CHAPTER THREE

THE NEW RESEARCH REACTOR—SCIENCE AND INDUSTRY

Introduction

3.1 In this chapter, the Committee considers the claims made by ANSTO and the Government that the new reactor replacing HIFAR will enhance Australian science and industry. The Committee traces the growth in neutron scattering research in Australia and the demands it is placing on the ageing HIFAR. It also examines the production of radioisotopes at Lucas Heights and their place in Australian industry. The Committee then considers whether nuclear science and technology is forward looking and can take Australian scientists into the 21st century. In the last section, the Committee looks at suggestions that Australia should rely on overseas research institutions or build a spallation source rather than construct a new research reactor. Finally, it touches on the issue of setting priorities in funding Australian science.

The validity of science and industry enhancement claims

3.2 ANSTO's main charter is to undertake research and development in relation to nuclear science and nuclear technology. This also includes research and development into the production and use of radioisotopes, and the use of isotopic techniques and nuclear radiation, for medicine, science, industry, commerce and agriculture.[1]

3.3 In considering whether or not a new nuclear reactor will significantly enhance Australian science and industry, the McKinnon Review found that 'for scientific use at least, there is a strong case for a research reactor, that is a neutron source, to be available nationally'.[2] But it then posed the following question:

> It is essential to ask, however, whether Australia has the scientists and the intensity of effort in this field to make such a purchase a good scientific investment, whether there are alternatives and whether our industry would be able to exploit its potential if Australia were to buy a new one.[3]

3.4 In addressing this matter, the Review was not convinced that the science undertaken at ANSTO was of sufficient distinction and importance to Australia to warrant the large investment required for a new reactor.[4] In commenting on the scientific accomplishments with HIFAR the Review stated:

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1 *Australian Nuclear Science and Technology Organisation Act 1987*, Part 11, section 5.

2 K.R. McKinnon et al., *Future Reaction: Report of the Research Reactor Review*, p. 28.

3 ibid, p. 28.

4 ibid, p. 65.

> The number of scientists and the range of scientific activities undertaken using HIFAR, even taking into account its limitations, are more limited than would alone carry the case for a new research reactor.
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> The volume of scientific effort on HIFAR (ANSTO plus university scientists) has increased since the establishment of ANSTO in 1986. The achievements are not yet sufficiently outstanding to allow confidence that a new reactor would be a good immediate investment. More time is needed.
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> The training of young scientists at a modest rate has been a successful function of HIFAR. The training of future scientists in this field necessitates either a local source or funds for individuals to have access to overseas sources.[5]

3.5 In respect to the industrial and commercial applications of HIFAR the Review concluded:

> ANSTO's efforts to generate commercially oriented activities have been successful with many new but as yet immature activities. Overall ANSTO has succeeded in building up revenue from the use of its personnel and facilities to 35 per cent of its income in 1992–93.
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> The HIFAR-related commercial activities include isotope production, substantial revenue from silicon doping, and relatively minor revenue from other irradiation and neutron activation activities.
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> The Review is not convinced of the prospects for Synroc, believing future development and marketing ought to be undertaken commercially if it is to be taken further.[6]

3.6 In announcing the Government's decision to replace HIFAR with a new reactor, Mr Peter McGauran, the Minister for Science and Technology, stated that the new facility would support ANSTO's 'nationally important work' in areas such as environmental studies, agriculture and in assisting industry. The proposed reactor would also encourage scientific research and higher education through better access to a modern, versatile neutron source.[7]

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5 K.R. McKinnon et al., *Future Reaction: Report of the Research Reactor Review*, p. xviii. and pp. 65–66.

6 ibid, p. 81.

7 ANSTO, News Release, 'Nuclear Reactor Replaced', 3 September 1997, http://www.ppk.com.au/mediareleases.html (7 September 2000).

Nuclear reactor as a research tool

3.7 A nuclear research reactor is a nuclear physicist's tool. It is much like a microscope—it produces 'a beam of neutrons to see the world'.[8] Neutrons comprise one of several probes, including electrons and x-rays, which are important for investigating the structure of materials at the atomic level. Indeed, Dr Erich Kisi, Member, Neutron Scattering Specialist Committee, AINSE, noted that neutron scattering, a leading technique used to study the structure and dynamics of a wide range of materials, is not nuclear science. It uses neutron beams that are produced by a nuclear reactor more or less as a by-product.[9] Neutron scattering has been performed at ANSTO since 1958.

HIFAR's contribution to research and development

An ageing HIFAR

3.8 Although it has undergone several upgrades over the years, HIFAR represents outdated technology. It was designed for a time when scientists and engineers used research reactors, in the main, to study the impact of radiation on materials to be used in nuclear power plants. Half a century later, the basis of nuclear science has moved on and broadened, and it now has wide application across many disciplines.[10]

3.9 Only a few participants to this inquiry question the assumption that HIFAR had reached its use-by-date and urge further careful assessment.[11] Most, however, agree that HIFAR belongs to a bygone era and that further efforts to upgrade the outdated technology would not be a wise use of resources.[12]

3.10 Professor Evan Gray, Chair of the Neutron Scattering Specialist Committee for ANSTO, spoke for many witnesses when he told the Committee that HIFAR's existing instruments are not competitive and could not be made so, even by totally renewing them. In particular he noted that HIFAR was not designed for the use of neutron beams; that it was literally a case of drilling holes through the reactor and taking beams out.[13] He explained that:

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8 Testimony of William D. Magwood, IV, Director of the Office of Nuclear Energy, Science and Technology, US Department of Energy, Testimony Subcommittee on Energy and Environment Committee on Science, 1999.

9 Dr Erich Kisi, *Committee Hansard*, 25 October 2000, p. 87.

10 See, for example, ANSTO, Press Release, 3 September 1997.

11 Professor Richard Broinowski was one participant who did so. See his submission no. 91.

12 Ms Jean McSorley, *Committee Hansard*, 25 October 2000, p. 45; See comments also by Mr Stephen Campbell, *Committee Hansard*, 25 October 2000, p. 121.

13 Professor Evan Gray, *Committee Hansard*, 25 October 2000, p. 92; see also Dr Brendan Kennedy, *Committee Hansard*, 26 October 2000, p. 160.

> The extraction of neutron beams at HIFAR is by radial beam tubes…Those are completely unsuitable for use in neutron scattering research. You really mostly require tangential beams and you cannot do that to HIFAR without completely deconstructing and reconstructing it—which is a new reactor.

3.11 Further, he pointed out that: 'There is a high neutron background count relative to a neutron guide hall and the useable flux is much lower than on a purpose designed reactor with the same peak flux'. Professor Gray submitted that even were guide halls to be installed, HIFAR has no cold source which precludes most experiments in soft condensed matter and biology.[14] He informed the Committee that it is not possible to achieve competitive cold neutron performance by upgrading HIFAR and fitting a cold source.[15] The Neutron Beam Users Group reinforced the view that refurbishing HIFAR would not significantly increase the flux available to researchers and hence would not make it internationally competitive.[16]

3.12 Researchers using the facility have found that, in addition to the low neutron flux and lack of a cold source, the reactor building is unconducive to research with very cramped conditions that do not allow big equipment to be brought in and with difficult access for users.[17]

3.13 Finally, these factors have led to more Australian scientists and engineers travelling overseas to conduct their research at more powerful, versatile and modern establishments—at ILL in Grenoble (France), HFIR at Oak Ridge National Laboratory (USA) and the spallation neutron sources IPNS at Argonne National Laboratory in Chicago (USA) and ISIS Oxfordshire (UK).[18]

3.14 In summary, by today's standards HIFAR has a low neutron flux, its instruments are far from 'cutting edge' and the associated research facilities are inadequate. It cannot offer facilities able to compete with world class facilities and its research capacity is not able to meet current scientific demand for instrument time which limits industrial applications of the technology.

