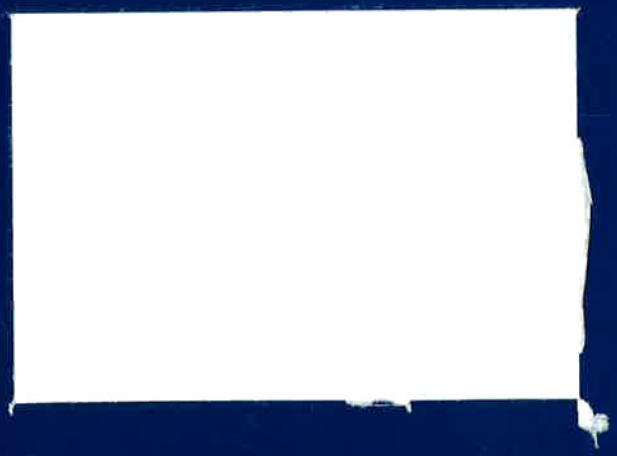
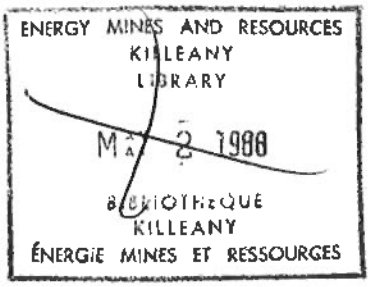
Energy, Mines and Resources Canada
Office of Energy Research and Development

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



Canada

ASSESSMENT OF BENEFITS FROM CANADIAN PARTICIPATION IN COLLABORATIVE ENERGY RESEARCH AND DEVELOPMENT UNDER THE INTERNATIONAL ENERGY AGENCY 1974-1985



Prepared by: Alexandra Cunningham
December 1987

OERD 87-05

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SUMMARY

The purpose of this report is to assess, as requested by the Panel on Energy R&D, the benefits to Canada from participation in collaborative R&D projects under the auspices of the International Energy Agency, for the period 1974-1985.

A survey of project managers was conducted which revealed thirteen general benefits from Canada's involvement. Among these were the ability to compare our capabilities and technologies with other participating countries, pooling of data and experience, focus and coordination for Canadian activities, more rapid use of results, increased efficiencies and product development, and an increased share in the market place. Other benefits included access to facilities not available in Canada, links forged between the private and public sectors, demonstration of our capabilities to others, standards development and considerable financial leverage. There were a few difficulties identified which emphasize the need for adequate commitment on Canada's part, consistent funding, established expertise and careful planning.

Overall, IEA collaboration in energy R&D has proved very successful for Canada. The benefits identified in this report far outweigh the drawbacks. It is recommended, therefore, that such collaboration continue, and that the Office of Energy R&D continue to provide the focus for coordinating and monitoring Canada's involvement. It is hoped that, in an effort to further the benefits derived, the following observations and recommendations regarding our participation will be carefully considered.

INTRODUCTION

Since joining the International Energy Agency in 1974, Canada has participated in 45 of the 78 collaborative energy R&D projects organized under IEA auspices. Canada's involvement, either by direct funding or contribution of knowledge from domestic RD&D activities, has derived largely from the Panel on Energy R&D.

The Panel directed the Office of Energy R&D to assess the benefits to Canada arising from this collaboration. The assessment covers projects which were initiated up to the year-end of 1985.

A questionnaire (Appendix A) was issued to all federal managers who are either responsible for Canada's participation in IEA projects, or responsible for the subject area and therefore most likely to have historical information on our participation in older projects. That questionnaire sought information on costs, objectives, R&D topics, organization of Canadian participation, and, most importantly, benefits to Canada. Respondents were asked to indicate specifically, and candidly, how participation has helped develop or improve Canadian energy-related science and technology programs and to identify any cases of involvement and use of results by Canadian industry.

This report includes a compilation of those responses under Appendix B. They provide insight into some of Canada's energy R&D achievements, the experience gained and the lessons learned. A matrix of individual project benefits is included at the beginning of Appendix B to provide an "at-a-glance" summary.

The more detailed analysis and recommendations which follow this introduction should be considered in planning of future energy R&D nationally and internationally.

BENEFITS

A list of thirteen benefits was derived from the submitted responses. The following paragraphs illustrate each benefit cited in bold type with examples taken from the projects in which Canada has participated.

1) **through the IEA, R&D activities of the participating countries were demonstrated to Canadian representatives**

   International technology was exhibited to Canadians in about one-third of the projects. Examples include novel burner concepts in Sweden and alternative boiler configurations in Japan (coal/liquid mixtures). Also, novel uses of hydrogen were revealed to us which could have an impact on Canada in the future; namely, hydrogen road vehicles, a direct injection hydrogen engine and an automobile running on dissociated methanol.

2) **pooling of up-to-date international data and operating experience to produce larger data bases than would otherwise be possible and to avoid duplication of effort; development of formal information centres**

   This benefit is evident in nine-tenths of the projects. For example, international pooling of data and test materials in the area of forestry bioenergy resulted in more complete and reliable data bases. This is particularly important in fields such as genetics and biotechnology, where the long time periods and complex methodologies involved in selecting, breeding and mass-propagating fast-growing, disease resistant energy crops can be significantly shortened and simultaneously made more reliable. The selection of strains of alders, willows and poplars for use in energy plantations in Canada has also been significantly advanced by this international pooling of data.

   Four projects were concerned with establishment or support of information centres, covering heat pumps, coal technology, biomass and air infiltration. The latter supports institutions active in air infiltration research (CHBA, PWC) through collation, analysis, evaluation and dissemination of experimental data and technical information. Services provided free of charge to participating countries include a bibliographic data base, literature surveys, a newsletter, handbooks, glossaries and design guides relating to air infiltration. The Centre also regularly publishes major reports and sponsors conferences and workshops on specialized topics.

3) **comparison, at low cost, of our capabilities and technologies to those of our partners and resulting improvement of them**

Comparison and improvement of Canada's capabilities and technologies was realized by one-third of the projects. One example was in the construction of the TEXTOR (Torus Experiment for Technology Oriented Research) fusion device at Julich Nuclear Research Centre in Germany. Several developments from TEXTOR have since been embodied in the Canadian fusion device, Tokamak de Varennes. The collaboration by Canadian companies in TEXTOR has enabled them to become technically capable of supplying components and expertise to both the European and Canadian fusion programs. Another example was access to the design concepts for in-furnace and external burner staging for NOx and SOx control. This information was then applied in demonstration projects in Canada, for example, the 150 MWe boiler demonstration at Saskatchewan Power Corporation with low-sulphur lignite and the 17 MWt demonstration at CFB Gagetown with high-sulphur Maritime coal.

4) **participation and evaluation of national programs and objectives beneficial towards planning a program of research and providing a focus for coordination of Canadian activities**

About one-third of the projects helped to plan, focus and coordinate future Canadian R&D activities. The work conducted, for instance, on heat pumps and on hydrogen identified whether there was potential for these technologies in Canada, and if so, in what market areas. Another field in which this direction has proved invaluable is in Wind Energy Conversion Systems (WECS). Membership in Large Scale WECS has allowed Canada to concentrate on the Vertical Axis WECS, while still monitoring and keeping abreast of the development of Horizontal Axis WECS technology in other countries.

5) **acceleration of the application of R&D results, and instigation of further energy R&D leading to spin-off technologies**

About one-fifth of the projects accelerated R&D applications or resulted in spin-off technologies. Work done in evacuated solar collector technologies has recently led a Montreal company to purchase the production technology for the Phillips evacuated tubes, hoping to use this technology to develop desalination or refrigeration systems for export markets. In electrolytic production, a specific type of electrolyte was found to be not only a novel plastic in its own right, but also to have applications in batteries, fuel cells and other electrochemical devices. Spin-offs, such as new semi-conductor materials and processes, were the main benefits of participation in the photocatalytic production of hydrogen.

6) **enhancement of energy efficiencies and production levels, and/or development of a specific new product/tool, increasing Canada's share in the market place and providing contracts to Canadian consultants**

About one-quarter of the projects lead to direct, visible successes in market access, efficiency levels or new product development. The pulp and paper industry is a case in point. Improvements in water removal (pressing) and drying have led to greater efficiency of paper machines at many Canadian mills and also to higher production rates. One mill calculated $100K/yr savings on drying steam alone and additional benefits from increased production.

7) **access to resources we do not ourselves possess, i.e. equipment, computer simulations, models, expert teams, etc.**

Several projects benefitted from access to facilities otherwise not available. For example, Canada commercially supplied a detector to TEXTOR, which entitled us to an invaluable seven percent of experiment time on the TEXTOR. Another example is a computer program, cooperatively developed out of the Energy Technology Systems Analysis Project (ETSAP). MARKAL (Market Allocation) is a flexible multi-period linear programming model, which can be adapted to describe the diverse national energy systems of participating countries. Canada was invited to send a representative to help develop a Canadian version of MARKAL. Unfortunately, the program was not as successful as expected for various reasons. Participation and access to the model did, however, provide a valuable learning experience.

8) **formation of cooperative links between public and private sectors (government, industry and universities)**

Over half of the projects brought the private and public sectors together in one way or another. In research conducted on vertical earth heat pumps, a computer model was developed by a Swedish university in cooperation with the National Research Council (NRC). This has been a great advantage for the ground source heat pump (GSHP) industry in Canada. There is now strong cooperation between NRC and Canadian GSHP companies and their share in the market place has greatly increased.

9) **demonstration of our own scientific and technological capabilities to an international audience, thereby receiving recognition and credibility**

In several instances, Canada was able to demonstrate its technical leadership and capability. For example, a solar radiation simulation model used by Environment Canada was verified by IEA participants as one of the best available to the IEA member countries. We demonstrated our bioenergy conversion technologies, and a technique for modelling long-term environmental effects from intensive biomass removal in which we are a world leader. Canada's coal/liquid mixtures program is in the forefront of the technology due to initiation of the first commercial conversion of a cement kiln and the establishment that derating of oil-designed units was negligible when firing coal-water fuel.

10) **participation in and contribution to standards development**

International standards were developed, amongst others, for ventilation, alcohol as fuel, peat, solar applications, fluidized bed facilities, coal combustion and wind. One project resulted in Canadian standards and test methods for solar collectors and systems. Canada has nominated three of the 12 coals being evaluated for combustion efficiency as standards in the international market. A western Canadian coal is being seriously considered as the reference standard for combustion properties. Standards which incorporate internationally accepted procedures lead to development of Canadian products which achieve an excellent reputation in both domestic and world markets.

11) **insight into barriers to development of technology (economics, industry, social, etc.); assessment, at low cost, that a technology is inappropriate for Canada**

The potential of a technology was assessed in several projects. For example, it was concluded from one study that hydrogen will not be economically viable as an energy source before the year 2025, although it may be of interest for national goals involving energy supply and the environment.

12) **avoiding costly investments due to insufficient information; knowledge of possible problems before undertaking a project; gaining valuable insight into the validity of some modelling techniques**

Several participants were able to successfully apply what they learned from others before making costly investments. A case in point is work done on central solar heating plants with seasonal storage. When Canada got involved in the project, there was within Canada a movement to build such a plant. Participation in the IEA project forced a disciplined evaluation with others in a similar position first, thus avoiding what would have been a costly investment. Canada could now design an efficient system if called upon to do so. In another case, participation allowed Canada to gather reports of incidents/accidents and operational problems from MW scale wind turbine projects of other countries before starting construction of Éole, the large vertical axis wind turbine of Hydro Quebec.

The available information indicates that Canada has obtained significant **financial leverage** through international collaboration (see Summary of Direct Project Costs, page 29). On an average, Canada has contributed approximately 20% to direct project costs. However, this varies widely, from a very good leverage of 5% of the project cost, to a considerable Canadian contribution of 70%. These percentages do not reflect the indirect costs, such as travel expenses, salaries and a proportion of the domestic R&D program necessary to bring Canadian expertise to the international table. However, these indirect costs are also borne by other participating countries. As most projects involve an average of 8 other participating countries, with a range from 1 to 15, it could be argued that the leverage on indirect costs is in the same ratio as that of participation, assuming similar levels of national R&D investment.

