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TRW
SYSTEMS AND ENERGY

DISCLAIMER

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TRW TECHNICAL PROGRESS REPORT
FEBRUARY THRU JULY, 1977
ERDA CONTRACT EC-77-C-03-1446

MASTER

1446 8-1 Dw. Ltr. Dtd. 8/25/77

AC03-77CS40004

TRW TECHNICAL PROGRESS REPORT
FEBRUARY THRU JULY, 1977
ERDA CONTRACT EC-77-C-03-1446

August 20, 1977

INTRODUCTION

Contract Number EC-77-C-03-1446 was issued on July 11, 1977 with an effective date of February 1, 1977. The contract calls for monthly technical status reports due by the 20th calendar day of each month for the preceding month. This progress report is intended to satisfy the requirements for technical reporting from the start of the contract through July 30, 1977.

As of July 31, 1977, TRW has undertaken five tasks under this contract. All tasks have been documented prior to their inception in task statements. The five task statements are appended to this report.

OVERALL STATUS

The table below lists all deliverables required by the five task statements. It also shows the original due dates for each deliverable report and the actual dates of their delivery. It is evident that work progressed slower than anticipated in April and May, resulting in late delivery of some of the reports on Tasks 2 and 3. Work is now on schedule, however, and reports required by Task 5 and Task 6 (effective on August 8, 1977) are expected to be on or ahead of schedule.

DELIVERABLE	DUE DATE	DELIVERY DATE
TASK STATEMENT 1		
1. National Undertakings to Improve the Efficiency of End Use of Energy in the United States	4/15	4/25
TASK STATEMENT 2		
1. Analysis of S.977	4/13	Combined with Item 3
2. Oil Supply, Demand and Future Prices	4/20	5/3
3. Energy Policy	4/27	6/17

DELIVERABLE	DUE DATE	DELIVERY DATE
TASK STATEMENT 2 (Cont'd.)		
4. District Heating in the United Kingdom	5/4	Will be delivered about 8/5
TASK STATEMENT 3		
1. Thermal Energy Storage	5/5	6/15
2. Fuel Cells	5/18	7/11
3. Methane Drainage from Coal Beds	5/25	6/6
TASK STATEMENT 4		
1. Zero Based Budgeting Criteria	6/10	6/10
TASK STATEMENT 5		
1. Residential Heating Technologies	9/13	Not yet due

MONTH-BY-MONTH ACTIVITY ON CONTRACT EC-77-C-03-1446

FEBRUARY

Task 1 was defined and work begun. The purpose of the task was to present to ERDA a set of initiatives that would achieve energy savings in the very near term. Such initiatives would complement the on-going programs in ERDA that are primarily aimed at providing efficient technologies that will mature in the next 5 to 10 years. This task extended and completed work initiated under Task Order 3, Contract EY-76-C-03-1182.

The orientation of the work was by consuming sector. As a first step charts were prepared showing the amount of energy consumed by fuel type and by use in each sector to be considered. Next opportunities for fuel conversion in industrial processes.

MARCH

Work continued on Task 1. Studies in the buildings sector were completed. The study of fuel conversion in industry was expanded to include

opportunities for cogeneration. Finally, work was started on potential energy saving initiatives that might be undertaken in the industrial sector.

During the last week in March the developing needs of the Office were discussed with Dr. Murray, Mr. Powers, Dr. Eberhardt and Dr. Plunkett. It was decided that TRW could be helpful in two new areas.

First, TRW could analyze new developments in energy policy. This would give the Office needed background information in their attempts to respond to the evolving energy policy. Second, TRW could assist the Office by performing limited technology assessments of projects that are presently being considered or already being funded by the AA-Conservation. From this discussion, Tasks 2 and 3 were defined.

APRIL

Work continued on Task 1 studies.

Task 1 was completed and results were presented to Dr. Murray in draft form. After discussion, a final draft was prepared and delivered to the Office of Conservation Policy and Planning. Final delivery was made on April 25.

Task 2, on Policy Analysis, was prepared and work was started on April 6. Four deliverables were defined. These are briefly described below.

