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Analysis of Small Business Participation in the Photovoltaic Area of Solar Technology

April 1978

Prepared For
U.S. Department of Energy
Assistant Secretary for Energy Technology
Division of Solar Technology

Under Contract No. EG-77-C-01-4055

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ANALYSIS OF SMALL BUSINESS PARTICIPATION
IN THE PHOTOVOLTAIC AREA OF SOLAR TECHNOLOGY

1.0 Introduction

1.1 Purpose and Scope

This report presents the findings of TechMatics Corporation in its analysis of small business participation in the photovoltaic activities of the Division of Solar Technology (DST). The work was performed under contract EG-77-C-01-4055, as amended.

The initial purpose was to ascertain the level of participation of small businesses in photovoltaic technology and to make recommendations relative to improving the level of participation. Inexorably the analysis led to a progressively more complex problem due to the intertwining of technology, small business capability and big business intervention through the acquisition of successful or reasonably successful small businesses in the energy field. This latter aspect was addressed by the development of hypothetical examples of small businesses in the various stages of entry into or participating in photovoltaic activities and an analysis of the methods which could be used by DST to encourage and strengthen the participation by small business in the photovoltaic activities of DST.

Photovoltaics, as an entity, has fostered the growth of at least half a dozen successful small businesses in solar cell activities. Their obvious success ultimately led to a change of status to large business through acquisition or other means. It is highly doubtful that these organizations would have survived and flourished without an infusion of federal funding. The climate within Photovoltaics has been one which has encouraged the small entrepreneur to present and develop concepts which will come to fruition. However, other factors such as the comparatively recent economic phenomenon

of concurrent inflation and recession and the institutional constraints of government and its agencies must be considered if this climate is to continue and to become more pervasive not only in Photovoltaics but also the Division of Solar Technology and more importantly the Department of Energy. The desired end result would be an increase in the number of qualified small business sources available to Photovoltaics.

1.2 Executive Summary

1.2.1 Points of Interest Associated with Small Business Participation

The prime areas for improvement associated with small business participation can be summarized readily. As indicated below the areas of interest can be divided into three categories namely, Government/DOE/DST related aspects, small business view of the energy field and small business capabilities.

(a) Government related aspects:

- o No significant technology transfer
- o Excessive time between solicitations and awards
- o No effective assistance by SBA
- o RFP's are overly complex and not standardized
- o Repeated use of same contractors
- o Need for innovative policies to develop high technology small businesses
- o DOE/small business interplay and communications are minimal
- o Greater DOE technical and policy control over awards made by the national laboratories
- o Somewhat unbalanced award practices e.g., universities versus businesses.
- o Subcontracting by prime government contractors to small business is limited and essentially non-technological

(b) Small business views:

- o Energy policy and awards are geared to and guided by big business

- o Solicitations are unwieldy, disorganized and work to the disadvantage of small business and resultant awards impact cash flow due to slow government payment
- o Energy programs are considered to have limited production potential and are accordingly high risk
- o Expressed apprehension that possible shortages of critical materials could lead to limited sales
- o High cost of critical materials to small buyers could cause non-competitive positions
- o Lack of dialogue between DOE and small business
- o Lack of opportunities in research and development
- o Few incentives for small businesses

(c) Small business capabilities:

- o Limited technological capability
- o Limited financing for plant and equipment
- o Lack of familiarity with government contracting practices
- o Lack of technical personnel
- o Weaknesses in business management
- o Proliferation of quick profit "energy" firms
- o Lack of initiative
- o Limited funding, if any, for IR&D and proposals
- o Limited marketing capability and analysis
- o No national voice

1.2.2 Recommendations to Improve Small Business Participation in DST/Photovoltaics Activity

- o A functional DST technology transfer program
- o Parallel prime contracts for small businesses
- o Increased use of small business and 8A set asides
- o Directed subcontracting
- o Cost sharing

- o Increased technical and policy control by DST personnel over awards by national laboratories and also university grants.
- o Increased communications between DST personnel and small business persons
- o Long term contracting
- o Simplified RFP's

1.2.3 Summary Analysis of Photovoltaic Awards

The data included here is based on data available from DOE, other agencies and contractors for FY 1977:

a) Prime Contracts, Awards, Grants

	<u>Amount</u>	<u>%</u>
o <u>Total</u>	\$ 30,361,422	100 %
o Big Business	\$ 2,378,818	7.8%
o Small Business	\$ 174,033	0.6%
o Minority Business	\$ 0	0.0%
o Universities & Others	\$ 8,896,771	29.3%
o Government	\$ 205,000	0.7%
o Laboratories*	\$ 18,706,800	61.6%

b) Subcontracting by Above Groups

o <u>Big Business - Total</u>	\$ 207,885	100 %
To Small Business	\$ 81,190	39.1%
To Minority Business	\$ 0	0.0%
To Universities & Others	\$ 126,695	60.9%
To Big Business	\$ 0	0.0%
o <u>Small Business - Total</u>	\$ 49,961	100 %
To Big Business	\$ 34,961	70.0%
To Small Business	\$ 0	0.0%
To Minority Business	\$ 0	0.0%
To Universities & Others	\$ 15,000	30.0%

* JPL treated as prime recipient.

o <u>Minority Business - Total</u>	\$ 0	100 %
o <u>Universities - Total</u>	\$ 1,998,350	100 %
To Big Business	\$ 663,336	33.2%
To Small Business	\$ 1,085,014	54.3%
To Minority Business	\$ 0	0.0%
To Universities & Other	\$ 250,000	12.5%
o <u>Laboratories - Total</u>	\$ 7,724,233	100 %
To Big Business	\$ 5,559,855	72.0%
To Small Business	\$ 1,113,646	14.7%
To Minority Business	\$ 92,658	1.2%
To Universities	\$ 577,269	7.5%
To Laboratories	\$ 358,805	4.6%
TOTAL VALUE OF SUBCONTRACTS	\$ 10,060,243	

Division of Prime and Subcontracted Dollar

	<u>Amount</u>	<u>%</u>
<u>TOTAL</u>	\$ 30,361,422	100 %
Big Business	\$ 8,429,085	27.8%
Small Business	\$ 2,425,922	8.0%
Minority Business	\$ 92,658	0.3%
Universities	\$ 7,867,385	25.9
Laboratories	\$ 11,341,372	37.4
Government	\$ 205,000	0.7

NOTE: All computations are based on available FY 1977 data. Prime awards, et al are those made in FY 1977. Subcontracts include only those made by primes who received FY 1977 awards. This reduced the total subcontracted total dollars by less than \$100,000

2.0 Approach, Analysis and Recommendations

The initial scope was to simply analyze the Photovoltaics awards and to develop recommendations to increase the participation of small businesses including minority businesses. As the effort progressed it became apparent that many more elements needed consideration and review if realistic improvements were to result from this study. Accordingly the approach took a somewhat indirect course in order to touch all of the aspects deemed necessary to arrive at a significant and at the same time reasonable solution to the ever present problem of how to increase small business participation.

2.1 Approach

The first step was to contact DST/Photovoltaics technical personnel to gain insight into the background, complexity and attitudes towards photovoltaic programs, contractors and small and minority business. It should be noted, that the DST/photovoltaics personnel were very cooperative, informative and in addition were more enlightened and enthusiastic in their attitudes toward small business than is generally true in other Federal agencies. Logically, the national laboratories, namely Sandia and JPL, were also contacted since the bulk of photovoltaic activity is channeled through these laboratories. Laboratory personnel were helpful.