DIFFICULTIES

Although OERD's assignment was to assess the benefits to Canada of IEA collaboration, there will always be some difficulties inherent in the collaborative process. Following are of some of the difficulties encountered:

- Canada was invited to send a delegate to contribute to a project, however, we had no person available, nor any expertise, so instead someone was retained to provide Canadian contributions.

- The data generated in projects was never utilized. As energy supplies dwindle, this should become rare.

- The contractor chosen to do the task was incompetent, and this was not recognized for most of the project.

- Participants learned a healthy skepticism of the practical value of some computer programs.

- Projects had to be postponed indefinitely due to budget reductions.

- Insufficient funding and travel restrictions prevented Canada from sending the most appropriate, knowledgeable persons to participate in some projects.

There are several things we can do to minimize these difficulties in future collaboration. Primarily, Canada should participate in those areas in which we have an existing body of expertise. We must not only be competent in the area, but also willing to make an investment towards expected returns. Funding must be sufficient to ensure that Canada is represented by our most experienced persons. It is also important to ensure, prior to participation, that there is a use for the information being developed.

CONCLUSION	RECOMMENDATION
1. The evidence supports the view that there are considerable benefits to Canada's participation in collaborative R&D projects of the IEA.	1. The federal Energy R&D Program should continue its policy of encouraging and supporting participation in IEA R&D projects.
2. The realization of the full value of participation has, in various cases, been limited by:	2. The Panel should, as appropriate to the situation, require participating managers to:
- participation in areas which lack an existing body of Canadian expertise.	- ensure that Canada has adequate experience, even if only in one niche, to both contribute to and comprehend developments.
- inappropriate or inexperienced Canadian representatives.	- send Canada's most experienced and competent members of the scientific community to represent Canada.
	- choose a representative of an industry association, so as to spread the information gained over as wide an area as possible.
- discontinuous or insufficient funding, which has prevented Canadian experts from attending technical meetings associated with the project.	- strive for continuity of participation, demonstrating a willingness to make an investment towards expected returns.
- lack of industry involvement, which can, on the one hand, delay the application of R&D results and on the other, lead to the development of products for which there is no market.	- encourage industrial involvement, particularly in the planning stages of Canadian participation in a project in order to promote cooperation and information transfer between public and private sectors.
- some projects dragging on beyond a point that was technically or economically justifiable.	- ensure more thorough monitoring and evaluation of projects, by both Canadian participants and the IEA community.

- the few technology developments which have occurred relative to the large number of studies done.

- poor dissemination of project reports to the Canadian private and public sector research and policy communities.

- place priority on technology development; however, this is eventually impeded by proprietary concerns.

- better publicize data bases and information centres to ensure good use is made of these studies. Furthermore, participants could be required to provide OERD with a listing of all persons to whom they have forwarded reports, so that any omissions can be rectified. OERD could also provide Panel members and PERD Program Chairmen in the appropriate R&D fields with abstracts from the IEA Bibliography of Collaboration in Energy RD&D 1976-1986.

- contribute to an international effort, coordinated by the IEA/CRD, to produce a current organization chart of IEA R&D to illustrate who is involved and under which implementing agreement each project falls.

Appendix A

Transmittal Letter and Questionnaire

Energy, Mines and Resources Canada
Énergie, Mines et Ressources Canada

Office of Energy Research and Development
Research and Technology
Ottawa, Ontario
K1A 0E4

Bureau de recherche et développement énergétiques
Recherche et Technologie
Ottawa (Ontario)
K1A 0E4

Your file Votre référence

Our file Notre référence

September 4, 1987

Subject: Benefits from Canadian Participation in International Energy Agency R&D Projects

Dear

I am writing to you to seek your help in an historical evaluation of Canada's involvement in energy research, development and demonstration projects organized under the auspices of the International Energy Agency.

Since joining the I.E.A. in 1974, Canada has participated in 45 of the 78 such projects. Canada's involvement either by direct funding or contribution of knowledge from domestic R,D&D activities has derived largely from the program administered by the federal Panel on Energy Research and Development.

The Panel has directed the Office of Energy R&D to assess the benefits to Canada arising from this collaboration. The assessment covers projects which were initiated up to the year-end of 1985.

Our records show that you are the federal manager responsible for Canada's participation in the projects attached to this letter. In some instances you may be the direct participant in the project, and in others you may have contracted with others to represent Canada. For some older projects, you might have inherited the responsibility for R&D in the subject area and are the most likely to have historical information on our participation, albeit by managers no longer available to be contacted directly.

It would, therefore, greatly assist OERD if you would complete the attached forms for each project. I have provided a set of guidelines for completing each section of the form. I realize the difficulties involved in mining old records and ask for your best effort in the time available. My intention is to compile your responses in an annex to a summary assessment which will be tabled with the Panel.

Canada

You may have already discussed aspects of this survey with Barbara Summers, who has since left OERD. If so, I apologize for inconveniencing you again in the process of picking up the traces!

Please address your replies to the attention of Bryan Cook in OERD (995-8860) by Friday, 25 September 1987. If you have any questions, OERD staff are available to assist you in the specific Tasks for which they are responsible.

Thank you for your cooperation.

Yours sincerely,

P.J. Dyne
Director General

Encls.

Dr. M.D. Everell, Chairman, PERD
OERD Staff

Same letter and attachments were sent to the following people.

Mr. R. Morris	-	EC
Dr. D. Jackson	-	AECL - Chalk River
Mr. R.J. Templin	-	NRC
Dr. R. Overend	-	NRC
Dr. O.J. Svec	-	NRC
Dr. I. Lowe	-	NRC
Dr. R.C. Biggs	-	NRC
Dr. E. Morofsky	-	PWC
Mr. G. Page	-	AC - CFS
Mr. F.D. Friedrich	-	CANMET ERL
Dr. D.A. Reeve	-	CANMET - ERL
Dr. H. Whaley	-	CANMET - ERL
Mr. G.K. Lee	-	CANMET - ERL
Dr. S.M. Ahmed	-	CANMET - ERL
Mr. F. Nemeth	-	EM&R
Dr. A.J. Dolenko	-	EM&R
Dr. J.P. Hea	-	EM&R
Mr. B. James	-	EM&R
Mr. G. Maund	-	EM&R
Mr. M. Wiggin	-	CANMET - ERL
Mr. C. Ficner	-	EM&R
Dr. S.M. Pnevmaticos	-	EM&R
Dr. D.W. Clayton	-	PPRIC
Dr. B.D. Pratte	-	NRC
Ms. M.A.J. Hurley	-	NRC (CISTI)

Guidelines for Completing an IEA Project Reporting Form

1. Project Title

Duration - Responsible Department - Nature of Participation - Status

This information is already provided by OERD. Please verify.

"Responsible Department" means department(s) responsible for work on the particular project.

Under "Nature of Participation": cost sharing means that each participant agrees to contribute financial resources to one operating agent (country) which acts as the coordinator and/or the performer of the activity for the benefit of the group.

task sharing involves either the sharing of information gained from national projects and/or the performance by each participant of component parts or tasks of a single project.

2. Direct Costs: Canada $ Other Participants (#) $

If possible, please provide for the full project life up to year-end 1985, the total direct costs to Canada and summed for the other participants ($ Canadian). Indicate if your information is estimated. If possible, please verify the number of participants, other than Canada, given in brackets.

Direct costs include direct contributions to Operating Agents and cost of inhouse or contracted RD&D which is dedicated to an IEA project; i.e. work which is initiated as a direct result of Canadian involvement in an IEA project which would not have been done otherwise.

3. Objective

4. Description

These have been derived by OERD from the IEA's Ten-Year Review of Collaboration in Energy R,D&D 1976-1986, sections of which have been copied and are attached for your information. Please revise the Objective and Description sections to describe from an IEA perspective what was being done and what resulted, without unduly exeeding the length of the current drafts.

5. Organization of Canada's Participation

Please provide, in no more than two paragraphs, a commentary on the nature and organization of Canadian participation and any linkages to Canadian public and/or private sector activities.

6. Benefits to Canada

Please provide your perception of the benefits to Canada from participating in this project. These might for example include:

- participation in activity which we would not have the resources to fund independently;
- the opportunity to compare our capabilities and technologies to that of our partners and in so doing improve then;
- assessment, at low-cost, that a technology is inappropriate for Canada;
- pooling of data and operating experience to produce larger data bases than would otherwise have been possible;
- participation in comparisons of various technology options which unilaterally were not possible;
- access to facilities we do not ourselves possess;
- the opportunity to demonstrate our own scientific and technological capabilities to an international audience.

Try to describe the benefits in order of importance. It is very important for this assessment that, when describing these benefits, you indicate how specifically they have helped develop or improve Canadian energy-related science and technology programs and that you identify any cases of use by Canadian industry.

7. Primary Canadian Contact

Name: Affiliation: Telephone #: ( )

Please provide the above information for the person in Canada most knowledgeable about the specific project.

Appendix B

Benefit Listing, Matrix of Benefits Against Numbered Projects, Summary of Direct Project Costs and Individual Project Responses

IEA BENEFITS

The following is a list of 12 generic benefits identified as a result of Canadian collaboration in international energy R&D.

1) through the IEA, R&D activities of the participating countries were demonstrated to Canadian representatives.

2) pooling of up-to-date international data and operating experience to produce larger data bases than would otherwise be possible and to avoid duplication of effort; development of formal information centres.

3) comparison, at low cost, of our capabilities and technologies to those of our partners and resulting improvement of them.

4) participation and evaluation of national programs and objectives beneficial towards planning a program of research and providing a focus for coordination of Canadian activities.

5) acceleration of the application of R&D results, and instigation of further energy R&D leading to spin-off technologies.

6) enhancement of energy efficiencies and production levels, and/or development of a specific new product tool, increasing Canada's share in the market place and providing contracts to Canadian consultants.

7) access to resources we do not ourselves possess, i.e. equipment, computer simulations, models, expert teams, etc.

8) formation of cooperative links between public and private sectors (government, industry and universities).

9) demonstration of our own scientific and technological capabilities to an international audience, thereby receiving recognition and credibility.

10) participation in and contribution to standards development.

11) insight into barriers to development of technology (economics, industry, social, etc.); assessment, at low cost, that a technology is inappropriate for Canada.

12) avoiding costly investments due to insufficient information; knowledge of possible problems before undertaking a project; gaining valuable insight into the validity of some modelling techniques.

MATRIX OF BENEFITS TO CANADA RESULTING FROM PARTICIPATION IN THE IEA

BENEFIT NUMBER (from previous page)	PROJECT #	3.1	3.2	3.3	3.4	3.5	3.6	3.7	3.8	3.9	3.10	3.11	3.12	3.13	3.14	4.1	4.2	4.3	4.4	4.5	4.6	4.7
	1							X		X			X	X			X	X	X		X	X
	2		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
	3	X	X	X				X		X			X	X			X	X	X		X	
	4			X	X			X	X	X	X				X							
	5							X	X	X				X					X		X	
	6							X		X				X						X		
	7			X						X				X					X	X		
	8			X				X	X	X	X			X	X		X	X	X		X	X
	9	X					X	X		X	X		X	X	X		X	X	X	X		
	10				X		X								X		X			X		
	11								X		X							X				
	12	X	X	X							X						X					

NOTES: There are several projects which are not expected to result in more than one or two benefits due to the nature of the project.

Although the intent of this report is to assess projects to the year-end of 1985, it should be recognized that many completed projects have resulted in further annexes, yielding additional benefits not mentioned here.

PROJECT # (Cont'd)

BENEFIT NUMBER (from previous page)	5.1	5.2	5.3	5.4	5.5	5.6	5.7	5.8	5.9	5.10	5.11	5.12	5.13	5.14	5.15	5.16	5.17	5.18	5.19	5.20
1				X	X		X			X			X	X		X		X		
2		X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X		X
3				X	X	X				X			X					X		
4				X	X					X	X		X			X	X		X	X
5										X		X	X	X		X	X			
6	X			X		X	X			X	X			X		X				
7					X					X	X	X								
8	X			X	X			X		X	X		X			X	X	X	X	X
9				X	X		X			X		X				X	X			
10	X	X					X			X	X			X						
11										X						X			X	
12					X								X							

NOTES: There are several projects which are not expected to result in more than one or two benefits due to the nature of the project.

