



RESEARCH AND EXPERIMENTAL DEVELOPMENT: ENERGY PRODUCTION, UTILISATION AND CONSERVATION ALL SECTORS, AUSTRALIA 1982-83

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MAIN FEATURES

The estimate of expenditure on Research and Experimental Development (R&D), relating to the production, utilisation and conservation of energy, carried out in Australia during 1982-83 was \$157m. This represents a 62% increase in expenditure compared with 1979-80. At constant (average 1979-80) prices R&D expenditure is estimated to have increased by 9% over the same period. Expenditure on energy R&D carried out by business enterprises (private and public sector) was \$59m, by general government organisations (Commonwealth and State) \$64m, and by higher education organisations \$34m. General government sources funded 66% of all energy R&D.

The estimate of manpower resources devoted to energy R&D carried out in Australia during 1982-83 was 3,222 man years. This represents an increase of 19% compared with 1979-80. Manpower resources devoted to energy R&D undertaken by business enterprises were 1,079 man years (an increase of 10%), by general government organisations 1,155 man years (an increase of 24%) and by higher education organisations 988 man years (an increase of 23%).

EXPLANATORY NOTES

Introduction

This publication presents statistics on the level and distribution of the expenditure and manpower resources devoted to energy R&D carried out in Australia by organisations within the Business Enterprise, General Government and Higher Education Sectors during 1982-83 (for the Higher Education Sector, the statistics relate to the 1982 calendar year). The estimates were derived from data collected in the 1982-83 Survey of Energy Research and Experimental Development and are comparable with the estimates previously published for 1979-80. Tables 1 and 2 compare the summary results from the two surveys. Some limited additional information from both surveys (e.g. State details and more detailed information on energy objectives, sectors of performance and funding) is available on request.

Definitions

2. *Research and experimental development (R&D)* is defined in accordance with the Organisation for Economic Cooperation and Development (OECD) standard as comprising 'creative work undertaken on a systematic basis in order to increase the stock of knowledge, including knowledge of man, culture and society, and the use of this stock of knowledge to devise new applications'. For a detailed description of R&D activity, refer to *Research and Experimental Development, All Sector Summary, Australia, 1981-82* (8112.0).

3. *Energy research and experimental development* refers to R&D activity predominantly directed towards producing, storing, transmitting, utilising and conserving energy. R&D projects classified as energy R&D relate to at least one of the energy objectives shown in the Appendix.

4. *R&D expenditure* includes capital expenditure on the acquisition (less disposals) of fixed tangible assets such as land, buildings, vehicles, plant, machinery and equipment, and current expenditure on such items as wages, salaries, materials, fuels, rent and leasing, repairs and maintenance, data processing, etc., and a proportion of expenditure on general services and overhead costs attributable to the R&D effort.

5. The item *man years of effort on R&D* includes the effort of researchers, technicians and other staff directly supporting R&D. *Overhead staff*, i.e. administrative and general service employees such as personnel officers, canteen staff, pay clerks, janitors, cleaners, groundsmen, etc., whose work indirectly supports R&D, are excluded.

6. *Researchers* refers to persons actually engaged in the conception and/or creation of new knowledge, products, processes, methods and systems. Included are executives and directors responsible for administering the energy R&D programs, but executives and managers who are concerned primarily with budget and manpower constraints rather than program content are excluded. *Technicians* refers to persons performing technical tasks in support of energy R&D, normally under the direction and supervision of a researcher. These tasks include assisting with or performing experiments (under super

vision), tests and analyses; preparing materials and equipment for experiments, taking records, making calculations and preparing charts and graphs; maintaining and operating advanced machinery and equipment; interviewing in social science surveys; and computer programming. *Other supporting staff* refers to skilled and unskilled craftsmen, secretarial and clerical staff working on or directly associated with energy R&D.

7. While the statistics in this publication have been compiled in accordance with the OECD guidelines for the conduct of national R&D surveys, they are not directly comparable with the international statistics on energy research, development and demonstration (RD & D) published by the International Energy Agency (IEA), for two main reasons:

- (a) IEA statistics *exclude* details of *basic research* except where it is clearly oriented towards the development of energy technologies.
- (b) IEA statistics *include* details relating to *demonstration projects* (projects which are aimed at demonstrating the technical and commercial viability of specific products or processes resulting from R&D activities prior to their commercialisation).

Sector classification

8. The sector classification used in the compilation of these statistics is adapted from the guidelines specified by the OECD for use in the conduct of R&D studies. Four institutional sectors are recognised: Business Enterprises, General Government, Private Non-profit and Higher Education.

