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A Division of Midwest Research Institute

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SITE SELECTION CONSIDERATIONS FOR LAND-BASED BIOMASS AND WIND ENERGY CONVERSION SYSTEMS (WECS) FROM A LEGAL VIEWPOINT

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FOREWORD

This paper on site selection considerations for land-based biomass and wind 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 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, Peter Hoffman, was a law student at the University of California at Los Angeles School of Law while he was participating in the Program. He is now a second-year student at the UCLA Law School. The Law Program is supervised by Jan G. Laitos, SERI Senior Legal Specialist.

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SUMMARY

This paper is a review of the legal problems that may be encountered in selecting a site for a wind energy conversion system (WECS) or a biomass facility. Because siting is a process that varies distinctly for different users, the siting process will be examined for three user categories: the utility, the industrial/commercial/large residential complex owner, and the homeowner/small farmer.

The size of WECS ranges from less than one kilowatt (kW) up to three megawatts (MW), the current largest WECS. Because the best wind regimes are high above the ground, WECS must be installed on towers that reach well above any other structure in the vicinity in order to obtain the most power from a given device. Individual WECS cannot be built on the huge scale of most utility power plants. Therefore, large-scale generation requires an array of WECS spaced in such a way as to avoid wind interference among the various machines.

Biomass plants are facilities designed to convert organic matter—trees, waste, manure, or crop residues—to useable energy forms. Largely because of the bulkiness of biomass, the facilities for converting biomass are limited in size. Storage, collection, and transportation problems restrict the size of a biomass plant to about 100 MW. Biomass can be burned directly to fire boilers and produce steam. This is the most promising use of biomass for the near future. Through fermentation or gasification, biomass materials can also be converted to liquid or gaseous fuels including alcohol, ethanol, or fuel oil. Methane can be produced from biomass by digestion.

Many laws influence the various processes involved in siting WECS and biomass. Siting is a diffuse term that covers any legal or institutional interaction or potential interaction that will influence the process of attempting to put a power plant on a given site.

Of the laws discussed, the most important are state and federal environmental acts and federal and local land-use acts. The environmental legislation of interest includes the National Environmental Policy Act (NEPA), the Clean Air Act, and the Clean Water Act. Each of these laws sets forth procedures or permit requirements that can affect either WECS or biomass. The federal land-use laws specify the character of activity that will be allowed on federal lands. They influence the granting of rights-of-way for transmission lines and WECS devices, as well as fuel collection techniques for trees and forestry residues.

Local land-use laws include zoning, building codes, and subdivision controls. These regulations will affect urban WECS and biomass users and may well preclude many WECS sitings altogether. Community support is the key to working within local land-use control. If local support for a project is obtained, local land-use regulations should be much more easily accommodated.

For large projects, particularly utility projects, NEPA is the most influential act in that it requires an evaluation of all the environmental consequences of the project if there is some form of federal action. For WECS, the environmental impacts are primarily aesthetic. Large WECS arrays also use significant quantities of land and, if situated near urban areas, can cause television interference. Biomass (wood chips, municipal solid waste or manure) is bulky and large areas must be used for storage. In large-scale operations, water pollution due to runoff of rain from these storage areas is possible. Air pollution control requirements, which differ according to the quality of the air in the

region in which the plant is being sited, will favor biomass utilization for sulfur emission because biomass is very low in sulfur. Particulate emission from direct combustion of biomass is a potential problem and the user may be required to use expensive particulate control equipment.

The medium-scale user could be the owner of either an industrial park, a commercial complex, or a large residential facility. Such an owner requires an interconnection with the local utility to satisfy his electrical needs when the demand of the complex exceeds the output of WECS or biomass generating systems. The rates this owner receives for the excess energy generated and the rate charged by the utility for the backup energy are important factors to be considered by a potential WECS or biomass user when evaluating the economics of the project.

If the medium-scale user's biomass facility is large enough to qualify as a major emitter and if the facility is to be located in an area that has not reached Environmental Protection Agency (EPA) ambient air quality levels, extensive particulate control equipment may be required by the Clean Air Act. Supply and storage requirements may preclude the siting of a biomass burning plant in an area that may not be receptive to storage piles of wood or combustible wastes or the frequent traffic of large trucks.

Zoning may restrict utilization of WECS in urban areas. Though the difficulties may be less pronounced for the medium-scale user than for the urban homeowner, the major obstacle for WECS siting in commercial or large residential districts is zoning. Height restrictions and setback requirements are the most conspicuous zoning limitations on WECS. The aesthetic appeal of WECS may also be an important factor. Aesthetic zoning is an accepted practice in many communities and even in the absence of a specific aesthetic zoning ordinance, local opposition on aesthetic grounds may induce zoning boards to interpret existing ordinances strictly against WECS utilization.

The homeowner in urban areas represents a direct contrast to the small farmer. Though both would be interested in similar size devices, the farmer's relative freedom from regulation, and the abundance of biomass, permit relatively unimpeded pursuit of energy self-sufficiency by using either WECS or biomass. The farmer essentially has no legal siting barriers to full exploitation of all available wind and biomass resources.

The homeowner, on the other hand, is faced with a host of regulations and institutional constraints. Zoning is again the most important consideration. The homeowner, even more than the medium-scale user, must have the support of his immediate neighbors in order to successfully site a WECS. Attempting to force WECS on neighborhoods could produce excessively stringent setback requirements that would effectively preclude any WECS installation. The major reason for such regulation is fear of unsafe devices. Cities and towns have a responsibility to promulgate regulations that protect neighborhoods from unnecessary risk. Due to a lack of standards designating specific WECS as safe and reliable, a cautious city council might establish setbacks that provide protection from the worst malfunction possible from a poorly constructed WECS. Such standards will preclude WECS siting in most urban areas.

Use of biomass by the homeowner is, for the most part, currently restricted to the wood burning stove. Fire codes, safety codes, and air pollution restrictions are current issues affecting the siting of wood-burning stoves.

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SECTION 1.0

INTRODUCTION

President Carter, in a recent energy speech [1], hinted rather strongly that a new procedure would be established for the siting of major energy facilities. He spoke pointedly about the need for increased electrical generation capacity and seemed to suggest that in building new plants to meet this need, environmental considerations might be sacrificed. This paper is based on the belief that where energy needs cannot be reduced by conservation, passive designs, or more appropriate use of specific energy forms, the techniques that are used to satisfy energy needs must be ecologically optimal. If an environmentally benign system is not practical, the chosen technology should be designed to address as many other-than-energy considerations as possible. The single-purpose, environmentally damaging energy plant should be built only as a last resort.

This report discusses the legal and institutional factors that influence the siting process for WECS and biomass (as a source of fuel and as a fuel itself for generating electricity). WECS have very few environmental impacts and therefore represent energy sources that are ecologically desirable. When biomass is burned directly, plant size and fuel supply limitations encourage cogeneration—the production of electricity and process steam in the same cycle. Through cogeneration, a much higher fuel efficiency is possible because the heat that would otherwise be waste heat is used productively. Biomass sources include municipal solid waste (MSW), sewage, woody industrial by-products, and any other organic material. Many such materials are wastes and their disposal causes environmental and logistic difficulties. By utilizing these forms of biomass for energy production, the waste disposal problems will be alleviated. Biomass therefore represents an efficient method of using available resources in such a way as to cater to energy needs and other nonenergy concerns.

An intelligent energy policy must begin with conservation practices. To the extent that conservation falls short of satisfying energy needs, first priority must be given to energy sources that do not damage the environment. WECS represent energy systems that are compatible with the environment. Second priority must be given to those energy sources that are efficient or that solve more than one societal problem. Biomass systems, as efficient and/or dual-purpose energy producers, represent this second priority category. Before President Carter's environmental compromises are allowed, these technologies and others that do not require the extreme compromise that a single-purpose plant might require should be fully utilized. Though fuels (gasoline, oil, or natural gas) produced from biomass are discussed in this report, the major thrust will be the siting of WECS and biomass facilities for generating electricity.

In 1976, the United States consumed 74.4 quads of energy [2]. Of this consumption, 21.4 quads [3] were used to generate 6.2 quads of end-user electrical energy [4]. Thus, the ultimate energy user consumed 59.2 quads, 6.2 of which were used in the form of electrical energy. This 6.2 quads represents 10.5% of the end-user energy demand.

This analysis highlights the relative weight of the current use of electricity as an energy form in the United States. Electricity represents approximately one-tenth of the U.S. end need. It is the potential WECS and biomass contributions to this one-tenth that is discussed in this report.

There are several reasons for concentrating on the electrical sector of the energy picture. Probably the most significant is the high energy cost of electricity. Although electricity supplies only 10% of the end-use energy demand, it requires almost 29% of the total energy consumption to generate that 10%. The difference represents 15.2 quads of lost energy.

Another reason to concentrate on the electrical side of the energy demand is the visibility and capital cost of electrical generation. A power plant costs hundreds of millions of dollars and takes years to build and license [5]. The utility investment in electrical generation is in excess of $200 billion [6]. This investment does not consider the environmental costs that such facilities impose on society, nor does it take into account the very real cost of depleting already scarce and nonrenewable resources.

There is no possibility that electrical demand will disappear even though more attention to appropriate and efficient end-use applications could reduce such demand [7]. Therefore, in recognizing a continuing need for electrical energy facilities, the best that can be hoped for is that in those situations that are conducive to benign or efficient methods of creating electricity, such methods will be used.

By the turn of the century, if President Carter's proposed 20% solar goal is realized, WECS could supply approximately 3.1 quads of energy [8], and biomass (generation and fuels) could provide another 5.7 quads [9]. Both technologies are currently being used to generate useful electricity in many places in the country. Both use renewable resources and afford significant environmental advantage over other electricity generating options.

Siting of an energy facility of any kind is a complicated process. There are essentially two parallel evaluations that must be performed, a technical site evaluation and a legal site evaluation. Discovery of insurmountable difficulties on either front will preclude locating the plant on a given site.

The question to be answered in the technical site evaluation is: "Will it work at this location?" [10] Technical siting involves many considerations that might seem obvious; there must be adequate wind for a WECS, and sufficient nearby fuel to supply a biomass plant. Other technical factors are less obvious, but depend on whether or not the site itself provides adequate resources and sufficiently favorable geographic characteristics to allow the facility to operate well.

The legal site evaluation deals with an analysis of those legal and institutional factors that influence the siting process in any way; either to encourage, delay, discourage, or forbid it. While technical siting is a fairly well-defined task, legal siting is a diffuse process that tends to include many areas that appear to be very loosely related. In this paper the siting question includes several threshold questions regarding the decision of whether to site a facility rather than where to site it. In particular, discussion will be included concerning the utility interaction with a cogenerator and the atmosphere that the regulatory agencies create for the small producer. Other threshold questions to be considered are the types of pollution control constraints that may frustrate the economics of the small producer and discourage him from proceeding with the project. Liability concerns are specifically excluded from this paper.

1.1 USER CATEGORIES

A particularly important variable in analyzing possible legal complications in siting any energy facility is the user of that facility. The user determines the general area (urban, rural, etc.) in which the plant will be located as well as the size of the plant. These two factors in particular will define the arena of legal confrontation (local, state, or federal) and the scope of institutional concern.

Because of the importance of the user, siting of WECS and biomass facilities will be examined in terms of three user categories—the utility, the industrial/large apartment complex owner, and the homeowner or small farmer. These user categories will be more fully defined in Section 2.0.

1.2 THE LAWS RELEVANT TO SITING

The initial sections deal with those laws—both federal and state—that influence the siting process either directly or on a threshold level. These discussions use the word "siting" in a very broad sense. Some laws may appear to affect the siting process only tangentially, but this tangential influence can have far-reaching impacts. One such influence is the effect of utility law on the siting process. Though there is no direct relationship, when fundamental decisions are being made about whether to site a facility at all or in which state this siting might be considered, the utility law can be a determinative factor. This paper examines the impact of such laws on this decision process. No effort will be made to formulate a comprehensive discussion of any aspect of the law that does not have either a direct or a threshold bearing on the siting process.

1.3 PAPER ORGANIZATION

Section 2.0 sets out the three user categories with which this paper is concerned. Section 3.0 discusses WECS and biomass generally in order to familiarize the reader with the technologies and with the siting issues peculiar to each. Section 4.0 explains the federal and state laws that may influence the siting of WECS and biomass facilities. Finally, Section 5.0 applies the laws outlined in Section 4.0 to the two technologies reviewed in Section 3.0, for each of the three specific user categories described in Section 2.0.

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SECTION 2.0

USER CATEGORIES

Potential siting problems vary for different users. Utilities are interested in very large systems; homeowners will use very small systems. The legal obstacles and institutional environments are entirely different for various types of users. Just as the siting considerations vary for different technologies, so, too, they differ among various users. In order to define the siting needs as narrowly as possible, three user categories are examined in this report.

These user categories could be characterized as large-scale, medium-scale, and small-scale users; however, such categorizations fail to properly identify who the actual user might be. Therefore, probable users of the three size classifications are discussed specifically. The large-scale siting is to be examined from a utility point of view. Siting of medium-scale applications is taken from the perspective of an owner of a large apartment building or an industrial park. Small-scale siting is concerned with the problems that might be encountered by a potential WECS or biomass user in an urban neighborhood or in a rural area on a farm. Table 2-1 summarizes some salient characteristics of the three user categories.

2.1 THE UTILITY

For the purposes of this paper, a utility is a regulated energy retailer whose primary activity is the sale of electricity to the public. The utility needs permission from the state public utility regulatory agency to construct a new generating station. It is further assumed that the utility is interested in large-scale power generating plants to supply electricity to its transmission grid; i.e., WECS or biomass for the centralized generation of electricity.

2.2 THE INDUSTRIAL PARK/LARGE APARTMENT BUILDING

A potential user of WECS or biomass is an industrial park or large apartment building owner who desires to supply electricity to his tenants. This user category represents the most promising urban application for WECS or biomass in that it most closely conforms to the scale to which these two technologies are most naturally suited. The medium-scale user is a commercial enterprise interested in obtaining its own energy at least cost, and in using available resources to obtain an economic advantage. The industrial park and the large apartment building are placed in the same category because each controls a significant amount of land and consumes moderate quantities of energy. The quantity of land available to these medium-scale users allows flexibility in the placement of the WECS. In the case of biomass, the possibility of generating fuel on-site (trash and other combustible by-products of industry or apartment dwelling) is enhanced by the additional land available.

Because both consume fairly large amounts of electricity, the industrial park and the large apartment building are able to take advantage of certain economies of scale that might be less accessible to the very small user. Also, because they are large consumers of energy, the benefits of alternatives to complete reliance on utility-generated power may prove to be more attractive. It will be assumed that the power levels of interest will be in the range of 40 kW to 10 MW.

2.3 THE SINGLE-FAMILY DWELLING/SMALL FARM

The final potential user of WECS or biomass is the homeowner or small farm owner. The homeowner category consists of single-family dwellers who believe that they can save money or avoid future grief by installing a WECS or a biomass facility to offset some of their energy needs. This effort will require from 1-25 kW of generating capacity. This range represents enough power to satisfy either a small part of the electrical needs (1 kW) to reduce the amount of energy purchased from the utility or all of the electrical needs to almost completely eliminate dependence upon the utility.

Without the cooperation of neighbors, the land-use and the wind access problems relative to WECS seem to be substantial for the single-family urban dweller [11].

The biomass plant will also present problems for the lone urban dweller. The wood burning stove is the residential homeowner's only commercially ready biomass technology. The use of a wood burning stove could reduce the energy needs within a house. In that respect, biomass use by the single-family dweller could have a valuable and constructive influence on the urban energy picture. Forty percent of the homes in Maine are heated with biomass by burning wood in stoves [12]. The potential in this area is not to be minimized, but, as far as electrical generation by burning biomass or fuel production from biomass are concerned, there is no current interest in siting such devices in single-family urban neighborhoods.

Because the farmer will have use for similar power levels and will to some extent be interested in the same types of devices, the small farm will be considered in the same category as the single-family dwelling.

Table 2-1. SALIENT CHARACTERISTICS OF USER CATEGORIES

User Category	Regulated?	Power Level	Purpose	Biomass Supply	Location of Plant
Utility	yes	3-100 MW	to sell	harvested wood	remote (centralized)
Industrial Park Large Apartment	no	up to 10 MW	to reduce need and offset costs	by-products, trash, and wood	urban—on site (decentralized)
Homeowner Small Farmer	no	4-25 KW	to reduce utility dependence and offset costs	trash and wood	urban—SFD area or rural—on farm (both on site) (decentralized)

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SECTION 3.0

CHARACTERISTICS OF WECS AND BIOMASS THAT MAY INFLUENCE SITING

3.1 WECS

WECS depend entirely on the wind for energy to generate electricity (or other forms of work). The need for wind is an extremely obvious aspect of wind systems, but it is nonetheless a very important consideration that must be taken into account in any discussion of WECS siting. All the institutional and legal encouragement possible will not make a WECS function where there is no wind. One must first examine those areas in which the wind will support a generating wind facility and then decide whether the existing legal framework supports WECS. The ability to alter the topography in such a way as to enhance the available wind is limited [13].

3.1.1 Why Wind?

The proposed Wind Energy Systems Research, Development and Demonstration Act of 1979, declares:

> that the United States must develop as quickly as possible a diversified, pluralistic national energy capability and posture [14] . . . that early demonstration of the feasibility of using wind energy for the generation of electricity could lead to relief on the demand on existing fuel and energy supplies [15] . . . that the widespread use of wind energy systems to supplement and replace conventional methods for generation of electricity would have a beneficial effect on the environment [16] . . .[and that studies and demonstration projects shall be performed and the data from these studies and projects shall be made fully available] so that the early, widespread, and practical use of wind energy throughout the United States is promoted to the maximum extent feasible. [17]

The act would authorize an appropriation of one billion dollars over the next seven years for wind energy research, development, and demonstration projects.

The introduction to this paper indicated that one-tenth of the energy used in the United States (in the form of electricity) requires an inordinate consumption of energy to produce and entails a significant capital expenditure. Other factors that were not previously mentioned are the environmental concerns, the import-export ramifications, and the general fuel supply difficulties that are now a routine aspect of conventional forms of electrical generation. There are also increasing numbers of people who have begun to recognize the advantages to decentralized and smaller generating systems [18] that are not vulnerable to widespread power outages since the generating plants are too small to have widespread effect. Wind systems naturally lend themselves to a number of these concerns.

WECS-produced electricity displaces conventional electrical generation fuel needs by a ratio of 3:1. It takes approximately three quads of oil, coal, gas, or even biomass to produce one quad of electricity. WECS therefore represents a renewable source of electricity that effectively saves three units of conventional fuel for every one unit of electricity it produces.

WECS are environmentally benign. They use no water and do not pollute the air. Though there are some small environmental effects, they will not exacerbate the acute health-related environmental problems that this country faces. WECS environmental effects are almost exclusively aesthetic, not health-related.

3.1.2 Devices Available for Capturing Wind Energy

As stated previously, the primary technical requirement in siting a wind capturing device is ensuring that there is enough wind to justify a WECS. Once minimum wind requirements are met, the device itself must be selected to match the particular wind characteristics of the site in order to extract maximum energy from the available wind. In making this selection, there are a variety of designs and parameters that must be considered. The device designs are extremely varied and consist of horizontal axis machines of many configurations, vertical axis machines, and even machines that capture the wind with no system rotation [19]. There are, among the horizontal devices, machines that catch the wind head-on (upwind WECS) and machines that face away from the wind (downwind WECS) [20]. Most of the large horizontal axis machines have two blades [21]; most of the small machines have three or more blades [22]. The rated power of the machines varies from less than 1 kW [23] up to 3 MW [24]. The best known and most promising vertical axis machine is the Darrieus (eggbeater type) WECS [25].

There is more to the selection of the device than the selection of the type of rotor to be used. The choice of generator size involves trade-offs between the rated power and the load factor (for a high rated power, higher wind will be required to reach that rated power due to increased generator resistance; the load factor will consequently be lower) [26]. The amount of power available to the WECS is a function of the square of the blade diameter and the cube of the wind speed [27]. The choice of the blade diameter is thus an important one. Other factors that must be considered are:

- the extent to which the device has yaw control to turn it to its best angle relative to the wind (horizontal machines only),
- the tower design [28], and
- the type of feathering or breaking system to be used to protect the device in high winds.

These are all technical considerations. Though they do not all directly influence the site selection process from a technical point of view, they do in one way or another influence some of the decisions that must be made on a legal/institutional basis. The reason for raising these considerations is to point out this overlap and the conflicts that may arise between the technical and the legal analysis. For example, the tower design is a critical aspect of the technical process of installing a WECS at a given site. The tower must be structurally capable of supporting the WECS at a height that will take advantage of the best available wind regime without maximizing the cost of the tower, and must be designed in such a way as to be compatible with the WECS rotor speed. All structures have a natural resonance frequency. For a WECS tower, this structural frequency must be compatible with the operating frequencies of the blade and generating system, or the structure will resonate and possibly destroy itself [29]. This is a technical consideration that has nothing to do with siting. The legal counterpart to it, though, is the aesthetic appeal of that tower. Several of the laws examined in Section 4.0 require review of aesthetic matters. With wind machines, the room for aesthetic accommodation is much reduced by the need to permit the wind to flow freely through the area. This can make aesthetic additions to the tower design undesirable or not feasible.* The evolutionary nature of the design process is likely to lead to tower designs that satisfy both technical and aesthetic concerns. The purpose of this example is to demonstrate the interaction between technical factors and legal siting concerns.

Another technical consideration that will influence legal siting is the fact that there is a practical limit on the size of WECS. Structural constraints on the size of the rotor limit the potential output of WECS to a few megawatts at most [30]. What is sought for a large-scale siting process is an area in which to put a number of WECS, each with a rated power of a few megawatts. This complicates the large-scale siting process in that the one large unit, which might be simpler to site, is not a technical possibility. Instead, wind farms (several WECS in one area) must be used.

It can be seen that the choice of WECS devices involves choosing between varied designs which relate to the site selection process both in the technical evaluation of performance and in the legal evaluation of how the legal framework at that site will receive the installation and operation of the device. These decisions must be made in parallel, but not independently.

The institutional evaluation of a site deals with a wide variety of site specific requirements and prohibitions. Device-related institutional problems range from the aesthetics of the device to the environmental impacts which vary with selection of materials and device designs. An example of this type of environmental concern involves the material from which the blade is made. If the blade is made out of wood, there is little radio frequency interference and the chance of neighbor complaints about flickering on their television sets is negligible. But if an aluminum blade is used on a large WECS, there may be interference with the visual television reception in the immediate area and the possibility of nuisance action arises.

3.2 BIOMASS-FUELED ENERGY SYSTEMS

Vast quantities of energy strike the surface of the earth each day in the form of sunlight [31]. Much of this energy is absorbed and stored in plants through photosynthesis.**

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*For example, planting trees to disguise the tower or growing ivy on the tower to make it more aesthetically pleasing would obstruct the wind and reduce the efficiency of the machine. But accommodations within the tower design itself are possible and attractive tower designs are likely to appear as WECS become more common.

**Photosynthesis is a process by which plants store the energy contained in sunlight. The energy stored in plants can be recovered in many ways—some of which are discussed in this section. The most obvious method of recovering the energy is to use plants for food. When plants are fed to animals, the full energy value of the plant is not utilized by the animal. The animal's manure can be used as a fuel either by burning it or by feeding it to microorganisms in digesters where methane is produced. A by-product of digestion is a sludge which can either be burned or used to fertilize the earth, providing more nutrients for plants. Other ways to recover the energy in plants include direct combustion or gasification.

