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Photovoltaic Commercialization: An Analysis of Legal Issues Affecting a Government-Accelerated Solar Industry

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PHOTOVOLTAIC COMMERCIALIZATION: AN ANALYSIS OF LEGAL ISSUES AFFECTING A GOVERNMENT-ACCELERATED SOLAR INDUSTRY

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FOREWORD

This paper on legal issues affecting the commercialization of photovoltaic systems was prepared by the Solar Energy Research Institute (SERI) to fulfill, in part, SERI's solar information dissemination function. The paper is part of the Community and Consumer Branch Law Program, which is in turn part of the overall program of the Planning Applications and Impacts Division. The function of the SERI Law Program is to identify and analyze significant legal issues affecting the development of solar technologies.

This paper was written as part of the Law Program's 1979 Summer Law Intern Program. The Program provided an opportunity for law students to research and address topics relating to law's impact on solar energy. The 1979 Program resulted in eight papers that discussed primary legal issues that are, or will be, generated by the commercialization of solar technologies.

The author of this paper, David Lamm, was a law student at Georgetown University School of Law while he was participating in the Program. He is now a second-year student at the Georgetown Law School. The Law Program is supervised by Jan G. Laitos, SERI Senior Legal Specialist.

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SUMMARY

Photovoltaic (PV) cells convert sunlight directly into electricity. Generally, the cost of today's PV systems prevents their widespread use in most commercial markets. If PV systems are to displace a significant amount of the fuels that are used to produce electric energy, the cost of generating electricity from PV systems must be competitive with the cost of generating electricity from conventional utility facilities. The Photovoltaics Research, Development and Demonstration Act of 1978 authorizes the Department of Energy (DOE) to establish plans for a 10-year, $1.5 billion program to reduce the cost of PV technologies. The DOE goals and strategies for accelerating the commercialization of PV systems are set forth in the Photovoltaics Program Multi-Year Plan (MYPP).

The activities of the MYPP subprograms are directed toward the commercialization of PV technologies in four markets: international and remote, mid-term, residential and intermediate, and central station. These markets are expected to develop during different time periods and may require varied applications of PV technologies. International and remote markets require non-grid-connected PV applications. These markets are penetrated at current PV prices. The mid-term market for PV systems is expected to develop in the early 1980s. The MYPP estimates that residential and intermediate commercial applications will be cost competitive with utility power in 1986, if a PV system price goal of $\$1.60/W_p$ (peak watt) or $\$.70/W_p$ array cost is achieved. Finally, the development of advanced collector technologies may permit utilities to profitably augment their generation capacity with central station systems in 1990, if PV system prices are reduced to $\$1.10$-$\$1.30/W_p$ ($\$.15$-$.40/W_p$ array cost).

The penetration of PV technologies into each MYPP market is highly dependent on PV system price. Accelerated PV system price reductions are likely to hasten the public use of PV products in each market. Because laws and regulations increase the price of PV products, the penetration of PV systems into the MYPP markets may be significantly delayed. This report examines the impact of the following legal issues on the timely achievement of MYPP goals: solar access considerations affecting PV system use; the impact of building code regulations on the installation of PV systems; the effect of PV product guarantees on product financing and sales prices; and the obligation of utilities to serve PV users at favorable rates.

Solar Access

Every market for PV power is affected by the availability of solar access. Without sunlight, PV cells would be inefficient energy producers. Existing evidence indicates that it may be more difficult to require unobstructed sunlight in PV residential retrofit markets than in the other MYPP markets. Residential market penetration may be impeded if existing land-use laws do not provide adequate protection from solar obstruction. Three consequences may result from inadequate legal protection: (1) consumers' perceptions of the risk of solar obstruction may act as a psychological barrier to market development and discourage financial institutions from lending money to potential PV- product purchasers; (2) high solar easement costs may prevent PV systems from becoming cost-competitive with grid power; and (3) concentrator systems, which require even greater solar access than flat-plate collectors, may suffer diminished efficiency and impaired marketability, from even partial solar obstruction. However, solar zoning and easement legislation would reduce the adverse impact of these market barriers.

Building Codes

Building code regulations are most likely to affect the residential and intermediate markets because the residential and intermediate markets will be geared toward building applications of PV technologies. Building code regulations may increase commercial readiness prices and thereby delay commercialization in these markets if (for safety or environmental reasons) they require that more expensive materials be used in the construction of PV systems than are used in the construction of MYPP systems. However, building code regulations may delay PV system commercialization even if commercial readiness prices are achieved in accordance with the MYPP timetable. If building officials are not convinced of the reliability of PV systems, or if building code regulations prohibit the installation of PV systems, the full benefits of PV power will not be realized by the public in the near future.

To lessen the impact of building codes on the commercialization of PV technologies, DOE might consider planning seminars for building officials on PV product performance and installation specifications. The familiarization of building officials with PV technologies would reduce uncertainties about PV systems and enhance their widespread acceptance. In addition, DOE might consider developing building code standards for PV systems. Such standards could be issued on the basis of performance criteria currently being developed by the Quality Assurance and Standards Program at the Solar Energy Research Institute (SERI). Also, DOE might consider administering a review of state and local building code regulations. Regulations that might unreasonably interfere with the commercialization of PV technologies could be brought to the attention of appropriate state and local officials for possible amendment or repeal.

Manufacturer and Installer Performance Guarantees

Every MYPP market will be affected by the existence of contractual PV performance guarantees. Insufficient product warranties may discourage consumer purchases and inhibit commercial financing. Alternatively, the high costs associated with adequate product guarantees may increase commercial readiness prices and impede PV market penetration. Because adequate contractual protection may be expensive, MYPP analysts should take care not to underestimate the costs associated with this balance of system (BOS) component.

It would seem that, at a minimum, every contract for a commercially ready PV component and system purchased by MYPP for demonstration or market application should include some provisions to insure adequate operation. Perhaps photovoltaic performance and service conditions could be set by the Quality Assurance and Standards Program, in conjunction with representatives of PV manufacturers and installers. These contractual provisions could also be required to comply in full with relevant sections of the Magnuson-Moss Warranty Act. Such measures would help insure adequate program protection from defective product performance. Finally, the Quality Assurance and Standards Program could continually apprise the PV industry of product standards and their warranty implications. If the PV industry demonstrates that it cannot provide adequate product protection, then government subsidy, insurance, or warranty assurance programs may be necessary to reduce the product risks inherent in this government-accelerated industry.

Utility Rate and Interconnection Policies

The fundamental MYPP objective is to reduce PV system costs to $1.60/$W_p$, so that electricity generated from residential and intermediate PV market applications will be cost-competitive with electricity produced by utilities. The rate and interconnection policies of utilities will affect the achievement of this goal. For example, the $1.60/$W_p$ commercial readiness price assumes that owners of 10-kW residential systems will be able to sell excess electric energy produced from PV systems to a buyer willing to pay from 50-100% of the current cost of grid power. Therefore, if utilities do not adopt favorable rate and interconnection policies, it may be necessary for PV systems to include storage facilities, which would increase PV system costs beyond the $1.60/$W_p$ commercial readiness price. Furthermore, residential systems may have to be scaled down if there are no ready and willing buyers for electricity generated by PV systems in excess of residential needs. Both the addition of storage cost and the inability to sell excess PV-generated electricity could substantially increase the $1.60/$W_p$ landmark price goal.

It is likely that most utilities will decide to connect PV systems to the electric grid. The failure of utilities to interconnect PV systems may violate antitrust laws, state statutory and common law service extension requirements, and federal interconnection provisions such as those contained in Section 202 (and possibly Section 210) of the Public Utility Regulatory Policies Act of 1978 (PURPA). Each legal basis for challenging the utility interconnection decision could be sufficient to compel a reluctant utility to provide service interconnection for PV users. The obviously unfavorable policy of denying service to PV users could be considered by the courts to be more unreasonable than relatively unobtrusive rate policies that also discourage PV system use.

It is more likely that if utilities intend to discourage the use of PV systems, they will adopt rate policies that impair the cost competitiveness of PV system prices. Utilities are afforded considerable latitude by Section 111(d) of PURPA to adopt unfavorable PV rates. It is possible that rate decisions approved by state public utility regulatory commissions will be exempt from the operation of the antitrust laws. Further, it is possible that some state anti-discrimination laws will not extend adequate protection to PV users. Therefore, it is imperative that all PV systems qualify for regulation under PURPA. The provisions in Section 210 of PURPA could provide broad protection for PV users against the imposition of unfavorable rates charged by the utility. The timely achievement of the MYPP $1.60 price goal and the ultimate success of the $1.5 billion PV commercialization program may depend upon the rules promulgated under Section 210 and regulation that encourages the commercialization of PV technologies.

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SECTION 1.0

INTRODUCTION

Solar (or photovoltaic) cells convert sunlight directly into electricity [1]. The technology for transforming sunlight into electrical energy has been successfully demonstrated in outer space [2] and remote terrestrial applications [3]. The continuing occurrence of large oil spills, petroleum price increases by the Organization of Petroleum Exporting Countries (OPEC), and nuclear generation and waste disposal accidents dramatically illustrates the need to accelerate widespread commercialization of PV technologies. However, many legal issues may impede the market penetration of PV products [4].

This report discusses five legal issues that may delay or prevent the commercial utilization of PV technologies. Each legal issue may increase PV system prices and impair the development of the PV market. The first legal issue concerns the protection of PV systems from solar access obstruction; without adequate sunlight, PV systems will not operate efficiently or economically. The second legal issue is the effect of building code regulations on PV system use; the absence of building code regulations in some instances may motivate building officials to prevent installation of PV systems in residential and commercial buildings. The third legal issue addresses manufacturer and installer guarantees about PV system performance; until product performance assurances become standard provisions in PV contracts, customers may be reluctant to purchase new PV products, and lending institutions may be hesitant to finance PV system purchases [5].

The other two legal issues discussed in this report involve the obligation of utilities to connect PV systems to electric power grids [6] and provide favorable backup and buy-back rates for PV users. Both legal issues intimately affect the marketability of PV products. The failure of utilities to interconnect PV systems and provide favorable backup and buy-back rates may prevent PV systems from being regarded as a cost-effective means of being supplied with electrical energy. Utility rate and interconnection policies are discussed with reference to relevant sections of state utility regulatory statutes, federal antitrust laws, and PURPA [7].

DOE programs and strategies for accelerating the commercialization of PV systems are contained in the MYPP [8]. Laws and regulations that increase PV system prices or permit utility policies unfavorable to PV system users may delay the timely achievement of MYPP commercialization objectives. The five legal issues mentioned above threaten to increase market prices of PV systems and thereby retard the accomplishment of MYPP goals. This survey of legal issues is the first attempt to assess the impact of various laws on PV program objectives. Additional reports on these and other legal issues affecting MYPP commercialization objectives will be undertaken as PV systems approach commercial readiness.

Section 1.1 of this report is a brief description of PV system designs and costs. Section 2.0 examines federal legislation intended to accelerate the commercialization of PV technologies. Section 2.0 also discusses the specific goals and programs established in the MYPP to fulfill the purposes of national PV legislation. Sections 3.0 and 4.0 discuss legal issues affecting the timely achievement of MYPP objectives.

1.1 PHOTOVOLTAICS SYSTEM DESIGN AND COST

Photovoltaic cells produced for commercial use are primarily composed of silicon, the second most abundant substance in the earth's crust [9]. Silicon solar cells are waferlike; they are oval and very lightweight [10]. Groups of silicon cells are mounted on flat surfaces called modules [11], which may be placed in structures called arrays [12] to facilitate installation and reduce system costs. The modularity of solar cells permits flexible system adaptation to electric power generation requirements [13]. For this reason, it is possible to use PV cells to generate power for anything from watches and stereos to homes, industries, and small communities.

Aside from their modularity, the fundamental advantage of PV systems is that they are fueled by the sun. Sunlight is an abundant, renewable, nonpolluting, domestic resource [14]. Solar-generated kilowatt hours (kWh) [15], unlike conventionally-generated kWh, will not deplete already scarce supplies of oil and gas, further pollute the air and water, or increase the nation's vulnerability to foreign oil embargos. In addition, because PVs produce electric power wherever there is sunlight, communities isolated from electric utility grids can generate their own electricity for medical and educational needs, without being burdened by the costs associated with the transportation of electricity and the construction of transmission lines. However, the commercial success of various PV applications depends upon the production of cost-effective PV systems. A summary of PV cost trends is discussed in the references [16].

The costs associated with the direct use, storage, and installation of PV power (noninclusive of solar arrays) are called balance of system (BOS) expenditures [17]. BOS costs are at least equal to the price of PV arrays [18]. The full cost of PV systems includes PV array and BOS costs. The high cost of PV systems is a major factor that prevents their widespread commercial utilization [19]. To overcome this problem, Congress may appropriate over $1.5 billion in the next 10 years for research, development, and demonstration of PV energy systems [20].

SECTION 2.0

GOVERNMENT-ACCELERATED PHOTOVOLTAIC COMMERCIALIZATION

2.1 THE PHOTOVOLTAICS RESEARCH, DEVELOPMENT, AND DEMONSTRATION ACT OF 1978

In the 5-year period that followed the Arab oil embargo of 1973, utility consumers in many states were saddled with enormous increases in retail electricity rates [21]. The price increases orchestrated by OPEC demonstrated the compelling need for the United States to begin progress toward energy self-sufficiency. The members of Congress resolved that alternative forms of electric power generation be developed immediately to lessen the nation's dependence on domestic and foreign supplies of fossil fuels. The advantages of solar PV power made PV an attractive candidate for congressional action. However, it was apparent that at present PV system costs, PV technologies would not be applied to offset current electric power demands. Therefore, if PV systems were to become a significant source of domestic electricity production, legislation for the development of PV technologies would have to embody a strategy for accelerated PV system price reductions.

2.2 PV SYSTEM COST REDUCTIONS

Many industry advocates and government committees presented evidence to Congress about PV markets and options for cost reduction [22]. The reports indicated that commercial markets for PVs at current prices were quite small [23]. Photovoltaic market analysts were not confident that two- or even three-fold solar cell price reductions would substantially stimulate PV demand [24]. Market uncertainty was compounded by a lack of studies concerning the nature of intermediate PV markets [25]. Many PV corporations hoped to increase cell efficiencies [26] and decrease solar cell costs through research and development of candidate cell materials and concentrator cell applications [27]. Although one study contended that significant cost reductions could be achieved through automation [28], the procedures for manufacturing solar cells were characterized as labor intensive [29]. Two factors discouraged automation of solar cell production. First, executives of PV industries were reluctant to invest capital for automation if a PV market was not reasonably certain. Many executives expressed doubt that profitable PV markets could exist at automated cell prices [30]. Second, because solar cells were undergoing extensive improvement and modification, there was a substantial risk that machinery purchased for automatic cell production would become obsolete before investment costs could be recovered [31]. Therefore, although existing evidence indicated that PV system costs could be reduced by tax incentives directed toward PV manufacturers, major technological breakthroughs in solar cell composition and design, and guaranteed PV markets [32], substantial and immediate PV cost reductions most likely would not be forthcoming in the absence of these motivating events.

The presentation of this and other market information strongly affected the development of federal PV legislation. The key evidence presented to Congress included the following conclusions:

- Significant domestic market development would not be possible unless PV system costs were competitive with rates charged by utilities [33].

- While solar cells of composed silicon were technically and commercially feasible [34], system cost reductions to utility rate levels would require automation and associated economies of scale [35].
- An intermediate market for conventional solar silicon cells would be necessary to attract industry investment in automation capital [36].
- The existence of a substantial intermediate market was not demonstrated empirically [37]; however, small villages located near the sunbelt in foreign countries have intermediate market potential [38].
- Industry was reluctant to invest in capital for large-scale manufacturing plants because of risks associated with market inadequacy and rapid capital obsolescence [39].
- Many candidate solar cells had a greater potential than solar silicon cells for high conversion efficiency and cost economy [40].

Thus, strategy for the cost reduction and commercialization of solar PV power had to be flexible. Exclusive development of silicon solar cell production was undesirable because small intermediate markets might prevent economies of scale and delay PV system cost reductions. In addition, financial incentives for cell manufacturers to stimulate cell production would not be effective if the existence of a market for their product was not certain [41]. Alternately, if primary reliance was placed on the development of advanced cell materials and processes, PV system cost reduction would be dependent on technological breakthroughs and might be postponed indefinitely.

2.3 LEGISLATIVE SOLUTIONS

The recognition of the need for photovoltaic power and the desirability of accelerating its widespread commercialization led to the passage of the Photovoltaics Research, Development and Demonstration Act of 1978 [42]. The act contemplates the establishment of a 10-year, $1.5 billion program for the aggressive research, development, and demonstration of PV energy systems [43]. The long-term objective of these expenditures is to "produce electricity from PV systems (that is) cost competitive with utility generated electricity from conventional sources" [44]. In order to meet this objective, the act authorizes federal assistance for purchases of PV systems [45]; competitive bidding procedures for federal purchases of PV cells and system components [46]; the creation of testing procedures and performance criteria for PV systems [47]; studies and investigations concerning PV market, legal, and institutional issues [48]; and a program to facilitate the expanded use of PV systems in other nations [49].

Embodied in this act is a blueprint for a comprehensive and flexible PV commercialization program. Market studies will provide industry and government with valuable information about the size and composition of intermediate market demand. Federal assistance for PV system purchases, federal solar cell purchases, and the PV program will also assist the development of intermediate- and long-term markets. Competitive bidding procedures should provide industry with additional incentives for PV system reductions. The simultaneous funding of advanced research and development of PV technologies will enhance the potential for breakthroughs and consequent price reductions. The projected expenditure of $1.5 billion and a 10-year program commitment are, perhaps, the most important commercialization incentives. The magnitude of this legislation shows that there can be no doubt as to the government's committment to the commercialization of PV energy systems.

2.4 THE PHOTOVOLTAICS PROGRAM MULTI-YEAR PLAN

The Photovoltaics Research, Development and Demonstration Act of 1978 directs the Secretary of DOE to establish such "research, development and demonstration programs as may be necessary to meet the objectives of the Act" [50]. This mandate grants the Secretary considerable discretion in organizing and selecting PV programs. DOE commercialization strategy and programs for the achievement of the objectives of the act are contained in the MYPP [51]. The central PV program strategy is to achieve major PV system cost reductions through the "aggressive pursuit of advanced research and technological development (and) to accelerate the transfer of PV system technology to the marketplace through real world testing" [52].