1. An analysis of Senate Bill S.977, the Coal Utilization Act of 1977. With the President's message delivered on April 20, it was decided that ERDA would more likely have to respond to the President's own initiatives in this area. Thus the study of fuel switching and coal utilization became part of the third deliverable under Task 2, concerning the President's Energy Policy.

2. Oil Supply, Demand and Future Prices. Articles by both D. Rostow and by the CIA have predicted that oil prices will drastically rise again in the mid-1980's. This study under Task 2 involved an analysis, primarily of the Rostow article. The predictions made in the article were compared to the price projections of the FEA and WEO. The study was completed in April and was briefed to Dr. Murray. The work was formally delivered on May 3.

3. A comprehensive analysis of the President's National Energy Plan was started on April 21. The analysis treated all the President's initiatives by the consuming sector to which they apply. TRW first compared the President's message of April 20 to the Bill submitted as HR.6381, then added a critique of the proposals for each sector. Emphasis was placed on the role that ERDA-Conservation might play in implementing the proposed initiatives.

4. District Heating. An analysis of the potential for district heating is presently underway. It treats the experiences with district heating in several foreign countries and discusses the implications for the proposed demonstrations of district heating in the U.S. This paper is scheduled for delivery in mid-August.

Work on Task 3 was scheduled to start on April 6. The purpose of this task was to assess various technologies from the point of view of the Office of Policy and Planning. The background data on each technology will prove helpful in evaluating competing technologies or new developments in any of the areas considered. Start date for Task 3 was delayed while work continued on Task 2.

MAY

Work continued on deliverables for Task 2 and work started on Task 3. The three deliverables for Task 3 were as follows:

1. A Study of Thermal Energy Storage. This study discussed the several applications of thermal energy storage (TES). As with other studies under this contract the applicability of this technology to each consuming sector was treated separately.

Both heat and cold storage systems were discussed in terms of their applicability for several geographical regions of the country. A short section was also included describing the impact that TES systems have had in the UK.

2. Fuel Cells. This study described fuel cell technology in general and then concentrated on the several large projects presently being pursued by ERDA and private industry. The results of economic studies of fuel cells were quoted. Note was also made of the many R&D projects being conducted by government, industry and in universities.

3. Methane Drainage. This paper discussed estimates of the resource base for methane drainage and the potential impact that a commercialized program could have in satisfying our demand for natural gas. The paper then concentrated on the technologies involved and the several new techniques being tried under EPDA auspices. Finally, the paper discussed the potential problems that might be encountered in attempting to commercialize these technologies.

JUNE

The Methane Drainage paper under Task 3 was delivered on June 6.

The Thermal Energy Storage paper under Task 3 was delivered on June 15.

The Energy Policy paper under Task 2 was delivered on June 17.

Task 4 was begun on June 1. Under this task, TRW defined a set of criteria that could be applied to the ranking of R&D technologies in the area of conservation. The choices of criteria was based on the importance of various areas of conservation as stated by the President in the NEP. The paper was delivered on schedule, June 10.

Under this task TRW was also asked to review the decision units submitted to the AA-Conservation by the Transportation Division. In this short task, TRW attempted to determine how the proposed decision packages could be subjected to a set of criteria that could also apply to packages from other divisions. This task was completed on schedule.

Task 5 was begun on June 13, and is scheduled to be completed in September. The purpose of the task is to provide the Office with background information on how well, and at what price, technologies presently satisfy the needs of the market for residential space heat. This information will be used to determine the goals that new technologies must achieve if they are to be competitive, and it is also useful in assessing the commercialization potential for several technologies presently being funded by ERDA.

Progress to date includes work on heat load calculations, life cycle costing and fuel price projections, as well as obtaining cost information on the specific technologies to be considered. A computer program is presently being written to analyze to the cost data using the lifecycle costing methodology. The results of this analysis will be ready for presentation to ERDA in mid-August.

