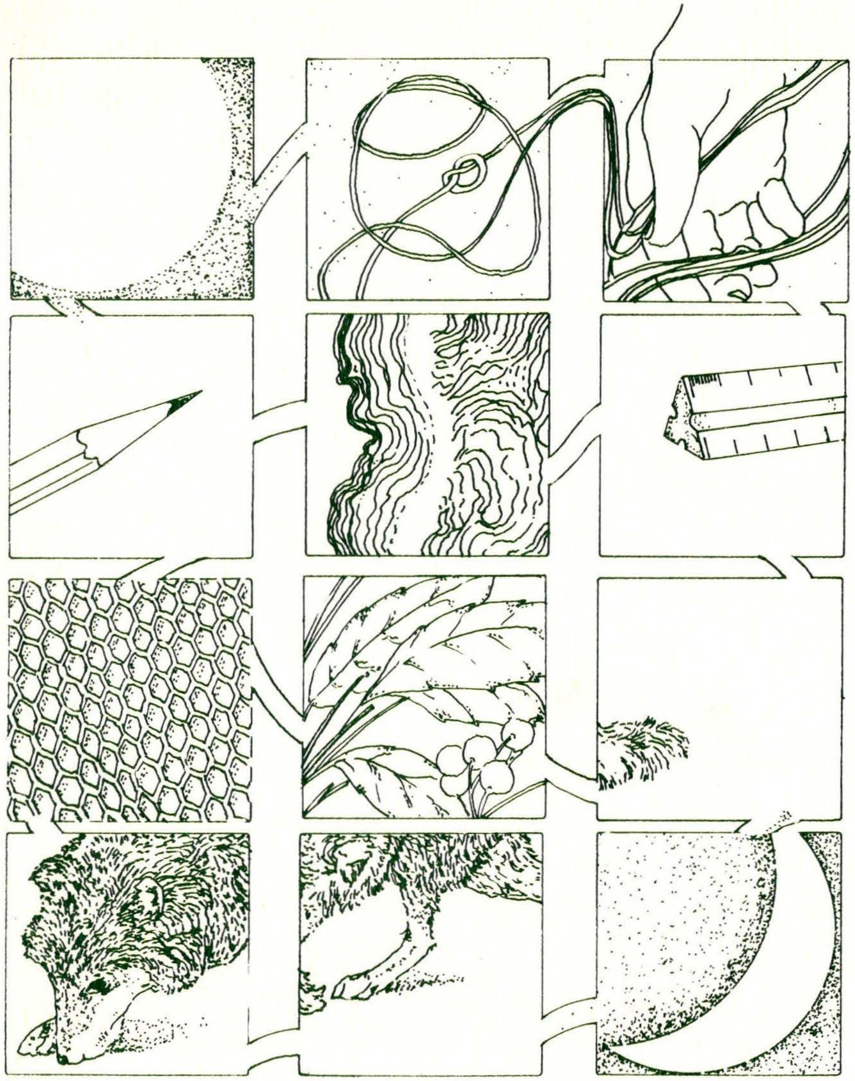

RENEWABLE ENERGY AND BIOREGIONS:

A NEW CONTEXT FOR PUBLIC POLICY

Peter Berg & George Tukel

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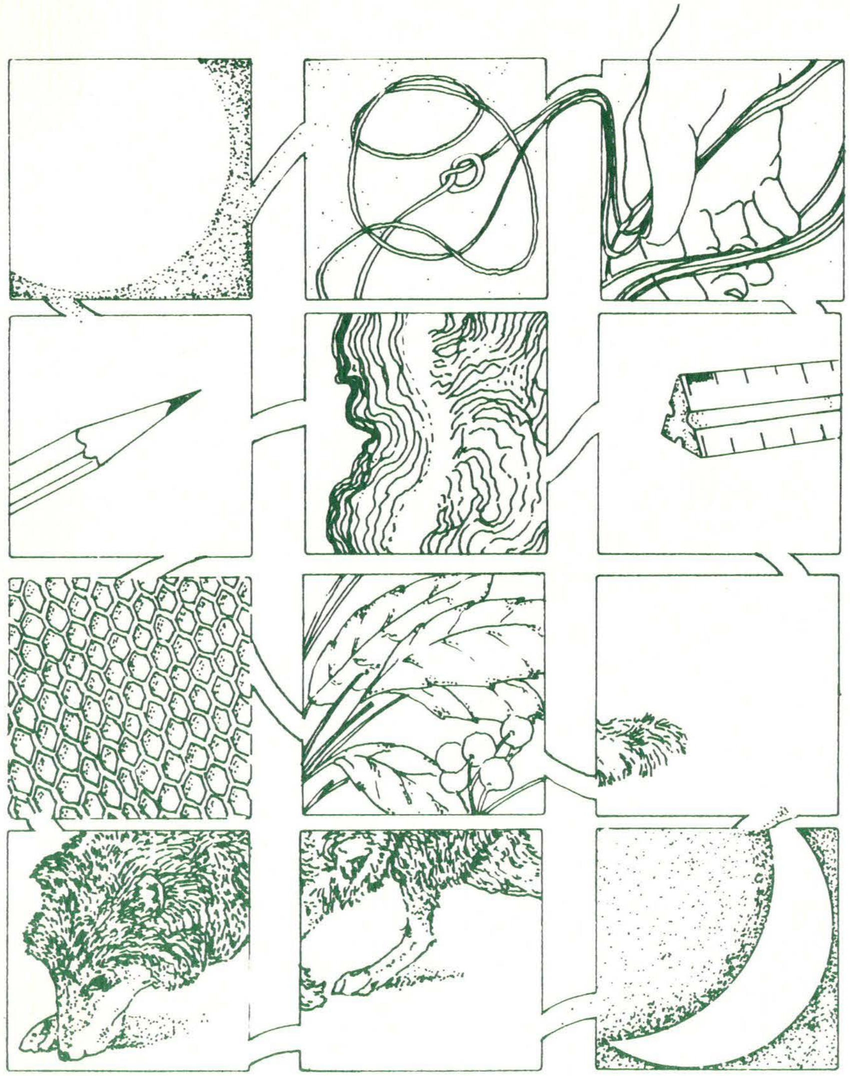

RENEWABLE ENERGY AND BIOREGIONS:

A NEW CONTEXT FOR PUBLIC POLICY

by

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prepared for

The Solar Business Office
State of California
Jerry Yudelson
Director

September 1980

FOREWORD

Public policy is concerned more and more with problems of energy supply and its impact on all aspects of modern life. ***Renewable Energy and Bioregions: A New Concept for Public Policy*** developed out of our strong sense that much of current energy policy-making is ameliorative, designed only to buy a little time, while postponing the shock of the major changes in economy and society which must accompany a sustainable energy future.

In particular, this report demonstrates that it is not necessary to sacrifice environmental quality to supply needed energy services, indeed, that a renewable energy future ***alone*** addresses contemporary concerns about under-employment and inflation, along with the need to regain local control and human scale in economic and political life.

Policy is always incremental; it deals with creating a practical context for the next step. This paper presents a major conceptual breakthrough, to get energy policy out of many of its current blind alleys. The authors deal with practical approaches for our highly urbanized society over the next decade, so that we can move in the direction of a transition to renewable energy systems and sustainable cities.

Most energy policy-making strategies to promote renewable energy resource development are organized by federal and state government and rely either on the jurisdictional boundaries of these governments or on the service areas of large electric and gas utilities as the domain of their activity.

There is mounting evidence that this arrangement is neither desirable nor necessary. In fact, many claim that this contemporary approach to energy policy and decision making is actually a significant hindrance to the rapid and wide-spread development of renewable energy systems. There are several reasons for this:

- Governments and utilities like to perpetuate their own existence as sources of centralized power, whereas renewable resources are inherently small-scale, diffuse and decentralized.
- Renewable energy resources are geographically distinct (in the case of solar, wind, biomass, hydropower and geothermal), often crossing government and utility boundaries.
- Since renewable energy resources are very often suitable for on-site energy production, they eliminate the need for centralized supply sources and large centralized facilities (although not the need for regional distribution systems).
- Full development of renewable energy resources requires major changes in contemporary economic and energy supply institutions, which are easiest to accomplish at the local or regional level and which are strongly resisted by the "business as usual" approach of state/federal governments and large utilities.

To overcome these obstacles, the ***bioregion*** is a more suitable decision-making unit. A bioregion is a geographical province with a marked ecological and often cultural unity. It is often demarked by the watersheds of major river systems, but can be composed of smaller hydrogeologic or biological units. Since renewable energy resources rely heavily on localized "solar" resources (sun, wind, vegetation and terrain), energy supply planning at the bioregional level makes good sense, for it allows more diversity and flexibility in planning and reduces the potential for conflict between political jurisdictions. The bioregional approach has also been adopted, with considerable success, for controlling both air and water pollution throughout the United States.

To build the argument for recasting energy policy into a bioregional mold, the Solar Business Office asked Planet Drum Foundation to develop a theory for bioregional energy policy and to apply the theory to a number of practical policy issues. We are impressed by the results and commend this paper to a wide audience of elected officials, planners, environmentalists, economists, community activists, businesspeople and energy experts.

– Jerry Yudelson, Director
Solar Business Office
September 1980

PREFACE

We are in the midst of a transition away from fossil fuels as the energetic basis of society. Renewable energy sources can become the primary means for supplying our future needs, and their use can resolve social and environmental dilemmas that accompanied the "Power Age" of fossil fuels. There is already sufficient renewable energy technology to meet basic human requirements and the activities of a "post-industrial" society. This solar transition has the potential to revitalize our cities, towns and suburbs, making them into "sustainable communities."