Six subprograms and numerous subprogram goals are established in the MYPP. Each subprogram will specialize in various activities relating to the commercialization of PV technologies. For instance, one subprogram focuses on the development of advanced cell technologies that promise to perform at superior conversion efficiencies and yield low cost methods of production. Other subprograms are directed towards the refinement and cost reduction of technically demonstrated PV systems and components, the performance of laboratory and real world experiments testing the technical feasibility of other PV components and systems, PV system demonstration programs, and market studies of current and projected demand for various PV technologies. A more thorough description of each subprogram is found in Ref. 53.

2.4.1 Market Goals and Achievement Dates Established in MYPP

The activities of the MYPP subprograms are directed toward the commercialization of PV technologies in four PV market classifications: international and remote, mid-term, residential and intermediate, and central station. These markets are expected to develop during different time periods and may require varied applications of PV technologies. The penetration of PV technologies into each market is highly dependent on PV system price. Accelerated PV system price reductions are likely to hasten the commercial use of PV products in each PV market. To the extent that laws and regulations increase the price of PV technologies, the penetration of PV systems into the four markets may be significantly delayed. The following section briefly describes the PV system applications, price goals, and achievement dates established in MYPP for each of the four PV markets [54]. Key landmarks for each market not noted in the text are referenced at the end of each MYPP market discussion [55]. The impact of the legal issues discussed in this paper on the timely achievement of MYPP market goals is highlighted here and elaborated upon in subsequent sections.

2.4.2 International, Remote, and Mid-Term Markets

A wide variety of PV applications can be utilized in remote areas where it is not economical to connect PV systems to utility power lines [56]. While the existence of a widespread electric utility grid limits the domestic demand for PV power in remote areas of this country, there is a potentially large market for PV products at current prices in foreign countries where electric grids are less pervasive.

In the early 1980s, the domestic demand for PV systems may increase as PV system costs drop to \$6-13/W_p [57] (\$2.00/W_p array cost) [58]. A large portion of this mid-term market for PV systems is likely to be devoted to remote PV system applications because the cost of PV-generated electricity will be far too high to compete with rates charged by utilities. The development of the remote, international, and mid-term markets will generate PV system operational experience for industry and consumers and will provide manufacturers with market incentives for cost reduction through automation [59].

The commercialization of PV products in the previously mentioned markets is likely to be enhanced by the existence of product warranties or service contracts. Adequate product performance guarantees may encourage customers to purchase rather expensive and novel PV products, and may induce banks and other lending institutions to finance the sale of PV products. However, the provision of adequate product and installation warranties and service contracts may tend to increase PV product prices as much as 15% above all other production costs. Nevertheless, the MYPP should require that PV systems and components for experimental and real world applications be adequately guaranteed against product malfunction.

It is possible that some mid-term PV market products will be installed in buildings. Until PV building systems are approved by national testing laboratories or are regulated by building code provisions, building officials may be able to prevent PV system installation or may order PV system proponents to finance expensive experiments that would substantiate the safety of PV products. In addition, existing building code regulations may restrict roof area available for PV system use, and thereby limit the cost- effectiveness of PV building systems.

2.4.3 Residential and Intermediate Markets

The primary MYPP goal is to develop PV residential and commercial systems that generate electricity which is cost competitive with electricity generated by conventional utility facilities [60]. Once this goal is achieved, it will be possible for PV systems to displace a significant amount of fossil fuels used to generate the bulk of this nation's electricity [61]. Market penetration is expected to occur in 1986, at PV system prices of $1.60/W_p ($.70/W_p array cost) [62]. Potential end-use applications in these markets include grid-connected single-family residences, commercial, institutional, and on-site industrial systems [63]. It is likely that PV systems in these markets will not include expensive storage equipment, and, therefore, will be dependent on utility connections for backup and surplus sale of electricity [64].

Every legal issue discussed in this report may affect the penetration of PV systems in residential and intermediate markets. If cites and localities do not adopt shade control or solar zoning legislation, total PV system costs may be increased because residential PV system owners may have to purchase solar easements from their neighbors. The impact of building code regulations will be especially acute in the residential and intermediate markets, because most of the PV market applications are designed for use in buildings. Similarly, the existence of adequate product performance guarantees for PV system applications may significantly affect system prices and lending decisions of financial institutions.

The rate and interconnection policies adopted by utilities will affect the commercialization of residential and intermediate PV market applications. Non-grid-connected PV systems may not be able to generate the continuous supply of electricity that is required by most electric power consumers. Unfavorable rate policies may prevent the price of PV-produced electricity from successfully competing with electricity rates charged by utilities. Both policies may increase PV system costs and threaten to delay MYPP commercialization objectives.

2.4.4 Central Station Markets

It may eventually become profitable for electric utilities to augment their generation capacity with solar PV power systems. However, significant price reductions in solar cell production will be necessary before central station systems can be economical for utility use. The MYPP predicts central station market penetration by 1990 at system prices of \$1.10-1.30/W_p (\$.15-.40/W_p array cost) [65]. It most likely will be necessary to use advanced collector technologies to achieve PV system prices as low as \$1.10/W_p [66].

The viability of central station PV applications will be influenced by a number of legal issues. The laws and regulations controlling the right of utilities to buy, sell, and lease PV systems are likely to affect central station markets [67]. Unfortunately, time did not permit the full exploration of this and other legal issues affecting central station PV system applications [68]. Further investigation of legal issues affecting this market is recommended.

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SECTION 3.0

LEGAL ISSUES AFFECTING MULTIPLE MYPP MARKETS

There is a broad range of laws directly affecting the commercialization of every solar technology [69]. This section addresses three legal issues that could delay PV commercialization in more than one of the four projected MYPP markets [70]. These legal concerns are solar access, building code regulations, and PV product performance guarantees. Solar access considerations affect all MYPP market applications because PV systems require direct sunlight for economic power generation. It is also apparent that every MYPP market application will be affected by the existence of adequate PV product performance guarantees. Product guarantees may affect product financing and consumer purchasing preferences. Although remote and international market applications do not generally include PV building systems, some mid-term market and virtually all residential and intermediate market applications will be aided by the promulgation of PV building code and certification regulations. This section focuses on aspects of each legal issue that uniquely relate to PV system operation and MYPP objectives.

3.1 SOLAR ACCESS

Solar access conflicts arise when two or more individuals compete for the exclusive use and enjoyment of sunlight. Courts in this country have not been willing to imply a common law right to light [71]. Absent a private agreement [72], subdivision regulation [73], or public zoning ordinance [74], the solar user's right to direct sunlight depends on the cooperation of his or her surrounding neighbors. There is very little empirical evidence confirming the assumption that solar access conflicts will increase proportionately with solar use. The results of recent studies indicate that existing land- use regulations may adequately protect solar users from solar obstructions [75].

A number of states have recently enacted legislation to protect solar system access to sunlight [76]. A few states have passed enabling acts for local solar access regulation. Other state laws facilitate the creation, recordation, and conveyance of voluntary solar easements [77]. In a small group of states, solar system obstructions are prohibited during specific daytime hours [78]. The only national solar access legislation presented in Congress was never reported out of committee [79].

Comprehensive solar zoning is probably the most effective method of allocating solar space [80]. Solar zoning techniques will lessen the need for purchasing solar easements and will employ rational planning methods to maximize the public benefits of solar space [81] utilization [82]. The existence of a rational zoning plan also reduces the likelihood that courts will overturn solar legislation that is claimed to violate the equal protection clause of the 14th Amendment, or that requires the payment of compensation under the 5th Amendment [83]. However, the results of one study of a 40-mi^2 area in west San Fernando Valley, Calif. suggest that solar zoning may not be necessary in some areas [84]. Satellite photographs and information processing techniques were used to assess the potential rooftop available for PV system application. It was concluded that "over 120 percent of existing power demands could be met by generating electricity from PV systems located on rooftops within the 40 square mile area" [85].

This experimental result indicates that cities in sun-rich regions may have sufficient aggregrate rooftop potential to support PV power generation. However, the availability of solar space in residential areas is quite small. As much as 95% of residential rooftops may not be suitable for PV system use [86]. Small lot sizes, low level housing, lush vegetation, and north facing roofs may account for the small residential PV power potential. Trees, shrubs, and new construction will continue to threaten to obstruct residential solar space. For this reason, homeowners with adequate roof orientation and unobstructed solar space will desire legal protection if they choose to install PV systems. If public or private solar zoning is not in force, homeowners may enter into solar easement agreements to protect solar system access.

3.1.1 Solar Access Considerations for PV Systems

The commercial viability of PV energy systems is highly dependent on an abundant supply of unobstructed sunlight. In some respects, PV system use intensifies solar access problems. For instance, PV users are likely to suffer greater economic hardship from solar obstruction than solar heating and cooling (SHAC) users because PV systems are comparatively more expensive. In addition, PV concentrator system users require more solar space than conventional SHAC users because concentration systems track the path of the sun across the sky [87]. Intensified price and space requirements for PV systems may prevent the acquisition of solar easements and discourage system use. While the risk of not acquiring an easement becomes more compelling as solar system prices increase, the ease of securing adequate access protection diminishes with the intensified need for solar system space. Expensive solar easement costs could impair the marketability of marginally cost-competitive PV systems.

The enactment of state solar access legislation will help relieve PV users from solar access obstructions. However, legislation protecting the access of "Solar Energy Systems" [88] (SES) must include solar PV applications in SES definitions. Photovoltaic systems without tracking mechanisms have no moving parts and do not have many features in common with passive solar systems. Therefore, SES definitions that include only active and passive solar uses may not adequately protect PV systems. Solar access legislation will encourage PV system use only if it provides unambiguous protection for solar users [89].

A few states have adopted laws that prevent solar obstruction during mid-morning and mid-afternoon hours [90]. The operation of concentrator PV systems may be adversely affected by these laws. Photovoltaic concentrator units are designed to track the sun's path from dawn to dusk. Without a direct supply of sunlight these systems will not operate effectively. State laws that protect the flow of sunlight for only a few hours each day may substantially reduce concentrator electric generation capabilities [91]. The need to protect PV concentrator systems will increase when they become cost competitive in commercial markets. At that time, it may be appropriate to extend legislative protection.

3.1.2 The Impact of Solar Access Laws on MYPP Landmarks

Every market for PV power is affected by the availability of solar access. Without sunlight, PV cells would be inefficient energy producers. However, the penetration into most commercial markets is not likely to be limited by the existence of access problems. In remote and mid-term markets, PV systems tend to be located far from manmade obstructions [92]. Intermediate market applications such as schools and industries often will be buffered by parking lots and extensive landscaping. Photovoltaic systems in this market probably will be situated in areas where access will be assured [93]. Central station PV systems need to be located on very large, spacious parcels of land. The availability of solar access will not prevent PV central market penetration, but it will force central station PV system users to locate far from potential solar space encroachments.

In residential markets, there is less direct sunlight and the potential for obstruction is greater than in other markets. Although vegetation growth obstruction may be a principle solar access barrier in residential PV retrofit markets, careful subdivision planning and solar zoning may greatly reduce such impediments to new solar home markets. Penetration into the residential and intermediate market by 1986 at a PV system price of $\$1.60/W_p$ may be hindered if existing land-use laws do not provide adequate protection from obstruction. Three consequences of inadequate legal protection may arrest market development: (1) consumer perceptions of inadequate legal protection for a substantial solar investment may act as a psychological barrier to residential market development and discourage financial institutions from lending to potential PV owners; (2) high solar easement costs may prevent PV systems from becoming cost competitive with grid power [94]; and (3) solar space requirements of PV concentrator systems that are more intensive than the access needs of flat-plate collectors may require more solar access protection than is afforded by existing laws. Partial concentrator system obstruction from sunlight may diminish system efficiency and impair marketability.

Solar zoning and solar easement legislation will reduce the adverse impact of these market barriers. The definition and protection of solar space will inspire the confidence and market participation of potential solar users. The specific needs of PV systems should not be overlooked. Review and amendment of state solar legislation will help provide adequate PV system protection from solar obstruction [95].

3.2 THE NEED FOR PV TECHNOLOGY PERFORMANCE STANDARDS

Evaluation of a technology commences with the development of standards. Standards are operational definitions used to assess materials, products, and systems [96]. Standard definitions enable discussion of a technology. Standard test methodologies allow for controlled observation of a technology. The attainment of consistent test results permits description and quantification of stipulated technology characteristics. Technology expectations are generated from the proliferation of constant test results. Technology performance includes design, safety, and reliability and is essential to the development of building codes and product warranties [97]. Without performance verification (i.e., test standards), manufacturers would not possess an important uniform reference by which product guarantees could be created and made available to consumers. Building officials would be at a similar loss to promulgate regulations for products with unfamiliar performance characteristics.

Most grid-competitive PV technologies and test methods for technology evaluation are currently being developed at various national research laboratories [98]. The primary obstacle to the immediate development of PV building codes and manufacturer product guarantees is the unavailability of reliable and accepted PV technology standards [99]. A comprehensive quality assurance program at the Solar Energy Research Institute is accelerating the formulation of PV technology standards [100]. The rate of accelerated PV standards development will significantly affect the reduction in magnitude of building code and warranty commercialization barriers [101].

3.3 BUILDING CODES

The construction, maintenance, and repair of buildings is regulated by building codes [102]. Building codes are typically supplemented with plumbing, mechanical, fire safety, and electrical provisions [103]. The constitutional authority to regulate buildings is derived from the state's police power to protect the health, safety, and welfare of its citizens [104]. While a handful of state-wide building codes have been enacted, most states have chosen to delegate building code authority to localities [105]. Thousands of differing codes have been enacted by localities. However, the majority of local codes are likely to be modified enactments of one of three model codes: (1) the Basic Building Code of the Code Administrators (BOAC); (2) the Uniform Building Code of the International Conference of Building Officials (ICBO); and (3) the Standard Building Code of the Southern Building Conference Code (SBCC) [106]. These model codes will be used in this section to assess the national impact of building regulations on PV system commercialization and MYPP landmarks.

The three model codes contain performance and material standards for building structures and components [107]. Each code authorizes a building official to insure compliance with building standards. The building official determines whether building elements [108] may be used if they are not regulated by the code [109]. If a building element is certified by a national testing laboratory, the building official will often grant a building permit, even if the component or material is not directly regulated by a specific code provision [110]. If an unregulated building element is not authorized by a national testing laboratory, it is considerably less likely to receive approval for use from a building official. Factors affecting the building officials' permit decision include: building element health and safety implications, manufacturer warranty information, building official familiarity with proposed building materials or components, the comparative utility of existing and proposed building elements, and the existence of evidence that influences the performance of the proposed building material or component. Building officials are not likely to permit the installation and use of novel, untested, or uncertified technologies [111].

3.3.1 Building Official Permit Discretion Affecting PV System Use

There currently are no model code provisions for the installation and use of photovoltaic systems [112]. Nevertheless, many PV system components including storage batteries, wiring, and power conditioning equipment are certified by national testing laboratories and are commonly used in residential and commercial buildings [113]. The predominant reservations of building officials will be directed toward the performance of solar cells and the optimum mix of PV system components. Neither solar cells nor PV systems are certified by a national testing laboratory for building use. Until such certification is obtained, building officials may not be willing to certify the utilization of PV building systems.

The electricity generated from PV systems will be used in buildings for a number of applications including air heating and cooling, food refrigeration, and mechanical appliance operation. Building officials may reasonably conclude that the malfunction of a PV system may adversely affect the potential user's health and safety. Without a strong guarantee of PV system reliability from a national laboratory or a manufacturer's warranty, building officials may deem it necessary to prohibit the operation of PV systems.

Photovoltaic system safety uncertainties can be mitigated by connecting building electrical systems with electric utility grid power. If PV system failure should occur, the presence of a grid connection would insure a continuous supply of electrical power. However, both the utilities and PV system users may not desire to effectuate the grid connection. Photovoltaic system users may desire to be autonomous from utilities because of high costs associated with transmission line construction and high rates charged for small quantities of energy consumption. On the other hand, utilities may favor the development of autonomous PV systems to avoid load management uncertainty and expensive peak load capital construction [114]. Although electric utilities and PV system users may occasionally prefer autonomous systems, building officials may sometimes prevent non-grid-connected PV system use, until sufficient guarantees of reliable PV system performance are obtained.

Photovoltaic systems are novel, relatively untested, uncertified, costly building components. Although PV systems may have to maintain an operating life of 20 or 30 years to be cost-competitive with grid power [115], some PV manufacturers do not warrant their products for more than one year [116]. If PV system performance is not adequately demonstrated or guaranteed, building officials may feel justified in withholding permission for installation even if the systems are connected to grid facilities [117].

3.3.2 Model Code Barriers to PV System Use

The model codes authorize building officials to require that the proponent of an unregulated building material or component conduct tests to demonstrate the adequacy of the proposed building element [118]. The building official may reject or accept the proposal on the basis of these test results. However, PV system testing is bound to be expensive and time consuming. The prospect of costly test demonstrations is likely to be a sufficient barrier in itself to widespread PV system commercialization in buildings [119].

Although there are no model code provisions that regulate PV system use, there are some regulations that discourage the generation of electricity from PV systems. For instance, the Standard Building Code requires that building height be measured to the top of the highest roof structure if the aggregate area of all roof structures is greater than one-third of the roof area [120]. The existence of this provision may prevent PV system retrofit of buildings already at maximum height levels. In addition, the Uniform Building Code limits roof structures to one-third of the supporting roof [121], and the Basic Building Code limits roof overhang to three and one-half feet [122]. These regulations can significantly limit PV system area, impair electric power generation capacity, and reduce system value. A review of regulations that prevent installation or reduce the value of PV systems is an important first step towards the elimination of PV building code barriers.

3.3.3 The Impact of Building Codes on MYPP Landmarks

The residential and intermediate markets will be geared toward PV system building uses and are most likely to be affected by building code regulations. Although commercial readiness prices in each of these markets may be affected by unfavorable building code regulations [123], regulatory building barriers may delay PV system commercialization even if price goals are achieved in accordance with the MYPP timetable. If building officials are not convinced of the reliability of PV systems or if building code regulations prohibit PV system installation, the benefits of PV power will not be realized by the public in the near future. However, building code barriers can be greatly reduced in the next six years.

The development of building code standards is probably the surest method of eliminating potential building code barriers to the widespread commercialization of PV technologies. The Quality Assurance and Standards Program at the Solar Energy Research Institute (SERI) is responsible for the development of test methodologies and performance criteria that will eventually be used to promote and formulate PV consensus standards and to certify real world PV system applications in third party certification programs [124]. The SERI Quality Assurance and Standards Program is also reviewing PV system field performance with respect to the MYPP Tests and Applications subprograms. Evidence of system performance will be used to verify test methodology. Verification of test methods will provide the necessary quality control on the technical adequacy and applicability of testing standards and will affect PV model building code organizations and national testing laboratories [125]. Accelerated development of model PV system building code standards and PV system certification would greatly reduce the impact of building code barriers.