TRW ENERGY SYSTEMS PLANNING DIVISION
CONSERVATION PLANNING AND POLICY TASK STATEMENT
CONTRACT NO. EC-77-C-03-1446

TASK STATEMENT NO. 1	TITLE Government Conservation Initiatives	PAGE 1 OF 3

PREPARATION DATE	EFFECTIVE START DATE	SCHEDULED COMPLETION DATE
January 15, 1977	February 1, 1977	April 15, 1977

REVISION	JOB NUMBER	WORK PACKAGE NO.	WORK UNIT NO.
1	0440-75	Not Applicable	Not Applicable

TASK MANAGER	PHONE	ERDA TASK MONITOR	PHONE
A.L. Wood	893-2000 X2333	Dr. George Murray	376-9041

PERSONNEL ASSIGNED:

MANPOWER REQUIREMENTS	1	2	3	4	5	6	7	8	9	10	11	12	TOTAL MANMONTHS
(A) CALENDAR MONTH	F	M	A										
(B) TRW MANMONTHS	1	1	1										3
(C) SUBCONTRACTOR MANMONTHS	0	0	0										

TOTAL BUDGETED MM.... 3

OBJECTIVES/TASK STATEMENT/DELIVERABLES/SCHEDULES/SPECIAL REQUIREMENTS ARE TO BE DESCRIBED ON THE FOLLOWING PAGE(S)

TRW ENERGY SYSTEMS PLANNING DIVISION
CONSERVATION PLANNING AND POLICY TASK STATEMENT
CONTRACT NO. EC-77-C-03-1446
CONTINUATION SHEET

TASK STATEMENT NO.	EFFECTIVE START DATE	SCHEDULED COMPLETION DATE	PAGE 2 OF 3
1	2/1/77	4/15/77	

OBJECTIVES/TASK STATEMENT/DELIVERABLES/SCHEDULES/SPECIAL REQUIREMENTS ARE DESCRIBED BELOW:

OBJECTIVE:

To prepare a paper on national conservation initiatives which might be undertaken to achieve savings in the near term of natural gas, oil and total energy.

TASK STATEMENT:

Prepare a paper on the following subjects:

1. Upgrading existing buildings through improvements in their thermal integrity and installed equipment
2. Upgrading new buildings
3. Conversion of many industrial uses of oil and gas to coal
4. Co-generation in industry
5. Switching to more efficient cars

The purpose of this paper will be to present descriptions of government initiatives which might be undertaken to achieve large energy savings within the next ten years.

The paper will address at least the following:

1. The size of the target and the energy saving potential
2. Technical possibilities to conserve energy
3. The major barriers to conservation
4. Programs which could overcome these barriers, bringing about desired changes
5. Estimates of program cost and benefits

TRW ENERGY SYSTEMS PLANNING DIVISION
CONSERVATION PLANNING AND POLICY TASK STATEMENT
CONTRACT NO. EC-77-C-03-1446
CONTINUATION SHEET

TASK STATEMENT NO.	EFFECTIVE START DATE	SCHEDULED COMPLETION DATE	PAGE 3 OF 3
1	2/1/77	4/15/77	

OBJECTIVES/TASK STATEMENT/DELIVERABLES/SCHEDULES/SPECIAL REQUIREMENTS ARE DESCRIBED BELOW:

DELIVERABLES:

A paper as outlined above. Due date for the final paper will be April 15, 1977.

A. L. Wood (signed)
TRW PROJECT MANAGER

George R. Murray (signed)
GOVERNMENT PROJECT OFFICER

TRW ENERGY SYSTEMS PLANNING DIVISION

CONSERVATION PLANNING AND POLICY TASK STATEMENT

CONTRACT NO. EC-77-C-03-1446

TASK STATEMENT NO.	REVISION NO.	TITLE	PAGE
2	0	New Developments in Energy Policy	1 OF 3

PREPARATION DATE	START DATE	COMPLETION DATE
April 4, 1977	April 6, 1977	May 4, 1977

TRW TASK MANAGER	ERDA TASK MONITOR
A.L. Wood 893-2000 ext. 2333	Dr. George Murray 376-9041

PERSONNEL ASSIGNED: Wood, Palmieri, Bancroft

MANPOWER

WEEK #	1	2	3	4	5	6	7	8	9	10	11	12	TOTAL
TRW MANHOURS	80	80	100	80									340
SUBCONTRACT MANHOURS													
TOTAL	80	80	100	80									340