Although the intent of this report is to assess projects to the year-end of 1985, it should be recognized that many completed projects have resulted in further annexes, yielding additional benefits not mentioned here.

BENEFIT NUMBER (from previous page)	PROJECT # (Cont'd) 6.1	6.2	6.3	7.1
1	X		X	
2	X		X	X
3	X		X	
4				X
5				
6	X		X	
7	X			X
8	X			X
9	X		X	
10				
11				
12				X

NOTES: There are several projects which are not expected to result in more than one or two benefits due to the nature of the project.

Although the intent of this report is to assess projects to the year-end of 1985, it should be recognized that many completed projects have resulted in further annexes, yielding additional benefits not mentioned here.

SUMMARY OF DIRECT PROJECT COSTS ($CDN)

The following figures estimate Canada's contribution to total project costs (up to year-end 1985) in relation to other participating countries. (Data available for only half of the projects in which Canada is involved).

	Canada's Contribution	Other Countries (# other participants)
3.3	$62,000	$529,000 (10)
3.7	85,000	550,000 (7)
3.9	60,000	230,000 (3)
3.11	54,000	890,000 (9)
3.13	792,000	2,800,000 (12)
3.14	35,000	15,000 (4)
4.1	120,000/yr	3,000,000/yr (11)
4.2	10,000/yr	150,000/yr (7)
4.3	25,000	200,000 (6)
4.4	455,000	1,205,000 (2)
4.5	600,000	1,200,000 (4)
4.6	40,000	775,000 (7)
5.1	150,000	2,000,000 (14)
5.4	100,000	1,500,000 (8)
5.5	554,000	3,500,000 (6)
5.7	845,000	995,000 (9)
5.8	15,000	300,000 (8)
5.10	172,000/yr	1,000,000/yr (11)
5.11	100,000	100,000 (1)
5.12	148,000	706,000 (3)
5.14	480,000	500,000 (11)
5.18	1,676,000	9,273,000 (4)
5.19	120,000	950,000 (7)
5.20	200,000	1,115,000 (3)
	6,898,000	33,483,000

Project Title

3.1 Commercial Buildings Energy Analysis

Duration	Responsible Dept.	Nature of Participation	Status
1977-1980	NRC	Task Sharing	Completed

Direct Costs: Canada $40,000 Other Participants (8) $

Objective

- To compare computer software from participating countries for calculating energy consumption in buildings using specifications from a hypothetical commercial building.

- To compare those results with measured values in an actual building.

Description

No consistency was achieved by the participants in evaluating thermal performance. Possible reasons for discrepancies have been suggested - notably the handling of solar gains. There were no plans to proceed with a hypothetical building system simulation. The Avonbank building in the UK was chosen as the "actual building" for objective two. Wide variations in results were found - some due to interpretation of the specification and output requirements.

Organization of Canada's Participation

The Canadian computer program was used to estimate the annual energy consumption of a hypothetical building. This was done by an engineering company under contract to NRC.

NRC also carried out a complementary project in which about 20 engineering companies calculated the energy for a hypothetical building - all using the same program. Here too, there was a wide range in the results. This showed that the discrepancies were not entirely due to the differences in the programs.

Benefits to Canada

The only valuable output from this project was the evidence that one should be skeptical about the accuracy of all calculated values of the annual energy needed to operate a building. Prior to this project many people thought that the values given by the various computer programs were reasonably accurate. Unfortunately this is not the case.

Primary Canadian Contact

Name: Leslie Jones **Affiliation:** Leslie Jones & Assoc., Ottawa **Telephone #:** (613) 233-2758

Project Title

3.2 Commercial Building Monitoring

Duration	Responsible Dept.	Nature of Participation	Status
1979-1983	NRC	Cost Sharing	Completed

Direct Costs: Canada $100,000 Other Participants (6) $

Objective

- To measure in detail energy performance of a commercial office building to allow comparisons of actual energy performance with that predicted by load/energy computer programs under the above project.

Description

The Collins Publishers building in Glasgow, Scotland was instrumented to monitor energy flows, together with internal and external environmental conditions. About six months of performance data were collected which enabled all participants to gain valuable insights into the validity of their modelling techniques. Notwithstanding, it was found that the agreement obtained between participants models was closer than that between models and the measured results.

Organization of Canada's Participation

Canada contributed to the fund that was used to pay a contractor to instrument a building in Glasgow and monitor its performance for several months.

Benefits to Canada

This project was almost a complete waste of time and money. The contractor (University of Glasgow) was not competent to do the job properly, and for most of the project this fact was not recognized. Eventually the British Building Research Establishment took over the management of the project and some data were collected. No use was ever made of these records in Canada.

Primary Canadian Contact

Name: D.G. Stephenson **Affiliation:** IRC/NRC **Telephone #:** (613) 993-9671

Project Title

3.3 Air Infiltration and Ventilation Centre (AIVC)

Duration	Responsible Dept.	Nature of Participation	Status
1978-ongoing	NRC	Cost Sharing	Ongoing

Direct Costs:	Canada $	Other Participants (11) $
At 31 January 87	148,400 Pds Sterling	1,269,162 Pds Sterling

Objective

- To support institutions active in air infiltration research through the collation, analysis, evaluation and dissemination of experimental data and technical information, and to assist in the coordination of national research activities in air infiltration.

- To develop methodologies which architects, engineers and energy management professionals could use to assess the energy losses, due to air infiltration, from residential, commercial and industrial buildings.

Description

The AIVC's bibliographic database AIR BASE covers more than 1900 abstracts and is available at anytime via the international data networks. This basic service is heavily supplemented by literature surveys, the "Air Infiltration Review" - a quarterly newsletter, surveys of current research projects, the "Air Infiltration Handbook", and a Glossary of terms relating to air infiltration. A "Design Guide" is currently in production. The Centre also regularly publishes major reports and sponsors conferences and workshops on specialized topics.

Organization of Canada's Participation

To oversee the AIVC activities, a Canadian coordinating committee has been formed. The Canadian representative to the AIVC Steering Group (IRC) and the staff of the coordinating committee meet twice a year prior to the Steering Group Meeting to discuss Canada's input to the AIVC activities. Members of other organizations such as CHBA, PWC, etc. are also invited to the meetings.

Benefits to Canada

The AIVC can be viewed as an information gathering, review and dissemination activity. It serves a useful function in compiling and analyzing research carried out by participating IEA countries and provides a forum for exchange of information and a mechanism to initiate cooperative projects. AIVC's services and publications are available, normally free of charge, to organizations of the participating countries

Benefits to Canada (Cont'd)

only. Canada, both government agencies and private sector, has always been making most use of the services of AIVC after the UK and the USA. Other benefits to Canada are: (1) to have direct input into all current and future AIVC activities and (2) to have access to all other ventilation, air movement and moisture transport activities undertaken by various Annexes.

Primary Canadian Contact

Name: C.Y. Shaw **Affiliation:** IRC/NRC **Telephone #:** (613) 993-9702

Project Title

3.4 Minimum Ventilation Rates

Duration	Responsible Dept.	Nature of Participation	Status
1980-1986	NRC	Task Sharing	Completed

Direct Costs: Canada $20,000 Other Participants (9) $

Objective

- To establish the common criteria necessary to determine minimum ventilation rates;
- To quantify more closely the factors which determine the concentrations of the pollutants identified and to determine the interrelationship between these factors;
- To establish minimum rates and all other suitable methods for ensuring that these pollutants are kept at acceptable levels; and
- To summarize, catalogue and assess the available techniques for controlling air quality and energy conservation.

Description

The completed first phase of this project provided a detailed analysis of the most important pollutants encountered in living spaces and the minimum ventilation rates necessary to prevent odour annoyance. The subsequent phase is concentrating on studies of emission rates of pollutants in living spaces, indoor transfer and chemical interaction of internal air flow and its control and treatment, and the modelling of indoor pollution including economic, social and health factors.

Organization of Canada's Participation

Canada prepared two sections for the report. These dealt with air cleaning devices and carbon dioxide. Originally this material was to be done by a contractor, but in the end it had to be prepared by NRC.

Benefits to Canada

The report that resulted from this project was a valuable compilation of information from many scattered sources. It would have required much more effort to do the task on our own.

This report has been used in planning a program of research in the field of air quality.

Canada got good value for the effort and funds invested in this project.

Primary Canadian Contact

Name: G.T. Tamura **Affiliation:** IRC/NRC **Telephone #:** (613) 993-9616

Project Title

3.5 Energy Auditing

Duration	Responsible Dept.	Nature of Participation	Status
1983-1988	NRC	Task Sharing	Ongoing

Direct Costs: Canada $100,000 Other Participants (9) $

Objective

- To produce and publish a "Source Book of Energy Auditing" which will present the methodology and strategy of energy auditing as well as facts and data.

Description

Subjects covered are parameters influencing energy use and auditing problems, energy conservation opportunities, worksheets for energy auditors, audit procedures, measurement techniques and instruments, analysis methods, reference, legal and target values, data base energy auditors, terminology and references.

Organization of Canada's Participation

The NRC retained the services of Leslie Jones and Associates to provide Canadian information to the Swedish operating agent. That firm, in turn, gathered material from other consultants and public sector organizations.

Benefits to Canada

The Source Book of Energy Auditing is a valuable reference handbook for any individual or organization that is involved in Energy Audits. Although the Source Book has been available for about one year it is not possible to identify any group that has made use of it. Its value will increase as our energy supplies dwindle.

Primary Canadian Contact

Name: D.M. Sander/L. Jones **Affiliation:** IRC/NRC **Telephone #:** (613) 993-9625

Project Title

3.6 "Energy Auditing in Hospitals"

Duration	Responsible Dept.	Nature of Participation	Status
1985-1987	Energy, Mines & Resources	Task Sharing	Completed

Direct Costs: Canada $3,000 Other Participants (5) $ (not known)

Objective

- To prepare a series of six handbooks for energy managers of hospitals to provide practical guidelines and directions to improve the standard of maintenance, reduce losses, increase the efficiency of systems and attain substantial savings in overall cost of energy consumed.

Description

This activity is a spin-off from the Energy Auditing Annex. Compilation has been completed of the systems and services normally existing in all hospitals, and the main parameters affecting the energy characteristics of hospitals and associated services have been listed. The finished work will be presented at ENERHEALTH 87, the Annual Conference of the Energy Management Task Force in Health Care Facilities in Canada in Toronto, October 6 & 7.

Organization of Canada's Participation

At the request of the National Research Council, the Energy Conservation Branch of Energy, Mines and Resources undertook to pay the travel expenses of the Chairman of the Energy Management Task Force in Health Care Facilities in Canada so that he could participate in Annex 13. Annex 13 encompasses Energy Management in Hospitals, and participation consists of attendance and contribution at meetings of the Annex held in the six member countries. Mr. Drodge's attendance was particularly appropriate since the Task Force has already produced two handbooks covering similar material.

Benefits to Canada

1) Because of the past experience in preparing such a handbook, and because of the calibre of Canada's representative, we were able to clear up a misconception with regards to Canada's standing in energy management in the health care field. Thus, Canada earned a very good reputation and demonstrated leadership in this field which should facilitate the sale of Canadian expertise in this area in international markets.

2) We participated in joint-sharing of information and gained an understanding of European energy management in hospitals.

3) Due to funding of the Energy Conservation Branch we were able to participate in Annex 13 which would otherwise have been impossible.

Primary Canadian Contact

Name: W.J. Drodge **Affiliation:** The Moncton Hospital, N.B. **Telephone #:** (506) 857-5600

Project Title

3.7 District Heating

Duration	Responsible Dept.	Nature of Participation	Status
1983-1986	EMR/ERL	Task & Cost Sharing	?
Direct Costs:	Canada $85,000	Other Participants (8) $550,000 (est)	

Objective

- To collaborate in a program of assessment and demonstration in four specific areas of interest:

  i) - development of heat meters;
     - low cost distribution and connection systems;
     - small size coal fired hot water boilers;
     - medium size combined heat and power plants.

  ii) - development of cost effective connections to new hot water systems;

  iii) - advanced friction reducing additives for district heating systems; and

  iv) - ice slurry systems for district cooling.

