ENERGY R&D PROGRAM

of the

FEDERAL GOVERNMENT

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MOSST
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~~Tentative~~

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Note to the
TASK FORCE on
Procedures of the
Canadian Committee on Financing University Research

The following remarks appear relevant to the discussion which lead to the establishment of the Task Force.

In preparing this working paper on the Energy R&D Program of the federal government, the following guidelines have been followed:

1. The paper was not intended to provide full substantive information on the Program, but to provide a program framework within which to complement federal data by data from provinces and universities.

2. Attention was to be paid to the type of funding in relation to the requirements of the program, although it was felt necessary to define these types of funding in a way that would permit some measure of assessment of the degree of freedom left to university researchers.

3. The paper was to serve as a basis for the Task Force recommendations to CCFUR on the kind of information to be sought from the provincial governments and the universities.

4. Once agreement was reached bn the above by CCFUR, the provincial and institutional representatives were to explore the feasibility of obtaining relevant information from their respective constituencies.

Energy R&D Program of the Federal Government

I. Structure and Management

As early as 1974, a Panel on Energy R&D reporting to the Minister of Energy, Mines and Resources (E.M.&R.) was established.

The Panel defined five major TASKS (or objectives):
- Conservation
- Fossil Fuels
- Nuclear Energy
- Renewable Energy
- Energy Transportation and Transmission

Each TASK is made up of a number of programs, managed under the responsibility of various departments and agencies (see Appendix A). It should be noted that the Program structure is compatible with "An Energy Strategy for Canada" which examines the period to 1990, and with further studies prepared for E.M.&R.'s Long Range Energy Study to year 2025.

The Panel has appointed Coordinators who report to the Panel on the activities of their respective TASKS and programs. In many instances, they report on work being done by more than one department or agency. They, however, do not have the status of managers. The Office of Energy R&D (OERD) of E.M.&R. acts as secretariat to the Panel and coordinates the R&D program between departments and agencies.

II. Federal Government Expenditures on Energy R&D, 1976-77

The survey of these expenditures is carried out by the OERD on the basis of the Program structure already described. A sample of how this information is provided by individual departments and agencies is shown in Appendix B. As can be observed, the narrative proceeds from projects within sub-programs and the quantitative information on personnel and costs are reported by sub-program number and department or agency managing the projects. These constitute, therefore, the basic information on program content and resources allocation.

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1. Expenditures by TASKS and Program and by Sectors of Performance

Table 1 provides a breakdown of expenditures by TASK and program and by Sectors of Performance, that is intramurally, in Industry, in the Universities and in other organizations.

Although detailed analysis by TASK and program could be done for each sector of performance from the available data, the purpose of this paper would be served by analysis at the TASK level only, further disaggregation being only useful to researchers or research managers.

Table 2 shows the relative distribution of total federal expenditures by TASK and sector of performance. This kind of analysis, however, is not too useful for planning at the national level. While it does provide a picture of how federal funds are disbursed, it does not allow inter-sectoral comparisons, since total expenditures are only available for the federal government sector.

It is possible, however, to assess the direction of research in the various sectors, assuming that federal expenditures in the other sectors are representative of the expertise and capabilities of these sectors. This is done by calculating the percentage distribution of funds among the different TASKS for each sector of performance, as shown in Table 3. One can see that each sector shows a different distribution by TASK. Whether this really reflects the expertise and capabilities of the sectors other than the federal government could only be verified if all expenditures in the other sectors were known.

2. Expenditures in Universities

The detail of these expenditures by type of funding, by university and by TASK is shown in Appendix C.

a) Expenditures by TASK and Type of Funding

Table 4 shows that two-thirds of Energy R&D funding in universities by the federal government was allocated by the NRC's Office of Grants and Scholarships for undirected research.

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The table also shows that the other third was allocated in a ratio of 1 to 2 through the Research Agreements Program of EM&R (10.2 percent) as opposed to contracts (20.3 percent).

It is worth noting that the Negotiated Development Grants were all for "plasma physics".