TRW ENERGY SYSTEMS PLANNING DIVISION
CONSERVATION PLANNING AND POLICY TASK STATEMENT
CONTRACT NO. EC-77-C-03-1446
CONTINUATION SHEET

TASK STATEMENT NO.	EFFECTIVE START DATE	SCHEDULED COMPLETION DATE	PAGE 2 OF 3
2	April 6, 1977	May 4, 1977	

OBJECTIVE: To assess new developments in energy policy and energy legislation, as to their impacts on:

- conservation
- work of the Office of Planning and Policy

TASK STATEMENT: Prepare papers on the following subjects:

1. S.977, The Coal Utilization Act of 1977

   A. An analysis of Senate Bill S.977, with a statement on the effects this bill would have in the areas of:

      - fuel switching
      - the need for conservation technologies to assist in meeting the goals of S.977
      - the role of ERDA-funded technologies in meeting the goals of S.977

2. Oil Supply, Demand and Future Prices

   A. An analysis of the expected supply, demand and future prices of world oil, as indicated by NEO, WEO, the Rostow article, CIA data and results of the MOP exercise.

   B. Analysis of effects of these prices on prospects for particular ERDA technologies, i.e., fuel cells, advanced gas turbines.

3. Energy Policy

   A. An analysis of the new energy policy to be announced by the Administration on April 20, 1977.

   B. The implications of this policy to the Office of Conservation.

4. District Heat in the United Kingdom

   A. An analysis of the recent study by the Central Electricity Generating Board (U.K.) which rejects most of the claims for district heat in the U.K.

   B. An analysis of the implications of this study to ERDA's own attempts to foster district heat in the U.S.

TRW ENERGY SYSTEMS PLANNING DIVISION
CONSERVATION PLANNING AND POLICY TASK STATEMENT
CONTRACT NO. EC-77-C-03-1446
CONTINUATION SHEET

TASK STATEMENT NO.	EFFECTIVE START DATE	SCHEDULED COMPLETION DATE	PAGE 3 OF 3
2	April 6, 1977	May 4, 1977	

DELIVERABLES: Papers as outlined above:

- S.977 paper due April 13
- Supply-Demand paper due April 20
- Carter Energy Policy paper due April 27
- District Heat paper due May 4

A. L. Wood (signed)
TRW PROJECT MANAGER

George R. Murray (signed)
GOVERNMENT PROJECT OFFICER

TRW ENERGY SYSTEMS PLANNING DIVISION
CONSERVATION PLANNING AND POLICY TASK STATEMENT
CONTRACT NO. EC-77-C-03-1446

TASK STATEMENT NO.	REVISION NO.	TITLE	PAGE
3	0	TECHNOLOGY ASSESSMENT	1 OF 3

PREPARATION DATE	START DATE	COMPLETION DATE
April 4, 1977	April 6, 1977	May 25, 1977

TRW TASK MANAGER	ERDA TASK MONITOR
A.L. Wood 893-2000 ext. 2333	Dr. George Murray 376-9041

PERSONNEL ASSIGNED: Wood, Palmieri, Bancroft

MANPOWER

WEEK #	1	2	3	4	5	6	7	8	9	10	11	12	TOTAL
TRW MANHOURS	20	20	0	20	100	100	100						360
SUBCONTRACT MANHOURS													
TOTAL	20	20	0	20	100	100	100						360

TRW ENERGY SYSTEMS PLANNING DIVISION
CONSERVATION PLANNING AND POLICY TASK STATEMENT
CONTRACT NO. EC-77-C-03-1446
CONTINUATION SHEET

TASK STATEMENT NO.	EFFECTIVE START DATE	SCHEDULED COMPLETION DATE	PAGE 2 OF 3
3	April 6, 1977	May 25, 1977	

OBJECTIVE: To develop, for the Office of Planning and Policy, papers which provide broad market-oriented backgrounds against which to consider the appropriateness of specific technologies.

