Energy, Mines and Resources Canada
Office of Energy Research and Development

Énergie, Mines et Ressources Canada
Bureau de recherche et de développement énergétiques

Canada

PLAN
OF THE
ENERGY RESEARCH AND DEVELOPMENT
PROGRAM

OF THE
INTERDEPARTMENTAL PANEL ON
ENERGY RESEARCH AND DEVELOPMENT

OF THE
GOVERNMENT OF CANADA

OFFICE OF ENERGY R&D
ENERGY MINES AND RESOURCES
DECEMBER 1990

OERD 90-08

FOREWORD

In 1988, the Federal Government reaffirmed a multi-year Plan for the federal Energy Research and Development Program. This supports the Government's priorities for economic renewal and, latterly, for sustainable development, and is coordinated between managing departments by the Panel on Energy Research and Development (PERD).

This document is the current version of the Plan, updated by one year since the previous version (OERD 90-3, February 1990). It describes the policy rationale, objectives, organization, review and management, R&D strategy and content, and the means of applying the results of research being funded under the Plan in the major energy supply and demand sectors.

The Panel's secretariat, the Office of Energy Research and Development (OERD), has constructed this Plan from documents at more detailed levels, prepared for the purposes of management and review. The "1990 Progress Report on Deliverables" (OERD 90-07) is the companion reference document to this Plan.

OERD would like to acknowledge the help and assistance of colleagues in many federal departments and agencies who helped prepare the earlier version of this report and who helped with this version by preparing, analyzing and approving, during the summer of 1990, the projects and deliverables upon which this report is based. Any questions concerning its content should be addressed to:

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PART 1

OVERVIEW OF THE PROGRAM

Historical Background

In 1973, the first OPEC oil embargo precipitated major changes in the energy policies of Western industrialized countries. These countries, including Canada, responded by collaborating in the International Energy Agency (IEA), investing in energy R&D to find and develop alternative sources of energy, and developing programs aimed at achieving efficiencies in the use of energy. The driving force was an overriding concern about energy security.

In Canada, the government formed a committee, with membership of Assistant Deputy Ministers from about 20 departments, to coordinate federal R&D across all energy technologies (except nuclear fission). This committee became the Interdepartmental Panel on Energy R&D (PERD) and began receiving an increasing annual budget to distribute and coordinate among government science departments.

By the early 1980s, the Government of Canada's Energy R&D Program had the four principal objectives of: using energy efficiently, particularly oil; developing indigenous resources; diversifying the energy economy to be less reliant on oil; and developing long-term alternate energy sources.

The annual budget for the Energy R&D Program peaked at about $170 million in 1984. Subsequent budget cuts, initiated in November 1984 to meet deficit reduction requirements, have halved the funding to a current FY 90-91 level of $90.1 million. The Government's response to major public criticism of cuts to the Program was to announce, in 1985, its commitment to continue the Program at the reduced level whilst seeking increased collaboration with industry and provincial agencies.

New Program Context

In Canada, in 1988, the Energy Options process of national consultation on energy policy found that:

> "Canada's energy policy should encourage a diversified and flexible research, development and demonstration program that adapts to changing demands, offers security by extending choice, and contributes to environmental sustainability".

As well, it noted that:

> "Commitment to research, development and management of technology is critical to enhancing Canada's energy choices and environmental quality into the 21st century".

This echoed the findings of the House of Commons Standing Committee on Energy, Mines and Resources.

There is no question that developed countries' energy policies, including those for science and technology, are feeling pressures more and more from environmental concerns articulated by Energy Options and other sources. We have been reminded, by the 1987 Bruntland Commission Report and the 1988 Toronto Conference on the Changing Atmosphere, of the importance of developing energy systems which sustain the quality of the environment. It is also being realized that we require a better understanding of the relationship between atmospheric build-up of greenhouse gases, climate change and our choices of energy supply and end-use technologies.

In this context, in September 1988, the Government reapproved and announced its commitment to the federal Energy R&D Program, which is designed to "sustain a diversity of environmentally compatible energy supply and end-use efficiency opportunities, regionally balanced, for the short, medium and long terms while encouraging the greatest possible participation by the Canadian private sector and provincial

governments." This interdepartmental Program funds the majority of federal R&D in all energy supply and end-use sectors except the CANDU nuclear fission technology, which is in the mandate of the Atomic Energy of Canada Limited.

The government's decision means that the Program received approval for a further four years (FY 89-90 to 91-92, with notional approval for FY 92-93) with some shifts in technical emphasis from fossil fuels to energy efficiency, alternative energy sources and the environmental effects of energy supply and use. A new laboratory of EMR's Canada Centre for Mineral and Energy Technology (CANMET) has been established at Varennes, Quebec, where efficiency, alternative energy and the environment are addressed.

The Program's shifting emphasis continues to be compatible with other events. In Paris in May, 1989, the IEA issued a communique following a meeting of its governing board at the ministerial level. This communique, endorsed by Canada, included the following resolution:

> "Ministers agreed upon the continued and increasing importance of energy technology and RD&D not only (for environmental protection) but also in general, as an essential basis for maintaining energy security in the long term. They agreed that it should be intensified in all Member countries across the full spectrum of laboratory development, testing, pilot plant and prototype demonstration, and dissemination and commercialization and within a context of strong international collaboration; government and private sector participation within competitive energy markets; and cost effectiveness (sic). Ministers noted the results of the IEA/OECD expert seminar on technologies for reducing greenhouse gas emissions, and agreed that the main priorities for future IEA RD&D activities should include technologies for better energy efficiency; for more environmentally acceptable use of coal; for enhancing the availability of low cost indigenous oil and natural gas resources; for increasing the accessibility of remote natural gas reserves; for renewable sources of energy and their effective integration into energy systems; for upgrading the reliability, flexibility and efficiency of the electricity sector; and for improving nuclear fission technologies and demonstrating the feasibility of nuclear power fusion systems."

All the preceding has some bearing on the direction of the PERD objective, stated in last year's version of this document and repeated below.

Objective

By helping to expand Canada's energy supply options and to use energy more efficiently, an enhanced and redirected R&D effort will increase the diversity and flexibility of the domestic energy system. In doing so, a more competitive marketplace for energy should result -- one which would be better able to satisfy the future needs of Canadians. Thus, the formal objective of the Program includes:

> "providing the science and technology for a diversified, economically and environmentally sustainable energy economy."

Rationale

Energy R&D is an integral part of a process of innovation and industrial development, thus influencing the range of technologies available to consumers and producers of energy. Energy research and development not only affects the choices available to these groups, but also supports a wide variety of policy related activities. The federal Program is one element in the total Canadian investment in energy technology. It is, however, crucial, covering areas which industry cannot be expected to support alone. These include:

- providing a technical basis for codes, standards and regulations to protect the public, workers and the environment;
- providing a technical basis for services essential to energy activities (weather, sea and ice forecasts; hydrographic charts) and a regional understanding of environmental processes affecting energy supply and use;
- advancing the knowledge of the Canadian energy resource base;
- developing independent expert opinion to review industry proposals and present evidence in public commissions of enquiry (Ocean Ranger, EARP hearings, NEB hearings);
- assisting industries in the development and adoption of higher-risk, new technologies with potential to improve their position in expanding domestic and foreign markets (e.g., coal) or increase yields from existing resources (e.g., heavy oils); and
- maintaining a base of expertise and participating in long-term international development (e.g., renewables, fusion).

Without the technical information provided by this Program, the Government would be vulnerable when making energy related decisions with environmental and public health and safety implications. This applies particularly to energy efficiency measures, coal, alternative transportation fuels and frontier oil and gas development. In addition to the preceding, the government's response to environmental concerns such as climate change will rely heavily on the technical anlysis and solutions offered by the program.

Market oriented energy policy does not preclude government support for R&D. The government recognizes that R&D has a special role to play in terms of basic research, and that the risks and long lead times associated with energy R&D are such that the private sector cannot be expected to support this activity on its own. Long-term stability which government support provides is needed for efficient conduct of energy R&D and is necessary, given current concerns on environmental issues and the possibility of disruptions in energy supplies from the Middle-East.

The Energy R&D Program provides a coordinated focus and the funding for the majority of Canada's international collaboration in energy R&D other than nuclear fission. This includes the U.S.-Canada Memorandum of Understanding on Energy R&D, bilateral agreements with other nations, and commitments to the cooperative R&D activities of the International Energy Agency (IEA). The considerable benefit of Canada's participation in the IEA has been assessed for the period 1974-1985 (reference: "Assessment of Benefits From Canadian Participation In Collaborative Energy Research and Development Under the International Energy Agency 1974-1985"
OERD 87-05). This assessment judged that the Program stimulated an average leverage of 5:1 on direct costs. The continuation of the Program meets the recommendation of an IEA review of October 1988.

Overview of Content and Priorities

The approval of the Program keeps energy R&D expenditures by federal and provincial governments comparable to those of Canada's partners in the IEA (Figure 1). It continues, for a further four years, the base funding for the majority of the energy R&D activity other than the nuclear fission program of Atomic

Energy of Canada Ltd. (Figure 2).

Existing federal laboratories in Ontario, Manitoba and Alberta, addressing particular nuclear energy and oil sands/heavy oils, influence the regional distribution of total federal energy R&D expenditures. Recognizing that redistribution through the competitive contracting process is unlikely, a deliberate reallocation has been made within the Program to begin to redress this regional imbalance by establishing a federal energy R&D laboratory in Quebec.

The Federal Program has been designed to place priorities on:

- securing a diversity of technological options in all energy supply and end-use sectors (Figure 3)
- balancing the interests of Atlantic and Western Canada, Quebec and Ontario
- providing a balance among R&D aimed at short, medium and long term energy applications
- addressing environmental, health and safety issues (Figure 4)

While the Program's objectives are energy related, projects funded recognize the environmental implications of energy supply, distribution and use. Over one-third of the Program's expenditures are focused on R&D to understand these implications and to develop energy technologies which are more environmentally compatible. Research in long-term energy-environment issues (e.g., carbon dioxide and climate change) has been expanded. The deliberate integration of energy and environmental objectives into the selection of technologies to pursue under the Energy R&D Program has been strongly endorsed by an OECD review team in April 1988.

Further, more specific details of the objectives, policy relevance and activities of the Energy R&D Program are provided in PART 2 (OVERVIEW OF PROGRAM TASKS) of this Plan.

The Program has already yielded considerable benefits (reference: "An Assessment of the Economic and Energy Supply Benefits From the Energy R&D Program Administered by the Federal Interdepartmental Panel on Energy R&D" OERD 85-03). The Program is designed and conducted in such a fashion as to continue to maximize its contribution to Canadian economic growth by providing the technologies and opportunities to:

- develop a variety of new industries across Canada;
- achieve substantial energy savings;
- expand markets especially for coal and electricity;
- develop resources (oil sands, bitumen, heavy oils, frontier oil and gas) in environmentally acceptable manners;
- maintain a diversity of options for longer-term, environmentally compatible energy supply; and
- support the development of research capability and centres of expertise throughout Canada.

Program Delivery

The federal Energy R&D Program is uniquely interdepartmental (Figure 5). EMR plays the major role, but ten other departments such as Transport, Environment, Fisheries and Oceans, Agriculture, and Public Works are significant partners. This ensures that energy technologies are developed which are appropriate to the various sectors of the economy.

The Panel on Energy R&D (the Panel or PERD), charged with continuing to coordinate the Program, is an ADM-level committee of the managing departments and four central agencies, chaired by EMR. The Panel advises the Minister of EMR, and has a mandate to implement a coordinated federal program on energy R&D; advises Treasury Board on the allocation of funds for energy R&D; coordinates energy R&D activities in the federal government, including the federal approach to major international and federal-provincial initiatives; follows the course of the government's environmental agenda and tailors the

Program accordingly; and provides for the exchange of information on energy policy and strategies which would affect the direction of federal energy R&D programs.

The Panel provides a forum for interdepartmental discussion and cooperation, making it responsive to a variety of government objectives. The Office of Energy R&D (OERD) in EMR is the secretariat to the Panel.

The Panel has organized the Program into seven broad technology areas called "Tasks". They are:

Task 1 - Energy Efficiency
Task 2 - Coal
Task 3 - Nuclear Fusion
Task 4 - Renewable Energy and Generic Environment
Task 5 - Alternative Transportation Fuels
Task 6 - Oil, Gas and Electricity
Task 7 - Coordination and International Participation

Every three years, the Panel returns to Cabinet for reapproval of the Program and its strategy. This reflects broad shifts in funding emphasis and any required changes in the delivery process of the Program. Upon approval, OERD undertakes to organize and coordinate the delivery of the Program. Within a continuous five-year planning framework, the Panel recommends a package of work, with appropriate resource allocation, annually to the Minister of Energy, Mines and Resources, who then makes recommendations to Treasury Board. This is the Fall Multi-Year Operational Plan (MYOP) exercise (reference PART 3 of this Plan). After approval, resources are placed in the budgets of the participating departments and agencies to manage the delivery of their parts of the Program.

PERD resources augment existing budgets of the participating departments in order to accelerate and coordinate their response to federal energy policy objectives within their largely non-energy policy mandates.

Programs within these Tasks are coordinated by interdepartmental committees which establish detailed R&D priorities and select a portfolio of projects. These committees have a variety of members fom industry, academia, provincial and federal governmnents depending on the particular subject matter. Current membership is described and listed in the PERD Committee Directory, issued by OERD.

Once the Panel has approved the portfolio of R&D recommended by committees, particlpating departments are held accountable for meeting the specific "deliverables" for each project. Monitoring and review of these deliverables is undertaken on a continual basis. OERD prepares a yearly update to the deliverables which is used as a technical audit tool. The "deliverables report" is an integral part of the PERD planning exercise and is thus the companion reference to this Plan document.

The Program delivery is designed to be compatible with the Government's Decision Framework for Science and Technology. About 60% of the Program (over $50 million) is contracted out to a variety of Industries, utilities, provincial research organizations and universities across Canada. Leverage is increasing as federal energy laboratories such as CANMET meet specific cost-sharing targets. The major energy industries in Canada have expressed their support for the Program through associations such as the Canadian Electrical Association and the Coal Association of Canada and through participation in energy R&D committees and committees advisory to Ministers, notably the Minister's National Advisory Council on CANMET.

Evaluation and Review

Energy R&D projects are developed in concert with A-base projects and are subject to the same rigorous review. The full scope of departmental reviews has been surveyed by the Office of Energy R&D, (reference: "Departmental Evaluations of Energy R&D" OERD 88-01). Internal Audit Groups evaluate management and efficiency in delivering programs. Annual line-management project reviews involve consultation with other government departments and the private sector for relevance and peer review for technical merit and performance. Annual department-wide reviews of research priorities take account of advice to Ministers from review committees of the private and academic sectors and provincial governments. Energy R&D is assessed as a component of each department's annual science and technology activities. It is also summarized in EMR's ASTP to demonstrate EMR's policy leadership and the Panel's coordination role. The Program is also reviewed to ensure consistency with other R&D programs of the Government of Canada.

The Panel arranges for strategic and technical reviews of Energy R&D through its interdepartmental committees, all of which solicit external advice (industrial, academic, and provincial) and participation through a variety of mechanisms including direct membership, workshops and project steering committees.

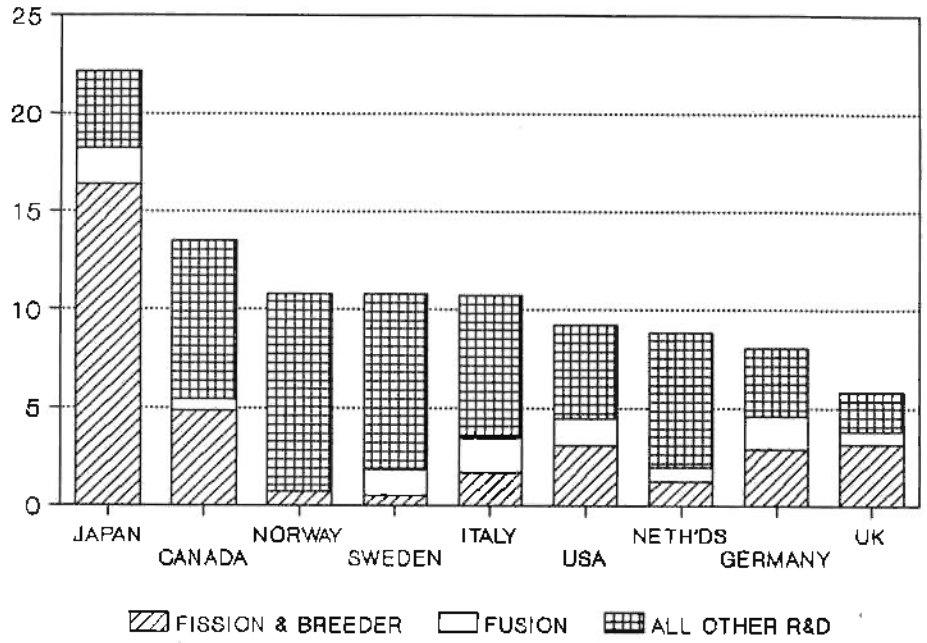
The Panel has initiated a further technical audit procedure to monitor the output of the Program against its objectives. The first year's progress report (reference: "1987 Progress Report on Deliverables of the Energy Research and Development Program Administered by the Federal Interdepartmental Panel on Energy R&D" OERD 87-04) showed success in improving the focus and delivery of the Program and the process is continuing. In response to recommendations of the Auditor General, periodic reviews of major technical areas are now contracted-out by the Panel. The results of the review are presented later, in the descriptive section for Task 5.

In fiscal 1990-91, the Panel contracted a $630K program evaluation, under the guidelines published by the Office of the Comptroller-General. The study looks at seven issues: is there a continuing need for the program; is the focus and balance of the program appropriate; is there incrementally and complementarity; how effective is the delivery process; what have been the benefits; what are the results; and, should the funding levels be changed?

The determination of the issues, the details of the methodology and the administration of the contract have been carried out under the auspices of a Program Evaluation Working Group, set up by and reporting directly to the Panel. This Working Group will report at the end of fiscal 1990-91 and the results will be discussed at a extensive meeting of the Panel, and selected advisors, in May of 1991. This meeting, and the results of the Program Evaluation, will determine the details of the 1992 Cabinet Submission. As a matter of interest, the PERD Evaluation will be the first program evaluation of a multi-departmental science program within the Canadian Federal Government and will be taken as a model for future evaluations.

FIGURE 1

PER CAPITA GOVERNMENT ENERGY R&D EXPENDITURES OF SELECTED COUNTRIES 1989 (IN $U.S.)

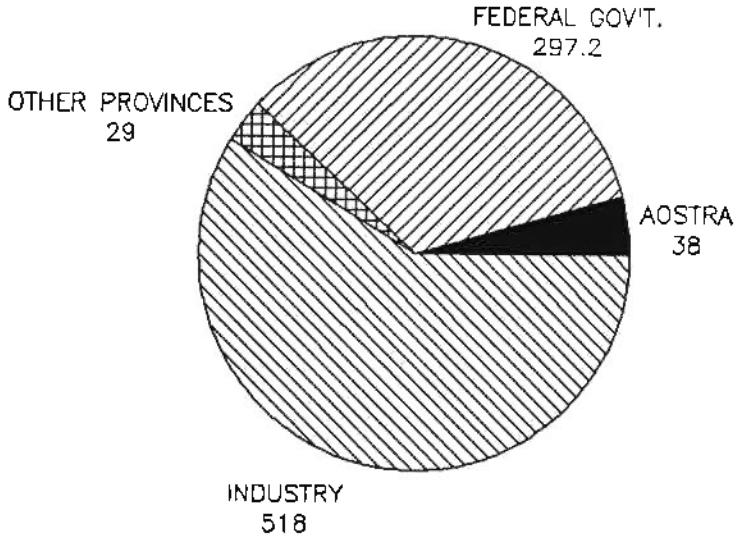


Notes: The figures for Canada are made up of expenditures by the federal government (about four-fifths) and provincial governments (about one-fifth).

Source: The total figures for each country were obtained from: Energy Policies and Programs of IEA Countries, 1989 Review, International Energy Agency. The per capita calculation was done by the Office of Energy R&D, EMR.

FIGURE 2

MAJOR COMPONENTS OF CANADIAN ENERGY R&D
1988 (INDUSTRY) AND FISCAL YEAR 1989-90 (GOVERNMENTS)
($ MILLION, IN 1989-90 $)

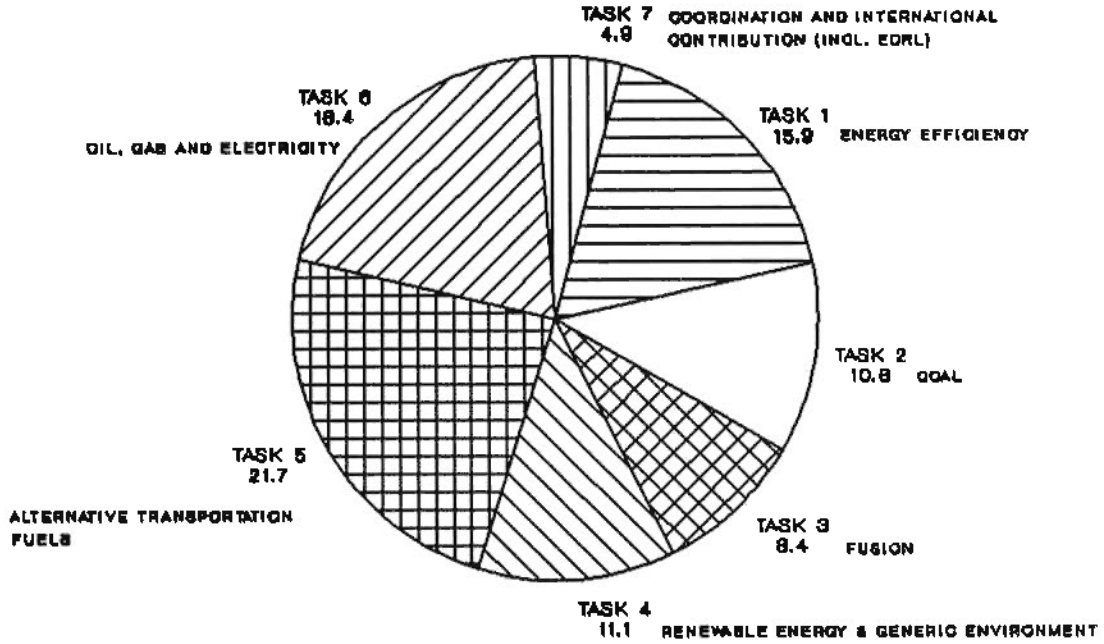


Notes:
- Federal Government consists of A-Base and PERD funds
- AECL A-BASE, for support of the CANDU program, is in the course of a declining annual budget

Source:
- Statistics Canada's Annual Survey of Canadian Industry R&D Expenditures
- Surveys by the Office of Energy R&D, EMR

FIGURE 3

DISTRIBUTION OF FUNDS BY TASK (TECHNOLOGY) IN 1991-92
ENERGY R&D FUNDS OF THE PANEL ON ENERGY R&D
($ MILLION, 1990-91 $)



TOTAL: $95.7 MILLION

Notes: Greater detail is given in Table 1-1

Task 1 Energy Efficiency - research and development organized through four sectoral Programs: Industry, Agrifood, Buildings and Transportation and two trans-sectoral programs: Industrial Energy R&D (IERD) and Energy Systems.

Task 2 Coal - covers technologies and science relating to coal geological assessment, mining, preparation, transport and utilization and related environmental R&D activities.

Task 3 Fusion - includes Tokamak de Varennes experimental facility and the Canadian Fusion Fuels Technology Project; international collaboration through the IEA as well as bilateral activities with the U.S., Europe and Japan.

