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QR #35

MARKET ANALYSIS FOR
FUEL CELL TOTAL ENERGY SYSTEMS

RPA Reference No.: RA-77-2953
ERDA Contract No.: EY-76-C-03-1223-QR35

T.O. 35

AT03-76CS70035

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July 22, 1977

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INTRODUCTION

As part of its work on the the development of the phosphoric acid fuel cell, ERDA's Division of Conservation Research and Technology (CONRT) and Buildings and Community Systems (B&CS), of the Office of Conservation, have contracted with Oak Ridge National Laboratory (ORNL), and its subcontractor, Resource Planning Associates, Inc. (RPA), to study the potential market for fuel cell total energy systems (FCTES). The work plan, schedule, and staffing plan which follow outline in detail how the work is to be carried out by the Oak Ridge and RPA teams. The goal of the study is to supply an objective evaluation of the potential number of unit sales and the impact of possible federal participation. This information will be used for the FCTES program review scheduled for this coming December.

To provide the answer for ERDA, ORNL and RPA will estimate the total potential market for the FCTES in the commercial, residential, and institutional sectors, to the year 2000. The institutional barriers to the widespread use of FCTES will be examined in detail, as will the competitive position of the new technology when compared with several others. This analysis will be integrated with the market study to determine a range of the possible sales levels of fuel cells. Alternatives for federal participation in market development will be analyzed and summarized in cost/benefit format.

ORNL and RPA will present the results of their study to senior ERDA program management by an oral briefing, and later by a written report.

WORKPLAN TASK DESCRIPTION

WORKPLAN TASK DESCRIPTIONS

TASKS	OBJECTIVES	METHODOLOGY	SOURCE/ RESPONSIBILITY PARTY	PRODUCT
0. <u>Draft and Final Work Plan</u>	To display tasks and responsibilities in detail prior to contractual agreement.		RPA--Requires formal ORNL acceptance	work plan and supporting materials including new cost proposal (deliverable 1) due to ORNL by July 22.
1. <u>Define Total Market and Identify Homogeneous Segments</u>	To establish relevant market and to create segments which may be subject to detailed analysis.	A formal set of project assumptions will be kept and submitted to ERDA by September 9.	RPA ORNL will support	DRAFT Market Report (deliverable 2)
1.1 Establish ERDA Base Case Requirements	To have a commensurate starting point to previous analyses. Also to establish conventions for analysis.	Review of existing studies to identify previous assumptions. ORNL, RPA, ERDA, UTC, joint meeting. Emphasis on TARGET study and production cost data.	RPA/ORNL support ERDA must supply supporting documents immediately	
1.2 Define and Identify Total Market and User Characteristics	To define and develop a data base reflecting: <ol style="list-style-type: none"> ERDA's target markets by size (kW) and sector (e.g., commercial), and on or off grid, new or retrofit Time Frame to be to year 2000 Load profile components Geographic fuel price segments and projections Geographic heat pump efficiency segments Alternative ownerships of fuel cells 	Meeting ORNL, RPA, ERDA, UTC Engineering data from ITC, CCB, Aerospace, IGT Primarily FEA price data and PIES scenarios ERDA/FEA data Previous RPA research	RPA, ERDA ORNL RPA/ORNL ORNL RPA	

*Electric
Gas
Building*

WORKPLAN TASK DESCRIPTIONS

TASKS	OBJECTIVES	METHODOLOGY	SOURCE/ RESPONSIBILITY PARTY	PRODUCT
	7. Pertinent economic factors of fuel cell ownership and use			
	8. Number of current and projected gas users			
	9. Relationship between size and loads			
	To Determine:			
	10. Number of total potential users in the future	Forecasts	RPA	
	11. Nature of future load profiles.	Engineering/economic forecasts using BNL energy use elasticities	RPA/ORNL	
1.3 Segment the Market	1. To determine a set of homogeneous segments based on characteristics established in 1.2		RPA	Estimate of potential users by segment
	2. To partition potential users by segments established in the above.		RPA	
1.4 Check Segments for Compatibility with Fuel Cell Total Energy Systems (FCTES)	To eliminate as soon as possible segments that are incompatible with the total energy approach.	To evaluate against nominal load profiles implied value per kW of fuel cell system at 50% and 100% electrical load - see task 3. (possibly only at 100%)	ORNL	Ordering by segment of value