It is also felt necessary to indicate that the Research Agreements Program of EM&R is less binding than contracts on the part of the researcher. This program is designed so that advantage can be taken of the expertise and capabilities that exist in Canadian universities. The department supports projects that are allied to the long-term objectives of its branches. Proposals are solicited by circulating copies of an information guide on the Program. The main feature of this guide, besides outlining the conditions of grants, is a detailed exposé of the objectives and areas of interest of the operational branches of the department, but without indications as to R&D priorities.

This Program may therefore be considered as mid-way between the funding of proposals initiated by the researchers (free research) and that initiated by departments through contracts (fully directed); it might indeed most likely be considered closer to the former type.

It could thus be concluded that only 20 percent of the federal funds allocated for Energy R&D in universities is for "directed" research.

b) Expenditures by Province

Table 5 shows the distribution of federal funds for Energy R&D to universities by province. Universities of four provinces received 86.3 percent of the funds; they were, in decreasing order of magnitude; Ontario, Alberta, Quebec and British Columbia.

Looking at the TASK ranking in each of these four provinces, it can be observed that the pattern is quite different, as shown in Table 6, where the rankings underlined for each province represent 80 percent and over of the total funding in a particular province. Ontario shows the

widest distribution and is the province where 62 percent of the funds for conservation are allocated. The four provinces rank high in Nuclear Energy, but only Quebec shows Renewable Resources to be a strong area of concern in universities, where 45.8 percent of all the funds allocated to this TASK are disbursed. Energy Transportation and Transmission ranks third in all provinces, but one-third of the funds allocated for this TASK are disbursed in Ontario.

Whether this distribution reflects provincial needs or problems, and how a particular pattern evolved, are questions that cannot be answered through this limited set of statistical evidence.

Ill. Federal Expenditures on Energy R&D in 1977-78

The comparative distribution of expenditures among the five TASKS for 1977-78 (Table 7)shows the beginning of a change in emphasis in favor of Conservation and Renewable Resources, at the expense of Nuclear Energy.

Initially, the major increase is taking place in the Renewable Resources. It will be supported by the formation of a Renewable Energy Resources Branch in EM&R to ensure that these alternate forms of energy receive full consideration in policy decisions.

The various areas of new emphasis in Renewable Resources and Conservation are indicated in Appendix D, as well as redirection of interest in Fossil Fuels and Energy Transportation and Transmission.

IV. Federal-Provincial Considerations

The Office of Energy R&D estimates that the 1975-76 expenditures of Provincial governments on Energy R&D were of the following order of magnitude (in millions of dollars).

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Renewable Energy	$ 3 M
Conservation	**21 (see note below)**
Fossil Fuels	8.5
Nuclear Energy	**2**
Energy Transportation and Transmission	**1**
	$ 35.5 M

(*Note: The $21 M Conservation expenditure includes programs on the Improved utilization of fossil fuels, materials conservation and other programs indirectly related to energy conservation which are embraced by Provincial definitions of energy conservation. The figure cannot therefore be directly compared with federal conservation expenditures.*)

Cooperation in energy R&D programs with the Provincial governments is essential and has been included in a number of federal-provincial agreements in energy, for instance (with an indication of the total federal contribution between brackets):

1) Canada – N.B. Coal Program ($3.2)

2) Canada – B.C. North-Eastern British Columbia Coal Development ($1.5M) - Pending

3) Canada - N.B. - N.S. Fundy Tidal Power Agreement ($1.5 M)

4) Canada - Quebec Hydro Quebec Agreement - grant to Hydro-Quebec Research Institute ($0,325 M/year)

5) Canada – N.B. Agreement on Minerals and Fuels Development ($2 M Energy component identified).

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6) Alberta/Canada Energy Resources Research Fund ($96 M in 6 years)

7) Canada - P.E.I. Renewable Energy Research Agreement ($3 M)

8) Canada - Alberta Oil Sands Environmental Research Agreement ($20 M in 10 years)

9) Canada - Saskatchewan Heavy Oil Program ($8 M in 5 years)

Because of the considerable and increasing energy R&D activities of the Provincial governments, both from their own funding and from federal support as shown above, it is most important that the federal energy R&D programs be properly coordinated with those of the Provincial governments, both in their elaboration and in their implementation.