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14 Professor Evan Gray, *Committee Hansard*, 25 October 2000, p. 93.

15 ibid.

16 Australian Neutron Beam Users Group, submission no. 61.

17 Professor Evan Gray, *Committee Hansard*, 25 October 2000, p. 93. See also Professor Beryl Hesketh, submission no. 79; and Professor John White, *Committee Hansard*, 4 December 2000, p. 419.

18 Australian Neutron Beam Users Group, submission no. 61.

3.15 Overall, Australian scientists believe that it is no longer economical nor advisable to continue the annual upgrades of HIFAR, as the technology required by the facility has changed considerably over the forty-two years of operation.[19]

3.16 The Committee agrees that it would not be a sound investment to further upgrade the reactor. It accepts the view that the research facilities could not be made internationally competitive by refurbishing the reactor or its associated instruments.

The growing demand for neutron scattering sources

3.17 In contrast to the conclusions of the McKinnon Review, as noted in Paragraphs 3.4 to 3.6, ANSTO, the Australian Institute of Nuclear Science and Engineering (AINSE) and other witnesses regard HIFAR as a major research tool for the organisation, for other scientists and researchers and for postgraduate training. They argue strongly that a new reactor can only enhance Australian research and scientific expertise.

3.18 It was submitted that through the work of AINSE, the reactor has enabled 28 Australian universities to undertake long-term research into neutron diffraction studies.[20] Further, as the skills and capabilities of Australia's nuclear researchers have developed, HIFAR has increasingly been involved in commercial research and development work for industry. According to the Australian Institution of Engineers (IEAust), Australia has nurtured, through access to this facility, core competencies in nuclear medicine, materials research, quarantine and agriculture.[21]

3.19 The Senate Economics References Committee noted that between 1993 and 1996 the number of university research projects utilising HIFAR increased by approximately two thirds, and access to the key neutron scattering instruments had been fully booked since that time. Furthermore, there had been a trebling in the use of overseas neutron scattering facilities by Australian research scientists, many of whom built their reputations on work conducted at Lucas Heights.[22]

3.20 Research links between HIFAR and Australian universities have been established with around 15% of PhD candidates in the physical sciences and

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19 See for example, Mr John Boshier, Institution of Engineers, *Committee Hansard*, 27 October 2000, p. 275; IEAust, submission no. 67; Professor John Patterson, submission no. 94. See also ANA, submission no. 81; ANSTO News Release, 3 September 1997; and, AINSE, submission no. 100.

20 IEAust, submission no. 67.

21 ibid.

22 Senate Economics References Committee, *A New Reactor at Lucas Heights*, September 1999, para 6.22.

engineering at Australian universities utilising reactor technology as part of their research.[23]

3.21 Recent figures show that there is continuing interest by Australian universities in using HIFAR. According to AINSE, researchers use several instruments to perform competitive science. The demand is high for these facilities and they operate 24 hours a day. The following table shows the growing access to the neutron beam facilities through AINSE:

Year	Number of days
1997/98	471 days
1998/99	484 days
1999/2000	549 days.[24]

3.22 Today, HIFAR must compete with advanced reactor sources being used by scientists in other countries producing industrial benefits from neutron scattering research. Such developments have occurred across a broad range of fields including polymers/polymer processing, the petroleum industry, residual stress in materials, semiconductors used in electronics, high temperature super-conductors, alloys and pharmaceuticals.[25] Professor Helen Garnett maintains that Australian neutron science has relied for too long on 'continuous initiative triumphing over obsolete technology'.[26]

3.23 AINSE is confident that a more powerful neutron source and a greater array of associated instruments will spur even further demand for neutron scattering techniques.[27] Indeed, the scientific community envisages that such a facility will maintain the interest and involvement of some of the country's best young scientists and technologists and attract quality scholars to Australia.[28] Dr Thomas Welberry,

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23 Senate Economics References Committee, *A New Reactor at Lucas Heights*, September 1999, para 2.30. Dr Ken Doolan, Director, Department of Physics Material Testing Laboratory, University of Western Sydney, in his submission noted that he would like to be able to bring all third year physics and chemistry majors from all member universities of AINSE to Lucas Heights for a day of experimental work on neutron scattering. Submission no. 174.

24 AINSE, submission no. 100. See also Australian Neutron Beam Users Group, submission no. 61.

25 ANSTO News Release, 3 September 1997.

26 ibid.

27 AINSE, submission no. 100.

28 See for example Dr Barry Muddle, submission no. 113; Dr Robin Batterham, submission no. 135.

President, Society of Crystallographers in Australia and New Zealand, told the Committee:

> If a better source were available in Australia, a larger proportion of our members would use neutron scattering as a first choice. At the moment it is difficult to do neutron diffraction because there are limited things one can do at Lucas Heights with the present facilities and anything more than that would require going overseas.[29]

Production of radioisotopes

3.24 The new reactor is also intended to produce radioisotopes for use in industry, scientific research and medicine. Radioisotopes are atoms that contain an unstable combination of neutrons and protons. They occur naturally but may also be created artificially in cyclotrons or in reactors by altering the atoms. They are produced in a reactor by bombarding small amounts of particular elements with neutrons. Radioisotopes produced in a reactor have practical applications in scientific research and are often used in industrial and laboratory situations.

3.25 According to ANSTO, the radioisotopes to be produced by the proposed research reactor will have broad application and be used, for example, to:

- study the sources and fates of aquatic pollutants and coastal and river zone erosion;
- accurately gauge thickness in high-speed production industries such as paper and plastic film;
- examine the integrity of crucial welds and structures;
- analyse mined ore samples and improve ore extraction;
- test metals and other industrial products by non-destructive methods; and
- help control insect pests for example through the sterilisation of pests such as fruit fly larvae.[30]

3.26 The Coastal Studies Unit at the University of Sydney was highlighted as just one case study of the diversity of research using radioisotopes undertaken at Lucas Heights. It is currently engaged in a joint research project with ANSTO and the NSW Department of Land and Water Conservation. The research, using radioactive sand tracers, is aimed at providing a better understanding of the

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29 Dr Thomas Welberry, *Committee Hansard*, 27 October 2000, p. 287.

30 Federation of Australian Scientific and Technological Societies, 'Lucas Heights reactor replacement', Press Release, 8 September 1997, http://www.usyd.edu.au/su/fasts/1997/Reactor.html (18 August 2000); ANSTO home page, 'HIFAR reaches 500th operating program landmark', News Release, 28 August 1998, http://www.ansto.gov.au/infor/press/pr0898.html (17 August 2000).

processes that contribute to beach erosion and sand transport from beaches onto the inner continental shelf during major storms and the return of such sand to the beaches during lower wave conditions. It is claimed that this study, the first of its kind in Australia and internationally, will result in a significant improvement in the ability to understand the dynamics of beach erosion and recovery along the Australian coast. It will help predict the actual initiation, movement and deposition of eroded beach sands on the inner shelf.[31]

The new research reactor and its role in Australian industry

3.27 ANSTO's mission statement commits the organisation not only to facilitate basic research but to ensure that its work helps to increase the competitiveness of Australian industry.[32]

3.28 In 1993, the McKinnon Review found that links between neutron sources and industry were not yet as pervasive and deep as the evidence of scientific usefulness suggested they be. The Committee now looks at the connection between neutron beam research, radioisotopes and industry in Australia today.

