ERDA 76-13

The International Energy Agency With Emphasis On The Subgroup On Energy Research And Development And The Energy Conservation Working Party

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Prepared By

Division of Buildings And Industry
Office of Conservation
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SUMMARY

As a result of the 1973 oil embargo and rising oil prices the United States and other members of the Organization for Economic Cooperation and Development (OECD) created an International Energy Agency (IEA) to administer an International Energy Program. The program's objectives are: to insure that all participating countries will be able to satisfy their minimum oil requirements; to promote cooperation between oil-producing and oil-consuming countries; and to reduce dependence on imported oil through research and development, energy conservation, use of alternative energy sources, and uranium enrichment.

The IEA is composed of a Governing Board, a Management Committee and four Standing Groups (Emergency Questions, Oil Market, Long-Term Cooperation on Energy, Relations with Producer and Other Consumer Countries). Standing Groups are further organized into Subgroups, and each project of the various Subgroups has its Working Group.

Of particular interest to the Energy Research and Development Administration (ERDA) is the Standing Group on Long Term Cooperation on Energy which was formed to consider energy conservation, alternative sources of energy, energy research and development, and uranium enrichment. The Subgroup on Energy Research and Development is of major interest to the United States. This Subgroup has selected nine projects to explore the following: (1) hydrogen from water, (2) waste heat utilization, (3) municipal and industrial waste utilization, (4) coal technology, (5) radioactive waste management, (6) nuclear safety, (7) thermonuclear fusion, (8) solar energy, and (9) energy conservation.

The United States is the lead country of the Working Groups on (6) nuclear safety and (9) energy conservation. The nuclear safety project is well under way with studies being conducted in the U.S., Germany and Japan, and with agreement on the need for annual publication of a Nuclear Safety Research Index.

The Chairman of the Working Group on Energy Conservation is Dr. Melvin H. Chiogioji of ERDA. The four major projects under investigation are (1) thermal characteristics of buildings, (2) heat pumps, (3) thermal storage, and (4) heat exchangers. These projects are described below.

THERMAL CHARACTERISTICS OF BUILDINGS

This program consists of four basic tasks to examine the possibilities for energy conservation through improved design of buildings. Task 1 will gather information and analytical methods helpful in predicting the annual energy consumption of a specific building design and building equipment. Computer programs will be heavily utilized. Task 2 will determine the consistency of results obtained in Task 1. Task 3 will undertake to understand and resolve discrepancies revealed in Task 2 through analyses and simulation techniques. Task 4 will validate the accuracy of the simulation techniques.

HEAT PUMPS

Initial efforts will concentrate on the exchange of information regarding heat pump systems and the preparation and execution of research and development. A central information exchange center will be established for this purpose.

HEAT EXCHANGERS

Under consideration is a proposal to implement an IEA Heat Transfer Advisory and Research Service with a national center in each IEA country to organize research in heat transfer and coordinate this work with the other national centers through a central IEA body. This service will be based on the current Heat Transfer and Fluid Flow Service (HTFS) in the United Kingdom. HTFS offers to companies a subscription service which provides design information, computer codes and consultancy.

THERMAL STORAGE

Three programs have been proposed in this area. The first program will demonstrate the use of water and common building materials to store heat in solar houses. The second program concerns long-term storage for district heating and will consist of two experiments: the storage of hot water in a lake, and the storage of hot water in an aquifer. The third program will explore short-term hot water storage in a distribution pipeline, the development of storage tanks and three different types of encapsulation methods.

THE INTERNATIONAL ENERGY AGENCY

The oil embargo of 1973 and the marked increase in world oil prices that occurred almost simultaneously severely disrupted the economies of most importing nations and strained their political, strategic, and economic relationships. Inadequate cooperation among the industrialized countries resulted in unilateral efforts on the part of many to obtain supplies of oil. The United States and certain other members of the Organization for Economic Cooperation and Development (OECD), based on the need demonstrated by that experience, have undertaken to achieve a coordinated approach to decrease their dependence on foreign oil, and to reduce the strategic and economic vulnerability such dependence can cause.[1]

As part of this effort, the United States and certain other OECD members* agreed in September 1974 to develop an International Energy Program (IEP) for sharing energy imports in times of emergency, and for cooperating on other energy programs such as research and development. Pursuant to the formulation of the IEP, an International Energy Agency (IEA) was established as an autonomous institution within the OECD to administer, monitor, and execute the IEP.