V. Concluding Remarks

1. In Energy, as in any other area, the first step consists in the classification of the fields of research relevant to the objectives defined for the area. Although this has been done at the federal level, it is only through the use of a common framework that the situation can be assessed adequately and future plans developed.

In presenting this model to the provinces, differences such as those indicated in section IV above ought to be taken into consideration. No framework or program structure is perfect, but agreement of all interested parties on a common one is required for program coordination.

2. The existence of complete information, whether substantive, quantitative or both, from only one of the sectors involved, makes it practically impossible to draw conclusions on the situation in sectors for which information is incomplete or to plan funding for these sectors. This can be seen from the above attempts to assess the situation in the provincial and university sectors.

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3. In attempting to develop information from the provincial and the university sectors, the following guidelines appear appropriate:

a) The proposed program structure as developed at the federal level should be followed, even if there is some disagreement with it; these disagreements could be ironed out at a later stage of the process.

b) Sources and destination of funds by sector will have to be clearly identified to avoid double counting.

c) Definitions of what is R&D and what is not, used by all sectors, should be the same; it is suggested that definitions used by MOSST and Statistics Canada should be adopted, as they are comparable to those generally used in the OECD countries.

d) The funding instruments should be described in ways allowing proper assessment of complementarity or differentiation with practices at the federal level.

e) The type of expenditures, current or capital, ought to be clearly defined; for instance, in federal payments to universities, funds that may be used by the institutions for capital expenditures are reported as current expenditures at the federal level. The same might be true in the transfer of funds from provincial governments to their institutions, or from the federal government to the provinces. To avoid double counting, it would appear preferable to include only current expenditures as identified by the source of funds.

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FEDERAL CURRENT EXPENDITURES ON ENERGY R&D 1976-77

($ 000)

TASK / PROGRAM	Federal Government	Industry	University	Other	Total
1. **Conservation (Sub-Total 1)**	6,594	1,996	274	250	9,114
1.1 Energy Efficiency in Buildings	1,768	110	21	75	1,974
1.2 Energy Efficiency in the Transportation System	1,401	312	121	--	1,834
1.3 Energy Efficiency in the Food Supply System	11	19	35	--	65
1.4 Thermal and Material Waste as Energy Sources	17	122	4	--	143
1.5 Municipal and Industrial Waste Energy	288	687	--	--	975
1.6 Energy Efficiency in the Burning of Oil, Gas and Coal	303	125	37	175	640
1.7 Industrial Process	541	390	--	--	931
1.8 Energy Conversion and Storage	1,954	231	38	--	2,223
1.9 Location and Urban Form	259	--	18	--	277
1.10 Consumer Products	13	--	--	--	13
1.11 Efficiency of Energy Distribution Systems	39	--	--	--	39
2. **Fossil Fuels (Sub-Total 2)**	8,405	4,492	1,034	--	13,931
2.0 Conventional Oil and Gas	317	2,860	152	--	3,329
2.1 Oil Sands and Heavy Oils	2,986	298	616	--	3,900
2.2 Coal Gasification and Liquefaction	207	918	120	--	1,245
2.3 Coal Supply	3,468	326	130	--	3,924
2.4 Coal Utilization	1,311	--	16	--	1,327
2.6 Naterials for Resource Industries	116	90	--	--	206
3. **Nuclear Energy (Sub-Total 3)**	86,640	5,871	1,228	--	93,739
3.1 RSD in Support of the Regulatory Function	1,776	--	250	--	2,026
3.2 Securing the Fuel Base: Uranium and Thorium	5,171	--	46	--	5,217
3.3 Nuclear Energy Utilization and Support	78,751	5,871	91		84,713
3.4 Nuclear Fusion	942	--	841	--	1,783
4. **Renewable Resources (Sub-Total 4)**	3,285	910	483	50	4,728
4.1 Development of River and Tidal Power	1,673	592	35	--	2,300
4.2 Solar Energy	1,231	50	310	50	1,641
4.3 Agricultural and Forestry Waste Conversion	75	--	70	--	145
4.4 Wind Energy	13.8	268	68	--	474
4.5 Geothermal Energy	168	--	--	--	168
5. **Energy Transportation and Transmission (Sub-Total 5)**	4,278	1,161	614	--	6,053
5.1 Transportation of Energy Commodities	3,456	552	85	--	4,093
5.2 Transmission and Distribution of Electricity	822	609	529	--	1,960
6. **Overall Coordination**	160	--	--	--	160
6.1 Office of Energy Research and Development	160	--	--	--	160
T O T A L	109,362	14,430	3,633	300	127,725