- (a) *Business Enterprise Sector* includes all firms, organisations and institutions (private and public sector) whose primary activity is the production of goods or services for sale to the general public at a price intended approximately to cover at least the cost of production. It includes the private non-profit institutions mainly serving business enterprises.
- (b) *General Government Sector* includes government departments and other authorities engaged in administration, defence and regulation of public order, promotion of economic growth and welfare and technological development, provision of health, cultural, recreational and other social and community services free of charge or at prices which do not fully cover their costs of production. Also included are other non-profit organisations wholly or mainly financed and controlled by public authorities or which primarily serve government bodies and unincorporated government enterprises producing goods and services for the government itself. Excluded are public sector enterprises mainly engaged in higher education (e.g. universities and colleges of advanced education), trading or financial activities.

(c) *Higher Education Sector* includes all universities, colleges of advanced education (CAE) and other institutions of post-secondary education, whatever their source of finance or legal status. It also includes all research institutes, experimental stations and clinics operating under the direct control of, or administered by, or associated with, higher education establishments.

(d) *Private Non-profit Sector* includes private or semi-public organisations which are not established primarily with the aim of making a profit, and private individuals or households. Non-profit organisations which mainly serve or are wholly or mainly financed and controlled by organisations within the other sectors are excluded from this sector.

Coverage

9. The main exclusions from the survey coverage are:

- (a) *Business Enterprise Sector*—Enterprises mainly engaged in agriculture, forestry, fishing and hunting (i.e. industries in Division A of the ASIC, 1978 edition).
- (b) *General Government Sector*—Local government organisations.
- (c) *Higher Education Sector*—All post-secondary institutions apart from Universities.
- (d) *Private Non-profit Sector*—All organisations.

10. The main reason for excluding these organisations is that, in general, their contribution to Energy R&D is very low.

11. The 1982-83 Energy R&D survey comprised a complete enumeration of organisations which:

- (a) by their response to the 1981-82 R&D surveys and the 1979-80 Energy R&D survey were identified by the ABS as likely to have carried out R&D directed towards energy objectives in 1982-83; or
- (b) were identified from other sources as having carried out significant energy R&D in 1982-83. Such sources included: the list of recipients of grants under the National Energy Research, Development and Demonstration Program (NERDDP); the Department of Resources and Energy's Compendium of Australian Energy Research Development and Demonstration Projects; and reports in newspapers, journals, etc.

12. All universities within the Higher Education Sector coverage were surveyed.

Other classifications

13. Details in Table 3 of this publication are classified by energy objective. The energy objectives shown there are the same as those listed in the Appendix (in respect of which respondents were asked to classify expenditure on energy R&D projects) except that in Table 3 the individual objectives have been combined in different ways primarily to accord with the IEA standard energy technology areas. For a more detailed description of the IEA energy technology areas see the Department of Resources and Energy's *Compendium of Australian Energy Research, Development and Demonstration Projects No 4, June 1983*. The energy objective categories represent ultimate national needs rather than the immediate objectives of the researcher or the organisation performing the energy R&D.

14. In accordance with IEA practice, source of funds data in Table 3 are classified as either Industry or Government. *Industry funds* relate to funds made available by private and public sector business enterprises and private non-profit organisations for energy R&D. This category includes funds made available by business enterprises to conduct their own energy R&D (own funds) as well as the direct funding of the energy R&D activities of other sectors (i.e. the general government and higher education sectors) by business enterprises and private non-profit organisations. *Government funds* relate to funds made available in Commonwealth and State Government Budget Appropriations, to Government departments and authorities, universities and colleges of advanced education, which were used in carrying out energy R&D. This category also includes Governments' direct funding of business enterprises' energy R&D activities by way of grants and donations (e.g. NERDDP and Australian Industrial Research and Development Incentives Board (AIRDIB) grants).

Constant price estimates

15. Constant (average 1979-80) price estimates of energy R&D expenditure for 1979-80 and 1982-83 are shown below. In concept, constant price estimates are measures from which the direct effects of price change have been eliminated. Although expressed in monetary terms, the constant price measures shown in this publication vary only with changes in the underlying quantities in inputs purchased (including labour). In effect, quantities of broadly defined categories of inputs are weighted by their prices in the base year (1979-80). Because the measures relate to input quantities, they do not reflect changes in the efficiency with which labour, capital and other inputs are used.

