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SUPPORTING THE ETHICAL ENGINEER— THE ROAD AHEAD

by Stephen H. Unger

The IEEE has taken some important steps to encourage the ethical practice of engineering. These include the adoption of a code of engineering ethics, filing of the amicus curiae brief in the BART case, the award (by CSIT) to the 3 BART engineers for Outstanding Service in the Public Interest, enactment of Bylaw 112 (see 12/77 issue of T&S for background) which includes measures for assisting engineers placed in jeopardy as a result of adhering to the code of ethics and, finally, the application of the aforementioned measures in the Edgerton case (see 6/78 issue of T&S). But much more remains to be done.

THE PUBLICATION PROBLEM

Perhaps the most immediate problem is that, while Bylaw 112 provides that reports of the Member Conduct Committee (MCC) on its cases may be published (on the authority of the BOD or its executive committee) no mechanism has been established for implementing this provision. A formal process is needed that MCC, perhaps with Executive Committee approval, can invoke to mandate publication of its reports in a suitable IEEE periodical.

The logical publication medium is Spectrum, the only archival publication received by all IEEE members. Note that The Institute, although similarly distributed, is not archival. It is not available in libraries or to non-IEEE members, and is not indexed. Thus there is no way for individuals to retrieve articles from past issues.

The basic difficulty is that Spectrum functions as a virtually independent magazine, making its own editorial decisions. Its goal is to maximize its attractiveness to readers and advertisers. Publication of routine IEEE news is avoided, and space is at a premium. The result is that, while some ethics case reports might be judged of sufficient intrinsic interest to merit publication, others might not. The length of a report would be an important consideration. If the editors are permitted to condense a report there would be a danger of loss of key facts that might unbalance the report and, under some circumstances, even lead to litigation. The Institute, whose mission is to print IEEE news, tends not to publish complete documents such as MCC reports unless it receives a specific subsidy in each instance.

Resolving this dilemma will require a decision at the BOD level. Note that The American Association of University Professors (AAUP) does print all similar reports in its quarterly journal as a standard practice. (Such publication is on the authority of the its counterpart of the MCC.) The magnitude of the problem for IEEE is not likely to be large. There is very little danger of our publications being swamped

TO OUR READERS

As discussed in issue No. 22 (the delayed June 1978 issue) of TECHNOLOGY AND SOCIETY which you recently received, the editorial staff is hard at work clearing up the backlog from 1978. The one you are now reading is the delayed September 1978 issue. You should be receiving the final issue from 1978 in four weeks. Thereafter we will be resuming the 1979 publication schedule under the editorship of Norman Balabanian. All contributions of material should be sent to him. (His address appears inside.) We call your attention to the subscription form inside and urge any of you who have not yet subscribed to do so now by mailing the form. Please accept our apologies again for the delay.

IN THIS ISSUE

a trial period of a few years, then some other approach could be developed. On the basis of member polls, there is good reason to think that IEEE readers would find such material quite interesting. These are, after all, stories about professional dilemmas involving real people with whom they can readily identify.

INFORMATION TO MEMBERS AND OTHERS

No provisions exist for notifying IEEE members as to their obligations and rights under Bylaw 112. This could easily be remedied by sending out with each dues renewal notice (or initial bill for new members) a leaflet incorporating the IEEE Code of Ethics and a summary of the highlights of Bylaw 112 along with instructions as to whom to contact for advice or aid in ethics-related matters.

In addition, means should be found for conveying similar information to employers of engineers.

OTHER UNFINISHED BUSINESS

As was pointed out in an earlier article (T&S 12/77), Bylaw 112 provides that a member can be disciplined for ". . . other materially unprofessional conduct." In view of the great differences of opinion as to just what constitutes proper professional conduct, the presence of this open-ended clause constitutes a threat to members who might somehow antagonize a future MCC or BOD. Should this provision ever be invoked, IEEE would run the risk of a civil suit for violation of due process.

Another problem centers around the fact that IEEE Policy Statement 7.9C has not been repealed. This statement, approved several years ago with amicus curiae briefs in mind, states that ". . . the IEEE will not, as to disputed facts, interfere on behalf of

any real case, where some facts will almost invariably be in dispute. The simplest solution is to repeal 7.9C. This does not mean that the Institute would then be compelled to take positions in every case. Nothing would prevent MCC or BOD from declining to rule on allegations of fact where they could not resolve substantial doubt.