This paper develops concepts of renewable energy in terms that are more appropriate to its role in carrying out ongoing natural processes in the biosphere. Human uses of sources such as direct solar, wind, moving water, biomass and ocean gradients complement and participate in the flows of energy through natural systems. The concept of a bioregion locates renewable energy considerations in the web-of-life, and the ideas of solar income and natural succession are related to human uses of energy. We also discuss the effects of these ideas on personal involvement with energy and social values.

New frameworks of information are necessary to arrive at public energy policies that have relevance for both human and natural communities in a bioregion. We explore composition of a bioregional model and operation of figures of regulation to provide information, as a response to the new social priorities and reinvented social activities that come with a transition to renewable energy sources. We suggest the first steps public energy agencies can take to make this transition.

Energy choices have a direct bearing on social choices and the form of society. The paper concludes with an examination of this relationship and the effects of choosing a renewable energy future.

INTRODUCTION

Energy considerations are no longer merely factors influencing our industrial society: they have risen in importance to become some of society's more dominating concerns. Easy availability of cheap fuels and access to electrical power were prerequisites for achieving full-scale industrialization, and until recently fuels and power were taken for granted. Expansion of industrial technology had been our major preoccupation. Today it is obvious that energy availablility is the main limiting factor of not only industrial processes but of the economic, social and political functions of society as well. Fossil fuel resources, global supply lines, mammoth energy processing and generating facilities, and stores of supplies have become the most important targets of military strategy and defense. Public policies regarding energy now extend to determining whether people will freeze in winter and deciding whether armed forces should be committed in a Middle East war. Energy considerations have dramatically shifted from matters of well-being to terms of life and death.

While the role of energy in society has been transformed, there has been no accompanying change in the basic concept of energy which would ameliorate the adverse effects of energy domination. Gasoline, diesel fuel and heating oil are no longer cheap and are becoming less available, as easily recoverable oil reserves are exhausted. Rising prices for fuel and inevitable shortages are realistic expectations, in contradiction to industrial society's ideal of a constantly improving quality and ease of life. Our capability to change direction is severely limited by the social commitment which has already been made to fossil fuels. Industrial production, commerce and styles of life are powered beyond low-energy capabilities, and they are explicitly devoted to an ideal of progress that views escalating levels of energy use as the key to material well-being.

We have adopted an economic system whose morphological development depends on storing and using fossil fuels. The energy we consume in the production of goods and delivery of services is not a mere commodity or factor in the system, it is the enabling means by which the system exists.

Energy costs are a significant proportion of all costs. As demands exceed supplies of cheap energy, all prices rise to make basic living in industrial society progressively more difficult. The inflexibility and fragility of production processes which have resulted from dependency on limited energy sources to accomplish single purposes preclude our ability to adapt and retool easily for changing conditions.

In this sense, is the question of foreign or domestic oil supplies really relevant? At the present stage in the evolution of industrial society, it is becoming clear that the foundation link between fossil fuels and production processes itself is the dynamic factor which leads to economic stagnation and eventual collapse.

The concept of energy as a non-renewable but expendable force that can be universally applied without regard for its continued availability or the broader context of its use, the concept that underlies industrial society's goals and promises, has failed. Trying to make it succeed by searching out the last reserves of fossil fuel or endangering the biosphere with coal plants and nuclear reactors and their wastes only reduces our capability to eventually adopt a different approach to energy and different social goals.

We need a concept of energy and a way of understanding its relation to society which is founded in renewable and inexhaustible energy sources. Ultimately the energy flows of the earth, ecosystems and human communities are solar-based, either directly or indirectly. We need to shift energy considerations toward the regenerative processes of the planetary biosphere; our uses of energy must be seen as an extension and part of those natural solar-originated processes.

The current conflict between environmental priorities and energy use must be resolved by linking renewable energy sources and the technologies for employing them with a recognition of natural energy flows through broader life-systems. Using solar power as a mere replacement for fossil fuels without accounting for the way it is used or distributed, for example, perpetuates an open-ended and abstract concept of energy. We need to account our uses of energy in terms of whole-life-systems.

Our sense of personal involvement with energy should extend beyond the misleading context of bills and prices, and there needs to be a restatement of the social values reflected by energy policies. These can become the basis for a new social contract between the public and the agencies that oversee energy availability.

There is no question that energy considerations will continue to play a significant part in determining the direction of society. The question is whether it is necessary to follow the terms of non-renewable energy and the form of industrial society. Rather than being dominated by a narrow and self-defeating concept of energy, we can begin identifying patterns of renewable energy and aligning human needs with them. Rather than exhausting our options, we can begin relocating our energy concerns within natural cycles that allow flexibility and open new options.

PART I

Adapting to Renewable Energy: Concepts, Personal Identity and Social Values

A LIFE-SYSTEM BASIS FOR ENERGY ACCOUNTING

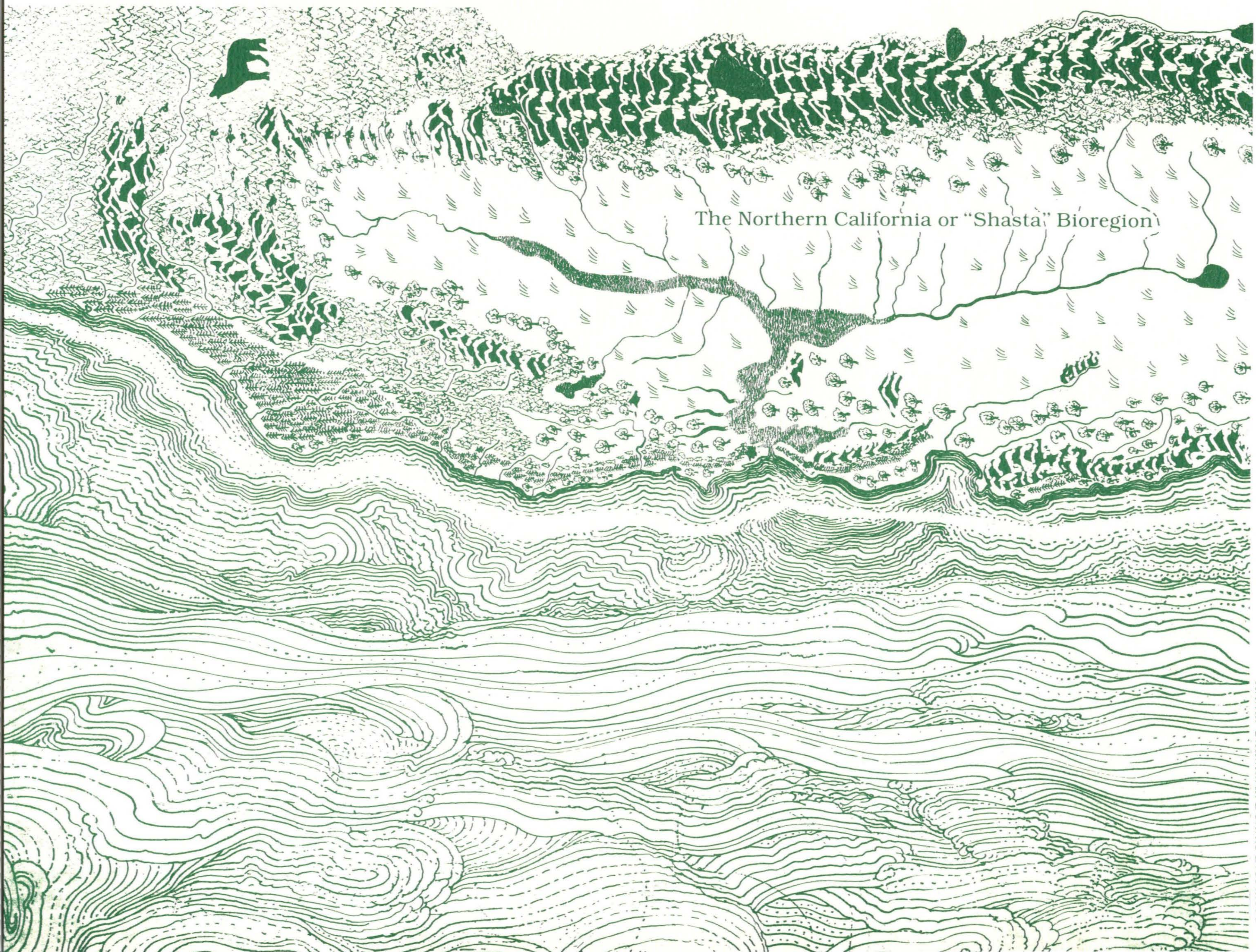
The flow of energy through natural systems can be related to human communities if we address the questions: Energy to and from where? Energy for what? Energy for whom?

The extent of energy accounting that accompanies the goals of industrial society is limited to market prices and negotiating an end to disruptions of energy supplies so that production of food or delivery of services can continue to maximum profit. Accounting is concerned more with quantities of inputs than with the way in which energy is used to provide services such as lighting, motive power, thermal comfort or process heat. If energy conservation or renewable sources are employed, they are only considered as stop-gaps to lessen the impact of declining fossil-fuel supplies.

Natural systems are covered over with high-energy requirements to satisfy the most basic human needs of food, shelter and water in industrial society. At the current stage of development, vast areas of land are plowed up for short-term grain production, the Amazon jungle is cut down for once-through use of timber and pulp, and rivers are systematically diverted to bring fresh water to distant metropolitan areas. Environmental depredations are undertaken with mammoth technological force through a global economic and political infrastructure, and their magnitude, frequency and duration make them increasingly dangerous to the health of the biosphere.

It has become necessary to conceive of more responsible ways to account for energy supply and use. Individuals and communities have to be able to appraise information and events within frameworks that have importance for energy requirements and preservation of life-systems in their local areas.