Other means by which potential building code barriers to the commercialization of PV technologies could be overcome could include DOE-coordinated seminars for building officials on PV product performance and installation specifications. The familiarization of building officials with PV technologies would greatly reduce uncertainty about PV systems. In addition, there could be a DOE-administered review of state and local building code regulations. Regulations that might unreasonably interfere with the commercialization of PV systems could be brought to the attention of appropriate state and local officials for possible amendment or repeal.

3.4 MANUFACTURER AND INSTALLER PV PERFORMANCE GUARANTEES

Consumers are often skeptical of representations made about new products by manufacturers and installers. This skepticism is reinforced by the legal tradition of caveat emptor, requiring buyers to assume responsibility for the consequences of their investment [126], by knowledge of unscrupulous entrepreneurship, and high insolvency rates among burgeoning industries. For these and countless other reasons, novel and expensive products manufactured by new industries are often perceived by consumers as a risk of wasted investment.

Consumers frequently borrow money to finance the purchase of expensive products. Commercial banks and savings and loans organizations often provide consumers with sufficient funds to complete financial transactions. Because the products desired by consumers are used as collateral for loans, lending institutions are very concerned about such products' value and reliability. Novel products possess the risk of malfunction that may cause them to become worthless collateral [127].

One method of consumer protection that facilitates consumer acceptance of new products and encourages financial institutions to assist cash- poor consumers in purchasing such products is to guarantee that the products will perform in accordance with prior representations and reasonable commercial expectations. Product guarantees contained in an agreement separate from the product sale contract that involve the maintenance and performance of the product may be called service contracts; when contained in the original contract of sale, they may be called warranties. Express warranties are communicated directly from the seller to the buyer, either verbally or in writing [128]. If a consumer does not receive an express warranty and it is reasonable to assume that a guarantee should have been made, the court may imply the existence of a warranty.

3.4.1 Express Written Warranties—The Magnuson-Moss Warranty Act [129]

Every manufacturer, supplier, or distributor that warrants a consumer product in writing is subject to regulation under the Magnuson-Moss Warranty Act [130]. The act imposes three basic requirements on warrantors. First, the terms and conditions of written warranties for consumer products must be fully disclosed in simple language [131]. Second, every written warranty for a consumer product must be designated to be of either full or limited duration [132]. Full warranties must meet federal minimum standards established in the act, including: a remedy within a reasonable time without charge, no duration limitation on implied warranties, and reasonable refund provisions for defective products [133]. Warranties that do not meet these federal minimum standards must be conspicuously designated as limited [134]. Third, no written warranty for a consumer product may disclaim or modify any implied warranty made with respect to that product, unless the duration of the implied warranty is limited to the written warranty's duration [135]. The act also specifies enforcement provisions to ensure compliance with these legislative regulations [136].

The protection afforded by the act extends primarily to purchasers of consumer products [137]. A consumer product is defined as "any tangible personal property . . . normally used for personal, family or household purposes . . . (regardless of) whether it is so attached or installed" [138]. Without question, the act applies to noncommercial purchases of PV retrofit equipment. Photovoltaic systems are tangible and it is not relevant for purposes of this act that they may become "attached" property after installation. The status of PV systems that are purchased as integrated components in a new solar home is less distinct.

A Federal Trade Commission (FTC) advisory opinion appears to suggest that at least part of a PV system in a solar PV home is a consumer product. The agency has determined that PV system components such as boilers, air conditioners, space heaters, and central vacuum systems are consumer products because they have an individual function [139]. Thus, PV system arrays that are fully integrated into the roofs of new homes may be considered consumer products because their distinct function is to produce electricity. However, the agency has also determined that certain items including wiring, electric panel boxes, and light fixtures do not have separate functions and are not consumer products [140]. Therefore, even though wiring and power conditioning of a PV product may be manufactured and installed by one company, only the PV array warranty may be required by the act.

The separate function test applied by the commission does not provide a definitive answer to the issue of PV system coverage [141]. If fully integrated PV systems are considered more like light fixtures than furnaces, no warranty projection is forthcoming from the act. Other interpretations of the opinion could warrant partial or complete PV system coverage. An administrative ruling on the extent of PV product coverage will most effectively resolve this issue. Absent this ruling, the question of PV product coverage remains academic.

One class of consumers not regulated by the act is business consumers. Consumer products must be sold to private persons, families, or households [142]. Products sold to businesses are not products sold to private persons, families, or households and, therefore, are not consumer products. Although at least one state has extened Magnuson-Moss warranty protection to commercial enterprises [143], in the absence of state legislation to the contrary, written warranties for PV products sold to businesses are not regulated by this legislation [144].

3.4.2 Implied and Express Warranties—The Uniform Commercial Code

The Uniform Commercial Code (U.C.C.) is a compilation of model provisions concerning the law of sales [145]. Every state, except Louisiana, has adopted (with modifications) the U.C.C. [146]. The implied warranties of merchantability and fitness lie at the heart of U.C.C. warranty provisions. "A warranty that goods shall be merchantable is implied in the contract for their sale if the seller is a merchant with respect to goods of that kind" [147]. Merchantable goods must suit the purpose for which they were bought [148].

The code establishes an implied warranty of fitness "where the seller at the time of contracting has reason to know any particular purpose for which goods are required and the buyer is relying on the sellers skill or judgment to select or furnish suitable goods" [149]. Both these provisions offer warranty protection to consumers despite the failure of the seller to offer such assurance. However, in certain circumstances, the model U.C.C. permits the seller to limit or eliminate various implied warranties [150].

Section 316 of the U.C.C. provides that "implied warranties can be excluded or modified by (1) course of dealing, (2) course of performance, (3) usage in trade," or language that makes it plain that there are no implied warranties such as "as is" or "with all faults" [151]. In addition, when the buyer, before entering into a contract, fully examines or refuses to examine goods or the sample or model, "there is no implied warranty with regard to defects which an examination ought . . . to have revealed to him" [152]. In order "to exclude or modify the implied warranty of merchantability," the language must mention merchantability and, if in writing, must be conspicuous [153]. Exclusion or modification of the implied warranty of fitness must be in writing and must be conspicuous [154]. Nevertheless, most states have modified or eliminated Section 316 of the U.C.C.. State legislation diminishes a seller's authority to alter implied warranties designed to protect the buyer [155].

Express warranties to purchasers are created when promises, descriptions, samples, or models become part of the basis of the bargain. The code requires that the goods conform to warranties made by the seller [156]. Express warranties do not include mere puffing or sales talk [157], although the distinction between concrete promises and puffing is often ambiguous.

The warranties in the U.C.C. derive from the sale of commercial goods. Commercial goods are products "that are movable at the time of identification to the contract of sale" [158]. U.C.C. warranty provisions should apply directly to contracts for the purchase of PV retrofit equipment. Photovoltaic retrofit systems are goods that are movable at the time of sale [159]. However, the purchase of PV products that are fully integrated into nonmovable structures (such as PV roof shingles installed in new homes) may not involve a sale of commercial goods to which the provisions of the U.C.C. would apply [160]. Therefore, it is possible that warranty protection for purchases of PV products integrated within stationary buildings may not be derived from the U.C.C. [161].

3.4.3 The Impact of U.C.C. and Magnuson-Moss Warranty Provisions on PV Warranties

The Magnuson-Moss Warranty Act requires that all terms and conditions of warranties for PV consumer products be completely disclosed in simple language [162]. Although the act prohibits written limitations of implied warranties [163], the existence of implied warranty provisions is largely defined by state judicial and legislative U.C.C. interpretations [164]. Thus, Magnuson-Moss protection of state-implied warranties is only as effective as state interpretation of implied warranty laws.

State UCCs may afford substantial warranty protection to purchasers of PV goods. If the implied warranties of fitness and merchantability are not disclaimed or prohibited from modification, then, at a minimum, courts will have authority to require that PV goods be fit for the ordinary purpose for which they are bought [165]. The specific warranty requirements mandated by the U.C.C. are a subject for judicial definition. Expensive PV systems that are purchased for reliable and economical power supplies are likely to inspire judges to require comprehensive warranty protection for the consumer. Ultimately, court decisions favoring consumers may discourage the use of unreasonable warranties and motivate industry to improve PV warranty standards.

Nevertheless, the value of federal and state warranty protection is questionable. Litigation to substantiate the existence of warranties will be risky, time consuming, expensive, and may injure the PV industry reputation and its products. Most consumers would rather buy a reliable product than a successful lawsuit. Tarnished industry reputation and extensive consumer warranty litigation may seriously impair PV market development.

Aside from warranties implied by law, the U.C.C. and the Magnuson-Moss Warranty Act do not authorize courts to require manufacturers and installers to include performance, reliability, and design conditions in warranties. These laws are designed to prevent consumers from being deceived by warranties. However, warranties will not necessarily provide consumers with adequate investment protection or product security. Stable market development will require meaningful PV product guarantees to mitigate consumer product uncertainty.

3.4.4 The Need for Contractual Guarantees of PV Performance

The following subsections address two additional factors that influence PV contractual performance guarantees: (1) the quality of solar heating and cooling (SHAC) products, and SHAC warranties; and (2) PV industry perceptions of the need for warranties, and the costs associated with their use.

3.4.4.1 Solar Heating and Cooling Warranty Protection

The Department of Housing and Urban Development (HUD) recently surveyed warranties used by manufacturers and installers participating in the Solar Hot Water Heating and Demonstration Program. Many of the written solar warranties failed to comply with standards established in the Magnuson-Moss Warranty Act [166]. The study has prompted HUD to set minimum warranty requirements for program participants that fully comply with Magnuson-Moss warranty provisions. In addition, the solar systems must be under manufacturer warranty for five years against defective manufacturer materials and corrosion. Installers are also required to guarantee the solar system against defects in materials, manufacture, and installation for one year. Installers and manufacturers are exempted from liability for defects caused by each other's mistakes [167].

The warranty protection received by SHAC consumers outside the government is less than optimal. An attorney for the Bureau of Consumer Protection indicates that only 1 of 50 solicited SHAC companies is in full compliance with the Magnuson-Moss Warranty Act and Section 5 of the Federal Trade Commission Act (dealing with unfair or deceptive trade practices) [168]. Violations include inaccurate labeling of full or limited warranty requirements, tie-in arrangements, disclaimers of implied warranties, and "Baldwin Piano" clauses requiring that consumers ship heavy items back to the manufacturer in order to take advantage of the warranty. Enforcement action will be taken by the Federal Trade Commission if companies do not make their warranties comply with the law [169].

There is some evidence indicating that active SHAC systems are not performing reliably in real world environments. One study of peak-load capacity effects of SHAC systems was cancelled because of abnormally high solar system mechanical malfunction rates [170]. Only 23 of 100 units in the study operated without serious breakdown [171]. The author of the report concluded "that consumer frustration (from defective product performance) would impede the development of a solar market" [172]. Other reports of SHAC system failure are not uncommon [173]. It is possible that the combination of inadequate solar product warranties and high SHAC system malfunction rates may adversely affect consumer perceptions of solar products and the solar industry. In this environment, the market for new solar PV products may be critically dependent on the existence of suitable product warranties or service contracts.

3.4.4.2 PV Manufacturer Warranty Views

The Central Solar Energy Research Corporation has conducted a preliminary investigation of the "status and impact of warranties on the PV cell industry" [174]. Cell, module, and array manufacturers from an industry cross section were surveyed by questionnaires, telephone conversations, or personal visits. Although respondents usually qualified their statements with "these answers are my own opinion and do not necessarily reflect the view of the company," an examination of selected survey results partially illuminates the warranty attitudes and policies of PV manufacturers [175].

"Those manufacturers questioned that are presently offering a product for sale have at least a one-year guarantee on materials and workmanship." "Several companies provided a five- to ten-year performance warranty with an allowance for 25 percent performance degradation" [176]. "There was a general industry consensus that a five- to ten-year performance warranty is desirable" [177]. It was estimated that a warranty usually adds 6-15% of the cost of a device [178]. "The warranty cost is a function of application, location, length, and breadth of warranty" [179]. "The most common mode of failure in remote areas is vandalism" [180].

The coverage provided by those warranties examined in the survey is fairly comprehensive. All 1-year warranties cover both materials and performance. The 5-year warranties also cover materials and performance if the manufacturer performs system design. However, the warranties are void unless installed in accordance with manufacturers' directions and specifications. In addition, the manufacturer liability on the warranty is limited to the original cost [181].

These survey results indicate that PV manufacturers favor the development of comprehensive contractual protection for PV products. Closer examination of each provision will reveal whether the provisions comply with existing warranty laws and regulations. Some warranty protection is currently offered for all PV products manufactured by survey participants. The adequacy of this protection can only be determined on a product-by-product basis.

3.4.5 The Impact of Warranties on MYPP Landmarks

Every PV market will be affected by the existence of contractual PV performance guarantees. Insufficient product warranties may arrest PV market development and discourage commercial financing. On the other hand, the costs associated with adequate product guarantees may impede PV market penetration. The costs associated with PV product warranty regulation could affect commercial readiness prices for each commercial market. Because adequate contractual protection may be expensive [182], MYPP analysts should carefully assess the costs associated with this BOS component.

At a minimum, PV components and systems purchased by the MYPP for demonstration or market application should include some provisions to ensure the adequate operation of PV systems. Photovoltaic performance standards could be set by the Quality Assurance and Standards Program in conjunction with representatives of PV manufacturers and installers. These contractual performance provisions should also be required to comply in full with relevant sections of the Magnuson-Moss Warranty Act. These measures should help insure adequate program protection from defective product performance.

Finally, product standards should be carefully established. These standards must engender a delicate balance of consumer protection and market development interests. Extremely stringent standards could impair product experimentation, reduce product profitability, and eliminate small businesses unable to afford the cost of standards compliance [183]. The Quality Assurance and Standards Program should continually apprise the PV industry of product standards and warranty implications. If the PV industry demonstrates that it cannot provide adequate PV product protection, then government subsidy, insurance, or warranty assurance programs may be necessary to reduce the product risks inherent in this government-accelerated industry [184].

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SECTION 4.0

ELECTRIC UTILITY POLICIES AFFECTING PV TECHNOLOGY COMMERCIALIZATION

Virtually all of the electrical energy that is consumed in this country is generated and distributed by electric utilities [185]. The utilities have provided their customers with reliable and relatively inexpensive power for over 100 years. In order for PV technologies to significantly reduce the demand for electricity generated from conventional facilities, PV systems must be able to penetrate the market for utility-produced electricity [186]. Photovoltaic systems will be able to satisfy the demands of electric utility customers when they are capable of producing reliable and cost-competitive energy.

The government and private industry are dramatically accelerating price reductions of PV power [187]. However, many residential applications of PV technologies may not be economical unless excess PV-generated electricity can be sold to a ready and willing buyer. In addition, PV systems will not be able to provide consumers with electricity at night or during sunless days until the industry perfects existing electric storage technologies [188]. Therefore, many PV systems will require backup power and buy-back demand in order to produce reliable and inexpensive power for consumer use.

In most instances, public utilities are best able to fulfill the energy supply and purchasing needs of PV users. The utilities have an abundant, continuous supply of electrical power and will conserve fossil fuels if they purchase electricity from solar PV facilities. Nevertheless, public utilities may be reluctant to support the use of a technology that threatens to reduce their customer revenues and limit their industry expansion. Whether utilities have the authority to retard the commercialization of PV technologies can be determined according to law.

This section focuses on the connection of PV systems to power grids, and utility rates charged to PV users. Each of these policies can be used by utilities to impede the widespread commercialization of PV technologies. Autonomous PV systems may not be able to generate the continuous supply of electricity that is required by most electric power consumers. Unfavorable rate policies may prevent electricity produced by PV systems from successfully competing with power generated by utilities. The authority of utilities to implement unfavorable policies toward PV users is largely restricted by case law, state utility regulatory statutes, federal antitrust laws, and the Public Utility Regulatory Policies Act of 1978 (PURPA) [189]. Each utility interconnection and rate policy is discussed with reference to relevant sections of these laws. Section 4.7 discusses the impact of these utility policies on the timely achievement of MYPP landmarks. Section 4.1 contains a brief discussion of the effect of PV system use on utility peak power generating capacity and on electrical load control techniques. The conclusions developed in this section affect the desirability of the utility policies analyzed in the following pages.

4.1 PEAK DEMAND FACILITIES AND LOAD MANAGEMENT

The demand for energy varies with the season, time of day, climate, and a host of other variables. For this reason, a utility must estimate the energy demand, or load, so that a sufficient quantity of energy is produced to satisfy this need. Load estimates are based primarily on the prior energy habits of utility customers [190]. There are a certain number of hours each year when the demand for energy is at its peak. Since utilities cannot directly store electricity, they must maintain excess generating capacity to produce electricity during periods of peak demand [191]. Generally, it is more costly to use peak demand generating facilities than base load facilities (electric energy generators used during normal periods of demand) [192]. A significant increase in consumer electric demand often requires the construction of new power generation facilities. Utilities are sometimes able to offset the costs created by high demand through the employment of load management techniques [193]. One basic objective of load management is to maximize the use of base load facilities so that peak load facilities do not need to be used or constructed [194].

Two arguments are often used by utility proponents to justify the imposition of unfavorable rate and interconnection policies for PV users. First, it is claimed that the widespread use of PV technologies will reduce the reliability of load estimation techniques and thereby disrupt the efficient use of electricity generation facilities [195]. This argument presupposes that power demands of PV users will be substantially different from the power demands of conventional consumers. Second, it is often claimed that widespread PV use will require the construction of new energy generation facilities that will not be adequately financed by revenues collected from PV users [196]. It is argued that PV users will have a small monthly demand for energy and therefore provide scant revenue to the utility. Moreover, PV use will require the utility to build new facilities for periods when PV users' backup power demand is coincident with utility peak demand. The major assumption underlying this argument is that PV users will demand backup power during periods when the utility is experiencing a peak energy demand.

It is not certain that widespread PV use will increase peak demand or disrupt load management practices. Contractual agreements between PV users and utilities might restrict PV system backup power use during peak demand periods. Such an agreement and countless other load control techniques might prevent PV systems from increasing peak demands and frustrating load management objectives [197]. Even if load control techniques are not adopted by utilities, PV system use may not require generation capacity expansion equal to maximum PV system power output. One study prepared by General Electric [198] indicates that PV system use in some areas of the country will require a corresponding increase in utility generating capacity of 60% of the maximum PV system power output [199]. Therefore, absent the existence of load control techniques, it still may not be assumed that PV system use will require facility expansion equal to 100% of the PV system peak demand capacity.