Another problem lies with the limiting of support procedures to IEEE members. This could contribute to tax status problems in that it gives these procedures an aura of being a service to members rather than to the public. Extension of the IEEE procedures to all those eligible for IEEE membership would avoid this difficulty.

Some minor problems exist with respect to the size of MCC and its staff support, but these will probably be dealt with as experience is accumulated.

More important is the long-postponed review of the contents of the ethics code itself. It was put forward originally as "a living document" and discussion was invited. Proposals for improving the code have appeared in this publication in March and June of 1976. Now might be an appropriate time to consider such proposals.

Finally, the effect of the ethics support procedures would be greatly enhanced if other major engineering societies would adopt similar measures. An intersociety ethics committee would be even more effective. As a step toward this goal, IEEE, as a pioneer in the field, should establish contacts with other engineering societies. Some preliminary explorations of such possibilities are being carried out by CSIT.

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NEWS, NOTES & COMMENTS

In a Professional Engineer article [1], editor John Kane reports on a study of the long-term feasibility of distributed (i.e., decentralized), renewable energy supplies for the state of California. Sponsored by the U.S. Department of Energy, the 18-month study began in March 1977. The researchers have released a preliminary report, titled Distributed Energy Systems in California's Future, which projects that by the year 2025 California could supply at least 90% of its energy needs through distributed energy systems based on renewable--or virtually inexhaustable--energy sources located within its borders. These sources would include direct solar, biomass, wind, geothermal, and hydropower, plus extensive energy conservation. The report says that all the technologies it selected have the potential to become economically competitive by the year 2000.

The only major need that is not likely to be met entirely from these sources is for liquid fuels for transportation; if current trends in automobile use continue, synthetic fuels from coal will be needed to supplement biomass-derived liquid fuels. Another problem is that, if solar process-heating and electricity-producing facilities are located adjacent to the industries they serve, then their solar collectros will occupy 25% of all the urban land in California.

The study is designed to test Amory Lovins' "soft energy" concepts for a concrete case. (Lovins' book, Soft Energy Paths, will be reviewed in a future issue of T&S.) The preliminary report assumes that California's population will nearly double by the year 2025 and that its real GNP will then be three times the current level. The report characterizes itself as exploring the "degree to which an advanced, post-industrial region such as California can shift to operations based upon indigenous, sustainable energy resources while continuing to grow both in population and in per capita income."

1. John T. Kane, "DOE Explores 'Soft Path' Energy Options for California By Year 2025," Professional Engineer, May 1978, pp. 28-30.

F.K.

LETTERS TO THE EDITOR

Do you believe that we as engineers have especially great responsibilities to speak out on government policies that involve such matters as job security for ethically or politically active engineers; freedom of engineers to move from one job to another or from one country to another; and the use of high technology for military, political or economic purposes? If your answer is YES, as is mine, then certain political issues on the world stage today become great ethical issues for us. In particular, consider the following two ethical issues.

Ethical Issue No. 1

If a nuclear war devastates our and the Russian civilizations--to what extent are we as engineers responsible?

Ethical Issue No. 2

If the Soviet Union violates the Helsinki agreements in its treatment of politically dissident engineers and scientiest, to what extent should IEEE and other organizations of engineers take remedial actions?

The time has come, I believe, when we who are the prime implementers of technology must join with all ethically responsible political forces to bring about a) a humane use of our technology, leading toward a humane society in which technology plays an important role; and b) a world-wide political climate in which all engineers and scientists will feel secure in their jobs while acting on ethical principles. From my acquaintance with the IEEE Code of Ethics for Engineers (IEEE Spectrum, February 1975, page 65), I believe the IEEE does not have a clear mandate for advancing the engineering profession in these directions.

I suggest that the IEEE a) take steps to implement this expanded ethical role of the engineer, and b) take steps to deal effectively with Ethical Issues 1 and 2, as well as other specific ethical issues brought to the IEEE's attention.

Jack Sklansky, Professor of Electrical Engineering, Computer Science and Radiological Sciences.