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* Austria, Belgium, Canada, Denmark, Federal Republic of Germany, Great Britain, Ireland, Japan, Luxembourg, the Netherlands, Spain, Sweden, Switzerland, and Turkey. Subsequently, New Zealand became a participating member and Norway became an observer. Under special arrangement (Article 72 of the basic agreement), the Commission on European Communities and OECD's Nuclear Energy Agency also participate.

THE IEA - PURPOSES,
ORGANIZATION, PROGRAMS

The IEA was established to: (1) promote secure oil supplies; (2) develop an emergency self-sufficiency in oil supplies, restraining demand and allocating available oil among member countries on an equitable basis; (3) promote cooperative relations with oil-producing countries and with other oil-consuming countries, including those of the developing world; and (4) reduce member-country dependence on imported oil by undertaking long-term cooperative efforts on energy conservation, accelerated development of alternative sources of energy, energy research and development, and uranium enrichment.[2]

The IEA is organized into:*

- A Governing Board, composed of one or more ministers or their delegates from each participating country
- A Management Committee, composed of one or more senior representatives of the government of each participating country
- Standing Groups, composed of one or more representatives of the government of each participating country, on:
  - Emergency Questions, which deals with emergency self-sufficiency, demand restaint, allocation, activation, and an information system on the international oil market (Articles 1-36 of the agreement)

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* Reference to Exhibit 1 would be useful for the subsequent discussion.

- Oil Market, which is charged with developing an international oil market information system (thereby overlapping the Standing Group on Emergency Questions), and with establishing an internal, permanent framework for obtaining information from or consulting with individual oil companies on the oil industry (Articles 25-40 of the agreement)
- Long-Term Cooperation on Energy, which will focus on reducing, over the longer term, member dependence on imported oil (Articles 41-43 of the Agreement)
- Relations with Producer and Other Consumer Countries, charged with promoting cooperative relations with oil-producing nations (Articles 44-48 of the Agreement).[2]

Of particular interest to the Energy Research and Development Administration (ERDA) is the Standing Group on Long Term Cooperation on Energy. According to Article 42 of the IEP agreement, this group was to consider four areas in particular:

- Energy conservation, including cooperative programs on general information exchange, and on ways and means of reducing the growth of energy consumption
- Development of alternative sources of energy such as domestic oil, coal, natural gas, nuclear energy, and hydroelectric power

- Energy research and development (R&D), including priority cooperative programs on:
  - Coal technology
  - Solar energy
  - Radioactive waste management
  - Controlled thermonuclear fusion
  - Production of hydrogen from water
  - Nuclear safety
  - Waste heat utilization
  - Energy conservation
  - Municipal and Industrial waste utilization
  - Overall energy systems analysis and general studies.
- Uranium enrichment, including projects to facilitate development of natural uranium resources and enrichment services.*

SUBGROUP ON ENERGY R&D

An autonomous subgroup was established for each of these four areas, with the Subgroup on Energy R&D, of major interest to the U.S., chaired by a German delegate (Dr. Wolf Schmidt-Kuester). This subgroup was mandated to carry out national programs of energy R&D, as agreed to by two or more participating countries.**

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* In the draft U.S. statement delivered at the IEA meeting of November 18, 1974, joint programs were proposed for nuclear fusion, nuclear reactor safety, hydrogen from water, energy systems analysis, and enriched uranium.

** Except in the case of the Standing Group on Emergency Questions, Standing Group project participation is strictly voluntary. Participating countries that do not wish to take part in projects may abstain and are not bound by any actions taken in connection therewith.

Guiding Principles

To promote cooperation among participating nations and to facilitate practical implementation of cooperative energy R&D programs, a set of guiding principles was approved at the subgroup's June 1975 meeting and submitted to the Standing Group for further consideration at the group's July meeting. These guidelines ensure that:

1. All member countries support, through participation of appropriate public or private bodies, cooperative activities in which they can make a constructive contribution.
2. Obligations and advantages are shared on an equitable basis.
3. Activities are sufficiently diverse - i.e., ranging from information exchange to jointly financed projects.
4. General information developed in cooperative activities is disseminated among member countries as broadly as possible.

Major Projects

While this framework was being developed, nine projects, corresponding to those set forth in Article 42 of the agreement, were selected in February 1974 for development,* a tentative list of countries interested in each of these priority areas was established (see Exhibit 2), and a Working Party for each project was set up.

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* The tenth, overall energy systems analysis, has been postponed.