PV technology operation entails numerous benefits that may offset any additional costs not adequately financed by PV user revenues. For instance, although conventional utility customers may use electricity produced by PV systems, PV-system owners will not receive a guaranteed rate of return on their investment and may have to bear the full risk of financial loss [200]. Therefore, conventional utility customers will enjoy the benefits of PV-generated electricity without the burden of financing PV system use. In addition, PV users will reduce the need for utilities to purchase expensive and polluting fossil fuels for electricity generation.

Solar-generated electricity may directly affect the rates paid by conventional utility consumers in two ways. First, decreased energy demand caused by PV-produced electricity may exert downward pressure on the price of energy that is included in the rate bills of energy consumers [201]. Second, solar-generated electricity will reduce the need for energy produced by conventional facilities that pollute the environment. Because utilities are required to pay for pollution control equipment and the rehabilitation of polluted areas [202], utilities (and rate payers) will benefit financially from nonpolluting electricity generation. Therefore, even if utilities do not mitigate energy demand problems with load control techniques or provide capacity credit to PV owners, the financial advantages of PV use may adequately compensate any cost incurred by the use of PV technologies.

Although utility proponents may claim that PV systems will impair load management efforts and necessitate the construction of additional generation facilities, utilities may have difficulty producing supporting evidence. The current aggregate industry generating capacity is 39% greater than the national peak demand for energy [203]. In 1978, the national demand for electricity rose by 1.2% [204]. Escalation in the price of fossil fuels in the first half of this year will be likely to further restrain national demand for electricity if power rates increase commensurately with fossil fuel rates. Optimistic forecasts predict that PV energy will account for no more than 1% of the total supply of energy by the year 2000 [205]. Of course, each utility will have to justify its interconnection and rate policies on the basis of evidence that reflects its particular load structure and projected energy demand. Nevertheless, when viewed from a national perspective, existing evidence seems to indicate that only minor operational adjustments will be required to accommodate the use of PV systems by the end of this century [206].

4.2 THE IMPACT OF ANTITRUST REGULATION ON UTILITY INTERCONNECTION POLICIES

Antitrust law is designed to regulate the use of private economic power [207]. The objective of antitrust regulation is to promote competitive markets [208]. Courts have favored the development of competitive markets because under ideal conditions they utilize the least amount of resources to satisfy the greatest amount of consumer desires [209]. The maintenance of competitive markets is achieved through the prohibition of market agreements, unfair business practices, and power concentrations that actually or potentially disrupt the smooth operation of the free enterprise system [210].

The government will permit one firm to supply the full market demand for a good or service if it is likely that the benefits of competition are greatly outweighed by the benefits of a controlled market structure [211]. Utilities have been granted monopoly control over electric power markets largely because the presence of competition would cause the wasteful misallocation of scarce resources [212]. Despite the regulation of utilities by municipalities, state public utility regulatory commissions, and the Federal Government, utilities are not immune from the operation of antitrust laws [213]. This section focuses on the impact of antitrust regulation on utility interconnection policies [214].

4.2.1 Backup Interconnection Policies in Violation of the Sherman Act

The fact that a company occupies a monopoly market position is not illegal. However, if a monopoly is obtained or maintained through improper means, it may be subject to regulation. Section 2 of the Sherman Act forbids monopolization, attempts to monopolize, and conspiracies to monopolize [215]. Monopolization is prohibited by the act if a firm's conduct meets two conditions: (1) the company must have the most power in the relevant market [216], and (2) the monopoly power must be acquired or maintained by an unreasonable restraint of trade, or must be used or threatened to be used to prevent market competition [217].

It can be argued that the refusal of a utility to provide backup power to a PV user may be an unreasonable restraint of trade in violation of the Sherman Act. Three factors must be addressed to resolve this issue: (1) what is the relevant market; (2) does the accused company occupy a dominant market position; and (3) is the complaint or act an unreasonable attempt of the accused company to maintain its monopoly?

The relevant market for the purpose of this analysis is the electricity market. In general, products used for essentially the same purpose that may be freely substituted for each other (displaying a positive cross-elasticity) [218] are likely to be considered competitors in the same market [219]. Overlooking a few exceptions [220], virtually all residential and most industrial electricity is purchased from utilities. The electricity produced by PV systems will be likely to compete directly with electricity produced from conventional utility facilities, because consumers will not be likely to have other product options. For this reason, consumers who are not able to supply at least part of their power demands from PV systems will have to rely on the utility for backup power. Therefore, electricity produced from PV systems and the electric utilities are likely to be classified in the same market because they will tend to be used for the same purpose and will be likely to display a positive cross-elasticity.

The magnitude of a company's power in a given market is often assessed by comparing its sales records with the sales records of other firms [221]. However, it is likely that most electricity-producing utilities will be considered monopolies because their electric energy sales within their territory approaches 100% of total market purchases by electricity consumers [222]. Thus, having established the existence of a market, and a dominant market position, it becomes necessary to examine whether the alleged restraint of trade is unreasonable.

If the denial of service to a PV user is motivated by the desire of the utility to maintain its monopoly and prevent the growth of competition, this unilateral refusal to deal may be considered to be in violation of Section 2 of the Sherman Act [223]. However, specific intent to unlawfully maintain a monopoly may be difficult to prove. There are numerous business reasons that may be proposed by a utility to justify the decision not to connect PV systems to utility grids not directly related to the retention of market control [224]. Indeed, it may be argued that the interconnection refusal is motivated by a desire to protect the economic interests of conventional utility customers who would be unreasonably burdened by high PV system use costs.

The PV user might contend that accusing the utility of unreasonably restraining competition is unnecessary, because the consequence of not providing service may be the elimination of a market competitor. If PV users are not provided backup power by utilities, PV market penetration could be indefinitely delayed unless economical storage systems are developed for commercial use. Therefore, because the ultimate effect of not providing backup power for a PV system might impede or eliminate a viable market competitor, the refusal of the utility to provide this service may constitute a per se violation of the Sherman Act, Section 2 [225].

4.3 COMMON LAW AND STATUTORY UTILITY INTERCONNECTION OBLIGATIONS

Aside from the obligations imposed on the utility by antitrust regulations, the utility has a fundamental duty to provide safe and efficient service to all customers within its territory [226]. However, utilities do not have to provide service to all persons requesting service [227]. This section examines the case precedent that affects the obligation of utilities to provide service to customers desiring electric power [228].

The obligation of the utility to provide service extends only as far as its undertaking [229]. Generally, if the consumer request for extension of service is unreasonable, the utility will not be required to render service [230]. The reasonableness of a service request is determined on a case-by-case basis and includes consideration of such factors as the amount of demand, the cost of providing service, and the impact of providing service on the financial condition of the utility [231]. The utility may be excused from its duty to provide service when the demand for such service is small and the cost of furnishing power is excessive [232]. Service may be withheld even if failure to provide such service would not threaten the solvency of the utility [233]. Nevertheless, when the demand for service is actually or potentially large, though unprofitable, the utility may be required to render service if it is able to remain a profitable enterprise [234].

Photovoltaic system owners not residing within the service territory of an electric utility may not be able to acquire utility backup power. The service obligations of a utility generally do not extend beyond the limits of their undertaking [235]. Therefore, the decision to interconnect parties outside the utility's territory is largely a matter of business judgement. Photovoltaic system owners located far from existing service facilities may not be interconnected with the utility because the costs of providing service may not be adequately recovered from revenues generated from backup power use [236].

Photovoltaic system users will be provided backup power by the utility if the PV users reside within the utility's service area, or if a utility regulatory body or a court determines it is reasonable to compel a grid connection. Judicial decisions favoring the provision of power to PV users will be an important incentive for utilities to offer this service. However, the reasonableness of a utility service decision will ultimately be determined with reference to the specific facts involved [237].

If a utility is able to demonstrate that providing PV backup service would substantially impair the profitability of its operations, it may be excused from the service obligations. The compulsion of a utility to forfeit its profits might rise to the level of a Fifth Amendment taking that requires the payment of just compensation to the aggrieved party [238]. If it is assumed that PV systems are not located an excessive distance from existing utility facilities, and that the PV systems are in the utility's service territory, then it is not likely that the provision of PV system backup will cause the demise of a profitable electric utility operation. Nevertheless, if PV use should increase so as to affect electric energy demand, utility operation and rate adjustments can be implemented to minimize adverse PV system impact [239].

There is a divergence of judicial precedent concerning the service obligations of a utility when providing service does not endanger utility solvency. One line of cases does not require that utilities provide service if the demand for electricity is extremely small compared to the high costs of grid connection [240]. These cases are premised on the theory that the rights of a few should not be permitted to overburden the rate obligations of the majority of consumers [241]. The other viewpoint is represented by cases like General Telephone Company of Wisconsin v. Wisconsin Public Service Commission [242]. This case held that public convenience and necessity required that a utility extend service to customers not residing in the service territory of another utility [243]. The court added that the commission could properly require the extension of telephone service even though it might require a small increase in rates to the company's other customers, where public convenience and necessity required the extension [244].

The former line of precedent is not very helpful in determining the obligation of utilities to provide backup power to PV users. Although the existence of a small demand for power will reduce utilities' economic benefits from service extension to conventional utility customers, such demand will not adversely affect utility operations if PV users are located near grid power facilities. While the benefits of increased demand from conventional customers may necessitate grid power connection, the proliferation of PV system use will exacerbate utility operation difficulties. Thus, this precedent does not appear to support the denial of service extension to a small number of PV users, if it is assumed that PV users are not located a great distance from existing utility power facilities [245].

The provision of backup service to PV users is not analogous to the precedent discussed above because all customers may benefit from PV system use. Photovoltaic system use may exert downward pressure on all customer utility rates and may decrease utility costs associated with pollution prevention and elimination. Thus, while this precedent would permit the denial of service extension to conventional power customers (because the majority is harmed for the benefit of the minority), the same rationale may not justify the withholding of backup power from a small number of PV users. A large population of PV users may not adversely affect the interests of the majority, because the PV users may provide rate and environmental benefits to all utility customers.

The latter precedent rests upon public policy principles that can be used to assess the utility's duty to provide grid power to PV users. This viewpoint requires the extension of service when justified by the public convenience and necessity [246]. This language will give courts considerable discretion in weighing the benefits of PV grid power connection against the alleged cost of PV system operation. If a court is willing to find that PV system use will provide public rate and environmental benefits to utility customers, and if load management techniques that minimize detrimental PV system operational impacts are presented, then a court may rely on this precedent to require utilities to provide power for PV users [247].

4.4 THE IMPACT OF THE PUBLIC UTILITY REGULATORY POLICIES ACT OF 1978 ON UTILITY INTERCONNECTION POLICIES FOR PV USERS

The Public Utility Regulatory Policies Act (PURPA) is the section of the National Energy Act that addresses the production and regulation of electric energy [248]. PURPA contains programs to encourage electric energy conservation, equitable retail rates for electric customers, and efficient use of electric utility resources and facilities [249]. Section 202 of the act is designed to provide protection for small energy-producing technologies, including many PV applications. Thus, PURPA provides an independent base for PV users to challenge the interconnection decisions of utilities.

The act gives the Federal Energy Regulatory Commission (FERC) the authority to regulate "Small Power Production Facilities" (SPPF) [250]. SPPF produce electricity directly from biomass waste, renewable resources, or any combination thereof, and may not have a power production capacity greater than 80 MW [251]. In order to qualify for the rate interconnection provided in the act, these facilities may not be owned by a person primarily engaged in the generation or sale of electricity, and must, in addition, comply with rules prescribed by FERC [252]. The major restriction proposed by FERC for qualifying SPPF (QSPPF) is that they have a facility design capacity of at least 10 kW [253].

4.4.1 <u>The Interconnection of Qualifying PV Facilities</u>

Photovoltaic energy systems purchased by homeowners or industries are likely to be QSPPF. Such systems produce electrical energy directly from the sun (a renewable resource), are likely to be owned by persons intending to consume (not produce) electrical energy, and most likely will not be capable of producing 80 MW of electricity. Therefore, such systems are likely to be qualifying PV facilities (QPVF) and therefore eligible for the protections afforded by the act.

Section 202 of PURPA authorizes FERC to issue orders requiring the physical connection of utility transmission facilities with QPVF [254]. In addition, FERC may require that action be taken to ensure that interconnection is effective [255], that the sale or exchange of electric energy be commenced when necessary [256], and that transmission capacity be augmented to achieve adequate utility QPVF interconnection [257]. However, while the thrust of this section is to provide QSPPF with utility grid power, the authority of FERC to require interconnection is conditioned on many variables. For example, no interconnection order may be issued unless FERC determines that the interconnection (1) is in the public interest [258], (2) does not discourage conservation or the efficient use of utility facilities, or impair the reliability of utility operation [259], (3) is not likely to result in a foreseeable economic loss to the utility providing service [260], (4) does not interfere with the utility's ability to provide adequate service to its customers [261], or (5) can be financed by a QSPPF owner who is ready, willing, and able to reimburse the utility for his share of the foreseeable costs incurred in making the connection [262].

The abundance of these conditions for interconnection suggests that hearings to compel the provision of backup power for QPVF may be complex, long, and expensive. Nevertheless, if QPVF owners are willing to pay their fair share of the expenses for interconnection, the commission has authority to make utilities provide this service. The determination of utility service interconnection obligations will ultimately rest on the specific evidence presented to FERC. Unfortunately, the numerous prerequisites for interconnection may prevent QPVF users from availing themselves of the protections provided in this section [263].

4.5 SUMMARY OF UTILITY INTERCONNECTION OBLIGATIONS IMPOSED BY LAW

Photovoltaic users who are denied the option of receiving backup power from a utility may challenge the decision on at least three legal grounds. First, it may be claimed that the refusal of the utility to provide service unlawfully maintains the utility monopoly of the market for electricity and is in violation of Section 2 of the Sherman Act. Second, it may be argued that the statutory obligation of utilities to provide adequate service to their customers requires that backup power be extended to PV users if such extension does not impair utility solvency. Finally, Section 202 of PURPA may protect users of qualifying PV facilities who are willing and able to pay their share of the interconnection costs. The focus of most of this legal protection will be on the reasonableness of the utility interconnection policy. The reasonableness of utility policies will be determined with reference to the evidence justifying the utility interconnection decision.

4.6 UTILITY RATE POLICIES AFFECTING PV SYSTEM USE

Utilities, with the rate payments they receive from their customers [264], finance the construction of electric generation facilities, purchase the fuel used to produce electricity, and recover the costs associated with billing and servicing customers. Two rates that will affect the market penetration of PV technologies are discussed in this section. For the purposes of this discussion, a backup rate is defined as the retail charge by a utility to a customer for the contractual right to supplement his or her energy demand with grid power. A buy-back rate is the rate paid from a utility to a customer for the contractual right to purchase electric energy production in excess of consumer power demands. Unfavorable rate policies may discourage consumers from interconnecting or purchasing PV systems even though a utility may offer to provide service to a PV user. The following paragraphs consider the legal restraints on the ability of utilities to adopt rates that may discourage widespread PV use.

4.6.1 Rate Structure

Utilities use several different methods for calculating the rates charged to customers to finance the production of electric power [265]. A basic principle of rate design is that it reflect the cost of service [266]. A rate structure should (1) "recover the revenue requirements of a utility, (2) distribute the revenue requirement fairly among all customers, and (3) discourage waste and promote efficient use of energy" [267]. In order to achieve these goals, some rates charge the customer less money for increased consumption of electric energy. This type of rate is called a declining block rate and is the most common rate charged electric utility customers [268]. This rate is also called a promotional rate because it rewards customers when they consume large quantities of electricity [269].

There are many other rate structures used by utilities to recover their production costs. Time-of-day and seasonal rate structures are designed to charge consumers more money for energy that is consumed during peak demand periods and less money for energy that is consumed during nonpeak periods [270]. Interruptible rates are generally less expensive than normal rates because they give the utility the option of interrupting service at will [271]. Demand-energy rates can be very expensive for customers who consume small quantities of electricity. One part of the customer bill may reflect the cost of energy use by the customer and another part of the bill may charge the customer for the highest demand maintained for any 15-30 minute period. Thus, consumers that require a large amount of energy as infrequently as once a billing period may pay a great deal for that intermittent use [272].

The type of rate structure offered by a utility will affect the value of PV system use. Declining block and demand-energy rates will tend to discourage PV system use because they charge relatively high prices for small quantities of electricity. On the other hand, time-of-use and interruptible rates may encourage PV system commercialization because they will not tend to penalize the consumer for using small quantities of grid power. Congress has recently authorized FERC to oversee the rate structures adopted by utilities in the several states.

4.6.1.1. Utility Rate Structures Fostered by PURPA

Section 111 of PURPA provides that each state agency with regulatory authority over electric utility rates and every unregulated utility must consider whether it is appropriate to implement federal rate structure standards established in this section [273]. Although the standards are not mandatory [274], the act authorizes the Secretary of Energy to intervene in proceedings that concern the appropriateness of adopting the federal standards [275]. All of the standards established in Section 111(d) may benefit PV users. The act provides that utilities shall offer an interruptible rate to commercial and industrial consumers [276]; that rates charged to each class of consumers shall be on a seasonal basis [277]; that time-of-day rates shall be utilized if they are cost effective [278];

that the energy component of declining block rates may not decrease as consumption increases unless this rate structure for the energy component reflects the cost of service [279]; and to the maximum extent practicable, that rates charged reflect the cost of providing service [280].

Whether utilities and utility regulatory bodies adopt federal standards that favor solar PV users is left to their discretion. It is important to note that utilities could adopt unfavorable rate policies toward PV users and remain in full compliance with the federal rate standards in Section 111(d). For instance, the act does not provide that interruptible rates be offered to residential customers. Thus, residential PV users may not be able to benefit from the low prices offered by an interruptible rate structure. In addition, the act does not provide that utilities phase out declining block rates. It merely requires that where practicable, the energy component of these rates not be permitted to decrease in price with corresponding increases in consumption. Therefore, if utility rates structures are similar to those used by one utility in Colorado (where the energy component of the utility's rate accounted for only 30% of the total consumer bill) [281], existing federal standards will permit 70% of the customer rate to mirror a declining block rate structure.

