540
4-26-78

Ah. 350

SAN/1225/T010–1

ENERGY

CONSERVATION

INVESTMENT RISK EVALUATION TECHNIQUES: USE IN ENERGY-INTENSIVE INDUSTRIES AND IMPLICATIONS FOR ERDA'S INDUSTRIAL CONSERVATION PROGRAM

July 13, 1977

Work performed under Contract No. EY-76-C-03-1225-010

Energy and Environmental Analysis, Incorporated
Arlington, Virginia

MASTER

DEPARTMENT OF ENERGY · UNITED STATES OF AMERICA

U. S. DEPARTMENT OF ENERGY

Division of Industrial Energy Conservation

DISCLAIMER

Available from the National Technical Information Service, U. S. Department of Commerce, Springfield, Virginia 22161.

Price: Paper Copy $6.50
Microfiche $3.00

SAN/1225/T010–1
Distribution Category UC-95f

INVESTMENT RISK EVALUATION TECHNIQUES:

USE IN ENERGY-INTENSIVE INDUSTRIES AND IMPLICATIONS FOR ERDA'S INDUSTRIAL CONSERVATION PROGRAM

July 13, 1977

(703) 528-1900

Prepared For:

Division of Industrial Energy Conservation
Energy Research and Development Administration
Office of Conservation
20 Massachusetts Avenue, N.W.
Washington, D.C.
20545

Prepared By:

Energy and Environmental Analysis, Inc.
1701 North Fort Myer Drive
Suite 1213
Arlington, Virginia
22209

EXECUTIVE SUMMARY

The trade-off between risk and rate-of-return in investment evaluations is crucial in assessing the commercial potential of future energy-conservation technologies. The focus of the Industrial Conservation Program at ERDA is to reduce the perceived risks of a given technology to the extent that the private sector will adopt the technology within the normal course of its business operations. These perceived risks may emanate from technical, institutional, or commercial uncertainties, or in many cases they may result merely from a company's or industry's lack of previous experience with a particular technology. Regardless of the source of the risk surrounding a project, the uncertainty it poses to the private sector will serve to inhibit decisions to invest.

The purpose of this study was to evaluate the treatment of risk in capital investments in certain energy-intensive industries which are the primary targets of ERDA's Industrial Conservation Program. In order to accomplish this evaluation we relied on several sources of information including published surveys, personal interviews, academic publications, financial data bases, etc. We endeavored to place these risk evaluation considerations within a context that includes capital budgeting practices and procedures, organizational considerations, and basic rate-of-return evaluation procedures in the targeted energy-intensive industries (Petroleum, Chemicals, Paper, Textiles, Cement, Food Processing, Aluminum, Steel, Glass, and Agriculture).

General Findings on Evaluation Techniques

It is easier to characterize basic capital budgeting procedures and methods of simply calculating rate-of-return evaluations in industry than it is to distinctly portray the techniques used to evaluate risks in investments. A "textbook" explanation of discounting techniques would capture almost all of the information about the nature of rate-of-return calculations in the energy-intensive industries studied. Particularly when risk is a consideration, other techniques, when used, are generally supplemental and secondary to internal rate-of-return or net-present-value calculations.

In a number of industries, capital investments were categorized according to type of investment. Similar categories were discovered in many of the interviews suggesting consistency across industries as to how capital projects could be generally characterized. The notion of "mandatory" versus "discretionary" investments is prevalent throughout all the industries; however, the implications of a project being in a particular category is quite different from industry to industry and sometimes from company to company. For companies or industries that are to any significant extent capital constrained, a project classified as "discretionary" may have to meet unusually high hurdles since it will be competing for a relatively small pool of funds. This is not the case for industries that have easier access to sufficient capital funds. There is also some cross-industry differential in the importance associated with energy conservation; however, this tended to be related more to assured future energy supplies rather than incremental economics. In many cases, this circumstance could determine whether or not an energy related investment is classified as "discretionary" or "mandatory." An energy-related investment is more likely to be considered "mandatory (sometimes termed "survival") if it acts to guard against supply interruption.

Considerations of Project Risks

In most energy-intensive industries capital budgeting procedures include express considerations of risks. The capital intensity of these industries places a premium on thorough analysis of capital programs. However, the methods for dealing with risk vary widely from highly subjective qualitative procedures to more intricate statistical evaluations. In many cases the analysis used to evaluate risk varies from project to project depending on the level of risk relative to typical investments within a company. Such wide variation in procedures makes it more difficult for ERDA to effectively reflect these evaluation procedures in their technology funding decisions.

In Section VI of the report we suggest a sequence of evaluative procedures which can be applied generically and which are likely to result in evaluations consistent with those practiced by the energy-intensive industries targeted in the ERDA program. The method is a sequence of techniques that build on each other and yield additional information about the economic risk of a given project. Clear funding decisions on a given project can "fall-out" of the procedure at several points along the way, thus making it unnecessary to complete the more detailed and intricate steps. The basic steps include: deterministic discounted cashflow modeling, sensitivity analysis, scenario analysis and, finally, probabilistic analysis. Probabilistic analysis would only be required for the largest and most uncertain capital projects in ERDA's portfolio.

One growing body of financial theory that could be folded into this evaluation scheme is called the Capital Asset Pricing Model (CAPM). Its application to project evaluations could be useful as a means of calculating the cost of capital or required rate-of-return on an industry to industry basis. CAPM could potentially also be used for determining the risk/rate-of-return trade-off for individual projects.

A strategic issue for ERDA's industrial conservation program is the selection of the information transferred to the private sector about a given technology. The financial and economic data provided needs to focus more on the inputs to an evaluation rather than the results. Before being accepted by a company any project will have to undergo normal evaluation procedures; by providing the evaluation inputs, ERDA can facilitate this process. Furthermore, highly processed evaluation results leave questions about input assumptions that can foster skepticism. Optimizing this information transfer aspect of financial evaluations will play an important role in ERDA's conservation programs.

Evaluations of Energy Conservation Investments

In every one of the interviews, the following question was asked: "Are energy conservation investments evaluated differently from any other investment?" All of the companies stated that an investment which saves energy costs is treated the same as any other investment. The evaluation techniques used are the same, and it was generally found that energy conservation investments are subject to similar criteria as other investments of comparable risk. In fact, the only instances where energy conservation investments were treated differently found them apparently facing somewhat lower hurdles than many other investments. In two of the interviews it was stated that the energy conservation investments being currently undertaken are less risky than most other investments (especially capacity expansion) being considered. In two other cases, it was stated that energy conservation (and especially fuel form conversion) was an important "business strategy," and therefore energy investments were getting a somewhat higher "priority" than many other types of investments.

Certain companies may, in fact, raise hurdle rates and thereby penalize energy conservation investments because of the fact that they do not expand capacity or are "discretionary." However, this will depend on the business strategy of the particular company (e.g., are they seeking to cut costs?), and the capital availability situation of the company (e.g., are they rationing capital to the point where nearly all investments not required by law are being rejected?).

Industry Analysis

Much can be learned about the potential for energy conservation investments in an industry without focusing on any particular project or technology. To provide a useful backdrop to the project oriented micro-economic analysis discussed above, general industry financial information was obtained from a computerized financial data base. Section V of the report is an industry by industry analysis of the general financial circumstances facing the targeted energy-intensive industries. This macro-level analysis offers interesting insights into several factors that could be instrumental in determining how receptive different industries may be to energy conservation technologies. The results often verify general circumstances that were identified by industry executives in our interviews. Earnings performance, historical capital spending, current capital availability and other pertinent parameters are evaluated for each target industry to assess the potential for that industry adopting new energy conservation technologies. Similarly, the potential impact of various Federal incentive programs is evaluated.

A relatively simple system could be implemented to monitor such general financial and economic performance of industry groups or companies with provisions for updating as often as necessary.

The relative level of risk in capital asset investments has probably grown secularly for several decades if not longer. Advances in technological sophistication, capital magnitudes associated with economies of scale, environmental and other resource limitations and inflation have all served to increase the level of uncertainty in our economy's capital asset base. The academic and business communities have both responded to this circumstance by developing and implementing more sophisticated and systematic methods of dealing with uncertainty in investment evaluations. But the fact that many of these techniques are still evolving and the fact that the needs from industry to industry differ greatly, make it difficult to prescribe a discrete method for simulating the private sectors risk evaluation techniques.

A careful combination of the elements of the risk/rate-of-return procedures outlined in this report along with general industry analysis would allow ERDA to strategically optimize its funding portfolio by industry as well as by project. Furthermore, it would allow easier identification of the appropriate Federal role in sponsoring various energy conservation technologies through to commercialization.

TABLE OF CONTENTS

TABLE OF CONTENTS (Continued)

SECTION I

INTRODUCTION

Knowledge of industry's capital budgeting process and its treatment of risk in capital investments is important to ERDA's Industrial Energy Conservation program in a number of ways. It is the goal of ERDA's program to choose conservation technologies which are not currently being utilized by industry, but which have potential for commercial application. By funding research, development, and demonstration, ERDA's program attempts to remove barriers to commercialization which are based on technical uncertainty, economic risks, etc. At the earliest possible time, ERDA attempts to transfer the technology to the private sector for commercial application.

The following issues are of relevance to ERDA's Industrial Energy Conservation Program:

- What types of techniques are used in industry to screen proposals for capital commitments? This is of importance in ensuring that the methods used by ERDA to screen proposals for funding will accurately identify projects which will be attractive to industrial users. In transfer of information concerning performance of a technology, it will also be important to present evaluations which, in terms of format, level of detail, and sophistication, are similar to those which the private sector performs for its own use in capital budgeting. This subject area is discussed in Sections II and III.

- What is meant by "risk", and how do industrial companies evaluate risks and incorporate risk considerations into their capital budgeting decisions decisions? To what extent can the trade-off between risk and industry's desired rate of return be quantified? For purposes of ERDA's program planning, it is necessary to use private sector methods to identify and screen out proposals with inordinate amounts of risk. Transfer of technologies to the private sector will be most successful if risks are identified explicitly. Inter-industry differences in risk aversion can have implications for market penetration of risky technologies. Techniques used to deal with risk are discussed in Section IV.

- What determines the size of the total capital pool in a company, and what types of investments are (and will be) competing with energy conservation? What kinds of generalizations can be made about the financial circumstances of industry groups? ERDA technologies may appear to pass normal hurdles and to have acceptable levels of risk when evaluated using private sector methods. However, these technologies may not penetrate in certain industries because of a general lack of capital for those projects not required as the result of government regulations or equipment replacement needs. The general financial condition of an industry as a constraint to penetration of ERDA's conservation investment is discussed in Section V.

- What is an appropriate level of financial analysis for different ERDA proposals and technologies? What are the uses and limitations of private sector investment evaluation techniques for purposes of ERDA program planning? If economic incentives for technologies were to be offered, what form should they take in order to be favorably evaluated? These general program planning issues are discussed in Section VI.

This report is based on four major sources of information:

1. The current literature on the theory of capital budgeting techniques. This voluminous body of information was consulted in order to capture current thought on theoretically correct capital budgeting techniques. Much of the recent literature focuses on the issue of how to best incorporate risk into capital budgeting.

2. Published empirical studies of capital budgeting techniques currently used in industry. A number of studies are available which were done in the last five or six years and which give valuable insights into corporate goals, techniques used to allocate capital funds, and methods for incorporating risk. These studies generally involve large-scale mailing of questionnaires to between 100 and 200 corporations. The companies surveyed are nearly always relatively large companies with emphasis on industrial companies.

3. The "Value Line" computerized financial data base. This system was the source of financial data giving

the financial position of a number of the energy intensive industries. Data on current and historical financial performance was drawn from the system and analyzed in order to reach conclusions regarding the outlook for capital investment.

4. In-depth interviews with senior financial management of about 15 energy-intensive manufacturing companies. Interviews were conducted with large companies in a number of industries that use substantial quantities of energy.[1/] Most of the interviews were conducted at the corporate headquarters of the companies, and involved senior management (e.g., Vice President, Finance; Manager, Budget and Controls; Division President; Manager, Operations Research; etc.). The interviews dealt with capital budgeting procedures in the company, and focused especially on evaluations of risk. The interviews had a special emphasis on energy-related investments and the procedures that are used to evaluate their risks and rank them relative to non-energy investments. The interviews proved to be an invaluable source of information on not only the mechanics of capital budgeting techniques, but also general industry attitudes towards risk and energy investments. The insights gained were useful in more fully understanding the actual application of capital budgeting techniques to risky investments. These insights went beyond those which could be gained from the published results of general surveys.

1/ Steel, petroleum refining, paper, glass, cement, chemicals, aluminum, and food.

At a number of places in this report, the results of specific interviews are used to illustrate general concepts and to substantiate or contradict the results of broader published surveys. Passages are marked with a (▲) in those cases where summaries, paraphrasing of individuals, or direct quotes from the interviews are presented. Company names are not given because of confidentiality considerations. Further information on the interviews can be found in Appendix A.

SECTION II

OVERVIEW OF THE CAPITAL BUDGETING PROBLEM

A. Determination of the Size of Total Capital Expenditures

The first step in the capital budgeting procedure in a company is a management decision regarding the size of the total capital pool for a particular year. Such a decision is a function of a number of factors, and the circumstances of each company will be unique in some ways. However, some basic similarities in overall levels of capital expenditures do exist within many well-defined industry groups (e.g., steel, petroleum, cement, etc.). Such industry-wide trends (and the extent to which generalizations about industry groups can be made) will be discussed in detail in Section V.

In general, the size of the total capital pool is determined by management based on a consideration of the company's profitability and ability to raise capital as well as the investment opportunities (and "requirements") which the company has. Debt-equity considerations are an important factor in determining the size of a company's total capital pool. Companies will often put serious constraints on their capital spending in order to reduce the amount of debt that they have and thereby improve their financial rating (e.g., Moody's) and reduce their cost of capital. There can be a cyclical pattern to capital spending, as was the case with some of the companies interviewed.

- A steel company explained that it was currently limiting its capital expenditures as much as possible. Its capital pool is limited to government required expenditures (e.g., pollution control) and maintenance projects, with only a very few "discretionary projects." The current source of funds for the capital pool is entirely depreciation and retained earnings; the company is not borrowing now in an attempt to reduce its debt/equity ratio. When the ratio drops to a more acceptable level for the industry, the company will, as it has historically, undertake a proportional borrowing program and increase capital expenditures.

In addition to such capital supply considerations, the size of the total capital pool will depend on the profitable alternatives available for investment and the particular business strategy which the company wishes to pursue. The interviews with companies in the energy intensive industries uncovered a variety of situations regarding the demand for capital relative to supply.

- The chemical subsidiary of a major oil company said that the company is "capital intensive but managerially short." The company is not generally capital limited, and the real constraint "is a lack of people to manage and analyze projects."

- An aluminum producer stated that several years ago the demand for capital far exceeded the supply. During a period of heavy environmental spending a number of normally attractive projects were turned down. The hurdle rate rose considerably in an attempt to allocate capital.

B. Allocation of the Capital Pool

Once the size of the capital pool has been determined, it must be allocated among various capital projects. This is generally a two step process which starts with a broad allocation of capital among different general categories of investments. For example, management might first allocate the total quantity of capital among categories such as: (1) government requirements (e.g., EPA and OSHA), (2) equipment replacement and plant maintenance, and (3) "discretionary" investments. This preliminary allocation will often not be based on a detailed consideration of the specifics of particular individual projects. In the case of an allocation of funds to the "replacement and maintenance" fund, it is unlikely that management will analyze all of the individual projects within that category prior to the allocation in order to see if they are all worthy of funding. There are a number of different categorization schemes for classifying investments. These will be discussed further below; the discussion will consider their role in the capital budgeting process.

After the broad allocations of capital to major categories are done, each of these pools are allocated among individual capital projects. It is this project-specific allocation of capital which the next two sections will deal with in detail. The capital budgeting problem at this point involves analysis of different specific investment proposals and a decision to fund a particular project because it has the highest return (payback, rate of return, present value, etc.) or because it meets some other criteria such as fitting into a larger "business strategy." The investment decision is nearly always made on the basis of both quantitative measures of economic worth as well as qualitative considerations. The emphasis of the sections that follow is on the quantitative measures of project worth. A number of studies of investment evaluation techniques based on large-scale surveys of companies included questions on "qualitative" factors which affect the investment decision. Employee morale and safety, image, legal requirements, and social concerns are all frequently mentioned as major qualitative factors. However, when one recent survey asked if the quantitative factors outweigh the qualitative, 77 percent of the 109 corporations replied that the quantitative factors dominate.[1/]

It is acknowledged that non-quantitative factors are of considerable importance in allocating capital among different competing projects. However, after careful consideration of a number of published surveys of investment evaluation techniques and after in-depth interviews with the financial management of large corporations in the energy intensive industries, it is clear that the most useful model of corporate capital budgeting is one based on quantitative calculations of rate of return. That is, an assumption that investment decisions are made on the basis of a calculated return on investment offers the best predictability of corporate behavior in a relatively simple model.

"Management judgement" is a term often used by companies to describe how investment decisions are ultimately made. It is, in fact, true that no company makes investment decisions entirely by performing ROI calculations on all alternative investments and then mechanically comparing the results against some firm criteria. Management judgement is always an important factor in interpreting the results of financial analysis. Management judgement is particularly important when evaluating projects which have substantial risks or

---

1/ "The Capital Expenditure Decision-making Process of Large Corporations", J.W. Petty, et. al., The Engineering Economist, Vol. 20, No. 3, 1975.

uncertainty. It is difficult to reduce the complexities of a risky investment to a single measure of profitability such that it can be unambiguously compared to other investments. Nevertheless, "management judgement" is often applied to calculations of returns which include fairly structured risk assessments. By understanding these methods of risk assessments and how they relate to both deterministic calculations of ROI on the one hand and purely qualitative "management judgement" on the other, it will be possible to more accurately predict corporate capital budgeting decisions. Such an understanding is important to ERDA because of ERDA's need to be able to predict industry responses to different risky energy conservation technologies.

C. Categorization of Investments - Effect on Capital Budgeting Decisions

Many of the companies interviewed classify each proposed investment according to either a formal or informal categorization scheme (e.g., "mandatory investments", "replacement", "new capacity", etc.). This step in the capital budgeting process is sometimes presented as being the establishment of "priorities." To the extent that a "priority" listing of categories exists, this could become as important as (or more important than) calculating an ROI for each individual investment. In fact, however, careful questioning revealed that categories are significant in the capital budgeting process, but generally not as decisive a factor in capital project funding decisions as Return on Investment.

Many different categorization schemes are used by the companies interviewed. Government required "mandatory" invest-

---

1/ Although companies will still search for alternatives, and will evaluate the (often considerable) benefits which come from delaying the investment somewhat.

ments such as those required by EPA and OSHA are generally grouped in a category which gets "first priority" for capital funds.[1/] "Replacement and Repair" was another common category which generally was considered to have a "high priority". Investments within this category (along with "mandatory") were sometimes not evaluated and ranked by using sophisticated evaluation techniques. This is partly because many of the replacement investments tend to be smaller in size, and corporate management often delegates specific investment decisions to the divisions and only manages the replacement funds on a total "pool" basis.