Photosynthesis is a relatively inefficient means of collecting the energy in solar radiation. Depending on the crop, theoretical upper limits of the efficiency of photosynthetic storage of solar energy range from less than 1% to about 8% [32]. All biomass derives its energy from photosynthetic storage. For several reasons, the inefficiency of photosynthesis does not represent a disincentive for biomass use. One of the most important of these reasons is the fact that many biomass energy recovery processes satisfy constructive needs in other non-energy related areas. A simple example is the direct burning of municipal solid wastes (MSW) to produce steam for generating electricity or for industrial process heat. Wood products such as paper and cardboard, and organic wastes such as grass clippings or cloth are biomass materials and components of MSW. By burning the MSW, the quantity of waste is substantially reduced. This reduction could significantly alleviate current landfill and MSW disposal problems—especially in places where an outlet can be found for use of the ash as fertilizer.

Another attractive aspect of biomass is that it represents the only source of renewable fuels [33]. Oil, gas, and ethanol can be produced from biomass through various processes [34]. The most important are gasification (a major process of which is called pyrolysis), which produces liquid and gaseous fuels; fermentation, which produces alcohol or ethanol; and anaerobic digestion, which produces methane.

This report deals generally with two broad categories of biomass use—direct combustion and fuel production. Direct combustion refers to the burning of MSW, trees, digested and dried sewage sludge, or forest and crop residues. The heat generated by direct combustion may be used to fire a boiler to produce process steam or electricity.

Fuel production from biomass is dominated by three technologies: gasification, fermentation, and digestion. Gasification is a process in which organic material such as forest wastes or agricultural crop residues are heated in limited amounts of air. Fuels such as synthetic natural gas, methanol, or synthetic gasoline are produced by gasification [35]. Fermentation refers to the conversion of carbohydrates such as those found in cellulosic crop residues to fuels such as ethyl alcohol (ethanol) [36]. Digestion is the controlled decomposition of organic material by anaerobic bacteria to produce gases that can be burned as fuels. The anaerobic digestion of organic material such as manure, sewage, algae, seaweed, and forest and agricultural residues produces methane gas [37].

3.2.1 Environmental Impacts

The biomass energy cycle can be divided into three stages: collection, conversion, and waste disposal. Each of these stages must be examined for potential impediments to the utilization of biomass as an energy source.

3.2.1.1 Collection of Biomass

Collection of biomass is the process of gathering or producing the organic matter that will be converted to some other form of energy in the conversion stage. Some collection mechanisms are already in place. Municipal solid waste is routinely collected in every city. But if landfills and other forms of disposal are inexpensive, collection of the MSW for energy purposes may not be economically attractive. Thus, as the legal environment for landfills and dumping becomes less accommodating, the attraction of MSW energy production will increase. Because municipal trash is collected without being sorted, MSW contains a large percentage of nonorganic materials—metal, glass, ceramic, stone, plastic, etc. These components must be removed sometime in the collection process in order to obtain maximum value from the organic component. Legislation to encourage or mandate recycling of such nonorganic matter would force the separation of the organic from the nonorganic waste, making the cost of separation distinct from MSW energy production. Segregating this separation cost would enhance the probability of MSW combustion plant siting by making it more cost effective.

Digestion or combustion of manure generally requires large concentrations of livestock or municipal sewage in one place. Municipal sewage is already collected and digested in most cities. Many sewage plants use the methane (biogas) produced in the digestion process to heat or power the treatment plant [38]. But the sludge, which generally contains heavy metals and salts from industrial wastes [39], is usually dumped in landfills or discharged into the ocean. This is a practice that the EPA frowns upon and is attempting to discontinue [40].

For cattle and livestock manure, the collection mechanisms are not as well in place as they are for MSW and municipal sewage. Cattle and livestock raised on grazing lands do not produce a sufficiently concentrated manure supply to support collection. But many cattle are now raised in feedlots, which are concentrated cattle production plants confining thousands of cattle in feedpens. Feedlots represent both a supply of manure and an outlet for the sludge after it has been digested. The sludge can be dried and processed and refed to the cattle.

Lumber and pulp mills already collect the industrial wood wastes generated by their operations for on-site power generation [41]. Collection of industrial wood wastes is a matter of retaining byproducts that are generated on-site. Storage can become a problem in that it requires land and can cause water pollution if rain water is permitted to soak the wood and seep into waterways controlled by the Clean Water Act [42]. The stored wood wastes could also be a fire hazard.

For other wood combustion biomass facilities and for facilities using crops or crop residues as an energy source, two methods of collection are presently being considered—energy crop plantations and forest and crop residues collection.

Forest residues and crop residues contribute to some extent to the forest floor cover development [43], soil nutrient replenishment, and moisture retention [44]. Collection of such residues must be limited to the excess above that needed for proper land management. Removal of the excess for combustion or gasification will reduce fire hazard and enhance forest management practices, as well as provide a biomass supply [45], but the economics of such removal may impede utilization at many sites.

Energy crop plantations range in character from aquatic energy farms such as water hyacinth ponds (which purify waste waters and produce fermentable water hyacinth) to terrestrial energy plantations such as large tree farms that are harvested continuously on long-term cycles. Both aquatic and terrestrial energy farms require a commitment of large quantities of land and water. Particularly with the land-based energy crops, the potential for water pollution due to increased erosion from harvesting (cutting in forests or plowing in fields) could produce difficulties if not properly addressed by the plantation manager [46]. Air pollution could result from increased windblown dust due to soil preparation and crop harvesting techniques [47]. Any pollution by a facility may cause siting complications.

Clear-cutting is a controversial forest harvesting technique in national forests [48]. If the economics of a wood plantation depend upon clear-cutting on federal lands, legal and environmental difficulties may arise. The National Forest Management Act of 1976 declares that national forest system management plans must not be selected primarily because the greatest dollar return or greatest output of timber will be realized [49]. Multiple use and sustained yield principles must be applied [50], and clear-cutting is not to be used unless it is determined to be the optimum method of meeting the objectives of the land management plan [51]. Clear-cutting still may be used, however, on private lands [52].

3.2.1.2 Conversion of Biomass to Usable Energy Forms and Disposal of By-Products

Combustion, the primary form of biomass conversion, finds its major environmental impact in air pollutant discharges. Both sulfur and particulates are emitted by burning biomass [53]. The sulfur emissions are significantly lower than the emissions from either coal or oil. Particulate emissions are high, but control equipment can reduce them to below new source performance standards [54]. Because sulfur is a particularly acute air pollution problem, the fact that biomass combustion is low in sulfur is a strong point in its favor. With congressional mandates like the Powerplant and Industrial Fuel Use Act of 1978 (PIFUA) [55], coal or alternate fuels (biomass in particular) must be used in major fuel burning installations and power plants unless prohibited by environmental requirements or made impracticable by economic conditions [56]. In areas that have moderate sulfur concentrations in the air, use of biomass could effectively be mandated by the cross purposes of Clean Air Act regulations and national energy policy.

Biomass burning boilers, like coal, gas, and oil-fired units, use water as the working fluid of the power generating cycle. Siting of biomass facilities must therefore include an evaluation of water availability as well as the water pollution discharge potential in the combustion process. Water pollution control equipment may be required.

Production of methane by anaerobic digestion can be a very large- or a very small-scale operation. If a large-scale operation is being sited, land availability and land-use issues must be addressed by those desiring to site the plant. The site must be situated near manure supplies (e.g., large chicken farms or cattle feedlots). A digestion plant has two troublesome by-products—effluent and sludge. The effluent is water that has been used in the process and that contains high levels of suspended solid. Such effluents may not be discharged into waters covered by the Clean Water Act [57]. But the waters can either be treated, reused after partial treatment, or used as a nutrient-rich water for irrigating crops [58]. An appealing treatment method was being considered for a Lamar, Colo. biogas plant but is presently thought to be too expensive. This method feeds the effluent into algae ponds. Water cleaner than EPA standards require would flow from the other end of the pond. The algae feeds on the nutrients in the effluent and purifies it. The algae itself could then be harvested and mixed with dried sludge to enhance its protein value, and could be fed back to the cows.

Feeding dried sludge to livestock is not possible when the sludge contains herbicides, pesticides, or industrial wastes [59]. If such materials are in the sludge, the sludge will most likely be disposed of in landfills or may be dried and burned for steam or electricity production. Fermentation plants also have a combustible residue as a by-product. Pyrolysis produces low Btu gas, fuel oil, char, and ash, which can all be used.

SECTION 4.0

LAWS RELEVANT TO SITING

This paper discusses two technologies (WECS and biomass), three user categories (the utilities, the medium-scale commercial interests, and the homeowner), and two bodies of law (state and federal). The federal and state laws as they apply to the two technologies are described in this section.

This section builds upon the information contained in Section 3.0, but does not attempt to detail the impact of each law on the siting process. Each law described has the potential for influencing siting. Environmental laws prescribe minimum standards that a facility must meet during construction and operation. These laws influence the price of the facility and the fuel to be used. The standards promulgated under the authority of environmental laws are often tailored to specific locations or specific environmental aspects of any location.

Land-use laws promulgated by federal, state, and local governments impose site-specific regulation on most of the land in the United States. Every aspect of the land-use law that governs a specific site has the potential to control some feature of the siting process. Particularly in urban areas, land-use regulation in the form of zoning is often the most important consideration for a siting review.

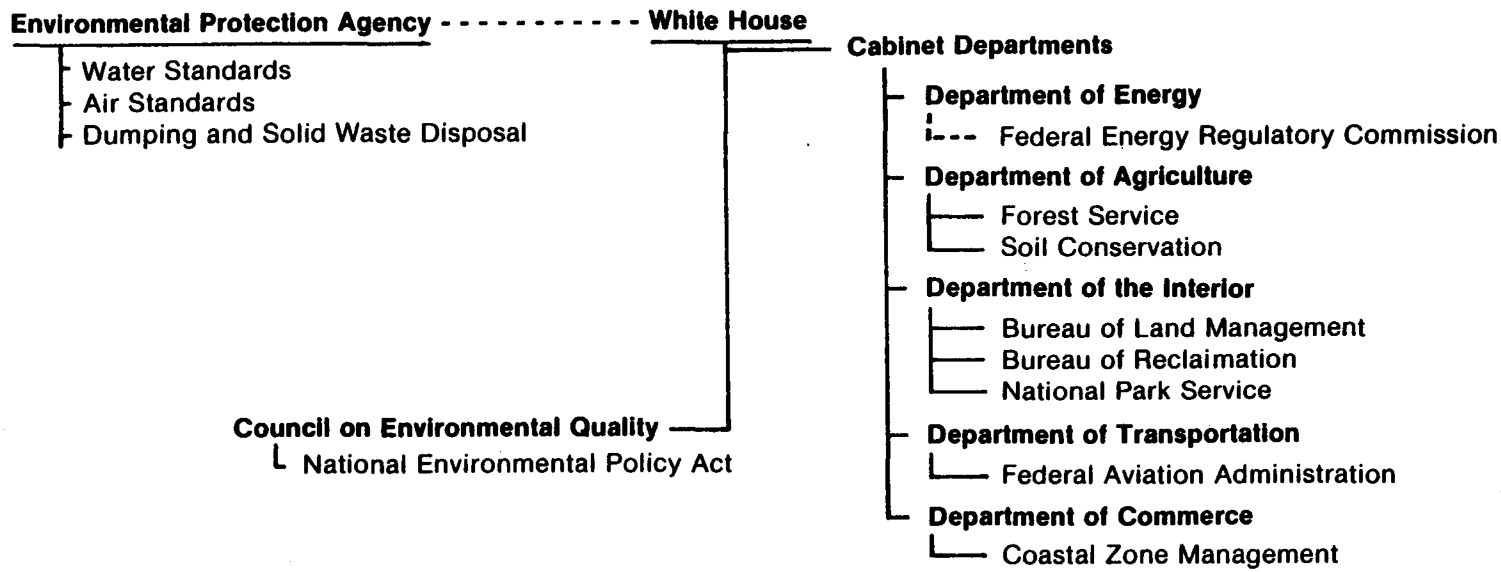
Historical, cultural, and wildlife protection laws apply only where a proposed project may encroach upon a protected area or species. If a project is found to threaten such a protected domain, the siting effort may be delayed or stopped.

The laws mentioned in the preceding paragraphs have a direct impact on siting. Other laws have a more incidental influence on siting and are referred to in this paper as threshold laws. These threshold laws defy categorization but include utility laws, which regulate public utility monopoly control of certain public services, including energy distribution. Public utility laws can influence siting by establishing a regulatory environment that either encourages or deters a project within a given area. Also included in these threshold laws are certain aspects of solid waste management laws, which, by encouraging recycling, have a side effect of making biomass in MSW more accessible, though the purpose of such laws is to promote conservation of metals and other nonorganic solids. Threshold laws mostly influence the decision of whether rather than where to site a facility.

In light of the preceding review, the applicability of each law described in this section to the general process of siting should be discernible. Section 5.0 will rely on an understanding of these laws to apply them to the technologies described in Section 3.0, in terms of the three user categories outlined in Section 2.0.

4.1 FEDERAL LAWS APPLICABLE TO THE SITING PROCESS

Many federal laws apply to the siting of energy facilities. An overview of how these laws interact and who is responsible for carrying out the tasks mandated by these laws is essential to a discussion of energy facility siting. This section will discuss federal laws that influence the siting of energy facilities in general and WECS or biomass facilities in particular.



[a] See U.S. Military and Government Organizational Chart Service, Division of U.S. Organizational Chart Service, February, 1979. This information was gleened from several charts.

Figure 4-1. Federal Responsibilities[a]

For the sake of clarity, the various federal statutes are grouped as follows:

- Federal laws mandating or encouraging state programs (TYPE I),
- Federal laws establishing federal regulation to be managed by federal agencies (TYPE II), and
- Federal land-use laws (TYPE III).

An important aspect of each law is the question of who in the Federal Government is responsible for overseeing that law's implementation. Figure 4-1 shows the general division of responsibility among the various federal authorities.

Two important elements of Fig. 4-1 are the connections to EPA and to the Federal Energy Regulatory Commission (FERC). In Fig. 4-1, EPA is set off by itself because it is an independent agency within the executive branch of the Federal Government.

FERC is located within the Department of Energy, but it, too, is an independent agency. FERC is therefore shown in Fig. 4-1 connected to the Department of Energy by a dashed line. The Commissioner of FERC is appointed by the President. FERC decisions are final decisions. They are not reviewed by the Secretary of Energy [60].

An understanding of Fig. 4-1 will place the following discussion in context [61].

4.1.1 Federal Laws Mandating or Encouraging State Programs (Type I)

Certain federal laws, relying either on the navigable water decisions [62] or the Commerce Clause of the Constitution [63], mandate or encourage states to establish programs consistent with federally established guidelines. These laws can be grouped in three categories. In the first category, incentives in the form of financial support merely encourage the states to establish a program. An example of this type of legislation is the Coastal Zone Management Act of 1972 [64], which authorizes the Secretary of Commerce to make annual grants to states that elect to establish a coastal management program. A state's decision to establish a coastal management program is voluntary. No consequence flows from a decision not to establish such a program. (The Federal Flood Insurance Program [65] also encourages voluntary state action).

The second category of federal law designed to inspire state programs is typified by the Water Pollution Control Act Amendments of 1972 [66], which are slightly more coercive than the Coastal Zone Management Act. Under the Water Pollution Control Act [67], EPA is directed to establish water pollution control standards for all states. Any state that chooses to establish its own program within the EPA-promulgated guidelines will receive funding to do so. In this type of legislation, the Federal Government is telling the states that the standards will be established, but that if the states want to assume control, the Federal Government will assist them in doing so.

The third method uses a federal statute to mandate that the states establish programs. If a state fails to establish a program, the appropriate federal agency will step in and impose a program on that state. The Clean Air Act operates in this manner. (Title I of the Public Utility Regulatory Policies Act (PURPA) [68] and The National Energy Conservation Policy Act [69] are also of this type.

In the first case, the Federal Government is informing the states that assistance is available for certain programs but that the states are in no way obligated to take advantage of that assistance. In the second case, the Federal Government declares that a federal agency will establish a program but that if the states choose to create their own program within federal guidelines, federal help will be made available. In the third case, the Federal Government directs the states to establish programs compatible with federal guidelines, facing federal imposition of a program if the state fails to act. The seven acts used as examples in the preceding discussion will be discussed in the following paragraphs.

4.1.1.1 Coastal Zone Management Act of 1972 as Amended

The "Coastal Zone" is defined as the "coastal waters (including the lands therein and thereunder) and adjacent shoreline (including the waters therein and thereunder), strongly influenced by each other and in proximity to the shoreline of the several coastal states" [70]. The Coastal Zone Management Act authorizes the Secretary of Commerce to make grants to any coastal state of up to 80% of the cost of planning [71] and administrating [72] a coastal zone management program. These grants are awarded on an annual basis.

In order to qualify for the grants, a state's plan must designate a single agency to administer its coastal program, which must be coordinated with local, area-wide, and interstate land-use plans [73]. The plan must also allow for energy facility siting in a manner that considers national as well as local and intrastate interests [74]. The Secretary of Commerce may make grants to a state of up to 80% of the costs of studying and planning for the siting of a coastal energy facility [75].

Once a state program is approved, all coastal activity would have to conform to that program. Even federal projects on federal coastal lands may be required to conform to the state program [76] in that the federal agency desiring to locate a facility on the coast of a state with an approved plan must conform to the state plan to the "maximum extent practicable" [77]. There is, however, some question about who is to determine what constitutes the maximum extent practicable [78].

Many coastal states have elected to establish coastal management programs under this act [79]. Large-scale wind facilities, which will very likely find technically favorable conditions in coastal regions, must conform to these plans. In this respect, the nature of the coastal energy facility planning will be critical. It is likely that WECS farms will be overlooked in the planning process and will not readily conform. In any event, the permit process will be more strict in coastal zones than it is elsewhere.

4.1.1.2 Federal Flood Insurance

The national flood insurance program is designed to provide affordable insurance coverage for potential flood victims. The Federal Government has established a national flood insurance program available to members of communities that adopt "adequate flood plain ordinances with effective enforcement provisions consistent with Federal standards" [80]. Community participation in the program is not required, but participation is a precondition for federal financial assistance for land acquisition or construction purposes within any area designated as having a special flood hazard [81]. Additionally, no landowner in any flood-prone area can obtain federal financial assistance unless flood insurance is obtained for that property. The program is now managed by the Federal Emergency Management Agency (FEMA) [82]. Special state or local land-use controls must be instituted for flood-prone areas, or flood insurance coverage will not be available to that area [83].

A major part of this insurance program is the identification of those areas that are particularly vulnerable to flooding [84]. Once areas are identified as flood-prone, FEMA, through the Federal Insurance Agency, evaluates and approves local land management and land-use ordinances for floodplains. For a given flood-prone area, state or local measures must restrict or control land development and construction and improve long-range floodplain managment so as to minimize the risk of flood damage [85]. Otherwise, the plan may not be approved and federal assistance and insurance coverage will not be made available. Implementation of this approval process has not been very strict.

The federal flood insurance program has a widespread influence on land use within floodplains. A facility desiring to locate with a flood zone will have to conform to regulations established by the community in order to obtain flood insurance or to obtain federal assistance. The influence of these regulations can be seen in the siting of two biomass plants that will be discussed in this paper. A bioconversion plant planned by the Lamar Utilities Board of Lamar, Colo. will be constructed within a 100-yr floodplain (1% chance of flooding in any year). The floodplain regulations for the area consist of special building codes that will minimize the risk of damage due to flooding. This criterion was easily met and will not pose a problem for the plant.

The municipal utilities board for Burlington, Vt. has purchased a 400-acre site on which it is planning to build a 50-MW wood-fired power plant. Floodplain regulations prohibit building on two-thirds of those 400 acres. This restriction limits the siting choices, but does not preclude the construction because adequate sites are available on the remaining one-third of the land. Land-use regulations within a floodplain are likely to be more strict than elsewhere. As federal agencies establish independent criteria for financial assistance within a floodplain, federal assistance for projects in flood-prone areas may become more difficult to obtain. Therefore, siting any facility within a floodplain is likely to involve stricter land-use contraints.

4.1.1.3 Clean Water Act

The Clean Water Act of 1977 [86] amends the Federal Water Pollution Control Act Amendments of 1972 [87]. The resultant statute [88] requires that EPA provide for the establishment of "areawide waste treatment management plans" [89]. EPA encourages the development of these plans by offering to subsidize the planning effort, and, once the plan is found to conform to EPA-established guidelines, by further subsidizing a pollution control program consistent with the plan [90]. The central control feature of this program is a permit process—the National Pollutant Discharge Elimination System (NPDES).

NPDES applies to the operation or construction of any facility that might lead to the pollution of navigable waterways or public waters. These terms are not defined in the statute, but EPA regulations construe them very loosely to include almost any waters [91] or potential waterways [92].

If a facility will be discharging any EPA-listed pollutant into any navigable waterways, a permit will be required [93]. The permit will be issued by EPA or, if EPA has approved the state's plan, by the designated state agency [94]. In order to obtain a permit for a new point source, the permittee must demonstrate that the "best practicable control technology" will be used to control the pollution and that operation of the facility will not be contrary to the goals stated in the pollution control program for the region [95]. An interpretation of "practicable" is important because what is practicable will determine what type of pollution control device will be required. The courts have interpreted "best practicable" to involve a balancing of the effluent-level reduction against the total cost of such reduction [96]. This cost/benefit analysis is to be made from the point of view of the public rather than the user. The "total cost" is to include external costs beyond the expense of the equipment itself [97]. These external costs should include energy, which is specifically mentioned in the statute, as well as non-water-related environmental concerns [98].

The best practicable control technology standards must be issued on an industry-wide basis. Biomass and cogeneration sources are not currently specified as particular types of sources and would therefore have to meet standards according to the specific components used.

4.1.1.4 Clean Air Act

The Clean Air Act [99] directs the states to prepare state implementation plans (SIPs) consistent with EPA guidelines and to submit the plans for approval. The federal air pollution law differs from the federal water pollution law in that air quality is analyzed on a regional basis, and the emission standards applicable to a particular facility depend upon the designated class of the region in which the facility is located. For water pollution, industry-wide standards apply uniformly to a given type of polluter, regardless of where that polluter is located (unless the state has adopted stricter standards than EPA requires). For air pollution, each area of the country that has air quality better than the ambient standard is designated as Class I, Class II, or Class III [100]. Class I areas are sensitive to even very slight deterioration in air quality (national parks or wilderness areas). A facility to be constructed in a Class I area must demonstrate that it will only slightly degrade the air quality, if at all. Class II areas are similar to Class I areas except that greater increases are allowed in the particulate matter and sulfur dioxide concentrations levels [101]. Class III areas are only slightly better than the ambient standards and degradation up to the standards would not be a significant deterioration [102]. EPA has not delegated to any state permit authority with respect to attainment areas.

Another substantial difference between the Clean Air Act and the Clean Water Act is that much of the Clean Air Act applies only to "major emitting facilities," unless the pollutant is listed as a hazardous pollutant (like asbestos, berylium, or mercury) [103]. A major emitting facility is a facility emitting over 250 tons/yr of pollutants [104].