Finally, the standards permit the utilities to adopt unfavorable rates for PV users because the standards are merely advisory. While state utility regulatory bodies and unregulated utilities are required to consider the various rate criteria presented in Section 111(d), they are permitted to determine the importance of each rate structure criterion. It is emphasized by the act "that nothing in Section 111 prohibits any State regulatory authority or unregulated utility from making any determination not to implement any such standard (established in Subsection d)" [282]. Even though the implementation is subject to judicial review, many of the standards appear to allow utilities sufficient flexibility to adopt unfavorable PV user rate structure policies.

4.6.2 Utility Rate Policies in Violation of the Sherman Act

The rate policies adopted by utilities for PV users may be challenged as anticompetitive business practices in violation of the Sherman Act. The impact of excessive backup and buy-back rate policies on PV users may be just as unfavorable as utility policies prohibiting service extension. However, regulated utilities need the approval of utility regulatory bodies in order to implement a given rate structure for a class of utility customers [283]. A fairly complex body of antitrust law has evolved around the issue of whether certain actions of the soverign states are immune from the operation of the antitrust laws. This section examines whether public utility regulatory body approval of an unfavorable utility PV rate structure constitutes "state action" that insulates the utility and the state decision maker from federal antitrust laws [284].

4.6.2.1 State Action Antitrust Immunity

The Sherman Act does not expressly state whether the federal antitrust laws may preempt the actions of sovereign states [285]. The Supreme Court has noted that "in a dual system of government in which, under the constitution, the states are sovereign, . . . an unexpressed purpose to nullify a state's control over its officers and agents is not lightly to be attributed to Congress" [286]. In Parker v. Brown, the Supreme Court immunized a state official's approval of a state raisin marketing plan that threatened to violate anticompetitive provisions of the antitrust laws [287]. However, only the conduct of the state official was granted immunity. The Court did not reach the issue of immunity for private conduct authorized by state action [288].

Since the Parker decision, the Supreme Court on several occasions has refined the limits of the state action exemption [289]. Generally, when state officials are directed by the state to approve the existence of anticompetitive conduct, they may be immune from the operation of antitrust laws if there is (1) adequate public supervision of the conduct [290], and (2) authorized state action clearly intended to displace antitrust law [291]. The state-authorized, anticompetitive conduct of private individuals may also fall within the penumbra of state action immunity. Without private immunity, the ultimate effect of the federal antitrust control would be to frustrate the purpose of lawful state regulation [292].

It is possible that the supervision of unfavorable PV utility rates by state public utility commissions constitutes "adequate public supervision." Public utility commission regulation might be considered adequate because the commissions have the final right to deny or grant the rate schedules proposed by a utility. In addition, the existence of a record of the Public Utility Commission rate decision process would assure that supervision is adequate. However, it remains unclear whether adequate supervision requires rigorous consideration of the conduct or merely that the conduct be approved by a state official [293].

With regard to the second state action criterion, it is likely that public utility commission approval of an unfavorable rate schedule for PV users will be considered "authorized state action clearly intended to displace anti-trust law." The decision in Cantor v. Detroit Edison Co. supports this conclusion [294]. In this case, the Michigan Public Service Commission approved the addition of the cost of light bulbs to the rate base of an electric utility that distributed the light bulbs to customers free of charge [295]. Cantor, a light bulb manufacturer, challenged this practice as being an unlawful restraint of trade in violation of the Sherman Act. The Court denied immunity to the utility largely because the light bulb program was not central or crucial to the state utility regulation program [296]. The majority reasoned that no immunity will be implied unless it is clear that an antitrust exemption is necessary to make the state regulation program work [297].

While the decision by the public utility commission in Cantor may be ancillary to its primary regulatory objectives, the rate approval exercised by a utility regulatory commission is perhaps the most important function of a state utility regulatory program. If the rate decisions of state utility regulatory commissions are not exempt from the operation of federal antitrust laws, the fundamental function of the lawful state regulatory program could be subject to preemption by federal antitrust law. Therefore, it may be concluded that state approval of unfavorable rates for PV users is clearly intended to displace federal antitrust law because the state prerogative to regulate natural monopolies could be eliminated through the operation of antitrust regulation.

If public utility commissions give adequate consideration to rates that are not favorable to PV users, it is likely that their decision and the conduct of the utility will be exempt from antitrust review. However, if immunity is not granted, there may be sufficient precedent to prohibit excessive or arbitrary rates charged PV users. For instance, a monopoly cannot lawfully use its market position to eliminate a market competitor [298]. Nevertheless, a rate differential between PV users and conventional utility customers that reasonably reflects different service costs associated with each class of consumers may not rise to the level of a Sherman Act violation [299].

4.6.3 Utility Rate Discrimination Against PV System Users

It has been emphasized that unreasonably high backup and buy-back rates may significantly inhibit the market penetration of grid-connected PV technologies. This section examines whether the adoption of unfavorable PV rates by utilities constitutes an unlawful discriminatory practice against PV users in favor of conventional utility customers.

Almost every state has enacted legislation prohibiting discriminatory utility business practices [300]. However, certain consumer classes have received preferential treatment from utilities despite the existence of these statutes. Two generalizations derived from the case law can be used to distinguish lawful from unlawful utility discriminations [301]. "The first is that preferential treatment is more likely to be found reasonable if it produces increased direct benefits to all customers" [302]. A more restrictive variation of this principle advanced by some courts is that reasonable discrimination can benefit one class of consumers but cannot burden another class [303].

Excessive rates charged PV users would not be likely to benefit all customers. In fact, discriminatory backup and buy-back rates may disadvantage all consumers because such rates would substantially diminish the environmental and rate advantages to be realized from the use of PV systems. Therefore, in jurisdictions where rate discrimination is legal if all consumers are indirectly advantaged by it, courts may hold rates to be unlawful if they unreasonably discourage PV use. In addition, this conclusion could remain valid even if conventional and solar PV users are charged the same rate for consumption of electricity [304].

The validity of excessive PV rates is somewhat different in jurisdictions that forbid discrimination to customers not favored by the preferential rate. While the establishment of excessive rates will surely disadvantage PV system users, rates that encourage customers to use PV systems may burden conventional users. It is possible that PV revenues may not adequately finance the cost of serving PV users. If both favorable and excessive rates for PV users discriminate against a class of utility customer, this principle will not resolve the legality of either discriminatory rate. The legality of preferential PV rates could be upheld under this principle if it is demonstrated that all classes of customers would benefit [305].

The second general principle common to lawful discriminatory policies is that "utilities may treat different classes of customers in different ways if there is a reasonable economic basis for distinguishing them" [306]. If conventional rates charged to PV users do not adequately finance the cost of providing service to PV users, this principle of discrimination might justify the imposition of higher rates for PV users to offset actual or potential revenue shortfalls. Alternatively, excessive rates charged to PV users would be prohibited if they were not supported by evidence of reasonable economic motives.

One method of analyzing the reasonableness of an economic motive to discriminate is to examine it in relation to the economic performance of the utility. For instance, in the early and late 1960s, the cost of providing electricity to customers actually decreased with each increase in electric consumer demand [307]. For this reason, it was considered reasonable for utilities to offer promotional rates to large consumers of electricity. All consumers benefited from this promotional policy because rate structures encouraging consumption would lower electricity consumption costs for all utility customers.

At some point during the early 1970s, the cost of producing electricity began to increase despite the continuing trend toward industry expansion [308]. Rate policies that encourage electricity consumption in the current market may no longer reduce the cost of electricity for all consumers. This change in the economic performance of the utility industry seems to disfavor the use of promotional rate structures. Promotional rate structures may increase energy rates for all consumers and provide benefits for very few classes of consumers [309].

The current industry trend of increased costs with increased consumption seems to justify the adoption of rate schedules that favor the generation of electricity by PV technologies. Many commentators agree that because of the conservation, rate, and environmental benefits derived from solar use, solar rates should be the promotional rates of the future [310]. Nevertheless, the most common rate structure used by utilities continues to be the declining block rate. This rate may remain the most prevalent unless it is superceded by the intervention of utility regulatory bodies or the courts.

4.6.4 The Effect of PURPA on Utility Rate Policies for PV Users

Section 210 of PURPA establishes an independent body of authority that affects rate (and possibly interconnection) policies of utilities. This section of the act requires FERC to prescribe rules it determines are necessary for the encouragement of QSPPF (of which QPVF are a subset) [311]. The following discussion examines more closely Section 210 rate authority, and focuses on provisions that may assist PV users in challenging unfavorable utility policies. Section 210 provides that FERC may require electric utilities to sell and purchase electric power in connection with QSPPF [312]. Section 210 further provides that the rules for rate regulation include provisions respecting minimum reliability of QSPPF power production and power reception for consumption [313]. The act requires that buy-back and backup rates be (1) just and reasonable to electric utility customers and in the public interest, and (2) not discriminate against QSPPF [314]. However, the conference report emphasizes that rates may not be used to discriminate against consumers of utility power [315].

An additional requirement is provided in the act for rates charged by the utility for the purchase of electricity from QSPPF. The rate charged QSPPF may not exceed the incremental cost to the utility of alternative electric energy [316]. Thus, the price paid by the utility must equal the cost the utility would have to pay for electricity purchased from QSPPF [317]. Finally, the act gives FERC authority to exempt QSPPF from any state regulation if such exemption is necessary to encourage QSPPF production [318].

4.6.4.1 Implied 210 Authority for Interconnection

The language of Section 210 provides strong protection for QPVF users. It may be implied that the comprehensive rate authority given to FERC in this section requires that FERC also have authority to order the interconnection of utilities and QPVF [319]. The advantage of the addition of Section 210 interconnection authority to extend FERC interconnection authority is twofold. First, the ability of FERC to order interconnection may be interpreted with reference to the purpose of Section 210, which is to encourage the production of electricity from QSPPF. The express intent to encourage production from QPVF may tip the balance of competing interests in favor of interconnection, whereas the Section 202 interconnection authority is decidedly more neutral. Second, Section 210 does not contain the multiplicity of interconnection prerequisites contained in Section 202 [320]. Thus, Section 210 connection proceedings may be less time consuming, less expensive, and more accessible to QPVF users than Section 202 proceedings.

4.6.4.2 Rate Protection for PV Users

Aside from the implied interconnection authority, Section 210 promises to protect PV users from being charged excessive backup and buy-back rates by utilities. Although the act does not permit rates charged to QPVF users to discriminate against conventional utility customers, it is apparent from the previous discussion of rate discrimination that if the full benefits of PV use are taken into consideration, in some instances PV users could be charged less than conventional utility customers without undue preference or discrimination [321]. In addition, because FERC has authority to promulgate rules respecting the minimum reliability of QSPPF, utilities may be prohibited from assuming that QPVF will require reserve generation capacity equal to maximum QPVF output [322]. Rules respecting QPVF system reliability may justifiably require that QPVF be given credit for capacity they add to utility generation capacity if the existence of QPVF capacity credit is supported by reliable evidence.

Section 210 gives FERC broad authority to adopt rules that encourage utilities to give favorable rates to QPVF users. Although the primary responsibility for establishing QPVF rates will likely remain with the utility [323], it should not be overlooked that FERC has authority to exempt QPVF from state laws and regulations of rates. The extent to which the exercise of this preemption authority is necessary will depend on the compliance of states with FERC QPVF rate policies. The specific policies adopted by FERC will be contained in regulations to be promulgated later this year.

4.6.5 Summary of Legal Restrictions Affecting Utility PV Rate Policies

Advisory federal rate structure standards established in Section 111 of PURPA appear to give utilities considerable latitude to adopt rates that may not favor PV users. In addition, unfavorable PV rate policies approved by state public utility regulatory commissions may be immune from the operation of antitrust laws. However, general principles derived from state statutes prohibiting utilities from adopting discriminatory policies imply that rates discouraging PV use may be unlawful, and rates promoting PV use may be justified by the increasing cost of electricity production. Finally, Section 210 of PURPA extends broad authority to FERC to encourage the generation of electricity by PV facilities.

4.7 THE IMPACT OF UTILITY RATE AND INTERCONNECTION POLICIES ON MYPP LANDMARKS

The fundamental MYPP landmark is to reduce PV system costs to $1.60/W$_p$ so that electricity generated from residential and intermediate PV market applications will be cost competitive with electricity produced by utilities. The rate and interconnection policies of utilities heavily influence the achievement of this goal. For instance, the $1.60/Wp system cost may not include the cost of storage [324]. In addition, the 1986 projected system cost assumes that owners of 10-kW residential systems will be able to sell excess electricity produced from PV systems to a buyer willing to pay 50-100% of the current cost of grid power [325]. Therefore, if utilities do not adopt favorable rate and interconnection policies, it may be necessary for PV systems to include storage facilities. Residential systems may have to be scaled down if there are no ready and willing buyers for electricity generated by PV systems that is in excess of residential needs. Both the addition of storage cost and the inability to sell excess PV-generated electricity could substantially increase the $1.60/W$_p$ landmark price goal.

It is likely that most utilities will decide to connect PV systems to the electric grid. The failure of utilities to interconnect PV systems may violate antitrust laws, state statutory and common-law service extension requirements, and federal interconnection provisions such as those contained in Section 202 (and possibly Section 210) of PURPA. Each legal basis for challenging the utility interconnection decision may be sufficient to compel a reluctant utility to provide service interconnection for PV users. In addition, the denial of service to PV users is a conspicuous policy that courts may consider to be more unreasonable than unobtrusive rate policies that also discourage PV system use.

It is likely that if utilities intend to discourage the use of PV systems, they will adopt rate policies that impair the cost competitiveness of PV system prices. Utilities are afforded considerable latitude by Section 111(d) to adopt unfavorable PV rates. It is possible that rate decisions approved by state public utility regulatory commissions will be exempt from the operation of antitrust laws. Further, it is possible that some state discrimination laws will not extend adequate protection to PV users. Therefore, it is imperative that all PV systems qualify for regulation under PURPA [326]. The provisions in Section 210 of PURPA could provide broad protection for PV users against the imposition of unfavorable rates charged by the utility. The timely achievement of the MYPP $1.60 price goal and the ultimate success of the $1.5 billion PV commercialization program are extremely dependent on the rules promulgated under Section 210, and regulation that genuinely encourages the commercialization of PV technologies.

SECTION 5.0

REFERENCES

1. For a technical discussion of the photovoltaic conversion process see Fan, J. C. C. "Solar Cells: Plugging into the Sun." 80 Technological Review. Aug./Sept. 1979 at 2,10; Merrigan, J. A. Sunlight to Electricity: Prospects for Solar Energy Conversion by Photovoltaics. 1975 at 30, 54.

2. Solar cells composed of silicon have been a reliable energy source for satellites. See Solar Photovoltaic Energy: Hearings Before the Subcomm. on Energy of the Comm. on Science and Astronauts, 93rd Cong., 2d Sess. 12, 15 (1974) (Statements of Dr. Joseph J. Loferski).

3. Current land-based uses of photovoltaic energy include pipeline and oil well corrosion protection, microwave telecommunication relays, and small electricity generation stations. See Costello, D. Photovoltaic Venture Analysis/Final Report. July 1978, for a thorough discussion of current and projected photovoltaic markets (hereinafter cited as The Venture Analysis).

4. Other legal areas not addressed in this report that may impact on the widespread commercialization of PV technologies include: adverse environmental consequences associated with PV manufacture, installation, and use, see Energy Research and Development Administration. Solar Program Assessment. Mar. 1977; Gandel, M.; Dillard, P. Assessment of Large-Scale Photovoltaic Materials Production. Prepared for the Environmental Protection Agency, Aug. 1977; Neff, T. Social Cost Actors and the Development of the Photovoltaics Energy Systems. MIT Energy Lab, May 1978; United States Department of Energy. Environmental Readiness Document: Photovoltaics 1977; financial and tax incentives for PV market development, see Venture Analysis (note 3 infra); the Energy Tax Act of 1978, Pub. L. No. 95-1324, §§ 101, 301 (1978); the Small Business Energy Loan Act, Pub. L. No. 95-315 (1978); government patent procedures relating to PV research and development; legal issues affecting proposed solar satellites; the constitutionality of exclusionary solar zoning or solar easement agreements restricting construction or habitation in stipulated areas; product and tort liability consequences for PV manufacturers and users; insurance liability for PV system use and ownership; the effect of labor laws on PV industry employees; and a host of legal issues that will become evident as PV use becomes more prominent. For an analysis of some of these issues discussed with reference to solar heating and cooling technologies see The Environmental Law Institute. "Legal Barriers to Solar Heating and Cooling of Buildings." Mar. 1978; Wallenstein, A. Barriers and Incentives to Solar Energy Development/An Analysis of Legal and Institutional Issues in the Northeast, Dec. 1978; Chew, R. Solar Law/A Manual for Practitioners/Active Applications. May 1979 (Draft); Kramer, S. Solar Law 1978.

5. These legal issues are analyzed in Section 3.0.

6. The word "grid" refers to the network of generation facilities and transmission lines that enable utility customers to receive electric power.

7. The legal obligations of a utility to provide adequate service and nondiscriminatory rates to PV users are discussed in Section 4.0.

8. Office of the Assistant Secretary for Energy Technology, U.S. Department of Energy. Photovoltaics Program Multi-Year Plan. Order of 3 May 79. For a discussion of photovoltaic market objectives see Section 2.0.

9. Other materials that are currently in the process of research and development for use in solar cells include: gallium arsenide, which yields potential conversion efficiencies of 26% compared to 22% for silicon, Fan, J. C. C. "Solar Cells: Plugging into the Sun." 80 Technological Review. Aug./Sept. 1978 at 32; cadmium sulfide—cuprous sulfide, which absorbs light at short distances and allows cells to be considerably thinner than silicon cells, Merrigan, J. A. Sunlight to Electricity: Prospects for Solar Energy Conversion by Photovoltaics. 1975 at 66-75; and indium phosphorous, gallium phosphorous, and cadmium felluride, which may improve efficiencies and power stabilities at higher temperatures than silicon cells. Id. at 75-79.

10. Discussion with Steve Nagy, PV Materials Research Analyst, Solar Energy Research Institute, 11 June 79.

11. Solar Energy Research Institute. Annual Review of Solar Energy. Nov. 1978 at 97.

12. Id. at 97. A "field" consists of one or more arrays that provide power for PV systems.

13. The major limitation on installation and expansion of PV systems is the availability of land receiving unobstructed sunlight.

14. The yearly average incidence of solar energy on the contiguous United States is 2000 times greater than the total energy supply used to generate this year's consumption of electricity. This statistic was derived from calculations by J. Merrigan, J. A. Sunlight to Electricity: Prospects for Solar Energy Conversion by Photovoltaics. 1975 at 22.