TASK STATEMENT: Prepare papers on the following subjects:

1. Thermal energy storage - paper to include discussions of:
   - the present status of commercialization in the private sector
   - the present efforts of the government in development, commercialization
   - estimates of potential for market penetration, energy savings, fuel switching
2. Fuel cells - paper to include discussions of:
   - competing technologies in the areas where fuel cells are expected to be used
   - the roles of the government, the gas utilities and electric utilities in development and demonstration
   - the effect on distributed electrical generation facilities
3. Methane drainage - paper to include discussion of:
   - the commercialization prospects based on geographical distribution of the opportunities
   - best cost estimates of the new supplies
   - potential for methane drainage as supplemental supply of gas

TRW ENERGY SYSTEMS PLANNING DIVISION
CONSERVATION PLANNING AND POLICY TASK STATEMENT
CONTRACT NO. EC-77-C-03-1446
CONTINUATION SHEET

TASK STATEMENT NO.	EFFECTIVE START DATE	SCHEDULED COMPLETION DATE	PAGE 3 OF 3
3	April 6, 1977	May 25, 1977	

DELIVERABLES: Papers as outlined above.

- TES paper due May 5, 1977 –
- Fuel Cells paper due May 18, 1977
- Methane Drainage paper due May 25, 1977

A. L. Wood (signed)
TRW PROJECT MANAGER

George R. Murray (signed)
GOVERNMENT PROJECT OFFICER

TRW ENERGY SYSTEMS PLANNING DIVISION
CONSERVATION PLANNING AND POLICY TASK STATEMENT
CONTRACT NO. EC-77-C-03-1446

TASK STATEMENT NO.	REVISION NO.	TITLE	PAGE
4	0	Conservation RD&D Technology Ranking Criteria	1 OF 3

PREPARATION DATE	START DATE	COMPLETION DATE
5/31/77	6/1/77	6/10/77

TRW TASK MANAGER	ERDA TASK MONITOR
A. L. Wood 893-2000 X2333	Dr. George Murray 376-9041

PERSONNEL ASSIGNED: Wood, Palmieri, Bancroft

MANPOWER

WEEK #	1	2	3	4	5	6	7	8	9	10	11	12	TOTAL
TRW MANHOURS	48	22											70
SUBCONTRACT MANHOURS													
TOTAL	48	22											70

TRW ENERGY SYSTEMS PLANNING DIVISION

CONSERVATION PLANNING AND POLICY TASK STATEMENT

CONTRACT NO. EC-77-C-03-1446

CONTINUATION SHEET

TASK STATEMENT NO.	EFFECTIVE START DATE	SCHEDULED COMPLETION DATE	PAGE 2 OF 3
4	6/1/77	6/10/77	

OBJECTIVE: To develop criteria to aid in ranking energy conservation RD&D technologies.

TASK STATEMENT: Develop from the objectives of the national energy policy (NEP) of the current administration appropriate criteria for ranking conservation RD&D technologies. Prepare a paper setting forth the criteria and explanation of the relationship between the criteria and the NEP.

TRW ENERGY SYSTEMS PLANNING DIVISION
CONSERVATION PLANNING AND POLICY TASK STATEMENT
CONTRACT NO. EC-77-C-03-1446
CONTINUATION SHEET

TASK STATEMENT NO.	EFFECTIVE START DATE	SCHEDULED COMPLETION DATE	PAGE 3 OF 3
4	6/1/77	6/10/77	

DELIVERABLES:

A paper as outlined above

Due date: June 10, 1977.

A. L. Wood (signed)
TRW PROJECT MANAGER

George R. Murray (signed)
GOVERNMENT PROJECT OFFICER

TRW ENERGY SYSTEMS PLANNING DIVISION
CONSERVATION PLANNING AND POLICY TASK STATEMENT
CONTRACT NO.