WORKPLAN TASK DESCRIPTIONS

TASKS	OBJECTIVES	METHODOLOGY	SOURCE/ RESPONSIBILITY PARTY	PRODUCT
2. <u>Institutional Analysis</u>	To identify, and where possible, quantify the types of institutional problems which will present barriers to the utilization of fuel cell energy systems		RPA	Draft Report on Institutional Problems (deliverable 3)
2.1 Define Preliminarily the Key Issues and Subissues and Formulate Preliminary Hypotheses	To specify types of problems that may occur and key associated issues (i.e.) <ul style="list-style-type: none"> • backup service • franchise laws • governmental policies • regulatory time lag • utility attitudes. 	Review key related studies and prior RPA work. Conduct library search and make select industry contacts.	RPA	A summary of issues within each identified area.
2.2 Develop Methodological Approach to Testing Hypotheses	To establish the methods and tools to collect the relevant information needed to qualify the issues identified in 2.1.	Define regions, systems, etc. for study purposes. Analyze methodologies of related studies. Identify data sources and collection approach.		
2.3 Test Methodological Approach	To check planned approach.	Conduct interviews to test for completeness of issue identification and validity of analytical approach. Initiate data collection approach to test for viability.	RPA -- ERDA representative must approve interview formats, etc. (It would be desirable to see UTC work)	
2.4 Finalize Methodological Approach	To revise: <ul style="list-style-type: none"> • issues and hypotheses • structure of analysis • data collection approach. 	Use information gathered in 2.3 to make necessary corrections.		
2.5 Implement Analysis		Collect and analyze data. Formulate conclusions.		
2.6 Test Conclusions for Reasonableness and Completeness	To assure that knowledgeable people have no significant disagreements on study methodology, execution, etc.	Review with select study participants.		

WORKPLAN TASK DESCRIPTIONS

TASKS	OBJECTIVES	METHODOLOGY	SOURCE/ RESPONSIBILITY PARTY	PRODUCT
1. <u>Technical and Cost Analysis of Competing Systems and Fuel Cell Total Energy System</u>	To technically complement Task 1 efforts and to provide a set of alternative system options (qualified by <u>cost and efficiency</u>) which can provide the same total energy functions as the fuel cell system.		ORNL	A set of system designs qualified by cost and performance where regional fuel prices and projections and materials costs are presented as explicit arguments of the cost function.
3.1 Validation of UTC Information on Cost & Estimate of FCTES Cost Function	To validate UTC assumptions and to develop supply cost function which reflects learning curve phenomena, economies of scale and technological advancement. UTC System assumptions (i.e., # of modules) will also be reviewed.	UTC data, previous studies	ORNL/RPA	
3.2 Development of Load Profiles	To develop load profiles for each regional building type segment that reflect operating and HVAC loads.	When possible, existing load data will be used: <ul style="list-style-type: none"> • CCB/UTC load profiles • IGT residential profiles • ITC institutional profiles • Aerospace commercial profiles • ORNL profiles • NASA Lewis Apartment profile Profiles must be modified to incorporate future energy conservation effects.	ORNL	
3.3 Conceptual Design of Competing Systems (including conventional)	To specify components and function of several competing systems; these must be responsive to different load profiles and geographic segments identified in Task 1. These systems will include the four in OTC study plus ACES, gas heat pump and district heating.	System design procedures.		

WORKPLAN TASK DESCRIPTIONS

TASKS	OBJECTIVES	METHODOLOGY	SOURCE/ RESPONSIBILITY PARTY	PRODUCT
3.4 Preliminary Value Analysis	To derive a preliminary ordering of Task 1 segments based on conventional systems.	For each segment (sector, geographic, load profile, etc.) the implied value per kW of fuel cell system (based on conventional alternative) shall be estimated based on meeting 50% and 100% of electrical load. Capability must exist for calculating value in future years as a function of future fuel, material, labor and O&M costs.	ORNL RPA will coordinate on Task 1 data.	Ordering segments (preliminary)
3.5 Alternative System and Cost Development	To develop detailed system and cost data. Economic assumptions to match Task 4.1 assumption.	Based on compatibility with segment, several designs will be developed in detail--cost will be explicit function of capital investment, regional fuel prices, and O&M requirements.	ORNL RPA will coordinate	
3.6 Final Value Analysis	To derive a final ordering of segments based on the best competing system, by segment.	Same as 3.2 except for non-conventional alternatives		