15. A watt (W) is a measure of electric power. It is equal to the product of voltage and current. A kilowatt (kW) equals 1 thousand watts, a megawatt (MW) equals 1 million watts, and a gigawatt (GW) equals 1 billion watts. Most homes require 1-10 kW, while the largest nuclear power plants can generate 1 GW of electricity.

    Electrical energy is measured in watt/time units. A kWh is therefore equal to 1000-W electricity for one hour of time.

16. Photovoltaic electricity generation cost approximately $2000 per peak watt ($W_p$) during the initial years of the space program. Miskell, J. "Other Energy Sources: Solar, Geothermal, Tidal, Wind, Etc." Proceedings for Energy Magazines First Annual International Conference on Energy. Energy: Myths and Realities. 1979 at 170. Current solar cell prices range from $10.00 to $24.00/$W_p$ (1978 dollars) Venture Analysis, Vol. 1 at 3. The cost of balance of system (BOS) components is at least equal to the current cost of solar cells. Id. at 107. (For discussion of BOS components, see the text accompaning notes 17 and 18.) The technology is now available to produce solar cells at $2.00/$W_p$. (1975 dollars, $2.60, 1980 dollars.); Massachusetts Institute of Technology. Residential Value of Photovoltaics in Energy Laboratory. April-June 1978 at 1. If PV electricity is to be cost competitive with electricity generated by utilities, total PV system costs could not exceed $.45/$W_p$ in Omaha or $1.25/$W_p$ in Phoenix. Id. at 1. The Department of Energy hopes to penetrate residential and intermediate markets for electricity in 1986. Photovoltaic system costs in 1986 are projected to be $1.60/$W_p$ and $.70/$W_p$ for collectors. Office of the Assistant Secretary for Energy Technology, U.S. Department of Energy. Photovoltaics Multi-Year Program Plan. Draft of 7 May 79. (Hereinafter cited as MYPP.)

17. Venture Analysis, Vol. 1, at 106. Balance of system components often include DC/AC converters, storage batteries, voltage regulation equipment, wiring, and PV system supports. Id. at 106-115.

18. Id. at 107. Hein, G. F.; Cusick, J. P.; Poley, W. A. "Impact of Balance-of-System (BOS) Costs on Photovoltaic Power Systems." Presented at IEEE Photovoltaic Specialists Conference. Washington, DC; June 1978.

19. See note 16.

20. The Photovoltaic Energy Research, Development and Demonstration Act of 1978, Pub. L. No. 95-590, § 13 (1978); Department of Energy Authorization Act of 1978, Pub. L. No. 95-315, § 208 (1978); National Energy Conservation Policy Act, Pub. L. No. 95-017, § 569 (1978).

21. During hearings on the Photovoltaic Energy Research Development and Demonstration Act of 1978, Senator Gary Hart of Colorado testified that homeowners experienced a 68% increase in the cost of electricity from 1973-78. Hearings on the Solar Photovoltaic Energy Research Development and Demonstration Act of 1978 before the Subcomm. on Energy Research of the Senate Comm. on Energy and Natural Resources; 95th Cong., 2d Sess. 41 (1978).

22. See Hearings on Oversight Photovoltaic Energy Conversion before the Subcomm. on Advanced Energy Technologies and Energy Conversions Research, Development and Demonstration of the House Comm. on Science and Technology, 95th Cong., 155 Sess. (1977); Hearings on the Solar Photovoltaic Energy Research, Development, and Demonstration Act of 1978 before the Subcomm. on Energy Research of the Senate Comm. on Energy and Natural Resources, 95th Cong., 2d Sess. (1978); Hearings on Solar Photovoltaic Energy Research, Development, and Demonstration Act of 1978 before the Subcomm. on Advanced Energy Technologies and Energy Conservation Research, Development and Demonstration of the House Comm. on Science and Technology, 95th Cong., 2d Sess. (1978).

23. "The total 1977 world production of PV cells (was) about 750 peak kilowatts." Assistant Secretary for Energy Technology, Division of Solar Technology, U.S. Department of Energy, National Photovoltaics Program Plan, 3 Feb. 1978. (Peter Thomson of the Solar Energy Research Institute estimates the world market for PVs to be one peak MW in 1979. Information received during June 14 meeting. See note 3.) See also MYPP at 1-17. Total electrical demand for the United States in 1978 was about 2.2 trillion kWh. Thompson, W. "Preparing for the Future in Electric Power." Public Utilities Fortnightly. 19 Apr. 1979, at 19. With a maximum commercialization effort, PV systems could provide approximately 1% of U.S. electricity by the year 2000. Total oil displacement over the 30-yr life from PV system capacity installed in 2000 would equal 160 million bl. See MYPP at 2-7.

24. See Costello, D. Venture Analysis at 66-71. A tenfold price reduction is necessary to make PV systems cost-competitive with grid power. See PMPP at 1-17.

25. Id. at 8.

26. The efficiency of a cell is equal to the ratio of incoming sunlight to electricity produced by the cell.

27. Concentrators increase the amount of light that reflects on a solar cell. The use of concentrators promises to decrease commercial solar cell costs because fewer cells are required to produce electricity from equal amounts of sunlight. For a discussion of concentrator cell technology, see Hearings on Oversight on Photovoltaic Energy Conversion before the Subcomm. on Advanced Energy Technologies and Energy Conservation Research, Development, and Demonstration of the House Comm. on Science and Technology, 95th Cong., 1st Sess. (Statement of James F. Gibbons, Stanford University) (9 Sept. 1977); Assistant Secretary for Energy Technology,

Division of Solar Technology, U.S. Department of Energy National Photovoltaic Program Plan, 3 Feb. 1978, at 4; Ralph, E. L. Solar Energy. 1966 at 67.

28. It is estimated that solar cell costs of $2/W$_p$ (1975 dollars) can be achieved through automation of solar silicon cell manufacturing procedures, Venture Analysis at 92.

29. Assistant Secretary for Energy Technology, Division of Solar Technology, U.S. Department of Energy National Photovoltaic Program Plan. 3 Feb. 1978 at 1.

30. Venture Analysis at 69.

31. Id. at 59-65 for an elaboration of PV manufacturer market risks.

32. The market for photovoltaic power is highly dependent on the cost of alternative sources of electricity. For instance, a threefold increase in the price of electricity by the year 2000 could dramatically increase the cost-effectiveness of photovoltaic power. Id. at 183.

33. Hearings on the Solar Photovoltaic Energy Research, Development, and Demonstration Act of 1978 before the Subcomm. on Energy Research of the Senate Comm. on Energy and Natural Resources; 2d Sess. 42 (Statement of Senator Gary Hart, Colorado). (Hereinafter cited as Senate PV RD&D Hearings); See also The Photovoltaics Energy Research, Development, and Demonstration Act of 1978, Pub. L. No. 95-590, § 2b. (Hereinafter cited as PV RD&D Act of 1978.)

34. Hearings on the Solar Photovoltaic Energy Research, Development, and Demonstration Act of 1978 before the Subcomm. on Advanced Energy Technologies and Energy Conservation Research, Development, and Demonstration of the House Comm. on Science and Technology, 95th Cong., 2nd Sess. 37-38, 46-56. Statement of Peter Zambas, ARCO Solar. (Hereinafter cited as House PV RD&D Hearings.)

35. Senate PV RD&D Hearings 68-9 (Statement of Peter Zambas, ARCO Solar); House PV RD&D Hearings 126 (Joseph Lindmayer, Solarex Corp.).

36. Hearings on Oversight on Photovoltaic Energy Conversion before the Subcomm. on Advanced Energy Technologies and Energy Conservation Research, Development and Demonstration of the House Comm. on Science and Technology, 95th Cong., 1st Sess. 7 (Statement of Dr. H. Marvin, ERDA) (1977); House PV RD&D Hearings 23 (Statement of John Day, Gnostic Concepts, Inc.).

37. Senate PV RD&D Hearings 60 (Statement of Dennis Costello); Venture Analysis at 8.

38. House PV RD&D Hearings at 24 (Statement of John Day, Gnostic Concepts, Inc.); Senate PV RD&D Hearings at 6869 (Statement of Peter Zambas, ARCO Solar Inc.).

39. See Venture Analysis at 59-65, 69. Testimony on the Results of the PV Venture Analysis was received by the Senate Subcomm. on Energy Research and Development, 19 Sept. 1978. The Final Venture Analysis Report was published four months prior to the passage of the PV RD&D Act of 1978.

40. Senate PV RD&D Hearings 64-67 (Statement of William L. Hittinger, RCA Corp.); House PV RD&D Hearings 128-188 (Statements of Dr. Joseph Lindmayer, Solarex Corp. and Standford R. Oushinsky, Energy Conservation Devices).

41. See Venture Analysis at 5-10.

42. Pub. L. No. 95-590.

43. Id. §§ 2a (21), 4.

44. Id. § 2b.

45. Id. § 5A.

46. Id. § 6.

47. Id. § 7.

48. Id. § 10.

49. Id. § 11. The act also establishes a Solar Photovoltaic Energy Advisory Committee, § 9, and measures to protect and encourage small businesses, § 12.

50. Id. § 4.

51. See note 8 supra.

52. Id. at 1.

53. Advanced Research and Development (AR&D). Id. at 2-9 through 2-11. Many candidate cell materials and concepts promise to perform at superior conversion efficiencies and yield low-cost methods of production. Cadmium sulfide, polycrystalline silicon, amorphous silicon, gallium arsenide, advanced thin film technologies, advanced concentrator technologies, and electrochemical cells are examples of advanced cell materials and concepts. Id. at 2-8, 2-9. However, additional reliability information and performance improvements are necessary to satisfactorily achieve solar cell performance potential. The AR&D subprogram will experiment with these technologies until they reach technical feasibility (TF), the subprogram milestone. A product of AR&D reaches TF when: "(a) stable and reproducible performance characteristics have been achieved; (b) a laboratory scale process has been defined that yields products with consistent characteristics, and (c) mass production is likely to yield a technically and economically viable product after suitable technology development." Id. at 1-6.

    Technology Development (TD). Id. at 2-11 through 2-15. Once the TF of solar cells or BOS components is demonstrated, they are a proper subject matter for the technology development (TD) subprogram. Several PV system components are being studied in this subprogram. Flat-plate silicon collectors, concentrators, numerous BOS components, and hybrid systems (which produce both electrical and thermal energy) are examples of TD technologies. Id. at 2-11 through 2-15. The essential purpose of the subprogram is to demonstrate manufacturing processes that hold the potential for economical and reliable PV system components. The TD program milestone is technical readiness of components (TR). "The accomplishments of TR requires a successful subscale demonstration of production processes that would yield economically competitive and reliable products if produced to sufficient quantities, and the availability of production prototypes for further analysis." Id. at 1-6.

    Systems Engineering and Standards (SES). Id. at 2-16 through 2-19. The focus of this subprogram is to develop practical and economical PV system designs by combining the optimum mix of BOS components and solar array technologies. Once optimum PV systems are created, performance criteria and test standards will be developed in controlled environments to measure system operation characteristics. System feasibility, the SES milestone, is achieved "when a photovoltaic system is first carried through design, installation, and operation in an actual user environment." Id. at 1-6.

    Tests and Applications (T&A). Id. at 2-19 through 2-23. The modularity of PV cells permits their application in a variety of end-use environments. The T&A

subprogram will direct a carefully selected series of experiments in remote, residential, industrial, and central station applications. Two classes of tests will be performed. Initial system evaluation experiments (ISEE) will be used to evaluate PV system performance characteristics, collect information on legal and institutional issues, and assess the utility of various system engineering designs. System Readiness Experiments (SRE) will be performed to achieve the same objectives but will use only ISEE approved systems and TR components. The T&A goal of "System Readiness is accomplished when fully integrated systems, using available technology Ready Components or prototypes are designed, built and successfully operated in an actual user environment." Id. at 1-6.

Commercialization and Industrialization (Comm). Id. at 2-23 through 2-26. Most PV systems will not be ready for commercialization until the mid- 1980s. Until that time, the Comm. subprogram will have two major tasks: (1) to implement near or intermediate market projects including those authorized in the Federal Photovoltaics Utilization Program (FPUP), and (2) to perform market studies to facilitate the creation of PV system commercialization strategies. The Federal Photovoltaics Utilization Program (FPUP) is one of a series of energy programs passed in 1978 as the National Energy Act. FPUP authorizes the expenditure of $12 million in fiscal year (October to October) 79, 80, and 81 for the demonstration of PV energy systems in federal facilities. National Energy Conservation Policy Act, Pub. L. No. 95-617, § 569 (1978). The Comm. subprogram milestone: commercial readiness of components and systems (CR) is achieved when products or systems are offered for sale, at a given price. Commercial readiness demonstration projects (CRDP) will be conducted once CR is established for a given system. MYPP at 1-6. The completion of CRDA conclusively establishes the completion of PV program goals.

Planning Assessment and Integration (PA&I). Id. at 2-26 through 2-29. The subprogram devoted to program mission analysis and subprogram coordination and oversight is planning assessment and integration. The PA&I subprogram goal is to enhance the competition of program goals and complete the following projects: environmental assessment of PV manufacture and system application; economic analysis of PV market suppliers and consumers; and legal and institutional policy studies of issues affecting the accomplishment of program objectives.

54. All landmarks are taken from the landmark table located at the end of Chapter 1 in MYPP.

55. Id. at 1-15.

56. For a list of remote PV cell applications, see note 2.

57. W_p is the abbreviation for "peak watt." This term represents the greatest demand for electric power (watts) for a given period of time (hours). A peak watt can be used to measure the maximum demand for energy on a given power system at any point in time.

58. Id. at 1-11.

59. Key international and remote market landmarks are:
    1. FY80: Congressional report on international activities, quantity goals, and commercialization (Nov. 1979).
    2. FY80: decision on further international and remote efforts and complete appropriate plans.

    Key mid-term market landmarks are:

1. FY80: technology readiness \$2.80/W_p array cost.
2. FY80: decision on purchase mechanisms to establish commercial readiness for \$6-13 Wp systems and \$2.80/W_p array cost.
3. FY82: commercial readiness for \$6-13 W_p systems and \$2.80/W_p array cost for mid-term markets (provisional—depends on FY80 decision).

60. Id. at 1-1.

61. For a comparison of grid power and PV system rates projected in 1986, see id. at 2-5.

62. The price estimates are based on several key assumptions:

		Residential	Intermediate
(1)	system site (DC)	10 kW_p	10 kW_p-5 mW_p
(2)	sell-back amount	48	0
(3)	sell-back rate	50%	NA
(4)	system life (years)	30	30

For a complete list of price assumptions, see id. at D4.

63. Id. at 1-2.

64. Key residential and intermediate market landmarks are:
1. FY82: technical readiness—arrays and BOS for residential and intermediate applications including \$.70/W_p array cost.
2. FY82: go, no-go decision for residential and intermediate system readiness experiments.
3. FY83: initiate commercialization activities to establish residential and intermediate commercial readiness.
4. FY84: system readiness \$1.60/W_p residential and intermediate system.
5. FY85: go, no-go for residential and intermediate commercialization readiness demonstration project.
6. FY86: commercial readiness residential and intermediate systems.

65. Id. at 2-21.

66. Id. at 2-4, 2-5.

67. Key central station market landmarks are:
1. FY82: technical feasibility (TF)—advanced cell technology with \$0.15-0.40/W_p potential.
2. FY83: TR—2nd advanced cell technology with \$0.15-0.40/W_p potential.
3. FY85: TF—3rd advanced cell technology with \$0.15-0.40/W_p potential.
4. FY86: TF—4th advanced cell technology with \$0.15-0.40/W_p potential.
5. FY86: technical readiness—collectors for central stations (CS).
6. FY87: initiated commercialization activities to establish CS commercial readiness.
7. FY87: technology readiness—BOS components for CS.
8. FY88: go, no-go for CS CRDPS.
9. FY89: system readiness—\$1.10-1.30/W_p CS systems.
10. FY90: commercial readiness—CS systems.

68. See Laitos, J.; Feuerstein, R. "Will Regulated Utilities Monopolize the Sun?" 56 Denver L.J. 31 (1979).

69. See Wallenstein, A. "Barriers and Incentives to Solar Energy Development" Dec. 1978; Environmental Law Institute. <u>Legal Barriers to Solar Heating and Cooling of Buildings</u>. Mar. 1978; Chew, R. <u>Solar Law/A Manual for Practitioners/Active</u>

Applications 1979, Draft. For a summary of books and articles written on these subjects see Seeley, D. Solar Energy Legal Bibliography. Mar. 1979.

70. The four MYPP markets are (1) remote and international, (2) mid-term, (3) residential and intermediate, and (4) central station. See Section 2.0 for a discussion of MYPP markets.

71. In England, the right of a landowner to enjoy fresh air and light is recognized by the common law "Doctrine of Ancient Lights." The Right to Light Act of 1959, 7&8 Eliz. 26.56. Noted in Zillman D.; Deeny, R. "Legal Aspects of Solar Energy Development." 25 Ariz. St. L.S. 35 N. 63 (1976). In the past century, most American courts have rejected the application of this doctrine. Fountainebleau Hotel Corp. v. Forty-Five Twenty-Five, Inc. is often cited to prove the erosion of the doctrine. 114 So. 2d. 357 (Fla. Ct. App., 1959). The court held that the Doctrine of Ancient Lights had been unanimously repudiated in this country and that absent an express authorization of this right by zoning ordinances of the city, a right to air and light would not be implied. Id. 357.

72. Adjacent landowners can enter into voluntary contractual agreements for the purpose of protecting access to sunlight. In effect, one person gives, trades, or sells another an interest in land. These agreements are often called solar easements. See Miller; Hayes; Thomson. Solar Access and Land Use: State of the Law. 1977 at 12. (Hereinafter cited as Solar Access and Land Use.)

73. Restrictive covenants are common land-use control techniques used by subdevelopers. Covenants are promises affecting the land usually incorporated by a subdeveloper in the deed for each subdivision. See Cribbit, J. Principles of the Law of Property. 349 (2d. ed. 1975).

74. The power to zone is derived from the police power of the state and is often delegated to local governments. See Village of Euclid v. Amber Realty Co., 272 U.S. 365 (1926). Building height, bulk, and use are often regulated by local ordinance. For a detailed discussion of solar zoning, see Hayes, G. Solar Access Law. May 1979 at 39-71.

75. Aerial photos taken of several communities at various hours of the day have indicated that the "vast majority of homes' roofs were free of shade during critical periods." Phillips, J. "Assessment of a Single-Family Residence of Solar Heating System in a Suburban Development Setting." Noted in Solar Access and Land Use at 3.