Description

Laboratory investigations are being conducted on dynamic response times and the influence of small temperature differences as well as the preparation of a testing program for some of the more promising new heat meter concepts. Surveys have been carried out to evaluate experience with various systems in seventeen utilities in the seven participating countries. Part of this collaborative program has been directed towards developing the best design for hot water central distribution units in the size range 5-15 MW with automated operation. This activity involves a technology review covering a selected number of alternative technologies and the drawing up of a conceptual design for a 10 MW grate fired hot water boiler. The results of the study dealing with combined heat and power (CHP) plants suggest that there is great technical potential in the participating countries for small CHP plants. Major new work is underway on friction reducing additives for district heating systems and on ice slurry for central cooling systems. Utility policies in Canada are now more favourable for CHP plants.

Organization of Canada's Participation

Coordinating/advisory committee includes Atomic Energy of Canada Ltd. (AECL), Public Works Canada (PWC), National Research Council (NRC), Department of National Defence (DND), Ontario Research Foundation (ORF), Centre de Recherche Industrielle de Quebec (CRIQ), Dearborn Chemical, Sunwell Engineering, INRS (University of Quebec), St. Mary's University, University of Laval, University of Ottawa. Some of these groups are contributing lab time and/or facilities for pilot or full scale testing.

Benefits to Canada

1) Focus for coordination of Canadian Activities.

2) Mechanism for marketing Canadian services and products.

3) Major source of current information on modern district heating technology.

4) Source of funding for some R&D in Canada.

5) Source of generic technology that is being applied in other areas.

Primary Canadian Contact

Name: Michael Wiggin **Affiliation:** CANMET/ERL **Telephone #:** (613) 996-8870

Project Title

3.8 Advanced Heat Pump Systems

Duration	Responsible Dept.	Nature of Participation	Status
1977-1980	NRC/DME & EMR/CANMET	Cost Sharing	Completed

Direct Costs: Canada $35,000 Other Participants (12) $

Objective

- To characterize current state-of-the-art for advanced heat pumps, involving a technology survey and a market study.

Description

It was concluded from this activity that RD&D efforts should be focussed on advanced heat pumps most likely to generate market potential by the end of the century, such as absorption, Rankine-Rankine and Diesel-Rankine systems.

Organization of Canada's Participation

Financial contribution through contracts to Canadian consultants for market studies and system modelling, as well as collection, organization and transmission of Canadian data to the operating agent (Germany).

Benefits to Canada

Canadian participation in this study focussed on heat pump systems driven by internal combustion engines burning natural gas. The market was identified but the results, and subsequent circumstances, showed that with very low energy prices the heat pump system was at an economic disadvantage in Canada. Certain research and development opportunities were identified in the areas of environmental impact, internal combustion engine technology and heat pump system modelling; all areas where Canada could exploit its expertise. The general benefits of shared information from all participants in the project applied in this case as well.

Since the completion of the above project, projects have been developed in cooperation with EMR/CANMET which more specifically address Canada's requirements. Such projects (ongoing) include non-azeotropic fluid mixtures, heat pump evaporators and modelling. Work on chlorofluorocarbon fluids (CFC's) is being explored. Benefits in knowledge for the resources invested is great as a result of leverage.

Since 1985, all work is overseen by an industrial/university/utility/government cooperative group - the National Heat Pump Coordinating Committee.

Primary Canadian Contact

Name: I.R.G. Lowe **Affiliation:** N.R.C. **Telephone #:** (613) 993-2439

Project Title

3.9 Vertical Earth Heat Pumps

Duration	Responsible Dept.	Nature of Participation	Status
1981-Ongoing	NRC/IRC & EMR/CANMET	Task & Cost Sharing	Completed

Direct Costs: Canada $60,000 Other Participants (4) $230,000

Objective

- To evaluate international experience with different vertical sub-soil heat source systems (with emphasis on electrically driven heat pump systems), and to assess market potential and outline a program for hardware development.

Description

A computer model was developed by the Swedish team from Chalmers University, Goteborg, in cooperation with the Institute for Research in Construction (IRC) of the National Research Council of Canada (NRCC). A series of laboratory experiments designed to validate the most important assumptions, inherent in developing the computer model, were performed by the Canadian participant, NRCC. The computer model was used for calculating the size of ground heat exchangers of various materials in differing soil conditions. Descriptions and costs were compiled on a variety of components such as pumping and drilling methods, solar collectors and ambient air heat exchangers, in order to enable comparisons to be made. It was concluded that although the technical potential for vertical earth heat pump systems is good, they were at that time not competitive owing to high installation costs. In climatic regions where air conditioning is not required and where normally there is insufficient time for the soil heat to be replaced by natural recharging during the spring and summer, extra energy must be supplied either by flowing ground water, air heat exchanger or solar collector.

It was also found, however, that potentially the cost of the ground heat exchange system could be significantly reduced by lowering the operating temperature and by developing more efficient ground heat exchangers.

Organization of Canada's Participation

Dr. Otto J. Svec of IRC, NRCC was responsible for Canadian participation in this Annex. The Canadian role was two fold: 1) Provide Operating Agent with all information needed for meaningful modelling, i.e. Canadian climatic data, types and thermal properties of soils and rocks across Canada, energy requirements for typical Canadian housing stock, etc. and 2) performing laboratory experiments on heat transfer characteristics of ground heat exchangers. IRC was already active in this field and it was only natural to focus the work in this direction.

EMR/CANMET is involved in the program to provide financial support for some aspects of the work and to insure integration with other "generic" R&D. The Renewable Energy Branch is involved to facilitate follow-up demonstration and technology transfer.

In late 1985, the National Heat Pump Coordinating Committee established a ground source heat pump R&D sub-committee to coordinate national R&D activities and to set priorities for IEA involvement.

Benefits to Canada

1) The Canadian team received results of many computer simulations of ground source heat pump (GSHP) systems using data for typical Canadian houses located in various climatic regions. As we do not have a computer model of this nature in Canada these results proved to be very useful in evaluating the potential of GSHP technology in Canada.

2) By taking part in this Annex, we had an opportunity to assess existing GSHP technology in all other participating countries and to study the possibilities for adopting it for Canadian conditions.

3) Operating experiences and data from actual installations received during the project duration were extremely valuable not only for our R&D program but also for the young Canadian GSHP industry to which this information was transferred.

4) Very good cooperation has developed on comparing state-of-the-art, operating experiences and various technology options among all participants. In fact, many of these ties and communication channels are not only still alive but have strengthened. Since Canada entered this agreement with the least amount of experience in GSHP technology, we probably benefitted the most.

5) Conversely, the other participants gained better insight into the detailed heat transfer processes at the heat exchanger-soil interface through the laboratory research performed by NRCC.

6) Through R&D work in NRCC, fueled by results of this Annex, the GSHP industry in Canada received a considerable boost. A clear indication of this fact is a lively cooperation between NRCC and Canadian GSHP companies and the large increase of their share in the market place.

7) Early work in this project has led to further research and novel applications including the use of ground source heat pumps for protecting permafrost below Arctic building foundations.

Primary Canadian Contact

Name: O.J. Svec **Affiliation:** IRC/NRCC **Telephone #:** (613) 993-3806

Project Title

3.10 Heat Pump Systems Applied in Industry

Duration	Responsible Dept.	Nature of Participation	Status
1981-1985	NRC/DME & EMR/ERL	Task & Cost Sharing	Completed

Direct Costs: Canada $100,000 Other Participants (8) $

Objective

- To evaluate international data on the experience and economics of industrial heat pumps and identify further applications of heat pump systems in industry.

Description

Reports were presented on thirteen operating heat pump systems and a synthesis report was prepared describing the state-of-the-art of industrial heat pumps, their economics and their R&D needs.

Organization of Canada's Participation

Canada provided information on an industrial heat pump application to the food industry. This heat pump demonstration project had been partly financed by NRC to investigate the potential and the operational problems of a heat pump waste heat recovery system in that industry. The company financial contribution approximately matched that of the federal government.

Benefits to Canada

This demonstration project, and many of those contributed by the other participating nations, was initiated at a time when industrial heat pump experience was very limited. The benefit from this exercise in general was that a good deal was learned of the very practical operational problems which arise in most industrial applications; most of the problems being process oriented. The experience gained, coupled with a period of reflection due to diminished demand for waste heat recovery resulting from depressed energy costs, has led to a much better understanding of requirements for future industrial applications. The international information pool was invaluable in this case.

This work formed the basis for establishing a focus for the current heat pump program which has led to the development of a steam generating industrial heat pump. Industrial, university, utility and government engineers and researchers subsequently organized into the National Heat Pump Coordinating Committee which oversees all current IEA work.

Primary Canadian Contact

Name:	Affiliation:	Telephone #:
I.R.G. Lowe	NRC	(613) 993-2439
M. Wiggin	EMR/CANMET	(613) 996-8870

Project Title

3.11 Heat Pump Information Centre

Duration	Responsible Dept.	Nature of Participation	Status
1982-ongoing	NRC replaced by EMR/CANMET in 1985	Cost Sharing	Ongoing

Direct Costs:	Canada	Other Participants (10)
	$72,500	$1,215,000
	$54,000 (net)	$ 890,000 (net)

Objective

- To promote the commercialization of heat pump technology by collecting, analyzing and distributing objective and reliable information to a wide variety of potential users.

Description

The Centre is active in two broad areas-information activity (including data collection and information dissemination) and analytical activity (including evaluation and analysis of collected information and preparation of value added information in reports).

Organization of Canada's Participation

Canada contributes financially as shown above. Twenty-five percent of Canada's contribution is rebated to be used for heat pump information activities in Canada. A National Heat Pump Coordinating Committee made up of representatives from across the heat pump community advises a Canadian national team on input to the IEA Heat Pump Agreement in general and to this project in particular. A member of the Canadian national team sits on the Heat Pump Information Centre Steering Committee.

Benefits to Canada

Heat pump information from this project is collected from both participating and non-participating nations and is distributed by two methods, the Heat Pump Information Centre Newsletter, and technical reports issued by the Centre. Canadian distribution is through the Canadian national team. The information provides the Canadian heat pump community with an up-to-date perspective of heat pump technology around the world. At the same time Canadian industry uses the Newsletter to report its achievements and capabilities to a world-wide audience. Participation in this project has also resulted in the better organization of the Canadian heat pump community through the National Heat Pump Coordinating Committee mentioned above. The national team is currently assembling a heat pump information data base which will be

Benefits to Canada (Cont'd)

available to Canadian heat pump interests and will be the Canadian input to an expanding IEA information bank. Analytical and market studies coordinated by the Centre spur examination of our own situation in the study context. Thus market opportunities, as well as pitfalls, are examined and the results disseminated nationally, exercises which might otherwise have been left undone.

Industry has commented that they benefit from the detailed description of applications that have not yet been demonstrated in Canada.

Primary Canadian Contact

Name:	I.R.G. Lowe	**Affiliation:**	NRC	**Telephone #:**	(613) 993-2439
	M. Wiggin		EMR/CANMET		(613) 996-8870

Project Title

3.12 Combustion Technology, Energy Conservation RD&D

Duration	Responsible Dept.	Nature of Participation	Status
1978-1992 (Third renewable Period)	EMR/TEB	Task Sharing	To be extended

Direct Costs: Canada $720,000* (In House "A" & PERD) NRC, & DND, RMC) Other Participants (7) $3.5M

Objective

- To conduct cooperative research, development, demonstration and exchanges of information regarding energy conservation in combustion in a shared program agreed among participating nations.