For a major emitting facility to obtain a permit, it must provide for the incorporation of the "best available control technology" (BACT) if in an attainment area [105], or the "lowest achievable emission rate" (LAER) if in a nonattainment area [106]. Though these terms sound similar, there is a great difference. BACT for a given type of facility is determined by EPA. In making this determination (on a case-by-case basis), EPA must balance the pollutant-level reductions against the energy, environmental, and economic costs of such reductions [107].

LAER is the "most stringent emission limitation which is contained in the implementation plan of any state for such class or category of source ... or ... the most stringent emission limitation which is achieved in practice by such class or category of source, whichever is more stringent" [108]. There are no allowances for considerations beyond air quality. BACT applies to areas that are meeting the ambient standards. In these areas, EPA may consider the full gamut of ramifications before stipulating what equipment constitutes the best available control technology. "Best," in this sense is a holistic expression that brings together all relevant factors. LAER, on the other hand, considers only the impacts on air quality and requires conformance with the most stringent standard possible.

A permit seeker desiring to locate a major stationary source in a nonattainment area must, in addition to satisfying lowest achievable emission rates, demonstrate that the facility will not "contribute to emission levels which exceed the allowance permitted for such pollutant" [109]. As an alternative to this, the permit seeker may find nonmajor emission polluters and reduce those facilities' emission levels to offset the emissions that his facility would produce. The lowest achievable emission rate must still be satisfied. Either option in this plan would impose difficulties for a direct combustion biomass user in a nonattainment area. Insofar as energy and environmental considerations other than air pollution could not be taken into account, the biomass user would be required to meet the same standards as a large single-purpose polluter.* The offset provisions of the act could very likely be prohibitively expensive to a small-scale user who would not have the assets to clean up other business' air pollution. The other alternative—demonstrating that no increases in already excessive pollutants would result from the facility—could be impossible for lack of sufficiently effective pollution control equipment. This situation could preclude the installation [110].

The states may choose to establish standards more strict than EPA guidelines require. Thus, the standards will vary from state to state. EPA New Source Review Standards act as technology-specific ceilings on emission standards [111]. BACT and LAER may not

*An energy advantage would be obtained from cogeneration; an environmental benefit could accrue from reduced solid waste volume.

exceed new source review standards. All SIPs are required to protect the areas that meet EPA standards from significant deteriorations in air quality and, in nonattainment areas, to provide for attainment as expeditiously as possible [112].

4.1.1.5 Solid Waste Disposal Act

The Solid Waste Disposal Act is managed by EPA, which is directed to publish guidelines to assist in the development and implementation of state solid waste management plans [113]. This act is not concerned with sewage or industrial discharges [114], though the act covers sludge from sewage treatment plants as well as conventional solid wastes (i.e., trash, garbage, and other discarded material) [115].

For biomass, the significance of the Solid Waste Disposal Act is twofold: the act mandates (1) greater scrutiny of solid waste disposal practices—particularly landfills and open dumps [116]—and (2) the encouragement of resource recovery from solid wastes [117].

Sanitary landfills are becoming increasingly scarce and action has already been brought in several states either to protect the existing landfills from use by out-of-state interests [118], or to prohibit the formation of landfills in an existing neighborhood [119]. Open dumps must be closed or scheduled for closing under a state plan if that plan is to be approved by the EPA, making federal implementation grants available [120]. Because the Solid Waste Disposal Act will intensify already existing pressures to find alternate means of disposing of solid waste (other than dumps and landfills), the attractiveness of biomass-fueled energy facilities will be enhanced. Instead of addressing only one acute problem (energy), biomass also represents a step in solving another acute problem (solid waste reduction and disposal). In many cases it is this double-value aspect of biomass processes that makes biomass potential so high.

The other key aspect of the Solid Waste Disposal Act is that it encourages resource recovery. "The term 'recovered resources' means material or energy recovered from solid wastes" [121]. Both aspects of this definition will contribute to biomass utilization. Encouraging material recovery from solid wastes is encouraging recycling. This means that programs should be developed to recover those metals, ceramics, and glasses that can be recycled [122]. Such materials are not biomass and encouraging their removal from solid wastes for other purposes (conservation) leaves a purer solid waste and consequently a more useable biomass supply.

The Solid Waste Disposal Act also mandates the formation of a special permit program for hazardous wastes [123]. This is not a voluntary program for the states. EPA identifies hazardous wastes and requires that permits be obtained from EPA prior to disposing of those wastes. A state may assume responsibility for the permit program if it submits a plan that obtains EPA approval [124]. This separate process for hazardous wastes encourages the segregation of hazardous wastes from useable biomass. This segregation would contribute to biomass utilization in the same way that a comprehensive recycling program would.

4.1.1.6 Public Utility Regulatory Policy Act (PURPA), Title I

The purpose of PURPA is "to supplement otherwise applicable state law" [125] by requiring that state utility regulatory authorities and unregulated utilities include a consideration of certain listed standards in their administration processes and rate-making hearings. These standards include: declining block rates, time-of-day rates, seasonal rates, interruptible rates, and load management techniques. No state utility commission is required to adopt these standards [126]. The only mandate is that the state commissions consider the proposed standards. There is much interest in these standards, but very little that pertains, even on a threshold level, to siting.

Section 113 (b) of Title I sets a federal standard banning master metering in new buildings [127]. The purpose is to encourage conservation by making each tenant in a given complex aware of his own energy consumption as well as his ability to influence that consumption. But, if such a general policy is adopted it will discourage a new building owner from attempting to supply the bulk of the energy requirements for the owner's tenants by using biomass and/or WECS generators. The owner will still have to install individual meters, which will complicate the electrical supply system and increase costs. This is tangentially related to siting in that states that elect to allow master metering in order to encourage biomass or WECS utilization will be more conducive to WECS and biomass siting than those states that choose to ban master metering.

4.1.1.7 National Energy Conservation Policy Act (NECPA)

Title II of NECPA §224 deals with retrofits of presently existing structures and mandates consideration of conservation devices. Solar wind is included in the list of conservation devices. NECPA uses financial incentives to encourage states to submit plans for energy audits to be conducted by utilities. The proposed regulations require energy audits—for conservation measures and for renewable resource measures [128]. In including WECS as a renewable resource measure, the proposed regulations contain standards applicable to wind systems. Of particular interest to siting of wind systems is a requirement that the minimum distance between the WECS support tower and a structure or a property line be one and one-half (1.5) tower lengths [129]. The question of tower height and safety area is critical for wind systems. A standard setting a distance equal to 1.5 tower heights as a minimum radius for a safety zone in which no structures or property lines would be allowed would preclude WECS siting in many neighborhoods. In an urban neighborhood with lots 100 ft wide, this standard would restrict the tower height to less than 33 feet. Even in R-1 zones, the most restrictive zoning category, buildings are often allowed to be built up to 35 ft high and could act as obstructions to the wind. This proposed standard is therefore a potential siting problem for residential WECS.

4.1.2 Federal Laws Establishing Federal Regulation (Type II)

4.1.2.1 NEPA

Probably the best known federal siting control law is the National Environmental Policy Act of 1969 (NEPA) [130], which stipulates that any "major federal action significantly affecting the quality of the environment" [131] requires an environmental impact statement (EIS) detailing the environmental consequences of the proposed project. The key elements of this mandate are (1) major federal action, and (2) a significant effect on the environment.

"Federal action" means that the project has some type of federal involvement, be it a loan [132], a permit [133], or complete federal control [134]. Federal action is major if it has a significant effect on the environment [135]. Whether there is to be such an effect on the environment can either be determined from a simple acceptance of the obvious fact or, if it is not clear that there will be any significant effect on the environment, an environmental assessment (EA) can be prepared to analyze the need for an EIS [136]. The new Council on Environmental Quality (CEQ) regulations provide for "scoping hearings" which define the areas of particular interest and the significant issues to be examined in the EIS [137].

The regulation also encourages that the EAs or EIS be tiered to avoid redundant efforts. For example, a programmatic EA for WECS has been completed by the Department of Energy (DOE).* This assessment could determine that the installation of large WECS will have no significant effect on the environment, or it could conclude that certain types of WECS do have a significant environmental impact. If no significant impact is found, the EA could be incorporated into the environmental assessments for any large WECS and save much time by eliminating the need to review many of the aspects of WECS that are adequately covered in the programmatic EIS. The assessment could then lead to a finding of no significant impact or, if the installations contemplated were exceptional, it could be determined that an EIS is required. If the programmatic EA determines that there is significant impact, the assessment process could be omitted. Even in this situation, the EIS preparation would be simplified by incorporating significant elements of the programmatic EA into the project EIS [138].

An EIS must consider four elements of any project: fabrication, installation, operation, and decommission [139]. The environmental impact of this entire project life cycle must be included in the analysis. This consideraton must include a statement of "purpose and need" [140], a description of the environment to be affected [141], the effect on that environment—including the energy requirements and the resource requirements [142], and alternatives—including the option of taking no action [143]. This last section, the alternatives section, is called the "heart of the environmental impact statement" [144]. It is designed to explore in detail all possible alternatives to the project being proposed. These alternatives are then incorporated into the decision-making process in which the environmental impacts, as enumerated in the EIS, are weighed against all other aspects of the program. The environmentally preferable alternative must be identified in the record of decision, and reasons for not adopting all practical means of avoiding environmental harm [145] must also be stated.

NEPA could prove to be a tremendous advantage to alternative energy sources because the NEPA mandate requires consideration of alternatives in the evaluation of conventional energy facilities. Particularly for biomass and WECS, this unified consideration of various alternatives will put these technologies in the same forum, before a decision-making body, and will force that body and the applicant to consider their potential usefulness. The need for consideration of the alternatives was recognized by the courts soon after NEPA was passed [146]. Now that the potential of WECS and biomass is beginning to be recognized, the consideration of these technologies should be an increasing part of the NEPA decision-making process in conventional electric energy projects.

NEPA's more direct impact on the siting of WECS and biomass projects may not be very

*Currently in DOE internal review.

profound—particularly for WECS. At this time, even though federal action in WECS demonstration projects is substantial, the NEPA requirements have not been a problem. The 200-kW MOD-OA wind turbine installed on Block Island, R.I. required an EIS [147], but the first five 2.5-MW MOD-2 WECS to be installed near Medicine Bow, Wyo. were issued a negative declaration; no significant environmental impact was discovered in the environmental assessment process [148].

Environmentally, biomass power plants are not radically different from fossil-fuel-fired power plants. The major difference is in fuel storage requirements and stack emissions, which may be lower in sulfur and higher in particulates for biomass. Because most fossil-fuel-fired power plants are subject to NEPA requirements, biomass power plants of the same size would also be subject to NEPA safeguards. But biomass plants do not tend to be the same size as conventional fossil-fuel-fired power plants. Because biomass plants tend to be smaller and are more likely to be the type of facility that is installed by a commercial or industrial interest, the potential for federal action on the project is low. Without federal involvement, NEPA does not apply.

Federal action could occur in the fuel collection portion of the biomass fuel cycle. If biomass is harvested from federal lands, the permit for that harvesting could require preparation of an EIS. But such a permit issuance may be handled in a programmatic EIS which could then be incorporated by reference into subsequent project EISs. A programmatic EA is being prepared by DOE for its biomass programs. It is likely that the effects of various harvesting techniques will be evaluated in this EA and will be able to be incorporated into all project EAs that might evaluate fuel supply environmental impacts.

Other areas of possible federal action in biomass power plants are: EPA NPDES permit (if EPA has not approved the state water pollution control program); EPA air pollution permit (in attainment areas or in states whose plans have not been approved); grant of right-of-way if located on public land; or any federal financial assistance.

4.1.2.2 The Federal Power Act

The provisions of the Federal Power Act relevant to this paper are contained in Part II of the act [149], which is amended by the Public Utility Regulatory Policies Act of 1978 (PURPA) [150]. The Federal Power Act confers upon FERC (formerly the Federal Power Commission) jurisdiction over all interstate sales of electricity for resale [151]. PURPA's amendments provide for exemption of qualifying facilities from both state and federal regulation in order to encourage potential small power production and cogeneration.

Under the act, a small power production facility is defined as an electrical generation facility using biomass, waste, renewable resources (including, according to Conference Committee comments, wind electric systems [152]), or any combinaton thereof [153]. To be a qualifying facility, it must, according to proposed FERC regulations [154], have a capacity of at least 10 kW and at most 80 MW. To be eligible for the exemption from state and federal utility law, the facility can have no more than 30 MW of capacity (applicable to wind), unless the fuel is biomass, in which case an exemption can be obtained for up to 80 MW.

A cogeneration facility is defined as a facility that produces both electricity and steam or some other useful form of energy. PURPA states no size limit for cogenerators [155]. To obtain qualifying status, a facility must apply to FERC for certification. Once qualified, a facility that has unsuccessfully negotiated with the appropriate utility can obtain a hookup order from FERC requiring that the utility hook up with the qualifying facility, provide backup power, and buy back the excess power generated by the small power producer or cogenerator [156]. Arrangements for rates (buying and selling) are implemented by the state regulatory agency [157].

The main siting-related effect of this law is a threshold effect. The decision to site or not to site will depend, for many small power producers and cogenerators, upon the terms of implementation of this law, particularly PURPA. PURPA directs FERC to encourage use of biomass, cogeneration, and renewable resource-powered small power production facilities. FERC's influence on the threshold questions could be profound. An example can be found in the proposed regulations for defining a qualifying facility [158], which set a minimum of 10 kW capacity for a facility to qualify. Setting this minimum could preclude obtaining a conducive regulatory environment for wind facilities of less than 10 kW. Obtaining backup power from the utilities could be difficult for such systems. Inability to obtain backup power could very well destroy the market for a great many small WECS (SWECS) and mute the siting question altogether.

Another potential difficulty with PURPA is the great weight placed upon reliability [159]. Depending upon how the regulations treat this aspect of small power production, widespread use of SWECS could be discouraged by the regulations simply because there are reliability problems with all WECS; they only generate electricity when the wind blows.

As far as biomass is concerned, PURPA appears to be a real boost for potential biomass users. Biomass has no inherent reliability problem, and it is likely that the 10-kW floor for qualifying facilities will not have much influence one way or the other [160].

4.1.2.3 Ocean Dumping (Marine Protection, Research, and Sanctuaries Act of 1972)

The purpose of the federal regulation of ocean dumping [161] is to control transportation of any material to the ocean to be dumped[162]. Material is broadly defined to include "solid waste, incineration residue, garbage, sewage, sewage sludges" and matter of any kind or description [163].

The ocean dumping regulations direct the EPA to establish a permitting process to control all ocean dumping. The law specifies that all ocean dumping of sewage sludge must cease by 31 Dec. 81 [164]. The regulations specify that the permit process must consider the need for dumping and the alternatives to dumping [165]. Restrictions on ocean dumping may create a more favorable environment for biomass-fueled energy facilities that could contribute to the solution of solid waste problems as well as energy problems.

This law acts to enhance the potential of biomass energy sources by exacerbating the problems inherent in other forms of disposal of biomass materials. The federal Ocean Dumping Regulation and the Solid Waste Disposal Act eliminate many techniques of disposal that were cheap and simple in the past.

4.1.2.4 Federal Aviation Administration (FAA) and Federal Communication Commission (FCC) Regulation

FAA regulations require that public notice be given "of the construction or alteration of any structure where notice will promote air safety" [166]. Notice must be given to the FAA [167] for construction that will produce a structure over 200 ft above the ground

[168]. There are additional notice requirements for structures in the immediate vicinity of airports [169]. The most probable result of a structure being within FAA notice requirements is that, if the structure is determined to be an obstruction, FAA lighting and marking requirements will be imposed [170]. Thus, FAA regulations amount to little more than simple prudence and will not hamper WECS siting, except possibly in the immediate vicinity of airports.

FCC regulations apply only to those WECS which cause electric-magnetic interference (EMI). Metal and, to a much lesser extent, fiberglass WECS blades will reflect high frequency electromagnetic radiation. The dominant effect of this reflection is to cause a flickering ghost image on television sets in the vicinity of the WECS. This effect was the basis of the decision to prepare an EIS for the Block Island, R.I. WECS (see Sections 4.1.2.1 and 5.1.2) [171].

FCC regulations are far from explicit in their coverage of WECS, but where FCC regulations apply to WECS [172], it is because WECS would be classified as incidental radiation devices [173]. Classified as such, a WECS would not be subject to licensing by the FCC [174], but would be subject to operating prohibitions which would not allow "harmful interference" with radio communications [175]. If such interference were caused, the WECS operator would be required to eliminate that interference [176]. For the Block Island WECS, cable TV was required [177].

WECS do not generally influence navigational radio transmission [178], but the Block Island EIS indicates that the MOD-OA wind turbine would have to be at least 1.4 km (kilometer) from any VOR Transmitter in order to satisfy the FAA requirement that no tall scattering objects be located more than two degrees above the horizon from the phase center of a VOR antenna [179].

Television interference difficulties could cause considerably more trouble. For those sites in areas of poor TV reception where the reflection geometries line up to produce significant signal distortion, certain solutions, such as wood blades, cable TV, or the installation of directional antennas to screen the reflected signal could be employed to circumvent the difficulty. Switching to cable TV could, however, impose costs on the WECS operation that would be burdensome.

4.1.2.5 Power Plant and Industrial Fuels Utilization Act of 1978 (PIFUA) [180]

This act mandates a national conversion from natural gas and petroleum to coal, biomass, and renewable energy sources [181]. It specifically calls for such a conversion in electric power plants and major fuel burning installations employing boilers, gas turbines, or combined cycle units [182]. WECS, therefore, are not covered by the act.

An exemption to the conversion mandate is allowed for cogenerators. If the petitioner demonstrates that the benefits of cogeneration are not possible without use of petroleum or natural gas, then that petitioner would be permitted to use petroleum or natural gas. The regulations proposed by the Economic Regulatory Administration (ERA) [183] add the requirement that the petitioner demonstrate that he is unable to use an alternate fuel. The California Energy Commission strongly recommends that this latter requirement be dropped [184]. There will be more cogenerators if this recommendation is followed, but it is not clear whether the more liberal exemption policy would affect the number of biomass users. The act will encourage biomass use to the extent that other fuels are discouraged. It will not otherwise have any profound effect on siting.

4.1.3 Federal Land-Use Laws (Type III)

Approximately 33% of the surface area of the United States is owned by the Federal Government [185]. Of this federal land, almost 45% is in Alaska [186] and another 45% is in the West (excluding Alaska) [187]. That 90% of the federal lands represents 90% of Alaska's land area and 44% of the land area in the 11 western states [188]. Because of this extensive federal land control, federal land-use regulation will play a key role in locating large-scale facilities in the western United States or Alaska.

The major influence of federal land-use regulations in the siting process will arise in the land acquisition phases for large-scale systems and the related transmission lines. Therefore, in this section the discussion will be geared toward large-scale WECS arrays and, because of the federal forest management programs, toward timber harvesting for wood burning power plants.

Almost all federal land is managed either by the Department of Agriculture or by the Department of Interior. The U.S. Forest Service is responsible for Department of Agriculture lands. The Department of Interior lands are managed by the Bureau of Land Management, the U.S. Park Service, and the Bureau of Reclamation.

4.1.3.1 Federal Land Policy and Management Act of 1976 (BLM Organic Act)

The Federal Land Policy and Management Act of 1976 [189] sets forth a comprehensive policy for management of federal lands. The act directs the Department of Interior (DOI) to develop land-use plans [190] incorporating a multiple use and sustained yield philosophy into DOI land management practices. The act empowers the Secretary of Interior to withdraw land from public use [191]; to exchange land when the public interest will be served [192]; to grant, issue, or renew rights-of-way through public lands [193]; and, under certain conditions, to sell nonwilderness public land [194].

In granting a right-of-way [195], the secretary must consider environmental impacts (including aesthetic, scenic, and wildlife values) and the appropriate state siting and construction standards [196]. The secretary must also require compliance with all state air and water quality standards as well as public health and safety regulations [197]. Particular land uses that the act specifies as appropriate for a right-of-way grant include systems for generation, transmission, and distribution of electric energy [198], which would include a large-scale WECS array and the associated transmission lines.

The Multiple Use and Sustained Yield Act of 1960 [199] established the multiple use and sustained yield policy for all national forests (managed by the Department of Agriculture). The BLM Organic Act applies this policy to DOI-managed lands and in doing so defines the elements of the policy more precisely than the Multiple Use and Sustained Yield Act of 1960. Managing DOI lands for multiple use means that all diverse and compatible resource uses should be controlled in a manner that considers both current and future needs for renewable and nonrenewable resources. The balancing that must be accomplished should attempt to coordinate harmoniously "recreation, range, timber, minerals, watershed, wildlife and fish, and natural scenic, scientific, and historical values" [200]. Sustained yield policies must strive for "achievement and maintenance into perpetuity of high-level annual or regular periodic output of various renewable resources . . ." [201].

In developing the land-use plans to implement these policies, potential wind-power sites are being considered a resource [202]. Wind, as a renewable resource, is therefore recognized as subject to the sustained yield provisions and WECS must be considered as one of the multiple uses possible on public lands.

4.1.3.2 National Forest Service Acts

There are several provisions of the U.S. Code that apply to management of public forest land controlled by the U.S. Forest Service. The basic management policy is established by the Multiple Use and Sustained Yield Act of 1960 [203], which requires harmonious and coordinated management of the various forest resources [204]. The National Forest Management Act of 1976 [205] and the Cooperative Forestry Assistance Act of 1978 [206] expand upon the Multiple Use and Sustained Yield philosophy and particularly emphasize the increased and efficient use of wood and timber products and by-products. The Cooperative Forestry Assistance Act directs the Department of Agriculture (DOA) to assist nonfederal landowners who control less than 1000 acres [207] to produce their timber in an efficient and recurring manner [208]. This act is directed only toward forest resources, which include timber but do not include energy [209].

The National Forest Management Act is directed to forest product utilization in federal forest lands as well as other lands. It calls for increased utilization of forest and wood product wastes and of urban wood wastes and wood product recycling [210]. This act strongly emphasizes the multiple use and sustained yield philosophy [211] and directs DOA to develop land and resource management programs for the national forests. The focus is on full utilization of the forest for timber production at a level that can be sustained forever. The act is not designed to increase energy production, but is concerned with the full utilization of every facet of each product that is derived from the forests. In this capacity biomass utilization should be strongly promoted by this act because full exploitation of all the potential of forest products would include by-product and residue recovery and use (e.g., use of these residues as biomass for energy production). To the extent that better forest management involves removal of forest residues [212], biomass siting near national forests will be encouraged.

DOA is subject to the same right-of-way process as DOI and is directed to consider all state and local regulations as well as all federal environmental standards [213].

One additional DOA responsibility that could influence siting of biomass facilities on or near farms is defined in the Soil and Water Resources Conservation Act of 1977 [214]. This act directs the DOA to study the "feasibility of collecting organic waste materials, including manure, crop and food wastes, industrial organic waste, municipal sewage sludge, logging and wood manufacturing residues . . . [to place] such materials on the land to improve soil tilth and fertility." Though this analysis does not speak directly to biomass energy applications, the study of collection feasibility should be directly applicable to biomass supply and siting questions because availability of supply is intimately tied both to siting and to collection feasibility. Also, this study should highlight the value of a competing use for certain biomass materials.