3.29 As noted earlier, ANSTO is a training ground for scientists and engineers interested in nuclear science and technology and its application. A number of these people now work in Australian companies.[33] The Cooperative Research Centre for Polymers stated that the new reactor will give polymer researchers and PhD students in Australia valuable educational opportunities by giving them easy access to world-class research facilities onshore. Currently they have to travel to the US or Europe, and many aspects of this arrangement are difficult.[34]

3.30 According to Mr David Taylor, Managing Director, Taylor Ceramic Engineering, employees from a number of small companies have had the opportunity, through collaborative research, to share the research facilities at ANSTO and the knowledge of ANSTO's scientists. Companies such as Taylor Ceramic Engineering, a manufacturer of advanced materials, regard the new reactor as a major tool to assist the development of new materials for tomorrow's advanced materials world. It argues that the enhancement of the facilities at ANSTO is 'vitally important for Australia to hold a mildly competitive position in the field of new materials development'.[35]

3.31 Similarly, the Cooperative Research Centre for Polymers submitted that 'based on our experience of interacting with companies in the industry, there is a strong requirement by key companies in the polymer industry for the new reactor,

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31 Associate Professor Andrew Short, Coastal Studies Unit, University of Sydney, submission no. 69.

32 ANSTO, *Annual Report 1999–2000,* p. iv.

33 Australian Ceramic Society, submission no. 55.

34 CRC for Polymers, submission no. 46.

35 Taylor Ceramic Engineering, submission no. 51.

particularly for its use in leading-edge polymer research using small angle neutron scattering'.[36]

3.32 Dr Barry Muddle, Professor of Materials Engineering at Monash University, outlined to the Committee some of the benefits that neutron scattering research brings to Australian industry. In particular, he noted the area of the design and development of opto-electronic materials, superconductors, nanostructures, electroceramics and sensors and the use of neutron imaging in quality control studies.[37]

3.33 He maintained that Australia was in the midst of major developments in the light metals industry, including the establishment of a magnesium production industry. In his view, the new research reactor would be an essential part of the research infrastructure needed for the growth and competitiveness of this industry. He believed that the new research reactor would integrate with major industry development, in this case, to provide the potential to expand the development and marketability of the country's resources.[38]

3.34 The mining and exploration industry also strongly endorses the work at Lucas Heights. For example, the Australian Mineral Industries Research Association Limited supported the new reactor on the grounds of preserving ANSTO's status as 'a world class organisation and maintaining its ability to service the needs of the minerals and associated industries'.[39]

3.35 More specifically, a number of companies involved in exploration and mining informed the Committee of the work being done at Lucas Heights in the analysis of samples of various natural materials. They referred particularly to an advanced and powerful form of chemical analysis known as Induced Neutron Activation Analysis (INAA). This type of study, which produces highly accurate results, relies upon the excitation of samples by neutrons from the reactor and the measurement of the radiation given off by those samples at a later time.[40] It is a high quality analytical technique that provides an alternative to, and a check on, conventional analytical methods. It is relatively interference free, simpler than the majority of analytical techniques and uses no chemicals so there is no danger of contamination from impure laboratory reagents. It does not suffer from problems of partial dissolution of samples.[41]

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36 CRC for Polymers, submission no. 46.

37 Professor Barry Muddle, submission no. 126.

38 ibid.

39 Australian Mineral Industries Research Association, submission no. 19.

40 Geostats Pty Ltd, submission no. 158; Homestake Gold of Australia Limited, submission no. 159; Careena Holdings, submission no. 166; Normandy Exploration, submission no. 165; and Royal Australian Chemical Institute, submission no. 169.

41 Becquerel Laboratories Pty Ltd, submission no. 156.

3.36 INAA requires a high neutron flux which currently can only be provided in Australia by HIFAR. A number of companies argue that Australia's exploration and mining activities would be compromised without ready access to the INAA facilities at Lucas Heights. Normandy Exploration submitted:

> As long as Australia continues to generate so much of its wealth from the mining industry, there will be a constant need for this type of analytical procedure. If we are not able to obtain these services in Australia, the alternative will be to ship samples to Canada. This is time consuming, and leads to loss of revenue for the country as well as job losses in Australia.[42]

3.37 Supporting this stand, Mr Max Brennan, former chair of the Australian Research Council, referred to the many thousands of samples sent by the mining industry to Lucas Heights for neutron activation analysis. He concludes that 'they would not send 25,000 samples a year overseas, so they would lose a very valuable source of information for mineral exploration and, similarly, in the mineral processing industry'.[43]

3.38 Witnesses to the inquiry mentioned other examples of the use of radioactive materials in industry which include neutron soil moisture gauges for Australia's wine growing industry in the Barossa and Hunter Valleys and the material thickness monitoring of conveyor belts in the cement industry.[44]

3.39 HIFAR is also used for neutron transmutation doping (NTD) of silicon for industry. Large ingots, each a single crystal of silicon, are inserted into the reactor. There, the neutrons change one atom of silicon in every 1,000 million to phosphorus. Silicon irradiated in HIFAR is returned to silicon suppliers in Japan where it is sliced into wafers and supplied to electronics companies.[45] The Japanese company, ENATEK, advised the Committee that the demand for NTD silicon is growing and expected to continue. In its submission, the company commented on the quality of irradiation and the service provided by ANSTO and stated it would like to increase its number of irradiation orders.[46] Komatsu Electronic Metals also expressed strong support for ANSTO and its ability to ensure a stable supply of irradiated materials. Further they hoped that ANSTO would be able to replace HIFAR with a new reactor with a higher flux that 'will make ANSTO a preferred

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42 Normandy Exploration, submission no. 165. See also Homestake Gold of Australia Limited, submission no. 159.

43 Transcript, 'Lateline', 10 June 1997.

44 Dr John Patterson, submission no. 94.

45 ANSTO home page, 'HIFAR reaches 500th operating program landmark', News Release, 28 August 1998, http://www.ansto.gov.au/infor/press/pr0898.html (17 August 2000).

46 ENATEK, submission no. 52; and, Komatsu Electronic Metals Co. Ltd, submission no. 113.

supplier of irradiated silicon because of the quicker irradiations and faster return delivery'.[47]

3.40 Businesses and research institutes that rely on the reactor for both research and analysis clearly regard the facility as a valuable research tool and strongly support the construction of a new reactor. For them, it will provide a research facility that will enable young scientists and engineers to gain the required level of education, experience and skills to hold a competitive position in particular areas of Australian industry.

3.41 Whilst the Committee received extensive evidence from industry regarding the benefits to them of a new nuclear reactor it also appears that there is a significant public contribution being made to benefit industry with little commercial return to ANSTO. For instance the Committee notes that the revenue generated by silicon irradiation accounts for only about $2 million a year.[48] The McKinnon Review also found that a new research reactor 'cannot be financially self-supporting'.[49]

3.42 The Committee believes that in view of the large expenditure of public funds involved in building and maintaining a new reactor an independent, rigorous and detailed analysis of the benefits to the Australian economy should have been undertaken prior to the decision being taken to proceed with the project. The Committee believes that such an inquiry should be undertaken.