Task 4 Renewable Energy and Generic Environment - covers hydraulics, active solar, passive solar, photovoltaics, bioenergy, wind, geothermal and generic environment issues relevant to all energy technologies (i.e., CO_2, etc.)

Task 5 Alternative Transportation Fuels - includes production and conversion of unconventional feedstocks (bitumen and heavy oil recovery and hydrocarbons enhancement); transportation fuels including fuel use, regulations for fuels such as propane, natural gas and methanol;

hydrogen and electrochemistry; environmental impacts of new liquid fuels production and use.

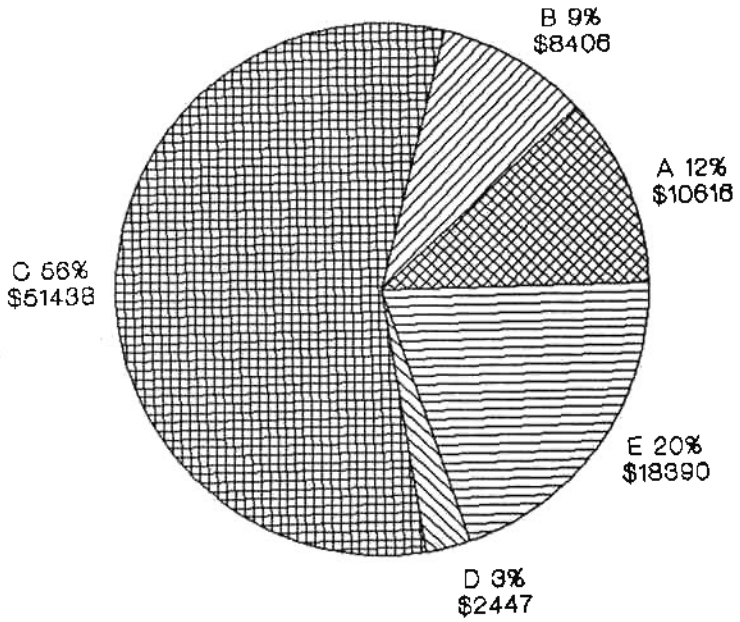
Task 6 Oil, Gas and Electricity - covers petroleum geoscience, permafrost and gas hydrates; marine engineering; offshore geotechnics, materials for offshore structures transportation of offshore oil and gas; environmental forecasting and impacts; electrical R&D.

Task 7 Coordination and International Contributions - supports overall coordination of the Federal Energy R&D Program; centralizes, for administrative purposes, contributions of funds to the energy R&D activities of the International Energy Agency (IEA). Funds assigned to this Task temporarily (Spring 1990) include about $3 million for the Varennes Energy Diversification Research Laboratory.

Source: Office of Energy R&D, EMR

FIGURE 4

DISTRIBUTION IN 1990-91 OF ENVIRONMENTALLY RELATED FUNDING ENERGY R&D FUNDS OF THE PANEL ON ENERGY R&D ($ THOUSAND, IN 1990-91 $)



TOTAL $91.3 MILLION

A To define environmental parameters for the design and operation of energy supply and use systems.

B To define, predict or directly mitigate environmental impacts of energy supply and use.

C To develop energy supply and use technologies that offer secondary environmental benefits within twenty years.

D To ensure worker and public health and safety.

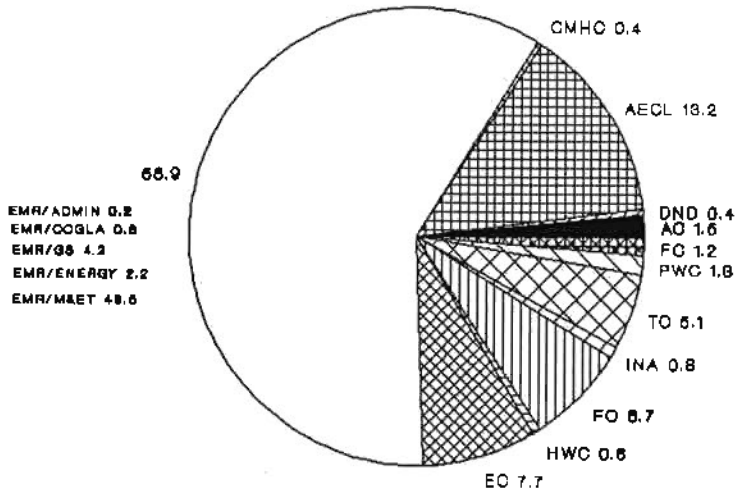
E Other energy R&D, including resource assessment and basic science (for technologies such as fusion and hydrogen) which might provide long term environmental benefits.

Notes: Improvements to the environment (and health and safety) can be made by reducing emissions, by greater efficiency and by substitution. All of these are considered in the definitions given above.

Source: Office of Energy R&D, EMR.

FIGURE 5

DISTRIBUTION OF 1991-92 FUNDS BY DEPARTMENT
ENERGY R&D FUNDS OF THE PANEL ON ENERGY R&D
($ MILLION, 1990-91 $)



TOTAL $95.7 MILLION

Notes: For greater detail, see Table 1-1.

CMHC Canada Mortgage and Housing Corporation
AECL Atomic Energy of Canada Limited (the fusion program)
DND Department of National Defence
AC Agriculture Canada
EC Environment Canada
HWC Health and Welfare Canada
FC Forestry Canada
FO Fisheries and Oceans (includes one-half the funding for the Canada Oil and Gas Lands Administration, COGLA)
INA Indian and Northern Affairs
TC Transport Canada
PWC Public Works Canada
EMR Energy Mines and Resources:
- **COGLA** see FO (includes one-half of the funding for COGLA)
- **GS** Geological Survey
- **M&ET** Mineral and Energy Technologies (CANMET)

(The subdivisions within EMR are the Planning Elements as used for financial planning purposes and do not necessarily correspond to the Department's organization structure).

Source: Office of Energy R&D, EMR.

TABLE 1-1
ENERGY R&D FUNDING
SUMMARY OF ALL TASKS
(from OERD Database #14B - in 1990-91 $)

ID	DESCRIPTION	91-92	92-93	93-94	94-95	95-96
1	ENERGY EFFICIENCY	15058 (25.0)	15094 (25.0)	14988 (24.0)	14988 (24.0)	14988 (24.0)
2	COAL	10816 (38.0)	10680 (36.0)	10557 (35.0)	10557 (35.0)	10557 (35.0)
3	FUSION	12794 (0.0)	8374 (0.0)	8374 (0.0)	8374 (0.0)	8374 (0.0)
4	RENEWABLE ENERGY AND GENERIC ENVIRONMENT	11300 (7.0)	11317 (7.0)	11401 (7.0)	11401 (7.0)	11401 (7.0)
5	ALTERNATIVE TRANSPORTATION FUELS	21944 (62.0)	21855 (61.0)	21833 (60.0)	21833 (60.0)	21833 (60.0)
6	OIL, GAS, ELECTRICITY	18434 (41.0)	18422 (41.0)	18322 (40.0)	18322 (40.0)	18322 (40.0)
7	COORDINATION & INTERNATIONAL CONTRIBUTIONS	5371 (29.0)	5555 (32.0)	5822 (36.0)	5822 (36.0)	5822 (36.0)
REPORT TOTALS:		95717 (202.0)	91297 (202.0)	91297 (202.0)	91297 (202.0)	91297 (202.0)

TABLE 1-2
ENERGY R&D FUNDING
SUMMARY OF ALL Departments
(from OERD Database #14B - in 1990-91 $)

DEPARTMENT	91-92	92-93	93-94	94-95	95-96
AGRICULTURE	1500 (5.0)	1500 (5.0)	1500 (5.0)	1500 (5.0)	1500 (5.0)
ATOMIC ENERGY OF CANADA LTD.	13161 (0.0)	8741 (0.0)	8646 (0.0)	8616 (0.0)	8616 (0.0)
CANADA MORTGAGE & HOUSING CORP.	383 (0.0)	388 (0.0)	338 (0.0)	338 (0.0)	338 (0.0)
NATIONAL DEFENCE	376 (2.0)	376 (2.0)	376 (2.0)	376 (2.0)	376 (2.0)
ENVIRONMENT CANADA	7715 (15.0)	8018 (15.0)	8175 (15.0)	7957 (15.0)	7971 (15.0)
ENERGY, MINES AND RESOURCES	56929 (158.5)	56958 (158.5)	57251 (158.5)	57464 (158.5)	57512 (158.5)
FORESTRY CANADA	1211 (0.0)	1211 (0.0)	1211 (0.0)	1211 (0.0)	1211 (0.0)
FISHERIES AND OCEANS	6712 (9.0)	6485 (9.0)	6254 (9.0)	6142 (9.0)	6032 (9.0)
HEALTH & WELFARE	638 (1.0)	678 (1.0)	707 (1.0)	842 (1.0)	842 (1.0)
INDIAN & NORTHERN AFFAIRS	765 (0.5)	729 (0.5)	751 (0.5)	763 (0.5)	811 (0.5)
PUBLIC WORKS CANADA	1265 (0.0)	1265 (0.0)	1165 (0.0)	1165 (0.0)	1165 (0.0)
TRANSPORT CANADA	5062 (11.0)	4948 (11.0)	4923 (11.0)	4923 (11.0)	4923 (11.0)
REPORT TOTALS:	95717 (202.0)	91297 (202.0)	91297 (202.0)	91297 (202.0)	91297 (202.0)

PART 2

OVERVIEW OF TASKS

TASK 1: ENERGY EFFICIENCY

Task Overview

The Energy Efficiency Task constitutes about 18% of the Federal Energy R&D Program. Research and Development in this Task is organized through four sectoral Programs: Industry, Agrifood, Buildings and Transportation and two trans-sectoral programs: Industrial Energy R&D (IERD) and Energy Systems. The work is managed by nine federal departments and agencies.

Rationale

The Energy Efficiency Task is based on the following assumptions: (1) energy costs will continue to be a significant part of the costs of goods and services, (2) there remain many areas where the costs of increasing the efficiency of energy use are lower than the costs of providing additional energy from primary sources and, (3) energy efficiency reduces the amount of environmental pollutants discharged from both end use and energy production activities.

Canada has made significant improvements in the efficiency of energy use since 1973. However, various technology assessments and forecasts estimate that further improvements of over 25% can be made by 2005.

These potential improvements are predicated on the availability of an adequate technology base. Generally the private sector should develop the technologies needed. However in several sectors the industry is highly fragmented and does very little research. In these and other sectors there are questions of health, safety, environmental impact, performance and reliability and measurement capability. In still others there are technologies which confer minimal benefit to a single firm but very significant benefit on a national scale. For the long term, in all sectors, few firms have any significant R&D effort and the magnitude and consistency of this effort is strongly influenced by short term swings in energy prices. For these reasons the federal government needs to invest in energy efficiency R&D.

Objective

To promote the continuing development of a Canadian technological base to enable energy to be used to increase the efficiency of all sectors of the economy.

Strategy

The strategy is:

- to perform R&D of a "unique technical services" nature i.e. the basis for codes, standards and regulations relating to design, performance, health and safety and environment and for policy development purposes, in government laboratories or through contracts;

- to reduce the risks of innovative technology development in the private sector by cost-sharing through programs such as the Industrial Energy Research and Development Program (IERD), and Development of Resources and Energy Conservation Technology (DRECT);

- to support longer-term/ higher risk applied R&D, in cooperation with the private sector and provinces with a focus on generic technologies, which is unlikely to lead to short-term benefits or where patent protection is incomplete or where national benefits are significant but benefits to a single firm minimal. The work can be done either in government laboratories, in the private

sector or universities;

- to perform R&D cooperatively wherever possible with the provinces, the private sector and internationally, through the International Energy Agency or though bilateral agreements with other countries if needed.

Policies:

Policies of the government that are supported by the Program include:

- energy efficiency;
- long term security of an economic energy supply;
- industrial efficiency and competitiveness;
- sustainable agriculture and fisheries;
- health policies concerning indoor air quality;
- environment policies including carbon dioxide reduction, waste reduction, recycling and reuse;
- support for related programs of EMR.

Organization and Description of Work

The Task is divided into four sectoral and two transectoral programs:

1.1 Industrial Energy R&D (IERD) Program
To cost-share with industry the development of systems, services, products and process technologies in all sectors of the economy which can be used to increase the efficiency of energy use. The majority of projects have been in the pulp and paper, metals and minerals and buildings areas, three of the two most energy intensive industries in Canada.

1.2 Industry
To promote the development of a technology base for standards, guidelines and performance criteria, new processes and generic technologies for the efficient use of energy in industry and municipal operations. The Industry Program is focused on four complementary areas: (1) generic technologies broadly applicable to industry: heat transfer (AECL), combustion (EMR), (2) waste utilization (EC) including the National Incinerator Test Program (NITEP) and the Development, Demonstration of Resource and Energy Conservation Technology (DRECT), (3) heat pumps and electrotechnologies (EMR); and (4) on industrial processes within energy intensive industries which are of major economic significance in Canada: pulp and paper and mineral processing (EC, EMR).

1.3 Agrifood
To promote the development of a technology base for an energy efficient sustainable agricultural and fishery system that can be used by farmers and fishermen and their respective supply industries. The Agrifood Program is focused on primary production (AC), emphasizing soil and crop management ecological agriculture, integrated agricultural system and food processing with a smaller program on energy efficient fishing vessels and energy efficiency in fishing operations (F&O).

1.4 Buildings
To promote the development of a technology base for codes, standards, guidelines, performance and design and energy management criteria for energy efficient buildings. The Buildings Program is focused on indoor environment including lighting (EMR, PWC, CMHC, HWC), heating cooling and ventilation systems (EMR, CMHC, PWC), energy management systems and integrated energy systems (CMHC, PWC). This work provides the technical base required for codes, standards,

system design and management tools and equipment development.

1.5 Transportation
To promote the development of a technology base for standards, guidelines, performance specifications and equipment design for energy efficient transportation in all modes. The Transportation Program focused on the development of technical information on fuels, engines, lubricants and vehicle systems under Canadian service conditions for road vehicles (TC, EMR), for use in the development of policies, standards, consumer information and design information for equipment and fuels and lubricants producers. Attention is also focused on specific projects which will increase the energy efficiency of railways, air system, marine and transportation infrastructure (TC).

1.7 Energy Systems
To promote the development of a technology base for optimizing the energy efficiency of total systems. The Energy System program relates to complex systems as distinct from development of specific equipment. It is focused on integrative technologies and system analysis and design in relation to district heating and cooling and community systems.

Consultation

Each Program is coordinated by an interdepartmental program committee of the Panel, made up of members of the participating departments and OERD, in which extensive consultation takes place. Each department has an external review committee made up of private sector, university and other representatives which review the conservation R&D as part of the department's overall R&D program. In addition, informal consultation takes place regularly between the federal scientists and program managers and their counterparts in the provinces, universities and the private sector.

International consultation takes place through the Working Party on Energy End Use Technology of the IEA and the Executive Committees of the Implementing Agreements in which Canada is involved, and informally through contacts by scientists at seminars, conferences and workshops.

Liaison with OERD in the CEA, NSERC and ACERRF ensures that federal work is complementary to private sector, university and provincial projects and that duplication is minimized.

Policy advice to the Task is provided through the Office of Energy Research and Development, EMR (H. S. Mohamed (613) 995-5782) with input from the participating departments. Coordination of the overall conservation R&D Task is the responsibility of OERD (H. S. Mohamed).

Application of Results

The results of the research and development are used to provide "how to" information, design guidelines, performance guidelines, protocols, standards, codes and design "tools", and to provide input for demonstrations, further R&D, workshops, seminars and policy development.

AC utilizes its R&D results to develop "how to" manuals and booklets for farmers and to provide technical information for the provincial agricultural extension services as well as design and performance data for the agricultural supply industry. AECL utilizes its R&D results to develop heat transfer equipment design data which are provided to industry through their membership in HTFS. CMHC's results are used in handbooks, standards and guidelines for the home building and renovation business. EC's (excluding DRECT) results end up in demonstrations, codes, design guidelines and performance guidelines. EMR's results input to handbooks, design guidelines, standards, technical demonstrations, further R&D and performance guidelines which are used by various industries to upgrade equipment,

design new equipment or optimize operations. F&O's results are used to prepare brochures, videos and other technical communication tools for fishermen as well as design data for vessel and gear manufactures. HWC's results are used to develop criteria and protocols in cooperation with the provinces for indoor air quality. PWC, by virtue of being Canada's biggest landlord, utilizes its results in "real life" situations to demonstrate new technologies as well as provide design guidelines and computer programs for design and analysis of large buildings. TC's results are used to develop technology, guidelines, standards, policy information and to put government experts in a knowledgeable position to talk to industry. The results of the IERD and DRECT programs are used directly in new products, processes and systems on a commercial scale.

TABLE 2-1-1
PERD FUNDING OF ENERGY EFFICIENCY (TASK 1)
BY PROGRAM
(from OERD Database #148 - in 1990-91 $)

ENERGY EFFICIENCY

ID	DESCRIPTION	91-92	92-93	93-94	94-95	95-96
11	INDUSTRIAL ENERGY CONSERVATION R&D (IERD)	5277 (4.0)	5277 (4.0)	5277 (4.0)	5277 (4.0)	5277 (4.0)
12	INDUSTRY	2788 (4.0)	2788 (4.0)	2642 (3.0)	2313 (3.0)	2313 (3.0)
13	AGRI-FOOD AND FISHERIES	1805 (5.0)	1805 (5.0)	1805 (5.0)	1805 (5.0)	1805 (5.0)
14	BUILDINGS	2553 (4.0)	2598 (4.0)	2434 (4.0)	2300 (4.0)	2300 (4.0)
15	TRANSPORTATION	1925 (7.0)	1925 (7.0)	1925 (7.0)	1925 (7.0)	1925 (7.0)
17	ENERGY SYSTEMS	460 (1.0)	451 (1.0)	451 (1.0)	451 (1.0)	451 (1.0)
18	COORDINATION	250 (0.0)	250 (0.0)	454 (0.0)	917 (0.0)	917 (0.0)
REPORT TOTALS:		15058 (25.0)	15094 (25.0)	14988 (24.0)	14988 (24.0)	14988 (24.0)

TABLE 2-1-2
PERD FUNDING OF ENERGY EFFICIENCY (TASK 1)
BY DEPARTMENT
(from OERD Database #148 - in 1990-91 $)

ENERGY EFFICIENCY

DEPARTMENT	91-92	92-93	93-94	94-95	95-96
AGRICULTURE	1500 (5.0)	1500 (5.0)	1500 (5.0)	1500 (5.0)	1500 (5.0)
ATOMIC ENERGY OF CANADA LTD.	367 (0.0)	367 (0.0)	272 (0.0)	242 (0.0)	242 (0.0)
CANADA MORTGAGE & HOUSING CORP.	383 (0.0)	388 (0.0)	338 (0.0)	338 (0.0)	338 (0.0)
ENVIRONMENT CANADA	1435 (2.0)	1435 (2.0)	1435 (2.0)	1261 (2.0)	1261 (2.0)
ENERGY, MINES AND RESOURCES	8122 (13.0)	8153 (13.0)	8292 (12.0)	8496 (12.0)	8496 (12.0)
FISHERIES AND OCEANS	305 (0.0)	305 (0.0)	305 (0.0)	305 (0.0)	305 (0.0)
HEALTH & WELFARE	292 (1.0)	292 (1.0)	292 (1.0)	292 (1.0)	292 (1.0)
PUBLIC WORKS CANADA	1265 (0.0)	1265 (0.0)	1165 (0.0)	1165 (0.0)	1165 (0.0)
TRANSPORT CANADA	1389 (4.0)	1389 (4.0)	1389 (4.0)	1389 (4.0)	1389 (4.0)
REPORT TOTALS:	15058 (25.0)	15094 (25.0)	14988 (24.0)	14988 (24.0)	14988 (24.0)

TASK 2: COAL

Task Overview

The Coal Task's two programs make up about 12% of the PERD Program. The first program covers technologies and science relating to coal geological assessment, mining, preparation, transportation and utilization. The second program covers related environmental R&D activities.

Rationale

The Canadian coal industry is both a major earner of foreign exchange with around $2.1 billion in export sales in 1989 and a significant contributor to Canada's energy mix, providing 15% of primary energy demand in 1988.

In 1988, the National Energy Board (NEB) forecasted that coal production may increase to between 77 and 102 million tonnes in 2005, depending on world oil and gas prices. This growth will also depend on access to Ontario's coal market and our aggressiveness in keeping our position in the international metallurgical coal markets. Virtually all the increase to 2005 is expected to be thermal coal. The NEB has projected that about one-third of this production will be exported but recognizes this is subject to major market uncertainties.

Policies of the federal government encourage self-development of indigenous energy resources for economic benefit and for security of supply. Although Canada's coal resources are vast, some may question our existing knowledge pertaining to its quality and reliability. Also, as conventional resource extraction and utilization techniques prove inadequate for the changing demands of society, in particular with our increasing environmental concerns, new technologies must be developed while environmental impacts are assessed on both new and conventional technologies. Additionally, high Canadian transportation costs have diminished the coal industries profitability and Canada's share in international and domestic coal markets.

Objective

To provide scientific and technological advances contributing to the safe, efficient and environmentally acceptable exploitation and use of Canadian coals.

Strategy

Because coal industry profitability is both modest and cyclical, R&D undertaken by coal producers is mainly concentrated on short-term problems, leaving longer-term work to be done by the federal government, as well as by certain provinces and coal consumers. Some expensive shorter-term R&D may be joint-funded by the Energy R&D Program, but, without participating in "no risk" efforts or any demonstration projects which are not in the mandate of the Energy R&D Program.

In summary, the overall strategy for the Task is:

- continued government assistance for the scientific support services that are needed by the coal industry;

- support, through cost-shared programs, for the development of efficient and advanced geological, mining, preparation, transport and utilization technologies meeting the needs of Canadian and international markets; and

- the development and assessment of fundamental and advanced technology that can identify and protect coal options for the longer term, in particular with existing and future environmental constraints.

Policies

Policies of the government that are supported by the Program include:

- minimize transportation costs and manage environmental constraints on the export and domestic use of coal;

- clean-up technologies for coal gasification products; and

- protect the health and safety for the workers and the public exposed to coal.

Organization and Description of Work

Task 2 consists of two programs; the first being divided into four disciplines:

2.1 Coal Technologies

Subprogram 2.11 **Coal Supply and Characterization:** to determine Canada's coal resource possibilities and to develop technologies for geological assessment in support of coal industrial development. Projects are related to the development and testing of predictive computer models for assessing coal quality; resource analysis and characterization and trace elements in Canadian coals.

Subprogram 2.12 **Mining:** to develop technologies for mine productivity and safety to help the Canadian coal industry meet existing and future markets. Projects are related to mine environment monitoring and control of coal dust explosions; underground and surface coal mining techniques, geotechnical engineering.

Subprogram 2.13 **Preparation and Transport:** to develop technologies for environmentally acceptable beneficiation and transportation of coal to help the Canadian coal industry meet existing and future markets. Projects are related to mobile dewatering and fine coal preparation plants; high sulphur coal preparation; upgrading of low ranked coals; coal slurry transport; fine coal processing; process control; transport of coal.

Subprogram 2.14 **Combustion, Gasification and Carbonization:** to develop advanced, more efficient and environmentally acceptable coal combustion, carbonization and gasification technologies aimed at expanded markets for Canadian coals. Projects are related to combustion performance; flame characteristics; fluidized bed combustion (FBC) of coal and other carbonaceous materials including pitch and coke; coal liquid mixtures; development of burners; industrial combustion applications; low NO_x control technologies; metallurgical coal technology development; gasification of coal.