The "mandatory" and "replacement" categories were the only categories which were even somewhat "standard" among those companies using categories. Some companies used the term "discretionary" to refer to all investments not in the mandatory or replacement categories.[2/] These companies sometimes had various "sub-categories" within the discretionary category. Other companies did not use the concept of discretionary versus mandatory in any formal sense. These companies had categories of investments such as "growth," "existing businesses," "cost saving", "new capacity," "survival," or simply dollar size, depending on the particular needs of the company.

It was generally the case that the different categories were used to systematically identify those qualitative aspects of an investment which, in addition to ROI, are of importance to funding decisions. For example, several companies mentioned

---

1/ Replacement or repair investments are not always "mandatory". It may be decided to let an old facility fall into disrepair and abandon it, as was the case with one steel company's treatment of some coke ovens where repair would have been an option with a low ROI.

2/ Ibid.

"survival" investments as a formal category. This category tended to include mainly energy supply investments which, if not undertaken, could lead to lost production, plant closures, etc. Investments in this category generally got a priority for funding which the calculated ROI by itself may not suggest. However, inclusion in most other investment categories would not automatically bestow such a significantly increased priority.

▲ A cement company uses the following formal categories of investments, which in order of "priority" are:

(1) legal & safety } "irrespective of ROI"
(2) mandatory }
(3) completion of ongoing projects
(4) maintenance of worn out equipment
(5) modernization of capacity
(6) new capacity with high expected ROI
(7) new capacity with average expected ROI
(8) other projects

While these were said to be "priorities," close questioning resulted in it being established that projects in lower priority categories are often approved over those in higher categories if the ROI is higher.

Categories are often used to make it easier for management to direct different "business strategies" by knowing what types of investments are being considered. For example, a company which decides that the long term profitability of the company requires capacity expansion can give some element of priority (above and beyond calculation of ROI) to investments in the "capacity expansion" category. The use of priority categories clearly involves many "gray areas", as the interviews with a paper and aluminum company clearly show:

- An aluminum producer uses the concept of "discretionary spending", but after a lengthy discussion of the concept, it was agreed that there is a definite "gray area" as to what <u>is</u> discretionary. For example, in the energy area an investment in energy <u>availability</u> ("to maintain production") would probably be viewed as "non-discretionary", whereas an <u>efficiency improvement</u> investment (to save energy costs) would probably be viewed as "discretionary."

- The concept of discretionary investments was discussed at length with a paper company. It was generally agreed that they may be required to jump a higher hurdle, but that this is not a clear cut concept. Many discretionary projects are omitted because of lack of capital, and <u>not</u> rate of return. For example, several years ago, no discretionary investments were made, and even certain "non-discretionary" investments (e.g., logging truck replacements) were put off. What a "discretionary" investment <u>is</u> is not always clear. As much as 1/3 of the capital budget might be "discretionary" (in the cost saving <u>or</u> capacity expansion categories), but the total quantity allocated by management to this pool will be largely judgement as opposed to strict ROI. Whether something is "discretionary" really depends on what it was that drove you to make the investment. Buying trees may <u>not</u> have been discretionary if the trees were needed for a sawmill (security). It is ultimately a function of the nature of the business strategy. If, for example, energy sufficiency is a business strategy (as it is with this company) then energy conservation and conversion investments are not discretionary. In forest management, however, fertilization is not discretionary in the long run, but it can be re-scheduled if necessary.

SECTION III

METHODS USED TO EVALUATE PROPOSED CAPITAL INVESTMENTS

A. Introduction

Most large companies utilize formal financial appraisals of capital projects which are based on one or more mathematical criteria. These criteria provide a way of projecting the expected profitability of a project. The results of such a calculation can then be compared to a minimum standard which the company has established as well as to other projects competing for capital. The major techniques used are as follows (in approximate order of usage):

1. Discounted cash flow rate of return,
2. Payback period,
3. Simple (accounting) rate of return, and
4. Net present value.

Many companies use more than one technique in evaluating capital investments. Most companies make some formal adjustment to their evaluations in order to account for risk, but risk adjustments are discussed separately in the next section. This section will discuss the application of the various criteria on a "deterministic" basis. That is, the techniques are first used by most companies by making "best estimates" for each of the input variables and then calculating a return. The four techniques listed above are generally used to arrive at a preliminary assessment of the value of a project. Most companies are careful to calculate returns in a consistent manner for all projects so as to be able to compare projects with each other as well as against some standard established by the company. However, a calculation of return serves nearly all companies as only a partial indicator of the desirability of pursuing a particular capital project. Both risk assessments and qualitative factors are also important in decisions on most capital investments.

B. Empirical Evidence of Investment Evaluation Techniques

1. Introduction

This section on capital budgeting techniques and the next section on risk evaluation techniques were based on two major sources of information: (1) published survey results, and (2) interviews with energy-intensive companies. The published surveys had the advantage of providing much broader coverage than would have been possible through interviews. The interviews focused on the energy-intensive manufacturing industries and provided much more detail about how various capital budgeting and risk evaluation techniques are actually applied. They also allowed for an assessment of industry attitudes towards risk and energy-related investments which the general surveys did not.

A number of surveys of capital budgeting procedures have been done by academic researchers. Five of these are summarized in Table 1. These five are particularly useful because they were done recently, emphasized fairly large manufacturing companies, and had large-scale questionnaire mailings. The questions asked on the surveys vary considerably, but all of the studies show data on usage of capital budgeting techniques and risk analysis methods. There were differences in the

TABLE 1

SUMMARY OF PUBLISHED STUDIES OF CAPITAL EVALUATION TECHNIQUES

Author	Date of Publication	Number of Companies Responding to Surveys	Sector(s) of Surveyed Companies	Size of Companies
P. J. Davey[1/]	1974	136	84% Manufacturing 16% Various Non-manufacturing*	Mainly Large
J. W. Petty[2/]	1975	109	100% Industrial ("Fortune 500")	Large
G. H. Petry[3/]	1975	284	68% Manufacturing 32% Various Non-manufacturing*	Large
J. M. Fremgen[4/]	1973	177	Various Sectors	Varied
T. Klammer[5/]	1972	184	100% Manufacturing	Varied

*Generally includes retail, utilities, transportation, mining, etc.

1/ "Capital Investments: Appraisals and Limits - A Report from the Conference Board", P. J. Davey, 1974.

2/ "The Capital Expenditure Decision-making Process of Large Corporations", J. W. Petty, Engineering Economist, Vol. 20, No. 3, 1975.

3/ "Effective Use of Capital Budgeting Tools", G. H. Petry, Business Horizons, October, 1975.

4/ "Capital Budgeting Practices: A Survey", J. M. Fremgen, Management Accounting, May, 1973.

5/ "Empirical Evidence of the Adoption of Sophisticated Capital Budget Techniques", T. Klammer, Journal of Business, July, 1972.

survey samples and differences in the questions asked and categories provided for responses. However, a general consensus is usually shown between the studies on key points, and these consensuses will be the focus of this section as well as the next section's discussion of risk evaluations.

Interviews were held with representatives of about 15 large corporations in a number of the energy-intensive industries. Companies were selected such that there was a diversity in industry affiliation and size of capital budget. Nearly all of the companies selected, however, were quite large. The interviews were with senior officials in the various companies who were familiar with capital budgeting procedures. Topics covered included: capital budgeting techiques, risk assessment methods used, energy conservation investment evaluations, and a discussion of capital investment in the company and how it can be affected by government incentives. Further details on the methodology for the interview segment of the study and a summary of the results of the interviews are provided in Appendix A.

2. Published Survey Results

Most of the survey results suggest that discounted rate of return (ROR) and payback are the two most widely used techniques for evaluating capital investments. Fremgen, Petry, and Petty all show that discounted ROR is somewhat more widely used than payback, although all of the surveys show that both techniques are used with approximately the same frequency. The "simple rate of return" (also called return on investment or "accounting rate of return") is generally shown to be the third ranking technique and Net Present Value (NPV) is usually the fourth most common. Both the simple rate of return and NPV generally rank fairly far behind discounted ROR and payback in terms of frequency of use. Numerous "other methods" are also listed as being used, although relatively infrequently compared to the four major techniques.

Fremgen's results are shown below as somewhat typical of the general findings of the studies:

INVESTMENT EVALUATION TECHNIQUES
("Methods in Actual Use")

	Methods Used	Most Important
Discounted ROR	71%	38%
Payback Period	67%	14%
Simple (or "accounting") ROR	49%	22%
NPV	20%	4%
Other Methods	16%	6%

There are some differences in the precise rankings shown by the different studies, but Fremgen's study is useful in illustrating two points which nearly all of the studies make. First, use of more than one technique is very common. The overlap suggested by the data between discounted ROR and Payback is particularly striking (71 percent of the companies use ROR and 67 percent use payback). Second, when asked to identify the "most important" method, a number of companies would not identify a single measure as most important. In these companies, either multiple hurdle rates exist, [e.g., a 15 percent ROR and a three (3) year payback] or no single quantitative measure of a project is compared against a set criteria ("hurdle").

The different studies investigate a number of relationships between evaluation techniques and various characteristics of the companies. Some of the major findings include:

- The capital intensive industries seem to prefer the time-weighted measures - discounted rate of return and net present value - and the less capital intensive firms prefer payback (Petry).
- Those industries which are capital intensive or exhibit rapid product obsolescence tend to use a greater <u>number</u> of evaluation techniques. While there is no strong relationship between size of company and type of technique used, larger companies tend to use a greater number of techniques (Petry).
- There are not any strong relationships between the industry that a company is in and the capital budgeting techniques which it uses. One exception is in use of risk techniques (discussed in the next section), where companies in the Petroleum Refining and Chemicals industries were much more likely to use a formal method of incorporating risk than companies in other industries (Klammer).
- Techniques used to evaluate investments in new product lines tend to emphasize the discounting techniques (NPV, discounted ROR) somewhat more than when screening investments in existing product lines (Petty).
- The use of discounting techniques has been increasing substantially (since 1964 and earlier), while the percentage of companies using simple rates of return or payback has been decreasing (Klammer and Petry).

3. Interviews with Energy Intensive Companies

a. Overview

The specific details of the capital budgeting process in each of the companies interviewed proved to be unique in terms of the investment proposal evaluation procedures, types of analysis done, risk assessment methods, and funding approval procedures. However, there were areas of considerable similarity in the basic technique used to screen capital expenditure proposals. Only one company interviewed did not use discounted cash flow analysis, and nearly half of the companies interviewed calculated both the payback and either NPV or Internal Rate of Return (IRR - "discounted cash flow rate of return") for investment proposals. Only two companies used a version of "Simple (Accounting) Rate of Return" as an indication of project profitability, and it is only in this area that the interview results are not in basic agreement with the results of the published surveys.[1/]

The goal of the in-depth interviews was not to attempt to make statistical inferences regarding differences in techniques between industries, between sizes of companies, etc. In fact, the results of the interviews are consistent with the broad published surveys in terms of an apparent lack of such relationships. This may not be too surprising with regard to company size, since all of the companies interviewed were quite large.[2/] However, even within the same industry (Chemicals) two companies were interviewed which varied greatly in the sophistication of their investment evaluation techniques. "Sophistication" is used here to mean the degree to which a

---

1/ The published surveys suggested a fairly high usage of simple ROI could have been expected.

2/ All companies were either "Fortune 500" companies or subsidiaries thereof.

procedure accurately reflects the true economics of an investment (e.g., accounts for the time value of money, evaluates all relevant cash flows over the life of the project).

b. Non-time Weighted Techniques

The only company not using a discounted cash flow framework as a tool for evaluating investments was a food company which was a subsidiary of a conglomerate. It used a relatively unsophisticated form of ROI as the basic economic criteria.

- Investment evaluations in this food company are keyed to a form called a Request for Appropriation (RFA). Approval of capital expenditures is tightly controlled, with any investment over $5,000 having to go to Corporate for approval, and any project over $100,000 having to be approved by management of the conglomerate of which it is a part. The RFA requires only a relatively simple economic calculation. The form of the ROI is:

  $$\frac{\text{(first normal year revenues) - (25\% of revenues)}}{\text{capital cost}}$$

  The "first normal year" revenues are used so as not to penalize a project with "normal start-up problems." The 25 percent deduction has its roots in the company's history as the standard deduction intended to cover various costs of the investment such as insurance, interest, etc. Twenty-five percent is always used, regardless of the nature of the project, and a 30 percent ROI (as calculated) is generally what they would "like to see". There is no formal cut-off, however. In cases of uncertainty, the project proposer is asked to supply a "best", "worst", and "most likely" estimate for the uncertain parameter(s).

Payback calculations were done as part of the investment evaluation procedure in about half of the companies interviewed. In every case, a DCF calculation (NPV or IRR) was done in addition to payback, but it was not always possible to say with certainty that the DCF analysis was the "primary" technique and payback was "secondary". Since the interviews were generally conducted with financial managers who knew the theoretical problems with payback, they tended to emphasize the DCF calculation over the more simplistic payback period. However, in a number of companies the payback measure was required on the capital expenditure authorization form, and the person being interviewed could not say with certainty that the person approving the expenditure (Divisional President, Board of Directors etc.) always based his or her decision entirely on one indicator or another. This might indicate that different individuals who were part of the decision process were more familiar or comfortable with different measures.

▲ The Manager of Budget and Controls for a major paper company explained the investment evaluation procedure in his company. The initial evaluation is done by the proposer of the investment, and the same calculations are done at all levels. The Present Value, Discounted Rate of Return, and Payback are <u>all</u> calculated for every investment (everything which is capitalized - even major repairs). However, he stated that "I personally cannot see <u>anything</u> useful being conveyed by Payback."

Petty's study is the only one which asked respondents to rank the order of importance of the various investment evaluation techniques. His study shows that for both new and existing product lines payback is a widely used technique, but mainly as a secondary technique. That is, it is fourth ranked as the leading evaluation technique, but is by far the leading technique among methods ranked second and third.

Payback as a "back-up" technique is also somewhat suggested by Fremgen, who showed that among companies willing to call a single technique "most important," payback is called the "most important method" infrequently relative to rate of return. Consistent with the basic findings of the various published studies, however, no discernable relationships between use of payback and the industry affiliation of the company was noted in the interviews.

The interviews were, in most cases, conducted with corporate or senior divisional management and staff. In some companies capital expenditure approvals were quite centralized, and corporate or divisional approval was needed before a plant or region could proceed with any expenditure over a relatively small dollar size. In these companies, the interviewees could say with confidence what evaluation techniques were used on a company-wide basis. However, in other companies there was more delegation of authority for expenditure approvals and it was indicated that the techniques used at the plant (or regional) level were not necessarily the same as at the corporate level. This was especially found to be the case for smaller expenditures and for replacement and repair items. Payback may be the criteria to a greater extent than DCF analysis at the plant level and for smaller projects, but the interviews did not provide any conclusive data on this.

▲ In a paper company with a "replacement capital" pool, the evaluations of "replacements" are not as sophisticated as those done to evaluate capacity expansions, etc. Investments are made from this pool if they are either strict replacements, <u>or</u> if they are labor saving, yield improving, etc. However, if the investment saves raw materials (or changes the type required), it is classified in the "capacity" category due to impacts beyond just the particular investment. Replacement investments are not always evaluated, and many are made with only a payback calculation or without any calculation of ROI. There are no standardized corporate requirements for the form of the evaluation, and there may be differences between divisions. There may, however, be a corporate policy on a particular type of replacement. For example, sophisticated analysis was done by Corporate Staff on the general logging truck replacement division. The policy which evolved as a result of that analysis is followed by the various regions.

c. Time-weighted (Discounting) Techniques

Details on the nature of the Discounted Cash Flow (DCF) analysis done by each of the companies interviewed will not be given. The major differences in "sophistication" between companies who use DCF techniques generally comes in the risk evaluation stage, (if any) and the DCF analysis was quite similar among the different companies. Some areas of difference were:

- <u>Current Versus Constant Dollars</u> - Current dollars were used somewhat more often, but some companies used constant dollars, or both. Energy prices were treated no differently from other prices in doing projections.

- Net Present Value (NPV) Versus Internal Rate Of Return (IRR) - Most companies used the DCF framework to calculate the IRR. A few companies used NPV, and some calculated both. One of these used IRR to make broad capital allocations and NPV to rank specific projects within a capital category.

- Standardized Assumptions Versus Divisional Initiative - Many companies published standard sets of assumptions which were to be used by everyone who was evaluating projects. Such assumptions include projections of general inflation rates, construction cost indexes, energy prices, etc. Some companies, however, do not require use of standard assumptions. One Chemical company claimed that doing so "lets the division people off the hook" in terms of making assessments and being accountable for their accuracy. Other companies also claimed that each division or plant faced local circumstances which it was best equipped to evaluate.

- A "Project Life" Time Horizon Versus A Shorter Period - Most companies performed the DCF analysis over a time corresponding to the useful life of the equipment. A few shortened the time horizon, often indicating that "with discounting, more than 10 years does not matter."

One characteristic of Discounted Cash Flow techniques which was apparent from nearly all of the interviews is that, relative to payback, the DCF techniques demand a considerable amount of data. In many companies this need for data forces assessments to be made by a number of departments such as marketing, (e.g., projected product sales), purchasing (e.g., projected raw material costs), technical (e.g., projected yields, performance), and energy (e.g., projected energy prices). Since nearly all of the companies indicated that they use the equipment's useful life (often 15 or more years) as the time horizon for the DCF calculation, the need arises for long term assessments of energy prices, product prices, and other such factors. While these assessments are often difficult to make, they are useful in identifying areas of uncertainty and in forcing more of a long run perspective on capital projects.

Use of a formal evaluation framework which structures the need for precision in data inputs is often useful in forcing assessments to be made. One paper company interviewed, for example, has a formal system for estimating capital costs of various projects. At each stage of the planning, from preliminary rough estimates to the final budget estimate, there is a requirement for a certain "class" of estimate. There is a formal system whereby capital cost estimates are designated "Class 90", "Class 50", "Class 10", etc. depending on the degree of certainty of the estimate. Preliminary allocation of capital is done using "Class 50" estimates of capital cost. These are relatively rough estimates which are not based on detailed study of a project and have a "ninety percent probability of being within a range of plus 50 percent, minus 10 percent." A "Class 10" estimate would have much greater accuracy, and would be used for final capital budgeting decisions. A formal check list of about 25 items (e.g., types of drawings done, specificity of material requirements, etc.) is used by this company to determine the "class" of an estimate. The confidence range is based on extensive data on company experience with the relationship between the degree of engineering and the accuracy of the estimate. At least for capital cost, this system structures the gathering of data and forces certain types of assessments to be made at each step in the capital budgeting process.