76. For a list of state solar access laws, see National Solar Heating and Cooling Information Center, State Solar Legislation (to July 1978). See also Solar Energy Research Institute; Solar L. Rep. July/Aug. 1979 at 454-91; Johnson, S. B. "State Approaches to Solar Legislation: A Survey." 1 Solar L. Rep. May/June 1979 at 111, 120.

77. See note 72 for a definition of solar easements.

78. In California, any person owning or in control of property is prohibited from placing any new vegetation or allowing vegetation to grow that would shade more than 10% of a solar collector surface from the hours of 10 a.m. to 2 p.m. Legislation discussed in Pollock, P. The Implementation of State Solar Incentives: Land Use Planning to Ensure Solar Access, Golden, CO, Mar. 1979, at Solar Energy Research Institute; Ch. 1154, 1978 Cal. Stats.; to be codified at Cal. Govt. Code § 66473-1, 66475.3.

79. The Sun Rights Act of 1976. H.R. 11677, 94th Cong., 2d. Sess.

80. See Jaffe, E. Protecting Solar Access, A Guide for Planners. 1978 at 107 for a discussion of solar zoning. See also Lamm, D. "Solar Access: The Federal Role." 1978 at 14-16 (unpublished) for a discussion of the advantages of solar planning. (Hereinafter cited as the Federal Solar Access Role.)

81. Solar space is air space that is transversed by sunlight.

82. The Federal Solar Access Role at 16.

83. Jet Propulsion Laboratory. Angelici, G. Solar Potential Inventory and Modeling. Draft, 1979, at Solar Energy Research Institute. (Hereinafter cited as The San Fernando Valley Study.)

84. Id. at 1.

85. On the average, only 5% of the total area within the residential subclass of the experiment was projected to be available for rooftop solar collectors. Id at 2.

86. Conventional SHAC systems are mounted in a fixed position and only utilize sunlight that falls directly on the collector, whereas concentrator PV systems can be designed to track the sun along both the north-south and east-west axis. House Hearings on Oversight on Photovoltaic Energy Conversion at 72.

87. Many states protect "Solar Energy Systems" from obstruction by making them the subject of the legislation. For instance, in Minnesota, a solar easement is defined as a right obtained for the purpose of "securing adequate exposure of a Solar Energy System." Ch. 786 § 21, 1978 Minn. Laws, Minn. Stats, § 116H (Supp. 1978).

88. See California Solar Rights Act of 1978. Ch. 1154, 1978 Cal. Stats; to be codified at Cal. Civ. Code § 801-801.5. (Solar easement only protects SHAC units.)

89. For a discussion of the applicability of National Energy legislation to photovoltaic systems, see Section 4.

90. In Illinois, restricted shading periods are between 9 a.m. and 3 p.m. from Sept. 22 through Mar. 22, from 8 a.m. to 4 p.m. between Mar. 21 and Sept. 21. Ch. 80-430, 1977; Ill. Laws; Ill. Ann. Stat. 96-112, § 7304; See also note 81.

91. It has been estimated that between 20% and 60% more power is available for conventional solar cells when tracking is used. James, L. W.; Moon, I. L. "Ga. As Concentrator Solar Cells." Presented at the 11th IEEE Photovoltaic Spec. Conf. Arizona (1975), cited in Mosher, D. M.; Boese, R. E.; Sourkup, R. J. "Technical Note: The Advantages of Sun Tracking of Plane Silicon Solar Cells." 19 Solar Energy 91 (Great Britain, 1977). Experimental results comparing the power output of a sun tracking solar cell with a stationary solar cell indicate that the tracking cell will produce 30% more electrical energy in the course of a relatively clear day than will the stationary cell. Id. at 96. At least 70% of the increased tracking solar cell output is achieved before 10:00 and after 2:00. Id. at 96. However, on cloudy days the output gain of tracking solar cells is greatly diminished. Id. at 96.

92. The attractiveness of remote markets stems from their isolation from structures or utility grids that could supply electricity more economically than PV systems.

93. The San Fernando Valley study found that 37% of available rooftop area in commercial subsections could support the use of photovoltaic energy systems.

94. It is possible to reduce the impact of easement costs by defining "solar energy system costs" to include the price of an easement, and taking an investment tax credit on total solar energy system costs. The solar easement might then be afforded in investment tax credit. Unfortunately, federal tax laws provide that only tangible

property qualifies for the credit. Easements, which are intangible, are therefore not likely to qualify for this tax advantage.

95. See Hayes, G. Solar Access Law. 1979.

96. For a discussion of the general value of product standards, see Bottaro, D. J. "The Purpose and Role of Product Standards in the Commercialization of New Energy Technologies." Oct. 1978 (working paper, MIT Energy Laboratory Report).

97. For a discussion of the several different kinds of standards and national agencies that promulgate standards, see Riley, J.; Odland, R.; Barker, H. Standard Building Codes and Certification for Solar Energy Applications. Golden, CO: Solar Energy Research Institute; Aug. 1979.

98. The Photovoltaic Program Multi-Year Plan projects that some grid-connected PV systems may be commercially ready by the mid-1980s. See Section 2.0 for a discussion of mid-term, residential, and intermediate markets.

99. This problem also threatens to impede the development of the solar heating and cooling industry. See Hearings on Consumer Protection Issues in the Development of Solar Energy Before the Subcomm. on Oversight and p. 11-99 of the House Comm. on Interstate and Foreign Commerce, 95th Cong., 2d. Sess. 5,6 (Statement by a Representative of the Solar Energy Industries Association) (1978).

100. See DeBlasio, R. "SERI/DOE Quality Assurance and Standards Program." Unpublished. Golden, CO: SERI; Mar. 1979.

101. Most of the work performed on the development of PV performance standards is authorized by Section 7 of the PV RD&D Act of 1978. Needless to say, it is important that funds continue to be appropriated for this very important commercialization task.

102. For a discussion of the impact of model building code provisions on solar heating and cooling systems, see The Environmental Law Institute. Legal Barriers to Solar Heating and Cooling of Buildings. Mar. 1978 at 49, 75. (Hereinafter cited as ELI Legal Barriers Review); see also Wallenstein, A. Barriers and Incentives to Solar Energy Development—An Analysis of Legal and Institutional Issues in the Northeast. 1978 at 75.

103. Model regulations for PV systems may eventually be amalgamated into the National Electrical Code, published by the National Fire Protection Association. 1978. This code is the basis for most local codes and is approved by the American National Testing Institute. Id. at 1. (Hereinafter cited as the National Electrical Code.)

104. See American Sign Corp. v. Fowler, 276 S.W. 2d. 651, 652 (Ky. Ct. App. 1955) "building code statutes are designed to promote public safety, health and welfare." Id. at 52; Walker v. State, 262 F. Supp. 102 (W.D.N.C. 1966), aff'd 372 F. 2d. 129 (4th Cir.) cert. denied 388 U.S. 917 (1969).

105. The following states have enacted mandatory state-wide building codes: Alaska, Connecticut, Idaho, Indiana, Michigan, Minnesota, Montana, New Jersey, New Mexico, Oregon, Virginia, and Washington. Each statewide code is an enactment of one of the model codes discussed in the previous text.

106. Sixty-three percent of 919 cities with building codes reported that they had enacted one of the three model codes. Field, C.; Revkin, S. The Building Code Burden. 6, 1975.

107. Performance standards are regulations that require structures or materials to yield acceptable responses when exposed to a given stimulus. For instance, it might be required that all building walls in a given structure be able to withstand a given level of stress. Prescriptive standards, on the other hand, regulate the kinds of materials that may be used in a given structure and how the materials should be utilized. For example, a building code might require that all walls in a given structure be composed of brick, cement, or other such material. The actual material, not the material performance, is regulated by the code. Material standards are generally easier to administer and less easily adaptable to code alternatives than performance standards.

108. In this subsection, the phrase "building elements" is used interchangeably with the phrase "building components and structure."

109. Building officials may determine on a case-by-case basis any additional requirements essential for structural, fire, or sanitary safety not covered by the code. Building officials and code administrators, Basic Building Code, § 101.3 (1975). While an appeal board determines the adequacy of alternative building elements under the Uniform Building Code (§ 204), the building official may approve unregulated building elements if sufficient proof of their compliance with related code section is demonstrated by the building element proponent. International Conference of Building Officials, The Uniform Building Code, § 106 (1976). Section 103.5 of the Standard Building Code authorizes the building official to set health and safety requirements not mentioned in the code (1976 edition). Of course, building officials' determinations are subject to judicial review. See Coffee City v. Flowson 535 S.W. 2d. 758 (Tex. Civ. App. 1976), where the court overturned the decision of a building official because the decision was based on a broad delegation of authority to the building official that did not place any restrictions on his permit decision.

110. See Basic Building Code, § 100.6. Building officials must consider nationally recognized technical or scientific authorities when promulgating regulations for new building materials. Id. at § 201.0.

111. See ELI Legal Barriers Review at 52-62.

112. However, provisions for conventional generators can be found in the National Electrical Code at Art. 445.

113. See the National Electrical Code.

114. See Laitos, J.; Feuerstein, R. Regulated Utilities and Solar Energy: A Legal-Economic Analysis of the Major Issues Affecting the Solar Commercialization Effort 57 (June 1979), SERI/TR-62-255, for a discussion of utility rate disincentives for solar system users.

115. MYPP at Appendix D-2.

116. Central Solar Energy Research Corporation. Photovoltaic Systems, Aug. 1978 (Internal Report).

117. There also may be some adverse health effects that occur when certain protective array coverings or cell materials such as gallium-arsenide are combusted at residential or industrial sites. Building officials may withhold installation permits for grid-connected PV systems until their fire safety is well documented or fire code regulations are promulgated.

118. See ELI Legal Barriers Review at 52, 59.

119. The various code groups should work towards establishing minimum testing requirements to lessen potential testing costs and market barriers.

120. Standard Building Code, § 402.2(a).

121. Uniform Building Code, § 3601(b).

122. Basic Building Code, § 311.2.

123. If subsequent environmental analysis of solar cells or their protective covering reveals adverse operational consequences of these materials, building codes may require the use of more costly substitute materials.

124. DeBlasio, R. "SERI/DOE Quality Assurance and Standards Program." Unpublished. Golden, CO: SERI; Mar. 1979.

125. Discussion with DeBlasio, R. Project Manager of the SERI Photovoltaic Quality and Standards Assurance Program, 30 July 79; Id. at 6.

126. With the advent of consumer protection laws, the potential harshness of this legal tradition has been greatly reduced. One judge has commented that "caveat emptor is an unadmirable relic from common law and is a doctrine that exalts deceit, condemns fair dealing, and scorns the credulous." Beavers v. Lamplighters Realty, Inc., 556 P. 2d. 1328, 1331 (Okl. App., 1976).

127. For a discussion of financial institutional perceptions of solar heating and cooling systems, see Barrett, D.; Epstein, P.; Harr, C. Financing the Solar Home. 1977.

128. A warranty for the sale of personal property may be defined as a statement or representation made by the seller of goods, . . . as part of a contract of sale . . . having reference to the character of the goods, by which the seller promises or undertakes that certain facts are or shall be as he represents them. Black, H. C. Black's Law Dictionary. 1958 (11th ed., 1978).

129. The Magnuson-Moss Warranty/Federal Trade Commission Improvement Act 15 U.S.C.A. § 2301 (1978).

130. Id. at § 2702A.

131. Id. at § 2302A. Some items that may be required by rule to be included in warranties are: identity of the party to whom the warranty is extended, identity of warrantors, explanation of parts covered by the warranty, procedures for satisfaction of warranty conditions, and a statement of obligations and expenses the consumer must bear. Id. at § 2302A(1)-(13).

132. Id. at § 2303.

133. Id. at § 2304.

134. Id. at § 2303.

135. Id. at §§ 2308(a) and (b). The act also prohibits tie-in arrangements in which the validity of a warranty is conditioned on the use of certain products specified in the warranty, unless the commission finds a waiver is in the public interest. Id. at §§ 2302(c)(1) and (2).

136. Id. at § 2310. The act authorizes suits by the Attorney General and consumers, as well as settlement procedures.

137. Id. at §§ 2302-2305. Service contract provisions are also regulated in § 2306 of the act.

138. Id. at § 2301(1).

139. Homeowners Warranty Corp. and National Assn. of Home Builders-Advisory Opinions, § 110, Magnuson-Moss Warranty Act (17 Dec. 76).

140. Id. at 2.

141. The Commission comments that the key to understanding items covered by the act lies in the distinction between the physical separateness of an item and the separate function of an item. For example, both roofing shingles and furnaces may be physically separate items at a given point in time. However, physical separateness of an item is not determinative. Rather it is the separateness of function that distinguishes the two. A furnace has a "mechanical, thermal or electrical function," whereas roofing shingles have no separate function. Such items as humidifiers, burglar alarms, smoke detectors, water heaters, and kitchen applicances have separate functions of their own. However, such items as wiring, ducts, gutters, cabinets, doors and shower stalls are not functionally separate. Id.

142. The Magnuson-Moss Warranty Act at § 2301(1).

143. Solar Energy Products Warranty Act, Ch. 649, 1978 N.Y. Laws; to be codified at N.Y. Energy Laws §§ 12-101, 12-114 cited in Johnson, S. B. "State Approaches to Solar Legislation: A Survey." 1 Solar L. Rep. May/June 1979 at 55, 104.

144. State law is only preempted if it conflicts with written warranty provisions in the act. The Magnuson-Moss Warranty Act at § 2311.

145. Uniform Commercial Code (U.C.C.) § 1-101, note 1.

146. U.C.C. pocket part at 1. (1979).

147. U.C.C. § 2-314(1).

148. Id. at § 2-314(2)(10). In addition, merchantable goods must at least be such as (a) pass without objection in the trade under contract description, (b) are of fair average quality within the description, (c) run within variations permitted by agreement . . . , (d) are adequately contained, packaged, and labeled as the agreement may require, and (e) conform to the promises of affirmations of fact made on the container or label, if any. Id. at 2-314(2).

149. Id. at § 2-315.

150. Id. at § 2-316.

151. Id. at §§ 2-316 (3)(c) and (a).

152. Id. at § 2-316 (3)(b).

153. Id. at § 2-316 (2).

154. Id. Language to exclude all implied warranties of fitness is sufficient if it states, for example, that there are no warranties that extend beyond the description on the face hereof.

155. See Barriers and Incentives to Solar Energy Development at 35 for a list of northern states that have modified or eliminated § 316 of the U.C.C..

156. U.C.C. §2-313 (1).

157. Id. §2-313 (2). It is not necessary to use formal words such as warrant or guarantee to create an express warranty. Id.

158. Id. §2-105.

159. See Lakeside Bridge and Steel Co. v. Mountain State Cons. Co. Inc., 400 F. Supp. 273 (Washington, D.C.; 1975). (Structural materials purchased for a dam site are movable at the time of sale.)

160. A fixture constituting a permanent accession to real estate may not be goods under U.C.C. § 2-105. See Centennial Ins. Co. of New York v. Vic Tanny Intern of Toledo, Inc. 346 N.E. 2d. 330, 46 Ohio App. 2d. 139 (1975); Paul v. First Nat. Bank of Cincinnati, 369 N.E. 2d. 488 (1977).

161. It should be noted that purchasers of new homes are often protected by warranties offered by developers and private organizations. For example, the homeowners warranty corporation insures enrolled builders for a 10-yr warranty on houses they have built with approved standards .... (This program is administered in 44 states and is expected to expand.) Barriers and Incentives to Solar Energy Development at 37.

162. The Magnuson-Moss Warranty Act at § 2301(a).

163. Id. at § 2311.

164. Id. at § 2301. Most state-implied warranty determinations spring from interpretation of the Uniform Commercial Code. Some courts may imply warranty rights independent of the U.C.C. These state law determinations are controlling unless they conflict with the Magnuson-Moss written warranty provisions. Id. § 2311.

165. U.C.C. § 2-314(2)(b).

166. See Chew, R. Solar Law at 71, 72.

167. See Barriers and Incentives to Solar Energy Development at 36-7.

168. Sneff, W. "Federal Trade Commission Surveys Solar Warranties," 1 Solar L. Rep. July/Aug. 1979 at 271-73.

169. Id. at 273.

170. Hearings on Consumer Protection Issues in the Development of Solar Energy before the Subcomm. on Oversight and Investigations of the Comm. on Interstate and Foreign Commerce, 95th Cong., House 2d. Sess., 103 (Statement of Jack Meeker) (1978). (Hereinafter cited as House Hearings on SHAC Consumer Protection).

171. Id. at 105.

172. Id. at 106.

173. See generally, House Hearings on SHAC Consumer Protection (note 171).

174. Internal Report for Masel Study on Photovoltaic Systems. Aug. 1978 at Central Solar Energy Research Corporation.

175. Id at 12. The following organizations were questioned during the survey: Solorex Corporation; Solar Power Corporation; Mobil-Tyco Solar Energy Corporation; Motorola, Inc.; Sensor Technology, Inc.; RCA Laboratories; Bell Telephone Laboratories; IBM Corporation; Optical Counting Laboratory, Inc.; Dow Corning Corporation. Id. at 8.

176. Id. at 3.

177. Id. at 6.

178. Id. at 3.

179. Id. at 8.

180. Id. at 4.

181. Id. at 3.

182. There is conflicting evidence that warranties for solar equipment will increase manufacturing costs. See Hearings on Consumer Protection Issues in the Development before the Subcomm. on Oversight and Investigations of the House Comm. on Interstate and Foreign Commerce, 95th Cong., 2d. Sess. 101 (Testimony of Marvin M. Yarosh) (1978). Preliminary data on costs of HUD solar systems with warranties above what was required in the public sector demonstrates that the cost of warranties provided under the HUD program was not significant. Id. at 101.

183. See Product Standards Cripple the Solar Industry.

184. For a suggested program to assure warranty protection for solar system owners, see The House Consumer Protection Hearings at 305 (Solar Energy Domestic Policy Review Institutional Incentives and Barriers Panel) (1978).

185. See Dean and Miller. "Plugging Solar Power into the Utility Grid." 7 Environmental Law Rep. 50069, 70 (1977).

186. See note 33 and accompanying text.

187. The government hopes to decrease PV system costs by a factor of ten by 1986. See Section 2.0.

188. See The Venture analysis at 110 for a discussion of current storage costs for existing PV technologies, and MYPP at C-7 for a discussion of expected battery requirements for various future PV market applications; Office of Tech. Assessment, Application of Solar Tech. to Today's Energy Policy Needs 470 (June 1978).