Description

Fundamental research, development and demonstration work is planned and shared in the areas of advanced piston technology, furnace and boilers, fundamental studies and supporting activities. Each area has sub-areas. Canada became an active member of this implementing agreement in 1985 reporting work in advanced Piston Technology (DND); Furnace and Boiler R&D (CANMET & NRC (Jet Engine Burner)) and in Fundamental Studies (NRC - Laser Diagnostic Measurements). The CANMET Work was transferred to the "Coal Combustion" IEA Agreement on its formation in 1986.

Primarily related to the concerns of combustion efficiency in reciprocating and continuous burn engines over the foreseen use of increasingly aromatic fuels derived from tar sands and heavy oil, the work covers the evaluation of Diesel Engines on future fuel compositions (DND Military Requirements) EMR Combustion Efficiency and Emissions) and the altitude effects of burn in jet engines (NRC & DND).* All work addresses these concerns and is NOT done solely for IEA. There are eight projects reported.

Fundamental work in the composition of fuels and their combustion properties is being made inclusive of laser diagnostic and modelling work of engine and combustion performance. The principal aim is to have researchers report and meet their confrères of other nationalities for a free interchange of research matters at scientist level. This is arranged annually with accompanying visits to the Host's national combustion research facilities.

Organization of Canada's Participation

Bi-annual meetings of research participants are held prior to the Agreement's spring Executive Meeting and the Task Leaders Meeting in the fall. A review of progress in research is requested for the spring meeting and participation is requested from NRC and DND for the Task Leaders Meeting to present R&D achieved. The meeting venues are hosted in rotation by member countries.

Benefits to Canada

In the three years of operation the benefits to Canada have been in the awareness of new non intrusive diagnostics, some benefits in discussing research approaches with overseas scientists and the exchange of ideas and results with overseas research in similar areas.

While the combustion R&D being carried out by NRC & DND was introduced into the IEA program in 1985, it was subject to severe financial reviews, restraints & cuts. At NRC scientific positions were reallocated to Space and other programs. Travel restrictions were such than NO SCIENTIST attended the 1985 Task Leaders Meeting in Tokyo and ONLY ONE SCIENTIST attended the 1986 Meeting. This failure to participate was the subject of comment in the Executive Committee - a pointed record being made in the 1985 & 1986 minutes.

These negative aspects of the Canadian activity are principally due to the work being operated from limited A-Base funds. Only one-twelfth of the activity had PERD Funding ($60K total) which was committed and not used for travel. This position was somewhat redressed in 1987 when Canada hosted the T.L.M. in Ottawa for four days. Fifty three scientists attended from nine countries, 46 papers were presented, four review and discussion groups held and two technical visits were made. This was therefore the opportunity to demonstrate Canadian scientific technical capabilities to the IEA member scientists. Eight Canadian papers were presented.

The lack of funding for scientist travel and interaction has somewhat negated the effectiveness of participation and consequent benefits. It is necessary to somehow ensure funding for attendance at the T.L.M. for participation.

Primary Canadian Contact

Name: Geoffrey Maund **Affiliation:** EMR/TEB **Telephone #:** (613) 996-5966

Project Title

3.13 Pulp and Paper Industry

Duration	Responsible Dept.	Nature of Participation	Status
1981-ongoing	EMR/CANMET	Cost Sharing/Task Sharing	Ongoing

Direct Costs: (to 86-12-31) Canada $792,000 Other Participants $2,800,000

Objective

- To encourage research, development and information exchange on energy conservation in the pulp and paper industry.

Description

This area of cooperative R&D is comprised of a number of independently subscribed-to projects. Canada has been involved in projects entitled:

TS* 1. Mechanical Defibration, Beating and Water Removal (with Norway, Sweden and U.S.A.);
CS 2. Pulverized Wood Combustion (with Norway, Sweden and U.S.A.);
TS 3. Improved Energy Efficiency in Paper Drying (with Sweden and U.S.A.);
TS 4. Heat Pumps in Pulp and Paper (with Norway and Sweden).

* TS = task-sharing; CS = cost sharing.

Organization of Canada's Participation

Projects 1, 3 and 4: Work carried out at the Pulp and Paper Research Institute of Canada (with partial funding from Canadian Government programs) and at various paper mills. Government representatives, major equipment suppliers, consultants and paper companies assisted in development of programs, providing linkages to both public and private sectors. Project 2 (cost-sharing): Work done at the International Flame Research Foundation (IFRF), IJmuiden, Netherlands. Canadian Technical Representative is Dr. A.C.S. Hayden, EMR/Canmet.

Benefits to Canada

Improvements in water removal (pressing) and drying have led to greater energy efficiency of paper machines at many Canadian mills and also allow higher production rates. (Quantitative estimate for whole industry difficult, but one mill calculated $100,000/yr. saving on drying steam alone, and additional benefits from increased production.)

The Norwegian work on the effect of chemical treatment in reducing energy required for the mechanical pulping of hardwoods has complemented our own in this research field.

Benefits to Canada (Cont'd)

Canada gained access to Swedish and U.S. research results on the fundamental principles of pressing and the role of the key pressing parameters, and to Norwegian and Swedish feasibility studies on heat pump applications. This pooling of data and operating experience has produced larger data bases than would otherwise have been possible.

The work on powdered wood combustion was done at the I.F.R.F. with equipment not available in Canada. A report on the experimental work and a videtape on full-scale application have laid groundwork for further improvement of this technology in Canada, which is already in use in at least one mill.

Information on the work has been sent to pulp and paper companies and equipment suppliers in reports printed in Canada with funding from the Federal government.

In addition to the work on specific projects, the Executive Committee considers that the network of personal contacts that has been established as a result of its work is extremely valuable. These contacts provide opportunities for exchange of technical information and discussion of problems as a basis for developing approaches to solving them.

Primary Canadian Contact

Name: D.W. Clayton **Affiliation:** Pulp & Paper Research Institute of Canada **Telephone #:** (514) 630-4105

Project Title

3.14 Alcohol Blends as Motor Fuels

Duration	Responsible Dept.	Nature of Participation	Status
1984-1988	EMR/TEB	Task & Cost Sharing	Ongoing

Direct Costs: Canada $35,000 Other Participants (5) $15,000

Objective

- To collect, classify and comment on data obtained by international experience in the production and use of alcohol and alcohol blends as motor fuels; and

- To develop guidelines that could be used in choosing national strategies for replacing motor fuels in whole, or in part, by alcohol.

Description

The results of this work have been assembled in a recently published report. Further activities are planned within this collaborative project concerning alcohols production, data sharing on methanol buses field trials and the relative status of the technology with respect to potential markets. The Canadian "Methanol In Large Engines" project will form part of this international collaboration.

Organization of Canada's Participation

Canada's participation was mainly researching activities in alcohol fuel in Canada from all sources and providing the said data to the operating agency. We were also involved in providing supply and demand technical and economic data and in reviewing and approving the draft and final reports. Linkages with methanol producers, vehicle manufacturers, provincial and other federal departments were established and maintained.

Benefits to Canada

The report (3 volumes) has been widely distributed in Canada and has provided an excellent reference book for alcohol interests. Canada could not have produced such a comprehensive report alone. The nature of the transportation industry is international requiring such world wide perspectives.

The main benefit to Canada has been the expansion of the data base and the implementing of additional annexes.

Transportation is a universal requirement and international cooperation in development of alternatives is essential. We have seen mutual advancement in such concepts as Flexible Fuel Vehicles, lubrications for alcohol engines and improved air quality through alcohol use.

Benefits to Canada (Cont'd)

The real benefits are yet to come as we demonstrate to our IEA colleagues our capabilities in alcohol fuels. Additionally, we will benefit from extensive R&D in other countries on emission control systems for alcohol fuel and avoid duplication of effort.

Primary Canadian Contact

Name: B.A. James **Affiliation:** TEB **Telephone #:** (613) 996-5965

Project Title

4.1 Coal Technology Information Centre

Duration	Responsible Dept.	Nature of Participation	Status
1975-ongoing	EMR/CANMET	Cost Sharing	Ongoing

Direct Costs: Canada $120,000/yr Other Participants (12) about $3M/yr

Objective

- To provide information and economic assessment services to member countries on all aspects of coal technology.

Description

IEA Coal Research is headquartered in offices in London, U.K., and is under the guidance of British Coal. Member countries second experts to the staff. Studies are approved by the Executive Committee in the areas of coal science and utilization; mining, geosciences and coal handling; supply, transport and markets; coal and the environment.

Organization of Canada's Participation

Annual membership fee represents less than four per cent of project budget. Information is disseminated to Canadian interested parties by the CANMET Technology Information Division. EMR provides member of the Executive Committee and also sends a delegate to technical committee meetings.

Benefits to Canada

Major benefit is on-line access to Coal Data Base with over 90,000 entries. This is used widely in Canada. Studies are widely distributed and provide authoritative references for Canadian coal producers and users. Papers are also used by the Coal Division to develop background positions relating to coal use in Canada. A recent example is a study entitled "The Cost and Availability of Canadian Coal", 105 pages.

Primary Canadian Contact

Name: D.A. Reeve **Affiliation:** CANMET/ERL **Telephone #:** (613) 996-4570

Project Title

4.2 Atmospheric Fluidized Bed Combustion

Duration	Responsible Dept.	Nature of Participation	Status
1980-1990	EMR/CANMET	Task Sharing	Ongoing
Direct Costs:	Canada $10,000/yr	Other Participants (8)	$150,000/yr

Objective

- To demonstrate the technical feasibility, reliability and economics of employing the AFBC technique in boilers and thus provide design and operating experience for wide application.

Description

This project involves twelve IEA countries with established national AFBC programs on the design, construction and operation of AFBC boilers. Each country has agreed to share information and experience on technical feasibility, reliability and economics. Canada's major contribution is the information from the AFBC at Summerside, P.E.I. The results to date have led to an improved understanding of the possibilities of FBC and of the design of fluidized bed boilers. This cooperation was deemed most useful by the participants and as a result the original agreement was extended in 1985 for five more years to 1990.

Organization of Canada's Participation

CANMET serves as Canada's representative and attends the formal technical meetings. CANMET periodically hosts meetings in Canada which are structured to include participation by industry, academic and government experts.

Benefits to Canada

Information exchange provides the primary benefit to Canada. This is achieved via biennial technical meetings to critique data from participants on the design, operational experience and the results of performance tests. Between meetings informal technical presentations and seminars are held and reports are exchanged among interested parties. Plant visits are also arranged where appropriate.

Particular benefits have accrued to Canada through unpublished data which contributed to the resolution of fluidization and steam tube erosion difficulties encountered at the demonstration projects at Summerside and Chatham. A mathematical modelling sub-group of the IEA has generated refinements to the CANMET FBC mathematical model and is working with CANMET to validate the model and to use it as a "standard" for use on a wide range of FBC facilities. The information obtained through the various meetings is disseminated to Canadian industry and government bodies on a regular basis via seminars under auspices of technical societies and universities.

Primary Canadian Contact

Name: F.D. Friedrich **Affiliation:** CANMET/ERL **Telephone #:** (613) 996-4570

Project Title

4.3 Coal/Liquid Mixtures (CLM)

Duration	Responsible Dept.	Nature of Participation	Status
1981-1986	EMR/CANMET	Task Sharing	To be extended

Direct Costs: Canada $25,000 Other Participants (7) $200,000

Objective

- To assess the potential utilization of coal/oil and coal/liquid mixtures in participating countries and to develop a cooperative plan.

Description

This cooperative project involves the pooling of experience and results from the national CLM programs within the participant countries. The Canadian participants are engaged in seven tasks in the area of CLM:

i) design, construction and operation of a coal-water fuel (CWF) preparation plant;
ii) development of CWF burners for utility boilers at Chatham, New Brunswick and at Charlottetown, P.E.I.;
iii) coal-water fuel dusting assessment of oil-designed utility boilers;
iv) fluidized bed combustion of CWF;
v) spherical agglomeration applied to CLM's;
vi) development of CLM burner tip and assembly;
vii) coal-liquid mixture combustion parameters.