C. Evaluations of Energy Conservation Investments

In every one of the interviews, the following question was asked: "are energy conservation investments evaluated differently from any other investment?" All of the companies stated that an investment which saves energy costs is treated the same as any other investment. The evaluation techniques used are the same, and it was generally found that energy conservation investments are subject to similar criteria as other investments of comparable risk. In fact, the only instances where energy conservation investments were treated differently found them apparently facing somewhat lower hurdles than many other investments. In two of the interviews it was stated that the energy conservation investments being currently undertaken are less risky than most other investments (especially capacity expansion) being considered. In two other cases, it was stated that energy conservation (and especially fuel form conversion) was an important "business strategy", and therefore energy investments were getting a somewhat higher "priority" than many other types of investments.

This finding is in opposition to a thesis which has been advanced by Thermo Electron Corporation.[1/] They state that:

1/ "A National Policy for Industrial Energy Conservation", G. N. Hatsopoulos, et. al., Thermo Electron Corporation, April 25, 1977.

> "Yet, most typical business people at the present time will invest in a discretionary project only if the return on capital is about 30 percent or higher, although they invest in expansion projects that are expected to yield no more than 15 percent."

Energy conservation investments are apparently always discretionary according to their thesis, and they make the further distinction between "discretionary investments" on the one hand and "mainstream business investments" on the other. "Mainstream" investments are said to require a lower rate of return. They further state that there is a "disparity between criteria for return on investment in cost reduction and in plant expansion", and that returns must also be higher for "discretionary investments that do not increase production and are not generally practices in the industry." The interviews with companies in the energy-intensive industries did not show that such generalizations are valid.

The Thermo Electron thesis states that higher hurdle rates will have to be met by investments which:

(1) are "discretionary" as opposed to "expansion"

(2) are "discretionary" instead of "mainstream business investments"

(3) are "cost reduction" as opposed to "plant expansion"

(4) are "not generally practiced in the industry"

Of these various dimensions of an investment, only the element of higher risk (somewhat related to "generally practiced in the industry") was shown by the interviews to generally imply a higher hurdle rate. Thus, the fact that an energy conservation investment is "discretionary", not "capacity expanding", or not a "mainstream business investment" was not found to automatically result in a higher hurdle rate being imposed.

The categorization of investments as part of the capital budgeting process was discussed in the last section. Through use of the interview results, it was shown that the concept of a "discretionary" investment is not a clear-cut one. Similarly, it was not found to be the case that energy conservation projects, as "cost saving investments," are at a disadvantage relative to "capacity expansion" investments. In fact, a number of the companies (e.g., steel and cement) stated that capacity expansions are generally risky relative to cost reduction investments due to the uncertainty surrounding the ability to sell the increased production.

- In the course of discussing risk and uncertainty, a steel company Vice President stated that the "largest fuzziness in the numbers" is in the 6 to 10 year outlook for steel demand. The pricing and volume uncertainty "overwhelms" any uncertainty in capital costs, energy savings, etc. This uncertainty has meant that the company has been proceeding slowly with expansions.

Certain companies may, in fact, raise hurdle rates and thereby penalize energy conservation investments because of the fact that they do not expand capacity or are "discretionary." However, this will depend on the business strategy of the particular company (e.g., are they seeking to cut costs?), and the capital availability situation of the company (e.g., are they rationing capital to the point where nearly all investments not required by law are being rejected?).

Except for the dimension of risk which Thermo Electron hints at, new energy conservation technologies will not be penalized by industry in general because they are "discretionary" or "cost saving." Even with regards to risk, it was found that new conservation technologies may sometimes be viewed as having less risk than capacity expansion investments whose market uncertainty is often substantial.

SECTION IV

INDUSTRY USE OF RISK EVALUATION TECHNIQUES

A. Definition of Risk

The last section described a number of techniques for calculating the return on capital investment. It was noted that returns are usually calculated on the basis of a "best estimate" for each of the variables in the particular formula being used. Regardless of the technique used, however, it is obvious that there are inherent uncertainties surrounding projections of raw material costs, wage rates, process yields, energy costs or most other such variables in an investment evaluation. This uncertainty about the "correct" values for such variables necessarily translates into uncertainty about the calculated rate of return. "Uncertainty" implies that the rate of return could either be lower <u>or</u> higher than the "expected" rate based on best estimates of the variables. However, "risk" is most often thought of in relation to the probability of returns being less than expected. This emphasis on downside risk is clearly shown by quotes from interviews with business executives in James Mao's study of capital budgeting.[1/] When asked what they understood by the term "investment risk", three of the responses were:

- "Risk is the prospect of not meeting the target rate of return,"

1/ "Survey of Capital Budgeting: Theory and Practice", James C. T. Mao, Journal of Finance, May, 1970.

- "Risk is financial in nature. It is primarily concerned with downside deviations from the target rate of return. However, if there is a good chance of coming out better than you forecast, that is negative risk (a sweetener) which is taken into account in determining the security of an investment."
- (in a company where investment decisions are few, but large in size) "There are three things that concern me in evaluating the risk of an investment: the chances of losses exceeding a certain percent of my total equity, the chances of earning the required rate of return, and the chances of breaking even on a cash flow basis. Cash break-even is kind of a survival point."

In his survey of 109 large industrial companies, Petty similarly showed that "risk" was most often defined as "the probability of not achieving a target return". Forty percent of the total responses were in this category, although thirty percent defined risk as a "variation in returns." This more "theoretically correct" response correctly allows for uncertainty in both a negative <u>and</u> positive direction.

The emphasis on downside risk was substantiated by the interviews in the energy-intensive industries. Whether they explicitly defined "risk", or simply described management reactions to risk evaluation techniques, an emphasis on downside uncertainty was prevalent:

▲ A vice president of corporate planning for a major oil company defined risk as "the downside possibility of uncontrollable events".

- In a paper company where "best" and "worst" scenarios are used to incorporate risk, a manager of facilities planning stated that, in fact "management tends to focus on the 'worst' cases. They are skeptical about the 'best' cases."

B. Indications of Wide Use of Risk Evaluation Techniques

The five studies cited in the last section all included questions on risk evaluation techniques as part of their surveys. A precise comparison of results of the various studies is hampered not only by the previously mentioned differences in survey coverage, but also by different phrasing in the questions on risk considerations in investment analysis and different treatment of multiple responses (use of more than one technique). However, all of the surveys show that many companies (most studies suggest a clear majority) systematically consider the risks and uncertainties which their deterministic calculations do not deal with. A wide variety of techniques can be used to identify and quantify risks. The five studies are not in complete agreement as to the most widely used technique, but if rough corrections are made for different company samples and different questionnaire categories, a clear pattern emerges.

Three of the recent studies (1974 and 1975) are in quite close agreement as to the percentage of companies which explicitly account for risk in making capital budgeting decisions. Petry's study showed that 71 percent of the large corporations he surveyed "explicitly accounted for risk," and Davey (62 percent) and Fremgen (67 percent) had similar survey results. Klammer's study suggests that a somewhat lower 45 percent of those companies responding to his questionnaire "use some formal risk analysis method." Based on these studies, it would appear that one-half to over two-thirds of the large industrial corporations go beyond merely comparing a single point estimate of the projected economic return on a project against some fixed criteria. In an attempt to deal with risk, these companies use one or more non-subjective techniques for dealing with risk.

There are a number of techniques available for analyzing and dealing with the uncertainty in capital budgeting decisions. Some are relatively unsophisticated and do not make explicit to management the true nature of a project's risk. Other techniques are favored by academicians because they allow a more detailed assessment of the likely probability of various rates of returns on a particular capital project. The techniques fall into a number of general groups, although the exact nature of a technique as applied by a particular company might be unique. The major techniques are briefly described below, and an indication of the prevalence of their use is given based on interpretation of the various published studies. It should be noted that use of more than one technique is common, and that some of the techniques are interrelated. For example, sensitivity analysis is generally done to determine which variables are most important and should be analyzed in a probabilistic model.

1. Hurdle Rate Adjustment

Some companies adjust for risk by having more than one hurdle rate for screening capital expenditure proposals. For those projects which are determined to have unusually uncertain returns, the normal hurdle rate is not used, and the project must exceed a higher rate of return (or have a shorter payback). For example, if a company's "riskless" or "normal risk" hurdle is a 15 percent rate of return, (or three year payback in the case of a company using payback) then the hurdle for "risky" projects might be 18 percent (or a two and a half year payback). For a particular project, it is therefore necessary to somehow determine whether a particular project is more risky than average and whether it should therefore have to exceed the risk-adjusted hurdle.

The published surveys suggest that this is one of the more common techniques used in large corporations. From about a third to over half of the companies in most of the survey samples seem to adjust either payback period or rate of return requirements as one of their methods of accounting for risk. Fremgen, Klammer, and Petry all show that requirement of a higher rate of return is somewhat more common than requirement of a shorter payback period as a means of risk adjustment.

Used as the only method of risk evaluation, hurdle rate adjustments are generally unsatisfactory as a means of accurately accounting for the risk of various projects competing for capital funds. This is because it is difficult to determine whether a project is actually more or less risky than "average." It is also difficult to determine how much the hurdle should be adjusted for those "risky" projects. Presumably the hurdle should be high enough so that if the project should turn out to have a lower than expected return, there is a "margin of safety" over the normal desired rate of return. However, whether the "risky" project hurdle should be set at 20 percent instead of 18 percent rate of return (given a "normal" hurdle of 15 percent) depends on the level of uncertainty in the various variables in the calculation of return and whether there is a high probability that the rate of return will be 3 or 5 percentage points below what is expected. Simply raising the hurdle does not assist in identifying areas of uncertainty.

Companies trying to use hurdle rate adjustment to effectively deal with risk must also deal with the problem of not being able to accurately adjust hurdle rates in proportion to risk. That is, it is difficult to relate a higher level of risk to a proportionately higher hurdle rate. Any simple rule such as "a 25 percent higher risk means a 25 percent higher hurdle rate" is inaccurate. Due to the compounding effect of discounted cash flow calculations, a change from a 15 to 20 percent IRR hurdle is a substantially larger "penalty" than intuition would generally lead one to believe. It is difficult, if not impossible, to subjectively adjust hurdles by an amount commensurate with the increase in risk.[1/]

Several of the companies interviewed in the energy intensive industries use hurdle rate adjustment as part of their procedure for incorporating project risk. None of the companies interviewed used this method as their only method of risk assessment.

- A glass company stated that it calculates a hurdle rate based on the cost of capital. This cost of capital "already has some risk in it," but they also expect higher returns on riskier investments, such as new products, international operations, or projects with long time horizons. The "base" hurdle rate is "about 15 percent", and is adjusted upward somewhat if there is risk.

1/ "Incorporating Risk Aversion Into Risk Analysis", Robert A. Hayes, The Engineering Economist, Vol. 20, No. 2.

- The chemical subsidiary of an oil company uses scenarios as well as a hurdle rate adjustment. They do a DCF calculation using "best estimates" of the various parameters. The cost of capital (currently about 12 percent) is calculated frequently and used for most DCF calculations of net present value. While the current "normal" criteria is 12 percent, it could be 15 percent if there are significant risks in a particular project. For low risk investments (current energy conservation investments were categorized as such) a <u>lower</u> criteria might be used. The hurdle rate adjustment is admittedly subjective. They like to "stand back from the mechanical manipulations" and take a more "entrepreneurial approach" which, in particular, involves looking closely at the assumptions behind a calculation. Even the 12 percent hurdle "has some risk built in," since they "really don't expect to make 12 percent," and have not historically.[1/]

2. Sensitivity Analysis and Scenarios

Sensitivity analysis is a procedure through which the key variables in a given calculation of return on investment are identified. It is often a first step in probabilistic analysis, because it determines which of the input factors have the greatest effect on the rate of return. Sensitivity analysis consists of varying each input factor one at a time and noting the effect that a given variation has on the

---

1/ This suggests that they calculate their required rates of return based on historical evidence rather than future earnings expectations.

project's profitability (as measured by payback, net present value, rate of return, etc.). Each variable can be changed by a given percentage (10 percent increase, 10 percent decrease), by the amount it is felt "likely" to vary on both the up and down side, or by the "maximum" amount it would be expected to vary. In a particular project evaluation, for example, this procedure might identify energy cost and operating rates as the two most important factors in determining the return on investment. Focusing attention on these variables allows management to spend its time analyzing the assumptions behind those factors which are most important to the project's profitability and which are the source of most of the risk or uncertainty in a project.

Scenarios can be used in several different ways to identify areas or risk in a capital project. One use is as a type of sensitivity analysis whereby several variables are changed from their "base case" levels at the same time in order to investigate the effect on the rate of return. This is particularly useful if there are variables which are not completely independent. For example, low sales volume might imply decreased equipment efficiency due to lower utilization. Similarly, an "inflation scenario" might involve inter-related changes in the values of several variables. Another use of scenarios involves projecting the return at three levels: "pessimistic", "optimistic", and "expected". This can be done by taking each of the variables at their best possible and worst possible levels. This will, however, often give results which are far above and far below the "expected" or "base case" rate of return. An effort might therefore be made to somehow acknowledge the fact that it is very unlikely that all of the variables would be at their extreme (good or bad) at the same time. In such a case, the "optimistic" scenario would represent less than a combination of all variables at their maximum positive values. However, unless the analysis becomes probabilistic in some way, this adjustment will be subjective in the setting of various parameters at particular levels.

Most of the published surveys do not include "sensitivity analysis" or "scenarios" as a questionnaire category in their sections on risk adjustment methods. This may be because, taken by itself, sensitivity analysis is not seen as a method of risk adjustment. Alternatively, it may be that the authors considered sensitivity analysis to generally be the first step in probabilistic analysis. Davey's study for the Conference Board includes both "multi-level projections", and "sensitivity analysis" as types of risk adjustments. Of the 84 companies in his survey which explicitly evaluated risks, 7 used "multi-level projections," and 29 rely on sensitivity analysis. Most of the 69 companies which he identifies as using "risk analysis" (mainly probabilistic) also would be using sensitivity analysis as one step in their procedure.

The interviews with the energy-intensive companies showed that sensitivity analysis and use of scenarios was a widely used technique. In a number of companies, it was the most important element of risk analysis, with the results being given to management for their consideration of which scenarios or changes in individual variables are the most reasonable to expect. It often served to identify areas where greater analysis was necessary.

- In a major chemical company the capital budgeting procedures are not standardized between the different divisions, and corporate normally asks only to see the projected performance of the entire business. However, within the largest division (Chemical and Plastics) a net present value calculation is done for each capital project, and rankings are established first on the basis of NPV. Project evaluations are first done using the "most probable" data submitted by the proposer. They then "play the 'what-if' game" and change different parameters (such as market volume, raw material cost, etc.) to test sensitivity. This is not done in a particularly systematic way, and there is no formal way of comparing the likelihood of the returns calculated in the various "what-ifs". It does identify those assumptions which are important to the projects' calculated NPV and which would have the largest adverse effect if they proved to be erroneous.

- The operations research staff of an aluminum company has developed a computerized system for investment evaluation which has the emphasis on allowing both proposers and the financial staff to quickly and easily test sensitivities in capital proposals. The system is used to calculate NPV, rate of return, and return on assets for the company's various capital proposals. It allows the user to use three different discount rates for present value calculations, as well as varying the life of the investment. The sensitivity of return on investment to "Sales, Cost of Sales, Operating Expenses, and Capital" can be calculated. The system calculates the "expected ROI", and then allows the user to choose the size (10 percent, 25 percent, etc.) of the "unfavorable change" and "favorable change" in each variable which is used to re-calculate the ROI. Variables are not only changed one at a time in sensitivity analyses, but also collectively in "case studies." These case studies generally consist of "reasonable variations" of key variables. "Management judgement" is applied to the results of this risk assessment in order to make the project decision.[1/]

3. Probabilistic Risk Evaluation Techniques

A limitation of the techniques described above is that they do not give an accurate portrayal of the probability of various rates of return. For example, a "pessimistic" scenario or a single pessimistic sensitivity analysis might be calculated which shows that the rate of return could be well below the company's hurdle rate, and well below the "most likely" scenario. However, it will not be known how likely that particular outcome is. In the case of a "pessimistic" scenario showing a 5 percent rate of return due to capital and energy costs being at a level well above the base case, and equipment efficiency below the base case, no indication will be given of what probability there is of these events occurring simultaneously. If, in fact, probability distributions for each of these three key factors were to be determined, it might be seen that each of the pessimistic values chosen have a probability of occurrence of only 0.1. In combination (assuming no relationship between capital cost, energy cost, and equipment

---

1/ Judgement will, of course, also have been applied at the point of deciding what are "reasonable" variations.

efficiency) the probability of the pessimistic scenario occurring would be only one in a thousand (0.1 x 0.1 x 0.1). Management may be willing to accept a very small chance of attaining only a 5 percent return, but without some form of probability analysis, it will not know how likely or unlikely the results of a "pessimistic" scenario showing a 5 percent return is.

Some companies using multi-level scenarios (pessimistic, optimistic, likely) attempt, through non-quantitative means, to construct scenarios for various projects such that "pessimistic" scenarios for all projects are roughly comparable in their likelihood of occurrence. However, this is difficult to do, and management will still be likely to see "pessimistic" scenarios from different projects with very different probabilities of occurrence. It is possible, however, to explicitly estimate the probability distributions for the variables in a rate of return calculation. By combining these individual probability distributions through computer simulation it is possible to estimate a probability distribution for the rate of return on a project as a whole. This is generally in the form of a cumulative probability distribution of discounted cash flow rate of return or net present value. Such a distribution allows management to see the range of rates of returns as well as the probability of achieving each return within the range.

The published surveys of risk evaluation techniques suggest that use of probabilistic techniques is fairly widespread, although it is generally not shown by most studies to be the leading method of risk analysis. Petry found that "adjusting cash flows, probabilistic basis" was the second most common method of risk adjustment, with 26 percent of the responses in this category. Similarly, Klammer's study showed 33 percent of the survey responses as "determining probability distribution," Fremgen states that 32 percent of the responses in his survey showed firms "adjusting estimated cash flows by use of quantitative probability factors", and Davey shows 48 percent of the responding companies using some form of probabilistic analysis. It should be noted that the form which these probabilitic procedures take can vary considerably. In some cases, "short cut" methods may be used to approximate probability distributions or rates of return. This is in lieu of doing full computer simulations using probabilitistic inputs to derive a cumulative probability distribution of a project's return. It is also important to note in interpreting these fractions of usage that many companies gave multiple responses to the questions on risk analysis techniques, and probabilistic analysis (of some type) might be only one of several methods used in a given company.

The interviews with the energy intensive companies identified only one company (a steel producer) which is currently using probabilistic analysis as a major method of risk analysis. Several other companies might occasionally use a probabilistic model to analyze a very large and risky capital expenditure, and in a number of other cases, probabilistic methods of risk analysis were used formerly and then abandoned, usually because of the difficulty of probabilistic assessments.