- Hydrogen from water. Since hydrogen will almost certainly become increasingly important as a medium for energy storage and transmission and as a fuel, the immediate implementation of a 3-year research program, under the leadership of the Commission of European Communities (CEC), was sanctioned at the second meeting of the Subgroup on Energy R&D (February 1974). At the end of April (1975), the Working Party determined the technical and organizational activities of committees on electrolytic processes, thermochemical cycles, and assessment. Projects involving the development of efficient techniques and suitable materials for hydrogen production are currently in progress; no new projects have been proposed for Calendar Year (CY) 1976.

- Waste heat utilization. Recognizing the importance of the reuse of rejected heat as a technique for conserving energy, the subgroup approved implementation of a research program in this area at its second meeting (February 1975). Designed to provide participating countries with essential data for the planning of integrated energy systems, the project will address the use of rejected low-grade heat (particularly that arising from electricity production); the techniques of mapping the demand for heat in industrial and residential districts; and heat storage. Under the leadership of West Germany, work is proceeding in the

former two areas; the third program is still in the proposal stage. No new projects have been proposed for CY 1976.

- Municipal and industrial waste utilization. As of February 1975, the waste utilization Working Party was requested by the Subgroup on Energy R&D to proceed immediately with an assessment of ongoing work on the utilization of waste to promote energy conservation. Two distinct surveys are currently being conducted under the leadership of the Netherlands. These involve investigations of energy recovery from the incineration and pyrolysis of waste, and of energy conservation through the recycling of glass, paper, and metal waste materials. No new projects have been proposed for CY 1976.

- Coal technology. The development of a research program in this area, headed by Great Britain, was considered to be a high priority by the Subgroup on Energy R&D at its February 1975 meeting because the development of coal is becoming increasingly more appealing as the relative price of competing fossil fuels increases. During the June 1975 meeting, it was reported that the CEC, West Germany, and the United Kingdom (U.K.) were prepared to participate in four joint service projects and one R&D project proposed by the Working Party:

- Creation of a coal technical information service to collect, process, and disseminate scientific and technical data on coal R&D.
- Creation of an economic assessment service for coal.
- Establishment of a World Coal Resources and Reserve Data Bank Service to collect, process, and disseminate information on coal reserves.
- Development of a Mining Technology Clearing House Service to collect, collate, and distribute information on deep and surface mineral coal production.
- Consideration of fluidized combustion of coal - specifically the design, construction, and operation of an experimental fluidized bed combustion rig.

- Radioactive waste management. The Subgroup on Energy R&D agreed in February 1975 that priority should be given to cooperative projects on the disposal of radioactive waste conditioning for storage and disposal. By May (1975) the Subgroup had approved the Working Party's proposal for program implementation under the leadership of OECD's Nuclear Energy Agency (NEA). Another project proposed at the June (1975) meeting was the implementation of a system for increased information exchange on radioactive waste R&D. The OECD Nuclear Energy Agency is now in the process of coordinating and consulting with potential cooperating countries.

- Nuclear safety. The option of employing nuclear-powered heat sources to satisfy increasing demands for electricity and industrial process heat will depend upon the use of engineering design features that ensure the safety of nuclear installations. Therefore, at the February (1975) meeting of the Subgroup on Energy R&D, the Working Party on nuclear safety, under the leadership of the USA, was requested to design detailed implementation proposals for specific cooperative projects, taking into consideration the existing international mechanisms, particularly the OECD Nuclear Energy Agency's Committee on Safety of Nuclear Installations.

  By May (1975), draft agreements had been reached on the need for annual publication of a Nuclear Safety Research Index, directed initially toward light water reactor safety research, and for multilateral technical exchange in the field of reactor safety R&D. In June (1975), further projects were defined for the Working Group, including safety studies at a decommissioned superheat steam reactor (Grosswelzeim, Germany); experimentation at the Power Burst Facility with the behavior of nuclear fuels in abnormal and accident conditions (Idaho Falls); testing of effects of flaws on response of heavy wall steel pressure vessels to in-service and accidential related stress (Oak Ridge); and experimentation on nuclear fuel safety under various reactor-accident situations at the Nuclear Safety Research Reactor (Japan).

- Thermonuclear fusion. To accelerate development of fusion reactors for large-scale power production, the Working Party on controlled thermonuclear fusion has selected four cooperative R&D projects on plasma physical and fusion technology: (1) exploitation of intense neutron sources; (2) superconducting magnets; (3) plasma/wall interactions; and (4) large experimental devices in the U.S., Japan, and various European countries. Promotional activity is being carried out under the leadership of the CEC, and the Subgroup on Energy R&D is anticipating program implementation by the end of 1975.