To obtain a broader perspective, a number of other agencies as well as large, small and minority businesses were contacted as were some universities. Cooperation in these instances varied rather drastically. Specific names associated with this group of contacts have been omitted since any such reference would diminish the objectivity of this report as well as possibly effecting the attitude of various organizations and individuals toward one another. In all, approximately 30 organizations were contacted. It should also be noted that the small businesses were a mixture of DST contractors and sub-contractors, other DOE contractors and subcontractors and some companies which were seeking entry into the energy field.

The result of all of these contacts was to develop a consensus of what might be the preferred methods to increase small business participation in

photovoltaic activity. Of necessity, the scope of the recommended methods transcends the scope of Photovoltaics since this activity, of itself is a subset of a division within DOE which obviously must interact with other DOE divisions.

Additionally Photovoltaics award data were analyzed in a manner analagous to that used in DOE publication DSE/4033-1 which was produced under contract EG-77-C-01-4033. The depth and scope of this effort was less than that of the referenced report which dealt with all solar technology awards.

2.2 Analysis

Converting sunlight into electricity without the complication of gathering solar heat and passing it through a thermodynamic cycle has a great appeal for its simplicity and ultimately, its low cost. The achievement of low-cost solar cells has been an elusive goal. However, a number of small businesses have flourished in this field as a result of government contracts. Following are some of the reasons which may explain why greater effort is required to sustain available body of small and minority businesses to compete actively in this area. Three representative states or levels of small business have been developed to aid in arriving at specific recommendations.

2.2.1 Cost Factors

The production of low-cost solar cells has been an exceedingly difficult goal. An extremely large cost reduction will be required before large energy farms using solar cells compete with present fossil or gas fueled utility electric power. Through many years and many more millions of dollars being spent on research and development, the cost has been reduced in 10 years from approximately \$75 - \$100 per peak watt to the present cost of \$11 - \$15 per peak watt. However, to be economically feasible the cost must be further reduced to approximately \$0.50 per peak watt. Considering present costs and efforts being put into this project, a time estimate to reach this \$0.50 goal is set at 1986. If the entire spectrum of activities related to solar cell production is considered, it is found that a wide range of financial levels must necessarily

be a significant factor. From the production of basic cell material which is capital intensive one can travel to the cell manufacturer, who on a small scale can develop a business which requires only limited capitalization. As it presently appears few small minority business firms have the requisite financial and technical capability necessary to become active in the photovoltaic area.

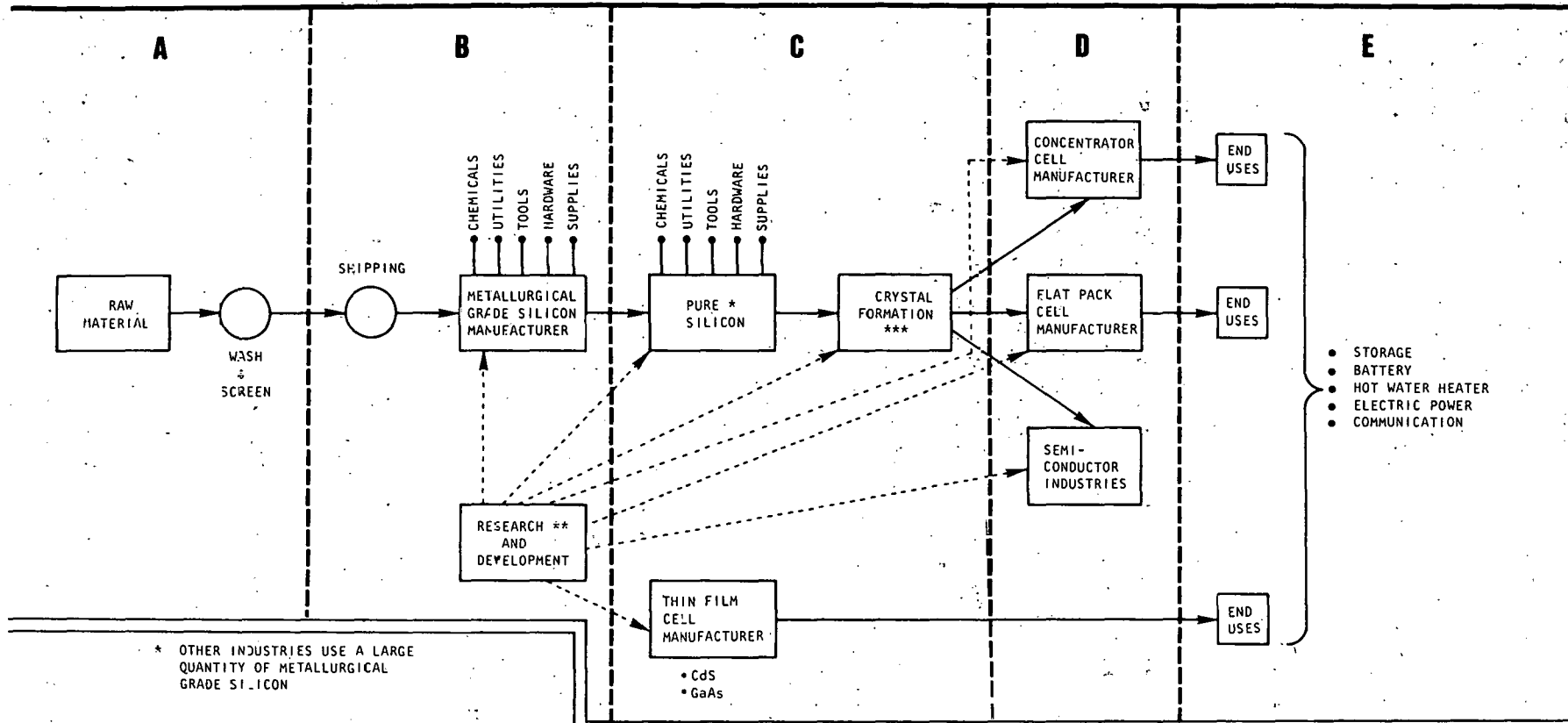
2.2.2 Manufacturing of Solar Cells

The high cost of silicon cells is attributable not primarily to the intrinsic cost of the basic material but more to the cost of processing. Silicon is one of the most abundant elements in the crust of the earth, but it is never found in pure form, and must be separated from its compounds, see Figure 2-1. The raw material for metallurgical grade silicon is silica sand, SiO_2 . This is reduced by heating in an electric furnace to yield a purity of 96-98%. Further purification can be obtained by repeated leaching. The purity required for solar cells is extremely high. To obtain this high purity, the commercial grades can be chemically converted to silicon tetrachloride, SiCl_4 , which is reduced to silicon by reaction with metallic zinc, yielding a material 99.99% pure. This material is then grown as a crystal by the Czochralski method. The purity of silicon at this point is so high that it is referred to in parts per billion of impurities.

Very briefly the manufacturing process of solar cells is as follows; the single crystal wafers are formed by slicing the boule approximately 0.5 - 1.0 mm thick. A typical wafer is 75 mm in diameter. The wafer is then cleaned and polished and finally doped so that the wafer can transfer a charge and produce electric current.