Relative Distribution of Total Current Federal Expenditures on Energy R&D by TASK and Sector of Performance

1976-77

(Percentages of Total)

TASKS	Sectors				
	Federal Government	Industry	University	Other	All[1]
1	**5.2**	**1.6**	**0.2**	**0.2**	**7.2**
2	**6.5**	**3.5**	**0.8**	-	**10.9**
3	**67.8**	**4.6**	**1.0**	-	**73.4**
4	**2.6**	**0.7**	**0.4**	reg.	**3.7**
5	**3.3**	**0.9**	**0.5**	-	**4.7**
All	**85.6**	**11.3**	**2.8**	**0.2**	**100.0**

JMay not add up exactly, due to rounding up.

Table to

TASK Concentration by Sector of Performance
(Percentages)

Sector of Performance	1	2	3	4	5	TOTAL
Federal Government	6.0	7.7	79.3	3.1	3.9	100.0
Industry	13.8	31.2	40.7	6.3	8.0	100.0
University	7.5	28.5	33.8	13.3	16.9	100.0
Other	83.3	-	-	16.7	-	100.0
TOTAL[1]	7.1	10.9	73.4	3.7	4.7	100.0

[1] Excludes $160,000 for Overall Program Coordination.

Table 3

Federal Funding of University Research by TASK and Type of Funding
for the year 1976-77
($ 000)

	Source and Type	Task 1	TASK 2	TASK 3	TASK 4	TASK 5	TOTAL
($ 000)	NRC: Peer adjudicated Grants	93	290	381	176	524	1,464
	Negotiated Develop. Grants	—	400	557	—	—	957
	(Sub-Total)	(93)	(690)	(938)	(176)	(524)	(2,421)
	EM & R: Research Agreements	57	190	25	36	63	371
	Contracts	89	154	265	206	27	741
	Other: Contracts	35	—	—	65	—	100
	(Sub-Total for contracts)	(124)	(154)	(265)	(271)	(27)	(841)
	TOTAL	274	1,034	1,228	483	614	3,633
(%)	NRC: Peer adjudicated Grants	2.6	8.0	10.5	4.8	14.4	40.2
	Negotiated Develop. Grants	—	11.1	15.4	—	—	26.5
	(Sub-Total)	(2.6)	(19.1)	(25.9)	(4.8)	(14.4)	(66.7)
	EM & R: Research Agreements	1.6	5.2	0.7	1.0	1.7	10.2
	Contracts	2.4	4.2	7.3	5.7	0.7	20.3
	Other: Contracts	1.0	—	—	1.8	—	2.8
	(Sub-Total for contracts)	(3.4)	(4.2)	(7.3)	(7.5)	(0.7)	(23.1)
	TOTAL	7.5	28.5	33.8	13.3	16.9	100.0

Table 4

Federal Funding of University Research by TASK and Province

0 000 and (Percentage[1])]