The 2.1 Program is chaired by OERD (EMR), and projects are managed by CANMET (EMR), GSC (EMR) and TC.

2.2 Environment

To address environmental problems which may impede the supply and use of Canadian coals. Projects are related to environmental protection criteria for mining and preparation facilities; waste management practices and environmental studies on FBC and other advanced combustion technology applications.

The 2.2 Program is chaired by EC and projects are managed by EC and F&O.

Consultation

Many energy R&D projects are closely planned and, in many cases, co-funded with industry, with the base budgets of several departments. Program managers within Task 2 seek input from a variety of sources when making or modifying Program plans. In particular, the system of Program Committee's allows intra and interdepartmental input to CANMET and GSC energy R&D activities in the coal programs and to EC's energy R&D activities dealing with environmental considerations.

The research program of CANMET is bi-annually presented to and approved by the Minister's National Advisory Council to CANMET (MNACC), in particular to its subcommittee on coal. In addition, GSC's coal activities are regularly presented to and approved by the Independent Review Committee which comprises federal, provincial, academic and industrial representatives. Both MNACC's and GSC's Independent Review Committee recommendations are tabled and considered at the 2.1 program committee meeting.

Further indirect sources of consultation to coal-related energy R&D programs exist, such as the Canadian Electrical Association (CEA), the Coal Association of Canada (CAC), the Committee on Atlantic Coal, the Interprovincial Advisory Committee on Energy, the Canadian Carbonization Research Association (CCRA) and the Alberta/Canada Energy Resources Research Fund (ACERRF) Program.

International consultation takes place through the Working Party on Fossil Fuels of the IEA (and the Executive Committees of the Implementing Agreements in which Canada is involved), the Canada/USA Memorandum of Understanding on Energy R&D and through contacts by scientists at seminars, conferences and workshops.

In addition, government/industry workshops are held to review and assess results and to discuss future directions.

Policy advice is provided to the Task by the Coal and Iron Division of the Mineral Policy Sector, EMR. Overall coordination is provided by the Office of Energy R&D, EMR, (Dr. L. R. Muir (613) 995-5299).

TABLE 2-2-1
PERD FUNDING OF COAL (TASK 2)
BY PROGRAM
(from OERD Database #148 - in 1990-91 $)

COAL

ID	DESCRIPTION	91-92	92-93	93-94	94-95	95-96
21	COAL TECHNOLOGIES	10158 (37.0)	9937 (35.0)	9814 (34.0)	9814 (34.0)	9814 (34.0)
22	ENVIRONMENT: COAL	658 (1.0)	743 (1.0)	743 (1.0)	743 (1.0)	743 (1.0)
REPORT TOTALS:		10816 (38.0)	10680 (36.0)	10557 (35.0)	10557 (35.0)	10557 (35.0)

TABLE 2-2-2
PERD FUNDING OF COAL (TASK 2)
BY DEPARTMENT
(from OERD Database #148 - in 1990-91 $)

COAL

DEPARTMENT	91-92	92-93	93-94	94-95	95-96
ENVIRONMENT CANADA	658 (1.0)	693 (1.0)	693 (1.0)	693 (1.0)	693 (1.0)
ENERGY, MINES AND RESOURCES	10006 (37.0)	9912 (35.0)	9814 (34.0)	9814 (34.0)	9814 (34.0)
FISHERIES AND OCEANS	0 (0.0)	50 (0.0)	50 (0.0)	50 (0.0)	50 (0.0)
TRANSPORT CANADA	152 (0.0)	25 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
REPORT TOTALS:	10816 (38.0)	10680 (36.0)	10557 (35.0)	10557 (35.0)	10557 (35.0)

TASK 3: FUSION

Task Overview

The Fusion Energy R&D Program, which receives about 9% of the PERD budget, consists of two main Programs: Tokamak de Varennes (cost shared with Hydro Quebec) and the Canadian Fusion Fuels project - CFFTP (cost shared with Ontario Hydro). International collaboration is a key component of the Task. The funds are managed by Atomic Energy of Canada Limited.

Rationale

Fusion is a good possible option for generating electricity in the long term. It will not produce acid emissions, high level nuclear fuel wastes or carbon dioxide nor will it necessitate flooding vast regions. Fusion fuels are virtually inexhaustible and globally available. Fusion will pave the way for wider spread use of electrotechnologies which will convey industrial productivity and environmental benefits.

Fusion development presents formidable technical challenges and is very expensive. No one country can mount a complete fusion research program. Major developments therefore require international collaboration. The present focus of international activity is the International Thermonuclear Experimental Reactor (ITER) - a joint project of the USA, the USSR, Europe and Japan. Canada is participating through Europe. ITER is the next logical step in fusion reactor development.

Canada has two unique features which permits it to participate in, and to gain benefits from, the international activity: a) Hydro Quebec's large grid which permits extended experiments with the Tokamak de Varennes, and b) Ontario Hydro's tritium handling technology which was developed in order to remove tritium to permit the recycling of heavy water used in the CANDU reactors.

Objective

The Task objective is to develop a Canadian technological base for fusion power by participating in the cooperative international effort and by supporting the development of specialized services.

Strategy

The strategy of the Task is to pursue a relatively small R&D program based on the above unique Canadian features in cooperation with Ontario Hydro and Hydro Quebec and with a range of high technology firms. This program is structured in such a way as to make unique and valuable contribution and thus share in the international knowledge base and to develop and market competitive Canadian industrial capability in fusion systems and components.

Policies

Policies of the government that are supported by the Program include:

- long term energy strategy;
- federal-provincial cooperation;
- development of Canadian science and technology expertise;
- international cooperation;
- industrial benefits from high technology activities.

Organization and Description of Work

The Task has two programs:

1. Tokamak de Varennes
2. Canadian Fusion Fuels Technology Project

Tokamak de Varennes:

The Tokamak de Varennes at the Centre canadian de fusion magnétique is a joint venture of PERD (through AECL), Hydro Quebec and INRS-Energie. It is a medium size special purpose magnetic confinement device. Its mission is to extend the range of present-day Tokamaks to reactor-relevant long pulse operation, being able to draw the requisite power for Hydro-Quebec's large grid without affecting Hydro Quebec's customers. Hydro Quebec's grid is one of the few in the world that can do this.

The experimental work areas being pursued in the next five years are new materials for use inside reactors, new diagnostic instrumentation and control of plasma impurities with magnetic divertors. Additional resources were to upgrade the Tokamak de Varennes to make it ITER-relevant and give it an important continuing role in international activities. It allows an expansion to include effects of long plasma pulses on reactor materials at high power densities, and microwave current drive for long pulses.

Canadian Fusion Fuels Technology Project (CFFTP):

The CFFTP is a joint effort of PERD (through AECL) and Ontario Hydro. Its mission is to develop and market Canadian capabilities in fusion fuels (tritium) technologies. CFFTP builds on Canadian capability developed in tritium separation and handling in the CANDU (fission) program, the only non-military source of such technology in the world. Additional resources were obtained to provide the design, operating costs and experimental apparatus for a world class tritium technology facility which will enable CFFTP to test prototype fuelling and waste management systems.

The experimental work areas being pursued in the next five years are: ceramic and aqueous lithium salt tritium breeder blankets, plasma first wall material interaction, fusion exhaust processing, hydrogen isotope separation and tritium extraction, storage and handling. CFFTP is also actively engaged in transferring CFFTP-developed technologies and seeking and managing contracts for hardware, technology and experts in foreign projects.

Management and Consultation

The Fusion R&D Task is managed by AECL. Strategic directions for the Task come from extensive consultation with participating provinces, utilities and federal departments through the forum of an ad hoc advisory committee with representatives of AECL, EMR, ISTC, NSERC, NRC, EA, the governments of Ontario and Quebec, Ontario Hydro and Hydro Quebec. The Tokamak de Varennes is overseen by an advisory committee with representatives from AECL, EMR, Ontario Hydro, Europe and the USA and directed by a board of directors made of representatives of Canadian high technology industry, Hydro Quebec, AECL and INRS. The CFFTP is overseen by an advisory committee made up of representatives of AECL, Hydro Quebec, EMR, McMaster University, USA, Japan and Europe and directed by a steering committee of AECL, Ontario Hydro and the government of Ontario.

Policy advice to the Task is provided through the Office of Energy R&D, EMR (H. S. Mohamed (613) 995-5782) in cooperation with AECL. Coordination of the overall fusion R&D Task is the responsibility of AECL (Dr. D. Jackson (613) 687-3175).

Application of Results

Although the use of fusion to generate electricity is a very long term prospect, the magnitude of the international development program (more than two billion dollars annually) generates markets for diagnostic tools, for tritium handling systems, for systems design capabilities and for new materials. The Canadian strategy of pursuing niches for the expertise generated in the two primary Canadian fusion projects has already led to participation in larger international cooperative projects and has resulted in the development and sale of specialized equipment, systems and services.

TABLE 2-3-1
PERD FUNDING OF FUSION (TASK 3)
BY PROGRAM
(from OERD Database #148 - in 1990-91 $)

FUSION

ID	DESCRIPTION	91-92	92-93	93-94	94-95	95-96
34	FUSION	12794 (0.0)	8374 (0.0)	8374 (0.0)	8374 (0.0)	8374 (0.0)
REPORT TOTALS:		12794 (0.0)	8374 (0.0)	8374 (0.0)	8374 (0.0)	8374 (0.0)

TABLE 2-3-2
PERD FUNDING OF FUSION (TASK 3)
BY DEPARTMENT
(from OERD Database #148 - in 1990-91 $)

FUSION

DEPARTMENT	91-92	92-93	93-94	94-95	95-96
ATOMIC ENERGY OF CANADA LTD.	12794 (0.0)	8374 (0.0)	8374 (0.0)	8374 (0.0)	8374 (0.0)
REPORT TOTALS:	12794 (0.0)	8374 (0.0)	8374 (0.0)	8374 (0.0)	8374 (0.0)

TASK 4: RENEWABLE ENERGY and GENERIC ENVIRONMENT

Task Overview

The Renewable Energy and Generic Environment Task constitutes about 13% of the Federal Energy R&D Program. It encompasses the technologies for harnessing Canada's large, dispersed, renewable energy resources. As well, generic environment issues relevant to all energy technologies are addressed in this Task. There are eight programs divided into the subject areas of: hydraulics, active solar, passive solar, photovoltaics, bioenergy, wind and generic environment. (Task management is also identified as a program). The main federal player is the Efficiency and Alternative Energy Technology Branch (EAETB), Mineral and Energy Technology Sector of EMR.

Rationale

Mankind has recognized that it is depleting the world's energy resources. Concerns so far have been dominated by the western world's use of oil and gas and the desire for security of supplies at acceptable prices. However, other concerns have emerged, an apprehension that the continued widespread use of fossil fuels could result in major climatic changes and adverse health impacts, irreversible on our time scale. We now see that energy concerns go beyond the issue of petroleum reserves and touch on the issues of energy mix, long term environmental appropriateness and sustainable economic development.

The problem of increasing CO_2, NO_x and other emissions from the combustion of fossil fuels, and the difficulties of disposing of nuclear wastes safely are but two issues now forcing their way to the forefront. In this context, renewable energy technologies are becoming more attractive. Not only do they appear to be more environmentally acceptable when managed properly than most existing technologies, but also the energy potential of these sources is enormous.

The renewable energy option offers the potential to progressively supplement our existing energy mix. Through R&D, we can learn how to extract and concentrate these renewable energy resources. As well, these energy technology options will be available in the future when we are faced with the need for an economic energy base more environmentally sustainable than that which we now have.

Canadian efforts to date have produced a fragile and fragmented renewable energy industry which requires nurturing at the most basic levels of R&D if Canada is to maintain this option and protect past investment in renewables. Characterization of the nature, quantity and distribution of the various renewable energy resources in Canada, such as solar flux, wind intensity, biomass availability, small-hydro sites, geothermal occurrences and peat inventory, is essentially complete and receives a minimum level of support.

Wood combustion in the forest industry and, to a lesser degree, in the residential sector, now provides about 7% of Canada's energy supply. The Program has contributed to this through technologies to improve combustion efficiency, process control and emission control. This 7% is in addition to the 12 per cent contribution made by other renewable energy technologies, principally hydroelectricity.

In economic terms, the forest products industry saves more than $500 million a year by burning wood and wood wastes rather than oil and other purchased energy. Further, the value of goods, products and services connected with renewable energy sources, excluding conventional hydroelectricity, amount to about an additional $500 million a year. Forest products industries offer significant regional growth potential in both domestic and export markets.

The Task currently helps provide the infrastructure vital to the development of renewable energy

industries, supports development of products and processes by and for these industries and as a result, helps develop world-class technologies at competitive costs. The option of technologies and services made in Canada is preserved, thus helping to create employment and maintain a positive trade balance.

Under this Task, there is also included a Generic Environment Program established to develop the know-how for remediating and/or understanding of environmental problems common to many if not all energy activities. Currently, subjects include the climate change gasses (carbon dioxide and others), ocean/carbon dioxide relationships and contaminated groundwater treatment.

Principal Objective

To encourage the development of science and technology to exploit biomass, solar, wind and other renewable energy resources and to investigate broad scale environmental issues associated with energy developments.

Strategy

The strategy for the Task is to:

continue government assistance for scientific support services that are needed by the developing renewables industry;

support, through cost-shared programs, the development by Canadian industry of cost-effective renewable energy products, processes, equipment and systems meeting the needs of Canadian and international markets;

develop underlying and advanced technologies that can identify, strengthen and advance renewable options in the context of an environmentally sustainable economy for the longer term; and

investigate the environmental problems facing energy technologies in general in order to better understand and recommend solutions to industry and government.

Policies:

Policies of the government that are supported by the Program include:

- regional development;
- support for industrial technological capability and competitiveness;
- additional emphasis in solar and bioenergy technologies to reduce the imbalance with conventional fossil fuel technologies;
- international cooperation.

Organization and Description of Work

That portion of the Task directed to the short term emphasises technology transfer, encouragement for the development and undertaking of industrial opportunities and acceptance of international trade and markets as a rationale for supporting Canadian companies in the field. The Program encourages the development and export of technologies and products to buyers in countries that are burdened with more expensive energy than Canada. In the course of this activity, our firms can develop their technologies and lower their production costs. This should have the incidental and desirable result of narrowing the cost disadvantage that renewable energy suffers when compared with its conventional

competition in Canada.

A decision has been taken by the Panel to cancel the watching brief in geothermal energy R&D activities. In Canada, the technology has a low application potential in the short and medium term. As well, a clear signal is evident from the continual funding level erosion of this area over the years.

Tidal energy R&D support is also under review for similar reasons although a decision has yet to be taken. Very significant environmental issues must be addressed before this technology is given serious consideration as a viable energy option.

The R&D program is undertaken by Energy, Mines and Resources (the lead agent), Forestry Canada, Environment Canada and Fisheries and Oceans. CANMET (Canada Centre for Mineral Energy Technology)/EMR involvement in Task activities is reflected through the efforts of EAETB and the Varennes Laboratory which is now functioning this fiscal year and has identified for itself a strong mandate in PV. About 75% of the Task's R&D is contracted out to private industry and universities, the latter having a longer-term R&D orientation.

The Task has eight programs with these formal objectives:

4.1 Hydraulics
To develop design methods and guidelines for advancing hydraulic technologies, particularly low-head/small-scale hydro;

4.2 Active Solar
To develop active solar energy technologies to the point where they are commercially competitive with other, more traditional energy forms;

4.3 Passive Solar
To increase and optimize the passive solar energy contribution to the energy load of buildings;

4.4 Photovoltaics
To develop photovoltaics technology to the point where it is commercially competitive with other, more traditional energy forms, particularly for applications where other feasible energy sources are economically or environmentally expensive;

4.5 Bioenergy
To develop bioenergy technologies (in production, combustion, anaerobic digestion, preparation, handling, pretreatment and conversion) which are capable of providing a growing and sustainable contribution to an environmentally acceptable renewable energy supply;

4.6 Wind
To establish a technology base for cost effective wind energy technologies as an energy supply alternative;

4.8 Generic Environment
To assess global and generic environmental issues which might constrain energy developments;

4.9 Coordination

To manage the Renewable Energy Program.

Renewable energy sources are distributed around the world and are not perceived as economically or environmentally threatening. This has resulted in strong commitments to international collaboration on renewables research, making possible significant leverage via shared programs. Canada participates, through the International Energy Agency, in the following Implementing Agreements:

- Solar Heating and Cooling;
- Bioenergy;
- R&D in Wind Energy Conversion Systems (R&D WECS); and
- Large Scale Wind Energy Conversion Systems (LS WECS).

Consultation

A number of committees are involved (directly and indirectly) in guiding the Task and promoting cooperation and coordination among participating departments (EMR, EC, F&O and FC).

Private sector input is received formally through steering committees, one each for the Bioenergy and New Energy Supply Technologies (NEST [non-bioenergy]) Programs of EMR. Each committee has a private sector chairman and many members from industry, academia and provincial governments. Federal government program managers and one OERD representative participate as observers. These two committees are currently "on hold" pending the formation and terms of reference of the MNACC committee for alternative energy technologies.

Interdepartmental coordination is maintained by OERD through two committees, one each for renewables and for generic environment. Members are the R&D program managers from participating departments. These committees determine, review and recommend the appropriateness of ongoing and planned R&D activities as well as recommend/adjust funding levels within the overall budget.

In EMR, (reporting to the NEST Steering Committee), there are **Technical Advisory Committees** (one for each technology), chaired by and principally comprised of private industry representatives who provide technical advice and program direction and also review and recommend proposals. Their input is received and integrated into the proposals submitted by EMR to the interdepartmental solar committee via the program managers.

In Forestry Canada, the ENFOR Technical Committee, made up primarily of FC regional and headquarters representatives, provides technical advice, and reviews and recommends proposals relating to forestry bioenergy production research.

In EMR, a bioenergy interdepartmental technical review committee reviews and selects proposals based on guidelines from private sector steering committees, expert workshops, economic advisors and other consultations.

Policy advice on environmental matters originates with the Office of Environmental Affairs, Corporate Policy and Communications Sector, EMR (Dr. J.D. McTaggart-Cowan, (613) 995-2833). Policy advice on renewable energy matters originates with the Efficiency and Alternative Energy Branch, Energy Sector, EMR (W.D. Jarvis, (613)995-0081). Coordination with the overall Energy R&D Program is the responsibility at the Office of Energy R&D (S.L. Bolcso (613) 995-2670).

Application of Results

Significant penetration of energy supply by renewable sources will be a long-term event. Nevertheless, many of the renewable energy R&D results are expected to see initial commercialisation in the marketplace in the near term. Thus, R&D efforts are directed towards enhancing commercial prospects through product and service development, cost/performance improvements, and fostering the emergence of an industrial capability to exploit an expanding domestic (as well as export) market. For example, current market niches exist in Atlantic Canada (for bioenergy and active solar) and remote locations (for wind, small hydro and PV). Additionally, some of this R&D effort is in support of the governments role in the development of product standards for consumer protection, improved performance and environmental emissions; a good example being those standards being developed for wood burning home appliances and for photovoltaic modules.

In the environmental context, the results from R&D activities are expected to help government discharge its responsibility for the development of policy and regulations on energy related environmental issues. Workshops with environmental experts and the energy industries will cooperatively help identify what R&D needs to be done to help address their particular industry problems.

TABLE 2-4-1
PERD FUNDING OF RENEWABLE ENERGY AND GENERIC ENVIRONMENT (TASK 4)
BY PROGRAM

RENEWABLE ENERGY AND GENERIC ENVIRONMENT

ID	DESCRIPTION	91-92	92-93	93-94	94-95	95-96
41	HYDRAULICS	375 (0.0)	400 (0.0)	400 (0.0)	400 (0.0)	400 (0.0)
42	ACTIVE SOLAR	875 (0.0)	875 (0.0)	875 (0.0)	875 (0.0)	875 (0.0)
43	PASSIVE SOLAR	1225 (0.0)	1200 (0.0)	1200 (0.0)	1200 (0.0)	1200 (0.0)
44	PHOTOVOLTAICS	600 (0.0)	600 (0.0)	600 (0.0)	600 (0.0)	600 (0.0)
45	BIOENERGY	5433 (2.0)	5433 (2.0)	5433 (2.0)	5433 (2.0)	5433 (2.0)
46	WIND	742 (0.0)	742 (0.0)	742 (0.0)	742 (0.0)	742 (0.0)
47	GEOTHERMAL	0 (0.0)	5 (0.0)	50 (0.0)	50 (0.0)	50 (0.0)
48	GENERIC ENVIRONMENT	1984 (4.0)	1996 (4.0)	2035 (4.0)	2035 (4.0)	2035 (4.0)
49	COORDINATION	66 (1.0)	66 (1.0)	66 (1.0)	66 (1.0)	66 (1.0)
REPORT TOTALS:		11300 (7.0)	11317 (7.0)	11401 (7.0)	11401 (7.0)	11401 (7.0)

TABLE 2-4-2
PERD FUNDING OF RENEWABLE ENERGY AND GENERIC ENVIRONMENT (TASK 4)
BY DEPARTMENT

RENEWABLE ENERGY AND GENERIC ENVIRONMENT

DEPARTMENT	91-92	92-93	93-94	94-95	95-96
ENVIRONMENT CANADA	1271 (3.0)	1221 (3.0)	1221 (3.0)	1221 (3.0)	1221 (3.0)
ENERGY, MINES AND RESOURCES	7824 (4.0)	7879 (4.0)	7924 (4.0)	7924 (4.0)	7924 (4.0)
FORESTRY CANADA	1211 (0.0)	1211 (0.0)	1211 (0.0)	1211 (0.0)	1211 (0.0)
FISHERIES AND OCEANS	994 (0.0)	1006 (0.0)	1045 (0.0)	1045 (0.0)	1045 (0.0)
REPORT TOTALS:	11300 (7.0)	11317 (7.0)	11401 (7.0)	11401 (7.0)	11401 (7.0)

TASK 5: ALTERNATIVE TRANSPORTATION FUELS

Task Overview

The Alternative Transportation Fuels Task, which makes up about 25% of the PERD Program, covers three areas. The production and conversion of unconventional feedstocks are covered by (i) a Program on bitumen and heavy oil recovery and (ii) a Program on hydrocarbons enhancement. The transportation fuels themselves are covered by Programs on fuel use, studying the use and regulations for fuels such as propane, natural gas and methanol, and on hydrogen and electrochemistry. There is a Program on the environmental impacts of new liquid fuels production and use. The principal participants in the Task are EMR and TC, with work also done by EC, AC, DND and HWC.

Rationale

The transportation sector accounts for more than one quarter of domestic energy consumption and nearly two-thirds of crude oil demand. The sector depends almost exclusively on crude oil, which provides the ground transportation system with its gasoline and diesel fuel and the marine, rail and air systems with their long-established fuels. Light crude oil is, by a wide margin, the best feedstock for providing the conventional transportation fuels. Light crude oil production from conventional sources in western Canada is on the decline. In the most recent National Energy Board study, it was projected that Canada could be importing about one-quarter of domestic light crude requirements by 2005.

Light crude oil from the frontier is a potential replacement for the Western oils in providing transportation fuels. This source of supply would certainly be more advantageous than increased imports into Canada. Likewise, improved vehicle efficiencies can reduce demand. But these are only partial solutions. They will not eliminate an energy shortage nor do they directly attack the environmental concerns of conventional fuels. Ultimately, we must rely on some combination of unconventional feedstocks, new transportation fuels and environment-sensitive practices.