4.1.3.3 Wilderness and Wildlife Acts

Three other federal acts will have a significant impact on the siting of WECS or the harvesting of biomass fuels. Under the National Wilderness Preservation Act of 1964 [215], Congress may designate areas as wilderness areas. Once a tract of land is designated a wilderness area, the department responsible for that tract prior to the designation assumes responsibility for preserving the tract "for the use and enjoyment of the American people in such a manner as will leave [it] unimpaired for future use and enjoyment" [216]. The wilderness areas are not to be in any way changed from their natural state. No structures or roads are permitted to be built in wilderness areas except that the President may authorize "power projects, transmission lines and other facilities needed in the public interest" [217]. Such an authorization is extremely unlikely for a WECS or a biomass facility because both tend to be relatively small power producers, and it is difficult to imagine the President disturbing congressionally designated wildlife preserves for a couple of hundred megawatts of power.

The Endangered Species Act of 1978 [218] provides protection for any species that is in danger of becoming extinct. This includes both plants and animals. The act provides for the voiding of any state law that would allow what this act would otherwise prohibit [219]. Permits are issued by the secretaries of whichever agency is taking the action that might threaten a listed endangered species [220]. There are exemption provisions in this act. A designated committee [221] can grant an exemption if it determines that denial of such an exemption would cause undue economic hardship to the applicant [222].

The National Wildlife Refuge System provides for the formation of wildlife preserves. Within these preserves, the Secretary of Interior can "permit use of, or grant easements in, over, across, upon, through or under any areas within the System for purposes such as . . . powerlines . . . where <u>he determines that such uses are compatible with purposes for which these areas are established</u>" (emphasis added) [223].

In an area where one of these three acts apply, any construction of any facility could be prohibited if that construction (or land use) would be contrary to the provisions of one of the acts. These acts may particularly affect WECS farms that will be dispersed over large tracts of land. But, because of the low effective land utilization of WECS farms, it may be possible to arrange the placement of each individual machine to avoid the sensitive portions of the array site. This flexibility in WECS siting could reduce the impact of the preceding three protection laws on WECS siting.

In that most biomass plants will be located in industrial areas, the protection laws may not have much effect on the plant siting. Biomass collection techniques may, on the other hand, be complicated by these protection laws.

4.2 STATE AND LOCAL LAWS RELEVANT TO THE SITING PROCESS

Most applications of biomass or WECS will encounter their major regulatory confrontations in their attempts to conform to state and local laws. The state air and water pollution control laws, coastal zone management laws, public utility laws, floodplains control laws, solid waste management laws, and land-use planning laws provide a complex framework that sometimes insists on conflicting requirements that can frustrate even the most accommodating of projects. Cataloging or attempting to describe the wide range of state and local laws and regulations that would influence the siting of biomass uses is beyond the realistic scope of this paper. Instead, a small sample of the methods employed by some states will serve as a guide in briefly reviewing the concepts involved in siting a power facility in accordance with state and local law.

4.2.1 Land-Use Regulation

"The orderly use and development of land is the focus of land use planning" [224]. In theory, all land-use regulation should be the result of comprehensive land-use planning.

In fact, the preparation of the regulation itself is often substituted for any true comprehensive planning [225]. Until recently, almost all land-use controls have been imposed by municipalities exercising the state's police power, which is delegated to them by the state constitution, a "home rule" statutory grant, or a state enabling act [226]. Now the states themselves are exerting more influence over land-use patterns and are increasingly instrumental in land-use decisions. As a result, land-use regulations are currently specified by a wide variety of laws and ordinances controlled by an equally diverse array of agencies, boards, and commissions. Three levels of government supervise these controls—municipal, county and regional, and state governments. This section will concentrate first on state land-use controls and then on local or regional controls.

4.2.1.1 State Land-Use Controls

Land-use control at the state level is an amorphous concept. The most obvious area of state land-use planning and influence is in transportation systems—particularly in roads and highways. Other areas of state land-use influence have grown out of environmental legislation and much of this legislation has been prompted by federal environmental laws such as the Clean Air Act, the Clean Water Act, and the Solid Waste Disposal Act. State Environmental Protection Acts (SEPAs) also significantly influence land use within a state. These environmental acts will be discussed in Section 3.2.2 and will not be considered land-use regulations as such because these laws control resources and only incidentally influence site-specific land use. For the purpose of this discussion, land-use controls will be considered to be regulations designed to restrict or encourage particular uses and forms of uses of specified lands. At the state level, such controls would generally flow from planning bodies attempting to establish desirable patterns of growth or land resource use. The principal laws relevant to siting of WECS or biomass facilities address coastal zone management, flood plain management, and state forestry and state park regulation—all of which are encompassed in state-level comprehensive planning.

As a rule, state-level land-use planning results in an advisory comprehensive plan that the local municipalities choose to follow or disregard at their own discretion [227]. Some states have recently strengthened their land-use policy by imposing minimum standards of compliance with state planning on the local municipalities, or by assuming direct control of the permitting process for specified activities or areas [228].

California has mandated local planning [229] and established a statewide office within the governor's office [230] to assist local and county governments and all other state agencies in coordinating their planning activities [231]. This Office of Planning and Research has "no direct operating or regulatory powers" [232], but it does establish guidelines for local general plans. Without general plans, local municipalities do not have the power to approve developments because the state mandates that development must be consistent with a general plan [233]. The local general plans must contain nine elements, including a "conservation element" for conservation, development, and utilization of natural resources [234]. Thus, resource planning must be a part of all local land-use planning in California. The impact of this requirement is open to question, though, because there is no specific direction that this local planning must take. Therefore, resource planning can be as comprehensive or as superficial as the local government decides to make it. The existence of such planning is all that is required for a general plan. The state has no power of review over the plan.

Because there is no binding and comprehensive statewide plan, all statewide planning is performed on a functional basis (e.g., water, air, transportation). The Office of Planning and Research thus attempts to encourage these state functional planners to coordinate with each other and with the local general planners to arrive at compatible land-use plans. This is the extent of state influence over local land-use planning. California represents a fairly standard state approach to land-use planning with a broad authority conferred on the local jurisdictions. The state has expressed a strong interest in ensuring the preservation and use of land "in ways which are economically and socially desirable" [235], and offers its assistance to local planners in the hope that these planners will pursue these goals.

A clear exception to this categorization of California's law is found in California's coastal zone management, through which the state regulates a strip of coastal land ranging from 1000 yd to a couple of miles inland of the mean high tide line. The State Coastal Commission, through six regional coastal commissions, issues permits and controls development and land use in the coastal zone [236]. This commission also establishes guidelines for local programs. When a coastal locality submits a coastal program that satisfies these guidelines, the permit power for that locality is transferred to the local agency [237]. The California coastal regulation is an example of a state controlling land use in a region until the local governments can assume control subject to state standards.

Colorado also delegates the land-use regulation to the local governments, but, through a process of identifying areas or activities of state interest, a degree of state control is retained over developments. Areas or activities of state interest are those areas or activities for which development poses a "danger of injury, loss, or damage of serious and major proportion to the public health, welfare, or safety" [238]. Statewide planning is performed by the Colorado Land-Use Commission, which provides recommendations and technical assistance to local agencies [239] that must designate matters of state interest and establish permit programs to manage development in these areas and activities [240]. Once the local agency develops a plan, the commission can review that plan and make recommendations that the local agency can accept or ignore.

This process, like California's statewide planning process, is largely an "expression of state concern" [241], but the state commission does have the power to notify the county planning commission if the state commission feels a development is threatening an area of state interest. If the county commission takes no action, then the state commission can, through the governor, issue a cease and desist order that can be enforced in the courts [242].

Thus, Colorado's Land-Use Commission has a little more authority than the average state retains for control of land use. This power is not great, though, and efforts to exercise it freely have met with legislative reprisals in favor of local control [243].

While a great deal more could be said about state-level land-use controls, the fact remains that the states' land use powers are almost completely delegated to the municipalities and counties.

4.2.1.2 Local Land-Use Controls

The most powerful tool of local land-use control is zoning regulation. The power to zone is delegated to the localities by the states and the extent of delegation of power defines the extent to which the local governments are allowed to control land-use patterns. This delegation comes in the form of home-rule powers or enabling statutes [244]. Often, as in Colorado and California, the land-use control enabling statute confers broad powers upon the localities. These powers usually include the power to establish building codes and subdivision controls, as well as zoning regulation [245]. Some states such as

California [246], impose a uniform building code on the whole state. And, certain states such as Colorado, exert some control over development by retaining some influence over "critical areas" [247] or "areas of state interest" [248].

The existence of private land-use restrictions in the form of covenants, restrictions, and subdivision controls [249], could also complicate siting of WECS or biomass in residential areas.

In most states, zoning can be implemented by cities only if the zoning ordinance will conform to a preestablished comprehensive land-use plan. But the need for this plan has been loosely construed and the planning requirements are often found to be satisfied by the ordinance itself [250]. The features of zoning ordinances that may restrict biomass or WECS siting are: maximum height restrictions, maximum lot usage restrictions, minimum setbacks within which no structures can be located, and aesthetic restrictions. These types of regulations are most likely to be encountered in urban areas.

WECS installations could be prohibited by height restrictions. If special setbacks (minimum distance between a structure and a property line or structure) are required for WECS, siting difficulties could be compounded. Even normal setback requirements, by prohibiting a structure in certain parts of the yard, could stop a WECS project. The tower may be a prohibited structure in the only areas of a lot available for siting it. Maximum lot usage regulations specify that only a given percentage of a lot may be used for structures. Often the homes placed on the lot use the entire allotted percentage of the property, leaving no additional space for a WECS or biomass plant.

Zoning and building codes can affect biomass use in wood burning stoves through fire and safety regulations or by outright bans on installations. The fire hazards of wood burning stoves are being viewed with increasing interest by zoning and safety boards [251]. Poor installation techniques are the cause of most of the fires from wood burning stoves. These poor practices may lead to increased siting complications for wood burning stoves.

The exact details of zoning ordinances vary from city to city. A general difficulty with conventional zoning regulations is the rigidity they impose on the structure of neighborhoods. Homogeneity of land use in each section of the city is emphasized by these regulations at the expense of flexibility [252]. In an attempt to remedy this inflexibility, some states are encouraging planned unit developments (PUDs) [253]. A PUD is an area zoned for multi-use and particularly planned for a harmonious mix of various activities. The goal is to select a combination of low and high density residential, commercial, and industrial activities that can interact constructively within a single neighborhood [254]. For a neighborhood energy project, this form of zoning could be ideal in that it breaks out of the inflexible mold of height limitation, setback minimums, and most important, standardized neighborhoods.

A difficulty with PUDs is that they are not as easily administered as conventional zoning. To keep the process free from abuse, a great deal of planning is necessary [255]. Also, there is a threat to the municipality's tight control over community growth in abandoning the rigid, and thus growth-limiting, standard zoning forms. This unwillingness to part with absolute control combined with a reluctance by city officials to get involved with a new concept that may cause administrative difficulties has limited the use of PUDs [256], but this reluctance appears to be subsiding [257]. Thus, PUDs, as a flexible local land-use control, could provide an accommodating zoning form for WECS and possibly biomass.

4.2.2 State Environmental Law

The four major areas of state environmental legislation deal with water pollution, air pollution, solid waste management, and state NEPAs. Having less pervasive effect on siting are historic preservation statutes, wildlife and plant protection statutes, noise statutes, and foresting management laws.

State air and water pollution control standards must fall within EPA-established guidelines. The discussions contained in Sections 4.1.1.3 and 4.1.1.2 therefore apply to state-level air and water pollution control. That discussion will not be repeated here except to reiterate that the states may elect to impose more stringent standards of environmental control than EPA requires. These more stringent standards may then supersede any EPA standards.

Many states have adopted state environmental protection acts (SEPAs) very similar to NEPA [258]. The effect of these statutes is to extend the requirement that an EIS be prepared. Through SEPAs, many projects that may have eluded full environmental evaluation due to lack of federal action, become subject to much the same level of environmental scrutiny as NEPA would have required. The exact procedures for preparation of the EIS vary from state to state, but because they are modeled after NEPA, the essential character of the requirement is the same [259]. An extensive review of all environmental impacts must be prepared and considered in the proposal stage of a project.

The solid waste management program implemented in the states following EPA approval of state plans will follow the EPA guidelines that were described in Section 4.1.1.4.

4.2.3 State Power Plant Siting Laws

Many states have adopted special laws for siting power plants and transmission lines [260]. The purpose of such statutes is to reduce the number of agencies from whom permits must be obtained, to coordinate all interest in the siting process, to perform comprehensive energy planning, and to circumvent potential obstacles like local zoning regulations. Many states with comprehensive siting laws reserve access to the facilitated siting procedure to major power facilities [261]. A common threshold for inclusion in the comprehensive siting process is 50 MW [262]. Thus, any power generating plant that produces less than 50 MW would be required to go through the normal multiagency permit process and would not be forced or allowed to go through the comprehensive siting process*. Most biomass-fueled generators will probably be less than 50 MW simply because obtaining fuel for a larger plant could prove troublesome [263]. With WECS generators in a large-scale application, the definition of a generating facility becomes critical because individual machines have low capacity and large arrays have high capacity.

Currently, the largest single WECS planned in the United States is the 3-MW wind turbine being installed by Southern California Edison in San Gorgonio Pass, Calif. [264]. A project in Medicine Bow, Wyo. is now ready to install five 2.5-MW WECS with potential for many more [265]. The Medicine Bow "WECS farm" (large-scale array of wind turbines)

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could ultimately include well over 50 MW of generating capacity. Whether this wind farm would be considered one or many facilities would have to be determined by interpreting the individual state statutes. WECS facilities would not be included in the comprehensive siting processes in New York or California that cover "major steam electric generating facilities" and "thermal energy sources" respectively—neither of which describe WECS [266].

Therefore, in those states that have a threshold size for inclusion in the comprehensive siting process, most WECS and biomass plants would not be directly influenced by that siting procedure. Nonetheless, the influence of such a procedure is substantial. The planning features built into many of the energy siting agencies (created by the siting legislation) bring an active consideration of all energy sources and alternatives into conventional siting activities [267]. An agency with the ability to invest in statewide investigation of resource mixes and desirable types of power generating plants can challenge power-producer siting requests with detailed evaluations of the need for and appropriateness of a proposed facility. Also, in public hearings, this agency can investigate (from a more public point of view than the utilities) the best statewide distribution of energy facilities, including potential WECS and biomass [268]. This planning and research process is essential in energy forecasting because forecasts tend to be self fulfilling. By being an active participant in the siting decision—rather than a passive referee—the agency is more able to serve the public interest [269].

Those states with no special power-facility siting statutes are generally not prepared to assess an application for a given power project on any multidisciplinary grounds [270]. Therefore, in such states, environmental review is separate from Public Utility Commission review. Demand forecasting, most likely performed by the applicant, is not necessarily the true balancing of all state interests that could be supplied by an energy commission forecasting with comprehensive siting responsibility. Colorado is a state without a special siting process for power facilities. For projects which receive federal assistance, the A-95 clearinghouse review [271], through which interested state and local officials and agencies are permitted to comment on the application for assistance, is the only possible interdisciplinary review. But, this process does not actually constitute such a review because the various agencies comment individually if at all and do not interact. Negative comments are rare [272]. Each permit required for any project is obtained from a particular agency that looks no farther than the scope of the permit which that agency issues.

California is a state that exemplifies the "one stop" siting procedure [273]. Colorado, on the other hand, is a state that has a mix of special interest agencies and permits (water, air, building, etc.) but no special comprehensive siting law. The difference in the way WECS or biomass siting would be conducted in the two states is actually very slight because the special siting procedure in California does not cover nonthermal generators (WECS) or facilities with a capacity of less than 50 MW (most biomass plants). The difference lies in the siting of conventional facilities and the nature of the energy planning in the two states. California can and does encourage WECS and biomass utilization both in its energy planning and in its consideration of alternatives in conventional power plant siting*. Colorado has not established a mechanism for such activities. Vermont has a

*Consideration of aggregating dispersed alternatives to counter a large power plant proposal has not been successful in specific power plant siting reviews in California. However, these decentralized alternatives are being pushed and may find their place in the review process in the near future.

special siting statute that represents a compromise between California's and Colorado's approach.

Vermont has enacted a statute vesting authority in the state Public Service Board (PSB) to conduct a preconstruction review of power-plant site selection [274]. This review must be coordinated with all interested state agencies. Approval of the selected site will result in issuance of a certificate of public good. This comprehensive siting process is only applicable to a company conducting any public service business which includes a business generating electricity "to be used ultimately by the public" [275]. This broad jurisdiction conferred on the PSB could include a cogenerator or a small WECS. The siting statute has no threshold generating capacity, so any proposed power production facility to be used by a company which is subject to PSB jurisdiction would be required to submit to this process. For many small generators, this may be an unnecessary complication because the extension scope of the comprehensive siting procedure could go beyond the needs of the small power producer and would involve more work than multiagency permitting.

The differences between Vermont, California, and Colorado raise the question of the value of the small plant exemption from the power-plant siting law to the WECS or biomass facility. Vermont has created a "one stop" agency for all public service generating facilities. California has created such an agency for all electric facilities using a thermal source with a capacity greater than 50 MW. Colorado has no comprehensive siting statute at all.

Yet Colorado's siting of WECS and biomass facilities would be very similar to California's siting of almost all such facilities. Vermont, on the other hand, may include all electrical generating systems in its "one stop" certification [276]. It is not clear which procedure is best for encouraging alternate energy sources. One commentator feels that, for WECS, the fact that alternative energy sources don't fit easily into the conventional examination processes indicates that alternative energy sources should be exempt from coverage [277].

The important facets of state siting legislation relative to WECS and biomass include the following:

- the extent to which the siting agency is responsible for forecasting energy needs and establishing state goals for meeting these needs with the best possible mix of technologies;
- the comprehensiveness of the review process in including all interested and responsible parties in an interactive evaluation of the project; and
- the types of facilities which fall under the domain of the siting agency—with special attention paid to the technology employed and the generating capacity.

4.2.4 State Utility Law

For any small power producer using WECS or biomass, it is essential to have an interconnection with the local utility for the purpose of selling excess power and purchasing backup power [278]. This particular area of law is in a state of flux due to PURPA, as well as the relatively new onslaught of interest in small power production. For this reason, discussion of the utility in relation to the WECS or biomass electrical generator will be limited to a stating of the problem. An in-depth analysis of this issue wanders too far from the discussion that is the focus of this paper. More thorough discussions of the issues are developed elsewhere [279]. The interconnection issue can be stated as follows: small power producers (WECS and biomass) find that the most economical method of supplying their own energy is to use the utility transmission grid for storage of their excess energy. When the small power producer is producing more energy than is needed on-site, the excess energy can be fed into the utility lines to be used by other utility customers. This electricity is effectively stored in the utility's lines for use when insufficient energy is being generated by the small power producer. For example, when there is no wind, SWECS produce no energy. The utility would then supply the necessary backup energy for the SWECS owner. When the wind is strong, the SWECS on a given site may produce more energy than is being used on that site. The excess energy would be fed back into the utility lines. The problem arises in determining: (1) what rates should apply to each direction of energy flow; and (2) when the utility should be required to provide for an interconnection between the utility's lines and the small power producer.

The utility is generally opposed to any interconnections with small power producers. If such connections are made, the utility wants to be charged a very low rate for the energy to be bought from the small power producer. The utility wants to pay no more than the equivalent fuel cost (wholesale) for the energy fed into the utility lines by the small power producer. The utility also claims that the interconnections are dangerous because the utility does not have control over the small-power-producer power that is fed into the utility lines, which could be a threat to utility personnel working on the lines.

The small power producer is concerned with the reliability of his supply of energy and with receiving a fair price for the energy he sells to the utility. Whether the utility should treat the small power producer as a fuel saver or as an offset of utility capacity needs is a major question that directly influences the determination of what constitutes a fair price for the excess small producer energy. If the utility must maintain generating equipment to back up the small power producer, then the energy supplied by the small power producer only saves fuel for the utility and does not reduce capital costs. In this capacity the small power producer is called a fuel saver. If, on the other hand, the utility can use the generating capacity of the small power producer as a credit against utility capacity requirements, capital costs for extra generating equipment would be saved. This credit is called a capacity credit. Whether the small power producer is treated only as a fuel saver or is counted as a capacity credit will profoundly influence the economics of small power facilities. This influence is related to siting on a threshhold level. Without satisfactory economies of operation, there may not be much effort to site small power facilities like WECS or biomass. Thus, on a threshhold level, the provision of law that establishes interconnection and backup criteria will have a significant effect on siting of WECS and biomass.

Another important influence on a potential small power producer's decision to produce power is the extent of regulation that may be imposed upon him by the state Public Utilities Commission. A small power producer will not want to be classified as a public utility because a public utility is subject to extensive regulation. The regulation is designed to control the state-granted monopoly that a public utility obtains as a part of its charter. If a small power producer is declared to be a public utility and is in the service area of an existing utility, the small power producer may be forced to stop producing power [280].

The definition of a "public utility" varies from state to state. Some states simply define a public utility as any person generating or transmitting electricity [281]. Other states require that the electricity be sold to the public [282] or that facilities be for public use [283]. The treatment of a small power producer by the state public utility law is important, but it is not sufficiently related to the purpose of this paper to merit extensive analysis. The problem does exist and the solution could be easily arrived at by exemption. California specifically exempts cogenerators from public utility regulation [284]. Whether such a solution should be adopted by many states is not within the scope of this paper.

SECTION 5.0

APPLICATION OF LAWS TO WECS AND BIOMASS SITING BY USER CATEGORY

5.1 UTILITY SITING CONCERNS

Utilities will want to use the largest practical scale WECS or biomass facilities. For WECS, a large array would be similar to the planned Medicine Bow Wind Project, which could eventually consist of an array of fifty 2.5-MW WECS. These WECS would work in conjunction with the Colorado Rivers Storage Project, a hydroelectric network, to supply 404 million kWh of reliable power per year [285]. For biomass, the utility scale plant would be at least 50 MW, similar to the planned direct-combustion wood burning 50-MW plant planned for Burlington, Vt. [286], but probably less than 100 MW due to supply problems.

Particularly with large WECS arrays, the need for transmission lines is inescapable. Because the sites that best lend themselves to multiuse applications are basically open space areas like agricultural, recreational, coastal, or desert lands, most large-scale WECS arrays will be located on rural or remote sites. Proximity to a transmission line is therefore an attractive and possibly necessary economic aspect of site selection.

For biomass power plants, an additional requirement presents itself; the plant must be located near a fuel supply. For a utility anaerobic digestion facility, this fuel supply could be several nearby feedlots [287]. For a direct-combustion wood burning plant, the utility could require a guaranteed supply from a forest large enough to be harvested in quantities sufficient to fuel the plant, while regrowing at a replacement rate.

Aside from these practical considerations, a utility using WECS or biomass must operate within a distinct, and sometimes limiting, legal environment.

5.1.1 Utility Legal Environment

The structure of utilities and the legal environment they face circumscribe utility interest in WECS and biomass. Several factors will bear on this interest. Laws promoting certain fuels or mandating pollution standards heighten utility interest in WECS and biomass. But the strong utility interest in large-scale facilities militates against utility use of biomass or WECS. This section describes those aspects of utility law that will influence utility interest in WECS or biomass, as well as those legal and institutional concerns that will regulate siting of WECS and biomass plants of a size that could be of interest to utilities. Utility interest in particular forms of energy is strongly influenced by the regulation imposed on the utility. Most utilities are regulated by state Public Utilities Commissions (PUCs). If a utility sells power for resale across state lines, that sale is regulated by the Federal Energy Regulatory Commission.