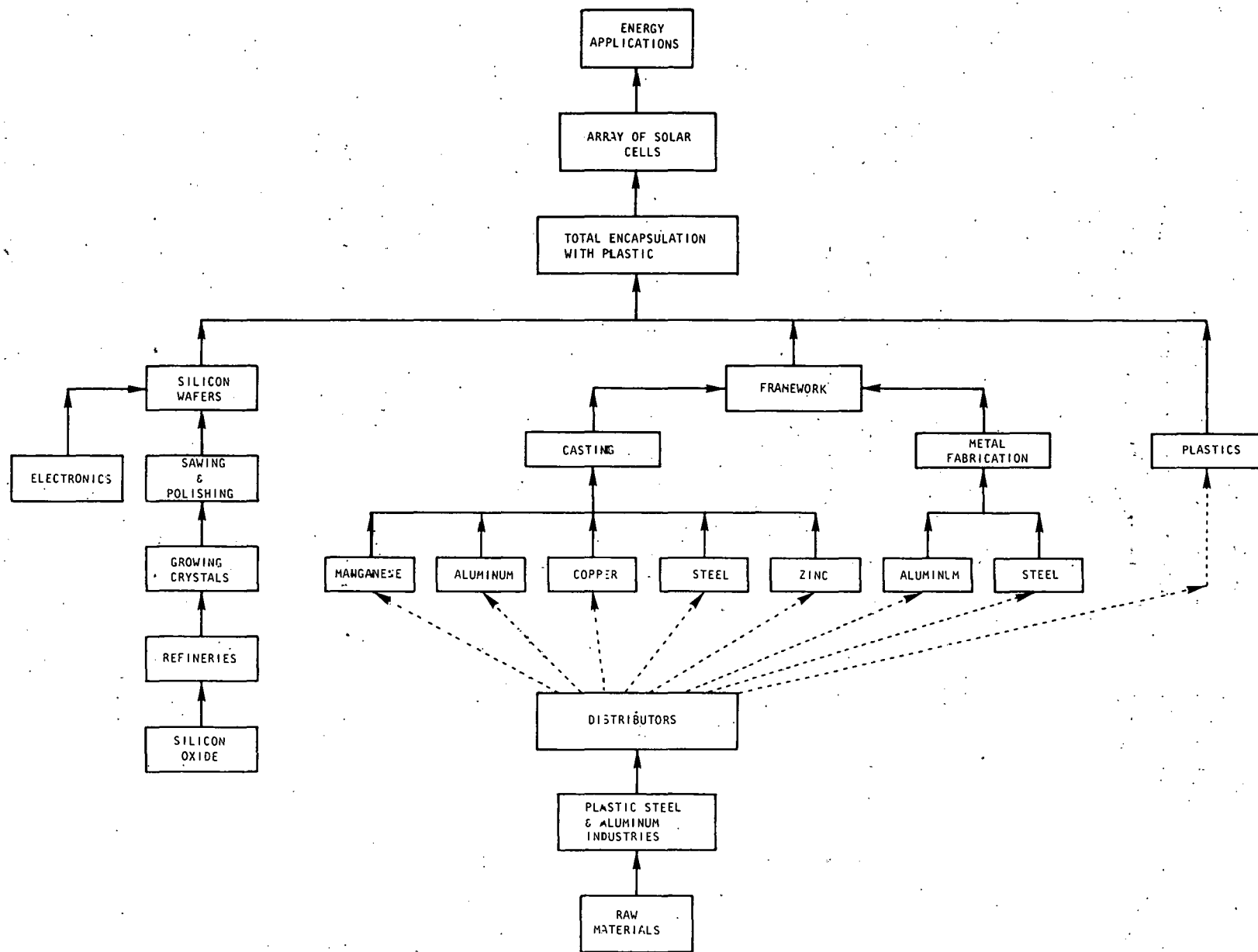
Covering the complete spectrum of the manufacturing of the silicon cell, it becomes obvious that the range of capital expenditures have significant impact on the feasibility of small business activity in this phase of solar energy, depending on whether a start-up, limited production or large production is the objective.

In the initial step, raw material handling, (Part A, Figure 2-1), that is, the excavation of quartzite or silica sand, it has been established that small businesses can operate freely and with little or no competition from large



- A - SMALL BUSINESS
- B - BIG BUSINESS
- C - BIG BUSINESS
- D - BIG BUSINESS AND LIMITED SMALL BUSINESS
- E - BIG BUSINESS AND SMALL BUSINESS

Fig. 2-1. CURRENT AND POTENTIAL SMALL BUSINESS ACTIVITY IN SOLAR CELL DEVELOPMENT



**Fig. 2-2. BASIC PHOTOVOLTIC CELL
ARRAY DEVELOPMENT**

corporations. This may be due to the fact that profitable quartzite deposits are confined to relatively small areas and excavation companies must move from location to location. This can be done more readily by small business firms since they are less structured than large businesses.

This area also included the washing, crushing and screening of the quartzite with the larger pieces (approx. 4"-6" dia.) being shipped via rail to the companies with large furnaces for processing into metallurgical silicon.

It is in the area of material processing (Parts B&C, Figure 2-1) that it becomes apparent that large capital investments are required and it is impossible for small business firms to become actively involved in the manufacturing process. Except in some cases the large corporations have a policy program set-up whereby they encourage and assist with technical information transfer to reliable small business firms in order that they can profitably supply products that have a meaningful impact in the manufacturing process of silicon. These programs vary drastically among the large corporations and it became obvious that most of the programs being talked about are in an undefined state.

In the area of R&D it is again obvious that large business must participate in a much greater capacity than small business. There are instances when a large corporation subcontracts an R&D project but most often when this is done it is discovered that the small business is a subsidiary of the larger firm. It is in the area of R&D that the government can play an important part by getting small business firms meaningfully involved in the solar energy program. There still may be some limitations but with the proper support and possibly some technical and/or financial assistance the goals set-up by the government may be attained more rapidly.

Crystal formation, again is a highly technical and cost variant area, depending on the scale, in which to operate:

- o At present time, it is an area where small business can function on a limited scale depending on the capital expenditures required.

- o In the future however, this may change as newer methods and techniques are established, the more sophisticated small business firms may participate in this field on a larger scale.

In the area of silicon derived product manufacturing, Part D, Figure 2-1 the status is as follows:

- o Highly technical
- o Controlled primarily by large business, however small business is making a strong impact. Many former employees of large business firms have left their employers and started their own small business.
- o Recognition of the potential of small business firms has caused many large corporations to offer assistance in both technical and managerial aspects in order to allow the small businesses to become main sources of supply and a base to achieve technological breakthrough in photovoltaics.
- o This is the most logical area of the spectrum for small business firms to become meaningfully active.
- o It has also been established in this area that while it is the greatest for small business firms it is also an area where rapid growth causes or creates the small business firms to suddenly blossom into the large business category and also entices large corporations to absorb many of the successful small business firms.
- o The semi-conductor industries are a large consumer of pure silicon and future expansion in these industries may cause a considerable overall shortage of pure silicon for the photovoltaic industry.