- The economic information conveyed to management in a steel company used to just be a point estimate (e.g., 16 percent) of the return on a particular investment. However, "risk-analysis" is now performed so as to "give management more information" about major projects. In the first stage, four or five key variables (e.g., capital and energy costs) are identified through sensitivity analysis, and "high", "median", and "low" values are assigned. The ROI is then calculated on a high, low, and most likely basis. Probability distributions are assessed for the values of the key variables, and using Monte Carlo simulation (with 200 iterations) a probability distribution is generated for the return on the investment. Concern was expressed about the validity of such a measure when taken by itself, however. In particular, the company's operating people do not always have complete confidence in the data (especially probability distributions) behind such probabilistic procedures.

▲ A glass company whose normal risk evaluation techniques do not proceed beyond adjustment of hurdle rates and sensitivity analysis hired a consultant several years ago to analyze a risky investment in a new glass melting process. The consultant used a very elaborate probabilistic framework with a Monte Carlo technique. The company's technical, marketing, and operating people each made probability assessments for the appropriate variables. A key input was the assessment of product yield from the new process at commercial scale (it was at pilot scale at the time of the analysis). The decision framework was "not a problem", but the assessments made by the technical people were far too optimistic, and the approach failed. The Vice President of Corporate Planning stated that "you are kidding yourself if you believe that probabilistic risk analysis has all the answers."

- An aluminum company which now relies on sensitivity and scenarios to evaluate risks developed a system using probabilistic modeling about five years ago. However, it turned out to be too difficult to get the necessary assessments of probabilities from people. Only for certain inputs (such as the life of a potline), do they have good probability data. The system was also not utilized effectively because it had a level of sophistication which was too high to be widely understood. Finally, the handling of inter-dependencies between variables introduced a complicating factor that helped to make the probabilistic approach "not worth the effort."

4. Summary of Risk Evaluation Techniques

There is no "standard" form which risk analysis takes among industrial companies. The techniques discussed above are the most common methods used to incorporate risk into the capital budgeting process. However, none of these techniques provides consistent and precise understanding of the risks of a particular project. Many companies use more than one risk evaluation technique, and all of the companies stressed that formal risk analysis is used only as a partial guide to the decision maker. "Management judgement" will be used in every case. The various quantitative risk evaluation techniques are useful in helping to convey more information about a project than can be transmitted through a simple deterministic calculation of rate of return using "best estimates" for the values of the input variables.

Of the techniques discussed above, probabilistic techniques convey the most information about the nature of a project's risks. The various published surveys suggest that these techniques are quite widely used by large companies. However, the interviews with the energy intensive companies suggest that many companies have problems applying probabilistic analysis. For most of the companies using the technique, it appears that it is utilized mainly for large projects with considerable risks. The major areas of difficulty in application appear to be:

(1) Difficulty in getting the appropriate operating people to estimate probability distributions for the values of raw material costs, yields, energy savings, or other important variables which affect the rate of return.

(2) Management understanding of the resulting cumulative probability distribution of rate of return. Lack of understanding of the method leads to the impression that "too much is being hidden" or "lost" by deriving and combining the various probability distributions.

C. Quantifying The Risk-Return Relationship: The Capital Asset Pricing Model

1. Introduction

A clear conclusion of the last section's discussion is that higher returns are expected from riskier capital projects. However, none of the widely used risk evaluation methods discussed above provides a means of quantifying the trade-off between risk and rate of return. While the interviews showed no relationship between the risk evaluation technique a company used and its industry affilation, significant inter-industry differences in attitudes towards risk were discernible. For example, the chemical companies interviewed were far more accustomed to dealing with "risky" investment proposals than the steel companies. By using the techniques which these particular companies use for evaluating risk, however, it would not be possible to predict with certainty whether they would accept or reject a certain "risky" investment proposal. The risk assessment techniques which this study has found to be prevalent involve such a large nonquantitative "judgemental" component that they are difficult to use in predicting investment behavior. A financial theory called the Capital Asset Pricing Model (CAPM) has been developed to quantify the trade-off between risk and rate of return for various industries or companies.

The CAPM allows one to calculate the cost of capital for different industries, and also makes it possible to quantify the risk/rate of return requirements of particular projects based on relative risks in capital markets as a whole. The CAPM theory is built on the concept of systematic and unsystematic risk. Systematic risk is that component of uncertainty that exists in the market as a whole, whereas unsystematic risk is uncertainty associated with a particular stock. According to portfolio theory, by holding enough stocks, the unsystematic risk can be reduced essentially to zero; however, the systematic risk cannot be diversified away. This idea is readily applied to the stock market where some broad index (e.g., Standard & Poors 500 or composite New York Stock Exchange) can be used as a measure of systematic risk. Any single stock can be compared to this composite (often referred to as the "market portfolio") to measure its relative variance. This comparison gives a direct measure of the relative uncertainty or risk associated with a particular stock compared to the market as a whole. CAPM theory is built on the premise that relative levels of risks in investments determine the required rate of return on any investment. The parameter that measures this covariance with market risk is referred to as β (beta). It is applied to calculate the cost of capital associated with the equity of a given company in the following formula:

$$k = r_f + \beta(r_m - r_f)$$

where:

k = required cost of capital

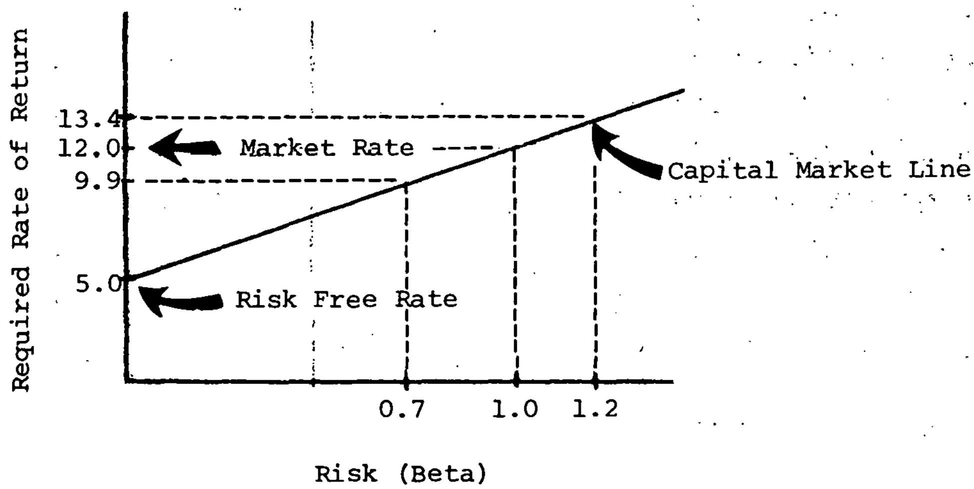
r_f = riskless rate of return often associated with Treasury bills

β = coefficient of covariance

r_m = required market rate of return

If a company's stock or a portfolio of stocks has a β of 1.0, it is as volatile or uncertain as the market as a whole. Thus if overall market return expectations went up to 1 percent, this particular stock would likewise be expected to go up by 1 percent (i.e., without a change in earnings performance the stock price would be bid down giving an effective yield increase of 1 percent).

In order to apply CAPM theory it is necessary to determine the overall market expected return on equity capital. This point in association with the riskless Treasury rate describes the "Capital Market Line." Thus, with short-term riskless rate of 5% and an expected equity market return of 12%, the capital market line would look as follows:



Once this capital market line is established for a period, it represents a tool that can be used for three purposes:

- Calculating the cost of capital for an individual company given the β (covariance) of the stock involved against market fluctuations.
- Calculating the cost of capital for an industry or portfolio of companies given the β for the group as determined by comparing stock fluctuations.
- Calculating the required rate of return on an individual project given the β (or covariance) of the project's returns. This is determined by use of probabilistic modeling of the particular investment's expected return.

2. Using the Capital Asset Pricing Model to Calculate a Company's Cost of Capital

Using the Value Line computerized data base, beta coefficients for various industries were determined. The Value Line system compares weekly prices of some 1400+ stocks to the composite New York Stock Exchange index and determines the beta for each company's stock. Each company in turn is listed in a specific industry global file (e.g., the Steel global file contains Armco, United States Steel, National Steel, etc.). By weighting the beta value for each company by its share of the industry's global net worth, an overall industry beta was calculated. The result of this operation is displayed below:

INDUSTRY BETA'S

Industry	# of Companies in Global	Composite Industry Beta
Food Processing	53	.841
Cement	14	.876
Petroleum	47	.896
Textile	23	.916
Steel	14	.976
Chemicals	14	1.047
Paper	25	1.063

Other industry groups were not available in global files in the Value Line system and therefore could not be measured. However, independent global files could be set up for these industries to allow for an assessment of any other industry's beta.

In order to calculate the cost of capital for these industries it is necessary to first establish the capital market line. For example with short term Treasury rates currently at approximately 5 percent and assuming equity market return expectations of 12 percent[1/], the cost of capital becomes:

$$k_i = 5.0 + \beta_i\ (12.0-5.0)$$

which yields the following cost of capital figures:

Industry	Cost of Capital*
Food Processing	10.89%
Cement	11.13%
Petroleum	11.27%
Textile	11.41%
Steel	11.83%
Chemicals	12.33%
Paper	12.44%

*This represents common equity capital only. To obtain an overall weighted cost of capital this would have to be averaged with the component of debt capital in a company's overall capital structure.

This cost of capital represents the required rate of return for an "average" investment in any of these industries. It therefore would be used as the appropriate discount factor in the evaluation of any investment by a company in the industry if the risk of the investment is perceived as normal to the business.

3. Use of CAPM in Evaluating Risky Investments

The capital asset pricing model is gaining acceptance in industry for cost of capital calculations. It has been successfully used in various regulatory and judicial proceedings when more traditional methods were rejected. Its application can be extended to the evaluation of particular projects within

---

1/ Useful application of this financial theory would require rigorous assessment of these rate of return values, since they are fundamental in the specification of the capital market line.

a company as opposed to the use of calculating a company's cost of capital. Care must be taken in this application to be sure that certain factors are kept on a comparable basis. For example, the 11 percent market return suggested earlier represents the expected return of the "market portfolio" over a reasonably discrete interval - perhaps, no more than one year. However, a discounted cash flow calculation uses cash flows over a project's entire life which may be several decades. To be strictly applicable this ROI would need to be stated on an annual basis. Thus the ROI on a given project will have at least two components of variance. First there is the relatively deterministic variance from year to year inherent in the project's life cycle. Added to this there is the uncertainty of any year's cash flow as a result of the risks associated with technical, commercial and institutional factors. Considered together these components of variance will describe an expected cash flow for any project and a standard deviation around this mean. This pattern of returns on a particular investment can also be compared to some index (e.g., New York Stock Exchange composite) and the particular value of beta determined. Using the same capital market line described above, the required rate of return for any project can then be determined.

One key assumption of the capital asset Pricing Model is the ability to diversify unsystematic risk out of a portfolio. This assumption runs into some difficulty when assessing projects within a company rather than stocks within a portfolio. To deal with this problem, analytical constructs exist which treat the total variability of a project (unsystematic as well as systematic). Not only does this help the diversification issue, but it also makes implementation of the theory for individual projects considerably simpler.

Use of the Capital Asset Pricing Model in the private sector is still relatively sparse; however, experts suggest that it will eventually become a cornerstone of financial analysis. The attraction of using the theory in making decisions for technology/project funding in ERDA is that it allows quantitative constructs for calculating not only the cost of capital for different industries or companies, but it more importantly allows a quantitative assessment of the risk/rate of return requirements of particular projects based on relative risk in capital markets as a whole.

More precise development of this methodology would require effort not only on the individual project evaluations, but also careful consideration of the capital market line from which required rates of return would be determined.

D. Attitudes Towards Risk Evaluation in R&D Divisions

It became apparent after interviewing a number of companies that the riskiest technologies are not evaluated by the corporate planning and finance departments, since many of the investments evaluated as part of the normal capital budgeting process are not high risk evaluations. The people interviewed were therefore often not comfortable with the idea of extremely risky investments. In order to gain another perspective, representatives of the Research and Development divisions of three companies (steel, glass, and petroleum) were interviewed. It was expected that these groups might have different attitudes towards risk and might use different evaluation techniques to evaluate technological options.

It was found that the research groups tend to avoid structured economic evaluations when evaluating research and development proposals or on-going projects. A greater emphasis is instead placed on assessing the technical merits particular project. Detailed calculations of the projected return on a particular technology in a commercial application are often avoided, but economic evaluations are done when the technology reaches a stage of development where it requires substantial funding. These economic evaluations tend to be much less structured and standardized than those which the interviews showed to be used for capital budgeting purposes.

A study by the Research on Research Committee of the Industrial Research Institute (IRI) on project selection showed that relatively few of the IRI's member companies (Research Divisions) use "formalized methods of project selection." Only about a third of the companies surveyed replied that they used formalized project selection methods. The IRI study found that:

> "Formalization within these companies focuses on collection of information and judgements, and not on mathematical manipulation of the data to establish project acceptability and priorities. The formalized methods are applied primarily to development projects, and not to exploratory or basic research ... Project selection remains a highly judgemental process."1/

The degree to which formal evaluation techniques are used by research divisions is clearly a function of technology size and maturity. A distinction clearly needs to be made between "research" and "development" when making generalizations about techniques used.

1/ Industrial Research Institute, Annual Report, 1976.

A Vice President of Corporate Research for a petroleum company discussed research decision-making in his company:

- While economics <u>are</u> evaluated, they are only a part of the overall evaluation of a research program. Non-quantitative factors such as having a sponsor with "an emotional attachment" to a project are often important to funding decisions. A lot of R&D decisions are "rather personal." The company does not have a formal evaluation procedure which it uses on every project. Having faith in the person doing the research can be more important than trying to do a DCF analysis and choosing a project on the basis of rate of return. Particularly for exploratory research, an economic evaluation is not stressed. More detailed economic analysis is utilized when evaluating development projects. Research was said to be inhibited by too much of a focus on finance and commercial economics. It is important to keep flexibility and allow room for judgements.

SECTION V

INDUSTRY FINANCIAL ANALYSIS

In making funding decisions for ERDA-sponsored technologies, it is important to consider the general economic and financial circumstances of the target industry in order to estimate the prospects for commercial acceptance. For example, an investment in an energy conserving technology that yields a 15% rate of return may be accepted by some industries and rejected by others as a result of differences in the industries' cost of capital or willingness to accept risk. Likewise, differences in the amount of "discretionary" capital may cause some industries to undertake a project that others may refuse due to capital constraints; or in some cases, industries or particular companies may be involved in business strategies that preclude the adoption of otherwise attractive energy conservation investments. Another important consideration in energy programs in particular is the impact of Federal incentives on different companies and industries. For example, tax credits to companies that are already not paying Federal taxes are of no value. Incentives of accelerated depreciation or larger investment tax credits may have little value in the steel industry where tax burdens are already relatively low due to depressed earnings and other existing tax relief programs.

A. Method of Analysis

To a large extent the program of interviews conducted in this study provided industry and company-specific considerations of what determined capital investment decisions. In order to supplement this direct sampling, data was collected pertaining to the financial circumstances of several key industries. The data was accessed from the Value Line computerized financial data base. This system maintains financial data for some 1400+ companies including some 300+ annual and quarterly parameters over a period of 20+ years. Industry global files are maintained that group companies into distinct industry categories. The analysis which follows was derived from these global files. The industries analyzed include:

Industry	Number of Companies in Global File
1. Steel	14
2. Petroleum	47
3. Cement	14
4. Paper & Forest Products	25
5. Food Processing	53
6. Textile	23
7. Chemicals	14

Global files are not maintained specifically for the aluminum, glass and agricultural industries, and therefore, statistics for these industries are not included in this analysis. It would be possible to develop independent global files for these industries (except perhaps agricultural which is too fragmented). Additionally, the global files maintained in the data base can be altered to add and/or delete companies as deemed appropriate. For the purposes of this analysis, the companies included in the fixed global files of the data base were not altered. At the end of this section of the report, the companies in each of the global industries are listed along with the aggregated balance sheets and income statements for each industry for fiscal year 1976. It, of course, must be recognized that there can be significant variations in these parameters from company to company. Though it would be possible, and perhaps useful to explore these variations, for the purpose of analyzing the aggregate industry circumstances, this variance analysis was not undertaken.

Table V-1 gives a listing and definition of several key financial parameters for these industries.

B. Industry Specific Considerations

The hurdle rates and risk/rate of return decisions of industries are shaped by the general circumstances and opportunities facing the business. In order to characterize the decision environment of the energy-intensive industries, global statistics were developed as detailed in the previous section. The following is an industry-by-industry analysis of these statistics. The balance sheets, income statements and company lists are included at the end of this section.

1. Steel

The steel industry had a peak financial year in 1974 as the momentum of the ensuing recession was developing. Return on equity (book value) hit a high of 14.75% (see Figure V-1).