A first step in reclaiming control over energy choices is to establish the geographic locations of human communities in terms of natural communities and systems, and this can be accomplished by using the concept of a ***bioregion.*** A bioregion is a distinct area where the conditions that influence life are similar, and these in turn influence human occupancy. The extent of a



Arthur Okamura/Dennis Breedlove

bioregion can be determined by using climatology, physiography, animal and plant geography, natural history and other descriptive natural sciences. The idea of a bioregion, however, is cultural. It defines both a place and adaptative ideas about living in that place.[1] ***Watersheds*** designate local natural communities and provide an organization for bioregional life through enlarging tiers of spring-creek-river networks; they can serve as a basis for organizing relationships between human communities in a bioregion as well. For example, Northern California within the crescent of the Tehachapi-Sierra Nevada-Klamath/Siskiyou mountain ranges is a natural bioregion in which households, towns and cities could establish links by following successive watersheds joining creeks to feeder rivers of the Sacramento-San Joaquin River system and eventually to San Francisco Bay.

Energy accounting that balances the requirements of human life with the necessities of maintaining local ecosystems and environments must derive its measures or scales of value from long-term stable characteristics of both natural and human communities. Natural characteristics include the amount of available energy in a particular bioregion and the way it is used by local ecosystems. Human interpretations of these are incorporated in patterns of understanding and value, and in the model that is used to observe the effects, interactions and limits of activities.

The energy available to a bioregion through direct solar radiation, secondary solar-derived energy flows, and watershed ecosystems can be referred to as ***solar income.*** Solar income includes the processing and storage of energy by plants, animals, micro-organisms, the watershed organization, and humans. It results in photosynthesis, respiration, the turning of nutrient cycles, mineral cycles, the hydrological cycle, and establishment of food chains. Solar income provides renewable energy resources in a wide range including raw materials, biomass, wind, falling water, currents, and tides.

[1]Berg, P. and Dasmann, R., 1979. "Reinhabiting California" in Reinhabiting a Separate Country, pp. 217 - 220, Planet Drum Books, San Francisco.

Natural Succession

Although ecosystems use and produce available energy in many complex ways, a coherent regional design pattern can be found in the progression of vegetation through natural succession to climax. Starting from a condition of bare soil, plant formations develop through primary and secondary stages until reaching a climax level of species diversity and population. In the Northern California Coast Range, for example, primary mosses and grasses would yield to secondary stage willows and alders which would in turn be shaded out by climax cedar and Douglas fir forests. Natural succession of vegetation relates to animal species directly because of the role plants fulfill as a foundation for animal food chains. Plants also play an essential role in the development and maintenance of soil quality.

A mature climax ecosystem offers an ideal model for wise and efficient energy use. Because natural succession moves through levels of diverse interdependent plant species which establish food chains as complex pathways through which energy and materials move in a wide range of forms, the climax stage is extremely stable. Even extinction of particular species will not cause the ecosystem to collapse because adjustments are readily absorbed in the process of succession. In the following table, Eugene Odum lists other aspects of the remarkable tendencies toward energy efficiency, complexity and self-correction that accompany the development of ecosystems to climax stages.[2]

Fossil fuel systems tend to disrupt natural succession because they displace complex biological organizations of energy. Clear-cutting a forest using heavy machinery and power saws is an obvious example of this, and the range of effects is much broader than is apparent in the immediate loss of trees. Subsequent soil erosion can permanently prevent a climax forest from returning to the area. Fossil fuels deliver surges of energy that strain and distort regional ecosystems and make them increasingly more fragile and dependent on extra-regional energy

[2]Odum, Eugene, 1975. Ecology: The Link Between the Natural and Social Sciences, p. 156, Holt, Rinehart and Winston, New York.

A Tabular Model for Ecological Succession of the Autogenic, Autotrophic Type.

	ECOSYSTEM CHARACTERISTIC	TREND IN ECOLOGICAL DEVELOPMENT: EARLY STAGE TO CLIMAX OF YOUTH, TO MATURITY OR GROWTH STAGE, TO STEADY-STATE.
Community Structure	Species composition	Changes rapidly at first, then more gradually.
	Size of individuals	Tends to increase.
	Number species of autotrophs	Increases in primary and often early in secondary succession; may decline in older stages as size of individuals increases.
	Number species of heterotrophs	Increases until relatively late in the sere.
	Species diversity	Increases initially, then becomes stabilized or declines in older stages as size of individual increases.
	Total biomass (B)	Increases.
	Nonliving organic matter	Increases.
Energy Flow (Community Metabolism)	Gross production (P)	Increases during early phase of primary succession; little or no increase during secondary succession.
	Net community production (yield)	Decreases.
	Community respiration (R)	Increases.
	P/R ratio	$P>R$ to $P = R$.
	P/B ratio	Decreases.
	B/P and B/R ratios (biomass supported/unit energy)	Increases.
	Food-chains	From linear chains to more complex food webs.
Biogeochemical Cycles	Mineral cycles	Become more closed.
	Turnover time	Increases.
	Role of detritus	Increases.
	Nutrient conservation	Increases.
Natural Selection and Regulation	Growth form	From rapid growth to feedback control.
	Quality of biotic components	Increases.
	Niches	Increasing specialization
	Life cycles	Length and complexity increases.
	Symbiosis (living together)	Increasingly mutualistic.
	Entropy	Decreases.
	Information	Increases.
	Overall stability	Increases.

imports. Modern fossil-fuel-powered agriculture is ultimately self-defeating for this reason. By displacing diverse natural ecosystems with monocultural crops and working at a constant primary stage of succession, power agriculture destroys the soil base and requires increasingly greater amounts of fertilizer and mechanization.

Figures of Regulation

Human understandings and values pertaining to solar income should be incorporated in bioregional ***figures of regulation***. These are cultural ways of expressing information which are necessary to maintain day-to-day stability and to respond to danger signals which indicate disruption of the balance between human activities and ecosystems. Roy Rappaport has shown how ecosystem-based low-energy societies develop myths and rituals that act as implicit elements in the stability of local natural systems and inform people about their behavior as they interact with them.[3] The natural dynamics of the biosphere support our day-to-day lives in ways that are both simple and complex, direct and indirect, short- and long-term. Our conception of reciprocity with the ongoing processes of the biosphere and the choices we make about adapting to or altering life-support systems depends on how they are perceived and the degree of respect they are given. In one tribe that Rappaport studied in New Guinea there were distinct cycles of rituals for regulating relationships with other tribes and nonhuman species. There were also personal rituals for members within the tribe that were a form of accounting to supernatural powers — the ancestors. Performing these rites "helps to maintain an undegraded environment, limits fighting to frequencies which do not endanger the survival of [their own] population as a whole, adjusts the man-land ratios, facilitates trade and marriage, [and] distributes local surpluses of [food] throughout a wide region."[4] This balancing of one's personal behavior and "success" with rituals relating to natural elements and other people acts as a ***figure of regulation*** and is a force for stability at the highest level of human understanding. It does so not by understanding the specifics of every homeostatic process (the nitrogen cycle, for instance) but by providing a framework for interpreting careful observations and undertaking corrective actions. Figures of regulation are checks on behavior which can accomplish large effects by maintaining complex, joined eco-cycles such as food webs.

Carrying Capacity

The relationships between populations and the levels of service that can be supported by renewable energy sources within a bioregion can be gauged through the modeling procedures used in determining carrying capacity. In the study of human communities, carrying capacity has been used to develop models of global population limits in terms of available food, water, air and essential raw materials. Carrying capacity was originally developed in the field of wildlife management to give definition to the number and types of animals that plant populations could support in a particular area. The geographic location for which carrying capacity is determined should be the natural area of a bioregion and its watershed tiers rather than one defined by arbitrary county or state boundaries. With the realization that energy density — the delivery of power and natural resources to high-energy locations — is more critical than population density, the idea of carrying capacity must include not only the question of necessary per capita supplies but also the quality of the energetic life-system for populations and communities.

[3]Rappaport, Roy, 1968. Pigs for the Ancestors: Ritual in the Ecology of a New Guinea People, Yale University Press, New Haven.
[4]Rappaport, Roy, 1974. "Sanctity and Adaptation," p. 56, CoEvolution Quarterly, Summer, Sausalito, CA.

A SHIFT IN PERSONAL INVOLVEMENT

Individuals within industrial society are generally viewed as consumers and their relationship to energy is designated as a sector of consumption. Reduced to the simplest equation, Citizen X in California uses daily the equivalent energy in 0.18 barrels of oil, including 1.5 gallons of gasoline. Deprivation of supplies for direct personal use in automobiles or indirectly in electrical power for households would currently bring near-catastrophe. People are utterly dependent on energy systems over which they have no control, and political manipulation of their dependency on a high level of fuel consumption is an overt fact of life.

The history of utilities management as electrical power developed is illustrative of the way in which social decisions came under the domination of energy considerations. By 1882, the first central electrical distribution system had been put in place by Thomas Edison. With the development of alternating current by Westinghouse in 1886, a basic technology for supplying electrical power to large service areas through power grids was established. The only limitation was obtaining necessary financing for growth based on projected load demands. By the 1920's, following the logic of economies of scale, consolidations occurred, and enlarged private utility companies were granted special privileges as "natural state-regulated monopolies" to serve various sectors of the economy. Subsequently, a number of public utilities took over their functions but have retained the same characteristics of large scale, sustained load growth, centralization and large capital investments.

The social contract which exists between utility companies and the public is actually a service contract that has been made credible by legislative and judicial action. It is mediated by regulatory commissions with the following two premises: utilities are entitled to a rate of return for their generating and transmission facilities and continuance of their credit-worthiness; the public receives all the electricity and gas it demands, at the lowest possible cost, and pays for services delivered which in turn underwrite the perpetuation of the utilities.