The foundation for the continuation of transportation fuels can be found in our vast, diversified hydrocarbon resource base in the form of natural gas, heavy oil, bitumen, coal, and biomass. The Alberta and Saskatchewan heavy oil fields are estimated by the Canadian Petroleum Association to contain some 1.7 billion cubic metres of in-place oil. The Alberta Energy Resources Conservation Board (AERCB) estimates that 27.8 billion cubic metres of bitumen from oil sands could be converted into synthetic crude. Two oil sands plants already produce about 30,000 m^3 of synthetic crude oil per day. Natural gas reserves are large, but not of the same magnitude as bitumen or coal. Coal reserves are immense and biomass resources, although limited, are potentially inexhaustible under careful management.

The challenge for Canada is to extract these nonconventional hydrocarbon resources and transform them into usable transportation fuels. Combinations of these various resources, which in some cases are found next to one another, could lead to some unique opportunities such as the co-processing of coal and bitumen. Natural gas will have a crucial role as a source of hydrogen for hydrogen-deficient resources such as heavy oil and bitumen. Alternatively, natural gas could be directly used for the production of liquid transportation fuels by a variety of processes. Biomass sources, from the forests, from agriculture or from waste, also can be converted to liquid fuels.

Objectives

The objectives of the Task are to establish the technical and regulatory base for a transition to alternative transportation fuels in the next century, through the economically and environmentally acceptable use of coal, bitumen, heavy oils, natural gas, biomass and electricity.

Strategy (Unconventional Feedstocks)

The strategy is that laboratory scale work in all these areas continue focusing on new reaction routes with fewer steps or with higher yields. Work will also continue on optimizing various processes by, for example, increasing material conversion factors and thermal efficiencies.

The oil and gas industry and the Alberta Oil Sands Technology Research Authority (AOSTRA) have themselves made significant R&D investments in oil sands and heavy oil, largely in the area of in situ production of bitumen. The strategy for federal R&D activities in this area supported by the Energy R&D Program has been designed to complement these activities, with emphasis on some longer term, higher risk elements and financial risk-sharing with AOSTRA and industry. In addition, with the expected increase in heavy oil production, upgrading is a priority of industry, the producing provinces and the Energy R&D Program.

More specifically, the strategy for the federal R&D activity in the **oil sands/heavy oils program** is primarily directed towards efficiency of recovery in support of AOSTRA-led initiatives and towards upgrading.

R&D activities in **upgrading** are directed to novel upgrading concepts and developing commercial uses for upgrading residues.

Strategy (New Transportation Fuels)

The transportation fuels selected for technology support under this Task have been chosen according to the following strategy, taken from the "Review of the New Liquid Fuels Task," OERD 1984:

> "A new fuel option should hold a reasonable promise of being economically comparable with competing fuels as a condition of R&D support, with the economic comparison between fuels based on true economic factors (price subsidies or tax concessions discounted)"; and
>
> "R&D aimed at developing technologies for commercialization of a new fuel, rather than at addressing policy or regulatory questions, should be undertaken by interests involved in the appropriate market activities, and should be cost-shared by government only if necessary and appropriate".

The Task's strategy flows from, for example, the federal government's role in supporting the technology on which are based CGSB's and others' standards for automobiles and their fuels. These standards, in turn, are relied upon by the provinces who also have legislative responsibility. The federal government writes the rules for new vehicles, the provincial governments for retrofits and most of the production, handling and distribution of fuels.

Technologies, which are now mature, dealing with **propane**, received R&D support in the early stages. There are now over 140,000 converted vehicles in Canada. The federal role is now one of low level support, addressing regulatory, environmental and safety issues.

Natural gas vehicles are several years behind propane in technology development and market penetration. The Task has helped develop a centre of excellence at the British Columbia Research Council. There are now about 20,000 converted vehicles in Canada. Support is being reduced as industry, through the Canadian Gas Association, assumes a leadership role in the development of new technology. The Task will continue support for technological information needed for regulations and safety, as is now done for propane.

As **alcohol** use as a transportation fuel is in the early stages, government support in the form of joint government/industry technology studies will be required for topics such as emissions testing and cold weather operation. The technologies concerning spark ignition and compression ignition engines are supported by the Task.

Fuel standards, emission (aldehydes) limits and safety codes remain to be fully developed. It will be important to develop the appropriate specifications for both oxygenates and neat alcohol fuels that offer performance and safety.

With respect to blends (alcohols/gasoline) the R&D requirements will rest mainly in the development of oxygenated fuel specifications. The elimination of lead from Canadian gasoline by December 1990 provides a window of opportunity for alcohols and other oxygenates as blends in gasoline, in particular methanol, ethanol and MTBE, as octane enhancers, even though neat ethanol appears less likely to be economically competitive in the medium term.

The Program also deals with the combustion of **broad specification** petroleum fuels, especially diesel and jet fuel in present and future engines, because revised fuel specifications could make more usable fuel available from each barrel of oil that is processed, and could allow better use to be made of the heavier crude oils that are forming an increasingly large part of Canada's crude oil mix. However, environmental concerns related to heavy duty diesel emissions, especially with broad specification fuels, are causing a reassessment of certain areas of research and have led to the investigation of the impact of future Canadian diesel fuels on emissions and their combustion in ceramic engines.

Canada has large renewable and inexhaustible energy resources, in particular hydro and nuclear. These resources can be harnessed through the generation of electricity. Electricity cannot, however, directly replace hydrocarbon fuels in many applications. In transportation, apart from electrified rail and urban trolleys buses, the electrical energy must be stored in a usable form. **Hydrogen** is one solution, **batteries** are another.

EMR sees hydrogen strategically as a longer term energy currency and the R&D program reflects this. There are three main components: hydrogen production; hydrogen utilization; and energy storage. The first application is, and will be, in upgrading fossil fuels and the research emphasis will thus continue to be on economic electrolytic production. Fuel cells have the potential for widespread application.

Batteries will have a long-term and environmentally clean application. The strategy is to support promising technologies with the ultimate goal of an electric vehicle battery. Such a battery could be used in displacing liquid fuels in the Canadian fleet or be the basis of battery exports, or both. Canada is favourably endowed with minerals for almost any battery technology.

Strategy (Protecting the Environment)

R&D aimed at the **environmental effects** of developing Canada's **oil sands, heavy oil and coal resources** are conducted through Environment Canada (EC), and Health and Welfare (HWC). Activities at EC are focused on the treatment and safe discharge or disposal of waste streams from oil sands and

heavy oil operations and HWC is studying toxicity and worker exposure to chemicals in the same operations. This work is conducted in cooperation with the relevant provincial departments and agencies.

The **new transportation fuels**, especially alcohols and the long term "fuels" of hydrogen and batteries, have the capacity to dramatically reduce harmful emissions from vehicles, although there would still be environmental concerns to be addressed during fuel production. However, there are advantages to dealing with environmental concerns from a few, large, stationary production facilities rather than from many small, dispersed, mobile sources. The Task then addresses two issues: (i) evaluating the relative environmental effects among various new transportation fuels and the fuels now in use and (ii) developing technologies, if necessary, to reduce harmful emissions during the production and use of these fuels.

The strategy of the program is to respond to the principal objectives of the Task by maintaining activity in various research areas, to ensure that any environmental or health related constraints or obstacles to fulfilling the main Task objectives are identified and addressed as early as possible in the overall program of the Task.

Policies:

Policies of the government that are supported by the Program include:

- the response to concerns on long-term energy security and environment using EMR programs;
- responsibilities in standards and codes for the introduction of new liquid fuels which include aspects on health safety and environment in the mandates of other departments;
- support of long term alternatives (e.g. hydrogen);
- development of new techniques, jointly with industry, for the recovery of heavy oil and oil sands bitumen; and
- collaboration with the provinces (Alberta and Saskatchewan) and the private sector in oil sands and heavy oil.

Organization and Description of Work

The Task's **unconventional feedstocks** programs and their formal objectives are:

5.1 Hydrocarbons Enhancement
To support technologies for the coprocessing of coal and/or bitumen, and heavy oils;

to demonstrate the production of liquid fuels from sewage sludge;

to develop improved technologies for the upgrading of synthetic crudes to conventional transportation fuels; and

to develop technologies for converting natural gas to liquid fuels.

The CANMET laboratories of EMR are the centre of federal research on the conversion of the fossil fuels.

Work on coal conversion technologies, in particular the development of coal/bitumen coprocessing, is an extension of CANMET's hydrocracking technology. The work is done largely in-house and is cost shared by a consortium of companies. Coal **Liquefaction** has also been investigated by CANMET, although for the moment this technology is considered less likely to be deployed before coprocessing

and its study has been discontinued.

In distillate treatment, the technologies under investigation address the production of high quality diesel and jet fuels from the highly aromatic synthetic crudes. The conversion of natural gas, a low energy density fuel to a liquid fuel of high energy density is another major topic in this program.

A major goal of CANMET is to cost-share activities with industry through contracting-out some programs, such as CANMET's 50/50 Energy Conversion Program.

A project to develop and demonstrate that sewage sludge can be thermally processed to liquid and solid fuels is being conducted by Environment Canada's Wastewater Treatment Centre at Burlington, Ontario. Further development of this important technology will be supported for several years as it is introduced into Canadian municipalities.

5.3 Bitumen and Heavy Oil Recovery
To support technologies for bitumen and heavy oil recovery and upgrading, for related new materials and to resolve environmental problems and constraints.

The CANMET laboratories of EMR are coordinating the R&D activities in this program, which is mostly contracted out. The program addresses the treatment of bitumen/heavy oil emulsions in water, and of effluent water, as well as processes for the recovery of bitumen and heavy oil. A significant component is the joint participation with AOSTRA and six other oil companies in the Underground Test Facility, located near Ft. McMurray, Alberta, for development of oil sands recovery technologies, including the application of horizontal wells. Another important component is the recently-formed consortium on the fundamental properties of tailings ponds sludge. Cooperative activities with provinces, USA are also covered.

Enhanced oil recovery of light and medium crude oils has recently been added to this program.

For the **new transportation fuels**, the Program objectives are:

5.5 Fuel Use
To establish the technical and regulatory basis for the utilization of alternative fuels.

The Efficiency and Alternative Energy Technology Branch (EAETB) at EMR receives over half the budget of the **Fuel Use Program**. EAETB is not yet a government laboratory thus virtually all of the work is contracted out. The contract arrangements range from joint-funding in cases where there is a strong industrial interest (e.g. the performance of methanol in large engines - project MILE - and the Canadian Gas Association natural gas vehicle R&D program) to full funding in cases where the government has an overwhelming interest (e.g. development of technical data to provide to the CGSB for preparation of national standards for oxygenated gasoline).

The $8 million MILE project is equally funded by government and industry. The project is now in the wind down phase. Work underway in this project has provided the necessary technical information to policy makers and identified areas where government and industry can cooperate to improve efficiency and develop better systems. Emissions testing and lubrication for alcohol-fuelled engines are other areas of potential research interest in a cooperative vein.

The CGA NGV R&D program is a joint industry-government improvement of the technology for natural gas as a transportation fuel. It addresses fundamental research, conversion hardware, storage and distribution and technology transfer. The R&D funding leverage on the federal contribution is over 5 to 1.

Transport Canada plays a major role in developing motor vehicle safety and emission standards necessary to protect the public. In addition, TC carries marine and rail transportation policy and regulatory responsibilities. Its Research and Development Directorate supports studies on the alternative fuels technologies for these modes. The Directorate also supports the assessment and development of federal and provincial regulations on the storage, handling and distribution of these new fuels.

Aircraft fuels as well as medium and high speed modern diesel technologies are being supported by National Defence.

5.6 Hydrogen and Electrochemistry

To support technologies for the production and use of hydrogen and for high energy batteries.

The **Hydrogen and Electrochemistry** Program deals with the production and use of hydrogen and the storage of energy, specifically hydrogen and electricity, for transportation uses. Hydrogen production is by water electrolysis in which Canada is a world leader. Hydrogen use could be through fuel cells and direct combustion. Hydrogen and electricity are generally regarded as fuels for the long term (hydrogen post 2020). They hold potential to improve the environment and enjoy a number of present day applications.

Support for research activities is extended through the centre for Hydrogen and Electrochemical Studies (CHES) and the Hydrogen Industry Council, among others.

Canada is a participant in a number of IEA R&D Agreements:

- Alcohol Fuels (Alternative Motor Fuels);
- Production of Hydrogen from Water (production, conversion, storage, safety and markets); and
- Fossil Fuel Technology.

Most **environmental** aspects of the above Programs are grouped in a single Program:

5.7 Environment

To identify the potential environmental and health-related constraints associated with the production and utilization of alternative fuels.

At present, the Program is responding to two main priority areas. Projects related to the **co-processing** of coal with heavy oil, bitumen and residuum (a CANMET research priority) deal both with health/exposure and waste characterization and treatability. A recent EMR-sponsored workshop with industry resulted in the environmental program incorporating and accelerating projects related to the use of neat **alcohol** and alcohol blends in motor vehicles into its activities. These projects include both the exposure/health aspects and emissions characterization of aldehydes and alcohols.

In most of the projects in this Program, significant amounts of departmental A-base and industry resources (CPA, PACE and product manufacturers) are an integral part of PERD projects.

Consultation

Task 5 is coordinated, planned and reviewed through various interdepartmental committees. All major projects are overseen by steering committees having federal, provincial and industrial members. In addition, the research program of CANMET is annually presented to and approved by the Minister's National Advisory Council to CANMET (MNACC). The advice of the CGSB, CGA and the Propane Gas Association of Canada is sought and considered in the planning of research activities dealing with automobile fuels.

Research results are presented at international conferences, national seminars and regularly published in specialized journals or government publications. EMR is a co-sponsor with the U.S. Department of Energy of the annual Windsor Workshop on Alternative Fuels (held in Toronto). All programs hold at least one technical workshop or seminar a year in addition to committee meetings.

The Alternative Transportation Fuels Task has been reviewed in 1989-90 by the DPA Group, Inc. This review covered the period of 1984 (the date of the last review) to 1989. The results of the review have been presented at, and endorsed by, the Panel on Energy R&D, at its meeting of October 12, 1990. The findings of the review were quite positive. The report by the DPA Group, Inc., and the response to it are available from OERD.

Policy advice on Alternative Transportation Fuels originates with the Efficiency and Alternative Energy Branch of EMR's Energy Sector, with input also from other departments. Coordination with the overall Energy R&D Program is the responsibility of the Office of Energy R&D (Dr. L. Vancea, (613) 995-6145).

Application of Results

The results are used primarily for energy policy, new fuel implementation strategies, regulations and standards development and the improvement of existing fuel use. More specifically, the results are applied by the federal government to:

- provide technical databases for national standards and regulations for the safe and environmentally responsible production and use of alternative fuels (for example, the results of project MILE will be used by the CGSB in setting national fuel specifications and by TC in setting national safety standards, for the use of methanol in compression ignition engines, which typically form the basis of provincial legislation);

- assist industry in higher-risk technological areas that have the potential to improve their competitive position in expanding domestic and foreign markets (for example, through joint funding with Ontario and Ford Canada for flexible fuel vehicle technology that can be used by the automobile company in producing original equipment for Canadian and foreign sales);

- transfer to industry, by licensing of government held patents, through organizations such as CANMET's Office of Technology Transfers (for example, CANMET has developed a process, for the mild hydrotreating of middle distillates derived from synthetic crude oil as a step to an acceptable diesel fuel, for which industry has expressed interest);

- assist the technology to be used by fragmented industries (for example, the propane industry) which are unable to mount a research program of their own; and

- support basic R&D (for example, for on-board hydrogen storage) for which there is no immediate commercial application.

TABLE 2-5-1
PERD FUNDING OF ALTERNATIVE TRANSPORTATION FUELS (TASK 5)
BY PROGRAM
(from OERD Database #14B - in 1990-91 $)

ALTERNATIVE TRANSPORTATION FUELS

ID	DESCRIPTION	91-92	92-93	93-94	94-95	95-96
51	HYDROCARBONS ENHANCEMENT	9334 (39.0)	9330 (38.0)	9308 (37.0)	9308 (37.0)	9308 (37.0)
53	BITUMEN AND OIL RECOVERY	3687 (3.0)	3687 (3.0)	3687 (3.0)	3687 (3.0)	3687 (3.0)
55	FUEL USE	4650 (11.0)	4650 (11.0)	4650 (11.0)	4650 (11.0)	4650 (11.0)
56	HYDROGEN AND ELECTROCHEMISTRY	2365 (5.0)	2365 (5.0)	2365 (5.0)	2365 (5.0)	2365 (5.0)
57	ENVIRONMENT	1908 (4.0)	1823 (4.0)	1823 (4.0)	1823 (4.0)	1823 (4.0)
58	MANAGEMENT	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
REPORT TOTALS:		21944 (62.0)	21855 (61.0)	21833 (60.0)	21833 (60.0)	21833 (60.0)

TABLE 2-5-2
PERD FUNDING OF ALTERNATIVE TRANSPORTATION FUELS (TASK 5)
BY DEPARTMENT
(from OERD Database #14B - in 1990-91 $)

ALTERNATIVE TRANSPORTATION FUELS

DEPARTMENT	91-92	92-93	93-94	94-95	95-96
NATIONAL DEFENCE	376 (2.0)	376 (2.0)	376 (2.0)	376 (2.0)	376 (2.0)
ENVIRONMENT CANADA	1863 (4.0)	1847 (4.0)	1818 (4.0)	1683 (4.0)	1683 (4.0)
ENERGY, MINES AND RESOURCES	17796 (53.0)	17683 (52.0)	17661 (51.0)	17661 (51.0)	17661 (51.0)
HEALTH & WELFARE	346 (0.0)	386 (0.0)	415 (0.0)	550 (0.0)	550 (0.0)
TRANSPORT CANADA	1563 (3.0)	1563 (3.0)	1563 (3.0)	1563 (3.0)	1563 (3.0)
REPORT TOTALS:	21944 (62.0)	21855 (61.0)	21833 (60.0)	21833 (60.0)	21833 (60.0)

TASK 6: OIL, GAS AND ELECTRICITY

Task Overview

The Oil, Gas and Electricity Task constitutes about 21% of the PERD Program. It comprises seven programs: petroleum geoscience, permafrost and gas hydrates; marine engineering; offshore geotechnics, materials for offshore structures; transportation of offshore oil and gas; environmental forecasting and impacts; and electrical R&D. Participating departments are EMR, EC, TC, INA and F&O.

Rationale

The conventional oil and gas and the electrical sectors are important to Canada's future energy security and prosperity through regional industrial development and trade. Task 6 provides the technical basis for the Federal Government to enhance the economic potential of these sectors while ensuring the safety of human life and the protection of the environment.

World oil prices and, therefore, development scenarios are notoriously volatile. Under any of the NEB's oil pricing scenarios, Canada's frontier oils will be developed before the first decade of the new century. Current plans for the Newfoundland Grand Banks and for the Beaufort Sea indicate that development may come before that, with production from the Hibernia structure before 1995. Given Hibernia, smaller finds elsewhere on the Grand Banks could become economical for floating production systems. The development of MacKenzie Delta Gas and the Amauligak field in the Beaufort Sea could also trigger subsequent development of associated smaller fields. Delivery options in both cases involve some combination of pipelines and tankers. Pilot projects in the Arctic Islands may continue and exploration on the West Coast is possible if the moratorium is lifted with the signing of a "Western Accord". A moratorium has been announced for Georges Bank due to the potential conflict with the multi-million dollar fishery on both sides of the international boundary. However, considerable research needs to be undertaken in order that the technical basis for regulation of this resource conflict can be properly taken into consideration.

The NEB reports that electricity is expected to account for 21% of Canada's end-use energy demand by 2005. The principle investment of federal R&D in this area is the CANDU fission program of AECL. It is not a part of the ERD Program. Task 6 supports the electric utilities through the Canadian Electrical Association (CEA), Task 3 supports long term research in fusion, while Task 5 covers hydrogen and energy storage.

Objectives

The Task objectives are to ensure that the Government of Canada has, in cooperation with industry, the technical knowledge to discharge its responsibilities relating to the supply of light-medium crude oil and natural gas, principally from the frontiers; and to participate with utilities in developing electrical technologies.

Strategy

Given the objectives of Task 6 and the development scenarios described above, 93% of Task 6 funding is related to oil and gas problems on the offshore and to areas of further exploration in the western basin.

The harsh and remote nature of the frontier environments make field work extremely expensive. The current downturn in R&D activities by the industry constrains fieldwork considerably since there is not as

much infrastuructural support received from industry. At the same time, Federal Energy R&D is under considerable pressure to maintain technical expertise in Canada and to continue some of the work previously supported by industry and its associated service and consulting companies. Task 6 R&D projects are focused on the evaluation of archived data to resolve technical gaps in knowledge identified from regulatory and scientific perspectives and on the development of technology, models and concepts.

The remainder of Task 6 funding (7%) is for electrical R&D which will, over the next few years, be largely limited to a contribution to the R&D program of the Canadian Electrical Association (CEA) comprising generation, transmission, distribution and utilisation. It allows the smaller utilities access to R&D programs and it allows closer coordination of research among the larger utilities.

Policies:

Policies of the government that are supported by the Program include:

- the Government of Canada's responsibilities for the safe development of hydrocarbon resources to:

  promote diversity, competitiveness and growth;

  promote security of energy supply;

  regulate the activities, provide essential services and assist Canadian oil and gas industry to develop new technologies and lower costs for the frontier regions;

  provide expert and independent information for the stewardship of the resources and environmental reviews; and

  ensure there is full coordination with the Northern Oil and Gas Action Program, and Environmental Studies Research Fund;

- the new Canadian electricity policy, which calls for increased R&D in electrical technologies; and

- encouraging the cost sharing of R&D programs with the private sector (e.g. CEA).

Organization and Description of Work

Task 6 comprises seven programs with the following objectives and working methods:

6.1 Geoscientific R&D
To improve the understanding of the origins of petroleum reservoirs and the hazards of onshore permafrost in hydrocarbon developments. Management is provided by GSC (EMR).

6.2 Marine Engineering
To provide the technologies and a technical basis for regulating for safety in marine hydrocarbon exploration and production systems. The program is chaired by COGLA, and projects are managed by COGLA, EC, and F&O.

6.3 Offshore Geotechnics
To improve the knowledge of seabed conditions and hydrates for hydrocarbon development,

regulation and environmental assessment. Management is provided by GSC (EMR).

6.5 Materials
To improve materials technologies for offshore hydrocarbon exploration and production systems, pipelines, and their regulation. Management is provided by CANMET (EMR).

6.6 Transportation of Oil and Gas
To improve ship and navigation technologies and hydrographic services for the safe and efficient transportation of oil and gas. The program is chaired by TC, and project management is shared between TC and CHS (F&O).

6.7 Environment
To improve forecasting of sea, ice and weather conditions and the management of environmental impacts of hydrocarbon developments, principally in the Canadian frontiers. The program is co-chaired by EC and F&O, and projects are managed by EC, F&O, and COGLA.

6.8 Electrical R&D
To participate with utilities in developing electrical technologies. Chairmanship is provided by CEA, with participation by NRC and Energy Commodities (EMR).

Consultation

Task 6 is coordinated, planned and reviewed through the eight program committees which each have representation from Federal departments (COGLA, EMR, EC, F&O, INA, NRC, PWC or TC), industry and provincial departments. Additional consultation is achieved through workshops, seminars, contracted reviews and external committees such as the Minister's National Advisory Committee to CANMET (MNACC). Cofunding and coplanning with targeted funds such as the Environmental Studies Research Funds (ESRF), and the Northern Oil and Gas Action Program (NOGAP) occurs since PERD program managers are members of committees governing these programs. International collaboration is common, especially on projects involving large field programs or extensive instrument development.

At the committee meetings in the summer of 1990, a fall program of work was extensively discussed by the committees. The major shift in emphasis was to approve four new projects related to northern pipelines which had been co-ordinated by the R&D committee of the Canadian Petroleum Association.