Old science, new science

3.43 Despite the evidence presented so far that outlines the contribution that HIFAR makes to Australian industry and science, some say investment in a replacement reactor is not forward looking. While they acknowledge that HIFAR may still be in demand as a research tool, they maintain that nuclear reactors are old technology; that new reactors are not being built.[50]

3.44 Professor Barry Allen, a former Chief Research Scientist in the Division of Biomedicine and Health at ANSTO, doubted whether nuclear science was a 21st century science. In 1998, he submitted to the Senate Economics References Committee that the nuclear era was over, and that the new research reactor 'is really a step back into the past'. He could see no new technologies emerging but rather reinforcement of old technologies and suggested that the new research reactor 'may be the last of its kind built in the world'.[51] For Professor Allen there was nothing

47 Komatsu Electronic Metals Co. Ltd, submission no. 113.

48 ANSTO, Annual Report 1999–2000, p. 124.

49 K.R. McKinnon et al., *Future Reaction: Report of the Research Reactor Review*, p. xx.

50 Ms Loretta O'Brien et al., submission no. 88.

51 Submission no. 4 to the Senate Economics References Committee. Sutherland Shire suggested that 'a brand new reactor may well be the last of its kind ever built' in their submission no. 7, Senate Economics References Committee, p. 10.

intrinsically wrong with the reactor—'it's just too late and it's not going to take us in the new directions that we should be going'.[52]

3.45 A number of participants to the inquiry supported this view including Dr Jim Green, Mr Steffen St. Devereaux, Mr Hans–Peter Schnelbögl, Ms Loretta O'Brien and the Australian Rail, Tram and Bus Union.[53]

3.46 Other participants in this inquiry, however, took issue with this proposition and argued forcefully that Australia needs a number of large-scale research facilities to help it move forward in the new economy. For them a nuclear research reactor is one such facility. Mr Boshier from the Institution of Engineers told the Committee:

> The replacement reactor is a key example of the kind of investment needed to enable Australia to shake off the label of an old technology economy. The replacement reactor will enable ongoing innovative research in the fields of polymers, ceramics and other new materials, life sciences and biotechnology, the understanding of complex industrial processes, and advanced treatment such as for health, medicine and also things like radiopharmaceuticals, therapeutic treatments and advanced environmental management processes.[54]

3.47 A number of scientists appearing before the Committee assert that the special attributes of neutrons guarantee their place in scientific research for the foreseeable future. For example, it was argued that neutron applications are becoming especially important in the area of biotechnology. Dr William Hamilton, an Australian neutron scatterer now working in a major US research institute, explained that the isotopic sensitivity neutron is beginning to be applied to the in-solution questions of protein function, that is in situations emulating true biological environments—to complement detailed structures that x-rays can only provide for crystallized samples.[55] He submitted:

> Neutron scattering will continue to contribute enormously to our understanding of the microstructure and dynamics of matter on the nanoscale, in a future in which our understanding on this level will be the foundation of our technological capabilities.[56]

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52 Radio National Transcripts, Background Briefing, 'Lucas Heights: Over Reaction?', 29 March 1998.

53 See Dr Jim Green, submission no. 1 Attachment (b) to the Senate Economics References Committee; Steffen St Devereaux, submission no. 50; Mr Hans-Peter Schnelbögl, submission no. 82; Mr Robert Mann, submission no. 87; Ms Loretta O'Brien, submission no. 88 and the Australian Rail, Tram & Bus Union, submission no. 108.

54 Mr John Boshier, Institution of Engineers, *Committee Hansard*, 27 October 2000, p. 276.

55 Dr William Hamilton, submission no. 57.

56 ibid.

3.48 Dr Brendan Kennedy, President of the Australian Neutron Beam Users Group, noted the work being done by a colleague who recently performed experiments on an anti-cancer drug using neutron beams to understand some of the subtleties of this material. He concluded; 'to say that we want to go into biotechnology, that this is the direction in which we need to go, and that neutron beams are not part of biotechnology, is not correct'.[57]

3.49 Similar views supporting the role of a new reactor were submitted by Professor Gray,[58] Dr Welberry,[59] and Professor Muddle.[60] These scientists presented a strong message that the future is highly promising for research using neutron scattering as it continues to push the boundaries of the scientist's understanding of the structure and dynamics of materials and as its application expands.

3.50 Information technology is another area that was identified as providing some insight into the breadth of neutron scattering research and its wide application. Dr Darren Goossens, post-doctoral fellow at the ANU, explained that information technology is built on silicon chips and semiconductors and that the basic understanding of silicon chips and semiconductors comes from fundamental physics that was done 40, 50 and 60 years ago. He pointed out that there are fundamental physical limits on how densely you can pack the components onto a silicon chip. New materials, new devices and new ways of building materials are needed to overcome these problems and move on to the next generation of computing facilities. Research facilities such as a research reactor and synchrotron are the tools that can help develop such new materials. He told the Committee that an investment in a facility such as the replacement research reactor 'is an investment in information technology'.[61]

3.51 The IEAust summarised the possible advantages it believed would be generated by the new research reactor:

> The new technologies will generate new companies, export income and employment for Australia. Along with providing ongoing teaching and research opportunities, the specialist scientists and nuclear engineers at the facility will provide a core group of specialists able to advise the government and general community on nuclear issues.[62]

It argued that failure to replace the reactor within the next five years would dramatically diminish Australia's long term capabilities in emerging technologies,

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57 Dr Brendan Kennedy, *Committee Hansard*, 26 October 2000, p. 166.

58 Professor Evan Gray, *Committee Hansard*, 25 October 2000, p. 98.

59 Dr Thomas Welberry, *Committee Hansard*, 27 October 2000, p. 287

60 Professor Barry Muddle, submission no. 126.

61 Dr Darren Goossens, *Committee Hansard*, 27 October 2000, p. 288.

62 IEAust, submission no. 67.

new materials processing, nuclear medicine and environmental management processes.[63]

3.52 The Committee notes the range and quality of the information presented by scientists and engineers using neutron scattering to further their research. It also notes that, in contrast to the array of evidence from science and industry presented, the Committee received very few submissions directly challenging the scientific and research value of a research reactor. This of course is not surprising given that the arguments against a reactor are largely based on other considerations. Whilst the Committee is of the view that nuclear science and technology is not backward looking and does offer opportunities for researchers to keep at the forefront of important areas in scientific research and development it does not automatically follow that the best way to promote scientific and medical research in this country is by spending substantial amounts of public funds for the next forty years on a single research reactor.

3.53 The Committee believes that the competing demands for such public funds should have been rigorously examined by an independent inquiry as recommended by the McKinnon Review. The Government has in this instance simply accepted the views of ANSTO and those closely involved with the existing reactor without properly considering alternative areas of research and development which are in need of public funding.