WORKPLAN TASK DESCRIPTIONS

TASKS	OBJECTIVES	METHODOLOGY	SOURCE/ RESPONSIBILITY PARTY	PRODUCT
4. <u>Assess Market Penetration</u>	To assess the feasible economic market for FCTES, now that market is limited by institutional barriers, and how product usage will progress over time.	A computer model will be constructed to evaluate FCTES versus alternative system cost performance. Based on these comparisons, market penetration will be projected by segment.	RPA	Product usage by units and kW over time; energy savings over next best alternative.
4.1 Define Market Environment Over Time	To synthesize Task 1 and Task 2 results into a base case, and select parametric changes for sensitivity analysis.	Review of Task 1 and 2 results to designate base economic, institutional, and regulatory variables.	RPA/ORNL ERDA Tech Rep approval	
4.2 Determine Segment Decision Process	To identify major players and processes in the selection of total energy systems.	Previous RPA work plus interviews with major players.	RPA	
4.3 Construct Penetration/Market Evaluation Computer Model	To have automated evaluation tool.	Previous RPA work	RPA	Evaluation Program
4.4 Assess Maximum Possible Market Penetration		Based on Task 3 Final Value Analysis (using base case data) all sectors in which FCTES has value in excess of NPV of system will be part of potential market in time zero. Sectors will also be eliminated in total or for some time lag based on Task 2 results. Potential will be updated on time basis as costs (value) change based on future fuel price and supply cost function.	RPA	
4.5 Assess Probable Market Penetration	To reflect the time dependent market diffusion of FCTES.	As 4.2 but with unit sales modified by diffusion process. Either Bass, Mitre, or similar diffusion models will be used. Results will summarize the number of units sold as a function of market scenario, FC size, and time.	RPA	
4.6 Sensitivity Analysis	To select key variables and associated range of parametric values, and quantify changes in penetration as a function of these parameter changes.		RPA, ERDA will review selection of parameters.	

WORKPLAN TASK DESCRIPTIONS

TASKS	OBJECTIVES	METHODOLOGY	SOURCE/ RESPONSIBILITY PARTY	PRODUCT
5. <u>Evaluate barriers and Incentives</u>	To identify, analyze and quantify the barriers to FCTES. Also to suggest potential federal roles to overcome these barriers and their relative impacts.		RPA	Draft task report.
5.1 Identification of Specific Barriers		Review Task 2 and Task 3 results and other RPA work to identify specific FCTES Barriers. Interviews with manufacturer and related supply industries.	RPA	
5.2 Generic Review of Alternative Incentives	To identify alternative federal policy alternatives to increase market penetration of any good.	Previous RPA work.	RPA	
5.3 Barrier-Incentive Matching	To identify several incentives policies which specifically address FCTES barriers and select several for specific evaluation.	Previous RPA work.	RPA/ORNL Approval of ERDA technical representative	
5.4 Incentive Evaluation	To evaluate cost and effectiveness of incentives.	Each incentive will be represented by a specific modification to market penetration model. Model will be rerun for each evaluation. Based on results, cost/benefit ratios will be determined. Appropriate structure for evaluation ratios will constitute a major research task.	RPA	

WORKPLAN TASK DESCRIPTIONS

TASKS	OBJECTIVES	METHODOLOGY	SOURCE/ RESPONSIBILITY PARTY	PRODUCT
6. <u>Reporting</u>	To present oral briefings, progress reports, draft and final reports.			
6.1 Monthly Progress Reports	To inform ERDA of project performance.		RPA/ORNL will each prepare reports. ORNL will coordinate and submit to ERDA.	Brief monthly summaries
6.2 Draft Task Report	To present task findings.		RPA #1, 2, 4, 5 ORNL #3	Task Draft Report - rough edit and typed
6.3 Final Reports	To present final report.		ORNL, RPA editorial review.	Six final edited and camera ready copies, available 60 days after final briefing.
6.4 ORAL Briefings	Study results will be presented in a formal briefing to ERDA, BCS, and CONRRT personnel.		RPA/ORNL	Slides, view graphs, etc. Final briefing will be available by Monday, December 19.