2.2.3 Competitive Marketing

The conversion of solar energy into electricity using the photovoltaic method with the silicon wafer can be accomplished in great part by small business firms, see Figure 2-2. However because of high cost and escalating prices, the number of small business/minority business firms able to compete

in this field will be very limited. One of the most active small business firms in this industry started in 1973 with two employees and has grown as of this date 1977 to 140 employees and grossing 4 million dollars in annual sales. At the current rate of growth this firm is expected to more than double its present size within the next two years. It is obvious that within a relatively short period of time this firm will no longer be in the classification of a small business firm but will join the ranks of large business. This will be another success story in the development of small business as a result of Photovoltaic funding. However, an element of concern might be the relative rapidity with which successful small businesses are absorbed by major energy corporations. The blandishments offered by a big business are often very attractive. Ultimately this may lead to a dearth of small businesses in the field. Several other small business firms that have had a similar fast rate of growth have been absorbed by large corporations, particularly oil companies, for several reasons but it is safe to say that high cost of operation including material, processing and manufacturing as well as remuneration played a sizable part in the reasoning for the acquisition of these small business firms.

2.2.4 Research and Development

Many hours and funds have been spent on research in the photovoltaic area. As briefly stated above the silicon wafer went through this period and finally the industry was able to produce a material in an almost ideal state. Today the photovoltaic scientist is carrying on these same activities with other processes in the thin film and ribbon silicon areas. One of the most promising techniques for cost reduction is the production of ribbon grown silicon. In this process the stages of crystal growth, cutting, and wafer production are shortened by growing the crystalline silicon as a thin ribbon of a single crystal. Another area that has captured the attention of the solar cell scientist is the development of the polycrystalline silicon cell. The cost of producing silicon cells from single-crystal silicon has led to considerable effort to find ways of using polycrystalline materials. Cadmium sulfide solar cells has long been the interest of the scientist but lost the race to silicon. One of the problems with cadmium sulphide was the unreliability of performance of manufactured cells and their propensity to degrade in the terrestrial environment. The fact, however that they can be produced by inexpensive thin-film deposition techniques has enhanced their potential value. All of the above methods which are currently being researched have possibilities of being developed for future use. However

this research is lengthy and expensive that at this time it is an unreasonable task to be a venture for small business concerns. Large corporations with millions of dollars allotted for research and development can afford these expenses.

2.2.5 Related Goals

Setting goals to be attained is a very important factor and at the same time it is an ever changing factor. As things progress and goals are attained, new goals are set-up and strived for. Looking at the picture as it now stands in relation to the silicon wafer being the prime element in photovoltaic energy. Some small businesses have apprehensions concerning the current high cost for silicon - the attitude is probably an expression of the typical fear of the small product due to his inability to get significant volume discounts. Hopefully, efforts will be exercised, with government support, such that lower cost processed silicon will be readily available. This appears to be a very critical area, in the minds of small business persons, and any change in this direction would permit small minority businesses to confidentially maintain themselves and encourage new firms to enter this field. Another goal is to change government attitudes to further increase investment in R&D and assist industry in general but primarily the small businesses to develop and grow by keeping them abreast of new manufacturing techniques and assuming a larger part of the financial burden associated with R&D.

2.2.6 General Problem Areas

Various factors tend to mitigate or limit the participation of small business in not only photovoltaic activity but also in other solar technology activities as well. For all practical purposes there is almost no minority business participation. These factors will be examined in the following paragraphs. Categorically they can be best grouped into three areas namely government related problems, small business perspectives and small business capabilities.

2.2.6.1 Government Related Problem Areas

- o Solar technology transfer to small business does not exist in a practical form. There are various information and workshop symposia which are available. They are open to industry but for the most part are

attended by representatives of big business, government and some small businesses more often than not located in the immediate vicinity. They tend to be run near government facilities or for the most part in the southwestern ("sun belt") quadrant of the country which has perhaps the highest concentration of businesses active in solar technology and which has also had, coincidentally, a significant population growth. However, in the light of the distribution of generally technically oriented small businesses in other areas of the United States especially in the midwest and northeast, perhaps a greater effort should be made to involve other areas of the country. However, this type of activity seems to be the only current means of accomplishing some technology transfer however minimal. A very obvious method of technology transfer is the resident engineer program at Sandia whereby the Laboratory provides work space for technical personnel from industry. It should be noted that virtually all attendees are from big business and that in the sample of small businesses queried on this particular point not a single one was aware of the program including some active in solar technology. This is further borne out by the fact that most awards or subcontracts to small or minority businesses are for routine products and services very few of which require professional skills.

- o The elapsed time between solicitations and awards is excessive - Often ranging from six months to a year and longer if a PON is used as the initial frame of reference. No allowance is made for the fact that cash flow and return on investment are especially pressing for small businesses. Presumably progress payments are a suitable means of easing the problem after award but this does precious little for the small business struggling to maintain or increase its niche in photovoltaics or any other high technology during a six month period of contemplation by DOE. Since there are no long term production awards for items such as solar cells, the business tends to run in a series of one-shot buys. To the small business person, the inability to see any reasonable payoff in the future can be discouraging and possibly accounts for the heavy bias, frequently expressed, against solar farms or concentration systems as opposed to relatively simple solar devices applicable to the residential market.

- o An almost universal statement among small businesses is that SBA assistance is "not worth the effort". This attitude is reflected from either actual experience or an intuitive feeling that the bureaucratic structure will hinder rather than help. Technical assistance from SBA is considered not to exist and financing is preferred through a bank, small business investment companies, individual investors, relatives, etc. rather than SBA. Collectively, the sentiment seems to be that SBA is an inhibitor rather than an aid to small business. Regardless of the merit in these attitudes, there is obviously a void which could be filled by individual agencies in areas other than direct financial assistance.

- o DOE RFP's are prepared in a manner which at best is confusing. There is ordinarily a myriad of attachments and appendices which have no discernible order. Some procurement offices, such as Oakland, prepare a more cogent bid package than those released through the Washington, D.C. office. RFP's from this latter office generally require repetitive breakouts of cost elements including some which require the presentation of actual salaries of proposed personnel. This requirement seems unnecessary and can lead to the possible risk of disclosure if not handled in strict accordance with existing regulations and procedures. DOE procurement would do well to incorporate some of the better practices used by DOD procurement offices. The DOE bid packages are often accompanied by a lengthy letter discoursing on the conflict of interest aspects but providing little useful information. Almost without exception the RFP's bury the statement of work and, in terms of small businesses, often include enough clauses to give pause to the small business person considering a bid because of the implied risk inherent in many clauses. This is especially true in organizations which have had little or no government contract experience.

- o DOE and in particular DST has not yet acquired the tendency to use the same contractor again and again. However, all of the elements are present which may lead to an advanced case of "incumbentitis". This condition does not currently exist in Photovoltaics but the potential is always present and a concerted effort should be made to minimize the possibility of it developing. There is no incentive to seek out new sources, just as there are no incentives to cause potential new sources to seek DST or Photovoltaics in particular. It is a natural

inclination for technical personnel to have an inclination toward familiar, established businesses both big and small. This is not yet a dominant factor in Photovoltaics but as active small businesses are absorbed by big business there will be progressively less known quantities available which will almost inevitably lead to repeated use of the same sources.