Following the results of the Program Evaluation, Task 6 as a whole will be reexamining the Task organization over the following year.

At their meeting in October 1990, the Panel reallocated funds away from Task 6 to work the Panel considered higher priority. Those reallocations which affect Task 6 are:

- a program in CO_2 - related work in Task 4 will receive $269 from Program 6.6 in 1991/92 and $255K in 1992-1994;
- a Low-level Ozone project in Task 5 will receive $149K from Program 6.5; and
- a project providing funds for the Hydrogen Industry Council will receive $150K, also from Program 6.5.

Project scientists are encouraged to publish the results of their work in the scientific literature. A Task Bibliography was published in 1986. Policy advice and overall coordination is provided by the Office of Energy R&D, EMR, (Dr. L.R. Muir, (613) 995-5299).

Application of Results

Much of the product of the Task is technical information in the form of manuals, reports, scientific papers, models, maps, design methods and criteria and governmental technical expertise. The economic benefits are largely indirect but provide improvements in the quality of information required to make prompt, knowledgable and economical regulatory decisions on proposed offshore oil and gas proposals. The technical information provides greater confidence in and cost-effectiveness of measures designed to protect both human and environmental safety.

Examples of applications of the work of the Task are:

- the improvement of essential services such as weather, sea state and ice forecasting and hydrographic charts;
- improvements in the regional understanding of environmental and geotechnical processes;
- the evaluation of national hydrocarbon reserves and resources;
- provision of technical advice and methodoligies for codes and standards such as the new CSA Code for the Design, Construction and Installation of Offshore Structures;
- the technical expertise to provide "independent" expert opinion in public forums such as environmental impact evaluations, development plan applications and commissions of enquiry such as that for the Ocean Ranger disaster;
- a technical basis for regulations developed by COGLA and TC;
- a sharing of research programs and results nationally and internationally, such as the Verification of the CSA Offshore Code, CASP, ERICA, LIMEX and the Canadian Electrical Association, which allows considerable leverage to be exerted by relatively modest federal funding.

TABLE 2-6-1
PERD FUNDING OF OIL, GAS, ELECTRICITY (TASK 6)
BY PROGRAM
(from OERD Database #148 - in 1990-91 $)

OIL, GAS, ELECTRICITY

ID	DESCRIPTION	91-92	92-93	93-94	94-95	95-96
61	GEOSCIENTIFIC R&D	1672 (6.0)	1672 (6.0)	1672 (6.0)	1672 (6.0)	1672 (6.0)
62	MARINE ENGINEERING	2610 (4.5)	2600 (4.5)	2600 (4.5)	2600 (4.5)	2600 (4.5)
63	OFFSHORE GEOTECHNICS	1670 (6.0)	1670 (6.0)	1670 (6.0)	1670 (6.0)	1670 (6.0)
65	MATERIALS	2342 (10.0)	2342 (10.0)	2281 (9.0)	2281 (9.0)	2281 (9.0)
66	TRANSPORTATION OF OIL AND GAS	3729 (5.0)	3717 (5.0)	3678 (5.0)	3678 (5.0)	3678 (5.0)
67	ENVIRONMENT	5052 (9.5)	5062 (9.5)	5062 (9.5)	5062 (9.5)	5062 (9.5)
68	ELECTRICAL R&D	1359 (0.0)	1359 (0.0)	1359 (0.0)	1359 (0.0)	1359 (0.0)
REPORT TOTALS:		18434 (41.0)	18422 (41.0)	18322 (40.0)	18322 (40.0)	18322 (40.0)

TABLE 2-6-2
PERD FUNDING OF OIL, GAS, ELECTRICITY (TASK 6)
BY DEPARTMENT
(from OERD Database #148 - in 1990-91 $)

OIL, GAS, ELECTRICITY

DEPARTMENT	91-92	92-93	93-94	94-95	95-96
ENVIRONMENT CANADA	2488 (5.0)	2822 (5.0)	3008 (5.0)	3099 (5.0)	3113 (5.0)
ENERGY, MINES AND RESOURCES	7810 (22.5)	7776 (22.5)	7738 (21.5)	7747 (21.5)	7795 (21.5)
FISHERIES AND OCEANS	5413 (9.0)	5124 (9.0)	4854 (9.0)	4742 (9.0)	4632 (9.0)
INDIAN & NORTHERN AFFAIRS	765 (0.5)	729 (0.5)	751 (0.5)	763 (0.5)	811 (0.5)
TRANSPORT CANADA	1958 (4.0)	1971 (4.0)	1971 (4.0)	1971 (4.0)	1971 (4.0)
REPORT TOTALS:	18434 (41.0)	18422 (41.0)	18322 (40.0)	18322 (40.0)	18322 (40.0)

TASK 7: COORDINATION AND INTERNATIONAL PARTICIPATION

Task Overview

Receiving about 2% of the Program's budget, this Task supports the overall coordination of the Federal Energy R&D Program and centralizes, for administrative purposes, contributions of funds to the cooperative energy R&D activities of the International Energy Agency (IEA).

Rationale

The interdepartmental Panel on Energy R&D (PERD) reviews federal Energy R&D activities; develops and implements a coordinated federal Energy R&D Program; advises Treasury Board on the allocation of funds for energy R&D; coordinates energy R&D activities in the federal government, including the federal approach to major international and federal-provincial initiatives; and provides for the exchange of information on energy policy and strategies which would affect the direction of federal energy R&D programs. Twenty departments are members of PERD. The Office of Energy R&D in EMR is the secretariat to PERD.

The IEA is a preferred route for governments to collaborate internationally in energy R&D activities. For purposes of better coordinating Canada's participation, contributions to specific projects are reviewed and authorized by a committee of OERD.

Objectives

The objectives of this Task are:

- to coordinate and advise on the interdepartmental energy R&D activities of the Government of Canada; and
- to maintain Canada's ability to collaborate in R&D activities of the International Energy Agency (IEA).

Strategy, Organization and Description of Work

OERD is responsible for assisting PERD in developing federal energy R&D policies and plans to support national energy strategy options; for information on Canadian and international energy R&D; for advice on and coordination of federal energy R&D resources, including managing the interdepartmental committees' process; for monitoring results and administering the allocation of funds; for participating in the technical evaluation of federal energy R&D programs; for coordinating and reviewing federal programs; and for liaison and communication with provincial, industrial and international partners in energy R&D and technology transfer. OERD also provides information and advice to EMR senior management on all aspects of energy R&D, and represents Canada nationally and internationally on these matters. Mr. B.D. Cook (Director General, OERD, (613) 995-8860) is the manager for the Task.

Consultation

The Office of Energy R&D consults with sectors responsible for the development of energy policy. Interdepartmental consultation is provided through the Panel on Energy R&D and its committee structure. International consultation is achieved through OERD representation on bilateral (e.g. Canada-U.S. MOU on Energy R&D) and multilateral (e.g. IEA Committee on Research and Development) committees. OERD represents the federal government on the management committee for the Alberta-Canada Energy Resources Research Fund. OERD staff also consult directly with governmental, industrial, academic and provincial organizations.

Application of Results

OERD ensures that the products of the Energy R&D Program are available to the public and private sectors through media such as overviews, databases, bibliographies, speeches and workshops.

TABLE 2-7-1
PERD FUNDING OF COORDINATION AND INTERNATIONAL PARTICIPATION (TASK 7)
BY PROGRAM
(from OERD Database #148 - in 1990-91 $)

COORDINATION & INTERNATIONAL CONTRIBUTIONS

ID	DESCRIPTION	91-92	92-93	93-94	94-95	95-96
71	COORDINATION	1281 (14.0)	1281 (14.0)	1281 (14.0)	1281 (14.0)	1281 (14.0)
72	INTERNATIONAL ENERGY AGENCY	970 (0.0)	970 (0.0)	970 (0.0)	970 (0.0)	970 (0.0)
73	ENERGY DIVERSIFICATION RESEARCH LABORATORY	3120 (15.0)	3304 (18.0)	3571 (22.0)	3571 (22.0)	3571 (22.0)
REPORT TOTALS:		5371 (29.0)	5555 (32.0)	5822 (36.0)	5822 (36.0)	5822 (36.0)

TABLE 2-7-2
PERD FUNDING OF COORDINATION AND INTERNATIONAL PARTICIPATION (TASK 7)
BY DEPARTMENT
(from OERD Database #148 - in 1990-91 $)

COORDINATION & INTERNATIONAL CONTRIBUTIONS

DEPARTMENT	91-92	92-93	93-94	94-95	95-96
ENERGY, MINES AND RESOURCES	5371 (29.0)	5555 (32.0)	5822 (36.0)	5822 (36.0)	5822 (36.0)
REPORT TOTALS:	5371 (29.0)	5555 (32.0)	5822 (36.0)	5822 (36.0)	5822 (36.0)

PART 3

PERD RESOURCE DATABASE (#14B)

NOTE ON THE PERD RESOURCE DATABASE

The following is the array of PERD projects approved in the Fall of 1990.

This Database (OERD #14B) is in 1990-91 dollars and covers a five-year period beginning in 1991-92. Database #14B was the basis for the Input to Departmental MYOP's in September 1990.

TASK #1 - ENERGY EFFICIENCY

ID	DESCRIPTION	DEPT/PE	91-92	92-93	93-94	94-95	95-96
PROGRAM #11 - INDUSTRIAL ENERGY CONSERVATION R&D (IERD)							
11102	Industrial Energy Conservation R&D (IERD)	EMR/M&ET	5277 (4.0)	5277 (4.0)	5277 (4.0)	5277 (4.0)	5277 (4.0)
PROGRAM #11 TOTALS:			5277 (4.0)	5277 (4.0)	5277 (4.0)	5277 (4.0)	5277 (4.0)
PROGRAM #12 - INDUSTRY							
12101	Heat Upgrading (Varennes)	EMR/M&ET	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
12102	Combustion	EMR/M&ET	140 (1.0)	140 (1.0)	140 (1.0)	140 (1.0)	140 (1.0)
12201	DRECT	EC/C&P	873 (2.0)	873 (2.0)	873 (2.0)	873 (2.0)	873 (2.0)
12203	NITEP	EC/C&P	270 (0.0)	270 (0.0)	270 (0.0)	270 (0.0)	270 (0.0)
12204	Sewage Treatment	EC/C&P	73 (0.0)	73 (0.0)	73 (0.0)	73 (0.0)	73 (0.0)
12205	Sludge Processing	EC/C&P	174 (0.0)	174 (0.0)	174 (0.0)	0 (0.0)	0 (0.0)
12206	FBC MSW Incineration	EMR/M&ET	50 (0.0)	50 (0.0)	50 (0.0)	0 (0.0)	0 (0.0)
12301	Industrial Minerals	EMR/M&ET	256 (1.0)	256 (1.0)	205 (0.0)	205 (0.0)	205 (0.0)
12303	Plasma	EMR/M&ET	150 (0.0)	150 (0.0)	150 (0.0)	150 (0.0)	150 (0.0)
12304	HTFS	AECL/IDEP	242 (0.0)	242 (0.0)	242 (0.0)	242 (0.0)	242 (0.0)
12305	Pulp and Paper	EC/C&P	45 (0.0)	45 (0.0)	45 (0.0)	45 (0.0)	45 (0.0)
12306	Base-Metal Ore Comminution	EMR/M&ET	315 (0.0)	315 (0.0)	315 (0.0)	315 (0.0)	315 (0.0)
12307	Falling Film	AECL/IDEP	0 (0.0)	0 (0.0)	30 (0.0)	0 (0.0)	0 (0.0)
12308	Enhanced Surfaces	AECL/IDEP	50 (0.0)	50 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
12309	Plate Characterization	AECL/IDEP	75 (0.0)	75 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
12310	Technology Assessments	EMR/M&ET	75 (0.0)	75 (0.0)	75 (0.0)	0 (0.0)	0 (0.0)
PROGRAM #12 TOTALS:			2788 (4.0)	2788 (4.0)	2642 (3.0)	2313 (3.0)	2313 (3.0)

TASK #1 - ENERGY EFFICIENCY

ID	DESCRIPTION	DEPT/PE	91-92	92-93	93-94	94-95	95-96
PROGRAM #13 - AGRI-FOOD AND FISHERIES							
13103	Sustainable Agriculture	AC/SRD	1500 (5.0)	1500 (5.0)	1500 (5.0)	1500 (5.0)	1500 (5.0)
13201	Fish Harvest	FO/AF	305 (0.0)	305 (0.0)	305 (0.0)	305 (0.0)	305 (0.0)
PROGRAM #13 TOTALS:			1805 (5.0)	1805 (5.0)	1805 (5.0)	1805 (5.0)	1805 (5.0)
PROGRAM #14 - BUILDINGS							
14101	Health and Comfort	HWC/EQH	292 (1.0)	292 (1.0)	292 (1.0)	292 (1.0)	292 (1.0)
14103	Field Studies - Large Buildings	PWC/DCRT	158 (0.0)	158 (0.0)	158 (0.0)	158 (0.0)	158 (0.0)
14104	Residential Buildings	CMHC/HS	75 (0.0)	75 (0.0)	100 (0.0)	100 (0.0)	100 (0.0)
14105	SEE Housing Indoor Air	EMR/M&ET	53 (1.0)	53 (1.0)	53 (1.0)	53 (1.0)	53 (1.0)
14203	BESA	PWC/DCRT	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
14204	Fireplaces and Chimneys	CMHC/HS	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
14205	Buildings, Energy and Environment	CMHC/HS	170 (0.0)	188 (0.0)	188 (0.0)	188 (0.0)	188 (0.0)
14206	Durable Buildings	PWC/DCRT	321 (0.0)	321 (0.0)	321 (0.0)	321 (0.0)	321 (0.0)
14207	Tech. Ass. Residential	EMR/M&ET	45 (0.0)	50 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
14208	Tech. Ass. Residential	CMHC/HS	45 (0.0)	50 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
14209	Tech. Ass. commercial	EMR/M&ET	108 (0.0)	98 (0.0)	134 (0.0)	0 (0.0)	0 (0.0)
14210	Energy/Environment Measures	PWC/DCRT	112 (0.0)	112 (0.0)	112 (0.0)	112 (0.0)	112 (0.0)
14302	Energy Storage and Distribution (Varennes)	EMR/M&ET	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
14303	Combustion	EMR/M&ET	407 (2.0)	452 (2.0)	452 (2.0)	452 (2.0)	452 (2.0)
14306	Heating & Cooling - Large Buildings	PWC/DCRT	247 (0.0)	247 (0.0)	247 (0.0)	247 (0.0)	247 (0.0)
14307	Integrated Energy Utility	PWC/DCRT	100 (0.0)	100 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)

TASK #1 - ENERGY EFFICIENCY

ID	DESCRIPTION	DEPT/PE	91-92	92-93	93-94	94-95	95-96
14403	Energy Management	PWC/DCRT	180 (0.0)	180 (0.0)	180 (0.0)	180 (0.0)	180 (0.0)
14502	Moisture Data Analysis	CMHC/HS	93 (0.0)	75 (0.0)	50 (0.0)	50 (0.0)	50 (0.0)
14603	Visual Performance & Day Lighting	PWC/DCRT	147 (0.0)	147 (0.0)	147 (0.0)	147 (0.0)	147 (0.0)
PROGRAM #14 TOTALS:			2553 (4.0)	2598 (4.0)	2434 (4.0)	2300 (4.0)	2300 (4.0)

PROGRAM #15 - TRANSPORTATION

15102	Vehicle Fuel Consumption Analysis/Monitoring	TC/P&C	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
15107	Diesel Fuels and Emissions	EMR/ENERGY	250 (1.0)	250 (1.0)	250 (1.0)	250 (1.0)	250 (1.0)
15108	Monitoring Technology and Regulatory Support	TC/P&C	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
15109	Particulate Trap	EMR/M&ET	75 (0.0)	75 (0.0)	75 (0.0)	75 (0.0)	75 (0.0)
15201	Road Transport R&D (Cooperative,Bus,Truck,Train)	TC/P&C	685 (0.0)	685 (0.0)	685 (0.0)	685 (0.0)	685 (0.0)
15204	Auto Fuel Consumption	EMR/ENERGY	100 (1.0)	100 (1.0)	100 (1.0)	100 (1.0)	100 (1.0)
15301	Transport Systems R&D	TC/P&C	408 (0.0)	408 (0.0)	408 (0.0)	408 (0.0)	408 (0.0)
15302	Fuel Conservation Technologies by Mode	EMR/ENERGY	45 (0.0)	45 (0.0)	45 (0.0)	45 (0.0)	45 (0.0)
15303	R&D Management	TC/P&C	296 (4.0)	296 (4.0)	296 (4.0)	296 (4.0)	296 (4.0)
15304	R&d Management	EMR/M&ET	66 (1.0)	66 (1.0)	66 (1.0)	66 (1.0)	66 (1.0)
PROGRAM #15 TOTALS:			1925 (7.0)	1925 (7.0)	1925 (7.0)	1925 (7.0)	1925 (7.0)

PROGRAM #17 - ENERGY SYSTEMS

17103	Energy Systems	EMR/M&ET	460 (1.0)	451 (1.0)	451 (1.0)	451 (1.0)	451 (1.0)
PROGRAM #17 TOTALS:			460 (1.0)	451 (1.0)	451 (1.0)	451 (1.0)	451 (1.0)

TASK #1 - ENERGY EFFICIENCY

ID	DESCRIPTION	DEPT/PE	91-92	92-93	93-94	94-95	95-96
PROGRAM #18 - COORDINATION							
18101	CADDET	EMR/M&ET	250 (0.0)	250 (0.0)	250 (0.0)	250 (0.0)	250 (0.0)
18201	Advanced Industry Technologies (OERD)	EMR/M&ET	0 (0.0)	0 (0.0)	85 (0.0)	415 (0.0)	415 (0.0)
18202	Advanced Buildings Technologies (OERD)	EMR/M&ET	0 (0.0)	0 (0.0)	119 (0.0)	252 (0.0)	252 (0.0)
PROGRAM #18 TOTALS:			250 (0.0)	250 (0.0)	454 (0.0)	917 (0.0)	917 (0.0)
TASK #1 TOTALS:			15058 (25.0)	15094 (25.0)	14988 (24.0)	14988 (24.0)	14988 (24.0)

TASK #2 - COAL

ID	DESCRIPTION	DEPT/PE	91-92	92-93	93-94	94-95	95-96
PROGRAM #21 - COAL TECHNOLOGIES							
21101	Technology Development for Coal Field Assessments	EMR/GS	211 (2.0)	211 (2.0)	211 (2.0)	211 (2.0)	211 (2.0)
21102	Resource Analysis and Characterization	EMR/GS	211 (2.0)	191 (2.0)	191 (2.0)	191 (2.0)	191 (2.0)
21103	Computer Modelling and Data Analysis	EMR/GS	165 (0.0)	165 (0.0)	165 (0.0)	165 (0.0)	165 (0.0)
21104	Trace Elements in Canadian Coal	EMR/GS	246 (2.0)	246 (2.0)	0 (0.0)	0 (0.0)	0 (0.0)
21106	Environmental Contaminants in Canadian Coals	EMR/GS	0 (0.0)	0 (0.0)	240 (2.0)	240 (2.0)	240 (2.0)
21107	Remote Sensing Technology for Near-surface Geological Anal.	EMR/GS	60 (0.0)	60 (0.0)	60 (0.0)	60 (0.0)	60 (0.0)
21201	Surface Coal and Oilsands Mining I	EMR/M&ET	50 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
21202	Underground Coal Mining	EMR/M&ET	150 (0.0)	150 (0.0)	150 (0.0)	150 (0.0)	150 (0.0)
21203	Coal Dust Explosion Control	EMR/M&ET	120 (0.0)	80 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
21205	Surface Coal and Oil Sands Mining II	EMR/M&ET	197 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
21301	High Sulphur Coal Preparation	EMR/M&ET	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
21302	Transportion of Coal	TC/P&C	92 (0.0)	25 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
21303	Research Program Administration	EMR/M&ET	273 (4.0)	210 (3.0)	210 (3.0)	210 (3.0)	210 (3.0)
21307	Process Control	EMR/M&ET	360 (1.0)	360 (1.0)	360 (1.0)	361 (1.0)	361 (1.0)
21309	Upgrading of Low Ranked Coals	EMR/M&ET	150 (0.0)	100 (0.0)	100 (0.0)	100 (0.0)	100 (0.0)
21311	Coal Transportation	EMR/M&ET	135 (0.0)	135 (0.0)	135 (0.0)	135 (0.0)	135 (0.0)
21312	Comm. on Atlantic Coal: Coal Preparation & Coal Combustion	EMR/M&ET	250 (0.0)	250 (0.0)	250 (0.0)	250 (0.0)	250 (0.0)
21313	Fine Coal Processing	EMR/M&ET	1314 (4.0)	1464 (4.0)	1464 (4.0)	1464 (4.0)	1464 (4.0)
21314	Industry Initiated Field Testing	EMR/M&ET	70 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
21315	Effluent Treatment Technologies (Form. NEW04)	EMR/M&ET	669 (3.0)	769 (3.0)	769 (3.0)	769 (3.0)	769 (3.0)
21320	Advanced Unit Coal Train -A.C. Traction Phase	TC/P&C	60 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)

TASK #2 - COAL

ID	DESCRIPTION	DEPT/PE	91-92	92-93	93-94	94-95	95-96
21401	Flame Characteristics and Diagnostics	EMR/M&ET	628 (2.0)	628 (2.0)	628 (2.0)	628 (2.0)	628 (2.0)
21402	Fuel Quality and Combustion Performance	EMR/M&ET	375 (4.0)	375 (4.0)	375 (4.0)	375 (4.0)	375 (4.0)
21405	Sorbents Characterization	EMR/M&ET	105 (1.0)	105 (1.0)	105 (1.0)	0 (0.0)	0 (0.0)
21406	Chatham CFB Demo	EMR/M&ET	163 (1.0)	163 (1.0)	163 (1.0)	0 (0.0)	0 (0.0)
21408	New Coal-Based Fuels	EMR/M&ET	800 (3.0)	800 (3.0)	800 (3.0)	800 (3.0)	800 (3.0)
21409	Low No(x) Burner Projects	EMR/M&ET	765 (1.0)	765 (1.0)	765 (1.0)	765 (1.0)	765 (1.0)
21411	Metallurgical Coke Production and Standards	EMR/M&ET	360 (0.0)	360 (0.0)	360 (0.0)	360 (0.0)	360 (0.0)
21412	FBC Systems for Coke and Pitch Residues	EMR/M&ET	300 (1.0)	300 (1.0)	300 (1.0)	300 (1.0)	300 (1.0)
21413	FBC Systems for Coal	EMR/M&ET	749 (3.0)	589 (2.0)	487 (1.0)	487 (1.0)	487 (1.0)
21415	Gasification of Non-Reactive Feedstocks	EMR/M&ET	497 (1.5)	497 (1.5)	497 (1.5)	497 (1.5)	497 (1.5)
21416	Hot Gas Clean-Up	EMR/M&ET	541 (1.5)	541 (1.5)	541 (1.5)	541 (1.5)	541 (1.5)
21417	Coal Injection Into Blast Furnances	EMR/M&ET	92 (0.0)	150 (0.0)	150 (0.0)	150 (0.0)	150 (0.0)
21418	Coal Combustion and CO2, and Workshop Priorities	EMR/M&ET	0 (0.0)	248 (0.0)	338 (0.0)	605 (2.0)	605 (2.0)
PROGRAM #21 TOTALS:			10158 (37.0)	9937 (35.0)	9814 (34.0)	9814 (34.0)	9814 (34.0)