This arrangement evolved during the period when generating costs were low and centralized power grid systems with apparently unlimited potential seemed justified by declining marginal costs of new plants and the needs of a continuously expanding economy. Today those assumptions are no longer valid.

The most vulnerable aspect of the contract in terms of serving public welfare is monopolization of access to and determination of the types of energy systems which communities use. Utility companies are characterized by severe centralization and radical dependence of the public on these remote institutions. Public insecurity about rising electricity costs is compounded by lack of participation in the decisions made by utilities and their regulatory commissions. In the current social debate over using nuclear plants to generate electrical power, where the public safety and health is a major issue, exclusion of the concerns of citizens has become a critical factor in reducing the credibility and sustainability of official decisions.

Social planning and policies cling to maintaining the original social contract even though it enforces dependency on an increasingly tenuous way of life which balances short-term needs against long-term survival. Nuclear energy was originally portrayed as an ideal centralized source for providing cheap and unlimited power. Proponents of nuclear power continue the ideal of a constantly expanding economy with a technological fix shrouded in the mystery of the nuclear reaction and a vocabulary inaccessible to the average consumer of electrical power. Just as the so-called Green Revolution perpetuates an illusion of solving the "hunger problem," so does the ***de facto*** designation of ***national sacrifice areas*** for strip-mining coal and uranium provide the illusion of solving the "energy crisis." The dangers of nuclear power, the demands of the Green Revolution for artificial fertilizers, pesticides and excessive fuel consumption, and the explicit confession of a "national sacrifice area" that whole regions would become uninhabitable by methods of extracting natural resources, all demonstrate that social contracts have hardened into a mode for enforcing public dependency. After the carrot of unlimited progress has been promised, critics are quieted with the stick, "Do it or starve, do it or freeze."

A bioregional relationship to energy, on the other hand, would involve individuals just as thoroughly but from a radically different perspective. Each person could become a participant in energy production and use, for both individual and community purposes. Rather than communicating with utility companies solely through the payment of bills, people would actively assume some of the roles of those institutions by developing their own life-system accounts for on-site energy production. They would help set limits for using only solar incomes and share in the creation and maintenance of community "wealth." There are recent indications that people are moving in these directions by matching housing designs and micro-climates with passive solar energy applications and undertaking wood-lot management in areas where wood-burning stoves are returning to use.

Personal involvement with energy issues and solutions in a bioregional context would become the basis for forming links to both the social community and the natural community of which it is part. No one owns a bioregion in the sense of property, but everyone owns a personal stake in its well-being. Starting with immediately local ecosystems and continuing through tiers of watersheds to the entire bioregion, there are successive stages of participation that constitute natural, social, and political identities for each person. The sense of a neighborhood would now include local creek ecosystems, the sense of a city or town would take into account the watershed in which it is located, and citizenship in a bioregion would replace the current notion of belonging to a state. Individual awareness and appraisal of bioregional conditions and health would become a primary and continuing subject of social communication and sharing, forming the personal component of figures of regulation.

BIOREGIONAL WORTH

When energy choices and decisions are located in the complex of bioregional life, individuals and communities are presented with a dimension of shared values that can be termed ***bioregional worth.*** A standard of bioregional worth would be whether planning or policy decisions contribute to restoring and maintaining the bioregion as a life-place. Value would extend to activities that are judged appropriate to the locale or effective in complementing natural energy flows through the bioregion.

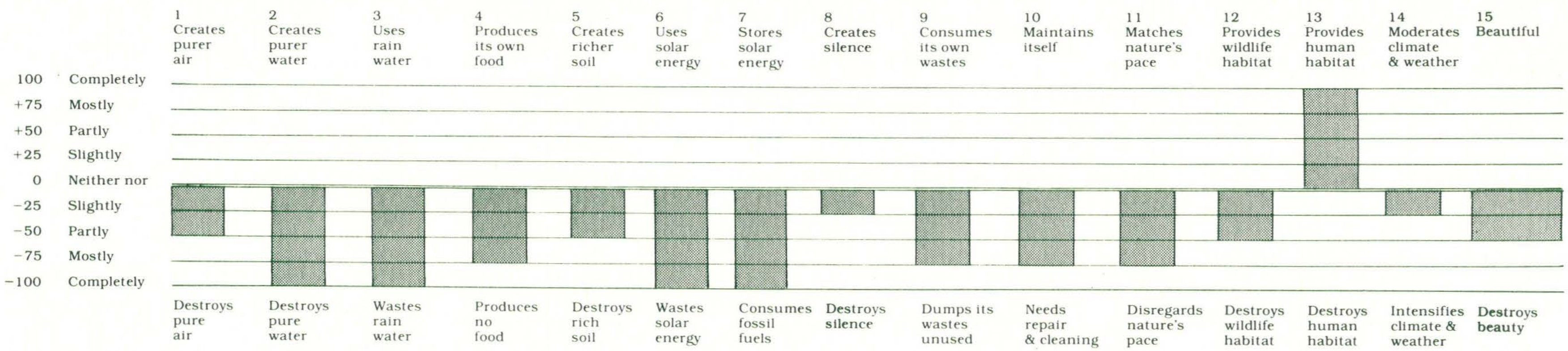
The design and construction of houses is an essential activity that involves a wide range of energy decisions where bioregional measures of worth can be applied. The general direction of these measures can be seen in Malcolm Wells' criteria for redesigning houses for minimal impact on the environment.[5]

Bioregional measures differ from Wells' generalized environmentalist criteria in that the latter exist in a local context and are related directly to the specifics of a place. Considerations of water purity, using rainwater, preserving topsoil and wildlife habitat would be made in terms of the specific watershed in which the house was located. For example, houses built on river floodplains, the site of most recent suburban development, violate a bioregional measure of worth associated with interrupting the flow of energy through the bioregion and displacing a major part of a watershed's ongoing role. Attempting to redesign the house to meet Wells' criteria would be of secondary importance to the necessity of relocating it out of the flood plain.

The materials used in houses and their style of construction can also incorporate measures of bioregional worth. The current rediscovery and further development of regional bioclimatic architecture yields low-energy-using forms that interact creatively with micro-climates and also are beautiful. Bioclimatic architecture is energy efficient on several levels that relate to maintaining and restoring the bioregion. These houses, of

[5]Wells, Malcolm, 1976. ". . . higher laws" in Energy Issues, pp. 55 - 56, Edmund Scientific Company, Barrington, New Jersey.

Typical Suburban Development



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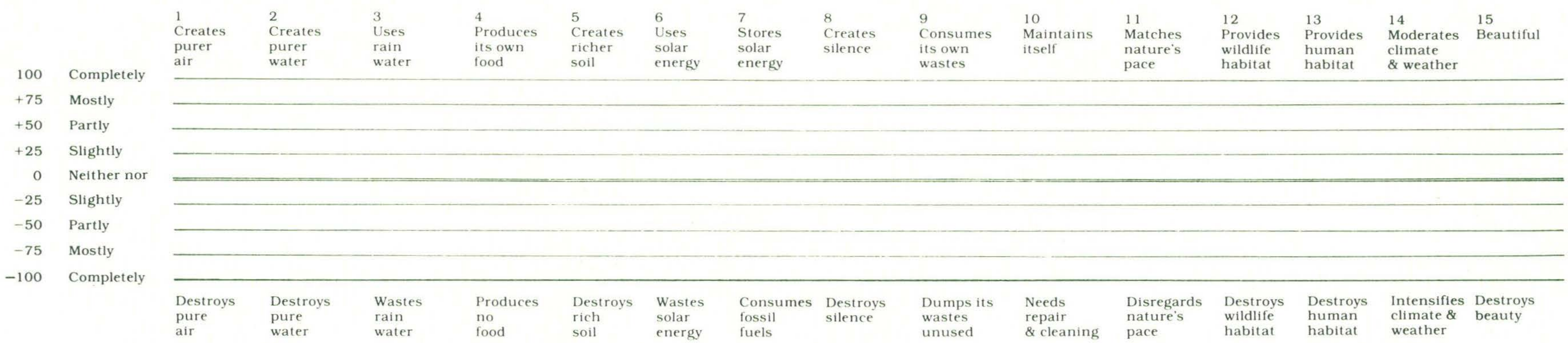
Your Own Development



Your score:

Malcolm Wells, Energy Issues

course, satisfy the usual requirements by using the least amount of energy to provide heat, hot water, and electricity necessary to maintain human comfort levels and household energy services, but they also continue the circular organizations of ecosystems. Using indigenous building materials is an obvious way in which this can happen. Native materials can be found close to the building site and can be transported and processed with local energy resources, whereas prepared industrial materials cannot. Their use closes loops in solar income that exist between geological characteristics, soils, and forests. (Native stone, clay bricks or adobe, earth sheltering and wood, are examples.) If they are not recycled in other buildings, extending their use pattern and energy value, they can be easily recycled naturally by returning them to the nearby places where they originated.

A design of a bioclimatic building complements the cycles of energy around it; the sun's movement during the day and through the seasons, proximity to moving water, and exposure to wind and weather. An indigenous housing form is also a special store of information about energetic processes that involve a number of species (human beings, trees, animals, etc.). Many traditional designs already embody bioregional know-how. The New England saltbox and Southwest Indian adobe pueblo houses are especially well suited to the regions where they originated. Experimental projects in indigenous bioclimatic architecture add to the store of information. (While information storage uses a little additional energy, it is more than justified by creating a framework for feedback that eventually increases the effectiveness and stability of the overall web of life.)

Designing bioclimatic buildings would also take into account the uses to which they are put and connections between individual dwellings and the community at large. For example, more bioregional worth would attach to recycling household wastes rather than flushing them away to become a sanitation problem downstream. Recycling would be understood as a factor in net energy efficiency. Energy would no longer be consumed in waste disposal; in fact, wastes would become a source of energy or of displacing the need for fossil fuel.