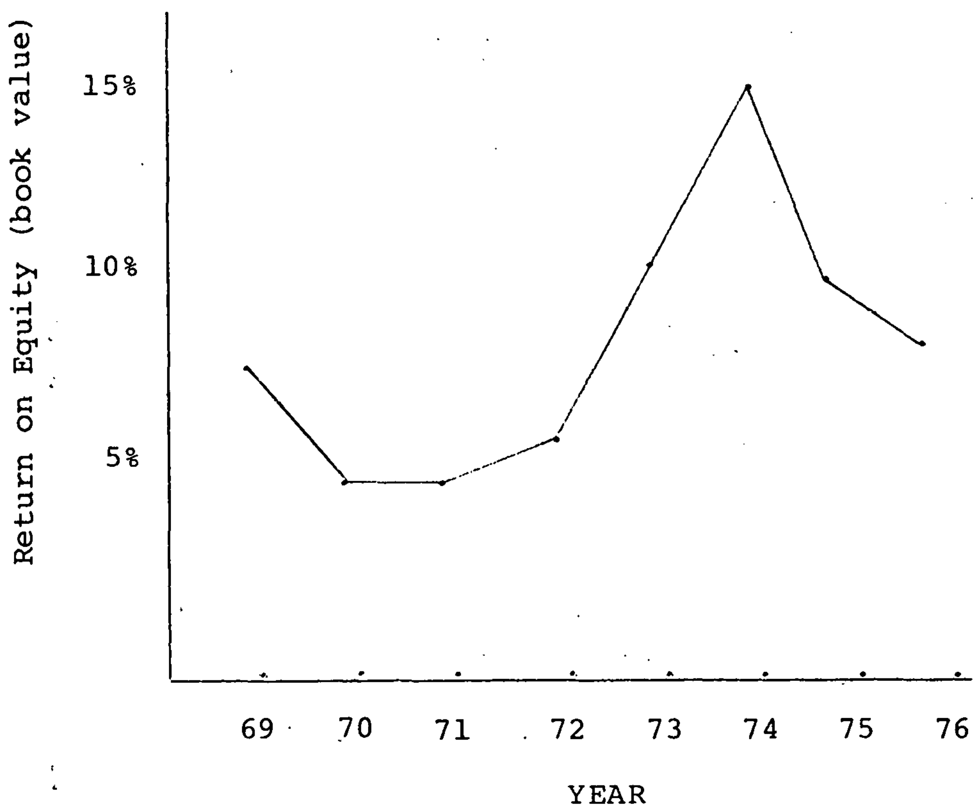


FIGURE V-1 Return on Investment in the Steel Industry

TABLE V-1: KEY FINANCIAL STATISTICS BY INDUSTRY

	STEEL	TEXTILES	CEMENT	FOOD PROCESSING	PETROLEUM	PAPER & FOREST PROD.	CHEMICAL
Return on Net Worth (book value) (%)	7.2%	8.4%	8.4%	14.5%	14.1%	13.3%	14.1%
Return on Assets (%)	3.8%	4.3%	4.4%	6.8%	6.3%	7.0%	7.1%
Return on Sales (%)	3.7%	2.8%	4.3%	3.3%	5.2%	6.4%	6.5%
Market Value/Book Value	0.71x	0.64x	0.67x	1.32x	0.97x	1.68x	1.76x
Return on Market Value (%)	10.1%	13.3%	12.5%	11.0%	14.5%	7.9%	8.0%
Return on Net Worth (book value) 8-Year Average (%)	7.7%	6.9%	8.0%	12.1%	12.5%	11.4%	12.6%
Long-Term Debt/Capital (%)	37%	32%	43%	34%	37%	38%	38%
Interest Coverage	3.7x	4.7x	4.0x	8.5x	12.6x	6.5x	7.2x
Assets/Revenue	.98x	.67x	.97x	.49x	.82x	.92x	.93x
Cash/Net Worth (%)	9.5%	11.5%	15.3%	21.9%	22.4%	12.8%	11.1%
Cash/Total Assets (%)	4.8%	5.9%	8.0%	10.3%	10.0%	6.7%	5.5%
Current Ratio	1.92x	2.66x	2.44x	2.08x	1.48x	2.10x	2.23x
Accumulated Depreciation (%)	53%	56%	50%	44%	39%	39%	49%
Depreciation Expense/Gross Plant (%)	3.5%	5.8%	4.2%	5.7%	5.0%	5.0%	5.9%
Average Asset Life (Years)	28.6	17.9	23.8	17.5	20.0	20.0	16.9
Annual Depreciation Expense (10^6 $)	1,260.4	326.9	113.3	1,498.1	10,785.8	1,331.7	2,838.6
Capital Expenditures (10^6 $)	2,935.2	438.2	132.8	2,917.2	30,250.9	3,008.9	6,260.5
Capital Expenditures/Depreciation Expense	2.3x	1.3x	1.17x	1.95x	2.80x	2.26x	2.21x
Capital Expenditures/Capitalization (%)	11.7%	7.7%	6.1%	9.2%	16.0%	13.0%	15.7%
Income Tax Rate (%)	12.4%	47.6%	32.1%	46.9%	62.1%	36.8%	41.4%

See notes on next page for explanation of financial parameters.
All annual values are fiscal 1976 unless otherwise specified.
Source: The Value Line Data Bases: Arnold Bernhard and Company, Inc., New York, N.Y.

TABLE V-1 (Continued)
EXPLANATION OF FINANCIAL PARAMETERS

Return on net worth - net income after taxes (1976) divided by the reported value of the equity of common and preferred stock holders. This is perhaps the best measure of cross-industry earnings performance since it isolates on the equity portion of the industry's capitalization. Since all industries compete equally in this capital market, this equity-based parameter represents an effective common denominator of performance.

Return on assets - net income after taxes (1976) divided by the reported total assets of the company (or industry on aggregated basis). A direct measure of the relative productivity of an industry's asset base.

Return on Sales - net income after taxes (1976) divided by the reported net revenues from operations. This is a less significant cross-industry earnings measure since it does not account for differences in capital intensities.

Market Value/Book Value - The average annual (1976) price of one share of stock to the value of that share according to reported net worth. On an industry wide basis, this is weighted average value. This ratio reflects the current market valuation of a company's (or industry's) equity versus its historical or book value. Values below 1.0 would indicate that new issues of equity would dilute the value to existing stock holders (i.e., a new share of stock would have a larger proportional value of the equity-base than an existing share). As a result, companies with market values less than book values have a large disincentive to issuing new equity shares.

Return on market value - net income after taxes (1976) divided by the market value of the equity base. This is a direct measure of the current earnings requirement placed on an industry or company by the investing public. A high value (e.g., 15%) indicates the investing public is looking for greater short-term earnings with the prospects of depressed longer term results. A low value (e.g., 7%) indicates the investor is willing to earn less in the short run with longer term performance expected to be above average.

Return on net worth 8-year average - net income in each of the past 8 years (1969-1976) divided by reported book value of the equity in the corresponding year. This parameter is provided as a comparison to the 1976 value to show the long-term industry earnings performance. It is not a time-weighted average.

TABLE V-1 (Continued) EXPLANATION OF FINANCIAL PARAMETERS

Long-term debt/capital - the ratio of all long-term (greater than one year) debt and other fixed liabilities (e.g., deferred taxes) to total capitalization. When this parameter is in equilibrium, it is a valid measure of the stability of an industry (higher values indicate greater stability); however, sometimes lower values suggest either conservative financial policy or strong market advantages (e.g., IBM with no long-term debt). Trend or short-term changes in this parameter signal possible stress on an industry (when the value rises sharply over a short period) or determined business/financial strategies (when the parameter is reduced consistently over several accounting periods).

Interest coverage - total gross income before taxes plus all interest payments divided by annual interest expense. A measure of a company's ability to pay its fixed financial fees. A low number indicates low margins of safety and higher financial risks. However, more stable companies can manage a lower ratio without being perceived as more risky. Trend and short-term changes in the value can be informative.

Assets/revenue - total assets of a company or industry divided by gross annual revenues. A direct indication of the capital intensity of an industry.

Cash/net worth and cash/assets - two measures of the liquidity of a company or industry. High transient values of these ratios indicate an ability to invest in capital plant and equipment or improve financial parameters by reducing debt.

Current ratio - current assets divided by current liabilities. A broader liquidity measure often used as an indicator of financial risk on short-term debt.

Accumulated depreciation - the accumulated value of all depreciation expenses on existing plant and equipment. On financial statements, this is generally accumulated on a straight line basis.

Depreciation expense/gross plant - annual depreciation expense divided by the book value of property, plant and equipment. On an aggregated basis, the average value of property, plant and equipment consumed in one year. The value may be distorted to some extent by the value of non-depreciable items such as land.

Average asset life - the reciprocal of the preceding item which gives an approximate measure of average life (accounting) of a company's fixed asset base.

TABLE V-1 (Continued) EXPLANATION OF FINANCIAL PARAMETERS

Annual depreciation expense - the simple value of total annual (1976) depreciation expense. The value is taken from published financial statements, and therefore generally reflects straight line depreciation.

Capital expenditures - the total annual (1976) value of all expenditures on plant and equipment.

Capital expenditures/depreciation expense - Both annual (1976) values. This parameter shows the relation of the investment in new plant and equipment to the "consumption" of plant and equipment through depreciation. It should be noted that the numerator is effectively current market prices whereas the denominator is historical costs. Inflation adjustments for the latter would put the two values on a more comparable basis.

Capital expenditures/capitalization - annual expenditures on plant and equipment as a percent of total capitalization. When adjusted for average asset life and the corresponding inflation factor, this is an indirect measure of the company's or industry's tendency to reinvest in itself and grow.

Income tax rate - total annual income tax expense divided by total gross income. The numerator included federal, state and local, as well as foreign income taxes. It also reflects deferred taxes (accelerated depreciation) and tax credits.

However, since the recession, earnings performance has dropped to a 1976 low of 7.2%. This is the lowest earnings rate of the seven industries studied in this section. Similarly, the 3.8% return on assets shown by the industry in 1976 is the lowest value of the major energy consuming industries. Although the debt-to-capital ratio of 37% does not appear out of line with other industries, this ratio has increased sharply since 1974 simultaneous with the depressed earnings rate. These circumstances together have caused interest coverage to drop to 3.7 times available gross earnings. In the face of this relatively bleak picture on the capitalization side of steel's balance sheet, 1976 capital expenditures in the industry were rather robust. Figure V-2 is a plot of 1976 capital expenditures as a percent of total capitalization versus the average asset life for each industry. The line fit through the various industry points is the specification of a linear regression through those data. The equation for this line is:

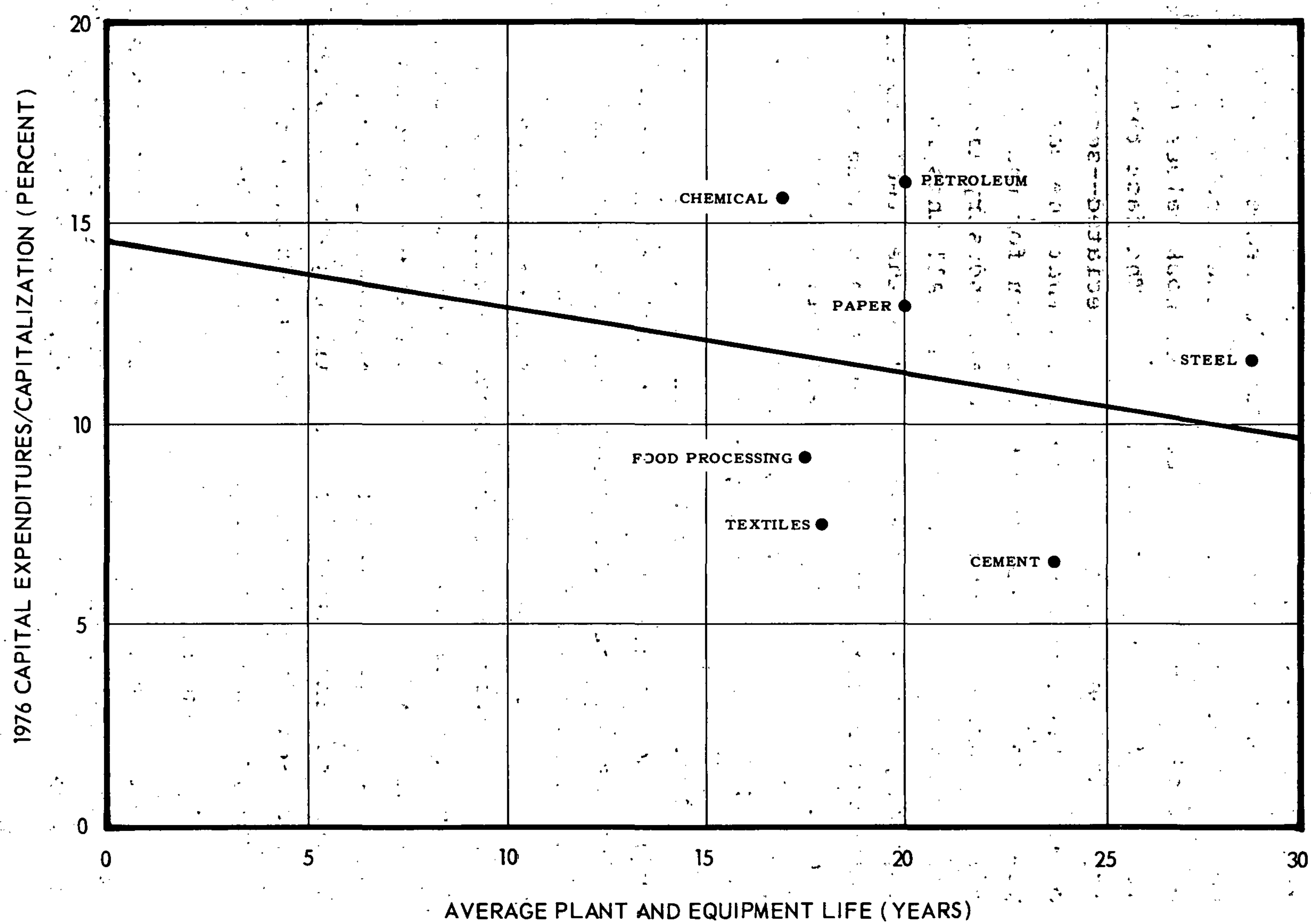
$$\frac{\text{Capital Expenditure}}{\text{Capitalization}} = 14.7 - .164 \text{ (average asset life)}$$

The downward slope of the line suggests logically that the longer the life of the plant and equipment in an industry, the less will need replacing in any one year. With this factor removed from the relative capital expenditures of each industry, the remaining error term (how far each point is off the line) is a relative measure of how bullish the capital expenditure programs of each industry are. Steel somewhat surprisingly falls above the line indicating relatively strong capital spending. This is most likely explained by the incidence of pollution control spending in this industry in 1976, which according to our interview with one steel industry executive, peaked in that year.

Thus, the prospects for heavy capital expenditure programs in the steel industry such as might be required by more

FIGURE V-2

INDUSTRY CAPITAL EXPENDITURES AS A FUNCTION OF AVERAGE ASSET LIFE



capital intensive energy conservation investments might not be very good. Earnings are low with foreign competition threatening to keep them there. Debt capacity seems to be filled, if not in excess of healthy limits; and the stocks of the industry are priced significantly under their book values (market value is only 71% of book value overall). The fact that the industry's plant and equipment is 53% depreciated--second highest of the industries studied--idnicates that the cash flow from depreciation will be relatively less than for the other industries. All the parameters measuring present industry liquidity also indicate a lack of investible funds. All this forebodes skimpy capital programs in upcoming years in the steel industry. Furthermore, our interviews suggested a growing interest in the steel industry toward diversification out of basic steel production, a factor that could work against energy conservation investments in the industry overall.

There is also reason to question certain incentive programs in the steel industry. In particular, programs that work through accelerated depreciation or investment tax credits could be handicapped by a relatively low tax burden in the industry. Total taxes paid on gross income average only 12.4%. Assuming a reasonable distribution on this factor, many companies may be paying no taxes at all due to poor earnings and other tax credit programs. Loan guarantees could conflict with the industry's need to get their debt ratios down. This leaves only incentives based on direct grants or other forms of front-end investment by the Federal Government to help usher in energy conservation technologies in the steel industry.

2. Textiles

Return on investment (book value of equity) has been more stable in the textile industry in recent years, but generally depressed. Like steel, the industry showed its greatest strength just prior to the recession with return on equity reaching 8.8% and 8.7% in 1975 and 1976, respectively (see Figure V-3).

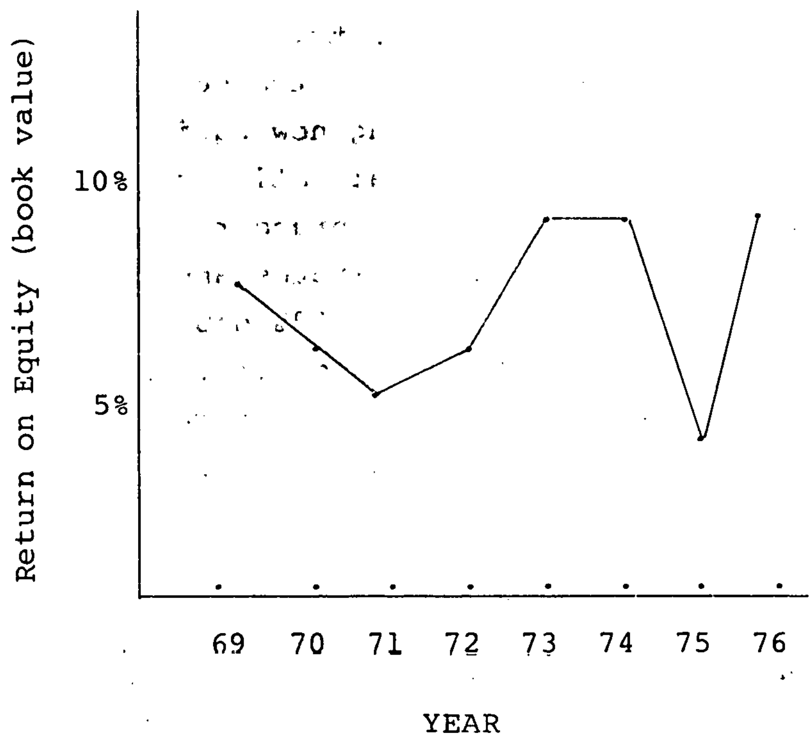


FIGURE V-3 Return on Investment in the Textile Industry

These returns are again low compared to other energy-consuming industries. Return on assets in the textile industry at 4.3% is second lowest (to steel) of the industries studied. Return on sales (which is the least significant measure of earnings strength) is lower in the textile industry than any of the other large energy-comsuming industries. The plant and equipment base in the textile industry is the most mature of all those studied (56% depreciated), yet capital expenditures were only 30% greater than depreciation expense. On an inflation adjusted basis, this would indicate attrition in the effective asset base of the industry. This circumstance is reflected in Figure V-2 which shows that with its average asset life of 17.9 years, the textile industry's capital expenditures were only 7.7% of their total capitalization instead of a figure of closer to 12% which would put them at the average for these energy-consuming industries.

The equity of the textile's industry has the lowest market value/book value of all the industries studied (.64). Such a low ratio is a real barrier to issuing new equity in the industry. Although the debt to capital ratio is the lowest of the seven industries, the interest coverage ratio does not indicate much capacity for new debt. Circumstances facing the textile industry may suggest that this 32% debt to capital ratio is actually higher than the investing community would like to see, indicating the need for the industry to reduce the ratio of debt in its capital structure even further.

Thus, the financial circumstance of the textile industry is much like that of the steel industry. All three primary sources of capital (retained earnings, new debt issues, new equity issues) are constrained by the poor performance of the industry. This suggests both limits to the amount of capital available for investment in energy conserving technologies, as well as the possibility that what discretionary capital is available might be best spent toward diversification rather than cost reduction investments.

3. Cement

The return on investment in the cement industry was not any better than in textiles (8.4% of book value of equity). Historical data on this parameter shows a higher average return on the last 8 years than textiles and more variability (see Figure V-4).

Debt is currently a higher percentage of total capitalization in the industry than for any other of the large energy-consuming industries (43%), and the interest coverage is the lowest.