Suitcase science

3.54 Evidence presented to this Committee indicates the useful place that nuclear science and technology has in today's world. Some, however, question the need for a country such as Australia with its relatively small population and limited scientific and technical resources to invest in this type of facility. They suggest that the number of scientists who would use the reactor does not warrant the substantial expense involved in building and maintaining a nuclear research facility. They argue that there is a strong case for so-called 'suitcase science'—of having some of Australia's scientists use facilities overseas.[64] This is particularly so, because of the high standard of the larger establishments in countries such as France and the US.[65]

3.55 For example, the People for Nuclear Disarmament submitted that the 'massive financial and health costs' connected with the new reactor do not justify the neutron scattering program in Australia and that there is no sound reason for the sizeable outlay of funds for the replacement reactor. It pointed out that there are at least fourteen research reactors around the world, most of which perform neutron scattering programs much more efficiently and to a higher standard than an

63 IEAust, submission no. 67.

64 See, for example, 'Lateline', 10 June 1997.

65 Waveney Kaeding, submission no. 66.

Australian reactor. It argued that Australia would be able to fulfil its needs in this research through information gained from these sources.[66]

3.56 A number of witnesses suggest, however, that this argument does not take full account of the central role that a local institution, such as a research reactor, has in facilitating research. Dr Hamilton argued that excellent research can and has been performed by Australian researchers using overseas facilities. He claimed however, that suitcase physics is logistically difficult and limited by the support facilities made available.[67] The Institution of Engineers, Australia, suggests that it is unrealistic to expect that Australia's premier nuclear researchers could undertake equivalent levels of leading edge research by renting space in research laboratories overseas.[68]

3.57 It is also claimed that postgraduate students experience particular difficulties in having to use overseas facilities. Professor Beryl Hesketh, Dean, Faculty of Science, University of Sydney, highlighted some of the problems facing students forced to travel overseas to carry out experiments necessary for their research programs to remain internationally competitive. She explained that time at these international facilities is by competitive applications and many of the instruments have 100-300% over-subscription rates. Moreover, the intensity of the experiments at the major international facilities is not conducive to the training of postgraduate students, and it is not possible to schedule experiments in several small blocks as is currently possible at HIFAR.[69]

3.58 In Dr Hamilton's view, true scientific sophistication in the field of neutron scattering comes only with in-depth technical involvement over the breadth of neutron scattering research. Put briefly:

> in the near future an Australian research reactor is the only way to maintain our country's involvement in neutron scattering research at the highest level and to share fully in the benefits of that research.[70]

3.59 Dr Darren Goossens, a young Australian scientist, maintains that a local facility gives more opportunity to research students than international facilities and provides a career path for them. Often such a facility provides the necessary stepping stone to a more powerful international facility.[71]

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66 People for Nuclear Disarmament (New South Wales), submission no. 44.

67 Dr William Hamilton, submission no. 57.

68 IEAust, submission no. 67; Mr John Boshier, Institution of Engineers, *Committee Hansard*, 27 October 2000, p. 276.

69 Professor Beryl Hesketh, submission no. 79.

70 Dr William Hamilton, submission no. 57.

71 Dr Darren Goossens, submission no. 32. Dr Welberry also made the point that Lucas Heights gives credibility to the neutron diffraction community which enables them to have access to facilities overseas. He told the Committee 'without that legitimacy, which I believe having a research reactor of

3.60 Dr Robert Robinson, Adjunct Professor in Physics at the University of New South Wales, University of California Riverside and New Mexico State University, also underlines the importance of this new facility as a means of improving Australia's standing in this area. He noted Australia's excellent reputation in the scientific exploitation of neutron beams and informed the Committee that Australian scientists, some of whom received their initial training at Lucas Heights, can be found in leading institutes around the world.[72] According to the Beam Users Group, the success of Australian scientists in gaining beam time at such facilities 'is a testament to the quality of the Australian researchers'.[73]

First class or second class facility

3.61 ANSTO's vision for the new research reactor, however, goes beyond providing a training facility for Australian researchers. Indeed, the proposed reactor has been touted, particularly by ANSTO, as a state-of-the-art facility.[74]

3.62 Those closely associated with the new research reactor proposal agree. Professor Evan Gray, an AINSE representative on ANSTO's beam facilities consultative group, was adamant that the facility proposed to be built at Lucas Heights would be first rate. He explained that because the facility is designed as a neutron beam research reactor, the effective flux is very high, and every one of the instruments that the beam facilities consultative group recommended to be built is world class. He stated:

> We adopted a policy of excellence, and we recommended that no instrument be built unless it would be of world class and that some of the instruments would be world leaders.

Put succinctly, 'the quality of science is not related to the size of the facility, it is related to the performance of the facility…the performance will be first class'.[75]

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our own gives, I do not think we will have as ready access to overseas facilities as we have even now'. Dr Thomas Welberry, *Committee Hansard*, 27 October 2000, p. 287.

72 Dr Robert Robinson, submission no. 18.

73 Australian Neutron Beam Users Group, submission no. 61.

74 See for example, 'Contract signed for Australia's History-Making Replacement Research Reactor', ANSTO News Release, http://200.51.6.19/press/0713/firma-ansto-e.htm (17 August 2000); ANSTO, News Release, 'Replacement Research Reactor for ANSTO', http://www.ansto.gov.Australia/information/press/nr15.html (17 August 2000). Some inquiry participants, however, were not convinced that the new reactor would be a world class leading facility. Mr Cameron Schraner informed the Committee that if Australia were to build a new reactor it would only rank 11th or 12th in the neutron scattering league. Mr Cameron Schraner, submission no. 56.

75 Professor Evan Gray, *Committee Hansard*, 25 October 2000, p. 89. Dr Kennedy agreed that the aim was to build the best instruments for neutron beam research. He stated that 'the preliminary design specifications show that we will at least equal the highest resolution machine at the world's most intense diffraction source, the ILL in France. In other words: 'this is going to be a world-class instrument on a world-class facility…that will enable Australia to do world-class science'. Dr Brendan Kennedy, *Committee Hansard*, 26 October 2000, p. 158. See too the Australian Minerals

3.63 In particular, according to ANSTO, the extra performance of the new research reactor stems from state-of-the-art neutron guides, which will have modern 'supermirror' coatings. These guides carry neutrons away from the reactor, so they can be used in a range of scientific instruments. The supermirror coatings will virtually eliminate losses of neutrons from the guides.[76]

3.64 ANSTO maintains that it will be one of only two reactors in the world using this technology for all its beam guides, and it will be in the first tier of reactors worldwide, with performance comparable to the national neutron sources of Japan, France and the US.[77]

3.65 The Australian Neutron Beam Users Group, representing a cross-section of Australian scientific interests, including industry, academia and CSIRO, was involved in the design of the instruments proposed for the new reactor. It is confident that much of the work currently performed overseas will be carried out at the new reactor. In addition, it argues that the cold source and the enhanced flux of the new reactor will enable many experiments in the rapidly developing areas of biotechnology, polymers and colloid science.[78]

3.66 A number of scientists envisage that the new research reactor will not only raise the visibility of science in Australia and attract young students but will also send a positive message to the rest of the world.[79] ANSTO, in particular, anticipates that the combination of four decades of experience and a modern research reactor will secure its place as a national and regional centre for neutron science.[80]

Industries Research Association (submission no. 19) which also supported the replacement reactor 'on the grounds of maintaining its status as a world class organisation and maintaining its ability to service the needs of the minerals and associated industries'.

76 ANSTO, Media Release, 13 July 2000; 'Contract Signed for Australia's History-Making Replacement Research Reactor'; INVAP Homepage, http://2000.51.6.19/press/0713firma-ansto-e.htm (17 August 2000).

77 ANSTO, Media Release, 13 July 2000; INVAP Homepage, http://2000.51.6.19/press/0713firma-ansto-e.htm (17 August 2000).

78 Australian Neutron Bean Users Group, submission no. 61; 'Replacement Research Reactor', ANSTO homepage, http://www.ansto.gov.au/ansto/RRR/char.html (18 August 2000). See also Professor Barry Muddle who submitted that the new research reactor will not only benefit from an enhanced neutron flux, but will also embrace new facilities such as a cold neutron source, a hot neutron source and tangential beams, and, most importantly, adequate space for advanced instrumentation that will allow industrial processes to be followed in real time, under various imposed temperature, pressure and stress regimes. Professor Barry Muddle, submission no. 126.