The actual process of constructing a house can exhibit bioregional worth in a number of ways. Labor exchanges, for example, can be associated with both the notion of bioregional sharing and the evolution of bioclimatic forms from shared perceptions of the builders.

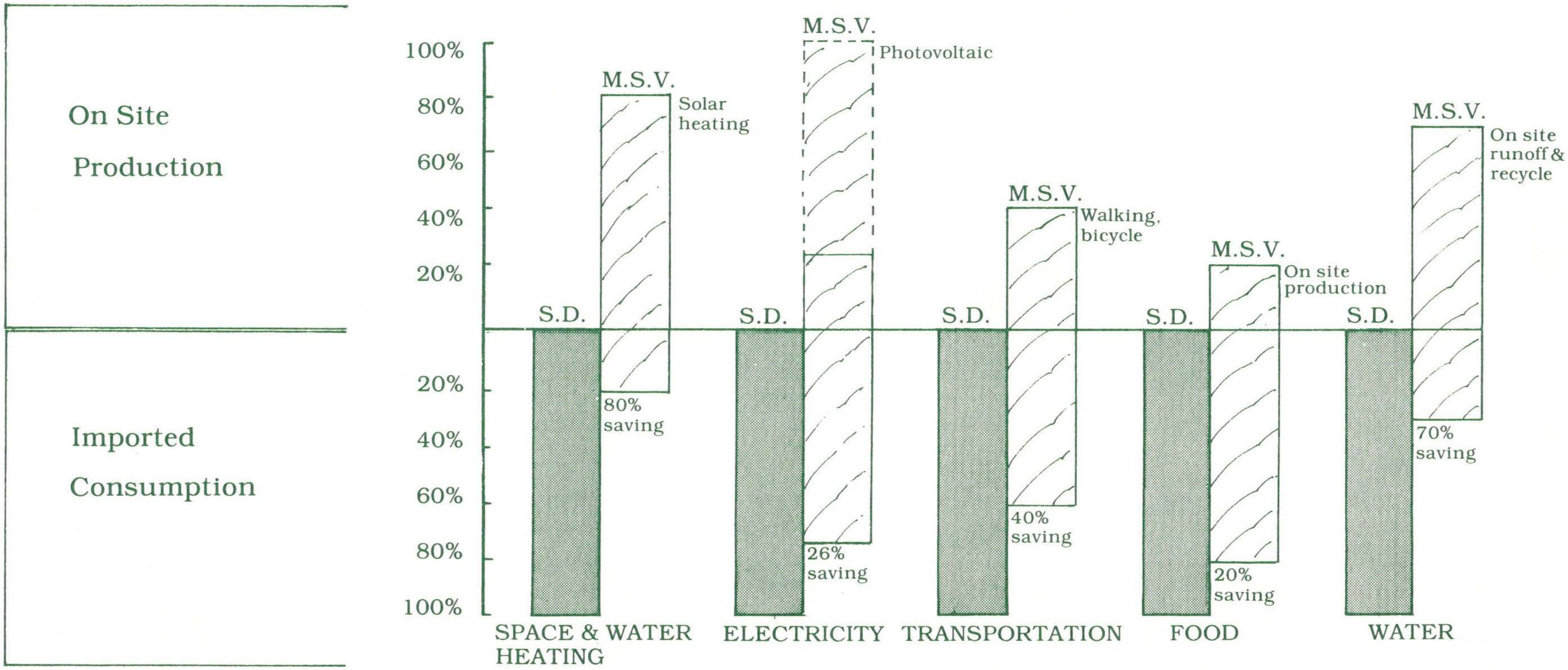
What are the practical effects and benefits of bioregional measures of worth? From an energy point of view they are allied with natural succession because human uses and technologies would yield net energy flows from low-energy sources. In terms of restoration and maintenance of the bioregion, the new measures of worth result in reappearance and abundance of native plants and animals and reoccurrence of annual animal migrations. They preserve fresh water flows and salt-fresh water balances in coastal estuaries, and return top-soil to productive use. Incorporating bioregional worth into standards of social value will improve the quality of local environments, and developing a sensitivity for bioregional worth should similarly improve the quality of life experienced by everyone.

An outstanding recent example of developing bioregional worth is the "Marin Solar Village Plan."[6] This plan envisions construction of 1900 dwellings on 1650 acres over ten years in the form of compact "solar villages," with nearby and related employment. The "Marin Solar Village Plan" is based on the concept of ***sustainabilty.*** It is designed to use far fewer non-renewable resources than the average new or existing community, and to emphasize on-site energy production and resource recycling. The Plan explains the concept of sustainability in a bioregional context which is clearly applicable to cities, towns and suburbs everywhere.

[6]Van der Ryn, Calthorpe, and Partners, 1980.

Energy and Resources Comparison Between Marin Solar Village (M.S.V.) and Standard Development (S.D.)

The bars compare energy and resource use in key areas between a Solar Village and a standard development of similar density. The bottom half of the graph shows estimated savings of imported fuels. The top half indicates on-site production. Photovoltaics are shown as a future source of on-site electricity.



Marin Solar Village Corporation, Marin County, California

PART II

Deriving Bioregional Energy Policies

SOLAR INCOME AND CARRYING CAPACITY

How can the hugely complex considerations of solar income and natural succession, the major patterns of renewable energy availability and ecosystems continuity in a bioregion, be represented to inform public energy policy?

In one respect, these patterns must be presented and interpreted in observable and quantifiable ways. However, the patterns can also be translated into cultural and social features which are appropriate to setting goals for a bioregional society. Ultimately public energy policy should inter-relate the energy and ecosystem facts of the bioregion with cultural and social terms which incorporate them.

The ***solar income*** that moves through a bioregion shapes both the physical landforms and the evolution of biotic communities. Natural energy flows occur in two primary ways to accomplish this, each turning recognizable cycles that interrelate in an open system.

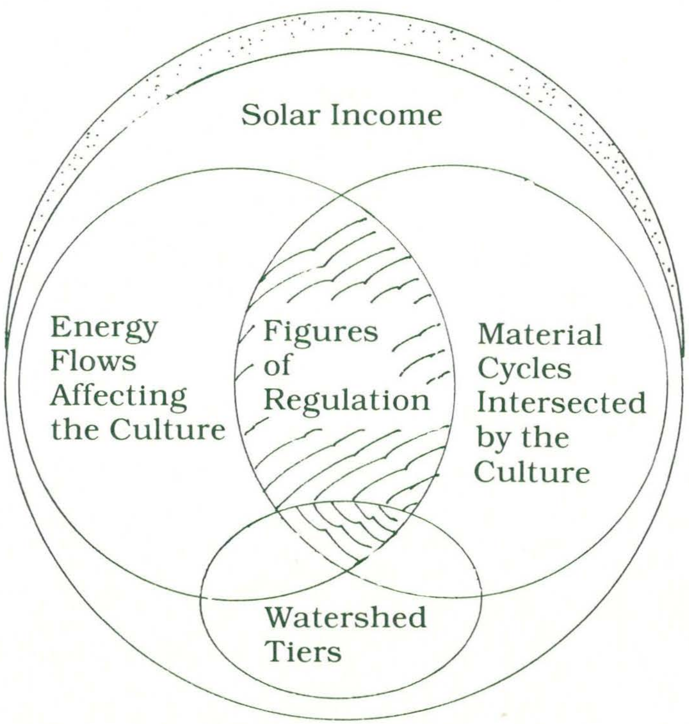
The hydrological cycle is a dominant feature of one type of energy. Running water outlines and contours the shape of a watershed. Erosion and the transportation of materials are main activities of this part of the hydrological cycle, and the form of a watershed and disposition of its soil are the results.

Photosynthesis is a major aspect of the second type of energy flow. Primary plant production carries the energy of solar radiation to generate and supply nutrient cycles and food chains.

There are interactions and modifications of energy flows and material cycles both integral to each and between the two types. Weather, terrain, the presence of water, and soil conditions are the context, for example, within which plants grow and photosynthesis begins to transform energy.

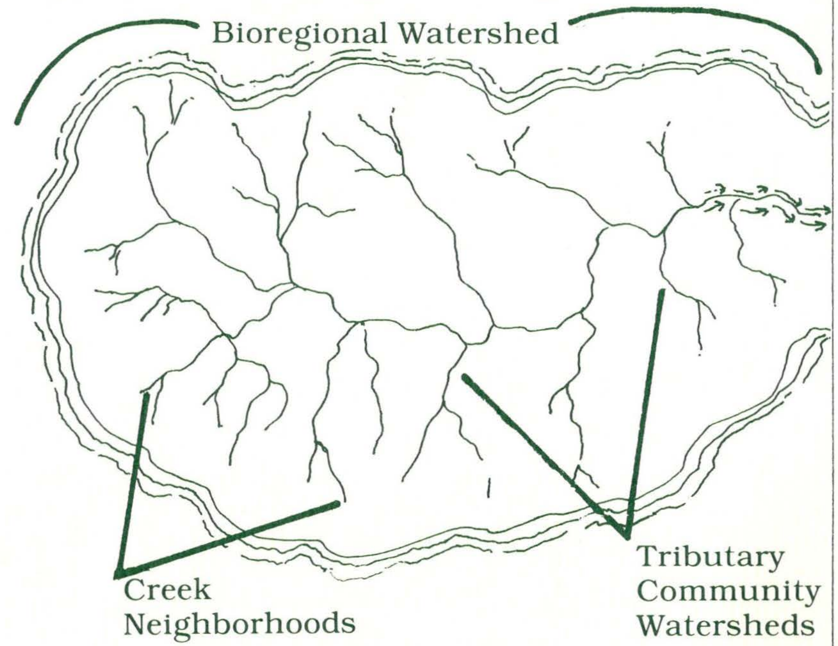
Aspects of solar income that present opportunities for direct human use such as sunlight, wind and biomass are considered later as part of a bioregional ***resources inventory.***

Derivation of "Figures of Regulation" From Societal Interaction with Energy Flows in the Natural Environment.