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Summary

Any list of the motivations for energy conservation -- increasing scarcity and price of fuels, environmental and health consequences of large-scale fuel consumption, foreign trade deficit, vulnerability of imported fuel supply, nuclear weapons proliferation and help to the third world -- is precisely the same list of reasons for using renewable, indigenous energy sources. These sources are sun, wind, and biomass; they appear in several direct and indirect forms, all of which are commonly grouped together under the inclusive general title of solar energy (SE). This paper summarizes the principal SE technologies and assesses the status and problems of the various programs. The two general problems with SE, the diffuse and intermittent nature of the source, increase the costs of these conversion systems.

The wide diversity of SE technologies requires careful attention (there are four that generate electricity). Although they are at very different stages of development, technical feasibility has been established for most of these technologies. For those, current efforts are directed chiefly at cost reduction, information dissemination and determination of their best areas of use. Other programs are still in design stages with uncertain prospects.

Altogether, the combination of effective conservation and renewable energy sources offers great promise for our energy future.

Introduction

A rare consensus in the realm of energy planning is on the need for wiser and more effective use of energy. The reasons are compelling and clear: Conservation of energy will extend our dwindling energy resources; save substantial amounts of money, thereby decreasing our international trade deficit; reduce our dependence on uncertain foreign supplies; improve the environment; reduce risks to health and security; and lessen the demand that forces up fuel prices that are a special burden on developing countries. Even with strong conservation measures, however, the U.S. will continue to need large amounts of energy while it reduces its present reliance on oil and natural gas. Those fuels now provide more than 75% of our energy although they are becoming our scarcest resources. Among the substantial alternative energy sources, we find that solar energy (SE) offers all the same benefits and motivations for its use as does conservation; in addition, it is widely available and flexible in its usage.

The generic title "solar energy" is generally used to include nearly all renewable energy sources: direct sunlight and indirect energy in the winds, the oceans, and "biomass" (any organic matter of biological origin). The quantities of energy in these sources are prodigious, even on the scale of U.S. energy use. The sunlight alone received by the U.S. is about 600 times our total energy consumption, the winds carry not much less, and the heat stored in tropical oceans is still larger. To utilize these resources, a wide variety of technologies have been developed and the engineering feasibility of many is established.

Why, then, is SE not in wide use? The answers are plain. There are two major problems with SE: it is diffuse and it is intermittent. These characteristics imply the need for large areas for energy collection and means for filling the gaps in the supply. (Ocean thermal energy is the one form for which these statements do not apply.) The principal impact of these problems is in the cost of complete energy systems. The land use aspect is seen to be manageable when we note that our rooftops alone receive more heat than our buildings require and all the electricity currently used could be generated from the sun at 10% conversion efficiency on an area only 1/10 of that devoted to roads (1). Thus, costs are the sole deterrent to the broad use of SE. The challenge to technology and to the nation is to make the costs acceptable.

Solar Technologies

Because SE products are just becoming familiar, the prospects for their success must be judged by projections and by the status of developmental programs. These will now be summarize briefly. Emphasis here is on the links to conservation, but it is obvious that <u>all</u> substitutions of SE for fuels are means of conservation of the natural resources.

Thermal Technologies

Heat from the sunlight can be used in many ways; it is customary to group them according to temperatures required in the various applications. At the low end of temperature scale are domestic hot water and space heating which account for 23% of our total energy use -- a very large market. It is estimated that by the end of 1978 some 40,000 buildings in the U.S. will be using low-temperature solar heat in some way.

The American Institute of Architects, in a detailed analysis, chose as a definition of energy conservation in buildings "The reduction of energy demand through the elimination of waste and the substitution, to the degree feasible, of on-site generation and regeneration capacity within an independent decentralized acquisition and conversion system that draws on nature's current income" (2). Here, the inextricable link between conservation and SE becomes explicit. In a follow-up study intended to provide an implementation plan for a national program of energy conservation in buildings, the same group concludes that savings of 60% in new buildings could be achieved now with techniques such as insulation, double glazing, reduced window area and lower aspect ratio, and optimization of pumps, fans, heating, cooling, and lighting; while in old buildings, savings of 30% are expected (3).