PROGRAM #22 - ENVIRONMENT: COAL

22101	Carcinogenic Compounds - Estuarine Receiving Waters	FO/SCIENCE	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
22102	Pilot Wastewater Treatment - Surface Coal Mines	EC/C&P	50 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
22103	Coarse Coal Refuse Management	EC/C&P	56 (0.0)	35 (0.0)	35 (0.0)	0 (0.0)	0 (0.0)
22104	FBC Technology Pollution Assessment	EC/C&P	212 (1.0)	233 (1.0)	233 (1.0)	233 (1.0)	233 (1.0)
22105	Advanced Coal Combustion/ Preparation Tech./Env. Imp.	EC/C&P	290 (0.0)	355 (0.0)	355 (0.0)	440 (0.0)	440 (0.0)
22106	Regional Scale Meteorological Control Systems	EC/AES	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)

TASK #2 - COAL

ID	DESCRIPTION	DEPT/PE	91-92	92-93	93-94	94-95	95-96
22107	R&D Coordination/Workshops	EC/ADMIN	20 (0.0)	20 (0.0)	20 (0.0)	20 (0.0)	20 (0.0)
22108	Sampling, Analytical Meth. of Coal Dust in Particulate Matri	EC/C&P	30 (0.0)	50 (0.0)	50 (0.0)	0 (0.0)	0 (0.0)
22109	Determin. of the Sources of Black Carbon Particles in Env.	FO/SCIENCE	0 (0.0)	50 (0.0)	50 (0.0)	50 (0.0)	50 (0.0)
PROGRAM #22 TOTALS:			658 (1.0)	743 (1.0)	743 (1.0)	743 (1.0)	743 (1.0)
TASK #2 TOTALS:			10816 (38.0)	10680 (36.0)	10557 (35.0)	10557 (35.0)	10557 (35.0)

TASK #3 - FUSION

ID	DESCRIPTION	DEPT/PE	91-92	92-93	93-94	94-95	95-96
PROGRAM #34 - FUSION							
34103	Tokamak Facility (Operating Phase)	AECL/IDEP	7100 (0.0)	5000 (0.0)	5000 (0.0)	5000 (0.0)	5000 (0.0)
34104	Support Activities	AECL/IDEP	337 (0.0)	337 (0.0)	337 (0.0)	337 (0.0)	337 (0.0)
34105	International	AECL/IDEP	300 (0.0)	300 (0.0)	300 (0.0)	300 (0.0)	300 (0.0)
34301	Fusion Fuels Project	AECL/IDEP	4520 (0.0)	2200 (0.0)	2200 (0.0)	2200 (0.0)	2200 (0.0)
34304	Support Activities	AECL/IDEP	337 (0.0)	337 (0.0)	337 (0.0)	337 (0.0)	337 (0.0)
34305	International	AECL/IDEP	200 (0.0)	200 (0.0)	200 (0.0)	200 (0.0)	200 (0.0)
PROGRAM #34 TOTALS:			12794 (0.0)	8374 (0.0)	8374 (0.0)	8374 (0.0)	8374 (0.0)
TASK #3 TOTALS:			12794 (0.0)	8374 (0.0)	8374 (0.0)	8374 (0.0)	8374 (0.0)

TASK #4 - RENEWABLE ENERGY AND GENERIC ENVIRONMENT

ID	DESCRIPTION	DEPT/PE	91-92	92-93	93-94	94-95	95-96
PROGRAM #41 - HYDRAULICS							
41101	Hydrologic Design Methodologies	EC/C&P	25 (0.0)	50 (0.0)	50 (0.0)	50 (0.0)	50 (0.0)
41102	Product Development	EMR/M&ET	119 (0.0)	119 (0.0)	119 (0.0)	119 (0.0)	119 (0.0)
41103	Field Testing	EMR/M&ET	90 (0.0)	90 (0.0)	90 (0.0)	90 (0.0)	90 (0.0)
41104	Site & Environmental Work	EMR/M&ET	90 (0.0)	90 (0.0)	90 (0.0)	90 (0.0)	90 (0.0)
41201	Concept Assessment	EMR/M&ET	51 (0.0)	51 (0.0)	51 (0.0)	51 (0.0)	51 (0.0)
PROGRAM #41 TOTALS:			375 (0.0)	400 (0.0)	400 (0.0)	400 (0.0)	400 (0.0)
PROGRAM #42 - ACTIVE SOLAR							
42101	Basic Technology Development	EMR/M&ET	235 (0.0)	235 (0.0)	235 (0.0)	235 (0.0)	235 (0.0)
42102	Design Information and Measurement Technology	EC/AES	75 (0.0)	75 (0.0)	75 (0.0)	75 (0.0)	75 (0.0)
42103	Near Term Product Development	EMR/M&ET	204 (0.0)	204 (0.0)	204 (0.0)	204 (0.0)	204 (0.0)
42104	Industry Support Services	EMR/M&ET	286 (0.0)	286 (0.0)	286 (0.0)	286 (0.0)	286 (0.0)
42105	Technology & Information Transfer	EMR/M&ET	75 (0.0)	75 (0.0)	75 (0.0)	75 (0.0)	75 (0.0)
PROGRAM #42 TOTALS:			875 (0.0)	875 (0.0)	875 (0.0)	875 (0.0)	875 (0.0)
PROGRAM #43 - PASSIVE SOLAR							
43101	Product Development	EMR/M&ET	200 (0.0)	200 (0.0)	200 (0.0)	200 (0.0)	200 (0.0)
43102	Technology Transfer and Industry Support	EMR/M&ET	225 (0.0)	225 (0.0)	225 (0.0)	225 (0.0)	225 (0.0)
43103	Basic Research	EMR/M&ET	125 (0.0)	125 (0.0)	125 (0.0)	125 (0.0)	125 (0.0)
43104	Modelling/Monitoring	EMR/M&ET	50 (0.0)	50 (0.0)	50 (0.0)	50 (0.0)	50 (0.0)

TASK #4 - RENEWABLE ENERGY AND GENERIC ENVIRONMENT

ID	DESCRIPTION	DEPT/PE	91-92	92-93	93-94	94-95	95-96
43105	High Performance Windows	EMR/M&ET	550 (0.0)	600 (0.0)	600 (0.0)	600 (0.0)	600 (0.0)
43106	IDMY	EC/AES	75 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
PROGRAM #43 TOTALS:			1225 (0.0)	1200 (0.0)	1200 (0.0)	1200 (0.0)	1200 (0.0)
PROGRAM #44 - PHOTOVOLTAICS							
44101	Cell/Module Research	EMR/M&ET	231 (0.0)	231 (0.0)	231 (0.0)	231 (0.0)	231 (0.0)
44102	Integrated Product Development	EMR/M&ET	158 (0.0)	158 (0.0)	158 (0.0)	158 (0.0)	158 (0.0)
44103	Testing/Monitoring/Simulation	EMR/M&ET	136 (0.0)	136 (0.0)	136 (0.0)	136 (0.0)	136 (0.0)
44104	Information and Technology Transfer	EMR/M&ET	75 (0.0)	75 (0.0)	75 (0.0)	75 (0.0)	75 (0.0)
PROGRAM #44 TOTALS:			600 (0.0)	600 (0.0)	600 (0.0)	600 (0.0)	600 (0.0)
PROGRAM #45 - BIOENERGY							
45101	Silviculture and Resource Assessment	FC/FRTS	366 (0.0)	366 (0.0)	366 (0.0)	366 (0.0)	366 (0.0)
45102	Environmental Impacts	FC/FRTS	570 (0.0)	570 (0.0)	570 (0.0)	570 (0.0)	570 (0.0)
45103	Economic Studies/Technology Transfer	FC/FRTS	146 (0.0)	146 (0.0)	146 (0.0)	146 (0.0)	146 (0.0)
45201	IEA Bioenergy Agreement	FC/FRTS	129 (0.0)	129 (0.0)	129 (0.0)	129 (0.0)	129 (0.0)
45301	Residential	EMR/M&ET	400 (0.0)	400 (0.0)	400 (0.0)	400 (0.0)	400 (0.0)
45302	Industrial	EMR/M&ET	331 (0.0)	331 (0.0)	331 (0.0)	331 (0.0)	331 (0.0)
45303	Municipal Solid Wastes	EMR/M&ET	200 (0.0)	200 (0.0)	200 (0.0)	200 (0.0)	200 (0.0)
45401	Biological Hydrolysis	EMR/M&ET	455 (1.0)	455 (1.0)	455 (1.0)	455 (1.0)	455 (1.0)
45402	Anaerobic Digestion	EMR/M&ET	100 (0.0)	100 (0.0)	100 (0.0)	100 (0.0)	100 (0.0)

TASK #4 - RENEWABLE ENERGY AND GENERIC ENVIRONMENT

ID	DESCRIPTION	DEPT/PE	91-92	92-93	93-94	94-95	95-96
45403	Anaerobic Digestion	EC/C&P	150 (0.0)	150 (0.0)	150 (0.0)	150 (0.0)	150 (0.0)
45404	Chemical Hydrolysis	EMR/M&ET	250 (0.0)	250 (0.0)	250 (0.0)	250 (0.0)	250 (0.0)
45405	Lignin & Other Co-product Development	EMR/M&ET	200 (0.0)	200 (0.0)	200 (0.0)	200 (0.0)	200 (0.0)
45406	Fermentation of C2 and C6	EMR/M&ET	100 (0.0)	100 (0.0)	100 (0.0)	100 (0.0)	100 (0.0)
45407	Ethanol Recovery	EMR/M&ET	50 (0.0)	50 (0.0)	50 (0.0)	50 (0.0)	50 (0.0)
45408	Basic Research	EMR/M&ET	250 (0.0)	250 (0.0)	250 (0.0)	250 (0.0)	250 (0.0)
45501	Vacuum Pyrolysis	EMR/M&ET	205 (1.0)	205 (1.0)	205 (1.0)	205 (1.0)	205 (1.0)
45502	Atmospheric Pyrolysis	EMR/M&ET	200 (0.0)	200 (0.0)	200 (0.0)	200 (0.0)	200 (0.0)
45503	High Pressure Pyrolysis	EMR/M&ET	100 (0.0)	100 (0.0)	100 (0.0)	100 (0.0)	100 (0.0)
45504	Gasification	EMR/M&ET	100 (0.0)	100 (0.0)	100 (0.0)	100 (0.0)	100 (0.0)
45505	Upgrading	EMR/M&ET	150 (0.0)	150 (0.0)	150 (0.0)	150 (0.0)	150 (0.0)
45506	Chemicals Separation	EMR/M&ET	50 (0.0)	50 (0.0)	50 (0.0)	50 (0.0)	50 (0.0)
45507	Centralized Analysis	EMR/M&ET	100 (0.0)	100 (0.0)	100 (0.0)	100 (0.0)	100 (0.0)
45508	Basic Research	EMR/M&ET	101 (0.0)	101 (0.0)	101 (0.0)	101 (0.0)	101 (0.0)
45601	Biomass Processing/Conveying	EMR/M&ET	330 (0.0)	330 (0.0)	330 (0.0)	330 (0.0)	330 (0.0)
45602	Beneficiation	EMR/M&ET	200 (0.0)	200 (0.0)	200 (0.0)	200 (0.0)	200 (0.0)
45603	Peat Mining/Handling	EMR/M&ET	200 (0.0)	200 (0.0)	200 (0.0)	200 (0.0)	200 (0.0)
45604	Biomass Processing (Varennes)	EMR/M&ET	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
PROGRAM #45 TOTALS:			5433 (2.0)	5433 (2.0)	5433 (2.0)	5433 (2.0)	5433 (2.0)

PROGRAM #46 - WIND

46101	Resource Assessment	EC/AES	47 (0.0)	47 (0.0)	47 (0.0)	47 (0.0)	47 (0.0)

TASK #4 - RENEWABLE ENERGY AND GENERIC ENVIRONMENT

ID	DESCRIPTION	DEPT/PE	91-92	92-93	93-94	94-95	95-96
46201	Turbine Development	EMR/M&ET	124 (0.0)	124 (0.0)	124 (0.0)	124 (0.0)	124 (0.0)
46202	Testing & Trials (AWTS)	EMR/M&ET	200 (0.0)	200 (0.0)	200 (0.0)	200 (0.0)	200 (0.0)
46203	Wind/Diesel Hybrid	EMR/M&ET	115 (0.0)	115 (0.0)	115 (0.0)	115 (0.0)	115 (0.0)
46204	Grid Connected WECS	EMR/M&ET	210 (0.0)	210 (0.0)	210 (0.0)	210 (0.0)	210 (0.0)
46205	Water Pumping	EMR/M&ET	46 (0.0)	46 (0.0)	46 (0.0)	46 (0.0)	46 (0.0)
PROGRAM #46 TOTALS:			742 (0.0)	742 (0.0)	742 (0.0)	742 (0.0)	742 (0.0)

PROGRAM #47 - GEOTHERMAL

47101	Resource Assessment	EMR/M&ET	0 (0.0)	5 (0.0)	25 (0.0)	25 (0.0)	25 (0.0)
47102	Feasibility Studies	EMR/M&ET	0 (0.0)	0 (0.0)	25 (0.0)	25 (0.0)	25 (0.0)
PROGRAM #47 TOTALS:			0 (0.0)	5 (0.0)	50 (0.0)	50 (0.0)	50 (0.0)

PROGRAM #48 - GENERIC ENVIRONMENT

48103	Carbon Dioxide Adviser	EC/AES	109 (1.0)	109 (1.0)	109 (1.0)	109 (1.0)	109 (1.0)
48104	Environmental Energy R&D Coordinator	EMR/ADMIN	91 (1.0)	91 (1.0)	91 (1.0)	91 (1.0)	91 (1.0)
48105	Oceanic CO2 Measurement	FO/SCIENCE	400 (0.0)	400 (0.0)	400 (0.0)	400 (0.0)	400 (0.0)
48107	RAG's Measurement	EC/AES	150 (0.0)	150 (0.0)	150 (0.0)	150 (0.0)	150 (0.0)
48108	Departmental R&D Coordination	EC/ADMIN	245 (2.0)	245 (2.0)	245 (2.0)	245 (2.0)	245 (2.0)
48109	Deep Ocean CO2 Transport	FO/SCIENCE	200 (0.0)	200 (0.0)	200 (0.0)	200 (0.0)	200 (0.0)
48110	Ground Water Treatment	EC/C&P	261 (0.0)	261 (0.0)	261 (0.0)	261 (0.0)	261 (0.0)
48111	ETSAP Project	EC/ADMIN	34 (0.0)	34 (0.0)	34 (0.0)	34 (0.0)	34 (0.0)

TASK #4 - RENEWABLE ENERGY AND GENERIC ENVIRONMENT

ID	DESCRIPTION	DEPT/PE	91-92	92-93	93-94	94-95	95-96
48112	Ocean Microbial CO2	FO/SCIENCE	200 (0.0)	200 (0.0)	200 (0.0)	200 (0.0)	200 (0.0)
48113	Carbon Cycle Climate Modelling	EC/AES	100 (0.0)	100 (0.0)	100 (0.0)	100 (0.0)	100 (0.0)
48114	CO2 Sequestering (Atlantic)	FO/SCIENCE	50 (0.0)	50 (0.0)	50 (0.0)	50 (0.0)	50 (0.0)
48115	Air-Sea CO2 Flux (Pacific)	FO/SCIENCE	144 (0.0)	156 (0.0)	195 (0.0)	195 (0.0)	195 (0.0)
PROGRAM #48 TOTALS:			1984 (4.0)	1996 (4.0)	2035 (4.0)	2035 (4.0)	2035 (4.0)

PROGRAM #49 - COORDINATION

49101	Planning Coordination and Management	EMR/M&ET	66 (1.0)	66 (1.0)	66 (1.0)	66 (1.0)	66 (1.0)
PROGRAM #49 TOTALS:			66 (1.0)	66 (1.0)	66 (1.0)	66 (1.0)	66 (1.0)
TASK #4 TOTALS:			11300 (7.0)	11317 (7.0)	11401 (7.0)	11401 (7.0)	11401 (7.0)

TASK #5 - ALTERNATIVE TRANSPORTATION FUELS

ID	DESCRIPTION	DEPT/PE	91-92	92-93	93-94	94-95	95-96
PROGRAM #51 - HYDROCARBONS ENHANCEMENT							
51101	Co-Processing of Coal With Bitumen/Heavy Oils/Residuals	EMR/M&ET	1063 (4.0)	1063 (4.0)	1063 (4.0)	1063 (4.0)	1063 (4.0)
51202	Demonstration of Liquid Fuel Produc'n from Sewage Sludge	EC/C&P	310 (0.0)	310 (0.0)	310 (0.0)	310 (0.0)	310 (0.0)
51204	Coal Liquefaction/ Coal Conversion Program	EMR/M&ET	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
51302	Fundamental Studies in Upgrading	EMR/M&ET	373 (2.0)	345 (1.0)	345 (1.0)	345 (1.0)	345 (1.0)
51303	Process Development Hydrocracking Technology	EMR/M&ET	85 (0.5)	55 (0.5)	55 (0.5)	55 (0.5)	55 (0.5)
51304	New Upgrading Process	EMR/M&ET	650 (4.5)	712 (5.5)	729 (5.5)	729 (5.5)	729 (5.5)
51305	Catalysts for Upgrading Processes	EMR/M&ET	428 (2.0)	466 (2.0)	498 (2.5)	498 (2.5)	498 (2.5)
51306	Physical/Chemical Analysis of Upgrading Products	EMR/M&ET	392 (2.0)	392 (2.0)	358 (1.5)	358 (1.5)	358 (1.5)
51307	Prod./Testing Asphalt Blends/ Residuals	EMR/M&ET	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
51401	Heavy Wall Pressure Vessel Fabrication & Inspection	EMR/M&ET	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
51402	Eng. Critical Assessment of Service Damaged Pressure Vess.	EMR/M&ET	210 (0.5)	60 (0.5)	0 (0.0)	0 (0.0)	0 (0.0)
51403	Weld Repair Procedures for Service Damaged Pressure Vess.	EMR/M&ET	194 (0.5)	194 (0.5)	194 (0.5)	194 (0.5)	194 (0.5)
51404	Assess. of Hydrogen-Induced Cracking (HIC) in Pressure Ves	EMR/M&ET	194 (0.5)	194 (0.5)	194 (0.5)	194 (0.5)	194 (0.5)
51405	Environmentally Assisted Subcritical Crack Propagation	EMR/M&ET	44 (0.5)	194 (0.5)	254 (1.0)	254 (1.0)	254 (1.0)
51501	CANMET 50/50 Contracts	EMR/M&ET	1138 (0.0)	1138 (0.0)	1138 (0.0)	1138 (0.0)	1138 (0.0)
51502	Techno-Economic Studies of Pet. Refining Adjustments	EMR/ENERGY	108 (0.0)	108 (0.0)	108 (0.0)	108 (0.0)	108 (0.0)
51503	Upgrading of Synthetic Crude Distillates to Transp. Fuels	EMR/M&ET	1247 (7.0)	1298 (7.0)	1261 (6.0)	1261 (6.0)	1261 (6.0)
51504	Separation of Environmental Pollutants fr. Synthetic Crude	EMR/M&ET	305 (1.5)	305 (1.5)	305 (1.5)	305 (1.5)	305 (1.5)
51505	Characterization of Refinery Catalysts and Distillate Anal.	EMR/M&ET	405 (4.5)	405 (4.5)	405 (4.5)	405 (4.5)	405 (4.5)
51601	Direct Methane Catalysis	EMR/M&ET	883 (3.0)	883 (3.0)	883 (3.0)	883 (3.0)	883 (3.0)
51602	Methane to Olefins	EMR/M&ET	281 (1.0)	281 (1.0)	281 (1.0)	281 (1.0)	281 (1.0)

TASK #5 - ALTERNATIVE TRANSPORTATION FUELS

ID	DESCRIPTION	DEPT/PE	91-92	92-93	93-94	94-95	95-96
51603	Natural Gas-Based Hydrocarbon Production	EMR/M&ET	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
51701	Environmentally Acceptable Prod. from Upgrader Residues	EMR/M&ET	1024 (5.0)	927 (4.0)	927 (4.0)	927 (4.0)	927 (4.0)
PROGRAM #51 TOTALS:			9334 (39.0)	9330 (38.0)	9308 (37.0)	9308 (37.0)	9308 (37.0)

PROGRAM #53 - BITUMEN AND OIL RECOVERY

53101	Bitumen/Heavy Oil Emulsions Treatment	EMR/M&ET	724 (1.5)	724 (1.5)	724 (1.5)	724 (1.5)	724 (1.5)
53103	Produced Water/Effluent Treatment	EMR/M&ET	275 (0.0)	275 (0.0)	275 (0.0)	275 (0.0)	275 (0.0)
53104	Leveraged In-Situ Recovery	EMR/M&ET	800 (0.0)	800 (0.0)	800 (0.0)	800 (0.0)	800 (0.0)
53105	New Generation Technology for Recovery of Bitumen & Heavy Oi	EMR/M&ET	668 (0.0)	668 (0.0)	668 (0.0)	668 (0.0)	668 (0.0)
53106	Cooperative R&D with Provinces USA & other External Agencies	EMR/M&ET	370 (0.0)	370 (0.0)	370 (0.0)	370 (0.0)	370 (0.0)
53107	Environmental Tech. Dev. for Bitumen & Oil Recovery	EMR/M&ET	450 (0.0)	450 (0.0)	450 (0.0)	450 (0.0)	450 (0.0)
53108	Tailings/Sludge Treatment (including Sludge Consortium)	EMR/M&ET	400 (1.5)	400 (1.5)	400 (1.5)	400 (1.5)	400 (1.5)
PROGRAM #53 TOTALS:			3687 (3.0)	3687 (3.0)	3687 (3.0)	3687 (3.0)	3687 (3.0)

PROGRAM #55 - FUEL USE

55102	Safety/Alternative Fuels (MeOH, CNG, LNG)	TC/P&C	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
55103	Emissions from Flexible-Fuelled Methanol Vehicles	TC/P&C	125 (0.0)	125 (0.0)	125 (0.0)	125 (0.0)	125 (0.0)
55104	Methanol Fuel Formulations for Flame Luminosity	TC/P&C	75 (0.0)	75 (0.0)	75 (0.0)	75 (0.0)	75 (0.0)
55105	Development of S.I. Cold Start Capability for M100	TC/P&C	75 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
55106	Cold Start Evaluation of Flexible Fuelled Methanol Veh	TC/P&C	25 (0.0)	25 (0.0)	25 (0.0)	25 (0.0)	25 (0.0)
55107	Tech. Eval. of Env. Health & Safety Impacts of Transp Fuels	TC/P&C	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)