16. The estimates of wages, salaries and other labour cost components of these constant price estimates were obtained by multiplying, for each broad category of labour, the quantity (man years) of labour used in each period by the relevant average labour cost in the base period. The non-labour cost components were estimated by deflating each current price value by a composite price index of relevant materials or capital expenditure items. In revaluing R&D expenditure, extensive use has been made of price series used in deriving constant price national accounts estimates.

17. The estimates of energy R&D expenditure at constant (average 1979-80) prices are:

1979-80	1982-83(a)	Change
(\$'000)	(\$'000)	(%)
96,632	105,562	9

(a) For the Commonwealth Government Subsector, the current price estimate for 1982-83 is not strictly comparable with the 1979-80 current price estimate due to the recording by some authorities (for the first time) of their contribution to staff superannuation funds in 1981-82; however, the discontinuity in the current price series does not apply to the constant price series.

18. For a more comprehensive description of constant price concepts and estimation procedures see *Australian National Accounts: Concepts, Sources and Methods* (5216.0).

Reliability of statistics

19. The statistics contained in this publication should be interpreted with caution for the following reasons:

- Many respondents did not record data on energy R&D activity separately in their accounts and therefore had to make estimates when completing the survey questionnaire. In addition, the OECD definition of R&D used for this survey differs in some respects from what particular respondents may regard as R&D.
- Universities were not required to report expenditures on energy R&D activities. The estimates of energy R&D expenditure for universities were derived from manpower data supplied by them together with expenditure data supplied by the Commonwealth Tertiary Education Commission from its annual statistical collection.

Related publications

20. Users may also wish to refer to the following publications:

Research and Experimental Development: Energy Production, Utilisation and Conservation, All Sectors, Australia, 1979-80 (8110.0), Australian Bureau of Statistics.

Research and Experimental Development: All Sector Summary, Australia, 1981-82 (8112.0), Australian Bureau of Statistics.

Compendium of Australian Energy Research, Development and Demonstration Projects, Department of Resources and Energy, No. 4, June 1983.

21. Current publications produced by the ABS are listed in the *Catalogue of Publications, Australia*, (1101.0) which is available free of charge from any ABS office.

Symbols and other usages

ASIC Australian Standard Industrial Classification
 n.e.c. not elsewhere classified
 n.p. not available for separate publication (but included in totals where applicable)
 — nil or rounded to zero
 r revised figures

22. Where figures have been rounded, discrepancies may occur between sums of the component items and totals.

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TABLE 1. ENERGY RESEARCH AND EXPERIMENTAL DEVELOPMENT(a), AUSTRALIA, 1979-80 AND 1982-83
TYPE OF EXPENDITURE BY SECTOR OF PERFORMANCE(b)
(S' 000)

Sector of performance(b)	Type of expenditure(d)							
	Total expenditure(c)		Capital expenditure		Current expenditure			
	1979-80	1982-83	1979-80	1982-83	Wages and salaries		Other current	
	1979-80	1982-83	1979-80	1982-83	1979-80	1982-83	1979-80	1982-83
Business enterprises(e)—								
Private	37,653	45,805	12,427	4,852	16,609	28,433	8,618	12,519
Public sector	6,914	13,242	2,748	5,650	3,245	4,795	920	2,796
Total business enterprises	44,567	59,046	15,175	10,502	19,854	33,228	9,538	15,316
General government—								
Commonwealth(f)	31,848	59,719	1,465	7,720	20,878	38,364	9,505	13,636
State	1,311	4,264	414	1,052	739	2,753	158	459
Total government	33,159	63,983	1,880	8,772	21,617	41,117	9,663	14,095
Higher education—								
Universities	18,906	33,756	2,164	3,509	13,125	23,910	3,616	6,337
Colleges of Advanced Education(g)	596	—	210	—	349	—	36	—
Total higher education	19,502	33,756	2,375	3,509	13,475	23,910	3,652	6,337
Total all sectors	97,228	156,785	19,429	22,782	54,946	98,255	22,853	35,747

(a) For definition of energy R & D see paragraph 3 of Explanatory notes. (b) See paragraph 8 of Explanatory notes. (c) Includes expenditure associated with overhead staff providing indirect services to energy R & D. (d) See paragraph 4 of Explanatory notes. (e) Excludes enterprises in ASIC Division A—i.e. enterprises mainly engaged in agriculture, forestry, fishing and hunting. (f) See paragraph 17 of Explanatory notes. (g) See paragraphs 9 and 10 of Explanatory notes.