Province	TASK 1	TASK 2	TASK 3	TASK 4	TASK 5	Total
Atlantic Provinces						
Newfoundland	4 (0.1)	11 (0.3)	12 (0.3)	–	5 (0.1)	32 (0.8)
Nova Scotia	–	7 (0.2)	–	–	–	7 (0.2)
New Brunswick	–	–	–	–	27 (0.7)	27 (0.7)
P.E.I.	–	–	–	–	–	– –
Sub-Total	4 (0.1)	18 (0.5)	12 (0.3)	–	32 (0.8)	**66 (1.8)**
Quebec	37 (1.0)	**6 (0.2)**	389 (10.7)	**221 (6.1)**	99 (2.7)	752 (20.7)
Ontario	170 (4.7)	320 (8.8)	289 (7.9)	142 (3.9)	207 (5.7)	1,128 (31.0)
Western Provinces						
Manitoba	–	–	–	65 (1.8)	18 (0.5)	83 (2.3)
Saskatchewan	**8 (0.2)**	**8 (0.2)**	146 (4.0)	–	85 (2.3)	247 (6.8)
Alberta	55 (1.5)	581 (16.0)	144 (4.0)	**20 (0.6)**	83 (2.3)	883 (24.3)
British Columbia	–	62 (1.7)	233 (6.4)	35 (1.0)	45 (1.2)	375 (10.3)
Sub-Total	63 (1.7)	651 (17.9)	523 (14.4)	120 (3.3)	231 (6.4)	1,588 (43.7)
Unspecified		39 (1.1)	15 (0.4)	–	45 (1.2)	99 (2.7)
TOTAL	274 (7.5)	1,034 (28.5)	1,228 (33.8)	483 (13.3)	614 (16.9)	3,633 (100)

JMay not add up exactly due to rounding.

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TASK Ranking of Federally Supported Energy R&D in Universities of Four Provinces 1976-77

TASK	Provinces			
	Ontario	Alberta	Quebec	British Columbia
Conservation	41	4	4	--
Fossil Fuels	**1**	1	5	2
Nuclear Energy	2	2	**1**	**1**
Renewable Resources	5	5	2	4
Energy Transportation and Transmission	3	3	3	3

[1]Underlined rank numbers represent 80 percent and more of Energy R&D in corresponding TASK area.

Table 7

Total Federal Energy R&D Budgets (1976-78)
($ 000)

TASK	1976-77 $M	1976-77 (%)	1977-78 $M	1977-78 (%)
Conservation	9.1	(7.1)	**12.8**	(9.3)
Fossil Fuels	14.0	**(11.0)**	15.5	(11.3)
Nuclear Energy	93.7	(73.3)	93.7	**(68.0)**
Renewable Energy	4.7	(3.7)	9.1	**(6.6)**
Energy Transportation and Transmission	**6.1**	(4.8)	6.5	(4.7)
Coordination	**0.2**	**(0.1)**	**0.2**	**(0.1)**
TOTAL	127.8	(100.0)	137.8	(100.0)

1Of this amount 83.4 will be expended by AECL in the following manner:

Power Reactor Systems	29.7
Nuclear Fuel Cycle	15.9
Environmental Protection and Radioactive Waste Management	7.4
Heavy Water Processes	8.4
Underlying and Advanced Systems Research (some medical research work included in this item)	**22.0**

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Appendix A

TASK and Program Structure for Federal Energy R&D

Task 1 Conservation

- Program 1.1 Energy Efficiencies in Commercial Buildings and Residences (NRC - DBR)
- Program 1.2 Increase Energy Efficiency in the Transportation Sector (TC - TDSS)
- Program 1.3 Improve Energy Efficiency in the Food Supply System. (AC)
- Program 1.4 Recovery of Energy from Thermal Power Plants (EMR - OEC)
- Program 1.5 Municipal and Industrial Wastes Energy (DFE - EPS)
- Program 16. Energy Efficiency in the Burning of Oil and Gas (EMR - CANMET)
- Program 1.7 Industrial Processes (ITC)
- Program 1.8 Energy Conversion, Heat Transfer and Storage (NRC)
- Program 1.9 Energy and Urban Form (MSUA)
- Program 1.10 Consumer Products and Lifestyles (CCA)

Task 2 Fossil Fuels

- Program 2.0 Conventional Oil and Gas (EMR - CANMET)
- Program 2.1 Oil Sands and Heavy Oils (EMR - CANMET)
- Program 2.2 Coal Gasification and Liquefaction (EMR - CANMET)
- Program 2.3 Coal Supply (EMR - CANMET)
- Program 2.4 Coal Combustion (EMR - CANMET)