79 For example, see Dr Darren Goossens, *Committee Hansard*, 27 October 2000, p. 288. The Australian Academy of Science was confident that once the replacement research reactor was operational, it would achieve performance levels at least ten-times higher than those at HIFAR. It would also ensure that a modern neutron source was available to students and researchers from universities in Australia and New Zealand. Australian Academy of Science, Media releases and reports, 4 September 1997 http://www.science.org.au/academy/media/reactor.htm (21 August 2000).

80 ANSTO News Release, 3 September 1997. See also ANSTO, Overview of Proposed Replacement Nuclear Research Reactor, http://ansto.gov.Australia/ansto/RRR/eis_overview.html (18 August 2000). The INVAP design has provided substantially more irradiation facilities, and subsequently

3.67 Indeed, the scientific community hoped that rather than lose Australian scientists to overseas institutions, the new reactor would attract promising researchers. Professor White conveyed the aspirations of the scientific community when he expressed the hope that the new research reactor would not only benefit the Australian scientific community for many years to come but would also be:

> A magnet to draw in scientists and technologists from neighbouring countries so that Australia could…re-establish in this area a profile which it always had in the past.[81]

Alternative technologies

3.68 A number of opponents of the new reactor acknowledge the benefits that derive from nuclear science and technology and the importance for Australia to have a capacity for using radioactive materials. They contend, however, that a reactor is not the sole source of neutron beams or of radioisotopes. They suggest that acceptable alternatives would perform the same function as nuclear reactors but would not present the health and safety and environmental problems associated with reactors.

3.69 Neutron beam experiments require a dedicated neutron source. There are two types of neutron sources—reactors and pulsed spallation sources. Reactors produce neutrons by nuclear fission, while spallation sources produce them by striking heavy metal with high-energy protons from an accelerator.[82] Reactors operate in a continuous mode and produce high integrated fluxes of neutrons of cold and thermal energies for both scattering and isotope production. On the other hand, spallation sources are most effectively operated in a pulsed mode creating high peak fluxes of cold and thermal neutrons, as well as large quantities of epithermal neutrons for time of flight experiments. The continuous or the pulsed nature of the beams produced by the two different types of neutron source determine the methods used for neutron scattering experiments.

3.70 Because a spallation source can produce a neutron beam for use in scattering experiments, it is held up as a possible alternative to a reactor. Many working in the field, however, regard the reactor and spallation based neutron sources as 'complementary and mutually supporting, each with its own unique

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higher neutron fluxes in the flux irradiation positions than ANSTO's minimum requirements. It will be able to provide support for industry at levels well beyond HIFAR's capabilities. 'Contract Signed for Australia's History-Making Replacement Research Reactor', INVAP Homepage, http://2000.51.6.19/press/0713firma-ansto-e.htm (17 August 2000).

81 Professor John White, *Committee Hansard*, 4 December 2000, p. 416.

82 Tormod Riste, 'Analytical Report', in OECD, *Neutron Beams and Synchrotron Radiation Sources,* Paris, 1994, p. 65. The spallation process is the name given to the physical process that is involved in the production of large numbers of neutrons using high energy accelerators. See Dr J.W. Boldeman, 'Accelerator driven nuclear energy systems' in ATSE , 'Energy for Ever: Technological Challenges of Sustainable Growth', Academy symposium, November 1997, http://www.atse.org.Australia/publications/symposia/proc-1997p11.htm (5 January 2001).

capabilities'.[83] Indeed, the neutron science community recognises the importance of both reactor produced and accelerator based sources. The question then arises which neutron source would best meet Australia's needs.

3.71 In 1993, the McKinnon Review could draw no conclusion on whether a reactor would be the best choice for a neutron source. It could see, however, rapid advances in the technology of accelerator based spallation sources which could make such a source a worthwhile consideration, if scientific purposes were to be the key reasons for a new reactor. It found that a spallation source would be unlikely to cost less than a reactor and that, if a spallation source were to be chosen, a small reactor of about one megawatt power for the production of radioisotopes would also be necessary, unless advances in cyclotron technology made that avenue the preferable course.[84]

3.72 The debate about an alternative neutron source for Australia was left open at that time. Since then, developments in accelerator technology have continued[85] and today, there are some people who continue to urge Australia to invest in a spallation source.[86] Dr Jim Green told the Senate Economics References Committee that spallation sources have been competitive with research reactors for neutron beam research for a number of years. Although recognising some of the limitations of the existing spallation sources in the production of radioisotopes and in silicon doping, he contended that their potential was enormous. While he acknowledged the present shortcomings of spallation sources, he submitted:

> Possibly a multipurpose spallation source will be a viable option within that time frame [by the permanent shut down of HIFAR]; if not, interim strategies such as importing radioisotopes can be deployed while spallation technology is more fully developed.[87]

3.73 He acknowledged, however, that for scientific research in Australia there is no prospect of a cutting edge spallation source such as is being built in the US because it would cost billions of dollars. He referred to Professor Allen's suggestion that a mid-range spallation source could be a useful scientific research instrument and would cost roughly the same as a reactor. Dr Green told the Committee:

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83 This is the opinion of The Neutron Scattering Society of America, see Tormod Riste, 'Analytical Report', in OECD, *Neutron Beams and Synchrotron Radiation Sources*, Paris, 1994, pp. 69–70. See also Australian Academy of Science, Media releases and reports, 4 September 1997, http://www.science.org.Australia/academy/media/reactor.htm (21 August 2000).

84 K.R. McKinnon et al., *Future Reaction: Report of the Research Reactor Review*, August 1993, p. xvii.

85 See for example, Dr J.W. Boldeman, 'Accelerator driven nuclear energy systems' in ATSE, 'Energy for Ever: Technological Challenges of Sustainable Growth', Academy symposium, November 1997, http://www.atse.org.Australia/publications/symposia/proc-1997p.11.htm (5 January 2001).

86 Dr Jim Green, submission to the Senate Economics References Committee, submission no. 1, p. 2.

87 ibid, p. 17.

> If you have $300 million, you are getting a mid-range facility. All this stuff about this proposed new reactor being world class, and so on, is laughable. For $300 million, you get a mid-range reactor or a mid-range spallation source, or you can invest in any number of particle accelerators and a whole mix—suitcase science, and so on.[88]

3.74 Nonetheless, he added that 'you would not want to jump in and decide on a spallation source without investigating the situation thoroughly…these things need investigation'.