189. Pub. L. No. 95-617, 92 Stat. 3117 (1978). See also, Conference Report: Public Utility Regulatory Policies Act of 1978, S. Rep. No. 95-1292, 95th Cong., 2d Sess. (1978).

190. Some utilities are characterized as summer peaking utilities because their customers have traditionally demanded the most peak power in the summer months. Other utilities tend to experience peak demands in the winter months. Knowledge of prior consumer energy demands enables utilities to make efficient arrangements for the use of generation facilities.

191. Utilities also maintain excess generating capacity as an operating reserve to guard against the possibility of generator malfunction. See Gainsville Util. Dept. v. Florida Power Corp., 402 U.S. 515, 517 (1960) for a discussion of the need to maintain excess capacity to prevent system failure from generator breakdown. Cited in Feuerstein. "Utility Rates and Solar Commercialization." 1 Solar L. Rep. 305, 312 Note 50 (1979).

192. Baseload generators are usually larger, more efficient generation facilities than peak load facilities. They also tend to use lower cost fuels. See id. at 312-313.

193. Load management techniques are electricity adjustment procedures used to reduce peak demand and operate generation facilities more efficiently.

194. Id. Several techniques are available that can effectively reduce utility peak demand. For instance, utilities can charge higher prices during periods of peak demand, enter into contracts giving the utility authority to terminate the service of certain customers during periods of peak demand, or make arrangements with other utilities to purchase electricity during high demand periods.

195. Efficient use of generation facilities may be disrupted because intermittent power demands by PV users may create the need for more peak load facilities that are capable of going on-line quickly.

196. See Chew, R. Solar Law, at 76, 77; Legal Barrier Review at 79-86; Dean and Miller. "Plugging Solar Power into the Utility Grid." 7 Env'l L. Rep. 50069 (1977).

197. One utility located in Georgia was able to limit its yearly peak demand simply by controlling the amount of energy that was supplied to air conditioners during a few crucial periods of peak demand. See Rodemann. "Load Management in Operation: A Consumer-Voluntary Program Pays for the System in One Hour." 1978. Presented at American Power Association Load Management Workshop, Colorado Springs, CO; 11 Dec. 78.

198. Electric Utility Systems Engineering Department. Requirements Assessment of Photovoltaic Power Plants in Electric Utility Systems. Electric Power Research Institute, June 1978.

199. Id. at 3, results based on probability estimates, not performance data.

200. Electric utilities usually are guaranteed a specific rate of return for capital invested in generating facilities. See Priest. Principles of Public Utility Regulation 139-227 (1969) for an extensive discussion of the utility rate base and the rate of return. Utility rate payers would not have to pay a similar rate of return to PV users.

201. Electric utility rates often contain three components: demand costs that vary with the energy consumption of the customer and include the cost required to finance electrical generation and transmission equipment; customer costs that reflect billing, metering, and other expenses associated with the collection of revenues for electricity consumption; and energy costs that vary with electricity consumption and reflect the cost of fuel used to generate electricity. An increase in any of these components will increase consumer electricity rates.

202. See Commonwealth Edison Co. 85 P.U.R. 3d 199, 201 (Ill. Commerce Commission, 1970) where provision was made in an electric rate order to require a company to make specific, substantial contributions to reduce environmental pollution caused by electrical generation facilities.

203. McGraw-Hill. "29th Annual Electric Industry Forecast." Electrical World. 15 Sept. 1978, at 61, 72.

204. Id. The 5-year average growth rate of peak demand between 1974 and 1978 was approximately 3.1%.

205. Reported in the recently released Domestic Policy Review cited in MYPP at 1-1.

206. It is probable that utilities in the southwest and western section of the United States will have more PV customers than the national average. PV penetration up to 5 years will not significantly affect utility operations.

207. See Gellhorn. Antitrust Law in a Nutshell. 1976 at 1.

208. Id.

209. For a good discussion of economic assumptions underlying antitrust laws, see id. at 41-III; Sullivan, Antitrust 1977 at 1-80.

210. The basic federal statutes prohibiting noncompetitive market activities are the Sherman Act 15 U.S.C. §§ 1,2 (1976); the Clayton Act 15 U.S.C. §§ 12-27 (1976); and the Federal Trade Commission Act 15 U.S.C.A. §§ 41-51 (1976).

211. But, see Priest. Principles of Public Utility Regulation. 1969 at 1-23 for a discussion of the need for monopoly regulation.

212. See Utility Users League v. F.P.C., 394 F. 2d 16 (7th Cir., 1968). The substitute for market competition is monopoly regulation.

213. Recent cases involving utility immunity from antitrust laws include: Cantor v. Detroit Edison Co., 428 U.S. 579 (1976); City of Lafayette v. Louisiana Power and Light Co., 98 S. Ct. 1123 (1978); Otter Tail Power Co. v. United States 410 U.S. 366 (1973).

214. The discussion that follows concerning the Sherman Act bears heavily on Gross. Impact of the Antitrust Laws on the Commercialization of Solar Heating and Cooling. Golden, CO: SERI;1979. (Hereinafter cited as SHAC Antitrust Review).

215. Section 2 of the Sherman Act provides that: Every person who shall monpolize, or attempt to monopolize, or combine or conspire with any other person or persons, to monopolize any part of the trade or commerce among the several States, or with foreign nations, shall be deemed guilty of a felony, and, on conviction thereof, shall be punished by fine not exceeding $1 million if a corporation, or, if any other person, $100 thousand, or by imprisonment not exceeding three years, or by both said punishments, in the discretion of the court.

216. See United States v. E.I. du Pont de Nemours & Co., 351 U.S. 377 (1956); United States v. Aluminum Co. of America, 148 F. 2d 416 (2nd Cir. 1945).

217. See United States v. Grinnel, 236 F. Supp. 244 (D.R.I. 1964).

218. "Cross-elasticity refers to the extent to which small changes in the current price of one product affect the demand for another product. If products are substitutes for each other they will display a positive cross-elasticity." SHAC Antitrust Review at 55, No. 129.

219. United States v. Grinnel, 236 F. Supp. 244 (D.R.I. 1964); United States v. Du Pont, 351 U.S. 377 (1956).

220. A few power consumers generate their own electricity through the use of windmills, small diesel generators, and a handful of other electric generation technologies.

221. See United States v. Du Pont, 351 U.S. 377 (1956).

222. Courts have found the existence of monopolies when one industry has accounted for 70% of product sales in a given market. See SHAC Antitrust Review.

223. See U.S. v. Otter Tail Power Co., 410 U.S. 366 (1973).

224. Some of these reasons include the fact that PV system use might adversely affect load management technologies, increase the need to build new generation facilities, or provide insufficient revenues to offset service costs. See § 4.1 (infra).

225. See, e.g., Puerto Rican American Tobacco Co. v. American Tobacco Co., 30 F. 234 (2d. Circuit), cert. denied 279 U.S. 878 (1929); Sullivan, Antitrust 135-6 (1977); SHAC Antitrust Review Act 34.

226. Almost every state has enacted legislation requiring utilities to furnish adequate and safe service to its customers. For example, the Illinois statute provides that "every public utility shall furnish, provide and maintain such service . . . , as shall promote the safety, health , conform and convince of its patrons . . . ." Ill. Rev. Stat. Ch. III 213 § 32 (1959) cited in Note, "Duty to Serve." 62 Colum. L. Rev. 312,

313 (1962) See also Hodel and Wendel. "The Duty and Responsibility of Oregon Public Agencies to Provide Adequate and Sufficient Electrical Utility Service". 54 Ore. L. Rev. 539 (1975); Dean and Miller. "Plugging Solar Power into the Utility Grid." 7 Environmental L. Rep. 50069; 50073 (1977). (Hereinafter cited as Plugging Solar Power into the Grid.)

227. Utilities are excused from service obligations for acts of God such as lightning, floods, and tornadoes, management controversies, supply shortages, and inadequate finances. Priest. "Principles of Public Utility Regulation." 237-244 (1969) (Hereinafter cited as Priest on Public Utilities).

228. Many of the legal principles stated in this section were derived from Note. "Duty to Serve." 62 Colum. L. Rev. 312 (1962).

229. See, e.g., I.C.C. v. Oregon-Washington R.R. and Navigation Co., 288 U.S. 14 (1973).

230. See Priest on Public Utilities at 236; Jordan Clarke-Washington Elec. Membership Corp., 262 Ala. 581, 80 So. 2d. 527 (1955).

231. See Note, "Duty to Serve." 62 Colum. L. Rev. 312, 316 (1962).

232. Id. at 317, Note 34.

233. Id. at 317; Mid-Monmouth Industrial Park v. Monmouth Consol. Water Co., No. 602-139, N.J. Bd. Pub. Util. Comm'ns, 30 June 60. See also Levitt v. Connecticut Pub. Util. Comm'n, 114 Conn. 628, 159 Atl. 878, 1932 C. 337 (1936). (Electric utility not required to build facilities for service extension simply because the construction would not affect its financial or rate structure.)

234. See Note, 62 Colum. L. Rev. at 318 Note 40.

235. See Note 230.

236. Photovoltaic users will tend to provide the utility less revenues than conventional utility customers because they do not consume and pay for as much electricity as conventional grid power users. Therefore, utilities may have even less of a financial incentive to interconnect remote PV rather than conventional customers. But, see preceding text notes 201-203.

237. See Priest on Public Utilities, at 236.

238. See New York ex. rel. Woodhaven Gas Light Co. v. Public Serv. Comm'n, 269 U.S. 244, 248 (1925) for a discussion of the dedication of property to a public use without just compensation.

239. See § 4.1.

240. See Note 233.

241. See Note, 62 Colum. L.R. at 317.

242. 54 P.U.R 3d. 210 (Cir. Ct., Dane County 1964).

243. Id. at 210.

244. Id. at 212.

245. It otherwise might be concluded that the smaller the demand for power occasioned by PV users is, the less severe the financial impact of PV use on utility operations and profitability will be.

246. See, e.g., General Telephone Company of Wisconsin v. Wisconsin Public Service Commission; 54 P.U.R. 3d. 210 (Cir. Ct., Dane County 1964). This conclusion assumed that the provision of power to PV systems will not affect utility solvency.

247. The refusal by a utility to connect PV systems with utility grids may also constitute an unlawful discrimination against PV users in favor of conventional utility users. See "Plugging Solar Power into the Grid," at 50017.

248. Pub. L. No. 95-617, 92 Stat. 3117 (1978). (Hereinafter cited as PURPA.)

249. Id. §2.

250. Id. §201 (definition). Regulation directly pertaining to SPPF is largely contained in §§202-212.

251. Id. at § 201, amending the Federal Power Act § 3 (17)(A)(i) and (ii).

252. Id. at § 201, amending the Federal Power Act § 3 (17)(C)(i) and (ii).

253. Department of Energy/Federal Energy Regulatory Commission. Proposed Regulations Providing for Qualification of Small Power Production and Cogeneration Facilities under § 201 of the Public Utility Regulatory Policies Act of 1978; 18 C.F.R. Part 292 (Docket No. RM79-54), 27 June 79.

254. PURPA § 202, amending the Federal Power Act § 210(A). This section also applies to qualifying cogeneration facilities defined in § 201 of PURPA.

255. PURPA § 202, amending the Federal Power Act § 210(B).

256. Id. at § 210(C).

257. Id. at § 210(D).

258. Id. at § 210(A)(2)(C)(1).

259. Id. at § 210(A)(2)(C)(2).

260. Id. § 204, amending the Federal Power Act § 212(A)(1). No reasonably ascertainable uncompensated economic loss may result to QSPPF if interconnection orders are to be granted.

261. Id. at § 212(A)(4).

262. Id. at § 212(B)(1).

263. It is possible that § 210 of PURPA will provide a basis by which PV users may seek interconnection with utilities. See § 4.6.4.1 infra.

264. See Note 202 for a brief discussion of the elements of utility rates.

265. For a listing of various rate structures, see Feuerstein, R. "Utility Rates and Solar Commercialization." 1 Solar L. Rep. 305, 325-334 (1979); "Plugging Solar Energy into the Grid," at 50073-77.

266. F.P.K. v. Hope Natural Gas Co., 320 U.S. 591, 603 (1944).

267. Feuerstein, R. "Utility Rates and Solar Commercialization." 1 Solar L. Rep. 301, 309 (1979). (Hereinafter cited as Utility Rates and Solar Comm.)

268. Id. at 329-330.

269. For a concise description of the impact of promotional rates on solar users, see "Plugging Solar Energy into the Grid," at 50073, 77.

270. The cost of producing energy varies with the time of use. Time-of-day and seasonal rates reflect this cost differential by charging customers more for energy that is more expensive for the utility to produce. Id. at 75.

271. Utility Rates and Solar Comm. at 334.

272. Garfield, P.; Lovejoy, P. Public Utility Economics. Englewood Cliffs, NJ: Prentice Hall; 1964 at 156; id. at 329.

273. PURPA at § 111(A). The act also requires utilities to consider federal load management technique standards. Id. at § 111(d)(c).

274. States may reject the Section 111 federal standards if they determine that implementation would not be appropriate. Id. at § 111(A).

275. Id. at § 123(d).

276. Id. at § 111(d)(5). The rate must reflect the cost of interruptible service to the class of which the consumer is a member.

277. Id. at § 111(d)(4).

278. Id. at § 111(d)(3). Cost-effectiveness of time-of-day rates is achieved if "the long-run benefits of such a rate to the electric utility are likely to exceed the metering costs and other costs associated with such use." Id. at § 115(b).

279. Id. at § 111(d)(2).

280. Id. at § 111(d)(1). See id. at 115D for an elaboration of cost of service rates, in § 111.

281. Telephone interview with Marilyn McAdams of PSCO's Medical Relations Department, 26 Apr. 79; cited in Utility Rates and Solar Comm. at 315.

282. PURPA § 111A.

283. Priest on Public Utilities at 31.

284. The analysis of Freeda and Turner, Antitrust Law (1978) at 57-133 bears heavily on the following discussion of state action immunity.

285. This fact permitted the Supreme Court in Parker v. Brown to exempt state action from the operation of antitrust law. 317 U.S. 341 (1943).

286. Id. at 351.

287. Id. at 368.

288. Parker was a suit brought in equity solely against a state official. Id. at 441.

289. Cantor v. Detroit Edison Co., 428 U.S. 579 (1976); Goldfarb v. Virginia State Bar, 421 U.S. 773 (1975); Bates v. State Bar of Arizona, 97 S. Ct. 2691 (1971); City of Lafayette v. Louisiana Power and Light Co., 98 S. Ct. 1123 (1978).

290. Goldfarb v. Virginia State Bar, 421 U.S. 773 (1978). (Supervision by the Virginia Supreme Court of minimum legal rate schedules was not adequate supervision justifying immunity from antitrust laws.) But, see Bates v. State Bar of Arizona, 97 S. Ct. 2691 (1971). (Active court supervision of advertising restriction was sufficient to remove concern that the anticompetitive activity was not receiving adequate supervision by a state agency.) See also Areeda and Turner. Antitrust Law. 1978 at 71-80.

291. See id. at 80-92; Cantor v. Detroit Edison Co. 429 U.S. 578 (1976) (Authorization of utility lightbulb program is not central to the fundamental state purpose of regulating a natural monopoly); City of Lafayette v. Louisiana Power and Light Co., 98 S. Ct. 1123 (1978). (Municipally owned utilities are exempt from the antitrust laws only if they are engaged in actions pursuant to state policy to displace competition through the regulation of monopoly public service.)

292. See Cantor v. Detroit Edison Corp., 428 U.S. 579 (1976).

293. See Areeda and Turner. Antitrust Law. at 75.

294. 428 U.S. 579 (1976).

295. Id. at 583.

296. Id at 598.

297. Id. at 597.

298. E.g., Standard Oil Co. of N.J. v. United States., 221 U.S. 1 (1911); U.S. v. American Tobacco Co., 221 U.S. 106 (1911).

299. See Lepevre v. FTC, 366 F. 2d. 117 (5th Cir. 1966).

300. See Priest on Public Utilities at 285-289.

301. The following principles of rate discrimination were presented by Dean and Miller, "Plugging Solar Power into the Utility Grid," 50069, 50071-72.

302. Id. at 50071.

303. Id.

304. Declining block rates charged to both classes of utility customers may disfavor PV users to a greater extent than conventional users.

305. Id. at 50072.

306. Id.

307. Id. at 50076, note 75.

308. Id.

309. See Section 4.6.1 for a discussion of promotional rates.

310. E.g., Utility Rates and Solar Comm. at 354.

311. PURPA § 210A. This section of the act also applies to qualifying cogenerators. See Section 4.6.4 for a discussion of QSPPF under PURPA.

312. Id. at § 210 A(b) and (2).

313. Id. at § 210A. However, such rules may not authorize a QSPPF to make any sale for purposes other than resale. Id. But see Conference Report: Public Utility Regulatory Policies Act of 1978, S. Rep. No. 95-1292, 95th Cong, 2d Sess. 97 (1978). The conferees intended that QSPPF be permitted to make retail sales pursuant to state law.

314. PURPA at §§ 210(b)(1), (b)(2), C(1), and (C)(2).

315. PURPA Conference Report at 98.

316. PURPA at § 210(b).

317. Id. at § 210(d). The PURPA Conference Report elaborates on the incremental rate that utilities may charge QPVF owners. It provides that the cost may be viewed over a longer period of time than the immediate period during which the electric power is purchased. The incremental rate may take into account any future energy savings created from prior purchases of QPVF generated electricity. At 98-9.

318. PURPA at § 210(e). However, QPVF with power production capacitites greater than 30 MW may not be exempted from such regulations. Id at § 210(e)(2).

319. See Department of Energy Federal Energy Regulatory Commissions, Staff Paper discussing "Commission Responsibilities to establish Rules Regarding Rates and Exemptions for Qualifying Cogeneration and Small Power Production Facilities" pursuant to § 210 of the Public Utility Regulatory Policies Act of 1978 (18 F.R. Part 292) (Docket No. RM 79-55) at 10-12. (Hereinafter cited as DOE staff paper discussing § 210 of PURPA).

320. See Section 4.4.

321. See Section 4.6.3.

322. See DOE staff paper discussing § 210 of PURPA at 20-22.

323. Id. at 4.

324. See MYPP at 2-15.

325. See Note 62 supra.

326. The Department of Energy (DOE) has proposed (see Note 253) that in order to qualify for regulation under § 210 of PURPA, PV systems must have a production capacity of at least 10 kW.