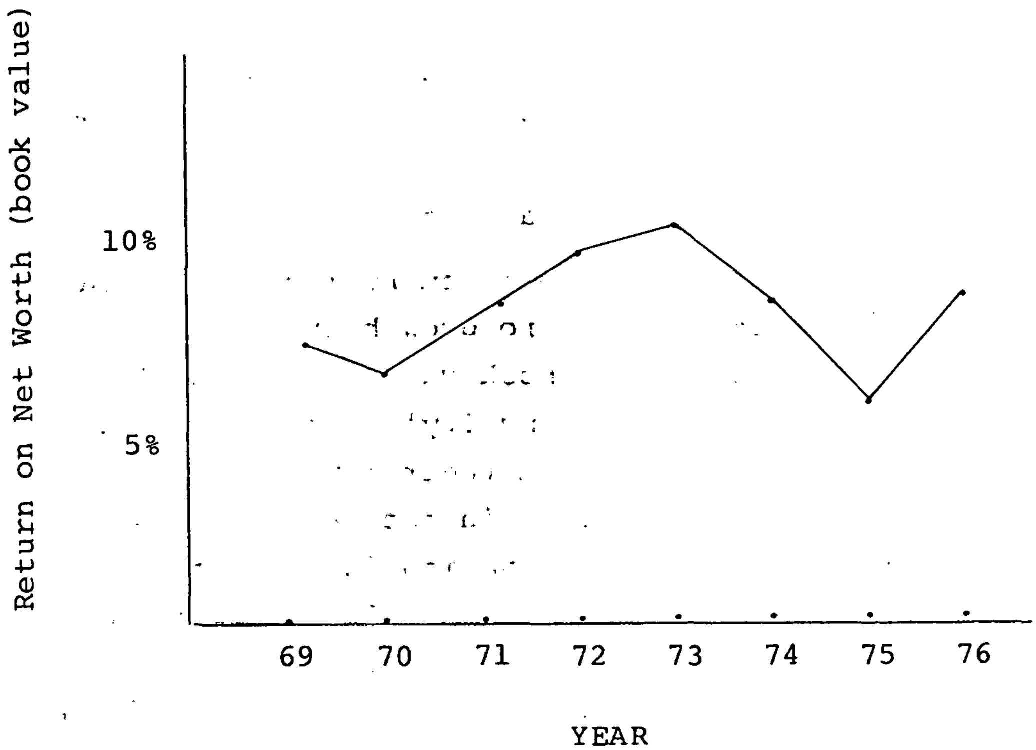


FIGURE V-4 Return on Investment in the Cement Industry

With the highly cyclical nature of the industry, one would not expect these ratios in this relative position. Except for steel, the cement industry has the most mature plant and equipment base coupled with long average assets life (23.8 years). These factors together would explain a low capital expenditure rate relative to depreciation expenses, but not as low as it actually is (1.17). This point is again made on Figure V-2, where the cement industry with its 23.8-year average asset life shows annual capital expenditures to be 6.1% of total capitalization where a value of 10.5% would be closer to an energy industries average for that asset life.

Similar to the steel and textile industries, the market value/book value ratio of the cement industry is very low at .67, again indicating a very poor environment for new equity issues. The relatively high return on market value for the industry, to some extent, reflects investor pessimism about the future earnings prospects for the industry (lower current market value returns indicate higher expected future returns and vice-versa). There does not appear to be any liquidity problem in the industry, and the income tax rate, although lower than average, does show capacity for Federal incentive programs.

In general, the steel, textile and cement industries can all be characterized as poor return, no growth industries. The severely depressed market value/book value ratios of the industries indicate the investing community's pessimism over the ability of these industries to put their investments to use as productive as has been possible in the past. The impact of these factors on energy conservation investments in these industries focuses more on the availability of capital than on required rate of return. For any company in these three industries, there is the additional consideration of the strategic value of investing what discretionary capital there is in a business that yields such poor overall returns on assets. An optimized strategy might be to diversify into more profitable businesses, foregoing all but the most essential investments in the base business. Such a strategy would not bode well for energy conservation investments which could be considered discretionary.

The picture changes somewhat for the remaining industries.

4. Food Processing

Return on net worth for the food processing industry in 1976 was the highest of all industries studied (14.5%). Historical data shows that this relatively high earnings performance of 1976 has been sustained and relatively stable over the past several years. (See Figure V-5.) The percentage of debt in the capital structure is about average for the industries studied, and combined with the relatively strong earnings performance, yields a strong interest coverage ratio (8.5x). Food processing is, by far, the least capital intense industry being studied with only 49¢ of assets being required to produce a dollar of revenues. As would be expected, this higher asset base has a shorter-than-average asset life (17.5 years) and is relatively new (44% depreciated).

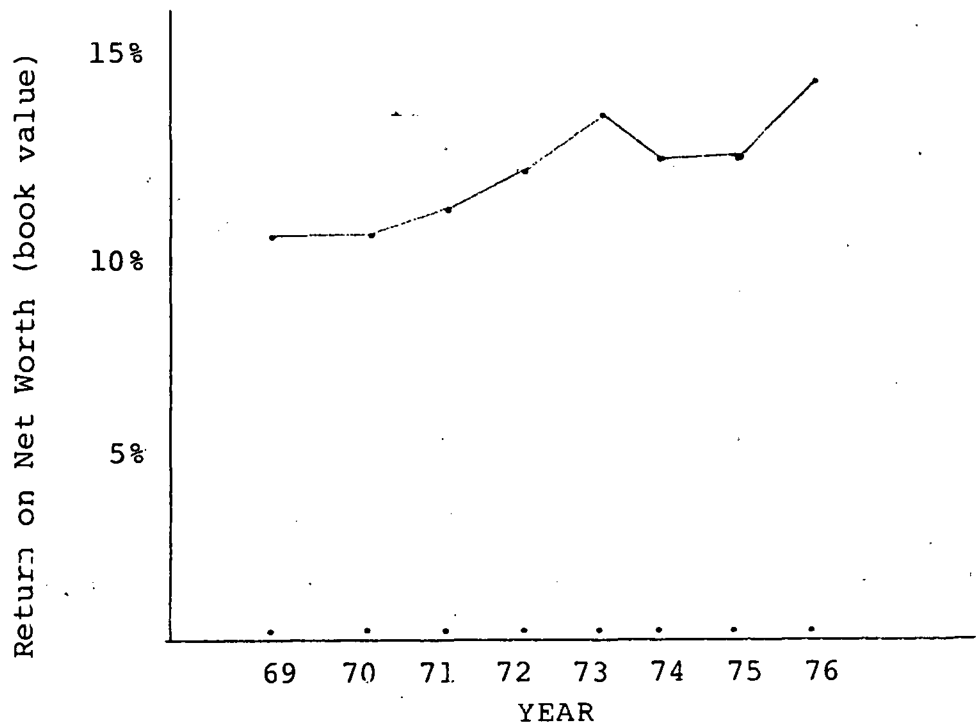


FIGURE V-5 Return on Investment in the Food Processing Industry

Interestingly, the capital investment rate of this industry is not as high as might be expected. As Figure V-2 shows, the adjusted annual average investment rate for this industry would be 11.7% of total capitalization of the company, whereas in 1976 it was only 9.2%. Part of this might be a transient circumstance in view of current business hesitancy to invest in plant and equipment (as of 2nd quarter 1977) due largely to inflation fears. This inference is corroborated by the high liquidity of this industry with cash representing 21.9% of the industry's net worth and 10.3% of its total assets.

This circumstance could be rationalized by increased expenditures in plant and equipment. By another measure, the current capital expenditures of the food processing industry appear somewhat stronger. When compared to depreciation expenses, capital expenditures are 1.95 times as great. With inflation accounted for, this represents a level of spending that should at least maintain the asset base.

In any event, it appears that there is more capacity for capital spending in the food processing industry than there is actual spending. For whatever reason explains this circumstance, it could possibly indicate larger opportunities for so-called discretionary investments. It is clear that the investment community sees good opportunities for the food processing industry by the fact that they have bid the industries stock up to 1.32 times its book value. However, the relatively high current return on market value of 11% (versus paper and chemical returns of 7.9% and 8.0%, respectively) perhaps indicates that the potential for future earnings growth may not be apparent. One possible explanation for this would be that the investment community believes the industry is fully matured and that growth prospects are limtied. This again would work to the advantage of energy conservation investments since fewer capital dollars would be going toward expansion of production capacity, leaving more funds for cost-saving investments.

5. Petroleum

Only the food processing industry showed a higher return on net worth (book value) than the petroleum industry in 1976. These returns have gained strength since 1973 and the Arab oil embargo. (See Figure V-6.)

Although the capital structure is relatively normal (37% of capital debt and long-term fixed liabilities) the strong earnings performance, coupled with the fact that the petroleum

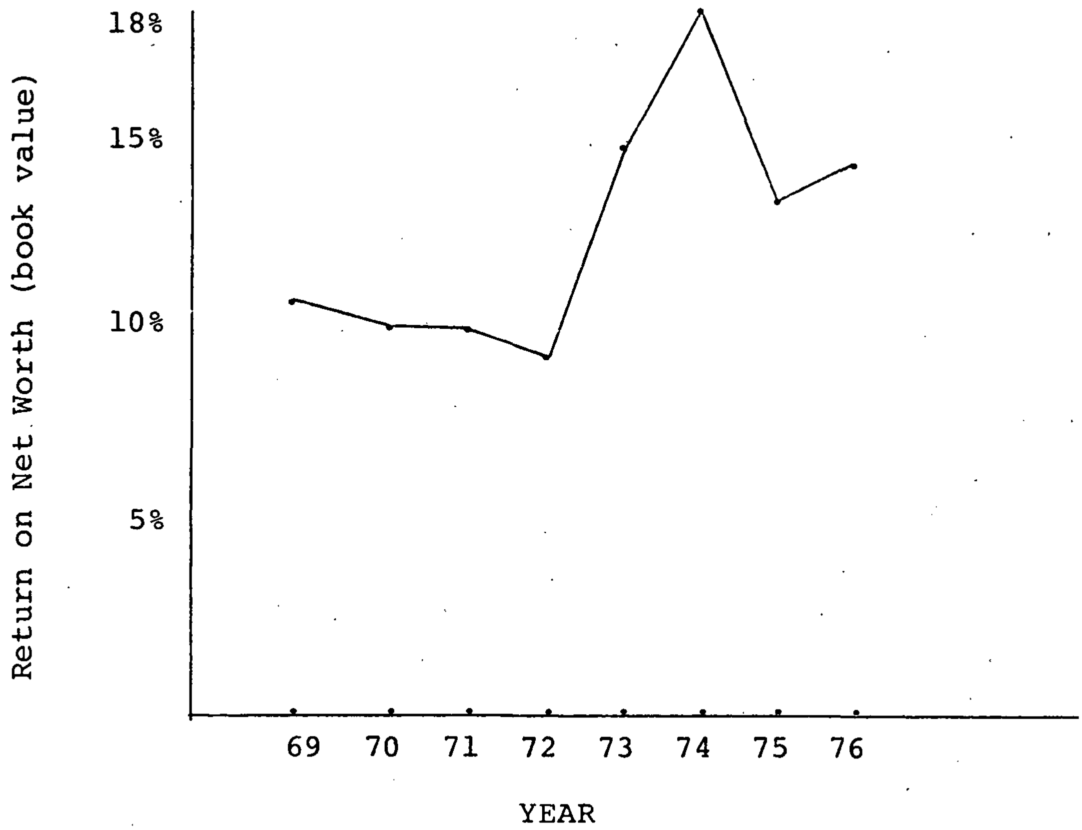


FIGURE V-6 Return on Investment in the Petroleum Industry

industry is less capital-intensive than other major industries, yields a strong ratio of gross income to interest expense. This suggests that debt capital is available if required by the industry without causing undue financial risks.

The average asset life of the industry is 20 years, and the current amount of accumulated depreciation is only 39%, making it one of the newest asset bases among the industries being studied. The level of capital expenditures in the industry is relatively high. Whereas on average the capital expenditures of the industry would be about 11% of the industry's total capitalization, in 1976 they were actually 16%, and an impressive 2.8 times as great as the depreciation expense for the year.

Interestingly, in the face of such good earnings performance on net worth, the market value of the industry's equity is slightly lower than the book value (.97x), yielding a relatively high return on market value of 14.5%. This is a clear indication of the investing public's expectations for the industry. The prospects of divestitures, windfall-profits taxes and other vagaries of world governments have caused investors to want their returns in the short-run in an industry with so many complicating factors in its future. As a result, it is not the best of times for new equity issues, perhaps a trivial finding considering the industry's tremendous internally generated cash streams. Without significant changes in the political circumstances, domestic or foreign, there seems little possibility of capital constraints in the petroleum industry.

6. Paper and Forest Products

The paper and forest products industry was also a strong earner in 1976. After a dip in earnings in the early 1970's, the industry has posted relatively good returns since with a significant drop in 1975 during the peak of the general economic downturn. (See Figure V-7.)

At 38%, the debt to capital ratio is not unduly high as is reflected in the 6.5 interest coverage ratio. However, the cyclical nature of the business may suggest limits to the industry's ability to significantly increase this debt ratio. The industry is relatively capital-intensive (92¢ of assets to produce one dollar of revenue) with a relatively new asset base (39% depreciated) and an average fixed asset life of 20 years.

Like the petroleum and chemical industries, the paper industry in 1976 exhibited a relatively aggressive capital expenditure program, spending 13% of the value of its total capitalization when about 11% would have been the cross-industry average. This same phenomenon is reflected in the high ratio of

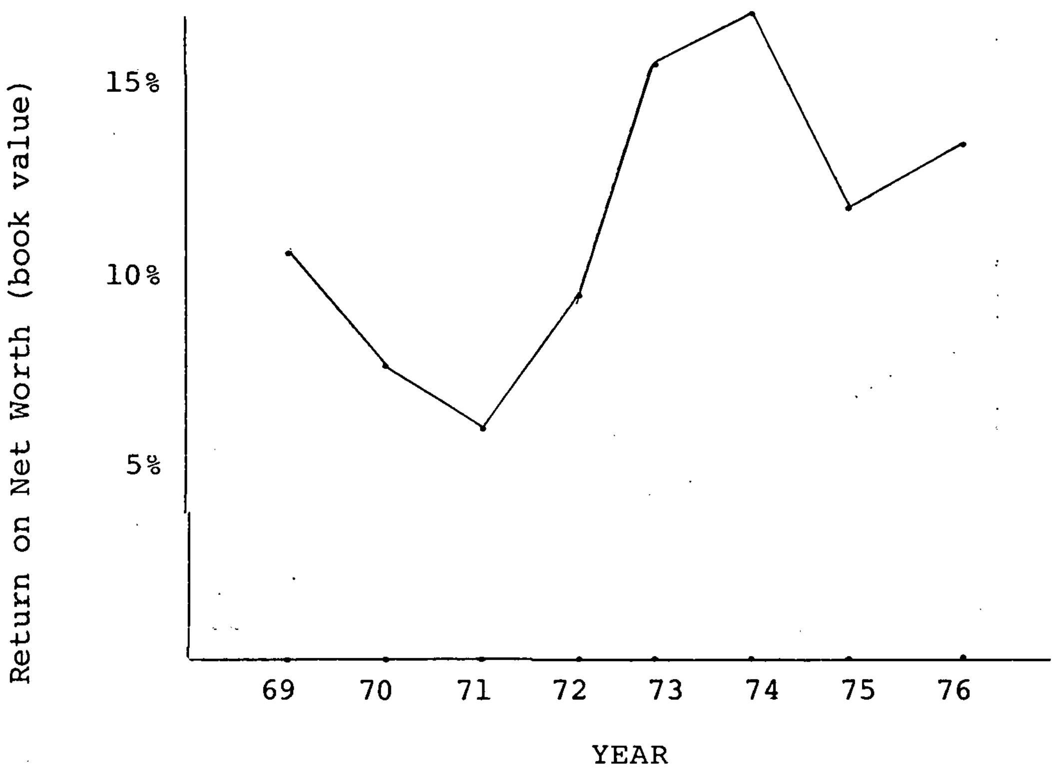


FIGURE V-7 Return on Investment in the Paper and Forest Products Industry

capital expenditures to depreciation expenses of 2.26. The investing community's appreciation of the paper industry's earnings performance is reflected in the high ratio of market value to book value (1.68). Perhaps even more significantly, the low current return on market value (7.9%) is an indication that the investing public sees future growth in earnings as a likely occurrence.

7. Chemical

The chemical industry's 1976 return on net worth of 14.1% was among the highest studied. Historical performance of the industry has shown the highest returns on investment of all the industries considered. (See Figure V-8.)

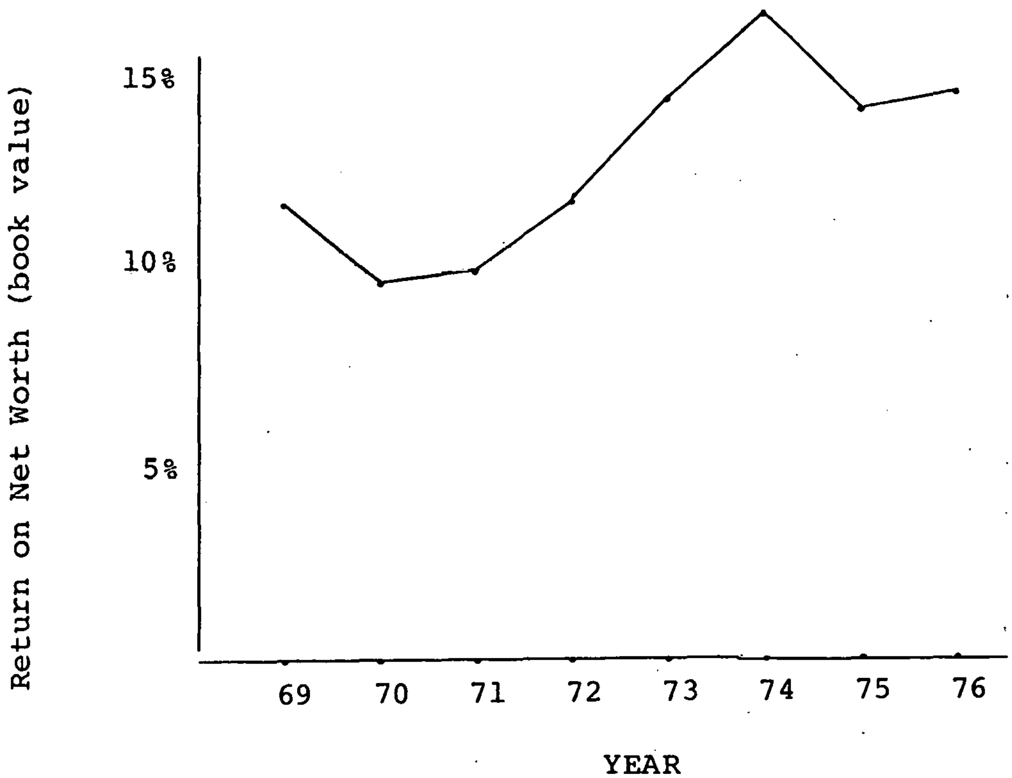


FIGURE V-8 Return on Investment in the Chemical Industry

Likewise, its performance in 1976 on return on assets (7.1%) and return on sales (6.5%) was the highest of all the energy-consuming industries.