3.75 Other witnesses, particularly those closely involved with the current reactor or the nuclear industry, did not share his optimism and drew attention to a number of problems for Australia in purchasing a spallation source. They include the relevancy of a spallation source to Australian researchers, the costs and uncertainties associated with the design and construction of such a facility and its limitations in producing radioisotopes on a commercial basis.[89]

3.76 As noted earlier, spallation sources can be used for neutron research, but reactor and spallation sources each have a special function which is generally complementary. Professor Gray, one of the few Australians whose work is best performed from a spallation source, explained the difference:

> Australian neutron beam time is dominated by powder diffraction and cold neutron techniques like small angle scattering and reflectometry. Many users believe that these techniques are best implemented at a reactor source. Spallation sources are best for high energy inelastic techniques and there are not many Australian practitioners of those techniques.[90]

3.77 Aside from a research reactor better suiting the needs of Australian neutron beam users, there are cost considerations. The Australian Neutron Beam Users Group informed the Committee that spallation sources are not commercially available and small countries, such as Australia, have identified reactors as the optimal method of producing suitable neutron beams.[91] Indeed, Professor Gray stated bluntly that Australia cannot afford a competitive spallation source and having a 'world-class reactor will make our facilities sought after and encourage international collaboration'.[92]

3.78 Dr Kennedy emphasised this point. He told the Committee that spallation sources were an emerging technology and although there are a number of very good

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88 Dr Jim Green, *Committee Hansard*, 26 October 2000, pp. 175–6.

89 See *Nuclear Issues Briefing Paper*, February 2000 and ANSTO, 'A Replacement Research Reactor for Australia: Background Information', http://www.ansto.gov.au/quanda.html (20 September 2000).

90 Professor Evan Gray, *Committee Hansard*, 25 October 2000, p. 86.

91 Australian Neutron Beam Users Group, submission no. 62.

92 Professor Evan Gray, *Committee Hansard*, 25 October 2000, p. 86.

spallation sources in the world, their development is not as commercially progressed as the development of reactors.[93] At the moment there are a number of spallation sources in the US and Europe but they were expensive to develop and build. The planned Neutron Source at Oak Ridge National Laboratory to be completed in 2005 is expected to cost $US1.3 billion dollars.[94]

3.79 Dr Kennedy went on to explain:

> There are two choices: we can either buy a reactor or buy a spallation source. There are at least six suppliers of reactors around the world who could come out and build the reactor. There are no commercial suppliers of spallation sources…that would mean…we would have to develop the technology actually to come forward to build an operating spallation source.[95]

3.80 Dr David Walker, Honorary Secretary, Nuclear Engineering Panel, Sydney Division, Institution of Engineers, held the same view. He considered that the risks involved in venturing into the area of building a spallation source were too great. He acknowledged that accelerator technology had reduced costs but that accurate costing of a spallation device built on a greenfield site in Australia would be a very open question.[96] Professor White also agreed. He believed that choosing a reactor is a better option because reactor technology is a better understood art than the design of spallation neutron sources at this time.[97]

3.81 In brief, ANSTO maintains that spallation neutron sources are very expensive and have not proven a reliable source for routine production of medical or industrial radioisotopes.[98] The Public Works Committee agreed. It found that the development of a source for dual medical isotope production and research would be more expensive than the proposed reactor.[99]

3.82 The Senate Economics References Committee Report found that, 'the evidence presented to us does not lead us to conclude that either cyclotrons or

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93 Dr Brendan Kennedy, *Committee Hansard*, 26 October 2000, p. 160.

94 See Carolyn Krause, 'The Pieces of the Puzzle for the Spallation Neutron Source', *The Oak Ridger*, 20 April 1998.

95 Dr Brendan Kennedy, *Committee Hansard*, 26 October 2000, p. 162.

96 Dr David Walker, *Committee Hansard*, 27 October 2000, p. 285.

97 Professor John White, *Committee Hansard*, 4 December 2000, p. 418. The Australian Academy of Science re-examined the question of whether better alternative technologies had emerged in the last few years. It found that nothing had emerged in the intervening years since the McKinnon inquiry to support a view that accelerator based alternatives could meet Australia's requirements either for neutron based science or the production of radiopharmaceuticals. Submission no. 151.

98 ANSTO, *Overview of the Proposed Replacement Nuclear Research Reactor*, http://www.ansto.gov.au/ansto/RRR/eisoverview.html (5 January 2001).

99 Parliamentary Standing Committee on Public Works, *Proposed Replacement Nuclear Research Reactor, Lucas Heights, NSW*, Canberra, 12 August 1999, p. 27.

spallation sources can provide a complete alternative to a new reactor at this point of time'.[100] The Committee went on to say:

> However it may be that funding for a package of such measures, combined with the importation of medical isotopes, is an alternative long term option to the proposed investment in a single reactor.
>
> The Committee supports the approach adopted in the Research Reactor Review that these issues need to be thoroughly investigated by an independent panel prior to any final decision.[101]

3.83 The Committee notes the rapid development of accelerator technology over recent years but believes that the findings and recommendations of the Senate Economics References Committee Report in 1999 on the issue of alternative technologies are still valid today. The Committee is critical of the Government for not investigating these issues further prior to its decision to build the new reactor.

Establishing priorities

3.84 During the course of the inquiry, a number of witnesses expressed their concern about the Government's strategy in funding a new research reactor and the influence it would have on scientific research in Australia. This issue is central to the question about priorities in funding and whether the planned research reactor should be high on this list of priorities.

3.85 In 1985, when proposed legislation on the establishment of ANSTO came before Parliament, the Government, while keen to encourage ANSTO to increase its commercial or cost recovery orientation, accepted that the organisation would be unlikely to achieve self-sufficiency for all its commercial activities.[102] Eight years on, the McKinnon Review also accepted that the current research reactor or any new reactor would not be completely commercially viable.[103]

3.86 The Committee notes that the replacement research reactor is not a commercially profitable undertaking and that it will require substantial and on-going public funding to construct it and to keep it operational.

3.87 Keeping in mind that the new facilities at Lucas Heights are costing close to $300 million with annual operating and maintenance costs of around $12

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100 Senate Economics References Committee, *A New Reactor at Lucas Heights*, September 1999, p. 72.

101 ibid.

102 See Senate, *Debates*, 6 November 1985, p. 1618; and House of Representatives, *Debates*, 19 February 1987, p. 406.

103 K.R. McKinnon et al., *Future Reaction: Report of the Research Reactor Review*, August 1993, p.xx.

million,[104] a number of participants to the inquiry question whether Australia is getting the best return from this large investment.

3.88 Those in favour of the new reactor point out that Australia is falling behind in R&D capability and that urgent government spending needs to be made to replace research and development infrastructure. They refer to the need for Australia to adopt a more focused approach to science and engineering and to concentrate on core competencies. They are convinced, moreover, that the reactor would form part of this much needed infrastructure. Mr Boshier told the Committee:

> …let us formulate a strategic direction for research and development in Australia, built up by the revealed spending patterns of the major investors, and the Australian government should then provide the infrastructure to enable that to happen…I think Australia's core competencies are in things like biotechnology and in adding value to our mineral exports. We therefore feel that the Lucas Heights reactor is part of the infrastructure needed for that purpose.[105]

3.89 Further, major Australian institutions, not specifically linked with research at Lucas Heights but in a position to have an appreciation of Australia's overall needs in the area of scientific research, endorse the proposed new reactor.[106] The Australian Research Council submitted that the availability of an up-to-date facility will 'stimulate research activity and deliver outcomes of significant value to Australian R&D especially in areas of advanced materials'.[107]

3.90 With equal conviction the Australian Vice-Chancellors' Committee believes that a modern research reactor will support 'Australia's standing as a technologically sophisticated society able to play its role in the new economy'. They, however, make no reference to the benefits of spending in other scientific areas of research or express concern that other fields of scientific endeavour may be neglected because of the funding being allocated to the new research reactor. This leads to the issue of priorities in science and decisions taken on funding major scientific infrastructure.

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104 Parliamentary Standing Committee on Public Works, *Committee Hansard*, 5 May 1999, p. 138.