- o DST/Photovoltaics has a generally excellent attitude toward the utilization of small businesses. This attitude is consistent with DOE Interim Management Directive IMD No. 0705 dated November 11, 1977 the stated purpose of which "---- is to establish and implement a comprehensive review and screening process for DOE procurement actions --- for potential award of contracts to small business firms, minority business enterprises, and firms located in labor surplus areas, ---". However, the general policy of DOE despite the state intentions has not resulted in innovative approaches to achieving the specified objectives in IMD No. 0705. It merely reiterates that there shall be screening coordination, development of small business bidders' lists etc. and that all disagreements shall be resolved in accordance with Federal Procurement Regulations. The directive is essentially "motherhood" with no real change in procedures. It should also be noted that basic research agreements with educational institutions and also incremental funding actions are exempted. The directive is essentially a passive document and ignores the activist posture which should be shown by DOE if there is a sincere desire to increase small and minority business participation. DOE does not seem to realize that platitudes are no substitute for original thinking and departures from existing patterns if progress is to be made in a high technology field.

- o There seems to be almost no interplay between Small Business Specialists and technical personnel. If there is no interaction and open communication then, for all practical purposes, there is no assistance being provided to technical personnel. At DOE, headquarters Small Business Specialists are essentially integral with the procurement structure. This arrangement tends to mitigate the efforts of the specialists since their efforts must be within the context of overall

procurement policy. The deleterious effects of this arrangement are painfully apparent at other government agencies. The generation of bidders' lists and the like as well as an array of "how to" handouts for small businesses in no way addresses the problem of increased small and minority business participation.

- o The DOE policy of using either Form 189 approval memo's and inter-agency agreements, etc. permits the national laboratories, for example, to proceed on an essentially independent course which does not necessarily assure compliance with DOE objectives concerning small and minority businesses. It is believed that a higher level of policy and technical control by DOE personnel can achieve a greater consistency with DOE objectives in awards made by the national laboratories. Both factors will dilute the intent of both DOE and technical in improving the position of small business. A typical example is the case of JPL which has no authority to make 8(a) set asides.
- o DOE has a policy which places universities in the position of requiring minimal justification for grants and this fact is further emphasized by the exemption of agreements with universities from the requirements of IMD No. 0705. By contrast, a small business with an innovative idea or an unsolicited proposal is more likely than not to get shuffled into a papermill or pointed in the general direction of the National Science Foundation if the sole DOE contact is made through procurement channels and not through receptive technical personnel such as is found in Photovoltaics. Sole source justification is the same whether a business is small or large. In effect, the only comparatively easy entries can be made by universities and 8(a) enterprises. Unfortunately, almost no work which has technological content is awarded to 8(a)'s because few if any are qualified. This is all the more reason to have a program which will offer small and minority businesses the assistance and preferential treatment needed to foster more participation on higher levels of technology. Big businesses have ready access to DOE and some divisions already have an advanced case of "incumbentitis".
- o Examination of prime contract awards to industry once again confirms the fact that low level supplies and services constitute the majority

of small business subcontracts. Subcontracting to minority businesses is almost non-existent and is, for all practical purposes, limited to standard products and trivial (-in terms of technical content) services. This condition would seem to be at variance with stated DOE policy and the enabling legislation for DOE. Grants awarded to universities are a monetary allocation which is effectively not available to any extent for small and minority businesses. Perhaps a grant system should be established for small businesses.

2.2.6.2 Small Business Views

The most common views expressed by small businesses established in the energy field or desiring entry to same and also some companies in related areas, such as thick and thin film devices, who have chosen not to consider entry into the energy field may be summarized as follows:

- o The most prevalent sentiment voiced is that energy policy and awards are weighted heavily in favor of big business. Some companies will take DOE work only on a simple subcontract basis if it is essentially a sole source procurement by a prime contractor and the products required are reasonably related to existing product lines or manufacturing capability. Small businesses which have an established position as either prime contractor and/or frequent subcontractor view solar cell applications in a somewhat more positive manner. They see some potential for growth but do not see reasonable production requirements or assurances of same in the foreseeable future. This outlook is reflected in a great reluctance to make capital investments since return on investment must first be apparent.
- o There appears to be a generally critical attitude toward RFP's (it should be noted that some big businesses have also advanced some adverse comments on RFP's, selection of bidders etc.). The small entrepreneur tends to be most vocal and exhibit the highest distrust of DOE procurement policies and practices. Presumably some of this can be attributed to a lack of experience in government contracting and a lack of understanding of the bureaucratic process. Another common fear, sometimes justified, is that the government is a slow payer and therefore more of a threat than a possible aid to cash flow needs.

- o Many production oriented small businesses believe that large scale solar energy systems are an expensive effort having limited if any production potential for them. This attitude is understandable if one's orientation is the low unit price commercial market place. This probably accounts for the fairly common bias in favor of small prepackaged units for residential and small structure applications. Small construction contractors are inclined to echo this sentiment since they are also in the commercial market regardless of whether or not they have participated in DOE related construction. Simply, they do not see a realistic, future high volume production and accordingly the energy field is one of high risk.

- o Companies in the business of solar cell manufacturing have reservations about the availability of critical materials such as purified silicon. The residual thought is that big business users will have first call on suppliers. It is difficult to say if there is any thing substantive to support this theory. However, countless examples of larger volume users getting preferential treatment over small volume users are manifest in various industries on an almost daily basis.

- o While dialogue may exist between Photovoltaics personnel and companies established in activities such as solar cell research, development and manufacturing, the broader small business opinion is that DOE or for that matter DST does not in fact maintain or attempt to maintain a dialogue with small business. There is a frequent expression of opinion to the effect that DOE dialogue is primarily with universities, big business and government agencies. This complaint is probably justifiable on a quantitative basis but on the other hand there are far more small businesses than universities, etal. However, dialogue between a group such as Photovoltaics is in fact largely restricted to active contractors and national laboratories leaving little time

other than through vehicles such as periodic open workshops. This does not permit much time to contribute to an appreciably greater dialogue with potential sources throughout the country. Additionally, the tired phrase "ivory tower" is frequently used which once again is symptomatic of an underlying feeling that DOE or any other federal agency does not understand the day to day problems of small business.

- Research and development is reserved for universities and big business. Unfortunately there is a very large element of truth in this statement. An analysis of contract awards and subcontracts by prime contractors as well as the exclusion of universities from any support for small and minority businesses bear witness to foregoing.
- Small business believes that there is no incentive provided by DST for entry into the solar energy field. This statement is accurate. Incentives can be provided in many ways but to date DOE as an agency seems fairly barren other than providing some nominal seed money for offsetting R&D investment by small businesses. However, major R&D awards to big businesses undoubtedly offer the opportunity to the businesses involved to get some advantage in future markets. It is apparent that seed funding and a major R&D contract do not equate.

2.2.6.3 Small Business Capabilities

Small businesses are large in numbers but vary radically in types of operations and in the general capability to successfully manage a business. Of the many small businesses in the country relatively few have high technological content as an element of their efforts and many of these are not hardware developers or producers. For this reason, it is not a simple matter to find many small or minority businesses capable of supporting photovoltaic or other energy programs. Some of the primary limitations of capabilities are as follows:

- As indicated above there are perhaps a handful of small businesses capable of participating in photovoltaic programs with minimal

impact on staff and facilities. Even companies currently active in solar energy programs may often be only 1 to 5 persons deep in high level technical skills and these people are generally the principals and managers in the company. This situation often limits the ability of an organization to seek and acquire new contracts with an R&D orientation. Entry level firms may not have equipment adequate to produce anything more than fairly rough samples.