Watershed tiers, the progression of watersheds from local ecosystems through river valleys to eventually include the whole complex of water systems within a bioregion, provide a basis for locating related geographic areas in terms of energy flows and cycles. Watersheds can be seen as the "home ground" of local human communities, and the inter-relationship of tiers connects each community to the others. Watersheds contain the natural foundations for incorporating ***figures of regulation*** that enable communities to live within their solar income.

Watershed Tiers
A Schema for Redefining "Place" in Terms Appropriate for Bioregional Energy Policy

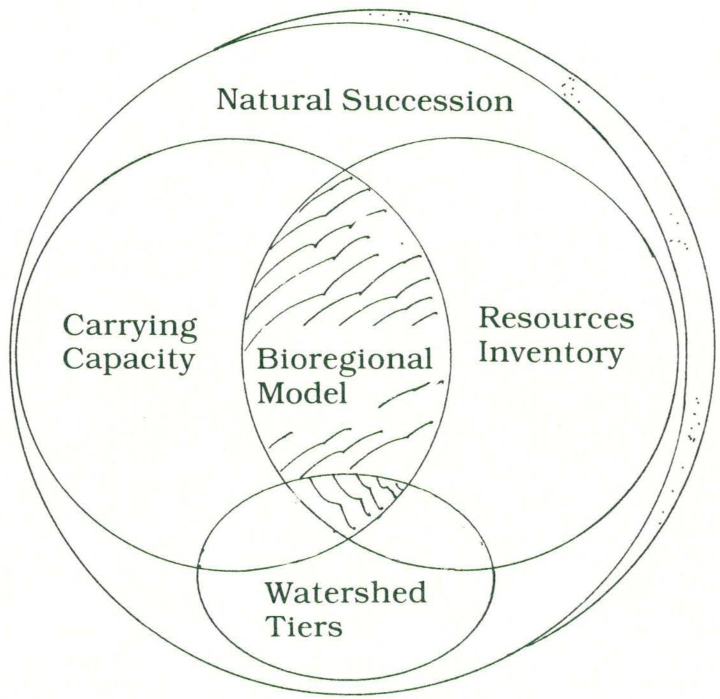


Figures of regulation symbolize energetic and ecosystem processes (and events that epitomize their interconnectedness) in practices, ceremonies, observances, ritual cycles, and holiday celebrations that ground human behavior and cultural adaptations. Observances commemorating Equinoxes and Solstices can be readily seen as having significance in this context rather than Columbus Day, for example. They complement processes that govern the ultimate flow and cycle of energy through watersheds. Figures of regulation must be discovered through perception and study of watersheds and bioregions in their present condition, and rediscovered through interpretations of the way they functioned in the past. Bioregional culture is an active adaptation undertaken with the understanding that human beings have accepted their interdependent relationship with the biosphere and intend to pursue creative and appropriate ways to live within it.

The movement of ***natural succession to climax*** from less stable to more mature stages exhibits "design criteria" such as increased energy efficiency, lower rates of materials loss, expansion of diversity, lower energy flow rates, higher levels of information, and creation of more complex regulatory mechanisms, which can be used to fit local resources within configurations of necessary food, water, air and concentrated energy supplies.

A ***resources inventory*** lists and describes traditional elements of a natural resources inventory including native plants and animals, climate, soils, geology, topography, water resources, land use patterns, population densities, and air quality. To fully portray bioregional life, a resources inventory also includes domestic plants and animals, and surveys low-energy sources such as solar radiation, wind, moving and standing water, and biomass which can become the basis for determining appropriate energy-generating technologies.

Development of a Bioregional Model from the Interaction of Carrying Capacity with Available Resources in a given Watershed Unit.



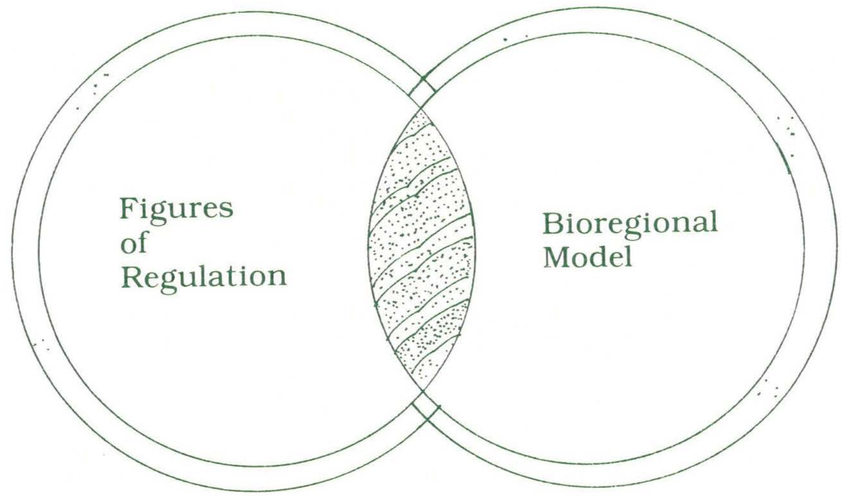
The ***carrying capacity*** of watersheds reveals the uses of resources and the energetic basis for integrating them with stages of natural succession. Carrying capacity represents a dynamic balance point for evaluating decisions that involve production alternatives and ecological costs and benefits. Consider how this could apply to evaluating energy-generating technologies where the importance of scale, geographical location, and energy quality is judged in relation to efficient end-use. Besides incorporating lessons from thermodynamics, these technologies must also be understandable, reasonable and applicable in a bioregional sense. Using local construction materials, for example, introduces questions concerning acquisition of materials and portable energy, resources management, net energy, and costs which have to be considered in an interactive way. Carrying capacity offers a context for studying that interaction. Carrying capacity can lead us to the development of plans for sustainable communities and away from the mentality of unlimited, unselective growth.

Integrating a resources inventory with carrying capacity yields the essential form of a ***bioregional model*** extending through watershed tiers. This model should provide the foundation for descriptive and analytic information to assess the condition of the watershed and its development in its physical, biological, and technological states. A bioregional model can take the form of a complex and responsive mathematical system for studying the effects of changing variables, and it may also be represented as a walk-through panorama or sculpture, or simplified as a set of major symbols for designs.

SOCIAL PRIORITIES AND RE-INVENTING SOCIAL ACTIVITIES

If figures of regulation develop fully as a form of initiating community action and if a bioregional model becomes an effective representation of the community, then there needs to be a means of inter-relating those so that reciprocity between cultural and eco-energetic processes can be understood.

The "Seed Ground" (shaded) for Public Policy Combines the Common Elements of Cultural Adaptation and Bioregional Components



The area of reciprocity between a people's image of themselves and the natural environment they inhabit can become a realm of ***public policy***. However, public policy does not follow directly from figures of regulation or the bioregional model. There have to be issues and questions before public policy can be formed, and these should come from the ***social priorities*** and the need for ***re-invention of social activities*** of a society based on renewable energy resources.

A principal social priority would be reconstituting "utility districts" into ***energy service districts*** located within watershed-based resource conservation and regeneration agencies. Electric power generating facilities have been organized on this scale in the past; e.g., Sierra Nevada electric power companies in the late 19th and early 20th centuries. The natural boundaries of districts would coincide with tiers of watersheds, with the addition of an extra-bioregional agency to relate to contiguous bioregions and larger related biospheric communities such as the North Pacific Rim. These "micro" and "macro" districts should be conceived broadly, beyond the notion of only providing power, to balancing solar income against requirements. They would give biological considerations equal importance with those of engineering technology.

Other social priorities would include establishing norms and judgments to encourage or discourage activities on the basis of their ramifications throughout the bioregion and arbitrating issues arising from selection of locations to promote decentralization and avoid conflicts of local interests.

Re-invention of social activities is necessary because of the new low-energy focus on bioregional society. Rather than being a retreat to a pre-industrial period of arduous time-consuming labor, however, re-inventing activities can bring the level of sophistication that already exists in some areas of present society to day-to-day uses of energy and the ways in which people employ their time.

Currently an enormous amount of personal income goes into buying and maintaining automobiles, for example. The fossil fuel economy creates extraordinarily distorted images of time economics such as waiting for several hours in gas lines and missing work which would have paid for the automobile and the gasoline. Public transportation can be reconceived and rescaled to meet the requirements and energy limits of watershed tiers. The design of vehicles and the type of energy they use can be tailored to specific local conditions. Networks of transportation lines operating within local watersheds would virtually replace private vehicles for short-distance trips. Linking connections with successively larger tiers for longer trips can be made using light rail systems that would be vastly more efficient and faster than private cars.

Social activities can be re-invented to open a greater number of personal role options throughout the range of society's functions. Food production, for example, is a major area where part-time activity for many of the bioregion's people can actively relate to bioclimatic architecture, land use, distribution networks, soil restoration, fresh water, and other aspects of natural energy flows. New visions of cityscapes point the way toward this integration of food, energy and water in urban areas.

The most important change in attitudes and activities would involve transforming the current operation of economics to the wider concept of "ecologics." The orientation and motivation of ***ecologics*** would be toward bioregional sufficiency and maintenance of natural life-system continuities rather than profit. Work and use of materials would be perceived and evaluated in a similar way as energy; sequences of ongoing multiple processes which serve the stability of the bioregion and human well-being. The exchange of goods and services within watershed-scale communities would follow standards of bioregional worth rather than abstract market mechanisms. Exchanges of goods instead of money, recycling of products through interconnected households, and bartering of services would be encouraged as ways to retain energy within the community.