The place of SE in this realm becomes clearer when it is noted that virtually all estimates show that "active" SE systems (i.e., external collectors) can readily provide more than 50% of the energy for

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existing architectural principles and both "passive" and active SE could provide essentially all the energy needed by new houses. It should be cautioned, however, that they would generally still need suplemental energy for lengthy periods of cloudiness. That need is a source of concern to some utility companies that fear being relegated to becoming suppliers of only back-up energy at low use-factors. This problem of reduced overall demand with concentrated peaks arises in the same way for heat pump-equipped houses or just well-insulated houses (5) so it must be dealt with. A recent, intensive analysis of this problem, as it pertains to SE, led to the conclusion that "Onsite equipment should not create insurmountable load management problems for utilities, even if a relatively large number of their customers use onsite devices" (5).

Costs for solar heating of buildings and their hot water have been analyzed repeatedly. It is essential for the purpose of comparing costs to those of conventional sources that life-cycle costing be used and that future costs of conventional energy be estimated. Both of these steps introduce uncertainties but the questions seem to affect only the particular date for economic feasibility of solar heating. The most extensive analysis to date, using four cities representative of different parts of the country, concludes that economic competetiveness with electric heat should occur in all four cities by 1985, and if a 20% investment tax credit is granted, SE can be competetive with electricity now (5). Since half of the houses being built in the U.S. now are equipped with electric heat, this result is of potentially great significance.

Another major area of application for solar heat is in agricultural and industrial processes; these also use very large amounts of energy at temperatures that are often not much above that required for space heating. Among the most energy intensive industries in that nation, paper, chemicals, food processing, and textiles use major quantities of such heat. In agriculture, crop drying takes place on large-scale crops such as corn and soybeans as well as on a wide range of other grains, fruits, and vegetables. This drying has often been done with natural gas in spite of its increasing price and scarcity. Not only could much of it be done with SE, but the nature of these processes reduces the need for heat storage. An interesting example of combined solar and energy-conserving design is the Wilton, ME wastewater treatment plant shown in Fig. 1.

The technology of low- to medium- temperature SE systems is fairly well developed although not standarized. For domestic hot water and space heating, 60°C is adequate and can be supplied readily by fixed flat-plate collectors. Improvements are being made in their "black" finishes and their heat transfer, but those changes appear to be small. Many demonstration systems of all kinds are in use, and the few that have had lengthy use generally maintain their performance reasonably well.

Temperatures up to ~150°C can be achieved rather simply in light-concentrating systems using rather low concentration factors in parabolic-trough collectors. Those systems are adequate for space cooling needs and a variety of the industrial steam requirements. A promising application of such systems is the pumping of agricultural water. The Rankine cycle (no electricity) driven by such collectors (6). For developing countries this is a particularly important potential application.

Electrical Generation Technologies

This category addresses another major energy demand area. We currently use 28% of all primary energy to generate electricity; it reaches its users with only ~30% efficiency; and then much is wasted in the end uses. It is essential first to minimize the waste, next to select wisely the uses for electricity that really require its great power and versatility, and then to generate as much as possible with renewable energy sources. To the extent that such generation takes place "on-site" we have a close analogy to an important conservation technique, cogeneration, which also utilizes an existing, on-site source for electricity. An important example of these principles is the electrical resistance heating of buildings which should be replaced wherever possible with solar heating of better-designed and better-insulated buildings, with back-up heat possibly supplied by heat pumps. Residence-generated solar electricity, however, is not close at hand.

There are four principal SE electric generation technologies that are feasible but they are at quite different stages of development. Therefore, their performance characteristics and costs are uncertain to different degrees.

The closest to commercial operation is wind power; both small and large wind-power generators have been demonstrated over extended periods. A 1.25 MW generator was used commercially in Vermont for ~two years and direct mechanical use of windmills reached about six million installations in the U.S. (mostly for water pumping) before cheap rural electricity became available. Because the power available from the wind varies as the cube of its speed, the choice of generation sites is of utmost importance. Nevertheless, over the 17 western (conterminous) states the annual average power in the winds is ~300 W/m^2, or about the same as sunlight on the ground (7). Moreover, the typical conversion efficiency of wind generators is 35%, quite high for electrical generation systems.