TIME SCHEDULE

TIME SCHEDULE

TASKS

0. Draft and Final Work Plan
1. Define Total Market and Identify Homogeneous Segments
 - 1.1 Establish ERDA base case requirements
 - 1.2 Define and identify total market and user characteristics
 - 1.3 Segment the market
 - 1.4 Check segments for compatibility with Fuel Cell Total Energy Systems (FCTES)
2. Institutional Analysis
 - 2.1 Define Preliminarily the key issues and subissues and formulate preliminary hypotheses
 - 2.2 Develop methodological approach to testing hypotheses
 - 2.3 Test methodological approach
 - 2.4 Finalize methodological approach
 - 2.5 Implement analysis
 - 2.6 Test conclusions for reasonableness and completeness
3. Technical and Cost Analysis of Competing Systems and Fuel Cell Total Energy Systems
 - 3.1 Validation of UTC information on cost and estimate of FCTES cost function
 - 3.2 Development of load profiles
 - 3.3 Conceptual design of competing systems (including conventional)
 - 3.4 Preliminary value analysis
 - 3.5 Alternative system and cost development
 - 3.6 Final value analysis
4. Assess Market Penetration
 - 4.1 Define market environment over time
 - 4.2 Determine segment decision process
 - 4.3 Construct penetration/market evaluation computer model
 - 4.4 Assess maximum possible market penetration
 - 4.5 Assess probable market penetration
 - 4.6 Sensitivity analysis
5. Evaluate Barriers and Incentives
 - 5.1 Identification of special barriers
 - 5.2 Generic review of alternative incentives
 - 5.3 Barrier-incentive matching
 - 5.4 Incentive evaluation
6. Reporting
 - 6.1 Monthly progress reports
 - 6.2 Draft task report
 - 6.3 Final reports
 - 6.4 Oral briefings

LEGEND

- RPA deliverables
- ◻ DRNL deliverables
- ▲ ERDA decision points
- Meetings
- RPA monthly summaries to DRNL

- 01. Work plan
- 2. Task 1 draft report
- 3. Task 2 draft report
- 4. Software documentation
- 5. Task 4 draft report
- 6. Task 5 draft report
- 01* Preliminary value analysis summary
- 2* Cost and performance summary on alternative systems
- 3. Task 2 draft report
- 4. Draft final report
- 5. Final report
- 01. Progress review meeting at RPA
- 2. Progress review meeting at DRNL
- 3. Progress review meeting at ERDA
- 4. Briefing rehearsal at RPA
- 5. Final briefing at ERDA
- A1. ERDA review base case assumptions and data base
- 2. ERDA review of institutional field approach
- 3. ERDA review of alternative systems and costs
- 4. ERDA review of alternative incentives
- 5. ERDA review of draft task reports
- 6. ERDA review of draft final report

* Critical path

STAFFING PLAN

STAFF PLAN
MAN HOURS

Personnel	Task	0	1	2	3	4	5	6	Total
H.C. Bailly	P	20		40		20	120	40	240
H. Hagler	P	40	40			20			100
R. Shanker	S.A.	120	80	120	40	200	120	160	840
S. Bowden	S.A.	24		240			40	40	344
L. Koppelman	AII	120	200		40	280	240	120	1,000
D. Hessen	AII	40		440			80		560
A. Luttwak	AII			480		320	120		920
R. Clark	AI					240	320		560
A. Palmer	AII		320			160	120		600
D. Darrington	T.A.					800		120	920
J. Fitch	AII		320			40			360
S. Berger	R.A.		320			320	160		800
J. Kelly	T.A.			160					160
D. Weinstein	AI			160		40			160
D. Greenstein	AII	24	80	80			80	80	384
B. Coltellaro	AII							120	120
Clerical		40	160	160		160	160	320	1,000
Total		428	1,520	1,880	80	2,600	1,560	1,000	9,068

P - Principal
 S.A. - Senior Associate
 AI - Associate I
 AII - Associate II
 T.A. - Technical Associate
 R.A. - Research Associate

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