TASK STATEMENT NO.	REVISION NO.	TITLE	PAGE
5	0	TECHNOLOGIES CHARACTERIZATION FOR THE RESIDENTIAL SECTOR	1 OF 5

PREPARATION DATE	START DATE	COMPLETION DATE
June 9, 1977	June 13, 1977	September 30, 1977

TRW TASK MANAGER	ERDA TASK MONITOR
A.L. Wood 893-2000 ext. 2333	Dr. George Murray 376-9041

PERSONNEL ASSIGNED: Wood, Palmieri, Bancroft

MANPOWER

WEEK #	1	2	3	4	5	6	7	8	9	10	11	12	TOTAL
TRW MANHOURS	88	88	88	88	88	88	88	88	88	88	88	88	1056
SUBCONTRACT MANHOURS													
TOTAL													1056

TRW ENERGY SYSTEMS PLANNING DIVISION

CONSERVATION PLANNING AND POLICY TASK STATEMENT

CONTRACT NO. EC-77-C-03-1446

CONTINUATION SHEET

TASK STATEMENT NO. 5	EFFECTIVE START DATE	SCHEDULE COMPLETION DATE 9/15/77	PAGE 2 OF 5

OBJECTIVE: To establish baseline data on the technical performance (efficiency, reliability, etc.) and cost (production, O&M, fuel, labor, etc.) of state-of-the-art energy consuming technologies as a basis for estimating similar numbers for new technologies. Such information will assist the Office of Conservation Planning and Policy in determining the reasonableness of economic and technical goals established for the Conservation program. The data also will be made available for use by the individual AC program divisions.

Initially the study will deal with technologies applicable to residential HVAC systems including self contained units for individual dwellings and systems serving an entire community.

The study will provide the Office with the capability to make technical and economic tradeoffs among heating systems as they apply in different regions of the country.

TASK STATEMENT

I. DATA GATHERING:

For four geographic regions, collect the following data for each of the technologies to be considered:

- Capital costs of equipment including installation costs
- Performance, efficiency and reliability characteristics
- O&M costs
- Fuel costs

Technologies to be considered are as follows:

Baseline Technologies: The following baseline technologies will be considered:

- Central oil heat
- Central electric resistance heat
- Central gas heat
- Electric heat pumps
- Insulation
- Community heating systems

Data will be collected from manufacturers, organizations including trade associations fuel suppliers, utilities, in order to determine the cost of service with each technology. Organizations will also be queried as to proposed modifications to baseline technologies, their economic effects on the market for each technology, and proposed timescale for the availability of modified baseline technologies.

New Technologies: The following new technologies will be considered:

- Central storage heaters
- Room storage heaters
- District heating
- Coal furnaces
- Solar heating
- Gas heat pumps
- New insulation materials
- New construction techniques
- Aces
- Improved community systems (ICES, etc.)

Data will be collected from manufacturers where these new technologies are to be available in the near future. Data from ERDA program managers will also be requested to estimate the economics of new technologies where the projects are sponsored by ERDA.

Fuel prices will be the same for baseline technologies and for new technologies.

ANALYSIS:

The analysis will result in a determination of the least lifecycle cost of using each of the technologies to be considered. The analysis will proceed as follows:

A standard dwelling unit will be assumed to determine the heating demands to be satisfied. Lifecycle cost for each technology will be derived.

The requirements for the heating system will then be varied by assuming use of more and less insulation. For each case considered, lifecycle cost will be calculated for heating-plus-insulation system. Several iterations of this procedure will establish the required amount of insulation and the required size of the heating unit in order to arrive at a minimum lifecycle cost for that particular technology.

The above analysis will be repeated for 4 geographical regions and for each of the technologies to be considered.

TRW ENERGY SYSTEMS PLANNING DIVISION
CONSERVATION PLANNING AND POLICY TASK STATEMENT
CONTRACT NO. EC-77-C-03-1446
CONTINUATION SHEET

TASK STATEMENT NO.	EFFECTIVE START DATE	SCHEDULED COMPLETION DATE	PAGE 5 OF 5
5	June 13, 1977	September 13, 1977	

DELIVERABLES: A report compiling the data and describing the analysis for each of the technologies with results displayed so as to emphasize the relative costs and technical performance of each of the technologies.

A. L. Wood (signed)
TRW PROJECT MANAGER

George R. Murray (signed)
GOVERNMENT PROJECT OFFICER