TABLE 2. ENERGY RESEARCH AND EXPERIMENTAL DEVELOPMENT(a), AUSTRALIA, 1979-80 AND 1982-83
TYPE OF R & D MANPOWER BY SECTOR OF PERFORMANCE(b)
(man years)

Sector of performance(b)	Type of employee(d)							
	Total man years(c)		Researchers		Technicians		Other supporting staff	
	1979-80	1982-83	1979-80	1982-83	1979-80	1982-83	1979-80	1982-83
Business enterprises(e)—								
Private	832.4	917.5	345.3	379.7	261.1	289.9	226.0	247.9
Public sector	147.6	161.6	83.4	88.3	48.1	55.5	16.1	17.8
Total business enterprises	980.0	1,079.1	428.7	468.0	309.2	345.4	242.1	265.7
General government—								
Commonwealth	895.9	1,061.6	421.5	437.2	257.9	263.1	216.5	361.3
State	37.2	93.5	21.4	50.9	13.1	33.9	2.7	8.7
Total government	933.1	1,155.1	442.9	488.1	271.0	297.0	219.2	370.0
Higher education—								
Universities	770.0	988.1	499.9	652.2	235.5	279.6	34.6	56.3
Colleges of Advanced Education(f)	30.9	—	15.8	—	12.2	—	2.9	—
Total higher education	800.9	988.1	515.7	652.2	247.7	279.6	37.5	56.3
Total all sectors	2,714.0	3,222.3	1,387.3	1,608.3	827.9	922.0	498.8	692.0

(a) For definition of energy R & D see paragraph 3 of Explanatory notes. (b) See paragraph 8 of Explanatory notes. (c) Excludes man years associated with overhead staff providing indirect services to energy R & D. (d) See paragraph 6 of Explanatory notes. (e) Excludes enterprises in ASIC Division A—i.e. enterprises mainly engaged in agriculture, forestry, fishing and hunting. (f) See paragraphs 9 and 10 of Explanatory notes.

TABLE 3. ENERGY RESEARCH AND EXPERIMENTAL DEVELOPMENT(a), AUSTRALIA, 1982-83
 DETAILS OF R & D EXPENDITURE BY ENERGY OBJECTIVE(b)
 (\$'000)

Energy objectives(b)		Sector of performance(e)				
Energy codes(c)	Description	Total expenditure(d)	General government and Higher education(f)		Source of funds(h)	
			Business enterprises(f)	Industry	Government	Government
513	Production and utilisation of energy—					
111	Oil and gas—mining extraction techniques	818	n.p.	n.p.	70	748
112,523,533	—refining, transport and storage	3,586	2,620	967	2,633	953
113,114,514,524,534	—other	10,110	2,230	7,880	2,897	7,213
512	Oil shale and tar sands	7,991	n.p.	n.p.	425	7,566
121	Coal—mining extraction techniques	9,520	n.p.	n.p.	5,990	3,531
122	—preparation and transport	9,159	5,136	4,024	3,930	5,230
211	—combustion	5,113	2,808	2,305	2,873	2,240
123,522,532	—other	13,550	2,503	11,046	1,560	11,990
131	Solar—heating and cooling	8,114	3,449	4,665	2,867	5,247
132	—photo electric	5,913	2,778	3,135	2,613	3,300
133	—thermal electric	4,065	682	3,383	329	3,736
141	Nuclear—non-breeder—light water reactor	1,377	431	946	469	907
142	—other converter reactor	1,850	—	1,850	1	1,849
143,511,521,531	—fuel cycle	387	—	—	—	—
144	—supporting technologies	13,980	n.p.	n.p.	736	13,243
145	—breeder	—	n.p.	n.p.	n.p.	n.p.
146	—fusion	—	—	—	—	—
151	Wind	7,714	n.p.	n.p.	n.p.	n.p.
152	Ocean	862	283	578	301	561
153	Geothermal	56	—	56	—	55
221	Biomass	60	—	60	—	60
154	Other sources and new vectors	6,929	2,644	4,285	2,497	4,432
		2,615	2,100	515	1,871	745
	Conservation of energy—					
311	Industry					
312	Residential and commercial	7,708	5,605	2,103	5,283	2,425
313	Transportation	6,062	3,349	2,713	3,133	2,929
314	Other	13,939	8,356	5,582	6,837	7,102
		1,645	1,298	348	1,174	471
	Other energy R & D (including supporting technologies)—					
411	Electric power conversion	4,098	2,533	1,565	2,201	1,897
412	Electricity, transmission and distribution	3,031	497	2,534	535	2,496
413	Energy storage n.e.c.	1,215	640	575	608	606
414	Energy system analysis	2,001	78	1,923	55	1,946
415	Other	3,316	245	3,071	221	3,096
	Total all energy objectives	156,785	59,046	97,739	54,109	102,676