Organization of Canada's Participation

Canada was one of the founder members (with USA and Japan) of the agreement which has grown to include eight countries. Annex I, a survey in six countries of the potential for CLM conversions and supply, was completed in 1983. Annex II, a technology exchange, comprises seven countries and includes task shared projects. In each country, government and industry representatives include reports on specific CLM activities. Past Canadian contributions have included work at (a) NB Power in the areas of transportation and use of CWF in boilers, (b) Cape Breton Development Corporation on CWF preparation, (c) Canada Cement Lafarge on Industrial CWF conversion and (d) NS Power Corporation on the economics of CWF conversions. Canada was operating agent of Annex II in 1986.

Benefits to Canada

Participation in this agreement gives Canada pre-publication access to RD and D activities in the participating countries, particularly Italy and Japan which have strong programs. The task-shared activity which is reported on at the "hands-on" level via contractors is further enhanced by special topic meetings and site visits.

Benefits to Canada (Cont'd)

Canada has been emphasizing boiler applications and has benefitted through exposure to the US gas turbine and diesel programs, pipelining studies in Italy, novel burner concepts in Sweden and alternative boiler configurations in Japan.

This larger data-base is extremely cost-effective from Canada's viewpoint even though we initiated the first commercial conversion to CWF (Canada Cement Lafarge) and were the first to establish that derating of oil-designed units was negligible (Charlottetown) when firing CWF. These achievements have placed Canada's CLM program in the forefront of this technology despite its relatively modest funding. Recently, Canada was invited to play a leading role at a recent IEA CWF Technology Assessment Workshop in Italy.

Primary Canadian Contact

Name: H. Whaley **Affiliation:** CANMET/ERL **Telephone #:** (613) 996-4570

Project Title

4.4 Low Nitrogen Oxides Coal Burner

Duration	Responsible Dept.	Nature of Participation	Status
1980-ongoing	EMR/CANMET	Task & Cost Sharing	Ongoing
Direct Costs:	Canada $455,000	Other Participants (3)	$1,205,000

Objective

- To assess the application of low NOx coal combustion technology to non-U.S. coals;
- To define the level of NOx control likely to be achieved;
- To determine the performance of the EPA Distributed Mixing Burner; and
- To assess the level of control of emissions of sulphur dioxide which will be possible when a burner is operated to minimize NOx emissions.

Description

Nine Canadian coals have been tested for NOx generation and the results have been validated in pilot scale burns. The next phase of this program will see trials conducted on three different size full-scale plants. As a result of the experience gained during the first five years of this project, the participants have now decided to provide each other with the technical data resulting from the installation of a number of low NOx burners with sorbent injection in boiler installations ranging from 17 MWt to 400 MWt in the four countries concerned.

Organization of Canada's Participation

CANMET represents Canada, funds Canada's contribution and coordinates industrial and government input into the Agreement. CANMET/DND are performing trials on a 17 MWt heating boiler at CFB Gagetown and Ontario Hydro is performing trials on a 100 MWe utility boiler for exchange with the participating countries.

Benefits to Canada

1) Confidential access to (a) theoretical maximum NO_x production data from 45 coals from around the world (b) design concepts for in-furnace and external burner staging for NO_x and SO_x control (c) a validated three-dimensional computer model for optimizing NO_x/SO_x suppression in pulverized-coal boilers and (d) original data on the influence of furnace size on NO_x formation.

   This information has been applied in demonstration projects in Canada which have been co-funded and technically supported by EMR. Examples are the 150 MWe boiler demonstration at Saskatchewan Power Corporation with low-sulphur lignite ($2.3 M project) and the 17 MWt demonstration at CFB Gagetown with high-sulphur Maritime coal ($1.0 M project).

Benefits to Canada (Cont'd)

2) Opportunity to demonstrate Canadian technology designs and expertise to potential foreign clients, based on knowledge generated to date which is more advanced than in other industrialized countries.

3) Comparison of foreign technology economics and effectiveness in suppressing acid rain emissions so that Canadian manufacturers can better compete on international markets.

4) Accelerating the application of R&D results to operational boilers. At present Ontario Hydro's Lakeview unit is being evaluated, under a joint Canada/Denmark Annex to this Agreement, to assess novel technology for reductions of acid rain emissions without impacting on boiler efficiency.

Primary Canadian Contact

Name: G.K. Lee **Affiliation:** CANMET/ERL **Telephone #:** (613) 998-0398

Project Title

4.5 Coal Combustion Sciences

Duration	Responsible Dept.	Nature of Participation	Status
1985-1988	EMR/CANMET	Task & Cost Sharing	Ongoing
Direct Costs:	Canada $600,000	Other Participants (5)	$1,200,000

Objective

- To investigate advanced analytic techniques and cooperate in basic and applied research in the field of coal combustion sciences; and

- To facilitate basic and applied research in the field of environmentally favourable coal combustion.

Description

This collaborative program is aimed at understanding the fundamental reaction taking place in coal conversion processes. The research is done at the Sandia National Laboratory, USA, and at the International Flame Research Foundation (IFRF) in the Netherlands.

Organization of Canada's Participation

CANMET co-funds Canada's contribution with the Alberta Office of Coal Research and Technology (AOCRT) and the Canadian Electrical Association (CEA) on a 50:25:25 basis. The three agencies also collaborate in a task shared program with seven other countries under this Agreement. The Canadian interests are priorized by a Technical Committee of the three co-funding agencies.

Benefits to Canada

1) Access to proprietary combustion data, not available through any other sources, on foreign coals which compete with Canadian export coals. These data have been instrumental in establishing Canadian export coals in western Europe.

2) Access to novel burner design criteria for suppressing acid rain precursors during combustion and validation on data technology of interest to, but otherwise not in, the public domain. One key development is a novel burner for enhancing sulphur capture with internal air staging.

3) Development of analytical procedures for potential as "standardized" techniques by which coals on the international market would be evaluated for combustion efficiency. Canada has nominated three of the twelve coals being evaluated under this cost shared program and a western Canadian coal is being seriously considered as the reference standard for combustion properties.

Benefits to Canada (Cont'd)

4) Participation in programs which could not be funded in Canada because of funding constraints and research limitations. CANMET and the Alberta Research Council have sent scientists to foreign laboratories for training on laser measurement techniques and the Canadian Electrical Association has sent personnel to the International Flame Research Foundation in Holland for special combustion research training as part of the Agreement.

Primary Canadian Contact

Name:	H. Whaley/	**Affiliation:**	CANMET	**Telephone #:**	(613) 996-4570
	G.K. Lee		CANMET		(613) 998-0398

Project Title

4.6 International Conference on Coal Science

Duration	Responsible Dept.	Nature of Participation	Status
1981–ongoing	EMR/CANMET	Cost Sharing	Ongoing

Direct Costs:	Canada $40,000 (3 conferences)	Other Participants (N/A)	$775,000 (est) (8 other countries)

Objectives

- To stimulate interest in coal science; and
- To provide the coal science community with an additional focus for intercommunication.

Description

This is a biennial conference sponsored by the IEA. The third in this series was held in Sydney, Australia in October 1985. It was attended by over 450 participants from 23 countries. The next conference will be held in Maastricht, Netherlands in October, 1987. Two hundred and twenty-eight papers will be presented in eight fields of coal research.

Organization of Canada's Participation

Canada is represented on the International Organizing Committee (IOC) of the International Conference on Coal Science by CANMET. The IOC meets annually to organize and select papers for the conference. Canadian funding for conferences has been provided by EMR through the Office of Energy Research and Development, class grants and contributions and from the ADM office reserve fund. Canadian scientists from industry, research foundations, universities and government laboratories participate in the conference.

Benefits to Canada

The conference provides a scientific forum for the exchange of research information on the following topics: coal beneficiation; coal combustion; pyrolysis; basic coal science; coal liquefaction; gasification; basic coal science; coal structure and characterization. Co-sponsoring the conference allows for Canadian participation and an opportunity to demonstrate our own scientific and technological capabilities to an international audience, as well as the opportunity to compare our capabilities and technologies to that of other countries. It enables Canada to determine priority areas as well as to identify areas suitable for collaboration, in which further energy R&D is then initiated.

Primary Canadian Contact

Name: John Price **Affiliation:** CANMET/ERL **Telephone #:** (613) 996-4570 Ext. 191

Project Title

4.7 Enhanced Oil Recovery

Duration	Responsible Dept.	Nature of Participation	Status
1979-1986	Petroleum Research Institute	Task Sharing	Extension
1987-1988	EMR Class Contribution		under review

Direct Costs: Canada $75,000 Other Participants (8) $

Objective

- To carry out fundamental studies, laboratory experiments and field tests on various techniques for the enhanced recovery of oil, with a view to applying the techniques developed to new and existing oil reservoirs, consistent with economic and environmental considerations.

Description

The participants in this project have undertaken to share their research, development and demonstration knowledge and experience. The areas adopted cover studies of fluids and interfaces in porous media, fundamental research on surfactants and polymers, the development of techniques for miscible flooding and thermal recovery techniques for heavy oil.

Organization of Canada's Participation

The Petroleum Recovery Institute (PRI) an independent non-profit organization formed in 1966 to conduct research on enhanced oil recovery (EOR) and located on the campus of the University of Calgary, has represented Canada under an International Energy Agency (IEA) program for EOR since 1979. The contracting parties include Austria, Canada, Germany, Japan, Norway and the United States.

Benefits to Canada

EMR has funded PRI indirectly through the Alberta-Canada Energy Resources Research Fund (ACERRF) while in addition providing travel expenses once a year to IEA meetings for two scientists to present papers. For this seed money and support under ACERRF, PRI has been willing to represent Canada at the IEA in addition to the benefits derived from technical and scientific exchanges with the signatories to the IEA agreement. A request for a class contribution for 1988-89 for the same amount is currently before Treasury Board.

Primary Canadian Contact

Name: Jim Hea **Affiliation:** EMR **Telephone #:** (613) 995-0054

Project Title

5.1 Performance Testing of Solar Collectors

Duration	Responsible Dept.	Nature of Participation	Status
1977-1987	NRC replaced by EMR/REB in 1985	Task Sharing	Ongoing

Direct Costs: Estimated to date Canada $150,000 Other Participants (15) $2.0M

Objective

- To assist in the development and utilization, on an international level, of common test procedures for rating the performance of a broad class of collectors for use in solar heating and cooling applications.

Description

Under this project test procedures have been developed to determine thermal performance of solar collectors, formats were developed for reporting the inspection of collector systems in operation and solar simulator performance has been improved to the point they are now widely used through out the world. Upon extension of this project in 1982 new emphasis was placed on characterization of the thermal performance of solar collectors, development of capability to evaluate solar domestic hot water system performance using short-term test methods and development of a basis for identifying the performance requirements and for predicting the service life of solar collection system components.

Organization of Canada's Participation

Canada's participation until 1985 was carried out at the Solar Calorimetry Laboratory of the Division of Building Research at NRC. Since 1985, when EMR/REB assumed responsibility for R&D in this field, the Solar Calorimetry Lab, along with the professional and technical support was transferred to the Queen's University Faculty of Engineering. Panel funds have been used to effect the transfer and continue the activity.

Benefits to Canada

1) The results of this work are reflected in the Canadian Standards and test methods developed for solar collectors and solar systems.

2) By having such standards which incorporate internationally accepted procedures the Canadian solar products have achieved an excellent reputation in the domestic and world markets. Canadian manufacturers have been successful in exporting their products to the U.S. and elsewhere.

Primary Canadian Contact

Name: S.M. Pnevmaticos **Affiliation:** EMR/REB **Telephone #:** (613) 995-2456
S. Harrison Queen's University (613) 547-6170

Project Title

5.2 Development of An Insolation Handbook and Instrument Package

Duration	Responsible Dept.	Nature of Participation	Status
1977-1980	EC/AES	Cost Sharing	Completed

Direct Costs: Canada $20,000 (estimate) Other Participants (9) $

Objective

- To obtain improved basic information for the design and operation of solar heating and cooling systems through a better understanding of the required insolation, related weather data and through improved techniques for the measurement and evaluation of such data.

Description

This objective was achieved by the compilation of a meteorological measurements handbook and through the development of design and performance specifications for an instrumentation package for measuring insolation and other meteorological data.

Organization of Canada's Participation

Membership in the Task.