For a utility to begin construction of a power generating plant, it must obtain a certificate of public convenience and necessity from the state PUC. Without this certificate, the PUC will not allow the utility to include the new plant in its rate bases and therefore, will not permit the utility to recover the capital invested in that plant. A regulated utility will not build a power plant without a certificate of public convenience and necessity. The process of obtaining this certificate entails hearings and extensive documentation to ensure that the plant is necessary (i.e., there is a need for the power that the plant will generate), that the plant is to be located at an acceptable site, and that the method of generating power is reliable. Some states with comprehensive siting statutes include the environmental site evaluation in the process of deliberating on the granting of a certificate of public convenience and necessity [288]. In other states with comprehensive siting statutes, the certificate cannot be issued until the site selection process is complete. Either way, the states with special siting legislation require that the site satisfy the state and federal environmental regulations prior to the issuance of a certificate of public convenience and necessity. States that do not have special siting procedures will issue the certificate upon the precondition that all other applicable permits are obtained [289].

The process of obtaining a certificate of public convenience and necessity is a major regulatory interaction for a utility. To undergo this process for a small plant like a biomass plant may be prohibitively time-consuming and expensive for a utility—especially a large utility. In many states, municipal utilities are exempt from public utility commission regulation because the fact of public ownership is considered to provide sufficient public control. Thus, municipal utilities are more likely to be interested in biomass plants than private utilities. This interest will translate into more sitings of biomass plants by municipal utilities than by private utilities.

Public utilities have a responsibility to provide reliable service to everyone within the service area of that utility. A part of providing this reliable service is forecasting future demand and building enough power plants to satisfy the projected demand. A margin of extra generating capacity must be maintained for both planned and unplanned power plant outages. This margin must be large enough to avoid interruption of service.

WECS can be used in a fuel saver mode or as a capacity credit. The inherent unpredictability of the wind is an issue because the amount of reliable capacity available from a WECS farm will be less than the rated capacity of the whole farm. Reliability is a threshold issue. Solutions to the unpredictability of the wind will very likely arise out of increased pooling and wheeling among utilities, as well as possible altering of the margin requirements by implementing load management techniques and interruptible rates where applicable [290].

Use of WECS to save fuel is of less interest to utilities than use of WECS as base or intermediate load capacity. As the price of fuel rises, interest in WECS as a fuel saver may increase on the part of utilities. But the double capacity cost of WECS (power available from WECS must be supported by an equal amount of power from conventional power plants if no capacity credit is allowed for the WECS) will significantly reduce utility interest in WECS.

One factor that works in favor of utility interest in WECS is the time required for building WECS projects. Because a utility cannot include a plant in its rate base until that plant is "on-line," a utility generally is, often interested in as fast a construction cycle as possible. WECS can be off-the-shelf items that take very little time to install. Thus, the utility would begin getting a return on its investment very quickly with a WECS farm. The delays encountered in other power-plant projects cause substantial quantities of utility funds to be tied up and unproductive for many years. This problem would probably not occur with WECS installation.

Even aside from the PUC regulations, the utility is the WECS or biomass user that will encounter the most regulation in siting a plant. But the utility is also the user most experienced with such difficulties and best able to work with them.

The utility seeks the largest practical facility because utilities, by definition, are interested in grid power. Larger facilities—more centralized facilities—minimize transmission line requirements, fuel transportation problems, and the number of facilities that must be licensed. There are also economies of scale to consider. However, some commentators argue that economies of scale are overplayed or actually favor smaller plants [291].

In any event, a large WECS array or a very large biomass facility, though small by most utility standards, are large enough to cause much regulatory involvement. Utility-scale biomass plants are likely to be labeled "major emitters" under the Clear Air Act and thus subject to BACT in attainment areas and LAER in nonattainment areas. If there is any federal action required on the project, an environmental assessment will be required to determine the necessity of an EIS. If the state has a "little NEPA," then an EIS may be required without any federal action. If the project is in a coastal region, then a coastal permit may be required; if in a floodplain, then floodplain insurance may be required. Management of these permits is a function of the state and local planning, as well as EPA, HUD, or DOC planning and approval.

Another characteristic of WECS and biomass that is particularly applicable to the utility is the need for a large quantity of land. WECS arrays must have spacings between machines of from 6 to 12 blade diameters [292] in order to minimize wind interference among the machines. Biomass facilities require land for the plant itself—which would be substantially the same as for a conventional plant—as well as land for a fuel supply. A 10-MW plant would require approximately 72 mi^2 of forest in order to obtain a continuous supply of wood over a 20-yr cycle [293]. The availability of this land either on federal lands, state lands, or private property must be evaluated.

Thus, the utility is likely to become involved in every aspect of regulatory and land-use law discussed in Section 3.0. But this type of involvement is not uncommon for utilities. WECS and biomass siting could prove to be much less troublesome than most utility projects. The following sections discuss the specific siting issues that may be encountered by the utilities seeking to locate either a WECS or a biomass plant.

5.1.2 Utility Siting of WECS—Current Status

Utility use of wind sytems is currently in the demonstration phase. Several large WECS machines have been installed under the auspices of the Department of Energy (DOE) with the cooperation of the National Aeronautics and Space Administration (NASA). The first such machine to be built was installed at NASA's Lewis Research Center (Plumbrook) near Sandusky, Ohio. This machine (MOD-O) has a rated capacity of 100 kW in an 18 mph wind and has been operating on the Ohio Edison Company's grid as a NASA test facility since 1976 [294]. Three 200-kW (in an 19.6 mph wind) versions of this machine (MOD-O) have been built and are operating at Clayton, New Mex., where it is interconnected with the Clayton municipal electric system; Block Island, R.I., in cooperation with Block Island Power Company; and Culebra, Puerto Rico, in cooperation with the Puerto Rico Water Resources Authority [295]. A fourth MOD-OA is planned for installation in Oahu, Hawaii, in cooperation with the Hawaiian Electric Company. In Boone, N.C., DOE has just begun operation of a 2.0-MW MOD-1 WECS in cooperation with the Blue Ridge Electrical Membership Corporation.

These machines are being operated as a part of a field test program which will last from two to four years. The utility companies will use the power from the WECS and monitor the systems for environmental effects as well as operational reliability and performance characteristics.

The substantial federal action in each of these projects triggered NEPA's documentary mandate. Environmental assessment of the field test program concluded that an EIS was required for the Block Island project. The other four systems currently in operation (Plumbrook, Clayton, Culebra, and Boone) received negative declarations—no significant environmental impact was found. The Block Island EIS was required mostly because of projected television interference due to reflection of TV signals from the blades. The EIS recommends installation of cable TV in the affected areas to solve this problem [296].

In the private sector, Southern California Edison is in the process of installing a 3.0-MW (in a 40 mph wind) WECS in San Grogonio Pass near Palm Springs, Calif. [297]. Because Southern California is financing this project from the utility's own funds and placing the machine on land owned by the utility, no federal action has occurred and NEPA does not apply to the project. The utility hopes to obtain data that might support a large-scale WECS array at the site [298] and will be taking extensive environmental data during the operational phase of the project.

The next stage of field demonstration will be the testing of large-scale arrays. Three areas in particular are planning large-scale arrays—Medicine Bow, Wyo.; Molokai, Hawaii; and Pacheco Pass, Calif. In Medicine Bow, the project is sponsored by DOE but the lead agency is the Bureau of Reclamation within the Department of Interior. An environmental assessment has been prepared for the first five machines (MOD-1 WECS with 2.5-MW capacity in a 19.6 mph wind). As a result of this assessment, a negative declaration was issued—the project was determined to have no significant effect on the environment [299]. The negative declaration stipulates that the WECS and related facilities will be located "at least .8 miles from prairie dog towns to minimize potential impact to black-footed ferrets," an endangered species [300]. The negative declaration also notes that the project is a field test and is temporary. Other sources indicate that if the tests yield the expected information, the machines will remain in service and up to 45 more machines will be added to the area [301]. If this decision is made, a new assessment will be required and it is likely that an EIS will be prepared [302].

The Pacheco Pass WECS array in California is planned by U.S. Wind Power Associates, a Massachusetts company, in cooperation with the California Water Resources Commission. The California Commission has contracted to purchase electricity from the first megawatt of capacity (20 machines). This project will use smaller machines (50 kW) and may ultimately include 500 installations [303]. The power will be used to offset the fuel needs of the California Water Project pumps. The environmental impacts are currently being assessed and an EIR (Environmental Impact Report) will probably be prepared under California's Environmental Quality Act.

The Molokai wind farm will be a joint effort of Molokai Electric (the island's utility company), the Hawaii Natural Energy Institute, and Maui County. Currently, preliminary negotiations are being conducted with Kaman Aerospace for the first ten 55- to 60-kW WECS. After an evaluation period with those 10 WECS, an additional 90 more may be installed. This 100-WECS array would provide 27 million kWh of energy per year [304].

5.1.3 Utility WECS Siting—Are There Problems?

Siting of large-scale WECS arrays should be no more trouble than siting transmission lines. Because more than 276,000 miles of transmission lines have been sited in the country [305], optimism may lead some to assume that WECS siting will be relatively trouble free. This assumption might be accurate and correctly reflects the WECS siting experience to date, but perhaps a more precise way to state the situation would be to assert that legal barriers will not prevent arrays from being sited because of any element peculiar to WECS. The same factors that must be examined for any project must be analyzed before attempting to site a WECS array. Prudent project management can obviate or modify most difficulties that may exist.

This comparison with transmission line siting is particularly apropos because, in spite of the many miles of sitings in the past, it is increasingly difficult to site anything—even transmission lines [306]. The legal framework for siting transmission lines is well established and provides a fairly straightforward procedure for defining corridors and obtaining rights-of-way. WECS arrays could be sited by essentially the same procedure. If there is no opposition, the process is a smoothly flowing and uncomplicated one. But opposition is a familiar element to almost every form of energy facility except large-scale WECS.

A poll conducted by the National Assessment of Educational Progress in Denver found that young adults were more amenable to wind machines within 25 miles of their homes than any other form of energy production [307]. But this poll also found that young adults were largely ignorant of energy alternatives, and therefore were not well informed about WECS. As large-scale WECS become more common, people will become more informed about the nature of large WECS and opposition is bound to arise. It is impossible to guess how strong this opposition will be. It is even difficult to determine the potential sources of this opposition. Environmentalists may oppose WECS siting because they may object to the aesthetics of large WECS arrays installed in open areas. They could object because of possible threats to wildlife. But, environmentalists may also decide that WECS arrays are the most acceptable alternative to coal, nuclear, or oil-fired power plants, in which case environmental opposition may not arise. It is possible that opposition could arise from coal or mining interests that would be unable to use the tracts land that are occupied by WECS arrays. Opposition could arise from many sources for various reasons that are difficult to predict. However, the real difficulty for siting WECS in the future will not be legislated complications. The problem will arise from popular rejection of WECS and the resultant legal barriers that can be erected by anyone who is opposed to anything.

5.1.3.1 Land Acquisition

WECS arrays require large tracts of land. But within such a tract of land, the actual machines only use a small percentage of the land area. For example, for the Medicine Bow primary site [308], development rights will be acquired (mostly from private land owners) for 4400 acres. Within this 4400-acre restricted development area, the five WECS will require 50.93 acres (including roads, transmission lines, and the WECS base area) [309]. The restricted development area prohibits construction over 50 feet above the ground without federal government approval. These figures indicate that below 50 feet, (the lowest reach of the WECS blade is 50 feet) less than 1.5% of the land is being used by the WECS array. The rest of the land will be available for grazing. Recreational activities or agricultural activities could also be carried on in the unused portions of the tract of land required for the WECS array.

For the Medicine Bow project, rights-of-way were acquired for transmission lines that crossed federal lands. Permanent easements were acquired for roads, buried transmission lines, and WECS site areas—which will be located on privately owned lands. Most of the overhead transmission lines will run within an existing transmission line corridor. The overhead line will be a 34.5 kilovolt (kV) transmission line [310].

To grant the right-of-way, the Secretary had to consider the environmental impacts of the project. The EA determined that the project would not have a significant impact on the environment. The Federal Land Policy and Management Act of 1976 [311] specifies that a grant of a right-of-way for generation, transmission, and distribution of electric energy is an appropriate use of federal lands. Thus, WECS arrays, after passing environmental muster, should not have trouble obtaining federal rights-of-way for the WECS themselves or for the required transmission lines. It should be mentioned that the transmission lines associated with a WECS array would probably not be huge steel towers with dozens of very high voltage wires such as those used for long-distance transmission of electricity. The Medicine Bow Wind Project will use single wood poles with three conductors mounted directly to the pole through insulators [312]. The transmission line proposed should be less obtrusive than overhead telephone lines.

Other land acquisition issues exist. Siting a WECS array in a wilderness area would be almost impossible. Siting in a coastal area would require a coastal permit in most states. Because of the relatively minor environmental impact of WECS arrays—when compared with other forms of energy production—and because energy facility siting must be included in coastal management plans, siting of WECS arrays in the coastal zone should not encounter major barriers [313].

Other site-specific concerns (endangered species, historical preservation, etc.) are not peculiar to WECS installations. In fact, the low percentage of land actually used for WECS arrays will permit greater flexibility in the placement of each machine and will therefore make it easier to work within wildlife and cultural protection laws without jeopardizing the project.

Easements over private lands can be obtained by negotiations or by eminent domain. Regardless of which method is used, the most critical matter of concern is public reaction to the WECS project.

5.1.3.2 Public Reaction to WECS

A landowner will not easily give up an easement for use of land if he believes that the project is foolish, that the project poses a danger to him and his property, or that the project will be a nuisance [314]. The general public has many misconceptions about windmills and is largely ignorant about WECS [315]. A key element of any siting project must therefore be an information campaign designed to enlist the involvement of the affected community in the siting process. Perhaps the most significant finding listed in the Medicine Bow EA was the determination that "[t]he proposed action is not controversial nor is there any known public opposition to the project" [316]. This is primarily a sociological issue, but it has profoundly legal impacts. Before granting a right-of-way on federal lands, the appropriate Secretary must consider the impact on aesthetic and scenic values [317]. NEPA regulations require that the environmental assessment include aesthetic impacts [318]. Eminent domain hearings must afford the affected parties the right to be heard [319]. If landowners feel threatened aesthetically or otherwise, their protest will be heard and the siting process will be complicated. Even in direct negotiations with a landowner for an easement on his property, that landowner's feelings about the project are critical.

To date, no opposition has been raised to any wind projects. Public reaction to the MOD-OA at Clayton, New Mex. has been very positive through the first year of operation [320]. A 1977 study by the University of Illinois found that "[p]eople are basically very favorable toward use of wind or solar sources for electric energy production" [321]. The report did not find that acceptance was universal. Particularly in Chicago—one of six places surveyed—the attitude toward WECS was found to be negative [322]. People from all survey sites felt that sample scenes were more pleasing without WECS installations and that "strings of windmills are likely to be only slightly better received than strings of powerlines" [323].

5.1.3.3 TV Interference, FAA Acceptance

Large-scale WECS arrays should cause very little TV interference because they will generally be located in areas of very low population density. The interference produced by the blades can affect television reception only within a few miles of the WECS installation.

The FAA requires lights on all large WECS towers and also requires that the blade be illuminated at night. This is accomplished with floodlights on the WECS hub shining along the blade.

If a WECS array is to be located near an FAA navigational aid, the structure must be below a plane rising 2 degrees from a horizontal plane starting at the navigational aid. For the 350-ft tall MOD-2 WECS to be installed near Medicine Bow, Wyo., the required distance from a navigational aid would be less than 2 miles.

5.1.4 Utility Siting of Biomass Plants

5.1.4.1 Current Utility Uses of Biomass

Supply problems limit the practical size of biomass facilities to a maximum of about 100 MW. Therefore, biomass will not fit into utility plans for large-scale plants [324]. Utilities with small plants are nonetheless interested in biomass, and in several parts of the country that interest is intensified either by particularly acute oil supply problems or by particularly strong interests in renewable fuels and energy independence. This latter sentiment appears to be strongest in Hawaii where biomass is presently used to generate approximately 13% of the electricity consumed in the state [325]. Much of this electricity is produced by burning bagasse (the waste from sugar processing) in boilers. The sugar industry generates this power to run its mills and sells the excess to the utilities.

Hawaii is also one of the few places in the county that is actually engaged in silvicultural plantations. Two projects farm eucalyptus trees as part of commercial venture in tree farming. Also, a major research project is underway to determine the best method of growing the Koa Haole tree as an energy crop. This tree is reputed to grow faster than the eucalyptus tree [326]. Currently, the paper pulp industry pays a better price for wood chips than the energy industry. One result is that all harvested and chipped eucalyptus trees are now being exported to paper pulp plants and not being used as an energy source.

Hawaii is also suitable for involvement in production of biomass fuels—particularly ethanol. Ethanol is produced by fermentation of high sugar content biomass. Though production of ethanol is not a utility function, producing ethanol for resale is a utility-scale operation.

Hawaii has recently submitted a proposal to DOE for a project that will use a former Seagram's rum plant to extract ethanol from molasses. Molasses is a by-product of sugar cane processing. The stillage from the ethanol fermentation would be sold as animal feed and fertilizer [327].

Biomass in the form of wood chips is being used by Burlington Electric, the municipally owned utility in Burlington, Vt. Two wood-fueled boilers now power two 10-MW turbines [328].

The city of Hempstead, Long Island is now burning 2000 tons of MSW per day and generating 40 MW of electricity to service up to 15,000 Hempstead homes [329]. A separation facility removes the combustible from the noncombustible components of the MSW. The combustible papers, cardboards, woods, and other organic residues (like lawn cuttings) are shredded underwater and then dried and burned. The ash, 3% of the original volume, is then removed to a landfill [330]. The city is sponsoring research on possible uses of the ash in the construction industry [331]. No air emission problems have been encountered [332]. After being separated from the combustible wastes, the noncombustible solid wastes are further separated into aluminum, ferris metals, and glass, which are sold.

The Lamar Utilities Board in Lamar, Colo. is planning to build a bioconversion facility for production of methane. The plant will produce over 1 million ft^3 of gas per day by digesting manure obtained from 3 feedlots within 15 miles of the proposed plant [333]. Over 50,000 feedlot cattle are confined in these three feedlots. The plant will be located on a 100-yr floodplain. Therefore, a permit to build within a floodplain will be required. To obtain this permit, the facility design will have to be appropriate for a floorplain region. The required precautions have been incorporated into the plant design [334].

The original plans specified algae ponds to purify the effluent, which would then be recycled to save water. This proposal has been tentatively dropped because the large area required for the algae ponds appears to make the process uneconomical [335]. The plant will therefore use approximately 350 gal. of water per minute in a once-through process. A wastewater discharge permit will be required from the Colorado Department of Health, which manages the NPDES in Colorado under EPA-approved standards and procedures [336].

The digester gas will be used to fire boilers at the Lamar power plant that produces electricity. Some of the waste heat from the power plant will be used to heat the digestion tanks at the bioconversion plant. The anaerobic digestion process must be maintained at 95° F [337]. This facility is still in the contract negotiation stage.

5.1.4.2 Utility Siting of Direct Combustion Biomass

There are three distinctions between biomass electric power plants and coal or oil power plants—collection, volume of material, and emissions. First, the collection techniques for biomass are significantly different from fossil-fuel recovery techniques. Harvesting of unmarketable trees, cultivating silvicultural fuel plantations, or collecting forest residues present unfamiliar complications to the energy industry. These difficulties are not more significant than the oil and coal recovery difficulties, the problems are just different.

Competition for biomass by other users rates high on the list of difficulties. The wood pulp industry is a prime contender for wood chips. Other competitive uses exist for forest products. A study done in North Carolina has determined that wastes from the forest industry "cannot be relied upon as a stable source of fuel wood since the industry itself is using more and more of its own wastes for energy" [338]. The study concludes that harvesting available unmarketable trees at a renewable rate [339] will provide plenty of wood [340]. Special tree plantations are not currently considered economical, but demonstration projects in Florida and semicommercial projects in Hawaii are bringing this concept closer to fruition. The competition problem could be even more acute with the energy plantation—not only would the forest products be sought by nonenergy interests, but the land itself may be sought for other uses once its value is proved.

Land use is the main problem in fuel collection for large-scale wood burning power plants. The harvesting of large quantities of wood (500,000 tons/year for a 50-MW plant [341]) has environmental consequences and the size of the operations requires that many square miles of land be available. Because of the low heat value and bulkiness of wood, it is not economical to transport it long distances. The plant must be sited close to the trees. Thus, wood burning power plants will be better suited to thickly forested areas like the Northeast or Northwest, and will not be appropriate in those areas that have very limited forest regions.

Wood is a bulky fuel; by volume it is 10 times as bulky per Btu as coal [342]. Because of this fact, transportation problems in siting a plant must be considered. A 50-MW wood-fired power plant can expect to consume between 1500 and 1800 tons/day of wood [343]. Given that one truck can carry 20-25 tons per load [344], up to 80 trucks per day may be required to supply such a plant. A given point on the route traveled by these trucks will see 160 passages per day. Such a large number of trucks can constitute a safety hazard that must be considered when siting a biomass power plant. Many neighborhoods will not tolerate the traffic from so many large trucks.

Another aspect of the bulkiness of wood as a fuel involves storage. The storage of wood wastes for use in a large plant may require many acres of land [345]. Runoff waters from such a storage area can cause water pollution and may, therefore, require a permit. The storage area itself may also be an eyesore and may violate local aesthetic zoning ordinances [346].

The final difference between a conventional power plant and a wood-fired power plant is the type of air emissions. The major pollutant from a wood burning plant is particulate matter. Wood is lower in sulfur than oil and vastly lower in sulfur than coal [347]. Thus, sulfur pollutants are only a problem in areas that already have fairly severe sulfur pollution levels. The particulate pollution level can be reduced by 99% with the appropriate control equipment [348]. New EPA Source Performance Standards for particulates can be met with control equipment and the standards for sulfur can be met without control equipment [349]. Thus, wood has a distinct emission advantage over both coal and oil.

Siting of direct-combustion MSW plants is very similar to siting of wood-fired power plants. One distinction is the fact that the collection mechanism is already in place. Garbage trucks are already traveling throughout cities every week picking up trash. Unfortunately, the content of that trash is difficult to predict and dangerous compounds will periodically appear. This difficulty can be reduced by processing the trash and converting it to refuse-derived fuel (RDF). Companies engaging in making this conversion are appearing in various places around the country and are looking for markets for RDF [350]. The separated nonorganic wastes are recycled as much as possible and the nonrecyclable residue is dumped in landfills.

There remains a problem with unpredictability of MSW. The presence of strange or dangerous chemicals or explosives is a risk. In designing and siting a plant to burn MSW, this risk must be taken into account. The storage of MSW presents a more acute problem than wood chips because MSW, if allowed to get wet, will settle in large unmanageable chunks. In Hempstead, Long Island, the MSW is kept indoors in a 3.5-acre storage building [351].

Many plants may burn MSW with coal to reduce sulfur emissions from the coal plant. New stationary source performance standards for fossil-fuel-fired electric utility steam generating units cover power plants with a capacity of more than 73 MW, and require a 70% reduction in sulfur emissions for low sulfur coal or a 90% reduction in sulfur emissions for high sulfur coal [352].