Task 3 Nuclear Energy

- Program 3.1 Nuclear Regulatory Research (AECB)
- Program 3.2 Securing the Fuel Resource Base - Uranium and Thorium (EMR)
- Program 3.3 Nuclear Energy Utilization and Support (AECL)
  - 3.3.1 Power Reactor Systems
  - 3.3.2 Nuclear Fuel Cycle
  - 3.3.3 Environmental Protection and Radioactive Waste Management
  - 3.3.4 Heavy Water Processes
  - 3.3.5 Underlying and Advanced Systems Research
- Program 3.4 Nuclear Fusion (NRC)

Task 4 Renewable Resources

Program 4.1 Potential for Future Development of River and Tidal Power (EUR - EPS)

Program 4.2 Use of Solar Energy (NRC)

Program 4.3 Conversion of Agricultural and Forestry Biomass to Energy (AC)

Program 4.4 Wind Energy (NRC)

Program 4.5 Geothermal Energy (EMR - EPB)

Task 5 Tranpsortation and Transmission of Energy Commodities

Program 5,1 Transportation of Energy Commodities (TC - TDSS)

Program 5.2 Transmission and Distribution of Electricity (EMR - EPS)

Appendix B

Inventory Format for the Survey of Energy R&D by Departments and Agencies of the Federal Government

Task: Conservation

Program: Energy Efficiency in Buildings

Program: Development of Technology to Minimize Energy Consumption

OBJECTIVE

To develop techniques and technology to reduce the energy used in spaed heating and cooling.

WORK

The Sub-Program work, which has been going on for many years, has a current emphasis on technology for the retrofitting of existing buildings, improved designs for new buildings and improved control of heating and cooling equipment. Work is also being done on the analysis of energy systems and the preparation of new building standards.

The above work includes the following projects:

Project OERD 1.1.1.1 - Establishment of Limits for Environmental Conditions in Occupied Space;, Establishment of appropriate maximum and minimum levels for temperature and humidity, minimum amounts of fresh air and minimum illumination levels for different types of occupancies.

Project OERD 1.1.1.2 - Development of Procedures and Data for Designing HVAC Systems and Model1ing System Performance. The development of algorithms to simulate and evaluate the performance of HVAC systems, including studies of coils and fenestrations.

Project OERD 1.1.1.4 - Development Work for Companies Making Components for Building Enclosures, Provision of a testing service for hygrothermal properties of building materials, development of new test methods and standards, testing of wall, window and door assemblies under simulated in-service condition, and development of sealed doublo glazing units.

Project OERD 1.1.1.6 -Heat Pumps. Identification of conditions for the economic use of heat pumps for heating or cooling buildings, development of standards and test procedures in cooperation with the Canadian Standards Association and design of a field project.

Projects 1.1.1.1 through 1.1.1.6 are the responsibility of the National Research Council.

Project OERD 1.1.1.8 - Development of Design Analysis Techniques for Evaluation of District Energy Systems. Development of existing and new programs for use by engineers in both public and private sectors; development of new algorithm.

Reference "Ottawa Master Plan Study" by Design and construction branch, Department of Public Works. October 1975, Responsibility of Department of Public Works.

Project OERD 1.1.1.10 - Development of Procedures and Data for Designing HVAC Systems and Modelling Systems Performance. Compilation, evaluation and development ot various energy systems analysis (ESA) computer programs with special reference to the Meriwether ESA series.

Reference "Reference Manual on ESA Series" by Technological Research and Development Branch, Department of Public Works. November 1975 (under continuous revision). Responsibility of Department of public Works.

Sub-Program Director:

Updated:

Tnvik!

Program:

Sutt Program:

Application of Electronic Technology to the Horn Efficient Utilization of thvergy. The application of new electronic technology to the minimization of the use of utility generated energy in households; the optimization of energy conversion and storage at the domestic level and the development of economical and efficient DC/AC power inverters, are some of the subjects undur investigation. Responsibility of the National Research Council.

Program Director: Dr. D.G. Stephenson,
Division of building Research, National Research Council,
Montreal Road, Ottawa, Ontario. K1A 0R9. 6U-993-H21

Updated: 31 January 1977.