- Solar Energy. The prospect of considerably higher energy prices over the long term has led to a reevaluation of harnessing this virtually inexhaustible source to assist in diversifying the energy sources of member countries. The Working Party, under the leadership of Japan, has determined five priority project areas on which they are preparing proposals to be submitted to the Subgroup on Energy R&D by the end of 1975. The areas and the respective countries responsible for information dissemination are: (1) development of solar heating, cooling systems, and hot water supply systems (Denmark); (2) development of components for the above systems (Japan); (3) thermal performance testing of solar collectors (Germany); (4) development of an insulation instrumentation package (USA); and (5) inference of insulation parameters from

existing meteorological records (Sweden). Expert consultations are proceeding with a view to establishing joint projects early in 1976. In addition, the West German delegation is preparing a background paper on a proposed 1976 project on remote electric power systems.

- Energy conservation. The first working session on energy conservation R&D was held in February 1975, with the USA as the lead country. Two additional meetings (May and October 1975) of the Working Group were held and a fourth meeting is scheduled for March, 1976.

The Chairman of the Working Party on Energy Conservation is Dr. Melvin H. Chiogioji of ERDA. Exhibit 3 lists the other members. The Working Party has established four objectives that guide their research activities.

1. Develop an international mechanism by which energy conservation research, development and demonstration can be performed for the maximum mutual benefit of participants and to accelerate the realization of these benefits.
2. Identify areas of mutual interest which represent major opportunities for more efficient utilization of energy.
3. Define and actuate mechanisms by which information and/or research results will be developed and exchanged.
4. Perform research and development in areas which have major energy conservation potential.

The US representatives have further established three principles which help to shape their actions. They are described below.

1. Bilateral and trilateral joint hardware research agreements. This is because of the greater tendency toward diffusion of responsibility (and a corresponding decrease in commitment and output) that comes with other arrangements involving members, Information exchange agreements can be made between many participants.
2. Research Program Implementing Agreements are employed. The Implementing Agreement resembles a contract between the members who are participating on a research project. This mechanism clearly delineates the work to be done, a schedule of events and, most importantly, who has what responsibilities.
3. The approved ERDA research budget governs the US commitments made to the ILA. Thus, when an IEA project is proposed, the US members will only make resource commitments when the research area has already been identified as an ERDA research priority and funds have been earmarked. This procedure precludes the necessity for determining a special IEA research budget beyond that needed for meetings support.

As a first step in establishing the "state-of-the-art," each of the member countries contributed data to produce a compendium of research projects in each country. The US has the responsibility for updating this compendium each June.

The Energy Conservation Working Group is actively investigating four major projects, with three others under consideration. The four major projects are:

- Heat Pumps;
- Thermal Storage;
- Heat Exchangers; and
- Thermal Characteristics of Buildings

The three projects under consideration are:

- Transportation;
- Utilities; and
- Energy Cascading.

Exhibit 4 shows the four major projects and lists possible participating countries on the basis of their expressed interest and existing programs.

On the following pages, the four major projects are described.

PROJECT AREA I: THERMAL CHARACTERISTICS OF BUILDINGS

Mr. G.S. Leighton of United States, Chairman

BACKGROUND

This project area is still in the formative stages. A research program for a draft implementing agreement has been submitted to the participating members for approval.

AREAS FOR COOPERATIVE R&D

The overall objective of this research program is to investigate the possibilities for conservation of energy through improved design of buildings with respect to their thermal characteristics.

Individual tasks that will be required in order to meet the program objective are described below. The country having the responsibility for completing the task is also identified.

Task 1 - Gather Data - In this task, each participating country will survey and collect analytical methods, particularly computer programs, that can be used for researching or predicting the annual energy consumption of a specific building design, or for selecting and sizing equipment for the building. The United Kingdom and the United States have developed questionnaires for conducting a computer program survey. These questionnaires are available for the use of all participating countries. Each participating country should forward the results of their respective survey to The Chairman of this Sub-Committee.

Task 2 - Determine Consistency of Results - Once the results of the surveys in Task 1 have been received, The Chairman will perform analyses

to determine to what degree consistency of results can be obtained from the various computer programs and other techniques.

Task 3 - Select Simulation Techniques - The Chairman will conduct analyses designed to understand and resolve differences in results found in Task 2. From these analyses, one or more of the computer programs or other simulation techniques that seem to best predict energy consumption will be selected. These candidate simulation techniques, along with supporting analyses will be submitted to the Working Party for comment. Each participating country will provide written comment to The Chairman within thirty days of receiving these preliminary results. The Chairman will submit final recommendations to the Working Party within sixty days of having submitted the preliminary results.