OAT CITYSCAPE

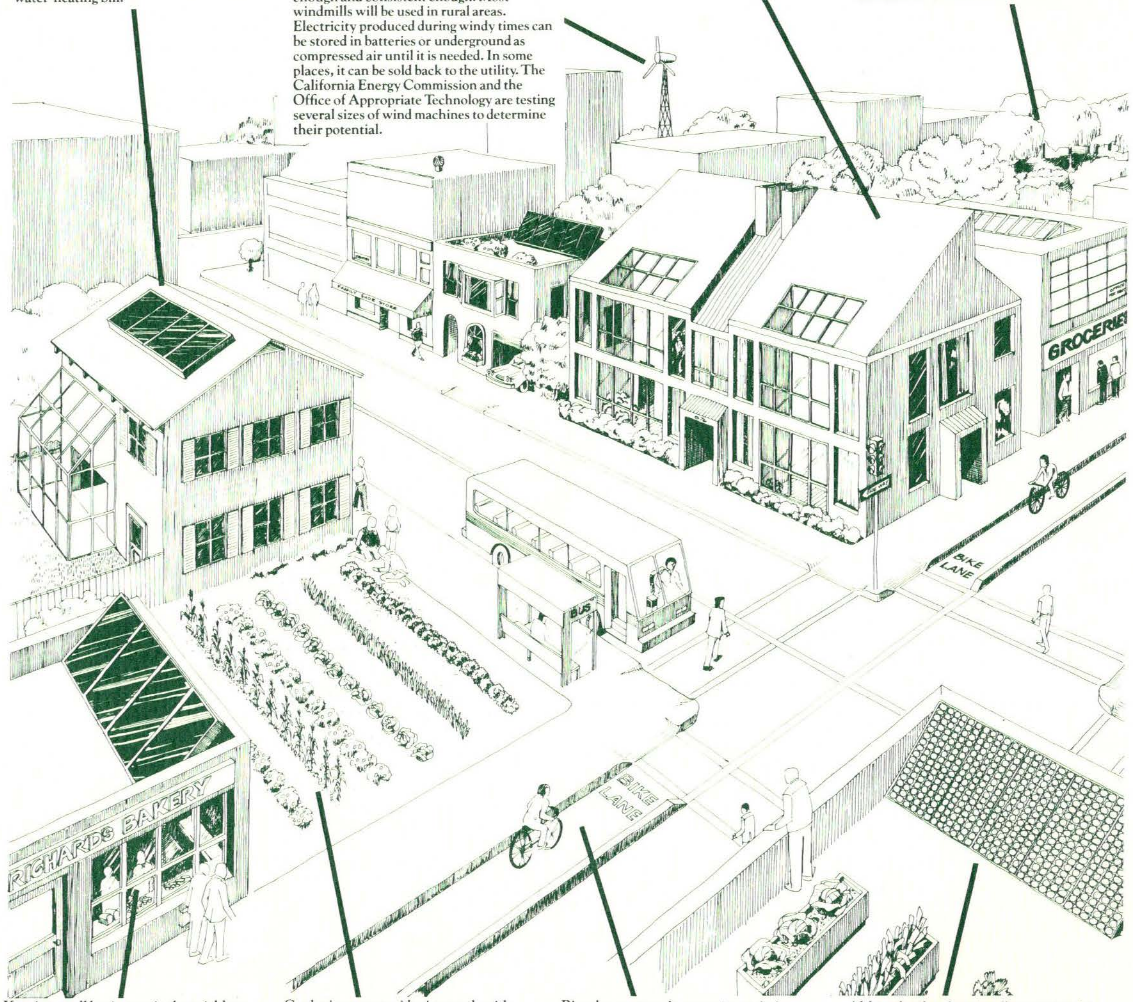
Renewable energy resources and other bioregional concepts can be easily integrated into existing cityscapes. The California State Office of Appropriate Technology is working to implement a number of these concepts.

If conditions are favorable, solar collectors can heat enough water during a year to save up to 70 percent of an average family's water-heating bill.

Medium-sized windmills can provide several homes—or even a small community—with enough electricity if the winds are strong enough and consistent enough. Most windmills will be used in rural areas. Electricity produced during windy times can be stored in batteries or underground as compressed air until it is needed. In some places, it can be sold back to the utility. The California Energy Commission and the Office of Appropriate Technology are testing several sizes of wind machines to determine their potential.

Buildings can be designed to use the sun for heating and cooling, so they need very little energy from other sources.

Local woodlots could provide some biomass to use for heating homes, at the same time providing a neighborhood with an interesting recreational area and more wildlife.



Wayne Creekmore Design, San Francisco, California

Keeping small businesses in the neighborhood encourages independence and free enterprise, makes services convenient, keeps the neighborhood diverse, provides both residents and business owners with the sense of familiarity and personal interconnectedness important to building a strong community, and keeps money in the community.

Gardening can provide city people with inexpensive, high-quality food while conserving fuels used for transportation, pesticides, fertilizers, and farm equipment.

Community gardens provide people who have no land with the opportunity to grow their own food, and also to become friends with other gardeners in their neighborhood or community.

Bicycles use muscle-power instead of gasoline, so they save liquid fuel while keeping users in good physical condition.

Providing safe bike lanes in streets helps prevent accidents and encourages people to use bicycles. The city of Davis has 24 miles of bike lanes and paths.

Although solar electric cells are expensive now and only useful in places without power lines, or for specific uses such as street lights, the solar industry and the Department of Energy think that the cells will be economical to buy by 1985. If that happens, the sun's rays can be captured to provide direct electricity.

BIOREGIONAL ENERGY POLICY

Bioregional energy policy is not distinguishable from public policy in general. They are derived together because information for making decisions comes from sources that consider natural energy flows and the ways they are used to underlie all the activities of the life-community. In this way, human uses of energy are included in rather than separated out from the life of the bioregion. Bioregions provide an important consideration which cuts across all policy areas, with issues of scale, social cost and sustainability.

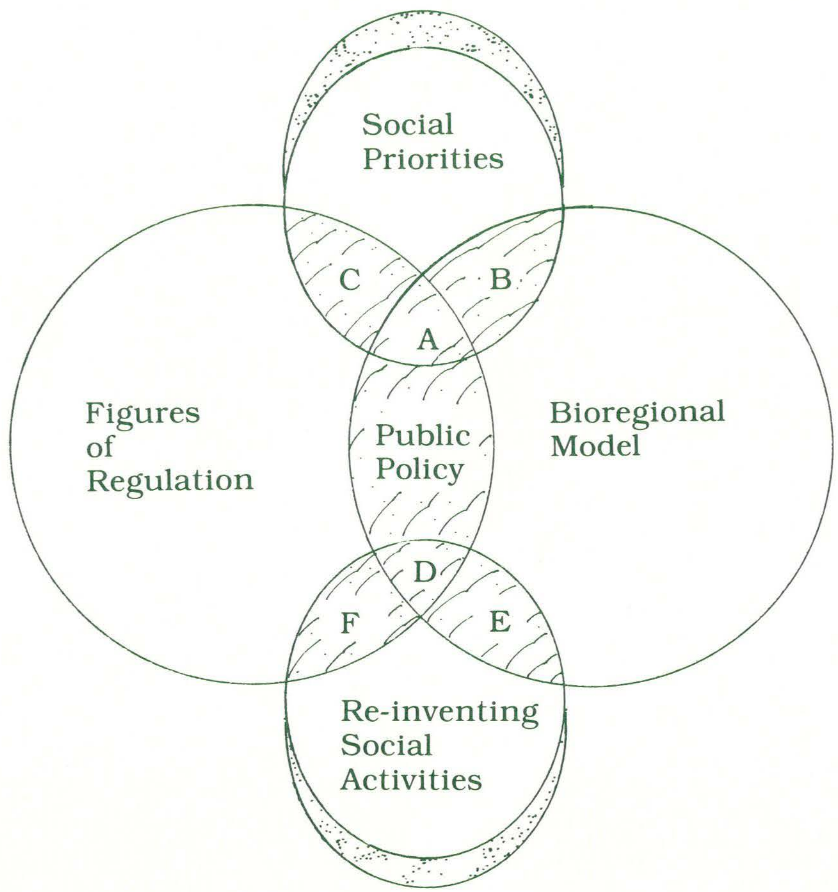
With the introduction of social priorities and re-invention of social activities as factors in deriving public policy, new areas of interaction between the bioregional model and figures of regulation are created in which primary functions of bioregional society and energy use coincide.

A. ***Watershed Utilities*** are energy service districts for progressive watershed tiers that coordinate on-site renewable energy generation with the maintenance of small-scale power grids; negotiate importation and exportation of energy; correlate human uses of water and water availability with reference to the needs of ecosystems and characteristics of the hydrological cycle (seasonal change, water tables, etc.); and oversee water recycling and waste-water management.

B. ***Production and Manufacturing*** relate to energy policy through their use of local materials drawn from the bioregional model as well as their energy requirements. Production plants are subject to criteria of scale and locale.

C. ***Education and Communications*** offer the means for informing people about energy and ecosystem conditions. The type of information presented and the form it takes, as well as the problem of creating greater access to information, is a priority concern of bioregional energy policy. Education will offer an understanding of energy in an ecological context.

Derivation of Public Policy Initiatives from Consideration of Social Activities and Priorities, Figures of Regulation and the Bioregional Model.



D. ***Commerce and Distribution*** are seen as energy transfers within the social organism, and should exhibit the maintaining characteristics of mature systems rather than the productivism of pre-climax stages of natural succession. Energy use should be low and steady rather than surging; dispersed rather than centralized. There is emphasis on keeping a product's use close to the point of production.