If a plant uses less than 25% fossil fuel, that plant is exempt from the percentage reduction requirements of the regulations. Refuse-derived fuels (RDF) are exempt from the sulfur standards. The regulations do not apply to most cogenerators. Thus, utilities or very large cogenerators who sell more than two-thirds of their power for a total sale of more than 25 MW are the only entities covered by these regulations. Any method used to reduce the sulfur emissions can be counted toward the required percentage reduction. Methods of reducing the sulfur emissions would include mixing the coal with a lower sulfur fuel like RDF, which can be made compatible with ordinary stoker-fired boilers by densification—a process by which the RDF is compressed and pelletized [353]. Though the process of densification is expensive and the regulations would require the use of a scrubber, even if the coal is mixed with densified RDF (because the percentage reductions could not be met fully by mixing the fuel), the use of RDF or wood mixed with coal could be attractive to utilities as a method of reducing sulfur emissions and simplifying some of the environmental difficulties involved in siting coal-fired power plants.

5.2 INDUSTRIAL, COMMERCIAL, AND LARGE RESIDENTIAL SITING OF WECS AND BIOMASS

This section will discuss the legal barriers and incentives that exist for the owner of an industrial plant, a commercial park, or a large apartment building, who desires to produce some or all of his own energy from WECS or biomass sources. Each of these potential users of biomass or wind energy systems tends to be unfamiliar with the processes of power generation or with the legal or institutional structures that exist to manage power generation. The other side of this unfamiliarity is the lack of experience that the institutional and regulatory agencies have in interacting with industrial, commercial, or large residential energy producers. Utilities, major energy suppliers, state and local governments, and even power consumers have worked with each other to form a closed circle of power generation with its own language and, to a large extent, rules that do not accommodate unfamiliar forms of energy production and use.

Many relatively small-scale power producers do exist and are managing their power needs quite satisfactorily. For example, the pulp and paper industry is now supplying almost half of its energy needs throughout the United States [354]. Over 150 pulp and paper facilities generate energy for use within their plants [355]. But, if the medium-scale industrial or the large residential consumers of energy are to begin generating and cogenerating to satisfy their electrical and process heat needs, several institutional and legal structures will have to change. These changes range from such intangibles as apartment-dweller attitudes to much more concrete adaptations of utility rate structures. Siting-related institutional barriers to on-site power generation from WECS and biomass are: zoning regulations, pollution laws, aesthetics, supply and storage requirements, and safety considerations.

5.2.1 Siting of WECS for the Medium-Scale User

Medium-scale users of WECS will probably be seeking to site machines capable of generating from 20 to 45 kW of power. Such machines would have rotor diameters of between 25 and 40 feet [356]. They must be supported on towers that stand at least 30 feet above any other structures in the area [357].

Because of the variability of the wind, a backup system would be required. Perhaps the ideal would be for a complex to use the wind in a fuel-saver mode (having no storage) and to use a biomass-fired direct combustion for backup. The biomass, which could be waste that is generated on-site, would be stored at times when the wind could adequately supply requisite power and would only be burned when the wind was not available. This system would not be inexpensive and it is more likely that the WECS would be sited alone. The utility grid would then be used for backup; that way excess wind-generated electricity would be fed back into utility lines. If an equitable rate structure could be arranged, this would amount to storage of the excess energy until such a time as the wind did not supply the full needs of the complex. Interconnections with the utilities are now being tried in several places in the country, in an effort to generate data that might support a determination of a fair rate structure [358].

Areas zoned for industrial use are generally much less restrictive than commercial or residential zones. The height or aesthetic excesses of a medium-scale WECS are not likely to be as troublesome in an industrial zone. But, because height requirements are likely to be much more lax, the industrial site may be particularly vulnerable to loss of wind due to neighboring industries' construction of large buildings. Thus, with height unrestricted protection of wind access rather that restrictions on building the machine, may be the problem. This same difficulty can occur in commercial areas that permit very high buildings.

In a residential area (zoned for large multifamily dwellings) height restrictions may forbid the building of a WECS tower. Siting of the WECS at such a location would therefore be precluded without a variance or a zoning amendment. Residential neighborhoods are also likely to have an Architectural Review Board that will approve or disapprove a project based upon such items as potential effect on neighboring property values, aesthetics, and compatibility with the existing neighborhood [359]. These boards are often inflexible and unimaginative and therefore unreceptive to innovation [360]. Thus, working with these boards could prove difficult for potential WECS users.

Some luxury apartment complexes are using more land and developing an environment of spaciousness, permitting greater flexibility in placing the WECS in a location that is obscured from the view of neighbors. If the neighbors are not able to see the WECS, complaints and problems will be minimized.

The height requirements of a WECS are inescapable. The only variable is the regulations that apply to the chosen site. If the site is zoned against structures over a given height and that height is lower than the technically optimum tower height, a variance or a zoning amendment must be obtained.

If the community and the neighbors are not amenable to a WECS, the variance will most likely be denied. Such a denial is well within the power of the community and would prohibit the building of the device. At least one case has arisen in which the granting of a variance for a WECS was found to be outside the variance power of the Zoning Board of Adjustment. This occurred in Hanover, N.H., where the board reversed itself after first granting a variance for a residential WECS. The arguments used by neighbors who sought the reversal were based upon the WECS not being an accessory to residential use and the fact that the board only had special exemption power to grant a variance for communication towers. The WECS was not a communications tower [361]. Therefore, the WECS owner was forced to seek an amendment of the zoning ordinance from the city council or to abandon the project.

The St. Petersburg Times in Clearwater, Fl., has erected a 15- to 20-kW WECS on the roof of one of its downtown Clearwater buildings. The tower is 115 ft high. Inside the tower, a stack of three Darrieus WECS (vertical axis, eggbeater-type) will spin in the wind to generate power for the building. This structure rises high above the Clearwater skyline and can be seen from any point in the downtown area. The fact that this structure exists shows that local zoning does not necessarily preclude siting. The support of the commmunity is the key to working within zoning regulations and variance procedures [362].

Safety is perhaps the main concern following aesthetics. The reason is that the aesthetics issue is one that can be readily focused upon. The fact that the neighbors do not like the WECS intrusion on the visual appearance of the neighborhood must be resolved. Fears for safety are not as easily addressed. The possibility of a tower falling over or of the WECS throwing a blade may be very remote, but fear of such an event is driving communities to propose setbacks equal to the blade-throw distance [363], or equal to some multiple of the tower height [364]. Such regulations could preclude the siting of a WECS in any urban environment. Taking the WECS installation in Clearwater as an example, the 115-ft tower would be said to require a 172.5-ft radius area with no structures or property lines in that area. (If NECPA-proposed guidelines are used.) The blade-throw range for most WECS would be even farther than the 172 feet that the 1.5 tower length set-back would require. To set aside such an extensive area would be prohibitively expensive or impossible for most urban developers or industrial WECS users.

The safety zones that are being suggested for WECS are to a large extent due to the lack of standards available for building inspectors' use in evaluating the safety of the machine or the tower. Unfamiliarity inspires caution. Lack of standards to assuage a zoning board's unfamiliarity with WECS is likely to inspire excessive caution. The result could be standards that effectively exclude WECS in urban areas.

5.2.2 Siting of Biomass for the Medium-Scale User

For industrial biomass, the focus is cogeneration. Through cogeneration, electrical production that is usually less than 30% efficient reaches efficiencies of up to 85%. Instead of wasting over two-thirds of the available energy in a given fuel, less than one-sixth is lost in cogeneration. If biomass is the cogenerator's fuel, conventional fuels are being saved at over twice the rate that they would be saved if the biomass was being used in a conventional power plant. In addition to these savings, the biomass fuel in industrial applications is likely to be a substance that was previously considered waste. In the agricultural processing industries, peach pits, walnut shells, and other woody food-processing wastes that were once liabilities now show great promise of providing energy independence for certain segments of the industry [365].

Unfortunately, legal barriers oppose full exploitation of the potential of biomass cogeneration. The industrial facility desiring to cogenerate will encounter many difficulties that are not related to biomass but simply apply to cogenerators regardless of the fuel. The most pronounced of these difficulties is the question of utility rate structure. An excellent example of the inequities of current utility treatment for cogenerators was offered by an employee of the Louisiana Pacific Corporation, in his testimony on a proposed 1600-MW power plant in northern California:

> On this subject of buying and selling power, the big problem we see is with rate regulation; Louisiana Pacific is both a supplier of power and only very infrequently a customer for power. According to established rate schedules we have to pay standby charges and also a demand energy cost for any power used. As an example, if we pulled 6 megawatts in the summertime peak energy period for only 30 minutes because of an upset in our generation sytem, we could have to pay PG and E $20,700 just for the demand charge. To make up for this we would have to sell PG&E 1,035 megawatt [hours] that month just to break even. The cost ratio of buying and selling power is 345:1. [366]

This issue is significant to siting only at a threshhold level. If industrial cogenerators are not given a reasonable price for the energy they buy as backup, and if they are not given satisfactory remuneration for the power they sell to the utilities, there simply may not be many sitings of industrial cogeneration facilities. A full discussion of this issue would encompass more than one paper's entire scope. For the purposes of this paper, it is sufficient to raise the issue. However, the importance of the issue cannot be minimized because it goes directly to cost, which will be a "make or break" consideration for the industrial user.

The forest products industries now generate most of the steam and electricity that are produced from biomass [367]. Thus, forest residues are the most popular fuel. Forest residues on commercial forest lands are rough, rotten, dead or small trees, or noncommercial species. This includes undergrowth, tops and limbs from commercial trees, and bark [368]. In other words, forest residues include any vegetation that cannot be used for lumber or for pulpwood. Forest residues are called fuel grade wood. This is the lowest grade wood and has no other commercial purpose. It should be noted in passing that as harvested wood becomes more efficiently utilized, fewer of the timber industry by-products will be considered fuel grade wood.

The forest products industry in several parts of the country is already approaching energy self-sufficiency. Through their lead, the technology for burning wood in industrial applications is well developed and off-the-shelf modular components for burning wood to generate steam or electricity are available in sizes up to 5 MW and 100,000 lb/hr of steam. These modules operate at efficiencies of greater than 80% [369].

Thus, for the industrial energy consumer with substantial woody wastes or by-products, technology that can convert his wastes into useable energy and cut down on disposal problems and energy costs is readily available.

5.2.2.1 Environmental Concerns

The industrial, commercial, or large residential biomass user will have to obtain several environmental permits. The major permits are air and water pollution permits. If the state is one that has a SEPA, then it is likely that the state involvement in the permit process will trigger environmental assessment reports that could lead to the preparation of an environmental impact report. Whether such a report is prepared depends upon many factors, including the size of the proposed facility, the extent of pollution control equipment proposed, the storage and supply provisions, and the quality of the environment where the facility is to be built.

Biomass is very low in sulfur. As a rule, particulate emissions are high but can be controlled to be well within EPA New Source Performance Standards. The control equipment is costly and an industrial user would want to minimize the amount of equipment required. The control equipment requirements depend upon the air quality in the region that the plant is to be located. If the air quality exceeds EPA National Ambient Air Quality Standards, then EPA is the permitting authority and BACT would apply. In arriving at a determination of what the best control technology is, EPA could consider energy (the cogenerator is over twice as energy-efficient as a conventional power generator); other-than-air environmental benefits (biomass burning on a large scale would reduce the need for encroaching on the environment to obtain conventional fuels, and biomass burning can positively affect solid waste problems); and economic impact (widespread utilization of biomass could reduce the need for imported fuels and excessively stringent control requirements could make the biomass cogeneration scheme excessively expensive).

If the proposed cogeneration facility is in a nonattainment area—the area exceeds national ambient standards for some pollutants—then in most cases the state will be the permitting authority. Lowest Achievable Emission Rate (LAER) will apply. LAER simply seeks the best pollution equipment that has been demonstrated in theory or in practice. No other factors are considered. In addition to the LAER requirements, the pollutants that will be emitted must be offset by reductions from nonmajor emitting facilities elsewhere in the nonattainment region in which the medium-scale biomass user will operate. These regulations will prevent siting of many cogeneration facilities, especially where state standards are more stringent than EPA requires.

If a plant will produce more than 250 tons of pollutant per year, then LAER or BACT will apply to that plant. Otherwise, the strict pollution control requirements for the Clear Air Act will not apply and the permit process will be much easier. The nonmajor emitting facility will not be subject to the offset requirements or the LAER or BACT requirements of the Clean Air Act.

5.2.2.2 Institutional Constraints

The intraurban commercial, residential, or industrial facility desiring to generate steam or electricity on-site with biomass will have to ensure an adequate supply of biomass. If such a supply is available from activities on-site, then the problem is much less acute. Therefore, the large apartment building that burns residential trash or the industrial site with woody by-products will have fewer supply problems. However, both are vulnerable to reductions in the supply of available fuel reduced because of increased efficiencies in the use of their fuel by-products.

For an on-site trash burning plant to work in a large apartment complex, some mechanism must be established for separating organic from inorganic trash. This could require the cooperation of the tenants and may prove very difficult to administer. Therefore, even where a significant supply of combustible material is generated on-site, it may prove easier and safer (uncertainty as to the content of the trash to be burned can be dangerous) to obtain fuel from a fuel supplier. Thus, both the commercial and large residential biomass user may find that the best source of biomass is not within their own operation.

Several environmental and logistic difficulties could arise from a need for an off-site source of biomass. The biomass must be transported to the plant and an adequate supply of fuel must be kept on-site to cover a sufficient period of time to avoid interruptions in energy supply. One utility with a 10-MW wood-fired boiler found that 30 days worth of storage was required to ensure a regular supply of wood [370]. Even if a smaller supply of fuel is found to be necessary, aesthetic and zoning conflicts come into play.

Of the several forms of biomass that are candidates for use in medium-scale applications, MSW, RDF, and wood chips are the most promising. RDF (shredded MSW with the inorganic components removed) and MSW are very bulky fuels that do not weather well if stored outside. RDF is becoming available in some areas of the country [371]. Wood chips are less bulky and can be readily stored outside, but require much more storage than coal.

Zoning could easily preclude any outdoor storage of MSW, RDF, or wood chips as an aesthetic blight on the neighborhood and a nuisance. Indoor storage in warehouses could be banned in residential and commercial districts by zoning regulations that consider warehouses to be industrial. In any event, because of the quantity of land required, storage of biomass could prove uneconomic for any medium-scale user. Thus, daily delivery mechanisms may be attractive.

Daily delivery of biomass to commercial and residential areas could cause traffic and pollution problems. Trucks emit air pollution. Traffic causes safety and environmental disruptions which are valid subjects of zoning regulation [372]. In commercial areas traffic concerns will be less of a problem, but the issue of pollution will have to be considered by anyone desiring to site a medium-scale biomass burning facility.

One solution to the problems that arise out of the bulkiness of many forms of biomass is to pelletize the fuel prior to delivery to the consumer. Pelletizing—or densification—is a process of densifying the RDF or wood chips. Through this process, the biomass bulk can be reduced by two-thirds [373]. Coal delivery and storage has not been a problem in the past. So, if RDF and wood chips can be reduced in bulk to only twice the bulk of coal (per Btu), delivery and storage difficulties would be substantially reduced. Pelletizing also makes RDF compatible with stoker-fired boilers. The difficulty with pelletization is that it is not presently done on a large scale and suppliers do not exist in most parts of the country. Densification is also an expensive process.

The industrial biomass user who generates enough waste on-site to satisfy energy needs might also have enough land to store the biomass in adequate quantities to ensure his supply. But such a user could still encounter land-use problems. A large pile of woody wastes would constitute a fire hazard and, if it became a home for many undesirable rodents and bugs, a nuisance. If it rains on the supply, the runoff from the pile could pollute local waters and require a permit stipulating that control measures be taken. The cost of such measures could outweigh the advantages of the on-site energy production to the plant owner.

Thus, the medium-scale biomass burning facility may be burdened with several siting difficulties. First, any such facility must ensure a supply that will minimize imposition of traffic on the neighborhood. It must have a method of storage that will not be out of character with the neighborhood and that will constitute a reliable energy supply. The operator of the facility will have to determine the size of the facility and must consider the pollution control requirements of the Clean Air Act if the operator finds that the facility must be of such a size as to be a major emitting facility. All such facilities must have methods of disposal for the ash produced by the burning process.

5.3 URBAN SINGLE-FAMILY DWELLING/SMALL FARM

Complete or partial energy self-sufficiency is not a realistic goal for many people. Farmers have a tremendous advantage over urban dwellers regarding accessibility of energy independence. Between livestock wastes and crop residues, the farmer's biomass supply is likely to be plentiful. Agriculture consumes about 12% of the energy used in this country and nearly all of this energy could be supplied by conversion of agricultural by-products [376]. In addition to biomass potential, the farmer has the advantage of open space and little or no zoning regulations to block or impede the installation of a WECS. The urban dwellers, even in a cooperative, are at the opposite end of the scale. Biomass supplies are not readily available. Land is scarce and zoning regulations are strict.

5.3.1 Suburban WECS and Biomass

5.3.1.1 Wind Systems

The principal barrier to SWECS utilization in urban and suburban areas is zoning [375]. The most influential zoning regulations are: height restrictions, setbacks, and maximum lot coverage regulations. In addition to these, use regulations can put an unpredictable gloss on zoning ordinances. For example, a man in a township in Pennsylvania was ordered to stop selling excess SWECS-generated power to the local utility because selling power was considered to be out of character with a residential neighborhood. To sell excess power, the seller had to apply for commercial rezoning [376]. This ruling by the township was reversed when the seller appealed with the support of his neighbors and the local business community [377].

By way of contrast, another man in a different Pennsylvania town was refused a permit to construct a SWECS on his property even though the zoning ordinance for the town specifically exempts windmills from height restrictions [378]. His appeal to the zoning board was denied and the permit was not issued. The grounds for denial was a maximum lot coverage regulation. The concrete support which was to be the base for the tower would have increased the portion of his property utilized for structures. The zoning regulations allow only 30% of a lot to be occupied by structures. The lot in question had already been allowed a variance for an addition to the house. Thus, 37% of the lot was occupied by the house. The SWECS support required only 18 ft^2 [379]. A key element in this case was neighbor opposition. The SWECS user's immediate neighbors opposed the installation because they feared that it would be "noisy, dangerous, and ugly" [380].

Fear of noisy, dangerous, and ugly contraptions is thus a primary obstacle of suburban SWECS siting. If the attitude of the community runs counter to the project, it is likely that the zoning board will deny a permit or refuse to grant a variance. On the other hand, if there is community support for a SWECS installation, even an initially resistant zoning board can be convinced to grant a permit or to construe the zoning ordinance liberally to allow the installation. Such a situation occurred in the first Pennsylvania town mentioned previously.

To avoid siting difficulties, it would be ideal to convince neighbors and zoning boards that SWECS are not noisy, dangerous, or ugly. Herein lies the fundamental difficulty with siting SWECS. There are no standards. There are no equivalents to Underwriter's Laboratory stamps of approval on any SWECS devices [381]. Thus, there is very little information available to zoning boards or neighbors who are unwilling to do extensive research. Whether or not the device will be noisy or dangerous is therefore a matter of conjecture and many communities will be cautious and oppose the installation.

The aesthetics issue is a different matter. SWECS appear no more offensive than other aspects of normal everyday lives—from streetlights and telephone poles to interstates and neighborhood electric relay stations. Television antennas, flagpoles, and ham radio antennas are relatively well received. SWECS are often accepted without controversy as well. But people are not familiar with SWECS and opposition to the appearance of the strange device in the neighborhood arises. Coupled with safety concerns and fear of noise, rejection on aesthetic grounds can be a potential barrier to SWECS siting. This barrier is created through the use of zoning regulations.

Many of the commercially available SWECS are safe and operate quietly. A DOE evaluation project currently underway at the DOE Rocky Flats plant in Golden, Colo., is testing and evaluating SWECS (less than 100 kW) in order to be able to "assist small machine manufacturers and provide information to potential small WECS users" [382]. This program will provide much needed information and will assist in commercializing SWECS.

DOE's Field Evaluation Program is also scheduled to purchase and install up to 125 SWECS throughout the country (two per state or territory). Each installation will be installed by DOE in cooperation with the local utility on a site that will be using the wind energy in a productive fashion. Siting and operating data will be collected and published. This project will produce valuable information on the performance characteristics of SWECS in actual operating circumstances. The siting evaluation, which should be completed by the fall of 1980, will be a comprehensive 50 state review with two case studies per state.

Another field demonstration project has been proposed by the Bonneville Power Administration. Ten to fifteen 20- to 40-kW SWECS would be installed on individual homes [383]. If a group of neighbors cooperatively use a larger machine, that machine would offset an equivalent number of smaller machines. This proposal seems to be interested in urban sitings. The DOE Field Evaluation Program, on the other hand, will seek out relatively urban sites.

Through these and other similar programs [384], popular awareness of SWECS and the energy potential of SWECS should increase. Some data will also be available on the noise created by SWECS operation. However, the safety issue may remain clouded until manufacturing standards are developed for SWECS and SWECS towers. In the meantime, there is the risk that towns will react in the same manner that Hanover, N.H., has reacted to controversy over SWECS installations. After encountering substantial community resistance to a proposed SWECS installation, the Hanover Zoning Board of Adjustment reversed a previous grant of a variance and refused to allow the SWECS to be installed. Subsequently, the Planning Board, working with a specially formed "wind turbine committee," proposed a zoning amendment to create a special exception for SWECS. This special exception would require a setback from property lines equal to the blade-throw range (the maximum theoretical distance a blade could be thrown if it were to fall off during SWECS operation). This proposal will not be considered until March 1980 [385].

A required setback equal to the blade throw range would preclude SWECS in most urban areas. An ordinance such as the one proposed in Hanover is based on the farthest conceivable reach of a possible, but unlikely, SWECS hazard. Such an ordinance may be appropriate in an era of uncertainty over the quality of the many devices on the market, but this level of caution may prove to be excessive at such a time as standards are established and SWECS can be safely installed with a confident recognition of the extreme improbability of a SWECS blade being thrown or a tower toppling over. The precedent of excessive caution may be difficult to modify.

Aside from zoning regulations, the only other siting difficulties in urban areas are guaranteeing wind access and avoiding conflicts with subdivision covenants, conditions, and restrictions.

"Wind access" refers to the need for the chosen site to remain a windy site. If a large building is constructed in the neighborhood, the wind patterns can change in such a way as to reduce the effectiveness of the installed SWECS. There is a significant body of legal literature on solar access for solar heating and cooling systems (SHAC). Most of this literature concludes that a negative easement must be obtained from neighbors. This easement would prescribe certain areas on adjoining properties that could not be used in such a way as to cast shadows on the solar device [386]. The wind access issue is much less easily defined and an easement that would truly provide protection may be impossible to write [387]. The best protection is likely to be height restrictions in existing zoning combined with prudent siting that minimizes the vulnerability to potential wind obstructions. Problems with wind access may never really develop as a legal issue.

Subdivision covenants and restrictions have in some cases proven to be major barriers to flat-plate solar collector installations for solar heating and cooling [388]. In one case, the restriction was ruled to be in violation of public policy and therefore void [389]. A ruling of this nature in favor of SWECS is unlikely now, but it is conceivable that with a strong and clearly defined public policy in favor of SWECS, such a ruling could be forthcoming in the future. Currently no such policy exists and the support for SWECS that does exist in the Federal Government is directed at rural use, not urban use. Therefore, subdivision controls remain a problem.

Urban SWECS utilization can therefore encounter formidable legal and institutional barriers—especially if the neighbors in the immediate vicinity of the installation oppose the project. The major concern will be zoning regulation that reflects a lack of certainty over the noisiness and safety of the device. Resistance by neighbors on aesthetic grounds is also a significant problem.