Task 4 - Validate Accuracy of Simulation Techniques - Once the Working Party has adopted one or more of the simulation techniques for further analysis, The Chairman will prepare a methodology for an experimental validation of accuracy.

Other areas that will be considered for cooperative R&D are:

(a) Integrated architectural/engineering concepts, design methodologies and demonstrations of energy-optimized buildings.

(b) Development of investigational and measurement techniques for post construction verification of thermal performance.

(c) Development of HVAC (heating, ventilating and air conditioning) systems which minimize intrinsic losses of energy, and unnecessary control losses.

(d) Applications of new technologies, materials and management programs for energy-conserving retrofit of existing buildings.

PROJECT AREA II: HEAT PUMPS

P. V. Gilli of Austria, Chairman

BACKGROUND

The heat pump can conserve primary energy resources in many applications. At the October, 1975 meeting, the heat pumps experts' group met and confirmed that all member countries are carrying out development programs in the field of heat pumps, and all wish to participate in a heat pump project.

It was agreed that, in its initial stage, the project should consist mainly of information exchanges and occasional special meetings. A draft implementing agreement is now being considered by the members. This draft agreement is summarized below.

AREAS FOR COOPERATIVE R&D

The Project will include one central collection, collation and distribution center for the exchange of information regarding heat pump systems and for the preparation and execution of research and development.

The specific areas of interest will be:

1. Heat pump systems with air as a heat source for the generation of domestic heat, using the compression cycle. This excludes the absorption cycle.

   Emphasis will be on:

   - study of the freezing and de-icing problem
   - Comparison of the advantages and disadvantages of different distribution systems (air, water)

- Coefficient of performance optimization.

2. Heat pump systems with long term thermal storage for the generation of domestic heat using the compression cycle. This excludes the absorption cycle.
3. Thermally activated mechanical heat pump systems including but not limited to diesel, gas motor, Rankine cycle and Sterling engines. This excludes electrically driven or absorption system heat pumps
4. Industrial applications of heat pump systems including but not limited to the regeneration of waste heat in industrial plants.

A basic description of member country projects will be collected for each development program and should include:

1. Reporting country
2. Agency responsible for the work
3. Title of work and any individual national reference
4. The purpose of the work
5. The status of the Development Program
   a. By type of work
   b. By level of progress currently achieved
   c. By schedule for the completion of the work, the rendering of findings and conclusions, and the commencement of subsequent work which is a consequence of the Development Program.

An annual register of all basic descriptions of Development Programs will be maintained and distributed to the member countries.

PROJECT AREA III: HEAT EXCHANGERS

Dr. G. F. Hewitt of United Kingdom, Chairman

BACKGROUND

Heat exchange is a fundamental unit operation in all industries and in all heat recovery systems. This area for R and D work should encompass heat transfer from fuels to process streams (fired heaters, boilers for raising steam, etc.), from liquid to liquid, from liquid to gases, and from gases to liquids. There is also the area of heat transfer to or from solids (such as drying of materials) which could provide a fruitful field for energy conservation technology development.

At the October, 1975 experts' group meeting on Heat Transfer/ Heat Exchangers, a proposal was submitted to implement a Heat Transfer Advisory and Research Service under the auspices of the IEA. This proposal is described below and builds on the experience of a Heat Transfer and Fluid Flow Service (HTFS) which has been set up in the United Kingdom.

AREAS FOR COOPERATIVE R AND D

1. The HTFS in the United Kingdom

The HTFS has the objective of providing efficient technology transfer in this field. A subscription service is provided to which over 90 companies subscribe, and which provides design information, computer codes and consultancy. Firms from 10 countries have already joined the service. The UK Government contributes to this service, providing most of the funds for research work on applied heat

transfer. The current HTFS turnover is about $1 million, of which the UK Department of Industry provides about half.

HTFS was set up at the end of 1967 with the approval and encouragement of the UK Government. It serves industry in a number of different ways:

a. The HTFS Information Service. In return for an annual fee (in the range of $2500-$5000) companies are given the following information and services:

   1. Design reports concerned with the design of particular types of equipment or with general subjects such as fouling, heat exchanger selection and enhanced surface heat transfer.
   2. Computer programs as an aid to design in those cases where manual calculation is impracticable or uneconomic.
   3. Consultancy to each member about its problems in heat transfer, fluid flow and related topics.
   4. Information office where sponsors make use of data on heat transfer and fluid flow and on related matters such as fluid physical properties.
   5. Research information supported mainly by the British Government and including generalized research into the mechanism of heat transfer and fluid flow with particular reference to the performance prediction and design of industrial equipment.
   6. Contract research whereby the staff and facilities of HTFS can be made available to companies and

other outside agencies for confidential contract research.