TASK #5 - ALTERNATIVE TRANSPORTATION FUELS

ID	DESCRIPTION	DEPT/PE	91-92	92-93	93-94	94-95	95-96
55108	Tech. Investig. & Engineering Support Alternative Fuels	TC/P&C	50 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
55109	Safety Aspects of Alcohol Fuels - Phase IV	TC/P&C	25 (0.0)	25 (0.0)	25 (0.0)	25 (0.0)	25 (0.0)
55206	Emissions Testing of Heavyduty Vehicles Alternative Fuelled	TC/P&C	150 (0.0)	150 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
55209	Combustion Tech & Specfc'ns for Alternative Fuels	EMR/M&ET	50 (0.0)	50 (0.0)	50 (0.0)	50 (0.0)	50 (0.0)
55210	R&D in CNG in Transportation	EMR/M&ET	317 (1.0)	317 (1.0)	317 (1.0)	317 (1.0)	317 (1.0)
55211	Alternative Fuels Field Trials	EMR/M&ET	971 (1.0)	1071 (1.0)	1071 (1.0)	1071 (1.0)	1071 (1.0)
55214	Rail Single Cylinder Research Engine Testing	TC/P&C	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
55216	Operations/Technology Assessments	TC/P&C	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
55217	Properties of Tar Sands Derived Aircraft Fuels	DND/MS	90 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
55218	High Speed Diesel Combustion Studies	DND/MS	226 (2.0)	226 (2.0)	226 (2.0)	226 (2.0)	226 (2.0)
55219	Medium Speed Diesel Combustion Studies	DND/MS	60 (0.0)	60 (0.0)	60 (0.0)	60 (0.0)	60 (0.0)
55220	Propane Research	EMR/M&ET	150 (0.0)	150 (0.0)	150 (0.0)	150 (0.0)	150 (0.0)
55221	Alternative Fuels R&D Assistance Program	EMR/M&ET	800 (0.0)	800 (0.0)	850 (0.0)	850 (0.0)	850 (0.0)
55222	Nox Reduction - Gaseous Fuels/ Diesel Fuel	EMR/M&ET	150 (0.0)	50 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
55223	Methanol Fuel Environmental Studies	EMR/ENERGY	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
55224	Emissions Testing in Support of Altern. Fuels Field Trials	EC/C&P	100 (0.0)	100 (0.0)	100 (0.0)	100 (0.0)	100 (0.0)
55225	Evaluation of Methanol/diesel Fuel with Glow Plug Ignition	TC/P&C	105 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
55226	Raprenox System for NOx Emissions Reduction	TC/P&C	105 (0.0)	105 (0.0)	105 (0.0)	105 (0.0)	105 (0.0)
55227	Glow Plug Diesel Engines	TC/P&C	150 (0.0)	150 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
55228	Emissions Testing of Alternative Fuels	DND/MS	0 (0.0)	90 (0.0)	90 (0.0)	90 (0.0)	90 (0.0)
55229	Emissions Testing of Alternative Fuels	TC/P&C	0 (0.0)	230 (0.0)	530 (0.0)	530 (0.0)	530 (0.0)
55302	Storage/Handling/Distribution (Fed./Prov. Standards)	TC/P&C	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)

TASK #5 - ALTERNATIVE TRANSPORTATION FUELS

ID	DESCRIPTION	DEPT/PE	91-92	92-93	93-94	94-95	95-96
55303	Alcohol Dissociation	EMR/M&ET	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
55304	Fuel Cells for Transportation	TC/P&C	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
55305	Allocation within 5.5 subject to Fall 1989 5.5 meeting	TC/P&C	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
55306	Metering System for Heavy-Duty Methanol Engines	TC/P&C	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
55307	Natural Gas Storage Cylinder Safety Testing	TC/P&C	150 (0.0)	150 (0.0)	150 (0.0)	150 (0.0)	150 (0.0)
55403	Review & Evaluation of Res. Data for Selected Auto Fuels	TC/P&C	50 (0.0)	50 (0.0)	50 (0.0)	50 (0.0)	50 (0.0)
55404	R&D Management	TC/P&C	228 (3.0)	228 (3.0)	228 (3.0)	228 (3.0)	228 (3.0)
55405	R&D Management	EMR/M&ET	67 (1.0)	67 (1.0)	67 (1.0)	67 (1.0)	67 (1.0)
55406	Technology Assessment for Alt. Fuels Policy Development	EMR/ENERGY	283 (2.0)	283 (2.0)	283 (2.0)	283 (2.0)	283 (2.0)
55407	Provincial/International Coordination on Alt. Fuels	EMR/ENERGY	73 (1.0)	73 (1.0)	73 (1.0)	73 (1.0)	73 (1.0)
PROGRAM #55 TOTALS:			4650 (11.0)	4650 (11.0)	4650 (11.0)	4650 (11.0)	4650 (11.0)

PROGRAM #56 - HYDROGEN AND ELECTROCHEMISTRY

56103	Electrolytic Production	EMR/M&ET	100 (0.0)	100 (0.0)	100 (0.0)	100 (0.0)	100 (0.0)
56105	Polymer Separators	EMR/M&ET	100 (0.0)	100 (0.0)	100 (0.0)	100 (0.0)	100 (0.0)
56202	Ceramic Materials for Energy Technology	EMR/M&ET	281 (3.0)	281 (3.0)	281 (3.0)	281 (3.0)	281 (3.0)
56204	Storage, Conversion & Hydrogen (IEA I.A. Task VII)	EMR/M&ET	350 (0.0)	350 (0.0)	350 (0.0)	350 (0.0)	350 (0.0)
56206	Hydrogen Safety Committee Support	EMR/M&ET	15 (0.0)	15 (0.0)	15 (0.0)	15 (0.0)	15 (0.0)
56208	Fuel Cell Development and Evaluation	EMR/M&ET	185 (0.0)	185 (0.0)	185 (0.0)	185 (0.0)	185 (0.0)
56209	Alcohol Dissociation	EMR/M&ET	200 (0.0)	200 (0.0)	200 (0.0)	200 (0.0)	200 (0.0)
56210	Fuel Cell Research	TC/P&C	125 (0.0)	125 (0.0)	125 (0.0)	125 (0.0)	125 (0.0)
56304	Battery Research	EMR/M&ET	250 (0.0)	250 (0.0)	250 (0.0)	250 (0.0)	250 (0.0)

TASK #5 - ALTERNATIVE TRANSPORTATION FUELS

ID	DESCRIPTION	DEPT/PE	91-92	92-93	93-94	94-95	95-96
56305	Battery Research/Vehicle Integration	TC/P&C	125 (0.0)	125 (0.0)	125 (0.0)	125 (0.0)	125 (0.0)
56306	R&D Management	EMR/M&ET	134 (2.0)	134 (2.0)	134 (2.0)	134 (2.0)	134 (2.0)
56401	Government - Industry Hydrogen Program	EMR/M&ET	500 (0.0)	500 (0.0)	500 (0.0)	500 (0.0)	500 (0.0)
PROGRAM #56 TOTALS:			2365 (5.0)	2365 (5.0)	2365 (5.0)	2365 (5.0)	2365 (5.0)

PROGRAM #57 - ENVIRONMENT

57101	Pollution Abatement Technologies	EC/C&P	190 (1.0)	190 (1.0)	190 (1.0)	190 (1.0)	190 (1.0)
57104	Characterization & Assessment of Human Exposure to NLF	HWC/EQH	60 (0.0)	60 (0.0)	50 (0.0)	70 (0.0)	70 (0.0)
57108	Development of Methodology for Chemical Characterization	HWC/EQH	1 (0.0)	1 (0.0)	35 (0.0)	35 (0.0)	35 (0.0)
57109	Toxicological Testing of NLF Chemicals	HWC/EQH	110 (0.0)	110 (0.0)	110 (0.0)	150 (0.0)	150 (0.0)
57111	Human Health Hazards of Aldehydes and Methanol	HWC/EQH	75 (0.0)	75 (0.0)	75 (0.0)	150 (0.0)	150 (0.0)
57114	Environmental Implications of Synfuel Processes	EC/C&P	101 (1.0)	101 (1.0)	101 (1.0)	101 (1.0)	101 (1.0)
57115	Impacts of NLF in Motor Vehicles	EC/C&P	50 (0.0)	50 (0.0)	50 (0.0)	50 (0.0)	50 (0.0)
57117	Heavy Duty Vehicle Testing Facility	EC/C&P	120 (0.0)	120 (0.0)	120 (0.0)	120 (0.0)	120 (0.0)
57118	Assess. Human Exposure to Airborne, High Molecular PAH's	HWC/EQH	100 (0.0)	140 (0.0)	145 (0.0)	145 (0.0)	145 (0.0)
57119	Asses. of Env. Effects of Transportation Fuels	EMR/ADMIN	109 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
57201	Hydrogeological Aspects of Bitumen/Heavy Oil Recovery	EC/C&P	100 (0.0)	50 (0.0)	50 (0.0)	92 (0.0)	92 (0.0)
57202	Treatment of Aqueous Effluents from Insitu Operations	EC/C&P	467 (2.0)	442 (2.0)	377 (2.0)	400 (2.0)	400 (2.0)
57203	Treatment of Oil/Water/Sand In-Situ Sludges	EC/C&P	200 (0.0)	200 (0.0)	200 (0.0)	0 (0.0)	0 (0.0)
57204	Treatment Technologies: Heavy Oil Shipping Waste Water	EC/C&P	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
57205	Aquatic Regulatory Criteria & Protocols	EC/C&P	175 (0.0)	175 (0.0)	175 (0.0)	175 (0.0)	175 (0.0)
57206	Oil Sands Tailings - Water Treatment	EC/C&P	50 (0.0)	109 (0.0)	145 (0.0)	145 (0.0)	145 (0.0)

TASK #5 - ALTERNATIVE TRANSPORTATION FUELS

ID	DESCRIPTION	DEPT/PE	91-92	92-93	93-94	94-95	95-96
57207	Toxicity Studies and Chem. Identification for OS Products	HWC/EQH	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
57208	Worker Exposure to Chemical Hazards in OS/HO Industry	HWC/EQH	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
PROGRAM #57 TOTALS:			1908 (4.0)	1823 (4.0)	1823 (4.0)	1823 (4.0)	1823 (4.0)

PROGRAM #58 - MANAGEMENT

58101	New Liquid Fuels - R&D Planning and Coordination	EMR/ENERGY	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
58102	Alternative Fuels Provincial Liaison Council	EMR/ENERGY	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
58103	New Liquid Fuels - R&D Planning & Coordination	EMR/M&ET	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
PROGRAM #58 TOTALS:			0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
TASK #5 TOTALS:			21944 (62.0)	21855 (61.0)	21833 (60.0)	21833 (60.0)	21833 (60.0)

TASK #6 - OIL, GAS, ELECTRICITY

ID	DESCRIPTION	DEPT/PE	91-92	92-93	93-94	94-95	95-96
PROGRAM #61 - GEOSCIENTIFIC R&D							
61101	Geochemical Correlation for Crude Condensates	EMR/GS	83 (2.0)	83 (2.0)	83 (2.0)	83 (2.0)	83 (2.0)
61104	Quantitative Aspects of Petroleum Origin, W. Sed. Basin	EMR/GS	100 (1.0)	100 (1.0)	80 (1.0)	80 (1.0)	80 (1.0)
61106	Thermal Hist./Basin Evolution	EMR/GS	161 (0.0)	161 (0.0)	181 (0.0)	181 (0.0)	181 (0.0)
61109	Overpressure Studies - Venture	EMR/GS	111 (1.0)	111 (1.0)	111 (1.0)	111 (1.0)	111 (1.0)
61111	Geoscience Concepts Related to to Petroleum Recovery	EMR/GS	121 (1.0)	121 (1.0)	121 (1.0)	121 (1.0)	121 (1.0)
61112	Oil-based Drilling Muds	EMR/GS	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
61202	Heat and Mass Transfer in Permafrost Terrains	EMR/GS	60 (0.0)	60 (0.0)	60 (0.0)	60 (0.0)	60 (0.0)
61203	Design/Test, of Geophys Syst to Id. Ice-bond'd Permafrost	EMR/GS	100 (0.0)	100 (0.0)	100 (0.0)	100 (0.0)	100 (0.0)
61205	Classifica'n & Properties of Frozen Ground & Ground Ice	EMR/GS	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
61206	Properties of Frozen Soil In Situ and Disturbed	EMR/GS	30 (0.0)	30 (0.0)	30 (0.0)	30 (0.0)	30 (0.0)
61210	Laboratory Modelling of Frozen Ground	EMR/GS	50 (0.0)	50 (0.0)	50 (0.0)	50 (0.0)	50 (0.0)
61211	Caen Experiment	EMR/GS	180 (0.0)	180 (0.0)	180 (0.0)	180 (0.0)	180 (0.0)
61212	Mechanical Properties of Permafrost Soils	EMR/GS	20 (0.0)	20 (0.0)	20 (0.0)	20 (0.0)	20 (0.0)
61213	Subprogram Management	EMR/GS	50 (1.0)	50 (1.0)	50 (1.0)	50 (1.0)	50 (1.0)
61216	Laboratory Testing of Permafrost Soils	EMR/GS	10 (0.0)	10 (0.0)	10 (0.0)	10 (0.0)	10 (0.0)
61217	Research Monitoring of Pipeline R-O-W's in Pmf. Reg.	EMR/GS	50 (0.0)	50 (0.0)	50 (0.0)	50 (0.0)	50 (0.0)
61218	Shear Waves	EMR/GS	20 (0.0)	20 (0.0)	20 (0.0)	20 (0.0)	20 (0.0)
61219	Thaw Lakes	EMR/GS	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
61220	Slope Stability in Permafrost Terrain	EMR/GS	20 (0.0)	20 (0.0)	20 (0.0)	20 (0.0)	20 (0.0)
61222	Ground Probing Radar	EMR/GS	70 (0.0)	70 (0.0)	70 (0.0)	70 (0.0)	70 (0.0)
61223	Probabilistic Analysis for Northern Pipelines	EMR/GS	100 (0.0)	100 (0.0)	100 (0.0)	100 (0.0)	100 (0.0)

TASK #6 - OIL, GAS, ELECTRICITY

ID	DESCRIPTION	DEPT/PE	91-92	92-93	93-94	94-95	95-96
61225	Cross Mackenzie River Delta Pmf/Geol. Transect	EMR/GS	201 (0.0)	201 (0.0)	201 (0.0)	201 (0.0)	201 (0.0)
61226	Permafrost-climate relationship; Mackenzie Valley	EMR/GS	35 (0.0)	35 (0.0)	35 (0.0)	35 (0.0)	35 (0.0)
61250	Geolog. & Geophys, Assess/ Gas Hydrate Distrib.& Vol's	EMR/GS	50 (0.0)	50 (0.0)	50 (0.0)	50 (0.0)	50 (0.0)
61251	Co-op Studies with Industry on Hydrate Hazard and Control	EMR/GS	50 (0.0)	50 (0.0)	50 (0.0)	50 (0.0)	50 (0.0)
PROGRAM #61 TOTALS:			1672 (6.0)	1672 (6.0)	1672 (6.0)	1672 (6.0)	1672 (6.0)

PROGRAM #62 - MARINE ENGINEERING

62120	Wave/Wind Hindcasting	EC/AES	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
62121	Combined Environmental Extremes	EC/AES	40 (0.0)	38 (0.0)	38 (0.0)	100 (0.0)	100 (0.0)
62122	Climatological Evaluation	EC/AES	10 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
62123	Wave Turbulence Interaction	EC/C&P	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
62124	Shoaling Waves	EC/C&P	38 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
62127	Program Monitoring	EMR/COGLA	47 (0.5)	47 (0.5)	47 (0.5)	47 (0.5)	47 (0.5)
62128	Program Monitoring	INA/COGLA	48 (0.5)	48 (0.5)	48 (0.5)	48 (0.5)	48 (0.5)
62129	Ocean Current Hindcast	FO/SCIENCE	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
62132	Advanced Wave Models	FO/SCIENCE	83 (1.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
62133	Wave/Wind Field	FO/SCIENCE	50 (0.0)	30 (0.0)	30 (0.0)	30 (0.0)	30 (0.0)
62134	Towing Systems for Ice Covered Seas	FO/SCIENCE	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
62135	Hindcasts & Satellite Sensed Winds	EC/AES	80 (0.5)	110 (0.5)	120 (0.5)	75 (0.5)	75 (0.5)
62136	Extreme Storm Wind Model	EC/AES	45 (0.0)	70 (0.0)	70 (0.0)	30 (0.0)	30 (0.0)
62137	West Coast Waves	EC/AES	100 (0.0)	70 (0.0)	0 (0.0)	86 (0.0)	100 (0.0)
62138	East Coast On-Line Ocean Information Retrieval	FO/SCIENCE	70 (0.0)	70 (0.0)	40 (0.0)	40 (0.0)	40 (0.0)

TASK #6 - OIL, GAS, ELECTRICITY

ID	DESCRIPTION	DEPT/PE	91-92	92-93	93-94	94-95	95-96
62139	Predicting Wind Waves in Currents and Near Ice	FO/SCIENCE	0 (0.0)	55 (1.0)	80 (1.0)	100 (1.0)	100 (1.0)
62140	Remote Sensing Data Assimilation in Ocean Wind Model	FO/SCIENCE	0 (0.0)	45 (0.0)	45 (0.0)	45 (0.0)	45 (0.0)
62141	East Coast Oceanography On-Line Ocean Info Retrieval II	FO/SCIENCE	0 (0.0)	0 (0.0)	70 (0.0)	175 (0.0)	125 (0.0)
62142	Wave Current Interactions Stud in Nothern B.C. Waters - Codar	FO/SCIENCE	117 (0.0)	125 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
62143	Climate Change and Arctic Offshore Energy Development	EC/AES	0 (0.0)	20 (0.0)	10 (0.0)	0 (0.0)	0 (0.0)
62144	Grand Banks Shallow Water Waves Project	EC/AES	0 (0.0)	35 (0.0)	40 (0.0)	40 (0.0)	40 (0.0)
62145	Data Assimilation for Oceanographic Applications	FO/SCIENCE	55 (1.0)	90 (1.0)	110 (1.0)	100 (1.0)	100 (1.0)
62220	Wave Effects on Seafloor	EMR/COGLA	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
62221	Wave Effects on Seafloor	INA/COGLA	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
62222	Fill Retention Structures	EMR/COGLA	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
62223	Fill Retention Structures	INA/COGLA	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
62224	Submarine Pipeline Protection	EMR/COGLA	20 (0.0)	45 (0.0)	53 (0.0)	70 (0.0)	75 (0.0)
62225	Submarine Pipeline Protection	INA/COGLA	20 (0.0)	45 (0.0)	52 (0.0)	70 (0.0)	75 (0.0)
62226	CSA Code for Offshore Structures	EMR/COGLA	38 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
62227	CSA Code for Offshore Structures	INA/COGLA	37 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
62228	Environmental Design Criteria	EMR/COGLA	15 (0.0)	40 (0.0)	45 (0.0)	75 (0.0)	75 (0.0)
62229	Environmental Design Criteria	INA/COGLA	15 (0.0)	40 (0.0)	45 (0.0)	75 (0.0)	75 (0.0)
62236	Arctic soils - Pipeline/Casing Interaction	EMR/COGLA	80 (0.0)	80 (0.0)	80 (0.0)	100 (0.0)	100 (0.0)
62237	Arctic soils - Pipeline/Casing Interaction	INA/COGLA	80 (0.0)	80 (0.0)	80 (0.0)	100 (0.0)	100 (0.0)
62238	Structural Systems Reliability	EMR/COGLA	55 (0.0)	58 (0.0)	63 (0.0)	63 (0.0)	75 (0.0)
62239	Structural Systems Reliability	INA/COGLA	55 (0.0)	57 (0.0)	62 (0.0)	62 (0.0)	75 (0.0)
62320	Ice & Ice/Structure Interaction	EMR/COGLA	89 (0.0)	133 (0.0)	138 (0.0)	150 (0.0)	150 (0.0)

TASK #6 - OIL, GAS, ELECTRICITY

ID	DESCRIPTION	DEPT/PE	91-92	92-93	93-94	94-95	95-96
62321	Ice & Ice/Structure Interaction	INA/COGLA	88 (0.0)	132 (0.0)	137 (0.0)	150 (0.0)	150 (0.0)
62322	Sea Ice Distribution	EC/AES	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
62323	Marine Icing	EC/AES	20 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
62325	Labrador/Grand Banks Ice Study	FO/SCIENCE	70 (0.0)	20 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
62330	Ice/Structure Interaction: Development & Verification	EMR/COGLA	160 (0.0)	113 (0.0)	100 (0.0)	100 (0.0)	110 (0.0)
62331	Ice/Structure Interaction: Development & Verification	INA/COGLA	161 (0.0)	112 (0.0)	100 (0.0)	100 (0.0)	109 (0.0)
62332	Probablistic Framework and Models	EMR/COGLA	13 (0.0)	13 (0.0)	13 (0.0)	13 (0.0)	13 (0.0)
62333	Probablistic Framework and Models	INA/COGLA	12 (0.0)	12 (0.0)	12 (0.0)	12 (0.0)	12 (0.0)
62334	Pack Ice Driving Forces	EMR/COGLA	80 (0.0)	74 (0.0)	74 (0.0)	0 (0.0)	0 (0.0)
62335	Pack Ice Driving Forces	INA/COGLA	79 (0.0)	73 (0.0)	73 (0.0)	0 (0.0)	0 (0.0)
62336	Testing of Iceberg Impact	EMR/COGLA	0 (0.0)	0 (0.0)	13 (0.0)	13 (0.0)	13 (0.0)
62337	Testing of Iceberg Impact	INA/COGLA	0 (0.0)	0 (0.0)	12 (0.0)	12 (0.0)	12 (0.0)
62338	Ice Digitization Technology Development	EC/AES	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
62339	Iceload Transmission Through Grounded Rubble	EMR/COGLA	45 (0.0)	30 (0.0)	30 (0.0)	30 (0.0)	30 (0.0)
62340	Iceload Transmission Through Grounded Rubble	INA/COGLA	45 (0.0)	30 (0.0)	30 (0.0)	30 (0.0)	30 (0.0)
62341	Wave Effects on Ice & Ice Dynamics	FO/SCIENCE	20 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
62342	Sea-Ice Thickness & Concentration	FO/SCIENCE	80 (0.0)	80 (0.0)	80 (0.0)	80 (0.0)	30 (0.0)
62343	Mesoscale Ice Deformation and Limit Stresses	FO/SCIENCE	120 (0.0)	130 (0.0)	100 (0.0)	0 (0.0)	0 (0.0)
62344	New Techniques for Sea-Ice Classification	EC/AES	80 (1.0)	80 (1.0)	80 (1.0)	71 (1.0)	71 (1.0)
62345	Properties of Sea-Ice and Ice-Structure Interactions	FO/SCIENCE	0 (0.0)	70 (0.0)	180 (0.0)	100 (0.0)	90 (0.0)
62430	Air Service Operations	EMR/COGLA	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
62431	Air Service Operations	INA/COGLA	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)

TASK #6 - OIL, GAS, ELECTRICITY

ID	DESCRIPTION	DEPT/PE	91-92	92-93	93-94	94-95	95-96
62432	Escape from Helicopters	EMR/COGLA	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
62433	Escape from Helicopters	INA/COGLA	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
62436	Evacuation Technology	EMR/COGLA	50 (0.0)	100 (0.0)	100 (0.0)	104 (0.0)	125 (0.0)
62437	Evacuation Technology	INA/COGLA	50 (0.0)	100 (0.0)	100 (0.0)	104 (0.0)	125 (0.0)
62438	Life-Raft Standards	EMR/COGLA	35 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
62439	Life-Raft Standards	INA/COGLA	35 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
62440	Power Dolphin	EMR/COGLA	40 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
62441	Power Dolphin	INA/COGLA	40 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
62442	Improved Personnel Transfer System	EMR/COGLA	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
62443	Improved Personnel Transfer System	INA/COGLA	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
PROGRAM #62 TOTALS:			2610 (4.5)	2600 (4.5)	2600 (4.5)	2600 (4.5)	2600 (4.5)