Some difficulties that might be expected do not appear with SWECS. SWECS have almost no impact on the environment and they require little or no land for installation (if put on the roof of a building, no additional land is required) [390]. Also, contrary to some of the fears mentioned previously, commercial SWECS are not very noisy.

Many of the difficulties described would be substantially reduced or eliminated by forming a cooperative between adjacent neighbors. Not only would this improve the cost arrangements, it would allow much greater flexibility in siting the SWECS in such a manner as to please other neighbors. Complications of ownership and power distribution would arise, but they may be more easily settled than conflicts with the uninvolved community.

5.3.1.2 Biomass

The wood burning stove is a commercially ready biomass-fueled energy system available to the urban dweller. Installations of such stoves will not encounter any zoning, land-use or environmental resistance anywhere except in those cities that have ordinances restricting their installation for safety, pollution, or other reasons. The fireplace is in quite a different position than SWECS. It is such a familiar fixture in most homes that there is rarely any regulation—except safety and fire codes—restricting their installation.

The traditional fireplace is very inefficient. Most of the heat, particulate, and smoke go out the chimney. But these fireplaces are generally used for pleasure and aesthetic enjoyment—not for space heating. Wood burning stoves would be used for space heating and would therefore have a much different impact than the familiar fireplace.

The impact of a great number of wood burning stoves in an urban environment has not been analyzed. Because wood-burning space heaters would be used on a regular basis, full-time for some seasons, they belong in quite a different category than fireplaces, regarding both energy considerations and pollution.

Vail, Colo. has encountered pollution problems that have been attributed to wood burning appliances. The reaction of the city was to pass an ordinance restricting the number of such appliances (fireplaces, wood burning stoves, etc.) to one per household for any new construction or installation [391]. This ordinance could be an indication of potential trouble for widespread use of wood burning stoves in urban areas. Though there are generally no restrictions on siting such stoves now, as their use becomes more prevalent, siting problems may occur.

Other than wood burning stoves, urban biomass use is not presently feasible except for those purchasing new homes with central heating furnaces that utilize biomass, or for the handyman who chooses to design and build a system on his own. Even for this handyman, digestion systems would not be practical or feasible. A very small digester might contain four tons of organic material [392]. It is beyond the capacity of urban dwellers either to obtain the biomass supply or to dispose of the sludge and effluent.

Gasification devices currently are being made in laboratories on a scale small enough to accommodate urban use [393]. The air gasifiers may be designed to process newspapers, grass clippings, or wood chips to produce a gas suitable for household use. This gas would be high in carbon monoxide and therefore very toxic. Unless some method for adding a scent to the gas is developed, it may be considered too dangerous to produce such a gas in the home [394].

Therefore, the wood burning stove is perhaps the most commercially ready and available biomass-consuming energy device for the urban dweller. At the moment, there are no siting restrictions on wood burning stoves, but this could change with increased utilization of such stoves in densely populated areas.

5.3.2 The Small Farm

The farmer has a good supply of biomass—residues from his fields, manure from his livestock, and trees in windbreaks or on undeveloped parts of his farm. If the farmer chooses to install a digester, he will probably design and build it himself and spend a good deal of time operating it. Digesters require attention to maintain proper pH levels, the optimum temperature, and a desirable feed rate. The farmer will have no problem with the siting of the digester or in generating gas, but he may encounter building code violations in trying to use the gas in his home.

Building codes are designed to protect the public from poorly constructed housing. A permit process is used to ensure that construction and remodeling is done in accord with the code. The purpose is largely to protect home-buyers from poorly done projects of the previous owner or from shoddy contractor work. But, building codes are primarily written for the urban environment and most codes are specification codes which require specific, approved materials and methods. Specification codes are much easier to administer than performance codes, which is the main reason that specification codes are more common [395].

Beyond business codes, there is very little to stop a farmer from putting a biomass-fueled energy system on the farm. Gasifiers, direct combusters, and digesters are practical devices for farm applications and there are no significant legal hurdles involved in siting them.

In some states, agricultural land is specially zoned for agricultural use only. Hawaii, for example, has established six classes of soil quality. Projects on lands with soil suitable to agriculture must be used "primarily in pursuit of agricultural activities" [396]. Special permits may be issued for "unusual and reasonable uses within agricultural and rural districts" [397]. Energy production for farm use would probably be a reasonable use of agricultural land and could be considered to be in pursuit of agricultural activities. Thus, special agricultural zoning should not preclude siting of WECS or biomass facilities on farms.

Because the farmer owns his own open land, he is not likely to encounter neighbor opposition to any reasonable use of his land. Therefore, there are no foreseeable legal or institutional difficulties in siting SWECS on farms.

SECTION 6.0

CONCLUSIONS

6.1 SITING OF WIND ENERGY CONVERSION SYSTEMS

The environmental impacts of WECS are very small and generally confined to the construction phase of a project. For large WECS, possible siting difficulties will focus on aesthetics and potential television interference. Due to the extensive quantities of land required for a large-scale WECS project, there will very likely be land-use problems to consider. For urban SWECS, neighborhood reaction to the project based on aesthetic, safety, and possibly noise concerns will determine whether or not the siting is permitted. If the local attitude is not favorably disposed to the siting, zoning regulations and subdivision restrictions will be interpreted strictly to exclude SWECS.

Industrial, commercial, and large residential WECS will encounter the same barriers as urban SWECS, except that the difficulty should be on a much reduced scale. Safety regulations could complicate the siting of these medium-scale machines.

Farmers desiring to install WECS should encounter no siting difficulties of a legal or institutional nature.

6.2 SITING OF BIOMASS SYSTEMS

The various biomass technologies demand a supply of organic matter. Environmental impacts from collecting, transporting, and using this organic matter will influence the siting process. The utilities will generally find biomass plants to be too small for their use. The major potential market impact for biomass-fueled energy systems is in industrial cogeneration. Commercial and large residential projects can be expected to use biomass, but not as extensively as the industrial cogenerator. Siting difficulties for each of these medium-scale users will be similar. Zoning regulations will be the major concern, followed closely by air and water pollution regulations that include certain aspects of the collection and supply cycle. The clear air standards will complicate siting unless there are some allowances made for the energy efficiencies of cogeneration and the dual purpose nature of many biomass-using energy systems.

Most urban biomass users are presently restricted to the wood burning stove. There are homes being constructed that have central heating biomass-fueled furnaces. Other biomass technologies do not appear to be commercially ready at this time. Even with the wood burning stove, there are fire and safety codes and air pollution restrictions that must be adhered to in order to satisfy local regulations.

SERI

SECTION 7.0

REFERENCES

1. Carter, Jimmy. "Address to the Nation." 15 July 79.
2. Energy Information Administration Annual Report to Congress, Vol. III: 7; 1977.
3. Id. at 103 (The chart is in billion kWh, the figure in the text is converted to quads.)
4. Id.
5. See Steam-Electric Plant Construction Cost and Annual Production Expenses. 1975 28th Annual Supplement; DOE/EIA-0033/1; January 1978.
6. Statistics of Privately Owned Electric Utilities in the United States—1976 : Class A and B Companies. DOE/EIA-0044; p. 3. April 1978; Shows privately owned utility plant investment to be: $181.7 billion in 1977. Statistics of Publicly Owned Electric Utilities in the United States—1976. DOE/EIA-0146; p. 13; December 1978. Shows publicly owned utility plant investment to be $19.2 billion in 1976. The sum is just over $200 billion. Additions since 1977 and 1976 would put this figure well over $200 billion. This figure does not include transmission facilities.
7. See Meadows, D. "Fallacies that Block the Search for an Alternative Energy Plan." Paper adopted from a banquet address before Miami International Conference on Alternative Energy Sources. 5-7 Dec. 77. Fontainebleau Hotel, Miami Beach, FL.
8. Coty, U. A. Wind Energy Mission Analysis. Prepared for ERDA #SAN/1075-1/1. 1976. (Hereinafter cited as Mission Analysis.)
9. MITRE Corporation, Metrek Division. "Some Implications of a 20% Solar Goal." 4; 1979.
10. See generally Wood Energy for Small Power Producers in North Carolina, for information on biomass siting. 1978. (Hereinafter cited as Small Power). Also see Wegley, H. L.; Orgill, M. M.; Drake, R. L. A Siting Handbook for Small Wind Energy Conversion Facilities. Battelle PNL-2521/UC-60; 1978.
11. George Washington University, Program of Policy Studies in Science and Technology. Legal-Institutional Implications of Wind Energy Conversion Systems (WECS). Prepared for National Science Foundation; NSF RA 770204; p. 15; 1977. (Hereinafter cited as Implications.)
12 Society for the Protection of New Hampshire Forest and the Wood Energy Institute. "Maine Firewood Use Survey." Wood'n Energy. January 1979.
13. See, e.g., Eldridge, F. Wind Machines. Report prepared for the National Science Foundation discusses the rounding of two adjacent hilltops to augment wind speed between the two hills (hereinafter cited as Wind Machines). NSF-RA-N-75-051; p. 47; 1976.
14. 96th Congress, 1st Session HR 3558 §2(a)(1).
15. Id. § 2(a)(3).
16. Id. § 2(a)(7).
17. Id. § 7(a).
18. Lovins, A. B. Soft Energy Paths: Toward A Durable Peace. p. 99; 1976.

19. See generally Wind Machines, supra n. 13. Id. (the machines with no rotation of the system are the vortex generators discussed on page 60-61).
20. Id. at 18.
21. Id. at 30.
22. See, e.g., Commercially Available Small Wind Machines: A checklist of Systems, Manufactures and Distributors. 1979. Available from Rocky Flats Plant Energy Systems Group, P.O. Box 464, Golden, CO: 80401.
23. See, e.g., Senecebaugh Wind Electric, Model 400-14HDS (0.4 kW) or Model 500 (0.5 kW).
24. Wind Power Products Company, Schachle Wind Turbine Generator (being installed by Southern California Edison Co. in a demonstration project in San Gorgonio Pass, CA).
25. Thresher, R. W.; Wilson, R. E. "Characteristics of Vertical Axis Wind Machines," contained in Mission Analysis, supra n. 8, at Appendix 4-1.
26. Divone, L. V. "Wind Power Test Establish Role of Utility Systems." Public Power, p. 29; March-April 1978. (Hereinafter cited as Wind Power.) (Note: load factor is equal to the average power output of an energy system divided by its rated power.)
27. Wind Machines, supra n. 13, at 58.
28. Eldridge and Jacobsen. Distributed Wind Power Systems. McLean, VA: MITRE Corp; 1979.
29. Black, T. "Some Things in The Wind? ERDA Thinks So." Machine Design. p. 17, 19; 20 May 76.
30. Id. at 38.
31. Merrigan, J. A. Sunlight to Electricity: Prospects For Solar Energy Conversion By Photovoltaics. 1975.
32. Proceedings: Capturing the Sun Through Bioconversion. Washington, DC: 10-12 Mar. 76. Presentation #3 by R. S. Greeley at 186-187 (hereinafter cited as Proceedings).
33. California Energy Commission. Energy Choices for California . . . Looking ahead: An Introduction to the 1979 Biennial Report of the California Energy Commission. 1979. (Hereinafter cited as Energy Choices).
34. See generally Proceedings, supra n. 32.
35. Solar Energy Research Institute. Biomass: Solar Energy from Farms and Forests. 1979, at 3.
36. Id. at 4.
37. Id. at 37. Also see, Fuels from Biomass: Solar Assessment Program: Environmental Factors. ERDA 77-47/7, 1977. (Hereinafter cited as Assessment).
38. Private communication with Lawrence M. Gerber, Executive Director. Englishtown, NJ: Western Monmouth Utilities Authority.
39. Assessment, supra n. 37, at 7.

40. Pacific Legal Foundation v. Quarles, U.S. District Court of Southern California, decided 20 July 77; #CU 77-521-HP.

41. Forest Residues Energy Program. DOE TID-28416; 1978.

42. See infra §4.1.1.3.

43. Biomass Applications, infra n. 52, at 3.

44. Farley, R. "Biomass, The Final Frontier." 1979 (an unpublished paper).

45. Assessment, supra n. 37, at 6.

46. Id.

47. Hewett, C. E.; High, C. J. Environmental Aspects of Wood Energy Conversion. 1979. (Hereinafter cited as Environmental Aspects.)

48. West Virginia Division of the Izaak Walton League v. Butz, 522 F.2d 945; 5th Cir. 1975.

49. 16 U.S.C. §1604(g)(3)(E)(iv) (1978).

50. Id. §1604 (e).

51. Id. §1604(g)(3)(F).

52. Odland, R.; Schwab, C. "Legal and Institutional Aspects of Selected Biomass Applications." 1977. A paper presented at the World Energy Engineering Conference. Atlanta, GA: Association of Energy Engineers. (Hereinafter cited as Biomass Applications.)

53. Environmental Aspects, supra n. 47, at 11.

54. Id. Also see infra §4.1.1.3.

55. Pub. L. No. 95-620, 92 Stat. 3289(1978). (Part of National Energy Act of 1978). PIFUA applies to power plants or major fuel burning installations (MFBI). Both are defined to include only boilers with fuel inputs greater than 100 million Btu/hr. This is equivalent to about 11 1/4 tons of wood per hour if wood is assumed to have a heat content of 4200 Btu/lb. The Burlington wood-fired plant (See Section 5.1.4.1) will consume 2000 ton/day which is considerably more than 11 ton/hr. The Burlington power plant will be a 50-MW facility. Assuming further that 4 lb of wood contains about 1 kWh of energy, PIFUA would apply to a 3-MW wood burning power plant.

56. Id. §212(a)(1)(C).

57. 40 C.F.R. §412.11(b)(1978).

58. Reedy Creek Utility Company of Walt Disney Enterprises in Florida is currently using effluent from the Disney World sewage treatment complex to water eucalyptus trees. Presentation to SERI staff by Tom Jones of Reddy Creek Utility, 13 July 79.

59. Biomass Applications, supra n. 52, at 3.

60. 42 U.S.C. §7172(g), 1978.

61. See generally Battelle, Pacific Northwest Laboratories. Organizations Influencing Northwest Energy Policy and Management. BNWL RAP 20/UC-11, 1977. This report gives a more functional view of the agencies involved.

62. Gilman v. Philadelphia 3 Wall (70 U.S.) 713 (1366) interprets U.S. Constitution Commerce Clause to include all navigable waters within federal jurisdiction.

63. U.S. Constitution, Art. I §8.

64. 16 U.S.C. §1451 et seq. (1974).

65. 42 U.S.C. §4001 et seq. (1977).

66. 33 U.S.C. §1251 et seq. (1977).

67. 42 U.S.C. §7401 et seq. (1978).

68. Pub. L. No. 95-617, 92 Stat. 3117 (1978).

69. Pub. L. No. 95-619, 92 Stat. 3206 (1978).

70. 16 U.S.C. §1453(1) (1978 Supp).

71. Id. §1454(a).

72. Id. §1455(a).

73. Id. §1455(c)(2).

74. Id. §1455(c)(8).

75. Id. §1456a (c)(1).

76. "The Operation of the Federal Coastal Zone Management Act as Amended." 10 Nat. Res. Law. 211; 1977.

77. 16 U.S.C. §1456 (c)(1) (1978 Supp.).

78. "The Operation of The Federal Coastal Zone Management Act as Amended," supra n. 76, at 215.

79. There are 34 coastal states. As of 1 Aug. 77, 33 of the 34 states had received program development grants. State of Rhode Island Management Program and Final Environmental Impact Statement. X PB-283-424; 1978. Note: the Coastal Zone Management Act of 1972 only allows 4 years of program development grants. Therefore all programs should be submitted for approval by 1981.

80. Id. at §4002 (b)(3).

81. Id. at §4012a (a). Though 42 U.S.C. 4012a (a) does specify that no federal assistance of any kind is to be made available to communities which have not applied appropriate regulation to flood-prone areas, adherence to this policy has been lax. To force stricter adherence, Presdent Carter issued executive order 11998 in May of 1977. This executive order directs all federal agencies to assess the risk of flooding for a project in a floodplain prior to supporting that project. "Federal agencies are prohibited from directly or indirectly supporting floodplain development, or otherwise adversely effecting floodplain areas unless it can be demonstrated that there are no practical alternatives to such actions." 44 F.R. 1455.

82. 44 F.R. 29719 announces the absorption of authority for the Flood Insurance Program under the Federal Insurance Agency in the Department of Housing and Urban Development into the Federal Emergency Management Agency.

83. 42 U.S.C § 4022 (1977).

84. Id. at 4101 (c). A recent list of flood-prone communities is contained in 44 F.R. 23321.

85. 42 U.S.C. § 4102(c) (1977).

86. P. L. 95-217.

87. P. L. 92-500.
88. 33 U.S.C. §1251 et seq. (1977).
89. Id. §1288.
90. Id. §1256.
91. 40 C.F.R. §125.1 (p) (1977).
92. U.S. v. Phelps Dodge Corp 391 F. Supp. 1181, 1187 (1975).
93. 33 U.S.C. §1311(a) (1977).
94. Id. §1342(b).
95. Id. §1311(b)(1)(A).
96. CPC International, Inc. v. Train 540 F. 2d 1329 (1978) cert. denied 430 U.S. 990 (1976).
97. American Iron and Steel Institute v. EPA 526 F.2d 1027, 1075 (3rd Cir. 1975).
98. 33 U.S.C. §1314(b)(1)(B) (1977).
99. 42 U.S.C. §7401 et seq. (1978 Supp.).
100. 40 C.F.R. §51.24 (g)(1978).
101. 42 U.S.C. §7407(d)(1)(D) and (E) (1978 Supp.)(according to §7472(b)).
102. Essex Chemical Corp. v. Ruckelshaus 486 F.2d 427 (D.C. cir. 1973).
103. 42 U.S.C. §7410(a)(2)(D) (1978 Supp.) in general; 42 USC §7475(a)(1) (1978 Supp.) for Class I or Class II areas; 42 U.S.C. §7502(b)(6) (1978 Supp.) for non-attainment areas. Note: "major stationary source" is used instead of "major emitting facility." "Major stationary source" has a 250 tons of pollutant per year minimum for specific plant types, but is otherwise defined the same as "major emitting facility."
104. 42 U.S.C. §7479(1)(1978 Supp.). This section also lists specific industry types which are automatically "major stationary sources." This list includes municipal incinerators disposing of more than 250 tons of trash/day and fuel conversion plants which emit more than 100 tons of pollutant/year.
105. 42 U.S.C. §7475(a)(4) (1978 Supp.).
106. Id. §7503 (2).
107. Id. §7479(3).
108. Id. §7501(3).
109. Id. §7503(1)(B).
110. See Union Electric Co. v. EPA 427 U.S. 246 (1976).
111. 42 U.S.C. §7416 (1978 Supp.).
112. The EPA defines two national ambient standards—the National Primary Ambient Air Quality Standard, which is designed to protect public health (42 U.S.C. §7409(b)(1) (1978 Supp.) and the National Secondary Ambient Air Quality Standards, which protect the public welfare (42 U.S.C. §7409(b)(2) (1978 Supp.). New Stationary Source Performance Standards (NSSPS) are also promulgated by EPA to define minimum standards that new stationary sources must meet (40 C.F.R.) §60 (1978).

113. 42 U.S.C. §6942(b) (1977).

114. Id. §6903(27). Sewage and industrial discharges are covered by 33 U.S.C. §1342 (1978).

115. Id.

116. Id. §§6944 and 6945.

117. Id. §6951.

118. Waste Control Act, N.J.S.A. § 13: 1 I-10 (West Supp. 1978) (Struck down as restraint on interstate commerce by City of Philadelphia v. New Jersey 437 U.S. 617 (1978)).

119. See, e.g., Township of Harding v. City of Cadillac, 35 Mich. App. 260, 192 N.W. 2d. 384 (1971).

120. 42 U.S.C. §6945(c) (1977). Note: States are not required to develop a plan under the Solid Waste Disposal Act. The Federal Government, through EPA, has established financial incentives to encourage the state to plan and implement a program within federal guidelines. Both 42 U.S.C. §6901(a)(4) and Philadelphia v. New Jersey, 437 U.S. 617, 621 (1978) say that the state's authority is not preempted by this act.

121. 42 U.S.C. §6903(20) (1977).

122. See National Energy Conservation Policy Act of 1978, P.L. 95-619, which also strongly encourages recycling.

123. 42 U.S.C. §6925 (1977).

124. Id. §6926.

125. Pub. L. No. 95-617 §111(a).

126. Id. §113(a).

127. Id. §113(b)(1). Also see Id. §115(d) which mandates state PUC consideration of master metering.

128. See 44 F.R. 16594 to be codified as 10 C.F.R. §456.307(a).

129. 44 F.R. 16604 to be codified as 10 C.F.R. §456.706(a)(2).

130. 42 U.S.C. §4321-§4366 (1977).

131. Id. §4332(2)(c).

132. Proetta v. Dent 484 F. 2d 1146 (2nd. Cir. 1973). Also see 40 C.F.R. §1508.18 at 43 F.R. 5604.

133. Conservation Council of North Carolina v. Costanzo 398F. Supp. 653, affirmed 528 F.2d 250 (4th Cir. 1975).

134. Scientists Institute for Public Info, Inc. v. Atomic Energy Commission 481 F.2d 1079 (D.C. Cir. 1973).

135. 43 F.R. 55989 comments on 40 C.F.R. §1508.17. Also see Minnesota PIRG v. Butz 498 F. 2d 1314 (8th Cir. 1974).

136. 40 C.F.R. 1501.3(a) at 43 F.R. 55992.

137. 40 C.F.R. 1501.7(2) at 43 F.R. 55993.

138. 40 C.F.R. §1502.20 at 43 F.R. 55997.

139. Phillips. "NEPA and Alternative Energy: Wind as a Case Study." 1 Solar L. Rep. 29, 46 (1979).
140. 40 C.F.R. §1502.13 at 43 F.R. 55996.
141. Id. §1502.15.
142. Id. §1502.16.
143. Id. §1502.14.
144. Id.
145. Id. §1505.2 at 43 F.R. 55999-56000.
146. Natural Resources Defense Council v. Morton 458 F.2d 827 (D.C. Cir. 1972).
147. Wind Turbine Generator System, Block Island, Rhode Island—Final Environmental Impact Statement. DOE/EIS-0006; July 1978. (Hereinafter cited as Impact Statement.)
148. Environmental Assessment Report—Wind Energy, Wyoming. NDN 79-4 (LM) Region, 1979. (Hereinafter cited as Report.)
149. 16 U.S.C. §824 et seq. (1979).
150. Pub. L. No. 95-617.
151. 16 U.S.C. §824(b) (1979).
152. Joint Explanatory Statement of the Committee of Conference, Public Utility Regulatory Policies Act of 1978, §201.
153. Pub. L. No. 95-617 §201.
154. 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. Docket No. RM 79-55; 26 June 79.
155. Id.
156. 16 U.S.C. §824a(3)(a) (1979).
157. Id. §824a (3)(f).
158. Proposed Regulations Providing for Qualification of Small Power Production and Cogeneration Facilities under §201 of the Public Utility Regulatory Policies Act of 1978. Docket No. RM 79-54 §292.206(g); 27 June 79.
159. Id. §292.205a. The regulations as proposed deal with the question of reliability by setting maximum fuel use standards for a small power production facility.
160. For a much more detailed discussion of the impact of PURPA on the small power producer and cogenerator, see Rice, M. "Legal Issues Related to the Production of Electricity by Independent Small Solar Facilities and Their Interconnection with Public Utilities." SERI publication, 1979 (to be published).
161. 33 U.S.C. §1401 et seq. (1978).
162. Id. §1401(c).
163. 40 C.F.R. §220.2(d) (1978).
164. 33 U.S.C. §1412 a(a) (1978).
165. 40 C.F.R. §227.1(c)(3) (1978).