2. The Proposal to the IEA

Basically, what has been suggested is that each IEA country set up a national center which organizes research in heat transfer, coordinating this work with the other national centers through the medium of a central IEA body based on the current HTFS.

In this way, a service aimed at the dissemination of the most up-to-date information on heat transfer equipment would be offered directly to firms and organizations able to make immediate use of the information and advice in the participating countries. The major features of the program would be:

a. The recipients of the service would be individual firms and organizations, who would directly support the central secretariat services through subscriptions and would participate directly in the decision-making machinery for selecting the content and emphasis of the research program

b. A central secretariat would operate an information service and would prepare design reports and computer programs on selected topics of heat exchanger design which would aid the immediate implementation of more efficient designs in participating industrial firms

c. The information and design service would be backed by a selected program of R&D funded by the participating

national governments and carried out in the national centers.

3. The Technical Program of the Proposed IEA Services

Initially, the proposed service would supplement the current technical activities of the HTFS. These areas are:

- Condensation
- Air cooled heat exchangers
- Cryogenic heat transfer
- Single phase heat transfer
- Two phase flow and boiling
- Radiative heat transfer and flames.

Moreover, if the IEA implements the program, three additional areas for work are proposed:

- Optimization of heat transfer
- Cooling towers
- Regenerative heat transfer.

PROJECT AREA IV: THERMAL STORAGE

Dr. U. Plantikow of Germany, Chairman

BACKGROUND

Heat energy, at the required temperature level, may not always be available at the right time during a cyclic process, or at the right point of application. For these and other reasons, the concept of storing heat has great potential for energy conservation through improved heat management. Many media are available for heat storage, covering a wide range of temperatures. For example, cold water may be used to "store" refrigeration or hot water to store waste heat from a process.

The Thermal Energy Storage Working Group held meetings on 9th-10th October, 1975 in order to formulate specific recommendations of projects for sponsorship through the auspices of the IEA.

Several recommendations were made and they are described in the next section.

AREAS FOR COOPERATIVE RESEARCH AND DEVELOPMENT

1. Demonstration of Existing Storage Technology Applied to Solar House

Several countries indicated that they would conduct experiments to demonstrate the use of heat storage using water and common building materials. The application would be solar houses. The Austrian proposal to test three differently sized water storage devices (125, 80 and 4 m^3) and the use of storage within the construction materials themselves, was identified as the candidate project for sponsorship through the IEA.

The Group recommended that the level of cooperation be as follows: all participants thoroughly exchange information on their respective projects emphasizing the calculations establishing the size of the storage, the instrumentation selected and the operational data received. The economics of the system should be presented in detail. It was also recommended that a central organization be selected to receive and distribute all information and materials with special emphasis placed on monitoring the Austrian project.

2. Long-Term Storage for Application to District Heating

wo projects taken together were identified as a single total program for sponsorship through the IEA. The projects were: the storage of hot water in a lake specifically engineered to store, retain, and release, as necessary, the energy (a German project); and the storage of hot water in an aquifer (a United States project). The lake storage project will use a suitable material for lining the bottom of the lake (for example foaming plastic or plastic/concrete layers) and will also develop the cover material (for example floating sheetings) to prevent heat losses, evaporation, pollutions and waving of the lake surface. The project is on-going and it is hoped that construction of the lake can begin by January 1976.

The recommended level of cooperation calls for the two programs to be considered as one project demonstrating seasonal storage. In addition to the central control of information exchange previously recommended, it was also recommended that participants exchange technical personnel. The personnel can participate in any or all phases including design,

construction, testing, evaluation of test results and assessment of technical and economic viability. At the completion of the programs a joint IEA workshop should be sponsored with the results and conclusions presented and discussed in the workshop.

3. Short-Term Storage and Advance Technology

Plans for the development of short-term hot water storage in a distribution pipeline (Germany and United Kingdom) and the development of storage tanks (Austria, Germany and United Kingdom) for short term but large volumes were discussed. A United States program for encapsulating low temperature (10-90^{o}C) phase change materials was also presented.

The pipeline storage plan is to store the hot water directly in the distribution system. Developmental issues are primarily the problem of developing the proper insulation and establishing the costs of the system. These same issues apply to the development of large volume storage tanks. Specific costs for the controls (regulation), fittings, insulation, foundation, erection and freight are needed.