Large-generator development is being led by the NASA group at Plum Brook, OH under Department of Energy (DOE) sponsorship; 200 kW ratings are the current level of attainment (serving the town of Clayton, NM) and 1-2 MW systems are expected within a few years. That may be near the limit of useful size because of the severe mechanical demands on large rotors. Utility links with these large machines are already being arranged. Small generators of many types are evaluated chiefly at Rocky Flats CO; these will serve on-site needs, mainly at rural locations. Costs for both classes are expected to reach ~$1,000/kW; the large ones because they are more cost effective on a per Watt basis, and the small ones because their demands are less stringent and mass production will be possible. On the other hand, it is still unclear what the average operating capacity factors will be for wind systems so direct comparison with competing systems is difficult.

The U.S. Bureau of Reclamation has performed an interesting study of how to utilize the wind in the western states and increase the capacity factors by

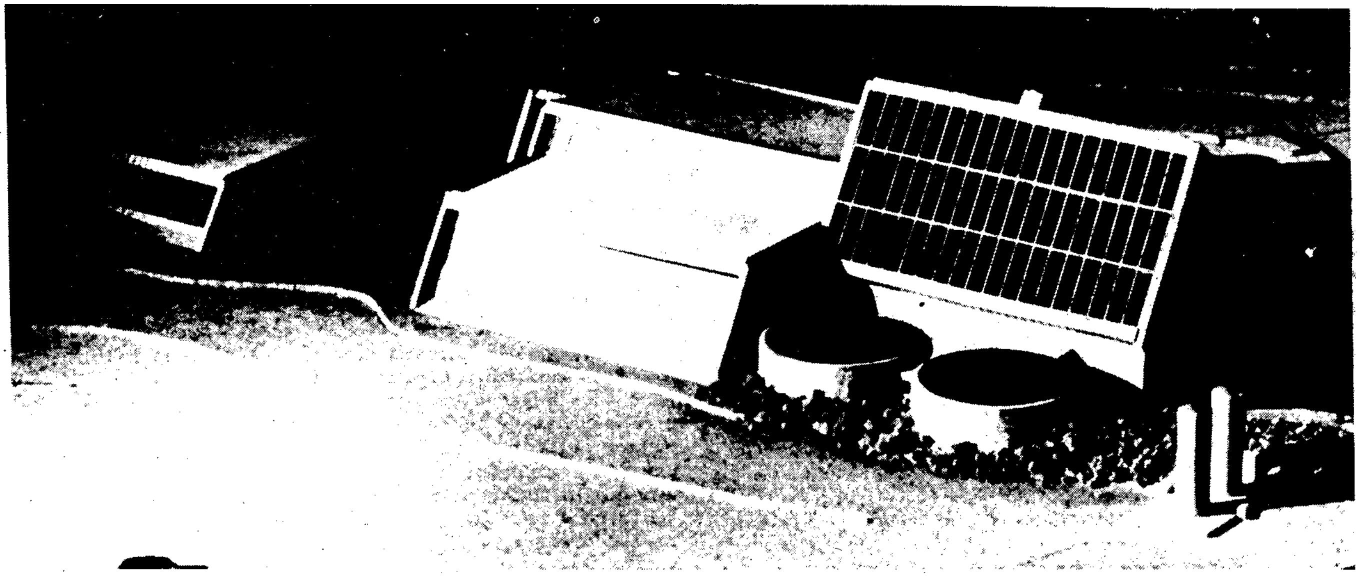

Figure 1. A highly energy efficient, solar wastewater treatment plant for Wilton, ME (designed by Wright, Pierce, Barnes and Wyman of Topsham, ME). This south-facing wall is covered by windows (light panels) for passive solar heat of the building or solar collectors (dark panels) for heating the two underground sewage processing tanks. Methane generated in the tanks can be used in the building, heat pumps extract energy from the effluent water and heat is recovered from the building's air system.

linking the wind generators with hydrostorage that is well known to the Bureau. From "wind farm" sites in the 17 western states, they conclude that "well over 100 GW" can be harvested (7). At that level, the bus bar cost would be 10 mills/kWh while the total cost, including storage and transmission to the load centers, would be 21 mills/kWh (7). These costs are fully competitive with present generating costs and the systems avoid many of the present systems' environmental liabilities.