166. 14 C.F.R. §77.3(a)(4) (1978).
167. Id. §77.11.
168. Id. §77.13(a)(1).
169. Id. §77.13(a)(2).
170. See "Obstruction Marking and Lighting." FAA Advisory Circular #AC 70/7460-1.
172. Impact Statement, supra n. 147.
172. Implications, supra n. 11, at 94.
173. 47 C.F.R. §15.3(c)(1988).
174. Id. §15.1(a) (1978).
175. Id. §15.25.
176. Id.
177. Impact Statement, supra n. 147, at 93.
178. Id. at 89.
179. Id. at 95.
180. Pub. L. No. 95-620, 92 Stat. 3289 (1978).
181. Id. §102(b).
182. Id. §103(a)(7)(A) and §103(a)(10)(A).
183. 43 F.R. 53974 Docket No. ERA-R-78-19.
184. Statement of Matthew V. Brady on Behalf of California Energy Resources Conservation and Development Commission. 1978.
185. 1978 U.S. Statistical Abstract 237 (data reflects 1977 conditions).
186. Id.
187. Id. (Data taken from the Table was converted to percent. States included were: Arizona, California, Idaho, Montana, Nevada, New Mexico, Oregon, Utah, Washington, and Wyoming.)
188. Id.
189. 43 U.S.C. §1701 et seq. (1978 Supp.).
190. Id. §1712(a).
191. Id., §1714.
192. Id. §1716(a).
193. Id. §1761(a).
194. Id. §1713(a). Tracts of land greater than 2500 acres require approval of Congress, Id. §1713(e).
195. "Right of Way" is defined to include an "easement, lease, permit, or license to occupy, use or traverse public lands . . ." Id. §1702(f).
196. Id. §1765.
197. Id.

198. Id. §1761(a)(4).

199. 16 U.S.C. §528 et seq. (1974).

200. 43 U.S.C. §1702(b) (1978 Supp.).

201. Id. §1702(h).

202. See Proposed Changes in 1605 Manual. DOI Bureau of Land Management Report, 27 Nov. 78 revision, 1605.34 Wind Power Sites, at 21.

203. 16 U.S.C. §528 (1978 Supp.).

204. Id., §531.

205. 16 U.S.C. §1601 et seq. (1978 Supp.).

206. 16 U.S.C. §2101 et seq. (1978 Supp.).

207. Id. §2103(c).

208. Id. §2101(b).

209. Id. §2109(d)(2).

210. 16 U.S.C. 1601(b)(2) (1978 Supp.).

211. Id. §1601(d)(1).

212. Assessment, supra n. 37, at 6.

213. 43 U.S.C. §1765 (1978 Supp.).

214. 16 U.S.C. §2001 (1978 Supp.).

215. 16 U.S.C. §1131 et seq. (1976).

216. Id. §1131(b).

217. Id. §1133(d)(4)(1).

218. 16 U.S.C. §1531 et seq. (1974).

219. Id. §1535 (f).

220. Id. §1539.

221. Id. §1536(e).

222. Id. §1539(b)(1).

223. 16 U.S.C. §688dd (d)(1)(B)(1978 Supp.).

224. Hagman. Urban Planning and Land Development Control Law. §5 1971.

225. Freilich. Interim Development Controls: Essential Tools for Implementing Flexible Planning and Zoning (Excerpts). Reprinted in Listokin, D. Land-Use Controls: Present Problems and Future Controls. 213, 217 n. 13 (1974).

226. Natural Resources Defense Council. Land-Use Controls in the United States: A Handbook on the Legal Rights of Citizens. 320-321; 1977. (Hereinafter cited as Handbook.)

227. "Regionalism or Parochialism: The Land-Use Planner's Dilemma." 4 8 U. Colo. L. Rev. 575,587 (1977) (hereinafter cited as Regionalism).

228. Handbook, supra n. 226, at 273.

229. Cal. Gov't Code §65100 (West Supp. 1978).

230. Id. §65037.

231. Id. §65040.

232. Id. §65035.

233. Id. §65860.

234. Id. §65302(d).

235. Id. §65030.

236. Cal. Pub. R. Code §30601 (West, 1977).

237. Id. §30519.

238. Colo. Rev. Stat. 24-65-104 (1978).

239. Id. 24-65.1-302.

240. Id. §301(a) & (b).

241. "1974 Land-Use Regulation in Colorado." 51 Den L. J. 467, 481 (1974).

242. Colo. Rev. Stat. 24-65-104 (1978).

243. See Regionalism, supra n. 227, which describes an effort by the Colorado Land Use Commission to force a power-plant project to be designated as an area of state interest. The resultant delay caused some bitterness in the Colorado Legislature, which subsequently cut personnel and funding for the Commission. For a review of actions taken by local and state governments under the authority of HB 1041, the Colorado Land-Use Act, see Bucknam, D. "Land-Use in Colorado." 34 Journal of Soil and Water Conser. 127 (1979).

244. U.S. Department of Housing and Urban Development, Federal Insurance Agency. Statutory Land-Use Control Enabling Acts in the Fifty States (1976). (Hereinafter cited as Land Use.)

245. Id. at 9.

246. Cal. Health and Safety Code §17958 (1976). Colorado allows counties to adopt building codes (Colo. Rev. Stat. 30-28-201) et seq. (1977).

247. See, e.g., Florida Stat. §163. 3161 (1978).

248. Colo. Rev. Stat. 24-64-104 et seq. (1978).

249. Implications, supra n. 11, at 98. Also see Spivak, P. Land-Use Barriers and Incentives to The Use of Solar Energy. SERI Publication SERI/TR-62-267; 1979.

250. Land Use, supra n. 244, at 5.

251. For a review of the dangers involved, see Eckert, B. "Safety Tips Can Snuff Out Wood Burners' Nightmares." High Country News 27 Jan. 78. This issue may be examined by building code officials. See Walker, C. "Casualties Including Wood-Burning Stoves on the Increase." The Washington Post. E14; 11 Aug. 79.

252. Handbook supra n. 226 at 328.

253. See, e.g., Colo. Rev. Stat. 31-23-313 (1977).

254. Wright. Land Use in a Nutshell. 9 (1978).

255. Handbook, supra n. 226, at 329.

256. Krasnowiecki, J. Legal Aspects of Planned Unit Developments in Theory and Practice. Reprinted in Listokin, D. Land-Use Controls: Present Problems and Future Reform. 185, 190 (1974).

257. Id. at 193.

258. See Energy Law Guide, §8.26 n.1 (1978) for a list of state NEPAs. Also see Baram. Environmental Law and the Siting of Facilities. 95-102 (1976).

259. Handbook, supra n. 226, at 25.

260. See Winter, J.V.; Conner, D. A. Power Plant Siting. 24 (1978). Twenty-seven states have statutes relative to power-plant siting.

261. See, e.g., N.Y. Pub. Serv. Code §140 (1978).

262. See, e.g., Ark. Stat. 73-276.2(b)(1) (1978). Cal. Pub. R. Code §25120 (1978). N.Y. Pub. Serv. Code §140 (1978).

263. Small Power, supra n. 10, at 4.

264. Scheffler, R. L. "Status of Southern California Edison Company 3-MW Wind Turbine Generator (WTG) Demonstration Project." (1979).

265. The Denver Post, Empire Magazine. p. 10, 15 July 79 (hereinafter cited as Empire).

266. N.Y. Pub. Serv. Code §140 (1978); Cal Pub. Serv. Code §25120 (1978).

267. See, e.g., Energy Choices, supra n. 33.

268. Id.

269. California Energy Commission. "Power Plant Siting Policy Paper." November 1978.

270. Baram. Environmental Law and the Siting of Facilities. 1976.

271. The A-95 Review Process is part of the implementation of the Intergovernmental Cooperation Act of 1968. 42 U.S.C. §4201 et seq. (1977). The Office of Management and Budget (OMB) issued circular No. A-95 (see 41 F.R. 2052) as part of the implementation of the act. This circular provides for project review by state and regional agencies for any application for federal assistance. The process merely allows governors, mayors, and county, state, and local officials to comment on application for federal assistance. Negative comments are rarely submitted and therefore the process does not have much influence. See Handbook, supra n. 219, at 303-306.

272. Handbook, supra n. 226, at 306.

273. A "one stop" power plant siting agency is not actually feasible. See "Power Plant Siting Policy Paper," supra n. 269, at 81-82. Also see "California's Energy Commission: Illusion of a One-Stop Power Plant Siting Agency." 24 U.C.L.A.L. Rev. 1313 (1977).

274. 30 Ver. Stat. Ann. §248 (1978).

275. Id. §230.

276. See supra n. 274.

277. Societal Analytics Institute, Inc. Barriers to the Use of Wind Energy Machines: The Present Legal/Regulatory Regime and Preliminary Assessment of Some Legal/Political/Societal Problems. Prepared for National Science Foundation NTIS PB-263576. 85 (1976). (Hereinafter, cited as Barriers.)

278. Small Power, supra n. 10, at 82.

279. See, e.g., Rice, M. Legal Issues Related to Production of Electricity by Independent Small Solar Facilities and Their Interconnection with Public Utilities. SERI Publication, 1979 (to be published).

280. Cottonwood Mall Shopping Center, Inc. v. Utah Power and Light Co. 440 F. 2d 36 (10th Cir. 1971).

281. See, e.g., Fla. Stat. 403.501 (1979).

282. See, e.g., All Ark. Stat. §73-201(d)(1) (1977).

283. See, e.g., Ill. Stat. 111 2/3 §10.3 (Supp. 1979).

284. Cal. Pub. Util. Code §218.5 (1978).

285. Empire, supra n. 265, at 10.

286. Memo from Thomas R. Carr (Project Manager of Burlington Electric) to Ralph Chandler (California Energy Commission).

287. March-April 1978 Public Power 29. The bioconversion plant in Lamar, CO will be fueled by manure from three nearby feedlots.

288. Ark. Stat. 73-276.4 (a)(9)(1977 Supp.).

289. Colo. Rev. Stat. 40-5-103(1)(1973).

290. See generally Kahn, E. "The Reliability of Distributed Wind Generators." 2 Electric Power System Research 1(1979). Also see Rodemann, U. Load Management in Operation: A Consumer-Voluntary Program Pays for the System in One Hour. 1978. (American Public Power Association Load Management Workshop 4 Dec. 78.)

291. Lovins, A. Soft Energy Paths: Towards a Durable Peace. 99 (1976). For WECS, the larger machines may actually be much more expensive per kilowatt because the blade cost increases tremendously as the length of the blade increases. An optimum cost/kilowatt size for a WECS is estimated to be about 50 kW.

292. Wind Machines, supra n. 13, at 46.

293. Small Power, supra n. 10 at 43.

294. Wind Power, supra n. 21, at 34.

295. Wind Energy Systems: Program Summary. At 31 and 107; DOE/ET-0093; 1978.

296. Impact Statement, supra n. 147, at 93.

297. Scheffler, R. "Status of Southern California Edison Company 3-MW Wind Trubine Generator (WTG) Demonstration Project." 1979.

298. Id.

299. U.S. Department of Interior, Bureau of Reclamation Negative Declaration Number NDN 79-4 (LM) Region (1979). (Hereinafter cited as Negative Declaration.)

300. Id.

301. Empire, supra n. 265, at 10.

302. Phillips, P. "NEPA and Alternative Energy: Wind as a Case Study." 1 Solar L. Rptr. 29, 52 (1979).

303. "DWR Plans To Buy Electricity from Windmill." Sun Up. 3 June 79. Also see "Up To 2000 Windmills to Generate Electricity." San Francisco Examiner. 19 Apr. 79, p. 42, which says that as many as 2000 machines may ultimately be sited in Pacheco Pass.

304. Hawaii Natural Energy Institute. HNEI Newsletter. Vol. 2 #3 July 79.

305. Sulpor, B. "High-Voltage Power Lines and Human Health." Public Utilities Fortnightly. 11, 12; 4 Jan. 79.

306. See generally Gerlach, L. "Energy Wars and Social Change." Contained in, Predicting Sociocultural Change. Southern Anthropological Society Proceedings 13 (1979).

307. "Young Adults Favor Wind as Energy Source." The Denver Post. 8 Aug. 79, p. 21.

308. Five sites were evaluated and two of these sites were covered by the Environmental Assessment. Site A is considered the primary site and the assessment, as amended at that site, includes five WECS. Report, supra n. 148.

309. Report, supra n. 148, at II-9.

310. Id. at II-5.

311. Supra §4.1.3.1.

312. Report, supra n. 148, at II-5.

313. For a contradictory opinion, see Ladd, E. "Solar Power Plant Siting." AIP Annual Meeting. New Orleans II-3. "Prime areas for siting windmills will not likely to be found in coastal areas or mountain ranges." Note: Block Island and Calebra, Puerto Rico Mod-oa installations are both in coastal areas. Southern California Edison's 3-MW WECS will be installed in a mountain pass.

314. See generally Gerlach, L. "The Great Energy Standoff." 87 Natural History 22(1978).

315. Coty, U. A. Wind Energy Mission Analysis: Final Report. Report for ERDA SAN/1075-1/1, 9-1 (1976).

316. Negative Declaration, supra n. 299 at 2.

317. 43 U.S.C. §1702(f) (1978 Supp.).

318. Maryland National Capital Park and Planning Commission v. U.S. Postal Service 487 F. 2d 1029 (D.C. Cir. 1973).

319. 26 Am. Jur. 2d Eminent Domain §8(1966).

320. Report, supra n. 148 at IV-13.

321. Survey Resarch Laboratory, University of Illinois. Public Reaction To Wind Energy Devices. 1977, p. 4. Report prepared for National Science Foundation NSF/RA-77-0026.

322. Id. at 7.

323. Id. at 8.

324. Kennel, R. "Testimony on Wood Energy Power Plants in Northern California." Prepared for California Energy Commission (Sept. 1978). "Small power plants of any type do not currently fit into investor-owned utility baseload or peaking requirements," at 15.

325. Hawaii Natural Energy Institute. Annual Report. 1978; 21.

326. Id. at 24.

327. Id. at 23.

328. Memo from Thomas R. Carr (Project Manager Burlington Electric) to Ralph Chandler (California Energy Commission) 5 (hereinafter cited as Memo).

329. Time, 11 June 79, at 75.

330. Conversation with Arnold Barnstein, Public Director, Hempstead Resource Recovery Corporation (20 Aug. 79). (hereinafter cited as Hempstead).

331. Id.

332. Id.

333. March-April 1978 Public Power 29.

334. Letter from Bill Carnahan, Superintendent of the Lamar Utilities Board to Ron Feuolia of the Farmers Home Administration (12 Dec. 77). Letter was submitted with the results of the A-95 review process.

335. Conversation with Bill Carnahan, Superintendent Lamar Utilities Board, 15 Aug. 79.

336. 40 F.R. 16713.

337. March-April 1978 Public Power 29.

338. Small Power, supra n. 10, at 4.

339. Renewable rate of harvest of fuel grade wood is about one green ton/acre/year. Neuroth, D. "Price and Availability of Wood for Fuel." Contained in Conference On Wood Chips for Fuel and Energy. 11 Jan. 79; Potsdam, NY: Clarkson College (hereinafter cited as Wood Chips).

340. Small Power, supra n. 10, at 4.

341. Memo, supra n. 328, at Environmental Problems Associated with the Procurement of Wood Waste for Fuel-2.

342. Small Power, supra n. 10, at 16.

343. Conversation with Thomas Carr (Project Manager, Burlington Electric) 2 Aug. 79.

344. Wood Chips, supra n. 340, at 5.

345. Conversation with Thomas Carr, supra n. 343.

346. Vermont's public service law, forbids issuance of a "certificate of public good" unless the Public Service Board determines that the project will not have an adverse effect on aesthetics. 30 Ver. Stat. Ann. § 248 (b)(4)(1978).

347. Small Power, supra n. 10, at 14.

348. Environmental Aspects, supra n. 47 at 12.

349. New Source Performance Standards for fossil-fuel-fired steam generators which include wood residue-fired generators, are contained in 40 C.F.R. § 60.42 (a)(1). Particulates are limited to 0.10 lb/million Btu. Two hundred forty-eight pounds of wood, at 4200 Btu/lb, would be required to generate one million Btu. Uncontrolled burning of wood in a power plant yields 10 lb of particulate per ton. Controlled burning yields 0.02 lb/ton (Environmental Aspects, supra n. 47, at 12). This means that wood burning generates 1.24 lb/million Btu uncontrolled and 0.0024 lb/million Btu controlled. A similar analysis with sulfur shows the uncontrolled emission rate

is 0.19 lb/million Btu, which is less than New Source Performance Standards allow (40 C.F.R. § 60,43 sulfur emission 0.80 lb/million Btu max.). For a discussion of available particulate control device see 44 F.R. 3491.

350. An example of such a facility is the Lane County Solid Waste Resource Recovery Facility in Lane County, OR.

351. Hempstead, supra n. 332.

352. 40 C.F.R. §60.43a (44 F.R. 33615).

353. Conversation with Jay Cambell, National Center for Resource Recovery, Inc. (7 Aug. 79).

354. Veigel, J.; Lohnes, L. "The Forest and Energy." Paper prepared for the Dartmouth Symposium on Renewable Resources. 5-9 Aug. 79, Holderness, NH.

355. Time, 15 July 79, at 74.

356. A Guide to Commercially Available Wind Machines. DOE RFP 2836/3533/78/3, 1978, p. 27

357. Id. at 110.

368. Wind Energy Systems: Program Summary. DOE/ET-0093, 25 (1978)

359. Reid v. Architectural Board of Review of City of Cleveland Heights, 119 Ohio App. 67, 129N.E. 2d 74(1963).

360. Id. Corrigan, J. Dissenting.

361. 1 Solar L. Rep. 255(1979).

362. Robertson, C. "Windmill Tower Erected." St. Petersburg Times. 17 Mar. 79, at 88.

363. Implications, supra n. 11, at 79.

364. See 1 Solar L. Rep. 255 (1979). Also see 44 F.R. 16604—NECPA regulations requiring 1.5 tower lengths between tower and any property line or structure.

365. Klaws Stobbe. "Tri-Valley Growers." Contained in Biomass Energy Conversion Workshop for Industrial Executives. SERI/TP-62-299. 19, 1979.

366. Testimony of C. Edward Taylor, PhD. 7(1978) (adjudicatory hearings on PG&E N.O.I to build a 1600-MW_e oil-fired power plant before California Energy Commission).

367. Personal conversation with Bob Farley, Staff Biomass Specialist. Golden, CO: SERI; 24 Aug. 79.

368. Forest Residues Energy Program 112 (1978) U.S. DOE TID-28416. Note: Page 16 defines material larger than 4 in. for pulpwood, material larger than 7 in. for soft wood sawlogs and material larger than 9 in. for hardwood sawlogs. This study is predicated on the assumption that future havesting will produce two products: wood chips and sawlogs. The chips will be separated into pulpwood chips (high quality) and fuel chips (low quality) Id. at 8.

369. Newoth, D. "Price and Availability of Wood for Fuel." Contained in Wood Chips, supra n. 340, 1, at 6.

370. Memo, supra n. 328.

371. See Bio-Energy Council, Bio-Energy Directory, 201-214(1979), for some examples of RDF projects in operation now.

372. Village of Euclid v. Ambler Realty Company 272 U.S. 359, 391, (1926).

373. Thomas, E. "Pelletizing Wood." Contained in Wood Chips, supra n. 331, at 67.

374. Press, F. President Carter's Science Advisor. Address to SERI Staff. 16 July 79.

375. Societal Analytics Inst., Inc. Barriers to the Use of Wind Energy, Machine the President Legal/Regulatory Regime and a Preliminary Assessment of Some Legal/Political/Societal Problems. 19 (1976).

376. "Utility Buys Wind-Generated Power." 1 Solar L. Rep. 17 (1979).

377. Id.

378. Lawrence, J. (AP). "Neighbors Oppose Windmill: Electrician Fights for Energy Saver." Boulder Daily Camera. 21 July 79. (Hereinafter cited as "Neighbors Oppose Windmill.")

379. Conversation with Patrick McLaughlin, 6 Aug. 79. Patrick McLaughlin is the man who sought to install the SWECS.

380. "Neighbors Oppose Windmill," supra n. 379.

381. Conversation with Rhoda Sheffer, Client Advisor, Underwriters Laboratories, 7 Aug. 79.

382. Department of Energy. Wind Energy Systems; Program Summary. 13, 1978; DOE/ET-0093.

383. Small Wind Energy Conversion system Pilot Project. 1979. (This document was obtained from Bonneville Power Administration).

384. See, e.g., "California WECS Demonstration." Wind Energy Report. February 1979.

385. "New Hampshire Windmill Prompts New Look at Town Zoning Ordinance." 1 Solar L. Rep. 255 (1979).

386. See, e.g., Eisenstadt. "Solar Right and Their Effects on Solar Heating and Cooling." 16 Nat. Resources J. 363 (1976).

387. Implications, supra n. 11 at 102.

388. See, e.g., "Solar Panels Unaesthetic?" 1 Solar L. Rep. 20(1979).

389. "Restrictive Covenants Unenforceable." 1 Solar L. Rep. 8 (1979).

390. Palensky, J. "Environmental Determination for Small Wind Energy Conversion System Pilot Projects." (1979). (Environmental analysis performed for Bonneville Power Administration).

391. Vail Ordinance #41, Series of 1978. Also see Butcher, S.; Sorenson, E. "A Study of Wood Stove Particulate Emissions." 29 Air Pollution Control. 724 (1979).

392. Chiranjivi, C. "Design Analysis of Small-Scale Anaerobic Digesters in India." Contained in Symposium Papers: Energy from Biomass and Wastes. 449, 452 (1978).

393. Retrofit 79: Proceedings of a Workshop on Air Gasification. SERI Publication SERI/TP-49-183. 11-31(1979). The cited entry in the directory section of this publication describes a very small gasifier design for use in a home-size furnace. The gasifier uses wood to produce a gas suitable for use in a converted oil flame furnace.

394. For a discussion of the dangers of gasifier-produced gas, see SERI Translation, Generator Gas: The Swedish Experience from 1939-1945. 309, 1950, original Swedish publication date; SERI/SP-33-140. The gas produced by a gasifier will be over 20% carbon monoxide. Id. at 299. Only 0.05% carbon monoxide by volume will cause unconsciousness in less than four hours. Id. at 301.

395. Park, J.; Schwind, D. Wind Power for Farms Homes and Small Industry. DOE document RFP 2841/1270/78/4. 7-5(1978). Also see Portola Institute. Energy Primer: Solar, Water, Wind, and Biomass Fuels. 168(1974).

396. Hawaii Rev. Stat. §205-4.5(b)(1976).

397. Id. §205-6.

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15. Supplementary Notes

16. Abstract (Limit: 200 words)

This paper will focus on the legal problems that may be encountered in selecting a site for a biomass or a WECS facility by considering various statutory siting provisions (both state and federal) as well as the land-use regulations that might either encourage or frustrate the site selection process. Centralized and decentralized facilities will be distinguished and dealt with according to their particular forms of siting difficulties.

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