Appendix C

ENERGY

Federal Grants and Contracts by
Program and Sub-program and
by University
1976-77

Abbreviations

RAP - Research Agreement Program of EM&R
UUG - Undirected University Grants from NRC's Office of Grants and Scholarships
NDG - Negotiated Development Grants from NRC's Office of Grants and Scholarships
Contracts - All contracts from EM&R unless otherwise specified

TASK 1 - Conservation

Program (Sub-program)	Grant/ Contract	University	Amount[1] ($000)
1.1	RAP	Carleton	21
1.2	RAP	Carleton	18
	UUG	Carleton	9
	"	Toronto	5
1.2.3	Contract	Montreal	8
	"	Calgary	4
1.2.5	"	Queen's	45
1.2.6	"	Calgary	11
1.2.7	"	Montreal	14
1.2.8	"	Queen's	5
	"	Toronto	2
1.3.1	Contract (Agriculture)	Saskatchewan	8
1.3.2		Guelph	27
1.4	UUG	Queen's	4
1.6	UUG	Calgary	22
	"	Laval	15
1.8	UUG	Toronto	34
	"	Memorial	4
1.9	RAP	Carleton	18
T O T A L			274

[1] Amounts may represent more than one grant or contract.

TASK 2 - Fossil Fuels

Program (Sub-program)	Grant/ Contract	University	Amount ($000)
2.0	RAP	Memorial	11
	"	(Unspecified)	20
	UUG	Alberta	21
	"	Calgary	12
	"	Toronto	20
	"	N.S.T.C.	7
2.0 - 10.4	Contracts	Carleton	60
	"	Ottawa	1
2.1	NDG	Alberta	400
	UUG	Alberta	58
	"	Calgary	6
	"	Queen's	16
	"	Saskatchewan	8
	RAP	Calgary	30
	"	Ottawa	8
2.1.2	Contract	Western	90
2.2	RAP	Alberta Res. Council	10
	"	Carleton	15
	"	McGill	6
	"	McMaster	16
	"	U.B.C.	15
	UUG	Calgary	39
	"	Toronto	6
	"	U.B.C.	13
2.3	RAP	Queen's	6
	"	U.B.C.	34
	"	(Unspecified)	19
	UUG	Alberta	5
	"	Western	42
	"	Waterloo	21
2.3.10	Contract	Toronto	3
2.4	UUG	Queen's	16
T O T A L			1,034

TASK 3 - Nuclear Energy

Program (Sub-program)	Grant/ Contract	University	Amount ($000)
3.1	Contract	Alberta	75
	"	Carleton	9
	"	I.N.R.S.	20
	"	U.B.C.	28
	"	Toronto	32
	"	Waterloo	86
3.2	RAP	Ecole Polytech.	10
	"	(Unspecified)	15
3.2.1	Contract	McMaster	15
		Queen's	
3.2	UUG	Western	6
3.3	UUG	Carleton	11
	"	I.N.R.S.	7
	"	McMaster	23
	"	Toronto	16
	"	Western	22
	"	Memorial	12
3.4	NDG	U. du Quebec	206
	"	Saskatchewan	146
	"	U.B.C.	205
	UUG	Alberta	69
	"	I.N.R.S.	108
	"	McMaster	30
	"	Western	10
	"	Montreal	38
	"	Trent	7
	"	Toronto	22
T O T A L			1,228

TASK 4 - Renewable Energy

Program (Sub-program)	Grant/ Contract	University	Amount ($000)
4,1	RAP	McMaster	16
	UUG	Laval	11
	"	Sherbrooke	8
4.2	RAP	Toronto	20
	UUG	Alberta	9
	"	Calgary	11
	"	Western	7
	"	U.B.C.	33
	"	Ecole Polytech.	5
	"	Toronto	19
4.2.1	Contract	Waterloo	75
	"	McGill	131
4.3	UUG	Waterloo	5
4.3.1	Contract (Agriculture)	Manitoba	65
4.4	UUG	McGill	17
	"	U.B.C.	2
	"	Sherbrooke	49
T O T A L			**483**