Benefits to Canada

Standards for on-site meteorological measurements at solar collector sites were specified and have been used in Canada.

Primary Canadian Contact

Name: Dr. Don McKay **Affiliation:** Atmospheric Environment Service **Telephone #:** (416) 667-4812

Project Title

5.3 Use of Existing Meteorological Information for Solar Energy Application

Duration	Responsible Dept.	Nature of Participation	Status
1977-1982	EC/AES	Cost Sharing	Completed

Direct Costs: Canada $20,000 (estimated) Other Participants (11) $

Objective

- To determine the quantitative relationship between measurements of solar radiation and other relevant meteorological parameters.

Description

Information on data sources from about eighty countries has been transferred to magnetic tape and tabulated in the "Solar Radiation Data Source Catalogue" which contains information on measuring period, instrument type, administrator of the station and frequency of daily meteorological observations. Two additional publications resulted from this work - "Handbook on Methods of Estimating Solar Radiation" and "Recommendations Concerning Meteorological Networks".

Organization of Canada's Participation

Membership on the Task.

Benefits to Canada

Unknown

Primary Canadian Contact

Name: Don McKay **Affiliation:** Atmospheric Environment Service **Telephone #:** (613) 667-4812

Project Title

5.4 Evacuated Tubular Collector Systems Performance

Duration	Responsible Dept.	Nature of Participation	Status
1979-1987	NRC replaced by EMR/REB in 1985	Task Sharing	Being completed

Direct Costs: Estimated to date Canada $100,000 Other Participants (9) $1.5M

Objective

- To develop further understanding of the performance of evacuated collectors in solar heating, cooling and hot water systems; and

- To compare the performance characteristics of such collectors in various systems and climates, particularly in industrial process heating.

Description

Each participant was responsible for the operation and analysis of at least an evacuated collector solar heating and/or cooling installation. By the end of 1985 all the objectives of the experimental phase of the research had been essentially accomplished. The cooperation will continue to extend task system performance modelling to other collectors and applications, to extrapolate the performance of systems to other climates and to disseminate task results to other solar energy scientists and to practitioners.

Organization of Canada's Participation

Canada's participation was carried out jointly by NRC and Professor Chandrashekar of the University of Waterloo, Department of Systems Engineering, until 1985. Since then it has been carried out by Prof. Chandrashekar on contract to EMR/REB using panel funds. The task is finishing at the end of 1987. A successor task to start in 1988 and cover advanced collectors will be carried out by INRS Énergie of Montreal on behalf of EMR/REB.

Benefits to Canada

1) This has been valuable to Canada because the evacuated collector technology has special merits in cold northern climates. The technical performance of various systems was confirmed. The evacuated tube technology was judged most promising for Canada.

2) A Montreal company has recently purchased the production technology for the Philips evacuated tubes. They are trying to develop special solar products which require this sophisticated technology such as desalination or refrigeration systems for the export market.

3) Canada's participation resulted in our industry's awareness of the several evacuated collector technologies being developed in Europe, the U.S. and Japan.

Primary Canadian Contact

Name: S.M. Pnevmaticos **Affiliation:** EMR/REB **Telephone #:** (613) 995-2456

Project Title

5.5 Centralized Solar Heating Plants With Seasonal Storage

Duration	Responsible Dept.	Nature of Participation	Status
1979–1988	NRC replaced by EMR/REB in 1985	Task & Cost Sharing	Ongoing

Direct Costs:	Canada $500,000 (contracts) Expenses (computertime, travel, etc.) $54,000 17 person months	Other Participants 1980–82(10) 1983–85(7) $3.5M, 110 person months

Objective

- To investigate the feasibility and cost-effectivness of central solar heating plants with seasonal storage and to test in practice the performance of real systems and to evaluate this information cooperatively.

Description

In general, the initial studies have concluded that there are local climatic and economic environments in which central solar heating plants with seasonal storage are already attractive. Where energy costs are high, these systems offer a viable means of achieving substantial displacement of non-renewable energy sources.

Organization of Canada's Participation

NRC and CMHC were involved in drafting the annex and defining the objectives of our participation. NRC, CMHC and PWC provided experts to work in the various subtasks and any deficiencies were filled by hiring specialists. An overall management contract was in force throughout the period providing quick response to tasks outside the government system and also some technical expertise.

When the focus shifted to constructing, monitoring and evaluating actual projects the consultants to PWC, who were involved in the design and operation of our Scarborough aquifer storage project, became more active. This was organized under one DSS contract to PWC which covered several firms grouped into one consortium. This arrangement continues to this day.

Benefits to Canada

1. When we got involved in the project, there was underway within Canada a movement to build a central solar heating plant with seasonal storage. In retrospect, we were not able to properly design such a system because of inadequate knowledge. Participation in an IEA project forced on us a disciplined evaluation with others in a similar position. We thus probably avoided a costly mistake and now could design an efficient system if called upon to do so.

Project Title

5.7 Solar Radiation and Pyranometry Studies

Duration	Responsible Dept.	Nature of Participation	Status
1982-1986	NRC replaced by EC/AES in 1985	Task Sharing	Extension under review

Direct Costs:	Canada	Other Participants (10)
	$845,000 (MV $545,000, P $300,000*)	$995,000 (estimated) (MV $240,000, P $775,000*)

Objective

- To demonstrate improvements in irradiance measurement for solar collector testing that can be achieved with detailed characterization of pyranometer responsiveness.
- To evaluate solar radiation simulation models for estimating hourly solar irradiance amounts.
- To gather information on small scale spatial variations in solar irradiation observations.

Description

During 1985 all the information required for the report on small-scale time and space variability of solar radiation was collected and a draft report containing the pertinent information was distributed for review and comment. A mini-validation exercise in the solar radiation model validation subtask was completed and the results distributed to the participants. The first round-robin of pyranometer characterizations was completed and all pyranometers were returned to Canada, the lead agent, for calibration.

Organization of Canada's Participation

Canada (Environment Canada) was operating agent and provided Sub-task leaders for two of the three sub-tasks (Model Validation and Pyranometry*).

Benefits to Canada

Canada's scientific reputation was enhanced with a successful leadership role in major projects.

The solar radiation simulation model used by Environment Canada was verified as one of the best available to IEA member countries. Areas for improvements have been identified and implemented as a result of this work. The quality of Canadian solar resource design information has improved.

Benefits to Canada (Cont'd)

Canadian techniques in radiation measurement have received international recognition and some of them are now the bases for the defined procedures written by the International Standards Organization. New and improved practices in pyranometry have been implemented in Canada resulting in better solar radiation observations and improved solar collector testing. Differences in radiation measurement between countries, which had been as much as ten percent, have been greatly reduced. Much of this progress was possible only through the large pool of expertise and experience available within the IEA participating countries.

Canadian hardware for the measurement of solar radiation was developed in cooperation with the private sector as a result of this work and significant sales have occurred in offshore markets.

Primary Canadian Contact

Name: David Wardle **Affiliation:** Atmospheric Environment Service **Telephone #:** (416) 667-4834

Project Title

5.8 Solar Materials R&D

Duration	Responsible Dept.	Nature of Participation	Status
1985-1990	EMR/REB	Task Sharing	Ongoing

Direct Costs: Estimated to date Canada $15,000 Other Participants (9) $300,000

Objective

- To contribute to the cost-effectiveness of solar energy systems by supporting the development of materials which can result in better performing, more durable and more reliable system components.

Description

The following four categories of materials will be given priority: collector and window glazing, collector absorber materials and coatings, heat transfer media with and/or without additives and thermal energy storage materials. The four activity areas considered of particular interest are: performance levels and evaluation criteria for selecting materials, test procedures and measurement techniques, service life prediction methods and failure and degradation modes.

Organization of Canada's Participation

Canada's participation in this task is through the work of Professor Terry Hollands of the University of Waterloo, Department of Mechanical Engineering. T. Hollands is project leader for the Centre of Expertise in Solar Thermal Research located at the University. Funding for this centre is provided through EMR/REB using Panel funds.

Benefits to Canada

1) The task leadership for this activity is provided by the Japanese.

2) It is a very important task because it is recognized that unless major breakthroughs are achieved in cost effectiveness, solar energy for heating and cooling will not be widely adopted.

3) The scope of this task is very broad and it would be prohibitively expensive to undertake in one country. Through this international cooperation, it is hoped that major improvements can be made in technical and cost performance of solar systems over the next 5-10 years.

Primary Canadian Contact

Name: S.M. Pnevmaticos **Affiliation:** EMR/REB **Telephone #:** (613) 995-2456
T. Hollands Univ. of Waterloo (519) 888-4053

Project Title

5.9 Biomass Technical Information Service

Duration	Responsible Dept.	Nature of Participation	Status
1976-1986	NRC	Cost Sharing	Canada withdrew 1986

Direct Costs: Canada $ Other Participants (14) $

Objective

- To collect and disseminate information relating to all aspects of biomass energy including cultivation, harvesting, materials handling, conversion techniques and environmental and economic aspects.

Description

This objective is achieved primarily through the publication of a bimonthly abstract bulletin "Biomass Abstracts". A specially developed Thesaurus of terms in use in the area of biomass energy is also produced. In addition, the Service also publishes several retrospective literature searches on specific biomass topics annually.

Organization of Canada's Participation

The National Research Council was designated by the Government of Canada to be the Contracting Party which would take part in the establishment and operation of the Biomass Conversion Technical Information Service (BCTIS) as outlined in the IEA Implementing Agreement signed in 1978. Until Canada's participation in the Agreement ceased in 1986, the Canadian Institute for Scientific and Technical Information, as part of the National Research Council, played an active role in BCTIS by providing:

- representation on its Executive Committee
- Canadian input to Biomass Abstracts and to the Retrospective Searches
- a point of contact for Canadian users of BCTIS
- promotion and distribution of BCTIS publications
- a reference and lending service for BCTIS publications

Benefits to Canada

Participation in the program ensured that: Canadian publications would be part of the major bibliographic tool for biomass literature, thereby maximizing the awareness of and distribution of the results of Canadian biomass research and development throughout an international community.

Canadian researchers in biomass energy would have access to specialized information services in their field. Canadian researchers would be consulted on the nature and content of bibliographic tools.

Primary Canadian Contact

Name: Susan Suart **Affiliation:** NRC/CISTI **Telephone #:** (613) 993-9637

Project Title

5.10 Forestry Bioenergy (changed to Bioenergy as of January 1, 1986)

Duration	Responsible Dept.	Nature of Participation	Status
1978-1985 Forestry Energy	AC/CFS & EMR/REB	Task & Cost Sharing	Ongoing
1986-1988 Forestry Bioenergy 1989-1991 New bioenergy agreement in planning stages - appears almost certain to be agreed upon shortly			

Direct Costs:	Canada $	Other Participants (12) $
	- 1978-1985 inclusive - $509,000 - 1986 - $172,000 - current (1987) annual contribution - $172,000	(currently 12; numbers have varied over the life of the agreement) - 1978-1985 (estimated) - $2,500,000 - 1986 - $1M - current (1987) annual budget - $1,006,500

(Note: Canada was one of 4 founders of this agreement and was for several years, along with Sweden and USA, designated as a "major participant". This special status was abolished in 1985 in favour of a system whereby all countries contribute to the agreement tasks (annexes) at a level commensurate with their interest in the activities within each of those tasks. Canada is presently (1987) contributing 17% of the total, down from an estimated 25% or more in the early years of the agreement.)

Objective

To establish increased collaborative research, development and exchange of information concerning the use of short rotation forestry species and forestry residues to produce clean fuels, petrochemical substitutes and other energy intensive products.

Description

The work under this agreement has been, and continues to be, concentrated in three areas: growth and production; harvesting, on-site processing and transportation; and conversion. Each of these areas comprises about 10 projects. Canada is "lead country" for the first of these and an active participant in all three. Each of these areas is the subject of a separate Annex and is primarily carried out on a task sharing basis.