Thirty (30) preliminary materials and twenty (20) back-up materials have been identified for further study. The goal is to develop three different types of encapsulation methods for several of the representative materials. Bulk encapsulation (for example, storage of a large volume of material in a tank) for use in buffer heat exchangers macro-encapsulation (for example, the storage of the material in spheres the size of tennis balls) for use in packed bed heat exchangers, and micro-encapsulation (for example, the storage of the material dispersed

in a foam) for use as basic construction materials, are being considered. This is a long range, basic research program.

The recommended level of cooperation would be the exchange of project-related information through a central organization.

INTERNATIONAL ENERGY AGENCY

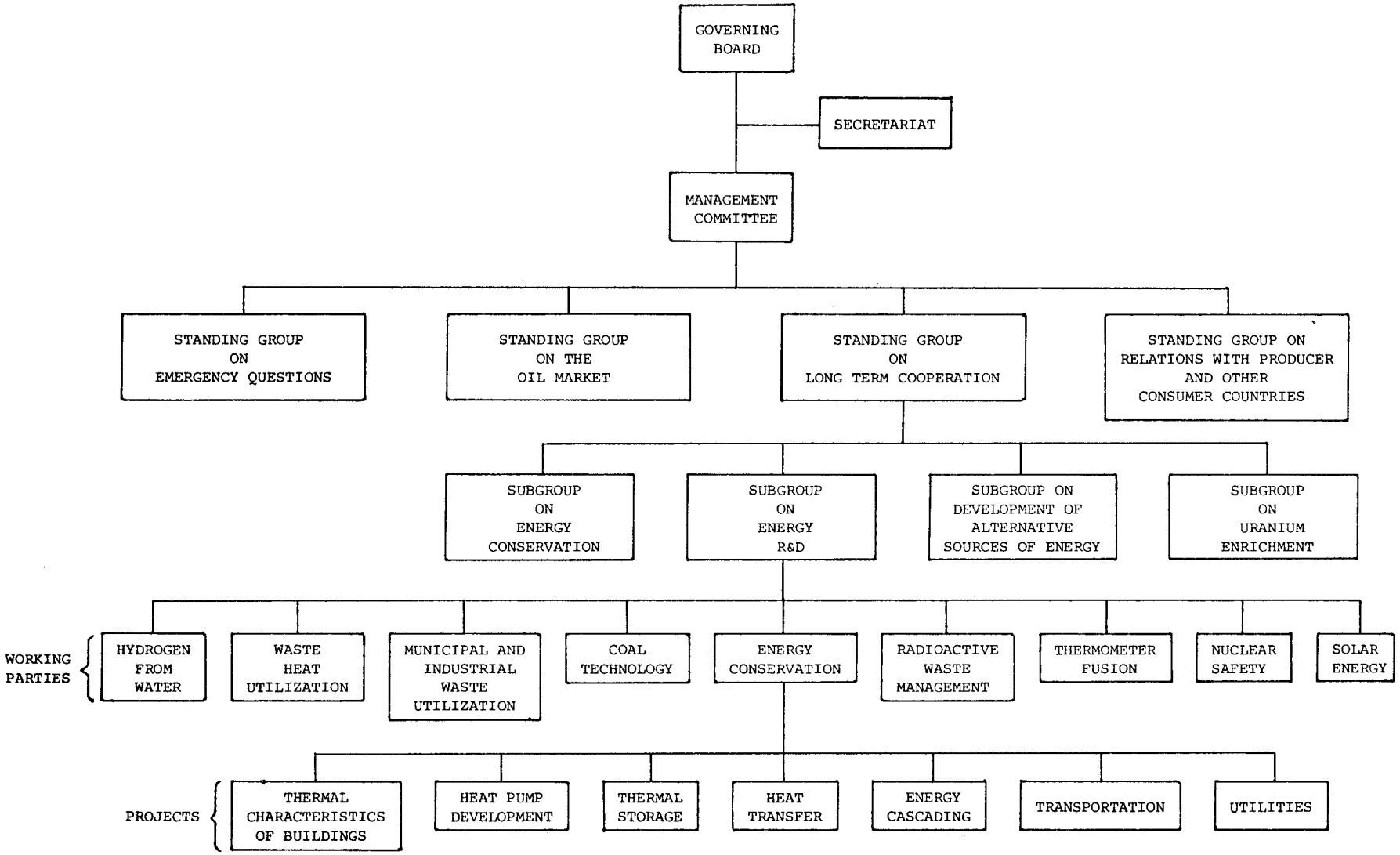

Exhibit 1

Exhibit 2

List of Interested Countries and Organizations

1. Coal Technology	Lead Country: United Kingdom Belgium, Canada, Germany, Ireland, Japan, Netherlands Switzerland, Turkey, U.S.A., E.C.
2. Solar Energy	Lead Country: Japan Austria, Belgium, Canada, Denmark, Germany, Italy, Switzerland, Turkey, United Kingdom, U.S.A., E.C.
3. Radioactive Waste Management	Lead Organization: NEA Austria, Belgium, Canada, Denmark, Germany, Italy, Japan, Netherlands, Spain, Sweden, Switzerland, Turkey, United Kingdom, U.S.A., E.C.
4. Controlled Thermo-Nuclear Fusion	Lead Organization: E.C. Austria (subject to confirmation), Belgium, Canada, Denmark, Germany, Italy, Japan, Sweden, Turkey, United Kingdom, U.S.A.
5. Production of Hydrogen from Water	Lead Organization: E.C. Belgium, Germany, Japan, Netherlands, United Kingdom, U.S.A., NEA
6. Nuclear Safety	Lead Country: U.S.A. Austria, Belgium, Denmark, Germany, Italy, Japan, Netherlands, Spain (subject to confirmation), Sweden, Switzerland (subject to confirmation), United Kingdom, E.C., NEA
7. Waste Heat Utilization	Lead Country: Germany Austria, Bergium, Canada, Denmark, Ireland, Italy, Japan, Netherlands, Sweden, Switzerland, Turkey (subject to confirmation), United Kingdom, U.S.A., E.C., NEA
8. Energy Conservation	Lead Country: U.S.A. Austria, Belgium, Canada, Denmark, Germany, Ireland, Italy, Japan, Netherlands, Sweden, Switzerland, United Kingdom, E.C.