E. ***Agriculture*** includes cultivation of native plants and animals as well as domestic stock and crops. More produce comes from small farms, community gardens and households than at present. Local renewable energy subsidies are emphasized to lower the energy consumed in completing food chains. The goal is to move toward a "sustainable agriculture."

F. ***Research and Experimentation*** take place throughout bioregional society, but the transition to low-energy capabilities requires special explorations in both technology and creative expression. The range of activities would extend from investigating technology transfers (such as adopting light rail systems) and studying biologically-based design approaches to developing art that invokes multi-species consciousness.

Solar Policy

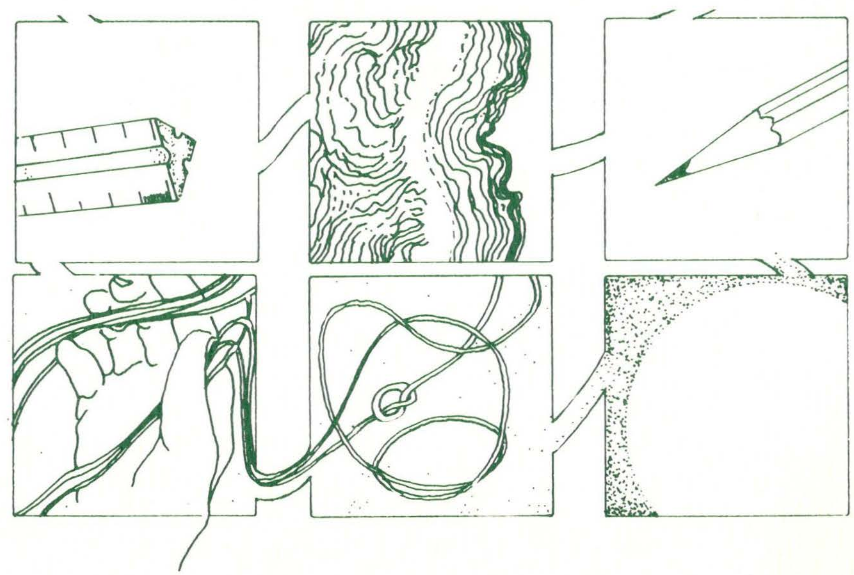
An example of how public policy would be formed can be taken from the important social priority of getting solar space heating and hot water technology into people's homes. Regardless of whether this is done by retrofitting existing houses with passive or active systems, or by building passive systems into new construction, the production and manufacturing of materials that will be used has to be assessed in terms of the bioregional model. Decisions about choosing native materials, recycling non-native materials from previous uses, and importing some essential materials from outside the bioregion should follow from an analysis of their end uses. For example, the stress limits of materials which are indicated by bio-climatic characteristics, as well as the net energy required to process various materials, should be considered.

The bioregional model would help determine which native materials should be used, the economics of importing materials, and the most energy-efficient production processes

Watershed utilities would determine the pattern and time-frame of solar technology installations, to integrate them with community power grids, and facilitate financial arrangements to pay for them.

Bioregional communications would convey information about the availability of active and passive systems, with instructions for their use. The relationship of solar technologies to natural energy flows and figures of regulation would become an ongoing concern of bioregional educaton.

A preliminary listing of the elements of a bioregional energy strategy which would be developed from these considerations is given in the ***Appendix***.



Making the Transition

How does the transition to adopting a bioregional concept of energy for making policy decisions begin? If a public energy agency in a particular region makes a serious commitment to this concept, what are the outstanding questions which need to be answered and the first steps to take?

How does the agency relate to the areas of interaction between society's functions and energy use which have been described? What "soft spots" exist within the institutional make-up of the community to allow immediate concrete actions to re-direct agriculture or production, for example, toward standards of bio-regional worth?

What are the other agencies, public or private, that contain the information and capability to organize and execute: a) a resources inventory study; b) development of a methodology to analyze factors of carrying capacity; c) integration of both of those into a bioregional model? How can the scope of other agencies be related to the scale of these problems and the social uses of their solutions? How would such a project be coordinated? How is it authorized? Which agencies could use it to make local energy studies?

What is the state of the art and reliability of small-scale power generating plants that could account for a community's energy needs beyond on-site generation? How can they be introduced into the power grid to take over the function of large-scale centralized plants?

What are the legal and financial considerations of shifting the present public utilities' role from power generation and distribution to that of distribution alone as managers of a power grid of dispersed energy sources?

What would happen if energy imports into the region stopped? What priorities would follow for developing a renewable energetic basis for the life-community? What courses of action would complement bioregional energy policies?

CONCLUSION

Leaders of industrially developed countries are not being overly dramatic when they state that further increases in oil prices will imperil their national economies and way of life. There is virtually no sector of industrial society that is unaffected by the availability of fossil fuels. As a consequence of declining oil reserves, public policy decisions for all major sectors of our society are increasingly shaped by energy needs rather than social values or political ideals.

The critique of industrial society as failing in its own terms through an intrinsic dependency on fossil fuels that has been put forth in this paper is radical, but it is not based on radical ideological premises. It is justified by rapidly deteriorating social and environmental conditions. The choice of fossil fuels as the energetic basis for a society is proving to have more to do with the course of that society that the particular ideology it espouses.

In fact, whatever form of energy a society chooses plays a dominant part in shaping it. A developing country, for example, that shifts from a low-energy basis to some level of fossil fuel-powered industrialization also moves from political decentralization to a centralized government. Its people leave diverse generalized occupations for wage labor and specialization, and they abandon dispersed, low-density rural areas for high-density cities. Social relationships become abstract matters arbitrated by police and courts rather than by face-to-face personal encounters. If developing or advanced countries choose coal and nuclear power as their primary basis, the degree of political centralization, specialization, population density, personal dislocation and social control will increase drastically. In addition, the possibilities for reversing the inevitable environmental damage which will accompany mining, storing, using and disposing of coal and nuclear materials are remote. A coal and nuclear-based society wages an all-out, no-win war against the biosphere.

Choosing renewable energy sources also has profound implications for the form and nature of society. One aspect of public policy alone, the creation of watershed utilities that mediate between energy-generating households, the community power grid and the processes of natural systems, maintains a balance between decentralized activities and central planning that is a radical departure from the current operation of public and private utilities. Individuals are "part-time employees" of the utility when they supply power to the grid, and they become "management" when they participate in deciding how it will be used. By planning energy-generating locations to complement local natural processes in the watershed, utilities can be directly involved with preserving natural communities and the watershed environment.

Bioregional society would formalize the elements which were previously described for deriving public policy. Watershed utilities, production and manufacturing, education and communications, commerce and distribution, agriculture, and research and experimentation would be the major sectors or departments of a bioregional government. Legislative bodies would be concerned with assigning social priorities and re-creating social activities. A bioregional model and related figures of regulation would become primary aspects of a distinct indigenous or reinhabitory culture, which would ultimately extend a sense of place to styles of life, diet and art.

Bioregional society implies a "new localism" that should not be confused with provincialism or isolationist attitudes. By stressing our reciprocity with local aspects of the overall biospheric web-of-life, we can authenticate our unified identity as a cooperative species sharing the planet.

APPENDIX

*Energy Policy Implications**

At present, it appears that a bioregional energy strategy for the advanced industrial countries should consist of these elements:

- Significant attention to reducing growth in demand, defined as total use of primary energy supply. What should be maintained are necessary ***energy services*** (e.g., home heating/cooling, transportation, lighting, power to industry), supplied as efficiently as possible.

- A commitment to ***reducing demand growth to zero by 1985*** and reducing input of non-renewable primary energy resources 10 percent by 1990. New buildings should have stringent "energy budgets" for future operations, to help achieve these goals.

- Politically, an emphasis on ***decentralized decision-making,*** diversity, local supply/demand equations, flexibility and resiliency in meeting reduced demands, providing capital to local energy enterprises, and encouraging many small experiments and innovations. We need strong goals, such as 35 percent to 50 percent renewables by the year 2000, complete solar and conservation retrofitting by 1990.

- Greater ***limitations on energy imports*** into and exports out of the bioregion, with more emphasis on regional energy self-reliance. We should be ***trading*** energy ***surpluses,*** not essential stocks. Otherwise, we are indeed mortgaging the future. Studies are needed as to the carrying capacity of the bioregion for various levels of energy supply.

- Development of ***county-level energy supply plans,*** well integrated into bio-regional strategies. Even though counties may not always demark bioregions (or *vice versa*), they are local enough to produce valid results and to encourage popular participation. There are about 3,000 counties in the United States, with incredible diversity as well as local ingenuity. At $100,000 per study, these 3,000 local plans would cost $300 million, or only about 2 to 3 times a single 10-MW "power tower" demonstration! Yet their ***cumulative*** potential for significant energy supply with local control is far greater than that of centralized systems.

- Energy supply should be closely matched in ***quality and scale*** to the end-use, should use decentralized production means and should be transmitted as short a distance as possible. To this end, about a 30 to 40 percent reduction in electrification (primarily for heating and cooling) is essential. This argues for ***appropriate energy technology:*** small-scale, renewable, capital-cheap, non-violent and accessible.

- Investments in energy supply should have short lead-times, show positive net energy production (no more than 2-4 year net energy payback) and should be amenable to local production and control. They should be capital-conserving, non-violent and equity-enhancing. Using conservation and cogeneration as a wedge, there should be many small local utilities created.

- Non-renewable resources should be priced at replacement cost, to give the marketplace a better signal. Regulation, subsidies and pricing should be used to internalize all relevant economic, social and environmental costs of energy production and use.

*Contributed by Jerry Yudelson, Director, Solar Business Office.

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