Another familiar SE electric technology is photovoltaics (PV). It is now widely recognized that the very high prices (~$200,000/kW peak) and high energy consumption that characterized the space-qualified silicon solar cells are not relevant to terrestrial applications on a large scale. Current prices are ~$10,000/kWp and still lower prices are clearly coming. Two major questions are how low such prices can fall and what markets there may be at the still-high prices in the next ten years or so. Concerning mid-term markets, a great many applications are being discovered in isolated locations for which the high-priced PV systems are being found to be economic. These include communications relay stations, corrosion protection for bridges and pipelines, aids to navigation, agricultural, and military applications. As an example of what can now be done, one installation being built at a community college in Blytheville, AR is a 360 kWp light-concentrating system. In addition, many developing nations are spending as much on diesel and gasoline generated electricity as current PV prices would require. These applications point up a facet of such on-site generators that is vital to their successful use. That is, their electricity costs must compete only with the price of alternative power delivered to the point of use, not with central station-generated bus bar prices. Thus, most parts of the world without extensive power grids are candidates for such on-site systems.

Central station solar electricity from PV seems distant, but feasible if current projections are realized (5,8). Figure 2 shows one version of the "learning curve" for these arrays and projections to the DOE goal in 1986 of $500/kWp. At that price, these systems will still be expensive compared to familiar base-load power because of the necessarily low capacity factor of PV systems and of other costs besides the arrays. Nevertheless, at that price wide applications for peaking power become possible and if the utilities acquire load-leveling storage capability that they are now seeking, these arrays will be able to provide intermediate load power with little cost increase. The importance of that prospect is not merely in the enlarged capacity, but also in the ability to cover the entire daily peak demand period. That would match current lifestyles better than the currently-discussed shift to off-peak hours to increase the use of base-load capacity.

Of course, PV arrays will benefit from large-scale mass production regardless of the size of installation in which they are to be used. In addition, a variety of promising, advanced PV technologies are under development. Some are based on thin films of active material such as amorphous silicon ~1 μm thick and CdS/Cu_2S ~20 μm thick which offer prospects of substantial further cost reduction.

The third SE electric technology is solar thermal conversion. To run turbogenerators with good efficiencies, working temperatures of ~500°C are desired so very high concentration ratios (~1,000) are required. These are not in current use although the DOE Sandia Laboratories has already begun use of its principal testing facility that will soon have a 5 MW (thermal) capacity for evaluation of designs of heliostats and the "boilers" which receive the concentrated sunlight. Both Rankine (liquid-to-gas) cycle and Brayton (all gas) cycle systems are under development (9). The DOE

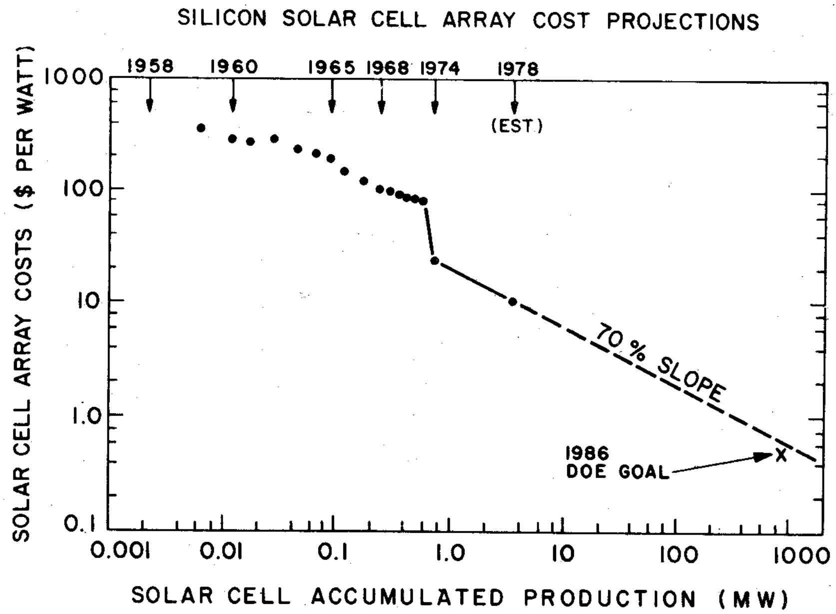

Figure 2. History (solid) and projection (dashed) in 1976 dollars of the price of silicon solar cell arrays. The 70% "learning curve" represents the anticipated need to meet DOE goals; the semiconductor device industry has generally had ~75% learning rate.

has already begun design of a 10 MW (electrical) prototype to be built near Barstow, CA by 1981.