Like the paper industry, rather typical financial leverage (38% debt and other long-term fixed liabilities/capital) was supported with a healthy 7.2 interest coverage ratio. The plant and equipment stock of the industry is relatively older than the petroleum and paper industries (49% depreciated on an average life of 16.9 years).

Also similar to the paper industry, the capital market has bid up the price of the chemical industry's stock to 1.76 times its book value. The resulting return on the market value of the stock of 8.0% suggests the expectation of future earnings growth. The expenditure program of the industry in 1976 was 15.7% of total capitalization, significantly higher than the adjusted average of 11.8% shown on Figure V-2.

C. Conclusions of Industry Analysis

It appears doubtful that capital constraints could be a significant problem in the chemical, petroleum, paper or even the food processing industries. There is a little uncertainty about the strategic goals of the food processing industry since reinvestment in the business appears to be less than what is justified by internal funds generation. The other three high earnings industries appear willing to invest heavily in their basic businesses. It would seem logical that any investment with an acceptable risk adjusted rate of return would be readily accepted by these industries. On the other hand, the relatively low rates of return, sub-optimum financial structures, and apparent reluctance to reinvest in the basic business exhibited by the Steel, Textile and Cement industries raise the spectre of capital constraints in their capital asset investment decisions. The logical result of this might be relatively higher required hurdle rates for projects that are considered discretionary. There will, of course, be significant variation among the different companies within a given industry. However, in assessing the overall effectiveness of ERDA's R&D portfolio, each technology should be assessed by its overall acceptability within a given industry or perhaps across industries. This evaluation is best done on a more aggregated basis to reflect the overall ability of the industry to adopt new technologies. The industry global approach used here allows a broad analysis of financial circumstances of an entire industry. This provides a broad macro-economic context within which the detailed project-specific micro-economic analysis can best be performed.

COMPANIES INCLUDED IN STEEL INDUSTRY GLOBAL

1. Armco Steel Corporation
2. Alan Wood Steel Company
3. Bethlehem Steel Corporation
4. Inland Steel Company
5. Interlake, Incorporated
6. Kaiser Steel Corporation
7. Lykes Corporation
8. Mclouth Steel Corporation
9. National Steel Corporation
10. NVF Company
11. Republic Steel Corporation
12. Steel Company CDA, Limited
13. Wheeling Pitts Steel
14. United States Steel Corporation

VG STEEL - INTEGRATED
BALANCE SHEET
(in millions)

		1976
ASSETS		
Current Assets:		
Cash	$	1,508.89
Accounts Receivable		2,948.35
Inventory		5,468.36
Other Current Assets		255.12
Total Current Assets	$	10,180.70
Property, Plant and Equipment:		
Gross Plant		36,467.40
Accumulated Depreciation		19,220.70
Net Plant	$	17,246.70
Long Term Investments		2,122.51
Intangibles		91.18
Deferred Charges		316.87
Other Investments		134.26
Other Assets		433.98
Total Assets	$	30,392.00
		=========
LIABILITIES AND NET WORTH		
Current Liabilities:		
Notes Payable	$	388.68
Accounts Payable		2,389.35
Taxes Payable		696.64
Long Term Debt Due in One Year		173.63
Other Current Liabilities		1,661.66
Total Current Liabilities	$	5,309.96
Long Term Liabilities:		
Deferred Taxes		1,789.65
Minority Interest		19.72
Long Term Debt		7,016.11
Other Liabilities		406.72
Total Long Term Liabilities	$	9,232.20
Net Worth:		
Preferred Equity		482.82
Common Equity		15,367.00
Net Worth	$	15,849.80
Total Liabilities and Net Worth	$	30,392.00
		=========

DATA SOURCE : VALUELINE
June 20, 1977

VC STEEL - INTEGRATED
INCOME STATEMENT
(in millions)

	1976
REVENUES	
Net Sales	$ 30,763.70
Other Income	293.58
Total Revenue	$ 31,057.30
EXPENSES	
Cost of Goods Sold	$ 26,736.30
General and Administrative Exp.	1,353.94
Depreciation and Amortization	1,260.39
Total Interest	488.18
Minority Interest	0.00
Other Expenses	(93.63)
Total Expenses	$ 29,745.20
Pretax Income	$ 1,312.10
Total Taxes	163.83
Net Income	$ 1,144.25
	==========
Preferred Dividends Declared	$ 23.40
Common Dividends Declared	$ 513.64
Earnings per Share	$ 4.19
Common Dividends per Share	$ 1.92

DATA SOURCE : VALUELINE
June 20, 1977

COMPANIES INCLUDED IN TEXTILE INDUSTRY GLOBAL

1. Bates Manufacturing, Incorporated
2. Belding Heminway, Incorporated
3. Burlington Industries, Incorporated
4. Barwick, E. T. Industries, Incorporated
5. Cannon Mils Company
6. Chesler Industries, Incorporated
7. Collins & Aikman Corporation
8. Cone Mils Corporation
9. Dan River, Incorporated
10. Fieldcrest Mils, Incorporated
11. Graniteville Company
12. Martin Processing, Incorporated
13. Lowenstein, M. & Sons
14. Ludlow Corporation
15. Mac Andiews & Forbes Company
16. Mohasco Corporation
17. Riegel Textile Corporation
18. Reeves Brothers, Incorporated
19. Springs Mils, Incorporated
20. Stevens, J. P. & Company, Incorporated
21. Texfi Industries, Incorporated
22. United Merchants & Manufacturers
23. West Point Pepperell

VG TEXTILES
BALANCE SHEET
(in millions)

		1976
ASSETS		
Current Assets:		
Cash	$	447.25
Accounts Receivable		2,254.48
Inventory		2,086.99
Other Current Assets		92.93
Total Current Assets	$	4,881.59
Property, Plant and Equipment:		
Gross Plant		5,790.68
Accumulated Depreciation		3,268.37
Net Plant	$	2,522.31
Long Term Investments		40.50
Intangibles		21.64
Deferred Charges		57.40
Other Investments		17.48
Other Assets		35.03
Total Assets	$	7,558.46
		==========
LIABILITIES AND NET WORTH		
Current Liabilities:		
Notes Payable	$	375.18
Accounts Payable		631.24
Taxes Payable		187.22
Long Term Debt Due in One Year		99.09
Other Current Liabilities		541.77
Total Current Liabilities	$	1,834.47
Long Term Liabilities:		
Deferred Taxes		131.14
Minority Interest		11.91
Long Term Debt		1,628.86
Other Liabilities		63.63
Total Long Term Liabilities	$	1,835.54
Net Worth:		
Preferred Equity		20.77
Common Equity		3,867.68
Net Worth	$	3,888.45
Total Liabilities and Net Worth	$	7,558.46
		==========

DATA SOURCE : VALUELINE
June 20, 1977

VG TEXTILES
INCOME STATEMENT
(in millions)

		1976
REVENUES		
Net Sales	$	11,344.60
Other Income		108.06
Total Revenue	$	11,452.70
EXPENSES		
Cost of Goods Sold	$	9,165.73
General and Administrative Exp.		1,142.48
Depreciation and Amortization		326.89
Total Interest		169.98
Minority Interest		0.00
Other Expenses		16.84
Total Expenses	$	10,821.90
Pretax Income	$	630.78
Total Taxes		300.03
Net Income	$	327.06
		=========
Preferred Dividends Declared	$	1.02
Common Dividends Declared	$	121.56
Earnings per Share	$	2.47
Common Dividends per Share	$	0.92

DATA SOURCE : VALUELINE
June 20, 1977

COMPANIES INCLUDED IN CEMENT INDUSTRY GLOBAL

1. AMCORD, Incorporated
2. Alpha Portland Industries
3. Penn Dixie Industries, Incorporated
4. Gifford Hill & Company, Incorporated
5. Giant Portland Mas & Cem
6. General Portland, Incorporated
7. Ideal Basic Industries, Incorporated
8. Kaiser Chemical & Gypsum Company
9. Lone Star Industries, Incorporated
10. Lehigh Portland Chemical Company
11. MEDUSA Corporation
12. Missouri Portland Chemical
13. Puerto Rican Chemical, Incorporated
14. Texas Industries, Incorporated

VG CEMENT
BALANCE SHEET
(in millions)

		1976
ASSETS		
Current Assets:		
Cash	$	203.84
Accounts Receivable		308.20
Inventory		371.96
Other Current Assets		36.33
Total Current Assets	$	920.33
Property, Plant and Equipment:		
Gross Plant		2,676.62
Accumulated Depreciation		1,332.67
Net Plant	$	1,343.95
Long Term Investments		169.35
Intangibles		24.94
Deferred Charges		30.87
Other Investments		10.35
Other Assets		51.28
Total Assets	$	2,540.72
LIABILITIES AND NET WORTH		
Current Liabilities:		
Notes Payable	$	13.89
Accounts Payable		178.91
Taxes Payable		62.86
Long Term Debt Due in One Year		26.04
Other Current Liabilities		94.98
Total Current Liabilities	$	376.68
Long Term Liabilities:		
Deferred Taxes		155.54
Minority Interest		10.25
Long Term Debt		642.38
Other Liabilities		19.84
Total Long Term Liabilities	$	828.01
Net Worth:		
Preferred Equity		88.60
Common Equity		1,247.44
Net Worth	$	1,336.04
Total Liabilities and Net Worth	$	2,540.72

DATA SOURCE : VALUELINE
June 20, 1977

VG CEMENT
INCOME STATEMENT
(in millions)

		1976
REVENUES		
Net Sales	$	2,609.23
Other Income		28.14
Total Revenue	$	2,637.37
EXPENSES		
Cost of Goods Sold	$	1,971.99
General and Administrative Exp.		305.00
Depreciation and Amortization		113.31
Total Interest		56.23
Minority Interest		0.00
Other Expenses		21.79
Total Expenses	$	2,468.32
Pretax Income	$	169.05
Total Taxes		54.34
Net Income	$	112.01

Preferred Dividends Declared	$	4.75
Common Dividends Declared	$	45.09

Earnings per Share	$	1.73
Common Dividends per Share	$	0.73

DATA SOURCE : VALUELINE
June 20, 1977

COMPANIES INCLUDED IN FOOD PROCESSING INDUSTRY GLOBAL

1. American Bakeries Company
2. Archer Daniels Midland
3. American Maize Products
4. Anderson Clayton & Company
5. Nabisco, Incorporated
6. Borden, Incorporated
7. Beatrice Foods Company
8. Consolidated Foods Company
9. CPC International, Incorporated
10. Chock Full O Nuts Corporation
11. Castle & Cooke, Incorporated
12. Cook Industries, Incorporated
13. Carnation Company
14. Campbell Soup Company
15. Central Soya, Incorporated
16. Dekalb Agresearch, Incorporated
17. Del Monte Corporation
18. Di Giorgio Corporation
19. Fairmont Foods Company
20. Gerber Products Company
21. General Foods Corporation
22. Green Giant Company
23. General Host Corporation
24. General Mils, Incorporated
25. Heinz, H. J. Company
26. Hershey Foods Corporation
27. Interstate Brands Corporation
28. International Multifds
29. Kellogg Company
30. Campbell Taggard, Incorporated
31. Kraft, Incorporated
32. Conagra, Incorporated
33. Norton Simon, Incorporated
34. Quaker Oats Company
35. Pet, Incorporated
36. Peavey Company
37. Pioneer Hi Bred International
38. Peter Paul, Incorporated
39. Pillsbury Company
40. Ralston Purina Company
41. Russell Stover Candies
42. Standard Brands, Incorporated
43. Stokely Van Camp, Incorporated
44. Smucker, J. M. Company
45. Staley, A. E. Manufacturing Company
46. Esmark, Incorporated
47. Tropicana Products, Incorporated
48. Tootsie Roll Industries, Incorporated
49. United Brands Company
50. Unilever, Limited
51. Unilever, New York
52. Ward Foods, Incorporated
53. Wrigley, W. M., Jr. Company

VG FOOD PROCESSING
BALANCE SHEET
(in millions)

		1976
ASSETS		
Current Assets:		
Cash	$	4,597.42
Accounts Receivable		8,438.00
Inventory		13,574.40
Other Current Assets		513.82
Total Current Assets	$	27,123.70
Property, Plant and Equipment:		
Gross Plant		26,334.60
Accumulated Depreciation		11,504.50
Net Plant	$	14,830.10
Long Term Investments		988.59
Intangibles		1,375.94
Deferred Charges		97.14
Other Investments		246.26
Other Assets		286.28
Total Assets	$	44,701.80
		=========
LIABILITIES AND NET WORTH		
Current Liabilities:		
Notes Payable	$	2,116.93
Accounts Payable		6,605.83
Taxes Payable		1,384.87
Long Term Debt Due in One Year		289.25
Other Current Liabilities		2,633.45
Total Current Liabilities	$	13,030.30
Long Term Liabilities:		
Deferred Taxes		1,304.98
Minority Interest		496.99
Long Term Debt		7,055.99
Other Liabilities		1,853.24
Total Long Term Liabilities	$	10,711.20
Net Worth:		
Preferred Equity		597.70
Common Equity		20,362.50
Net Worth	$	20,960.20
Total Liabilities and Net Worth	$	44,701.80
		=========

DATA SOURCE : VALUELINE
June 20, 1977

VG FOOD PROCESSING
INCOME STATEMENT
(in millions)

	1976
REVENUES	
Net Sales	$ 90,920.70
Other Income	393.55
Total Revenue	$ 91,314.20
EXPENSES	
Cost of Goods Sold	$ 73,353.10
General and Administrative Exp.	9,506.93
Depreciation and Amortization	1,498.06
Total Interest	803.61
Minority Interest	(3.71)
Other Expenses	124.74
Total Expenses	$ 85,282.70
Pretax Income	$ 6,031.51
Total Taxes	2,832.75
Net Income	$ 3,040.60

Preferred Dividends Declared	$ 36.87
Common Dividends Declared	$ 1,049.69

Earnings per Share	$ 3.03
Common Dividends per Share	$ 1.06

DATA SOURCE : VALUELINE
June 20, 1977

COMPANIES INCLUDED IN PETROLEUM INDUSTRY GLOBAL

1. Atlantic Richfield Company
2. Amerada Hess Corporation
3. APCO Oil Corporation
4. Apache Corporation
5. Ashland Oil, Incorporated
6. Belco Pete Corporation
7. British Petroleum, Limited
8. Clark Oil & Refining Company
9. Continental Oil Company
10. Cities Service Company
11. Commonwealth Oil Refining
12. Dome Pete, Limited
13. Total Pete North America
14. General American Oil, TEX
15. Getty Oil Company
16. Gulf Oil Corporation
17. Gulf Oil CDA, Limited
18. Helmerich & Payne, Incorporated
19. Husky Oil, Limited
20. Imperial Oil, Limited
21. Exxon Corporation
22. Kerr McGee Corporation
23. Quaker State Oil Refining Company
24. Mobil Corporation
25. Marathon Oil Company
26. Murphy Oil Corporation
27. Natomas Company
28. Tosco Corporation
29. Occidental Pete Corporation
30. Phillips Pete Company
31. Pacific Petes, Limited
32. Pennzoil Company
33. Royal Dutch Pete Company
34. Reserve Oil & Gas Company
35. Sabine Corporation
36. Shell Trans & Trading
37. Standard Oil Company, CALIF
38. Standard Oil Company, IND
39. Standard Oil Company, Ohio
40. Southland RTY Company
41. Sun, Incorporated
42. Shell Oil Company
43. Charter Company
44. Tesoro Pete Corporation
45. Texaco, Incorporated
46. Union Oil Company, CALIF
47. United Refining Company

VG PETROLEUM
BALANCE SHEET
(in millions)

	1976
ASSETS	
Current Assets:	
Cash	$ 26,644.30
Accounts Receivable	48,183.20
Inventory	36,957.80
Other Current Assets	887.73
Total Current Assets	$ 112,673.00
Property, Plant and Equipment:	
Gross Plant	217,845.00
Accumulated Depreciation	85,332.50
Net Plant	$ 132,512.00
Long Term Investments	16,758.30
Intangibles	128.11
Deferred Charges	2,432.60
Other Investments	2,751.79
Other Assets	706.82
Total Assets	$ 265,211.00
LIABILITIES AND NET WORTH	
Current Liabilities:	
Notes Payable	$ 7,061.68
Accounts Payable	52,021.90
Taxes Payable	10,573.00
Long Term Debt Due in One Year	2,090.36
Other Current Liabilities	4,603.27
Total Current Liabilities	$ 76,350.00
Long Term Liabilities:	
Deferred Taxes	12,322.40
Minority Interest	4,871.56
Long Term Debt	44,911.40
Other Liabilities	7,936.92
Total Long Term Liabilities	$ 70,042.20
Net Worth:	
Preferred Equity	3,659.95
Common Equity	115,159.00
Net Worth	$ 118,819.00
Total Liabilities and Net Worth	$ 265,211.00

DATA SOURCE : VALUELINE
June 20, 1977

VC PETROLEUM
INCOME STATEMENT
(in millions)

	1976
REVENUES	
Net Sales	$ 322,772.00
Other Income	6,415.71
Total Revenue	$ 329,188.00
EXPENSES	
Cost of Goods Sold	$ 244,865.00
General and Administrative Exp.	23,759.80
Depreciation and Amortization	10,785.40
Total Interest	3,972.69
Minority Interest	(62.54)
Other Expenses	(339.87)
Total Expenses	$ 282,981.00
Pretax Income	$ 46,207.00
Total Taxes	28,690.30
Net Income	$ 16,729.50
Preferred Dividends Declared	$ 163.70
Common Dividends Declared	$ 6,199.34
Earnings per Share	$ 5.16
Common Dividends per Share	$ 1.93

DATA SOURCE : VALUELINE
June 20, 1977

COMPANIES INCLUDED IN PAPER INDUSTRY GLOBAL

1. Boise Cascade Corporation
2. Brown Company
3. Chesapeake Corporation, VA
4. Domtar, Limited
5. Fort Howard Paper Company
6. Georgia Pacific Corporation
7. Great Northern Nekoosa
8. Hammermill Paper Company
9. Hudson Pulp & Paper Company
10. International Paper Company
11. Kimberly Clark Corporation
12. Louisiana Pacific Corporation
13. Mead Corporation
14. Olinkraft, Incorporated
15. Pacific Lumber Company
16. Potlach Corporation
17. Scott Paper Company
18. St. Regis Paper Company
19. Southwest Forest Industries
20. Union Camp Corporation
21. Champion International Corporation
22. Westvaco Corporation
23. Willamette Industries, Incorporated
24. Weyerhaeuser Company
25. Crown Zellerbach Corporation

VG PAPER & FOREST PROD
BALANCE SHEET
(in millions)