PROGRAM #63 - OFFSHORE GEOTECHNICS

63101	Seismicity (Beaufort)	EMR/GS	95 (0.0)	95 (0.0)	95 (0.0)	95 (0.0)	95 (0.0)
63102	Sea-Ice Scour (Beaufort)	EMR/GS	98 (0.4)	145 (0.4)	100 (0.4)	145 (0.4)	80 (0.4)
63103	Seabed Stability (Beaufort)	EMR/GS	303 (0.2)	160 (0.2)	165 (0.2)	100 (0.2)	100 (0.2)
63104	Soil Properties (Beaufort)	EMR/GS	76 (0.6)	130 (0.6)	120 (0.6)	160 (0.6)	200 (0.6)
63105	Sediment Dynamics (Beaufort)	EMR/GS	0 (0.0)	0 (0.0)	0 (0.0)	40 (0.0)	50 (0.0)
63106	Subsea Permafrost (Beaufort)	EMR/GS	90 (0.0)	125 (0.0)	80 (0.0)	100 (0.0)	100 (0.0)
63107	Thermal Modelling (Beaufort)	EMR/GS	20 (0.0)	20 (0.0)	20 (0.0)	20 (0.0)	20 (0.0)
63108	Coastal Engineering (Beaufort)	EMR/GS	0 (0.0)	0 (0.0)	80 (0.0)	40 (0.0)	55 (0.0)
63109	In-Situ Testing (Beaufort)	EMR/GS	98 (0.4)	80 (0.4)	95 (0.4)	80 (0.4)	80 (0.4)

TASK #6 - OIL, GAS, ELECTRICITY

ID	DESCRIPTION	DEPT/PE	91-92	92-93	93-94	94-95	95-96
63110	Code References	EMR/GS	0 (0.0)	25 (0.0)	25 (0.0)	0 (0.0)	0 (0.0)
63201	Iceberg Scour (East Coast)	EMR/GS	151 (1.2)	146 (1.2)	146 (1.2)	151 (1.2)	151 (1.2)
63202	Seabed Stability (East Coast)	EMR/GS	203 (0.6)	196 (0.6)	148 (0.6)	153 (0.6)	153 (0.6)
63203	Soil Properties (East Coast)	EMR/GS	146 (0.8)	141 (0.8)	189 (0.8)	196 (0.8)	196 (0.8)
63204	Sediment Dynamics (East Coast)	EMR/GS	162 (0.8)	157 (0.8)	157 (0.8)	162 (0.8)	162 (0.8)
63205	Seismicity (East Coast)	EMR/GS	65 (0.0)	65 (0.0)	65 (0.0)	65 (0.0)	65 (0.0)
63206	Continental Slopes (East Coast)	EMR/GS	120 (1.0)	117 (1.0)	117 (1.0)	120 (1.0)	120 (1.0)
63208	Program Publicatior	EMR/GS	0 (0.0)	25 (0.0)	25 (0.0)	0 (0.0)	0 (0.0)
63301	Seismicity (Pacific Coast)	EMR/GS	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
63302	Seabed Stability (Pacific Coast)	EMR/GS	43 (0.0)	43 (0.0)	43 (0.0)	43 (0.0)	43 (0.0)
PROGRAM #63 TOTALS:			1670 (6.0)	1670 (6.0)	1670 (6.0)	1670 (6.0)	1670 (6.0)

PROGRAM #65 - MATERIALS

65101	Fatigue Behaviour of Stiffened Tubular Joints	EMR/M&ET	286 (2.0)	286 (2.0)	300 (2.0)	300 (2.0)	300 (2.0)
65102	Optimisation of Stiffened Spacing in Tubular Joints	EMR/M&ET	210 (0.5)	220 (0.5)	220 (0.5)	240 (0.5)	240 (0.5)
65103	Welding Consumables with Enhanced Fracture Toughness	EMR/M&ET	120 (2.0)	120 (2.0)	120 (2.0)	120 (2.0)	120 (2.0)
65104	Pulsed Gas Metal Arc Welding Process Development	EMR/M&ET	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
65105	Reliability Engineering for Structures for Energy Indust.	EMR/M&ET	201 (1.0)	201 (1.0)	291 (1.0)	321 (1.0)	371 (1.0)
65106	Fracture-Statistical Significance of Local Brittle Zone	EMR/M&ET	50 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
65107	Weld-Zone Corrosion	EMR/M&ET	155 (1.0)	205 (1.0)	255 (1.0)	255 (1.0)	255 (1.0)
65201	Concretes for Offshore Applications	EMR/M&ET	415 (1.0)	415 (1.0)	415 (1.0)	415 (1.0)	415 (1.0)
65301	Internal Sulphide Corrosion in Pipelines	EMR/M&ET	200 (0.0)	200 (0.0)	200 (0.0)	200 (0.0)	200 (0.0)

TASK #6 - OIL, GAS, ELECTRICITY

ID	DESCRIPTION	DEPT/PE	91-92	92-93	93-94	94-95	95-96
65302	External Corrosion: Stress-Corrosion Cracking	EMR/M&ET	255 (1.0)	275 (1.0)	275 (0.5)	275 (0.5)	225 (0.5)
65303	Welding Consumables	EMR/M&ET	195 (0.5)	165 (0.5)	0 (0.0)	0 (0.0)	0 (0.0)
65304	PGMA Welding Process	EMR/M&ET	255 (1.0)	255 (1.0)	205 (1.0)	155 (1.0)	155 (1.0)
PROGRAM #65 TOTALS:			2342 (10.0)	2342 (10.0)	2281 (9.0)	2281 (9.0)	2281 (9.0)

PROGRAM #66 - TRANSPORTATION OF OIL AND GAS

66103	Energy Program Management	TC/P&C	305 (4.0)	305 (4.0)	305 (4.0)	305 (4.0)	305 (4.0)
66201	Ice Characterization	TC/P&C	0 (0.0)	50 (0.0)	50 (0.0)	50 (0.0)	50 (0.0)
66202	Ice Detection	TC/P&C	500 (0.0)	250 (0.0)	250 (0.0)	250 (0.0)	250 (0.0)
66203	Navigation Information Display	TC/P&C	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
66204	Traffic Management and Support	TC/P&C	200 (0.0)	300 (0.0)	300 (0.0)	300 (0.0)	300 (0.0)
66320	Precise Survey Positioning	FO/SCIENCE	118 (0.0)	150 (0.0)	100 (0.0)	100 (0.0)	100 (0.0)
66321	Tools for Surveys in Ice-Covered Waters	FO/SCIENCE	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
66322	Sensors for High Speed Arctic Surveys	FO/SCIENCE	560 (0.0)	475 (0.0)	411 (0.0)	411 (0.0)	411 (0.0)
66326	Arctic Tide & Current Measurement Technology	FO/SCIENCE	90 (0.0)	72 (0.0)	45 (0.0)	45 (0.0)	45 (0.0)
66328	Survey Design Tools	FO/SCIENCE	45 (0.0)	100 (0.0)	110 (0.0)	110 (0.0)	110 (0.0)
66329	Program Management	FO/SCIENCE	56 (1.0)	56 (1.0)	71 (1.0)	71 (1.0)	71 (1.0)
66360	Display of Digital Chart Data	FO/SCIENCE	203 (0.0)	263 (0.0)	200 (0.0)	200 (0.0)	200 (0.0)
66361	Data Management Technology	FO/SCIENCE	374 (0.0)	240 (0.0)	620 (0.0)	620 (0.0)	620 (0.0)
66362	Telecomm. of High Density Survey Data From Frontiers	FO/SCIENCE	130 (0.0)	150 (0.0)	150 (0.0)	150 (0.0)	150 (0.0)
66363	Cartographic Tools for High Density Survey Data	FO/SCIENCE	80 (0.0)	240 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
66364	Remote Sensing	FO/SCIENCE	80 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)

TASK #6 - OIL, GAS, ELECTRICITY

ID	DESCRIPTION	DEPT/PE	91-92	92-93	93-94	94-95	95-96
66365	Shallow Water Muti-Seam System	FO/SCIENCE	35 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
66401	Offshore Transportation Requirements	TC/P&C	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
66501	Oilspill Response Network	TC/P&C	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
66601	Arctic Shipping Requirements	TC/P&C	158 (0.0)	169 (0.0)	169 (0.0)	169 (0.0)	169 (0.0)
66602	Advanced Icebreaker Concepts	TC/P&C	200 (0.0)	300 (0.0)	300 (0.0)	300 (0.0)	300 (0.0)
66603	Arctic Propulsion Systems	TC/P&C	100 (0.0)	200 (0.0)	200 (0.0)	200 (0.0)	200 (0.0)
66604	Hull Structure Requirements	TC/P&C	395 (0.0)	297 (0.0)	297 (0.0)	297 (0.0)	297 (0.0)
66605	Terminals	TC/P&C	100 (0.0)	100 (0.0)	100 (0.0)	100 (0.0)	100 (0.0)
PROGRAM #66 TOTALS:			3729 (5.0)	3717 (5.0)	3678 (5.0)	3678 (5.0)	3678 (5.0)

PROGRAM #67 - ENVIRONMENT

67107	Arctic Oceanography from Insitu Operations	FO/SCIENCE	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
67111	Oceanographic Analysis of Sea Ice and Icebergs	FO/SCIENCE	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
67113	Small Scale Ice/Ocean Interactions	FO/SCIENCE	98 (1.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
67114	Beaufort Sea Ice Movement	FO/SCIENCE	20 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
67116	Satellite Radar Studies	EC/AES	50 (0.0)	328 (0.0)	340 (0.0)	0 (0.0)	0 (0.0)
67118	Satellite Communications	EC/AES	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
67119	Ice/Water Instrumentation	FO/SCIENCE	104 (0.0)	139 (0.0)	125 (0.0)	126 (0.0)	126 (0.0)
67120	Ice Thickness Radar	FO/SCIENCE	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
67121	Ice Classification Radar	FO/SCIENCE	98 (0.0)	64 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
67128	Autonomous Profiler	FO/SCIENCE	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
67129	Remote Wind Measurement	FO/SCIENCE	75 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)

TASK #6 - OIL, GAS, ELECTRICITY

ID	DESCRIPTION	DEPT/PE	91-92	92-93	93-94	94-95	95-96
67130	Remote Ocean Currents	FO/SCIENCE	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
67132	Wave Direction	FO/SCIENCE	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
67133	Departmental R&D Management	FO/SCIENCE	19 (0.0)	18 (0.0)	19 (0.0)	19 (0.0)	19 (0.0)
67134	Oceanic Response to Storms	FO/SCIENCE	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
67135	Atlantic Storms	EC/AES	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
67136	Predicting Ice Breakup	FO/SCIENCE	85 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
67145	Oil Mixing By Waves	EC/AES	10 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
67146	Surface Currents/Dixon Entrance	FO/SCIENCE	513 (1.0)	463 (1.0)	150 (1.0)	99 (1.0)	100 (1.0)
67147	Bottom Trawl Resistant Mooring	FO/SCIENCE	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
67149	Coastal Ocean Prediction (COPEX)	FO/SCIENCE	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
67150	Casp II	EC/AES	733 (1.0)	483 (1.0)	500 (1.0)	272 (1.0)	120 (1.0)
67152	West Coast Oceanography	FO/SCIENCE	60 (0.0)	29 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
67153	Acoustic Oceanographic Instrumentation	FO/SCIENCE	133 (1.0)	134 (1.0)	135 (1.0)	175 (1.0)	175 (1.0)
67154	Marine Wind Forecasting	EC/AES	118 (0.0)	54 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
67155	Ocean Wave Modelling	EC/AES	183 (1.5)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
67156	Expt. on Rapidly Intensifying Cyclones-Atlantic (ERICA)	EC/AES	98 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
67158	Operational Ice Modelling	EC/AES	70 (0.0)	178 (1.0)	200 (1.0)	200 (1.0)	210 (1.0)
67159	Atlantic Ocean Currents from Satellites	FO/SCIENCE	123 (0.0)	193 (0.0)	190 (0.0)	105 (0.0)	105 (0.0)
67160	Icefield Subsurface Characterisation-Beaufort Sea	FO/SCIENCE	0 (0.0)	148 (1.0)	230 (1.0)	234 (1.0)	234 (1.0)
67161	Vertical/Horizontal Exchange Georges Bank	FO/SCIENCE	89 (0.0)	38 (0.0)	39 (0.0)	0 (0.0)	0 (0.0)
67162	Sea Ice Flux onto Newfoundland Shelves	FO/SCIENCE	343 (3.0)	398 (3.0)	400 (3.0)	0 (0.0)	0 (0.0)
67163	Current Velocities for Labrador Shelf/Grand Banks	FO/SCIENCE	58 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)

TASK #6 - OIL, GAS, ELECTRICITY

ID	DESCRIPTION	DEPT/PE	91-92	92-93	93-94	94-95	95-96
67164	Climate Change East Coast	EC/AES	40 (0.0)	39 (0.0)	45 (0.0)	50 (0.0)	0 (0.0)
67165	Casp II Oceanography	FO/SCIENCE	238 (0.0)	218 (0.0)	130 (0.0)	104 (0.0)	104 (0.0)
67166	Oceanographic Modelling - Ice Forecasting	FO/SCIENCE	0 (0.0)	0 (0.0)	0 (0.0)	556 (3.0)	506 (3.0)
67167	Sea Ice Tracking Algorithm	EC/AES	40 (0.0)	89 (0.0)	100 (0.0)	0 (0.0)	0 (0.0)
67168	W. Coast Severe Storms Data Acquisition Network Assessment	EC/AES	0 (0.0)	49 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
67169	Polar Lows Experiment - POLE	EC/AES	0 (0.0)	0 (0.0)	90 (0.0)	505 (0.0)	482 (0.0)
67170	Data Assimilation into Ocean Wave Models	EC/AES	0 (0.0)	198 (0.5)	210 (0.5)	225 (0.5)	225 (0.5)
67171	Focus on Storms - FOS	EC/AES	25 (0.0)	178 (0.0)	215 (0.0)	200 (0.0)	200 (0.0)
67172	Trawlers-of-Opportunity - Ocean Data Acquisition	FO/SCIENCE	89 (0.0)	89 (0.0)	120 (0.0)	55 (0.0)	55 (0.0)
67173	Remote Sensing Forecasting	FO/SCIENCE	0 (0.0)	14 (0.0)	125 (0.0)	35 (0.0)	60 (0.0)
67174	Remote Sensing Forecasting	EC/AES	0 (0.0)	19 (0.0)	90 (0.0)	210 (0.0)	210 (0.0)
67175	POLE Oceanography	FO/SCIENCE	0 (0.0)	0 (0.0)	85 (0.0)	130 (0.0)	130 (0.0)
67178	Remote Sensing Forecasting	FO/SCIENCE	0 (0.0)	0 (0.0)	40 (0.0)	155 (0.0)	100 (0.0)
67179	A Three-Dimensional Circulation Model	FO/SCIENCE	45 (0.0)	54 (0.0)	55 (0.0)	60 (0.0)	60 (0.0)
67180	Winter Circulation on NE Nfld. Shelf	FO/SCIENCE	20 (0.0)	24 (0.0)	15 (0.0)	0 (0.0)	0 (0.0)
67181	Arctic Cli. Fore. & Monit. Using Passive Microwave	EC/AES	0 (0.0)	0 (0.0)	0 (0.0)	100 (0.0)	100 (0.0)
67182	Sea Ice Class. Sys. and Tools Using SAR Imagery	EC/AES	45 (0.0)	44 (0.0)	50 (0.0)	100 (0.0)	100 (0.0)
67183	Satel. Derived Data into Sea Ice Forecasting Proc.	EC/AES	45 (0.0)	39 (0.0)	40 (0.0)	100 (0.0)	100 (0.0)
67209	MFO Induction Measurements	FO/SCIENCE	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
67223	Natural Degradation of Oil	FO/SCIENCE	60 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
67227	Hydrocarbon Effects	FO/SCIENCE	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
67237	Integrated Hydrocarbon Monitoring	EC/C&P	30 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)

TASK #6 - OIL, GAS, ELECTRICITY

ID	DESCRIPTION	DEPT/PE	91-92	92-93	93-94	94-95	95-96
67238	Condensate Effects on Commercial Species	EC/C&P	88 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
67239	Organic Pollutants from Flare Stacks	EC/C&P	60 (0.0)	59 (0.0)	60 (0.0)	0 (0.0)	0 (0.0)
67240	Fate of Oil/Dispersants	FO/SCIENCE	30 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
67242	Hydrocarbon Stress on Juvenile Fish	FO/SCIENCE	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
67245	Produced Water Alternatives	EC/C&P	272 (1.0)	298 (1.0)	340 (1.0)	340 (1.0)	275 (1.0)
67246	Biodegradability of Base Oils	EC/C&P	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
67247	Bacterial Additive in Drilling Muds	EMR/COGLA	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
67248	Bacterial Additive In Drilling Muds	INA/COGLA	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
67249	Oil Volatilities	FO/SCIENCE	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
67250	OBM Cuttings/Fish Larvae	FO/SCIENCE	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
67252	Sublethal Tainting - Scallops	FO/SCIENCE	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
67253	Satellite Transmitter Bowhead Whales	INA/RDRM	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
67254	LMW Hydrocarbons & Scallops	FO/SCIENCE	70 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
67255	Long-term Weathering of Oil Spill Tars	FO/SCIENCE	0 (0.0)	56 (0.0)	45 (0.0)	25 (0.0)	25 (0.0)
67256	Toxic Zones for Fish at Offshore Rig Sites	FO/SCIENCE	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
67257	Narwhal Monitoring Technology-VHF & Satellite Systems	FO/SCIENCE	42 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
67258	R&D Coordination Workshops	EC/ADMIN	30 (0.0)	29 (0.0)	30 (0.0)	30 (0.0)	30 (0.0)
67260	Assessment of Site Tenacity of Tagged Bowhead Whales	FO/SCIENCE	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
67261	FLIR Remote Sensing Technology for Seal Lairs	FO/SCIENCE	50 (0.0)	49 (0.0)	30 (0.0)	0 (0.0)	0 (0.0)
67262	Effects of Oil on Juvenile Salmon Survival to Adults	FO/SCIENCE	143 (0.0)	138 (0.0)	40 (0.0)	0 (0.0)	0 (0.0)
67264	Flocculation and Settling Behaviour of Drilling Muds	FO/SCIENCE	85 (0.0)	85 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
67265	Particle Transport Impact on Scallop Communities	FO/SCIENCE	95 (0.0)	69 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)

TASK #6 - OIL, GAS, ELECTRICITY

ID	DESCRIPTION	DEPT/PE	91-92	92-93	93-94	94-95	95-96
67267	Pollution Perspectives	EC/ADMIN	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
67269	Evaluation Methodologies - Arctic Fish	FO/SCIENCE	28 (0.0)	59 (0.0)	70 (0.0)	97 (0.0)	97 (0.0)
67271	Western Basin Waste Management	EC/C&P	88 (0.0)	178 (0.0)	180 (0.0)	50 (0.0)	50 (0.0)
67272	Air-Deployable Sampler	EC/C&P	20 (0.0)	59 (0.0)	50 (0.0)	0 (0.0)	0 (0.0)
67273	Long Term Fate/Persistance of Oil Stranded on Course Sedimen	EC/C&P	30 (0.0)	29 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
67274	Tainting Potential of Oil Particulates for Comm. Species	FO/SCIENCE	65 (0.0)	64 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
67275	Prediction of Benthic Impact Zones Produced by Drill. Waste	FO/SCIENCE	0 (0.0)	0 (0.0)	55 (0.0)	50 (0.0)	25 (0.0)
67276	Sublethal Effects of Drilling Wastes on Sea Scallops	FO/SCIENCE	24 (0.0)	18 (0.0)	36 (0.0)	16 (0.0)	0 (0.0)
67277	Remote Sensing-Environmental Impact	FO/SCIENCE	20 (0.0)	0 (0.0)	174 (0.0)	195 (0.0)	200 (0.0)
67278	Remote Sensing-Environmental Impact	EC/AES	0 (0.0)	0 (0.0)	60 (0.0)	130 (0.0)	195 (0.0)
67279	Climate Change Impact	FO/SCIENCE	0 (0.0)	0 (0.0)	0 (0.0)	90 (0.0)	205 (0.0)
67280	Climate Change Impact	EC/AES	0 (0.0)	0 (0.0)	0 (0.0)	185 (0.0)	400 (0.0)
67281	Microbial Exoenzyme Assays for DFO Benthic Marine Environ.	FO/SCIENCE	55 (0.0)	64 (0.0)	65 (0.0)	0 (0.0)	0 (0.0)
67282	Hydrocarbon Contamination of Commercial Fish Stocks	FO/SCIENCE	0 (0.0)	38 (0.0)	39 (0.0)	39 (0.0)	39 (0.0)
67283	Field Verification of Oil Burning	EC/C&P	0 (0.0)	49 (0.0)	50 (0.0)	0 (0.0)	0 (0.0)
PROGRAM #67 TOTALS:			5052 (9.5)	5062 (9.5)	5062 (9.5)	5062 (9.5)	5062 (9.5)

PROGRAM #68 - ELECTRICAL R&D

68101	CEA R&D Program	EMR/ENERGY	1359 (0.0)	1359 (0.0)	1359 (0.0)	1359 (0.0)	1359 (0.0)
PROGRAM #68 TOTALS:			1359 (0.0)	1359 (0.0)	1359 (0.0)	1359 (0.0)	1359 (0.0)
TASK #6 TOTALS:			18434 (41.0)	18422 (41.0)	18322 (40.0)	18322 (40.0)	18322 (40.0)

TASK #7 - COORDINATION & INTERNATIONAL CONTRIBUTIONS

ID	DESCRIPTION	DEPT/PE	91-92	92-93	93-94	94-95	95-96
PROGRAM #71 - COORDINATION							
71101	Office of Energy Research & Development (O.E.R.D.)	EMR/M&ET	1018 (13.0)	1018 (13.0)	1018 (13.0)	1018 (13.0)	1018 (13.0)
71102	Contracts (O.E.R.D.)	EMR/M&ET	204 (0.0)	204 (0.0)	204 (0.0)	204 (0.0)	204 (0.0)
71104	PERD Financial Administration	EMR/ADMIN	59 (1.0)	59 (1.0)	59 (1.0)	59 (1.0)	59 (1.0)
PROGRAM #71 TOTALS:			1281 (14.0)	1281 (14.0)	1281 (14.0)	1281 (14.0)	1281 (14.0)
PROGRAM #72 - INTERNATIONAL ENERGY AGENCY							
72101	EMR Class Contributions to IEA and Its Agents (O.E.R.D.)	EMR/M&ET	700 (0.0)	700 (0.0)	700 (0.0)	700 (0.0)	700 (0.0)
72102	IEA Energy Technology Database	EMR/M&ET	270 (0.0)	270 (0.0)	270 (0.0)	270 (0.0)	270 (0.0)
PROGRAM #72 TOTALS:			970 (0.0)	970 (0.0)	970 (0.0)	970 (0.0)	970 (0.0)
PROGRAM #73 - ENERGY DIVERSIFICATION RESEARCH LABORATORY							
73101	Energy Diversification Research Laboratory (O.E.R.D.)	EMR/M&ET	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
73102	Varennes - Heat Upgrading	EMR/M&ET	552 (3.0)	500 (4.0)	700 (4.0)	750 (4.0)	750 (4.0)
73103	Varennes - Energy Storage	EMR/M&ET	388 (2.0)	384 (2.0)	455 (4.0)	480 (4.0)	480 (4.0)
73104	Varennes - Photovoltaics	EMR/M&ET	1240 (4.0)	1420 (6.0)	1425 (6.0)	1350 (6.0)	1350 (6.0)
73105	Varennes - Natural Gas-Based Hydrocarbons Production	EMR/M&ET	940 (6.0)	1000 (6.0)	991 (8.0)	991 (8.0)	991 (8.0)
PROGRAM #73 TOTALS:			3120 (15.0)	3304 (18.0)	3571 (22.0)	3571 (22.0)	3571 (22.0)
TASK #7 TOTALS:			5371 (29.0)	5555 (32.0)	5822 (36.0)	5822 (36.0)	5822 (36.0)

TASK # -

ID	DESCRIPTION	DEPT/PE	91-92	92-93	93-94	94-95	95-96
REPORT TOTALS:			95717 (202.0)	91297 (202.0)	91297 (202.0)	91297 (202.0)	91297 (202.0)