105 Mr John Boshier, Institution of Engineers, *Committee Hansard*, 27 October 2000, p. 278.

106 See Institution of Engineers (with a membership of around 60,000), submission no. 67; Australian Academy of Science, submission no. 151; Australian Research Council, submission no. 157; Australian Vice-Chancellor's Committee, submission no. 164; Federation of Australian Scientific and Technological Societies, submission no. 177.

107 Australian Research Council, submission no. 157, p. 1.

3.91 A number of witnesses to the inquiry contend that the funds being funnelled into the proposed reactor could be more productively employed in other fields of science and technology R&D or in hospitals and other medical research.[108]

3.92 For example, the Western Australian Branch of the Medical Association for Prevention of War suggested that ANSTO's slice of the cake denies other areas of science and technology proper funding to make advances in their fields of research.[109] A number of witnesses suggest that the science dollar should be spent on more important research fields or in creative or innovative areas.[110] Some wanted attention given to research devoted to more genuinely clean, safe and renewable technologies for power generation.[111]

3.93 Mr Hans-Peter Schnelbögl summarised these views. He submitted that if the cost of the proposal is compared to other potential scientific and technological projects of similar magnitude, then it becomes obvious that there is no gain from the reactor proposal for science or industry but rather a tremendous loss. He suggested that the funds allocated to the new reactor could boost research into:

- greenhouse—and environment-friendly energy and transport;
- preventative medicine; and
- peace and economic development with our neighbours and our own indigenous people.[112]

3.94 This view was supported by Greenpeace Australia which argued that there is a range of alternatives which, 'if Australia were to invest more of its money into this kind of technology, would open up a range of opportunities which are not offered by HIFAR and a reactor'. Mr Stephen Campbell, a campaigner for Greenpeace, told the Committee:

> My understanding is that, if you use alternative technologies, you open up and close down a range of options. It just basically depends on where you put your money. If you put your money into one lot of options, you open up research opportunities and opportunities for commercial and industrial research processes and you close down some. But that is a substantive

108 W.A. Branch of the Medical Association for Prevention of War, submission no. 75.

109 ibid.

110 People for Nuclear Disarmament (NSW), submission no. 44.

111 Catholics in Coalition for Justice and Peace, submission no. 2; Ms Amy Thom, submission no. 5; Ms Maureen Pearl, submission no. 27; Pro forma submission no. 30; Mr Warwick Billings, submission no. 72; Dr Bill Williams, submission no. 74; Ms J. Gough, submission no. 89; Ms Sharon Davies, submission no. 84; Ms Irene Cheong Poh Ai, submission no. 86; Ms Jan Thompson, submission no. 99; People for Nuclear Disarmament (NSW), submission no. 44.

112 Mr Hans-Peter Schnelbögl, submission no. 82. See also Mr Cameron Schraner, submission no. 56.

> choice you make. My understanding is that it is not sustainable to say that one is ultimately better than the other.[113]

He felt that the Australian science community had not had this debate.[114]

3.95 Professor Barry Allen shared this concern. He was worried that investment in the new reactor might have an impact on the scientific development of new directions for the 21st century; that such a large allocation of resources might tie funds up to this one area of scientific endeavour at the expense of others. He reasoned that ANSTO, for instance, 'will certainly require a lot of focusing of research to utilise the reactor, and that's absolutely inevitable. No-one builds a $300-million reactor and then lets people do non-reactor based research'.[115]

3.96 In a similar vein, Dr Jim Green stated that it was of 'endless astonishment' to him that the new reactor:

> …is going to be the largest single investment in a science facility in Australia's history and yet the government did not consult the Chief Scientist, did not consult CSIRO and did not consult ASTEC, the Australian Science, Technology and Engineering Council…That is why we need to be very clear about processes for a non-reactor future for Lucas Heights.[116]

3.97 Ms Jean McSorley was of the same opinion. She told the Committee that she did not think that the scientific community had been approached properly on this issue of priorities in funding the sciences. She stated 'the fact that the Chief Scientist of the Government at the time this proposal was put forward was not asked about this issue is one indication of the bad way in which this issue has been dealt with'.[117]

3.98 The Committee appreciates that funding research and development is a matter of balancing priorities. It takes note of the concern that directing funds into the new research reactor may well inhibit research into other technologies and thwart their potential advancement. The Committee is concerned that the Government took the decision to fund this major project, which will have implications for funding for scientific research in Australia for years to come,

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113 Mr Stephen Campbell, *Committee Hansard*, 25 October 2000, p. 106.

114 Mr Stephen Campbell, *Committee Hansard*, 25 October 2000, p. 106. See also the Medical Association for Prevention of War which supported this viewpoint. It maintains that the nuclear industry throughout the world has received a disproportionate amount of research funding: possible alternative and safer technologies maintain a low profile as with the case of medical isotopes. Dr Susan Wareham, Medical Association for Prevention of War (Australia), *Committee Hansard*, 27 October 2000, p. 267.

115 Radio National Transcripts, *Background Briefing*, 'Lucas Heights: Over Reaction?', Sunday, 29 March 1998.

116 Dr Jim Green, *Committee Hansard*, 26 October 2000, p. 177.

117 Ms Jean McSorley, *Committee Hansard*, 25 October 2000, p. 37.

without a thorough review of the needs of the scientific community. It believes that this key question about the relative importance of the new reactor when placed in the broad context of Australian research and development has not been addressed adequately.

3.99 A recent discussion paper by the Chief Scientist stated:

> World class infrastructure is essential for the generation of world-class research…Australian industry of the future will be reliant on researchers who have access to world-class equipment and facilities. Access to this infrastructure is a key ingredient in encouraging research stars to return to Australia to continue contributing to the knowledge pool.[118]

3.100 Another recent study of research and development in Australia undertaken by the Innovation Summit Implementation Group emphasised this point. It asserted that to create ideas, Australia must seriously invest in research and development. Put succinctly, 'we must maintain a world-class research base, operate in world-class facilities, and access world-class skills'.

3.101 The Committee agrees with this view and uses it to underline the importance of Australia having a very clear understanding of how best to develop its skill base. It argues that Australia should consider carefully its future needs and the major national facilities that will best meet those needs.

Conclusion

3.102 In 1993, the McKinnon Review observed that it was essential to ask whether Australia has the scientists and the intensity of effort in this field to make the purchase of a new reactor a good scientific investment; whether there are alternatives; and whether our industry would be able to exploit its potential if Australia were to buy a new one.[119] This question is as relevant today as it was then.

3.103 Based on the evidence presented to it, the Committee notes that Australian scientists and engineers present a strong case for the new reactor. Australia has both the young talent and experienced researchers able and keen to benefit from using the reactor.

3.104 Having said that, however, the Committee notes that the decision to build a new research reactor was taken without a comprehensive review of scientific research funding in Australia that may have given the Government and the Australian people a better understanding of where investment would be most productive. It is disappointed that the decision about the new reactor was made without broad consultation with the scientific community. In its opinion, an open public debate would have been a means of both informing the

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118 Discussion Paper by the Chief Scientist, August 2000, para 2.5.2.

119 K.R. McKinnon et al., *Future Reaction: Report of the Research Reactor Review*, August 1993, p. 28.

community about science in Australia and allowing interested people to participate actively in examining the question of whether Australia does need a new reactor. It would also have provided a better opportunity for experts in the field to study more closely the alternatives to a nuclear reactor and would have given scientists and engineers a chance to discuss research priorities.