- Financial constraints are especially true for the entry level company particularly if it does not have established lines of business in other areas. This problem is especially acute should plant or capital equipment be required. Generally speaking the demand would more likely be for capital equipment for entry level businesses. Plant investment might be significant if a prototype to production facility is required. However, it is most likely that space can be leased so that in this instance the major need is equipment. Entry level of marginal companies will ordinarily not have an adequate line of credit to support expansion. If no government contracts with progress payments are in hand it is difficult to obtain major financing from banking institutions.
- Many small businesses are completely unfamiliar with federal contracting procedures and practices. Often confusion, uncertainty and fear results from the first exposure to a Government RFP. The terminology and references are unfamiliar and are immediately suspect. The opinion is often expressed that RFP's, as written, are suited only for big businesses which have contract departments and the like. The technically oriented individual hoping to sell a perhaps valid concept frequently sees the bidding process as a maze of red tape intended to hinder rather than aid the small bidder.
- The depth of technical personnel is sometimes so minimal that perhaps only one or two qualified personnel can work on a project. If a small contract for a new project is received, the magnitude may

be insufficient to hire a full time skilled employee to work on it. In this case, projects are done in slow, serial fashion and depend exclusively on the efforts of one or two people. This type of operation is often very inhibited relative to new proposal efforts since both cannot be done concurrently. Organizations of greater depth but only peripherally related to a field such as Photovoltaics, may be reluctant to hire a knowledgeable engineer or scientist in hopes of winning a contract. The other alternative would be to hire a consultant but once again the availability of qualified consultants is limited. University personnel generally do not provide the consultant capability necessary to win an equipment or product contract.

- Idea oriented people may be the principals in a company but they may not have the ability to provide practical business management. Business survival is based not only on technical skills but also on sound business decisions. This may in part account for the success of big businesses in acquiring reasonably successful businesses in a potentially high pay-off field. It is often easier to avoid the risk and problems associated with expanding a fledging business by selling it for a good profit and perhaps a long term personal services contract. The usual problems of limited or no marketing, poor ordering and inventory controls, financing new projects on whims rather than business analysis, etc. are some of the typical shortcomings found in small businesses. The foregoing are reflections of attitudes, temperaments and personalities and cannot be legislated away. Only the right mix of people can make a business survive and grow.
- The temptation to make a "quick buck" be it in solar energy novelties or ill conceived or poorly design devices for residential use has caused a rapid appearance of "solar energy" companies. These companies are almost invariably small businesses. There are also small businesses making sound installations in conjunction with builders for typical residential hot water and heating applications.

However, even in these instances, cases of failure have arisen due to leakage at joints. This generally is caused by an excessive number of joints and a lack of appreciation of the range of thermal stress to which these joints may be subjected in ordinary operation to say nothing of a projected maintenance free life cycle of perhaps 10 to 15 years. Small business covers a broad gamut ranging from shoestring operations to sophisticated research and development firms. With so broad a variance it may be difficult to find a reasonable group of firms qualified or who have the potential qualifications to be recipients of photovoltaic contracts from DOE.

- o Many firms also have a kind of wait and hope something falls in the lap philosophy because of an unwillingness to market and take calculated risks. Still others underestimate their own ability to diversify into product areas such as solar cell manufacture and accordingly do not look for newer horizons. Still others feel that the government should in effect provide 100% of the support necessary to establish them in a new product line. Some of the apathy results from previous government contracts which had no long term potential and others may have been "burned" in the IFB syndrome. Regardless of the reasons, many technically oriented businesses do not seek DOE contracts.

- o Perhaps the weakest link in many small businesses is the failure to appreciate marketing and marketing research. Established companies in product lines often get lulled into a false sense of being in good times and develop an order taking philosophy. It's patently obvious that many a small business markets based on intuition. Admittedly many a big business, after extensive marketing research may still end up being guided by a chief executive's "gut feel". However, the main marketing research does separate the plausible from the unlikely. Most small businesses do not have the means to support research of this type but if more companies took advantage of data available from government and trade associations they could, with a good dash of common sense, analyze the market potential for a given product. Small business also rely on sales representatives who have many clients none of whom are served very effectively. There is no single panacea for the age old marketing problem of small business.

- o Probably the saddest fact is that there is no national presence to represent small business. There are various small trade groups, minority groups, alliances, etal., but they do not act in concert so that there is no national voice for small business such as there is for oil, steel or communications. Educational institutions have a dedicated DOE Office of University programs. As a direct result, there is no readily available source for determining the capabilities of small business in an area such as photovoltaics, solar to electrical conversion equipment or for that matter thin film deposition. With regard to technical capabilities, the capabilities of major oil, steel, integrated circuit companies, as an example are virtually never questioned, but "small business" or any part of it is suspect if a sophisticated, technical capability is required.

2.3 Recommendations

The various problems and perspectives of small businesses have been examined as has the general process of solar cell manufacturing. In the aggregate, what is needed is a specific set of goals, procedural changes and attitudinal modification which can lead to an increase of small businesses and minority business participation in solar energy or any other energy, DOE or Federal activity which uses the services and in particular, technical services, of small business.

2.3.1 Technology Transfer

Technology transfer is not merely paper, technical offices, catch all small business symposia, etc, but rather an exchange of thoughts in a given technical area. The thought process can be achieved in several reasonable ways and some of these are recommended below:

- o All DST grants for research and development to universities shall have the following mandatory requirements:

- Any university receiving such grant or grants totaling \$250,000 or more must establish and publicize or have established, on campus, a training program for engineers or scientists from small business.
 - No less than 15% of the total dollar value of such grants shall be used to provide salary and subsistence for training engineers and scientists from small businesses. At least one third of the sum shall be used exclusively for engineers and scientists from minority businesses.
-
- o All national laboratories shall establish and publicize a resident engineer and scientist program for small and minority business technical personnel prior to the receipt of any inter-agency agreement dealing with solar technology. All personnel taking advantage of this program shall receive salary and subsistence from a laboratory administration fund established by DOE/DST.
 - o DOE/DST shall establish a more effective technology transfer program to monitor these programs and other related technology transfer activities. A reconsideration of the whole concept of technology transfer might well be in order at this point in time. Present technology transfer efforts do not reach small businesses.
 - o DOE/DST shall establish and publicize a monthly DST Small and Minority Business Familiarization Program. This program shall, on a one day a month basis, conduct a group of pre-registered small business technical and management personnel through the procurement process, small and minority business activities, technological status and objectives, market potential and anticipated contractual requirements for DST.
 - o DOE/DST shall contract with big businesses to provide technical and technical management personnel to assist and/or train engineers and scientists in selected small or minority businesses which have DOE/DST contracts and whom DST deems likely to be aided by such temporary assistance. Typically a contract could exist between DOE and a major corporation to provide one senior scientist or engineer to each of three small businesses for a period of six months to assist these businesses in establishing or strengthening their positions in the solar energy field.

2.3.2 Parallel Prime Contracts

For the most part, DST projects are fairly large in scope embracing a significant number of technological elements within a given program. Conversely, the smaller research oriented projects which are common in Photovoltaics have essentially a single technical element. The type of projects being considered here are those which are composed of diverse technical elements. Recommendations in this area follow:

- o Large scale projects should be broken into discrete technical components which can be handled under individual contracts. The added cost for system integration or overall project management can be provided to a national laboratory, the dominant, project prime contractor or a qualified small business under separate contract.
- o Initiate a DST program to develop qualified small businesses to fulfill project engineering, system integration and program management requirements for large projects. This can best be accomplished by providing assistance to small businesses on moderately sized projects through the training and support assistance defined elsewhere in this section.