In the area of growth and production, collaborative efforts have been concerned with genetic improvement, evaluation and propagation of fast-growing tree species, understanding their growth process and the development of appropriate management regimes. In the area of harvesting, on-site processing and transportation, work has emphasized techniques for obtaining biomass for energy from small trees, logging residuals, and logging residues in conjunction with conventional forest

Description (Cont'd)

management, as well as techniques for establishing and harvesting short rotation forest energy crops. The long-term effects of intensive harvesting and biomass removal for energy purposes on site productivity have also received attention. In the area of conversion, a variety of processes that have promise as economical and environmentally acceptable means to obtain energy in various forms from woody biomass have been studied; processes include direct combustion, pyrolytic and catalytic liquefaction, and biochemical pre-treatment and conversion.

Organization of Canada's Participation

The Canadian Forestry Service (CFS) is the contracting party for Canada in the Forestry Energy (Bioenergy) Agreement. The CFS provides Canada's member on the Agreement Executive Committee; the Alternate member is from EMR/REB. Canada is presently Vice-Chairman of this Committee, and is expected to assume chairmanship in 1988.

Joint projects are developed, managed and coordinated through a series of Operating Agents (one for each of the three tasks) designated by the "lead country" for each task (Canada, Sweden and U.S.A.) Each Operating Agent is assisted by a Technical Committee made up of representatives (scientific and technical specialists) from each country participating in that particular task. The CFS currently provides Technical Committee members for the growth and production and harvesting tasks, and EMR/REB does the same for the conversion task.

Canada's participation in specific activities within each task reflects CFS and EMR/REB assessments of R&D needs and opportunities, and is strongly influenced by advice received from CFS and EMR Advisory Committees representatives.

Conversion activity links in cooperative research and information exchange were, by and large, through public R&D institutions and universities rather than with the private sector. Two reasons attributing to this were that most of the cooperative R&D was of a longer term nature that did not attract the immediate interest of commercial entities, and secondly, that information exchange among scientists in the public sector was perceived to be more open than if the private sector was involved. However, toward the end of the Forestry Energy Agreement, and in the revised Bioenergy Agreement that replaced it in 1986, there appeared to be a trend toward increasing private sector interest and participation.

One project was unique in that the international team or working group that was set up to perform a techno-economic assessment of liquefaction technologies was not comprised of the researchers themselves, but external experts without vested interest of advocacy in any of the technologies examined.

Benefits to Canada

The benefits to Canada (in approximate order of importance) from participation in the Forestry (Bioenergy) Agreement are:

1) We are able to obtain timely and detailed information on bioenergy production and conversion technologies of potential importance to Canada; this information would otherwise only become available to us

Benefits to Canada (Cont'd)

over a much longer time frame, in less detail, and/or at significantly greater cost; for example, several planting and harvesting machines developed in Scandinavia have become available to us by this means and have subsequently been adapted for use under Canadian conditions;

2) We are able to participate in a variety of research projects and exchanges of information at a significantly reduced cost and which, in many cases, we would be unable to fund independently; our contribution in effect "buys" us into R&D related activities valued at five or more times our direct costs;

3) We are able to demonstrate and transmit Canadian scientific and technical know-how to an interested and receptive audience, and thereby enhance the possibilities of commercial export of Canadian technology; several conversion technologies, as well as a technique for modelling long-term environmental effects from intensive biomass removal, in which Canada is a world leader, are cases in point. Canada's lead in these areas is not only apparent because of the IEA links, but is partially due to these links as well.

4) Through international pooling of data and test materials, we are able to obtain much more complete and reliable data bases than would otherwise be possible; this is particularly important in fields such as genetics and biotechnology, where the long time periods and complex methodologies involved in selecting, breeding and mass-propagating fast-growing, disease resistant energy crops can be significantly shortened and simultaneously made more reliable; selection of alders, willows and poplars for use in energy plantations in Canada has been materially advanced by this means;

5) We are able to much reduce the chances of "re-inventing the wheel" through ready access to larger data bases, access to results in other countries which may enable us to rule out certain technologies as inappropriate for Canada, and participation in broader (and hence more reliable) comparisons of technology options; proceedings of several IEA-sponsored conferences have provided excellent state-of-the-art summaries that have proven most useful as guides to future Canadian R&D programs.

6) We are able to accelerate the application of R&D results and to gain access to working teams from our IEA collaborators that would not otherwise be available to our national program. An example is the direct biomass liquefaction project where Canada's strength in primary pyrolysis oil production is complemented by the USA and Sweden in determining technical feasibility to upgrade Canadian oils to transportation fuels. The international working group performs a complete techno-economic assessment with technical oblique cost improvement suggestions to the researchers.

7) We are able to use the IEA as a framework and forum to gather experts from many countries to participate in voluntary biomass standards development, especially for analytical methods related to biochemical and thermochemical conversion of biomass.

Primary Canadian Contact

Name: Dr. Graham Page **Affiliation:** CFS **Telephone #:** (613) 997-1107 (ext. 9327)
Dr. Allan Dolenko EMR (613) 996-6162

Project Title

5.11 Peat Production and Utilization

Duration	Responsible Dept.	Nature of Participation	Status
1984-1988	NRC	Task & Cost Sharing	Canada withdrew 1986

Direct Costs: Canada $100,000 (approx.) Other Participants (2) $100,000 (approx.)

Objective

- To obtain, assess and treat pertinent information, to accomplish state-of-the-art studies, and to work out plans for future cooperative RD&D in the field of peat production and utilization.

Description

Collaboration is concentrated into five specific areas: milled peat and sod peat, fundamentals in peat dewatering, peat dewatering techniques, peat classification and standards and peat information exchange. Cooperation in this activity is largely on a task-sharing basis. Canada withdrew from this project in 1986 upon termination of the energy R&D program at NRC.

Organization of Canada's Participation

The participants for Canada were the peat program manager and his designated alternatives. Linkage to the ongoing Canadian program was through the peat forum that united the federal agencies involved. The program was terminated before significant industrial or contractor community involvement could be established.

The Canadian contributions were around peat dewatering fundamentals and included a contract of $56K to A.L. Burwash Consulting to prepare a report ("Final report on investigation of transferable technology for application in peat dewatering research." NRCC 24475), and support (approx $35K) for a workshop on peat dewatering fundamentals held as part of the 1985 Riviere du Loup CNC-IPS conference. This resulted in a publication "Peat and Water: aspects of water retention and dewatering in peat" (editor C.H. Fuchsman; published by Elsevier Applied Science Publishers).

Benefits to Canada

1. Access to data, information data banks, technologies, and facilities that we did not have in Canada. This supported the research community (mainly contract) involved in the program at that time.

Project Title

5.18 Hydrogen Storage, Conversion and Safety

Duration	Responsible Dept.	Nature of Participation	Status
1983-1986	NRC replaced by EMR/TEB in 1985	Task Sharing	Extended to 1988

Direct Costs: Canada $1,676,000 Other Participants (5) $9,273,000

Objective

- To study practical questions connected with hydrogen energy end-use, including hydrogen storage, energy conversion and overall safety.

Description

Particular emphasis has been put on the various techniques of hydrogen storage in various chemical and physical forms. These technologies include storage in metal hydrides, the use of the magnetocaloric effect in solid ferro-and paramagnetic materials and storage in glass micro-capsules.

Organization of Canada's Participation

NRC managed Canada's participation in this Task up to 1985. Projects were contracted out to industry and universities. Some work was done in-house. EMR took over management of Canada's participation in 1985. Work is conducted through the Centre for Hydrogen & Electrochemical Studies (CHES) of the University of Toronto. Industrial participation in the projects is actively sought to encourage the commercialization of results.

Benefits to Canada

Results from research were shared and have led to advances in fuel cells and hydrogen storage being made at CHES. Through participation in IEA activities, Canada gained access to the large amount of R&D being performed by the other participants, which could not have been funded by Canada alone.

In addition, novel uses of hydrogen were demonstrated by the IEA participants which could have an impact on Canada in the future e.g., hydrogen road vehicles, a direct injection hydrogen engine and an automobile running on dissociated methanol, inter alia.

Primary Canadian Contact

Name: N.R. Beck **Affiliation:** EMR **Telephone #:** (613) 996-6022

Project Title

5.19 Future Markets for Hydrogen

Duration	Responsible Dept.	Nature of Participation	Status
1977-1980	NRC	Cost Sharing	Completed

Direct Costs: Canada $120,000 Other Participants (8) $950,000 (estimated)

Objective

- To investigate the evolution of existing hydrogen markets, and to identify and assess its potential future use in the period 1985-2025.

Description

Results from this study showed that, in general, hydrogen from coal will be the least expensive route throughout the study period. This study produced a series of conclusions relating to timing and size of market penetration as well as what markets hydrogen will enter. The overall conclusion can be drawn that during the study period, hydrogen will not be economically viable as an energy source but it may be of interest for national goals involving energy supply and the environment.

Organization of Canada's Participation

NRC managed this task and it was performed by Noranda Research Centre.

Benefits to Canada

Markets in Canada were identified which could be penetrated by Hydrogen. Canadian industry is currently addressing these markets. This will lead to infrastructure development, encouraging more use of hydrogen in the longer term.

Primary Canadian Contact

Name: N.R. Beck **Affiliation:** EMR **Telephone #:** (613) 996-6022

Project Title

5.20 International Assessment

Duration	Responsible Dept.	Nature of Participation	Status
1986-1987	EMR/TEB & Hydrogen Industry Council	Cost Sharing	New

Direct Costs: Canada $200,000 Other Participants (4) $1,115,000

Description

This is a new project begun in 1986. It involves an international assessment of hydrogen technology. The Hydrogen Industry Council (HIC) of Canada will be the operating agent integrating international and domestic data. This activity will be supported by federal, provincial and industry contributions over 2 years.

HIC is requesting an extension of this Task by IEA.

Organization of Canada's Participation

HIC is the Operating Agent working through contact persons in the participating countries: Japan, Sweden, Switzerland, European Economic Community. The Government of Quebec and the HIC also provide funding for this task.

Benefits to Canada

Canadian studies identified various hydrogen opportunities in which Canada could take an international lead role. These are:

- hydrogen fuelled underground mining vehicle
- intercontinental hydrogen transport
- hydrogen enhancement of biomass gasification
- hydrogen in remote communities
- small scale ammonia plants

Primary Canadian Contact

Name: N. Nemeth **Affiliation:** EMR **Telephone #:** (613) 996-8729

Project Title

6.1 Plasma Wall Interaction

Duration	Responsible Dept.	Nature of Participation	Status
1977-1992	NRC replaced by AECL in 1985	Task & Cost Sharing	Ongoing

Direct Costs: Canada $1,045,000 Other Participants (6) $?

Objective

- The systematic analysis of plasma wall interactions, the development of a suitable wall system and the application of methods to actively influence the boundary layer.

Description

The project consisted of two parts, the contribution to the construction of the TEXTOR (Torus Experiment for Technology Oriented Research) fusion device at the Jullich Nuclear Research Centre in Germany and participation in the plasma physics program. Contributions to construction included both equipment contributions and scientific and engineering effort. This contribution entitled Canada to seven percent of the experiment time on the machine and a position on the TEXTOR executive committee. The Canadian contribution to the experimental program has been through attachment of Canadian staff to the project.

In the experimental program since 1982, Dr. H. Van Andel of the University of Montreal developed a method for measuring plasma turbulence parameters by forward laser beam scattering. Dr. J. Castracane of MPB Technologies in Montreal developed a method of measuring transport of heavy plasma impurity ions using a laser-energized impurity injection system. Dr. J.M. Larson of INRS-Énergie, developed a system using dedicated small computers for acquiring data from individual experiments. Dr. W. Shmayda of Ontario Hydro Research developed an apparatus using probes with iron membranes to measure atomic hydrogen fluxes. Dr. G. Ross, INRS Énergie, investigated plasma wall interactions, measuring temperature and density profiles in plasma edge regions.

During the building of the machine Dr. J. Robinson from UHV Instruments, developed and supplied the plasma probe drive equipment, Dr. E. Deksnis, Canatom, provided engineering assistance and Dr. Larson performed early work in developing the data acquisition systems.

Organization of Canada's Participation

The Canadian program has been managed and financed by the National Fusion Program which organized and adminstered the participation.