(a) For definition of energy R & D see paragraph 3 of Explanatory notes. (b) See paragraph 13 of Explanatory notes, and the Appendix. (c) See Appendix for a description of each energy code. (d) Includes expenditure associated with overhead staff providing indirect services to energy R & D. (e) See paragraph 8 of Explanatory notes. (f) Excludes enterprises in ASIC Division A—i.e. enterprises mainly engaged in agriculture, forestry, fishing and hunting. (g) See paragraphs 9 and 10 of Explanatory notes. (h) See paragraph 14 of Explanatory notes.

APPENDIX

ENERGY OBJECTIVES

The energy objective categories listed below are based on the International Energy Agency (IEA) classification of energy technology areas. See also paragraph 13 of the Explanatory notes.

<i>Broad objective area</i>	<i>Detailed Energy Objective</i>	<i>Code</i>
Production and utilisation of energy from—	Oil and gas (other than oil shale and tar sands)—Refining, transport and storage	111
	—Other (e.g. safety, health and environmental protection)	112
	Oil shale and tar sands—Refining, transport and storage	113
	—Other (e.g. safety, health and environmental protection)	114
	Coal—Preparation and transport (e.g. degasification, desulphurisation, coking, blending and briquetting)	121
	—Combustion	122
	—Other (e.g. safety, health and environmental protection)	123
	Solar—Heating and cooling	131
	—Photo electric	132
	—Thermal electric	133
	Nuclear—Non-breeder—light water reactor (LWR) including safety, health and environmental protection	141
	—other converter reactors (e.g. HWR, HTR, AGR, SCHWR) including safety, health and environmental protection	142
	—fuel cycle (excluding mine site aspects) including ore, uranium and thorium conversion; enrichment reprocessing; fissile material recycling; transport of radioactive materials; waste treatment; disposal and storage	143
	—supporting technologies (excluding mine site aspects) including safety, health and environmental protection related to the fuel cycle	144
	—Breeder	145
	—Fusion	146
	Other primary sources—Wind	151
—Ocean	152	
—Geothermal energy	153	
—Other sources and new vectors (e.g. hydroelectric, hydrogen, bagasse)	154	
Production and utilisation of synthetic fuels from—	Coal conversion (e.g. gasification and liquefaction)	211
	Biomass	221
Conservation of energy—	Conservation of energy in—Industry (e.g. reduction of energy consumption in industrial processing including development of new techniques, processes and equipment)	311
	—Residential and commercial (e.g. space heating and cooling; building design and materials)	312
	—Transportation (e.g. fuel optimisation; public transport systems; use of alternative fuels and engines)	313
	—Other (e.g. waste heat utilisation; district heating; heat pumps; recycling of wastes)	314
	Other energy R & D—Electric power conversion (e.g. electric power generation and conversion; cooling towers; thermal and air pollution; turboengines; multi fuel gas turbines; magneto-hydrodynamic conversion; boiler R & D)	411
Other energy R & D (including supporting technologies such as electricity transmission and distribution, energy storage, energy systems analysis, etc)—	—Electricity transmission and distribution (e.g. control systems; network problems; super conducting cables; SF insulation; AC & DC high voltage cables; NVDC transmission)	412
	—Energy storage not elsewhere classified	413
	—Energy systems analysis (e.g. sociological, economical and environmental impact of energy not specifically related to one energy objective listed)	414
	—Other (e.g. energy technology information dissemination; studies not related to the specific energy objectives listed)	415
	Extraction techniques—Uranium	511
	—Coal	512
Mining of energy minerals (including resource assessment techniques, and relevant aspects of petroleum geology, geoscience technology, geotechnics, and mining engineering)	—Oil and gas (other than oil shale and tar sands)	513
	—Oil shale and tar sands	514
	Prospecting and resource assessment techniques—Uranium	521
	—Coal	522
Other (e.g. safety, health and environmental protection)—	—Oil and gas (other than oil shale and tar sands)	523
	—Oil shale and tar sands	524
	—Uranium	531
	—Coal	532
—	—Oil and gas (other than oil shale and tar sands)	533
	—Oil shale and tar sands	534