TASK 5
Energy Transportation and Transmission

Program (Sub-program)	Grant/ Contract	University	Amount ($000)
5.1	RAP	Calgary	8
	"	Laval	10
	"	(Unspecified)	23
	UUG	Calgary	17
5.1.11	Contract	Toronto	2
	"	Saskatchewan Res. Council	25
5.2	RAP	(Unspecified)	22
	UUG	Alberta	7
	"	Calgary	51
	"	Memorial	5
	"	Laval	24
	"	McGill	12
	"	Manitoba	18
	"	I.N.R.S.	11
	"	Waterloo	99
	"	Windsor	37
	"	Ottawa	6
	"	Ecole Polytech.	42
	"	Saskatchewan	60
	"	U.B.C.	45
	"	U.N.B.	27
	"	Toronto	63
T O T A L			614

Appendix D

Federal Energy R&D Projects to be funded in the Fiscal Year 1977-78

Conservation (TASK 1)

Significant limitations of energy demand can be obtained through replication of research and development on conservation measures. One important thrust for new RJjD funding is to increase the efficiency of industrial processes. Industry uses about 30 percent of our annual energy consumption. Since large gains can be made in this area, the proposed funding, which will encourage and complement private sector expenditures, is expected to give a significant return in the short term. The new funding also emphasized other areas, such as transportation, waste heat utilization, recyclying and the use of heat pumps for Canadian conditions.

Developing technology for efficient use of energy in industry

Developing technology to minimize energy consumption in buildings

Establishing energy conservation standards for buildings

Transferring technology for minimizing energy consumption in buildings

Studies on bulk and individual metering

Determining conditions for improving automobile fuel efficiency

Developing automobile engines with combustion and characteristics suited to achieving optimum fuel economies in Canada

Determining parameters of automobile energy demand

- Examining energy-efficient urban configurations
- Recovering waste heat from thermal power plants
- Reducing energy consumption by recycling/recovering Vaste
- Improving efficiency of thermal power stations

Improving cncrgy-efficiency of urban passenger transportation

Reducing energy consumption in bulk freight transportation

Reducing energy consumption in urban goods transportation

Developing the use of hydrogen in the energy system

Developing electrochemical energy storage devices

Developing energy-efficient industiral electrocatalysts

Fossil Fuels (TASK 2)

There is a vital need to generate new fluid supplies to replace the rapid decline in conventional domestic supplies. The programs proposed include development of:

- Methods for exploiting and processing oil sands and heavy oils
- Methods of substitution of coal for oil and gas in the near term, including new methods for its utilization
- Methods for the improved and safe extraction of coal from Canadian fields.

Improving liquid yield from oil sands

Developing the technique of spherical agglomeration of oil sands

Heavy Oil development program

Improving technologies of coal conversion by gasification and liquefaction

Improving technology of mining Canadian coal deposits

Improving technology of combustion of Canadian coals

Improving beneficiation techniques for Canadian coals

Developing the technique spherical agglomeration of fine coals

Relating geoscience concepts to estimating coal resources

Renewable Resources (TASK 4)

The bulk of funding for renewable energy systems will go towards the demonstration of solar heating in new and existing buildings, the development and testing of solar heating components, and the assessment of the energy potential of wind and the development of vertical axis windmills. Investigations into the production of liquid and gaseous fuels from forestry and agricultural biomass will be accelerated. The prospects for geothermal heat will continue to be assessed. The applicability of these resources depends sharply on local geographical, geological and climatic circumstances and also on the cost and availability of other sources of power. Programs are recommended for the evaluation and demonstration of these resources for specific Canadian conditions.

Assisting Canadian industry to develop solar heating equipment

Remonstrating and monitoring solar heating systems and components

Developing capability to retrofit solar heating to existing Canadian buildings

Building a test facility for seasonal solar heating systems other than collectors

Developing methodology for researching climatic design for Canadian solar heating systems

Developing heat pumps and solar heating optimised for Canadian conditions

Researching basic science of directly converting solar energy to electricity

Improving measurement of 300-3000 Nanometer solar radiation

Defining the spectral distribution of solar energy

Assessing national wind energy potential particularly for vertical axis turbines

Researching the basic biology of anaerobic fermentation

Maintaining awareness of Canadian prospects for geothermal heat