9. Municipal and Industrial Waste Utilization	Lead Country: Netherlands Belgium (subject to confirmation), Canada, Germany, Italy, Japan, Sweden, United Kingdom, U.S.A., E.C.

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LIST OF POSSIBLE PARTICIPATING COUNTRIES BY ITEM FOR CO-OPERATION

ITEMS \ COUNTRY	AUS-TRIA	BEL-GIUM	CAN-ADA	DEN-MARK	GER-MANY	IRE-LAND	ITALY	JAPAN	NETH-ER-LANDS	SWE-DEN	SWIT-ZER-LAND	UK	US
I. HEAT PUMPS	P O		P O	P O	P O	P O	P	P O	P O	P O	P O	P O	P O
1. With auxiliary heating for space heating with atmosphere as heat source	P				P O	P				P O	P	P O	P O
2. Using solar energy as heat source	P O				P O	P	P	O	P O	P O	P	P O	P O
3. Using ground as heat source	P			O	P O				P		P		P O
4. Using natural water bodies as heat sources	P O				P O	P O			P O	P O	P	P O	P O
5. Using air to water transfer	P				P O	P O	P				P	P O	P O
6. Using residential, commercial, and institutional waste heat as heat source	P				P O	P			P	P O			P O
7. Simultaneously refrigerating and heating	P O				P O	P						P O	P O
8. Industrial Uses	P				P O	P						P O	P O
9. Mechanical, cycle and other improvements					P O	P			P O	P		P O	P O
II. THERMAL STORAGE	P		P		P O	P			P O	P O	P O	P O	P O
1. Storage properties of various gas and liquid media	P			P	P O	P				P O		P	P O
2. Demonstration of heat storage in fused salts and solids					P	P			P O	P O	P O	P O	P
3. Physical or chemical characteristics of containers					P							P	
4. Research on reversible chemical reactions					P				P O		P O		P
III. HEAT EXCHANGERS	P	P O	P		P	P	P O	P	P	P	P	P O	P O
1. Development and application of porous heat exchanger surfaces		P			P				P		P	O	P O
2. Extended surface exchangers for gas-liquid heat transfer	P	P			P		P O		P O		P O	P O	P O
3. Heat pipes		P			P	P	P O	P	P O		P	P O	P O
4. High temperature low pressure filters		P	P		P		P		P O	P	P	P O	P
IV. THERMAL CHARACTERISTICS OF BUILDINGS	P O	P	P O		P O	P O	P O	P O	P O	P O	P O	P O	P O

NOTE: A "P" in the column represents an expressed interest in participating in the project; an "O" in the column represents the fact that the country has an ongoing R&D program. If a country is both interested in participating and has an ongoing project, both letters are included in the box.

SOURCES

1. The Bureau of National Affairs, April 17, 1975.

2. Agreement on an International Energy Program, The National Fuels and Energy Policy Study, Serial No. 93-53, U.S. Government Printing Office, November 1974.