2.3.3 Small Business and 8(a) Set Asides

In order to develop greater technical skill levels within small and minority businesses in the night technology equipment design, manufacturing and assembly areas, greater emphasis must be placed on set asides. The following are recommended:

- o At least 20% of the total dollar value of all DST contracts in a given year shall be awarded to small businesses. One third of this 20% dollar goal shall be used exclusively for minority businesses. At least one half of the total shall be for professional or technology level support i.e., of the 20% devoted to small and minority businesses, at least 50% should be for technology or professional level products or support as opposed to routine services and products.

- o To increase the interest and participation on the part of small and minority businesses in research and development, at least 2 "every bidder a winner" small business set asides shall be scheduled in each fiscal year. For 8(a) organizations, 2 similar procurements shall be conducted in each fiscal year. The all winner system would apply for all reasonably qualified responders to a given bid.
- o All government agencies operating on agreements with DOE must authorize all procurement activities to issue 8(a) set asides.

2.3.4 Directed Subcontracting

Directed subcontracting by both quota and specific subcontractors should be integral elements of DST. Specific recommendations are:

- o All prime contracts shall have a mandatory 10% of the total contract dollar value shall be small business subcontracts. Of this 10%, one third shall be minority business subcontracts.
- o Of the total 10% cited above at least one half shall be for professional or technology level support.
- o Where technically feasible, DST shall direct prime contractors to utilize specified, qualified small businesses as subcontractors for specific project elements.

2.3.5 Cost Sharing

There are several options in the cost sharing concept other than some of the more obvious such as sharing R&D costs. For small businesses at different levels of maturity, the needs are quite different and no one given type of assistance offers a common solution. It should be noted that cost sharing must be a function of financial needs. Some recommended approaches follow:

- o Direct funding for valid R&D efforts performed by a small business contractor prior to submission of a given device for evaluation or preparatory to submitting an unsolicited proposal for a valid and reasonably unique concept to perform product development or improvement.
- o For new entry level companies, lease surplus laboratory equipment, work benches, desks, chairs, file cabinets, metal working machinery and the like for a nominal fee and relinquish control of same to the contractor after satisfactory contract performance over a specified interval of time.
- o Seed money to assure additional R&D on products or concepts which have technical merit but need further development.
- o Premium pricing payments for limited production items to offset accumulated R&D costs.
- o Gap filler funding to qualified but financially marginal companies to permit technical contributions on their part while maintaining cash flow during major lulls in the procurement cycle.
- o Capital equipment funding for companies making the transition from engineering model suppliers to small scale production houses.
- o Physical plant funding for growth or for entry level companies having no appropriate plant facilities.
- o Funding of companies to support personnel at educational institutions or national laboratories or possibly big businesses to improve technological levels within the company. Big businesses would probably be an unlikely candidate due to concern over risking exposure of proprietary data.
- o Funding minority or financially deprived students through college and graduate school if sponsored by minority or other firms providing

the students agree to pursue degrees which will assist the company in achieving its objectives of technological improvement and providing the student commits to work for the sponsoring organization for a specified time.

The foregoing would be tempered not only by the financial needs of a company but perhaps, by a stipulation on the part of such a company that all government supplies assets or the cash equivalent would be immediately returned to the government if it should be sold to a big business for a period of perhaps 10 to 15 years.

2.3.6 Control Over Grants and Inter Agency Agreements

It is believed that DST should maintain greater technical and budgetary control over universities and the national laboratories to assure not only a unified effort by all groups to help DST in achieving its goals to increase small and minority business participation but also to assure that higher level work is shared in an equitable manner. This increased control would also permit initially greater dispersion of high technology projects to small businesses.

2.3.7 Improved Communications

There is no effective continuing dialogue between small business persons and DST technical personnel. Small and minority business representatives within DOE do not bridge this gap. Many a small company believes that solar energy programs are developed by academics living in a fantasy land. There is no noticeable awareness or recognition that many DST personnel, e.g., those in Photovoltaics, have many years of business experience as well as technical experience and that this business experience is in both small and big business environments. If communications are limited, then there will be no change in the perspective of small business. Wide spread distribution of data, monthly technical bulletins, monthly awards for outstanding technical contributions from small business and other media related actions can help to alleviate the communications problem.

2.3.8 Long Term Contracting

The single greatest inhibition to capital spending, is the lack of production follow-on. DST should agree to long term limited production contracts (up to 5 years) in return for companies investing in equipment and whatever else is necessary to gain an efficient production level. This would require detailed planning on the part of DST to schedule projects so as to utilize the above production in a cost effective manner.

2.3.9 Procurements

The general changes needed in this area deal with RFP's and the recommendations are as follows:

- o Use standard clauses, in the same format for all DST procurements whether done directly through DOE or other agencies for DOE.
- o Eliminate the sample contract.
- o Restrict cost data to form 60's with standard back-up.
- o Prohibit the over emphasis on previous contractor DOE experience which already is rampant in some other DOE divisions and which has led to advanced "incumbentitis".
- o Develop a common, simplified handbook for both procurement and technical personnel which deals with all of the aspects of DST objectives and small and minority business procurement practices.
- o Develop and continuously update a small and minority business bidders capabilities summary. This should not be another meaningless list of company names, number of employees and standard industrial code numbers but rather should provide technical and financial capabilities to some useful level of detail.

- o Develop a standard conflict-of-interest certification.
- o Develop specific new procurement clauses for directed subcontracting and cost sharing support.
- o Prepare RFP's in a standard, logical sequential pattern which can be read and understood by most people.
- o Use set asides and special bidding arrangements referred to previously.
- o Special hybrid small/8a business set asides for team bids with splits not to exceed 60/40 in either direction as may be worked out with individual teams where either contractor could act as prime according to the preference of the bidding team. This would effectively permit the combining of resources so that a greater economic entity, less dependent on supplementary assistance, would be created thus distributing R&D and bid costs while allowing two businesses rather than one to grow stronger as the result of a specific contract.

2.2.10 Models of Representative Small Businesses

To more realistically analyze the requirements of small and minority businesses to become viable economic entities in the solar energy field, be it Photovoltaics or otherwise, three basic hypothetical descriptions or models of small business at various levels of business achievement in solar energy activities pertaining or potentially pertaining to DOE/DST activity are used to serve as a reference for the specific levels and types of recommendations contained in section 2.3. The models are described below.