		1976
ASSETS		
Current Assets:		
Cash	$	1,842.13
Accounts Receivable		2,876.38
Inventory		3,928.85
Other Current Assets		207.80
Total Current Assets	$	8,855.14
Property, Plant and Equipment:		
Gross Plant		26,740.60
Accumulated Depreciation		10,337.80
Net Plant	$	16,402.80
Long Term Investments		1,305.10
Intangibles		155.88
Deferred Charges		183.23
Other Investments		63.72
Other Assets		438.67
Total Assets	$	27,340.80
		==========
LIABILITIES AND NET WORTH		
Current Liabilities:		
Notes Payable	$	434.16
Accounts Payable		2,052.79
Taxes Payable		570.19
Long Term Debt Due in One Year		391.81
Other Current Liabilities		769.22
Total Current Liabilities	$	4,218.16
Long Term Liabilities:		
Deferred Taxes		1,501.68
Minority Interest		127.39
Long Term Debt		6,886.31
Other Liabilities		260.99
Total Long Term Liabilities	$	8,776.36
Net Worth:		
Preferred Equity		649.25
Common Equity		13,697.00
Net Worth	$	14,346.30
Total Liabilities and Net Worth	$	27,340.80
		==========

DATA SOURCE : VALUELINE
June 20, 1977

VG PAPER & FOREST PROD
INCOME STATEMENT
(in millions)

	1976
REVENUES	
Net Sales	$ 29,648.80
Other Income	195.55
Total Revenue	$ 29,844.40
EXPENSES	
Cost of Goods Sold	$ 22,042.80
General and Administrative Exp.	2,973.95
Depreciation and Amortization	1,331.67
Total Interest	552.61
Minority Interest	0.00
Other Expenses	(84.16)
Total Expenses	$ 26,816.90
Pretax Income	$ 3,027.46
Total Taxes	1,112.72
Net Income	$ 1,908.81

Preferred Dividends Declared	$ 34.88
Common Dividends Declared	$ 632.76

Earnings per Share	$ 3.03
Common Dividends per Share	$ 1.02

DATA SOURCE : VALUELINE
June 20, 1977

COMPANIES INCLUDED IN CHEMICALS INDUSTRY GLOBAL

1. Allied Chemical Corporation
2. American Cyanamid Company
3. Akzona, Incorporated
4. Celanese Corporation
5. DuPont E. I. DeNemours
6. Dexter Corporation
7. Diamond Shamrock Corporation
8. Dow Chemical Company
9. Emery Industries, Incorporated
10. Ethyl Corporation
11. GAF Corporation
12. Grace, W. R. & Company
13. Hercules, Incorporated
14. Inmont Corporation

VG CHEMICAL - BASIC BALANCE SHEET (in millions)

		1976
ASSETS		
Current Assets:		
Cash	$	2,743.71
Accounts Receivable		8,629.35
Inventory		9,402.28
Other Current Assets		519.16
Total Current Assets	$	21,294.50
Property, Plant and Equipment:		
Gross Plant		47,740.00
Accumulated Depreciation		23,314.20
Net Plant	$	24,425.90
Long Term Investments		2,200.67
Intangibles		620.92
Deferred Charges		424.54
Other Investments		213.67
Other Assets		419.41
Total Assets	$	49,385.90
LIABILITIES AND NET WORTH		
Current Liabilities:		
Notes Payable	$	1,397.21
Accounts Payable		4,385.88
Taxes Payable		1,496.76
Long Term Debt Due in One Year		416.46
Other Current Liabilities		1,845.16
Total Current Liabilities	$	9,541.41
Long Term Liabilities:		
Deferred Taxes		2,525.62
Minority Interest		524.54
Long Term Debt		11,333.30
Other Liabilities		668.09
Total Long Term Liabilities	$	15,051.60
Net Worth:		
Preferred Equity		724.76
Common Equity		24,068.10
Net Worth	$	24,792.90
Total Liabilities and Net Worth	$	49,385.90

DATA SOURCE : VALUELINE
June 20, 1977

VG CHEMICAL - BASIC
INCOME STATEMENT
(in millions)

		1976
REVENUES		
Net Sales	$	53,274.80
Other Income		460.82
Total Revenue	$	53,735.60
EXPENSES		
Cost of Goods Sold	$	36,542.10
General and Administrative Exp.		7,293.36
Depreciation and Amortization		2,838.60
Total Interest		996.48
Minority Interest		(8.93)
Other Expenses		(64.81)
Total Expenses	$	47,596.80
Pretax Income	$	6,138.80
Total Taxes		2,543.24
Net Income	$	3,491.16

Preferred Dividends Declared	$	34.88
Common Dividends Declared	$	1,337.62

Earnings per Share	$	4.12
Common Dividends per Share	$	1.59

DATA SOURCE : VALUELINE
June 20, 1977

SECTION VI

IMPLICATIONS OF FINDINGS FOR ERDA'S INDUSTRIAL CONSERVATION PROGRAMS

It remains to be shown how the results of the several published surveys, the interview program, the industry analysis and the academic theory all bear on the ERDA industrial conservation program. To the extent that ERDA's funding of new conservation technologies identifies the projects that the private sector will evaluate most favorably, it will optimize its impact on energy conservation in the industrial sector. To this end, ERDA stands to gain by applying analysis that generally reflects or anticipates the procedures the private sector uses. This section of the report will deal with this dimension as it relates to ERDA's project evaluation options.

A. Risk/Rate of Return Evaluation Tools

The results of the published surveys and the personal interviews validate the basic method of evaluating the rate of return of a project which ERDA's Division of Industrial Conservation currently employs. Discounted rate of return is used extensively throughout all industries studied. The current threshold criterion is based on this discounted cash flow approach and yields by far the best generic evaluation logic in assessing energy conservation proposals. In most cases, the results of simple discounted cash flow techniques will yield the required "go/no-go" decision without more extensive analysis. It is in those cases where the decision is not clear cut after this initial screening that more elaborate procedures may be needed to make supportable decisions both in the private sector as well as ERDA.

The personal interviews led to the clear conclusion that energy conservation investments are not evaluated differently per se. In some industries, it is likely that such investments will be lumped into what is termed a "discretionary" pool which in itself may be treated differently from so-called "mandatory" investments. Being designated as "discretionary" effects the evaluation of an investment most in a circumstance of capital constraint in a company or industry, or possibly in a circumstance where investment in a particular area is precluded by a company's overall business strategy.

There remains the issue of the proper discounting factor or required hurdle rate for an investment. This factor is always tied to some notion of the cost of capital, but the cost of capital itself is an elusive parameter to establish. The failings of all accounting measures for assessing this value have led academicians and several companies into empirically fit estimates of the cost of capital. The Capital Asset Pricing Model as discussed in Section IV is the leading theory in this area. Careful development of this model would allow the Industrial Conservation Division to establish cost of capital estimates for different industry groups which are composed of companies identified as likely targets for any given technology.

B. Risk Adjustment Procedures

The results of the interviews as well as the industry surveys make it clear that there is no preferred or common method for dealing with risk or uncertainty in the private sector. It must be recognized that the vast majority of investment decisions made in industry involve no unusual components of risk and, therefore, require no special risk evaluation. In fact, many so-called "mandatory" investments are exposed only to perfunctory analysis of the rate of return since they evolve out of the momentum of past investment and business decisions, and not funding them would be tantamount to going out of business. Unfortunately, most (if not all) new energy conservation-type investments will not have the luxury of such light scrutiny.

To some extent, a pattern does emerge when discussing risk evaluations techniques in the private sector. Projects that are perceived as unusually risky are generally required to jump higher ROI hurdles. Sensitivity analysis is done to see which parameters are likely to do the most damage if they do not behave as expected. In many cases, scenarios are run to see what happens if a series of events occur coincidently. But in all cases, the results of these techniques fall back on the comparison to some risk-adjusted hurdle rate.

Most times this adjustment is subjective and is easily biased by personal preferences, but regardless of its shortcomings, such risk-adjusted hurdle rate techniques with sensitivity and scenario analysis form the basis of risk-adjusted investment decisions. Capital asset pricing theory is again being touted as a partial cure to the subjectivity of more traditional methods of dealing with risk. But the use of this technique, as well as other so-called "state-of-the-art" evaluation techniques, involves the use of probabilistic analysis.

C. Probabilistic Techniques

As was noted in the sections dealing with the interviews and industry surveys, probabilistic techniques have been, and still are, used for more difficult investment evaluations. However, in some companies the techniques are rejected due to the difficulty in assessing probabilities, or because of the difficulty in management understanding how the inputs became the results. In other cases, it wasn't felt that such elaborate analysis was required when less sophisticated analysis offered enough insight to substantiate a particular decision.

The latter of these objections is an excellent reason to not perform probabilistic analysis. Frequently in probabilistic analysis, the decision-maker finds that the rigor of the analysis technique provides all the insights needed for the decision without completing the entire process. This will be true with ERDA's portfolio of technologies, too.

The arguments that probabilistic analysis is too sophisticated for the quality of the data, or that the inputs are too difficult to make, are invalid. The more tentative one is about the input assessments of a project, the more uncertain one is about the ultimate value of the project. However, probabilistic assessment enhances one's perception of such uncertainty and therefore is more useful rather than less useful in this circumstance.

The statement that probabilistic assessments are difficult is true--but therein lies their value. This difficulty in making assessments requires more disciplined efforts in identifying and gathering the information most important to a project's evaluation. It is this factor that often causes results to fall out of probabilistic assessments before the actual probabilistic calculations are even made.

It would be logical in many cases for ERDA's analysis of projects to be more thorough or sophisticated than the project might receive in the private sector. For one thing, if ERDA sponsors R&D on a particular project, the private sector will have better data to evaluate the project when such programs are concluded and the results known. Thus, ERDA is forced to make its funding decision with less extensive and less accurate data. More sophisticated analysis can overcome some of this disadvantage.

Many times ERDA will have a bigger investment in a particular technology than any other single private sector decision-maker. A technology that has several thousand possible applications in the private sector, but with a relatively small price tag per application, may be a major energy conservation prospect for ERDA, but a relatively modest investment for each of the private sector decision-makers. This differential value of the technology between ERDA and the private sector would make different levels of analysis a logical circumstance.

D. Information Transfer

The issue of how to present data to the private sector on energy conservation programs is important in the commercial acceptance of new technologies. One vice president of a major oil company suggested that the financial evaluation data most useful to him would be sensitivity and scenario analysis. Probabilistic results are too completely digested and leave an outsider wondering about input specifications. Carefully formatted deterministic modeling with sensitivity analysis not only offers the greatest credibility in results by showing the components of the evaluation, but it also provides useful information for the user to formulate his own scenario or probabilistic analysis if he feels it is necessary. This would relegate the use of probabilistic modeling by ERDA to providing information primarily for its own decision process rather than providing information to prospective private sector users.

It is clear that to increase the credibility and acceptance of ERDA assessments of particular technologies, financial and economic modeling results must be broken down as much as possible. Key inputs should be specified before results are offered. Price projections for energy or capital cost should be established before any discussion of rate of return. Sensitivity results will allow the reader to estimate the impact of changing an input parameter to a value he is more comfortable with. Such financial and economic evaluation should be separate from detailed technical results since they will be evaluated in different ways and by different people in the private sector.

E. Industry Analysis

For a strategic assessment of the commercial potential of ERDA's industrial energy conservation "portfolio," it is useful to study the business/financial/economic environment in the several industries targeted for the energy conservation measures. A great deal of insight can be quickly obtained from published financial data, as was shown in Section V of this report. It is possible to identify those industries that are currently operating with limited capital budgets or who are not reinvesting capital in their basic businesses at a pace to maintain their historical asset base. Such industries will be less receptive to the introduction of ERDA-sponsored technologies. On the other hand, industries (or companies) can be identified which are spending more aggressively, obviously pursuing growth strategies and funding them with readily available capital. Such analysis makes it possible to identify to a great extent the business strategies of the various industries. All these factors will have a great bearing on the acceptance of new energy technologies by the different industries.

The results shown in Section V clearly indicate the advantage of focusing on the differing financial circumstances of the energy intensive industries targeted in ERDA's industrial program. It is, of course, important to project these circumstances in cases where ERDA's program will require action by industry some number of years into the future. However, when this is the case, the best information of an industry's future financial circumstances will be its current business/financial decisions. ERDA, in making funding decisions, does not have the luxury of perfect knowledge of future business or economic circumstances of these industries. Their decisions and forecasts, therefore, have to be based on the best available information today.

F. Recommendations for ERDA Industrial Programs Project Evaluations

Clearly, the best first step in analyzing the huge number of projects competing for ERDA funding is the threshold criterion system currently in use. Projects that clear this screening can be categorized many different ways--by size of capital investment, by target industry, by level of risk or uncertainty, by time to targeted commercialization, etc. To a great extent, the R&D funding decision for any given technology will depend on how it is classified in these different dimensions. Generic evaluation system may cause important considerations to be lost or over-looked.

For those projects for which funding decisions cannot be made as a result of preliminary screening, a sequence of: a) more developed deterministic modeling (coupled with a search for additional pertinent data); b) sensitivity analysis; c) scenario analysis; and d) probabilistic modeling (coupled with capital asset pricing theory) should always yield a clear and easily substantiated funding decision. In most cases, it will not be necessary to complete this whole series of analysis before a qualified funding decision is reached.

As a backdrop to these project evaluations, monitoring of the business circumstances of the various target industries will offer useful insights into:

1. the nature of the capital spending programs in the industry;
2. the required return on capital for the industry using capital asset pricing theory or other techniques; and

3. the likely behavior of the industry in response to unusually risky investments.

An annual analysis of these factors would allow ERDA to focus its program toward industries that are most likely to show the quickest commercial acceptance of energy conservation technologies.

APPENDIX A

INTERVIEWS WITH ENERGY-INTENSIVE COMPANIES

A. Overview of the Interview Procedure

In depth interviews were held with fifteen energy-intensive companies in eight of the largest energy using industries. The companies were chosen in such a way that a number of industries would be represented. The emphasis in each industry was on large companies because large companies account for most of the energy use in the industrial sector. Based on an estimate from Bureau of Census data, one percent of the firms in the manufacturing sector use about 75 percent of the total energy used in the sector.[1/]

At least two possible biases were introduced by focusing on large companies and by interviewing corporate staff. Large corporations have more complex capital budgeting problems in terms of the total size of their capital budgets and the number of divisions and product lines. They also have more resources (e.g., staff) to analyze investments and tend to use a greater range of evaluation techniques. For these reasons, the findings of this study would not be expected to necessarily apply to small companies. Smaller companies would be expected to be less sophisticated in their evaluation techniques. Secondly, in most cases the persons interviewed were corporate staff or management, and responded

---

1/ Energy and Environmental Analysis, Inc. estimates, based on Census data.

to questions about capital budgeting and risk with the broader perspective of the corporation as opposed to that of the plants or divisions. In corporations where little capital budgeting authority is delegated, these perspectives may be quite similar. However, in many corporations the divisions and (especially) plants of a corporation may use different project evaluation techniques and have different attitudes towards risk than the corporate staff. For this reason the findings of this study may not be completely applicable to decisions made by plants and divisions. In most corporations interviewed, however, only relatively small capital expenditures were delegated to plant and division management.

B. Interview Methodology

The interview process was somewhat structured, but did not involve use of a standard questionnaire. The outline of the interview was generally the following:

- Placement of the individual being interviewed within the organization,
- Overview of organization and approval channels for capital expenditures,
- Capital budgeting procedures and analysis methods used,
- Methods for incorporating risk into capital budgeting,
- Special treatment (if any) of energy investments, and
- Government incentive programs and their likely affects.

Due to the fact that energy conservation investments were not treated differently from other investments in the companies interviewed, the capital budgeting and risk evaluation questions were often responded to in general terms. Examples given often involved investments in capacity expansion or non-energy cost savings. Questions were always asked regarding whether energy investments would involve any considerations different from the examples given. The sources and derivation of various inputs to DCF models were investigated. In particular, the energy price assumptions used were focused upon.

A significant portion of the interview was devoted to a discussion of risk. Examples of risky investments which have been evaluated were sought from the interviewees, and these were used to determine risk evaluation techniques used as well as general attitudes. In addition, reactions were sought to actual or hypothetical energy conservation technologies and an attempt was made to determine any special attitudes towards the risks of energy-related investments.

C. Study Findings

Most of the significant findings of the interviews have been discussed already. The economic evaluation techniques and risk assessment methods used by each of the companies interviewed are summarized in Table A-1. Whether a risk evaluation technique was classified as "major" or "minor" depended on how frequently the particular form of risk analysis was used as well as whether the results seem to have been relatively important to the ultimate decision on a particular project. Two categories are provided for probabilistic

TABLE A-1

SUMMARY OF INTERVIEWS WITH ENERGY-INTENSIVE COMPANIES

Company:	A	B	C	D	E	F	G
Industry:	Steel	Glass	Chemicals	Petroleum	Paper	Food	Paper
Person(s) Interviewed[a/]	FIN/PLNG/RES	PLNG/RES	FIN/OP	PLNG/RES	PLNG/EN	FIN/PLNG	FIN
Evaluation Techniques Used:							
Payback		yes			yes	yes	yes
DCF	yes	yes	yes	yes	yes		yes
Other[b/]					RONA		
Risk Technique(s) Used:							
Sensitivity	major	major		major	minor	minor	major
Scenarios			minor				major
Probabilistic Currently	major						
Probabilistic Formerly/Rarely		used once	formerly	future	rarely		rarely
Adjust Hurdle Rate		major	major	minor			
Qualitative/None					"judgement"		

---

a/ Key: FIN: Finance; PLNG: Corporate Planning; OP: Operations (Engineering); RES: Research; EN: Energy Department.

b/ RONA: Return on Net Assets; O&R: Operating and Revenues estimates for entire business.

TABLE A-1 (Continued)

Company:	H	I	J	K	L	M	N	O
Industry:	Chemicals	Food	Steel	Aluminum	Cement	Cement	Paper	Food
Person(s) Interviewed[a/]	FIN	EN	FIN/OP	FIN/EN	FIN/OP/PLNG	FIN/EN	PLNG	PLNG/EN
Evaluation Techniques Used:								
Payback	yes		yes	yes		yes		
DCF	yes	yes	yes	yes	yes	yes	yes	yes
Other[b/]	O&R		ROI(acct'g)					
Risk Technique(s) Used:								
Sensitivity	major			major	major	major	major	minor
Scenarios				major	major	minor	major	
Probabilistic Currently								
Probabilistic Formerly/Rarely	formerly			formerly	rarely		formerly	
Adjust Hurdle Rate			minor		minor			major
Qualitative/None		"qualitative"						

a/ Key: FIN: Finance; PLNG: Corporate Planning; OP: Operations (Engineering): RES: Research; EN: Energy Department.

b/ RONA: Return on Net Assets; O&R Operating and Revenues estimates for entire business.

techniques, since only one steel company is currently making frequent and effective use of the technique, but a number of companies used to use or occasionally use probabilistic methods.

☆U.S. GOVERNMENT PRINTING OFFICE: 1978-740-306/ 9420 REGION NO. 4