characteristic faith in the fairies at the bottom of the garden, arguing that the magic of market forces will produce a suitable level of R&D without restoring the tax incentive. While there does not seem any rational basis for this belief, it is likely to be supported by central government agencies still in the thrall of pre- Keynesian economics.

A final recommendation concerns the funding of research on the social dimensions of energy supply and use. The former National Energy Research, Development and Demonstration Council funded projects concerned with social and economic issues. When it was replaced by ERDIC, the conscious aim of the change was to give greater emphasis to commercial development of energy technology. This goal has been achieved, but one of the problems is that there is no longer an avenue for the funding of research on social issues. This is a serious deficiency because many aspects of energy supply and use are driven by social factors rather than economic or technical aspects. ASTEC recommends that a mechanism should be developed for funding of energy-related social science research.

The report is a commendably thorough and thoughtful analysis of the importance of energy supply and use technology in modern Australia. It gives solid data which point clearly to some current problems, and suggests a coherent way forward. It deserves a more considered treatment than is traditionally given to reports by expert advisory bodies.

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