<u>Type I: Principals</u>	-	one or two
<u>Employees</u>	-	one or two
<u>Qualifications</u>	-	principals are well qualified technically with one having had some experience with solar cell development
<u>Annual sales</u>	-	none
<u>Financial Status</u>	-	<u>Assets</u> - no tangible <u>Indebtedness</u> - \$25,000 <u>Facilities</u> - minimal <u>Capital Equipment</u> - none <u>Related products</u> - none

<u>Potential Products</u>	-	A solar cell offering approximately 40% improvement in efficiency over those currently under development - physics of approach have been partially verified.
<u>Other Professional Staff</u>	-	none
<u>Contractual History</u>	-	none
<u>Type II: Principals</u>	-	Four or five
<u>Employees</u>	-	70
<u>Qualifications</u>	-	Several principals and other staff are well qualified
<u>Annual Sales</u>	-	\$2,000,000
<u>Financial Status</u>	-	<u>Assets</u> - \$100,000 net tangible <u>Indebtedness</u> - \$120,000 operating \$ 75,000 long term <u>Facilities</u> - 20,000 sq. ft. total; 4,000 sq. ft. production areas; 2,000 sq. ft. laboratory; manufacturing and assembly equipment for assembling solar cell arrays. <u>Capital Equipment</u> - All necessary equipment for limited cell manufacture and encapsulation; metal work is purchased. <u>Related Products</u> - Small demonstration models for schools <u>Primary Product</u> - Solar cell arrays for DOE and DOE prime contractors
<u>Other Professional Staff</u>	-	8 well qualified professionals; 2 solely R&D
<u>Contractual History</u>	-	Three contracts with DOE since 1973 total value \$1,400,000; five subcontracts with DOE primes since 1971 total value \$3,200,000
<u>Type III: Principals</u>	-	four or five
<u>Employees</u>	-	135
<u>Qualifications</u>	-	several principals and other staff are well qualified

Annual Sales - \$6,000,000

Financial Status - Assets - \$250,000 net tangible

Indebtedness - \$220,000 operating
\$175,000 long term

Facilities - 45,000 sq. ft total;
16,000 sq. ft production;
5,000 sq. ft laboratory;
also manufacturing, assembly,
inspection, packing equip-
ment for production and
assembly of solar cell arrays
and new experimental solar
devices.

Capital Equipment - Fully outfitted in
producing solar cells and
assemble same into arrays
- could assemble and ship
approximately 100 2' X 2'
panels per month

Products - solar cell arrays for
DOE and commercial markets
solar cell novelties

Other Professional Staff - 15 well qualified professional
- 5 solely R&D

Contractual History - 8 contracts with DOE since 1973
total value \$3,000,000; 10
subcontracts with DOE primes for
arrays, R&D, and related products
total value \$9,000,000 over 3 years.

2.3.11 Recommendations/Business Status Matrix

Using the three model companies described in Section 2.6.4, it is possible to develop a crude matrix of representative forms of assistance required by businesses at different levels of maturity and technical expertise. The matrix follows:

	Model Type			Notes
	I	II	III	
1. Specific Aid				
2. University Resident	o	o		
3. National Laboratory Resident	o	o		
4. Familiarization Program	o	o	o	
5. Technical Staff Assistance	o	o		
6. Parallel Prime Contracts	o	o	o	For Type I may also require 5.
7. Small Business Set Asides	o	o	o	
8. Minority or 8(a) Set Asides	o	o	o	Must be minority or 8(a)
9. Hybrid 8(a)/Small Business Setasides	o	o	o	
10. Small business All Winner RFP	o	o		
11. Minority/8(a) All Winner RFP	o	o		Must be minority or 8(a)
12. Directed Subcontract	o	o	o	
13. Cost Sharing	o	o *	o *	*Limited for Type II and very unlikely for Type III
14. Sponsored Graduate Studies	o	o	o *	*Limited
15. Sponsored College Education	o *	o *		*Must be minority or 8(a)
16. Long Term Contracting	o	o	o *	*Somewhat limited for Type III

Table 2-1. Small Business/Assistance Matrix

2.4 Summary

In summary it can be concluded that:

- o DST/Photovoltaics is small business oriented.
- o Care must be taken to avoid the abuses in procurement found in other agencies and other Divisions of DOE.
- o Technology transfer must be developed.
- o Communication channels must be opened with the small business community.
- o Photovoltaics or agencies working through agreements with DOE must be funded to perform more a priori system engineering to increase small business participation.
- o New procurement perspectives must be developed.
- o Assistance to small business must be explored and developed well beyond existing boundaries.
- o Small and minority business award quotas must be established and met.
- o The untrammelled university grant system should have more constraints or else develop a comparable system to encourage small business participation in DOE/DST contracting as a result of reduced justification and delay in making awards.
- o The "big business dominated" image must be dispelled by positive actions.
- o A much greater emphasis must be put on minority business - this can be achieved by selected teaming of minority and non-minority contractors in hybrid small/8(a) business set asides.

2.4.1 Prioritization of Recommendations

Ideally the specific recommendations and the models of small businesses would lend themselves to a hypothetical model which would take into account return on investment, levels of market penetration, technology transfer, economic analysis of the industry, institutional and social constraints, economic risk by individual businesses future market levels, competitive energy sources etc. The result would be a rank/order placement. However, a major modeling effort is beyond the scope of this particular analysis. In lieu of the foregoing, a purely pragmatic evaluation considering both business and government attitudes as well as the level of institutional change required can provide some guidance in developing priorities with greater weighting given to the more expeditious and less politic recommendations which could lead to greater participation by small and minority businesses in DST and/or Photovoltaics contracts. In descending priority, the recommendations may be grouped as follows:

<u>Order</u>	<u>Recommendation</u>	<u>Rationale</u>
1	Implement small and minority business quotas and increase set asides for all DST contracts either through DOE or other agencies.	A matter of divisional policy.
2	Screen small businesses for qualified and potentially qualified sources for DST "products".	Can be initiated readily at some additional costs.
3	Publicize and subsidize resident engineer program at Sandia, establish same at other laboratories.	A working model exists; some added cost.
4	Establish a DST, in-house, monthly small business familiarization meeting program and monthly information bulletin with wide distribution; establish geographically distributed annual "solar technology fairs for small business"	Cost is relatively low and readily implemented.
5	Break new requirements into smaller, separable elements, for parallel prime contracts.	This requires additional preparatory work by technical personnel.
6	Develop a Photovoltaics small business handbook for technical personnel.	This would include capabilities, management, and financial data for current and potential, small and 8(a) businesses as applicable to photovoltaics; cost would be relatively small; for DST a comparable handbook would require a more extensive effort.

<u>Order</u>	<u>Recommendations</u>	<u>Rationale</u>
7	Improve technology transfer	This requires DOE/DST policy change and added costs.
8	Issue system integration contracts on projects management contracts through set asides.	Need to ascertain qualified small/8(a) businesses.
9	Develop hybrid small/8(a) business set asides and use all winner RFP's.	Requires no significant effort by DST but would require teaming by small and 8(a) businesses in advance - concept could be publicized through monthly bulletin.
10	Impose small/8(a) business quotas on grants.	Requires DOE policy change re universities, etal.
11	Directed subcontract and cost sharing clause definition.	Will increase technical risks slightly which will reflect in slightly higher prime contract costs - formal procurement action required to include clauses in RFP's.
12	Technology transfer program	Requires redirection of present efforts.
13	Issue contracts to big business to provide technical staff support to selected companies - perhaps 1 or 2 to start.	Added cost but can ultimately increase supply of qualified small businesses.
14	Simplify RFP's, cost back-up requirements and conflict-of-interest certification.	Procurement and legal support required.
15	Long term production contracting	This requires fairly extensive forward planning and integration of current and future DST demands for specific products.
16	Develop a "grant system" for small businesses	DOE policy change required
17	Sponsored graduate and undergraduate studies programs.	DOE policy change required