The characteristics of these thermal electric systems make them better suited to large installations than to small ones. They have thus attracted special interest from the utilities, particularly in the western part of the U.S. The geographic influence is the consequence of the generally clearer skies in the West. In turn, the importance of that lies in the fact that only the direct sunlight reaches the collector in high concentration-ratio systems; the diffuse light is not usable. In hazy or cloudy climates, therefore, solar thermal electric systems are less effective.

One other attribute of these systems is being studied intensively: the ability to make convenient "total energy" systems close to a load center. These systems are actually cogeneration schemes in which the reject heat as well as electricity is utilized. Such systems would have a double benefit in the water-short West since the need for cooling water is significantly reduced. It must be said, however, that such systems are still rather far from realization. Thus, although cost projections are in some cases encouraging, a number of uncertainties exist.

Even more uncertainties attend the fourth SE electric technology, ocean thermal energy conversion (OTEC), because intensive work on it is very recent. OTEC relies on the temperature difference in tropical oceans -- a surface temperature of perhaps 25-30°C and a deep-water temperature of ~5°C -- to drive a working fluid through a turbogenerator. The entire ocean is the solar "collector" and storage medium so OTEC is unique among SE systems in having uninterrupted base-load capabilities. The Gulf coast, Florida, Puerto Rico, Hawaii, and perhaps California, are within reach of the needed ocean conditions and there are huge amounts of energy in those waters.

The evident problems, however, are severe. Transporting the energy to load centers is difficult. The small temperature differences available mean very low thermodynamic efficiencies -- a maximum of 6-7%. Therefore, enormous quantities of water must be pumped, a requirement that will consume ~30% of all the power generated (10). Furthermore, the heat exchangers must have exceptionally good performance in spite of the threats of corrosion and biofouling. The net operating efficiencies are therefore expected (10) to be no more than 2-3%. It is also a matter of environmental concern that large numbers of these systems could modify the ocean temperature distribution.

Nevertheless, proponents of this system have responses to all of these objections and they claim cost-effective power is possible. They are proceeding to develop and test the crucial heat exchangers that will be the heart of any OTEC system. A "mini-OTEC" test system is being designed to furnish 50 kW from Hawaiian waters.

Biomass

Conversion of natural organic materials (biomass) to clean fuels and petrochemical substitutes comprises a group of some of the most interesting SE options. Thus, there is the attractive prospect that energy-efficient, solar-heated buildings may meet their limited needs for auxiliary energy with solar-derived fuels. The ranges of biomass sources and methods are already large and new ideas are flowing in rapidly. Estimates of the present magnitude and future potential of available biomass energy vary widely but there seems to be general agreement that at least 10% of our current energy needs could be met if these sources were exploited well (11). A more optimistic projection has been given by the new Solar Energy Research Institute according to which a "conservative estimate" of the potential for the year 2000 is (12) 20Q (1Q = 10^{15} Btu or $\simeq 10^{18}$ J) which is more than ¼ of current total U.S. consumption. For the nearer term, a recent study finds that 100 million tons of just agricultural waste are "immediately available;" this translates to ~300,000 BOE/day (barrel of oil equivalent) (13) or 3-4% of our oil imports. The use of agricultural and urban wastes for energy provides additional benefits by reducing waste disposal problems and in some cases permits mineral nutrients to be recycled. For a number of developing nations in the tropics, sun and biomass are the only significant indigenous energy sources, but they lack the proper technology for their effective use.

Of the multitude of biomass options, the use of urban waste and corn, wheat, hay, soybean, and sugar cane residues look most promising. Already the forest products industry obtains 40% of its total energy needs (or ~1 Q/yr) by burning its own wastes (14). In the eastern half of the U.S., the forests contain enough cull wood to make a singificant impact on peak heating demand in that area (11). There are numerous proposals for special energy crops to be grown but there are questions about the competition for land and about the depletion of soil nutrients, both of which may limit such enterprises.

The manner in which biomass can be used is equally varied. Simple burning has much to recommend it for a number of appropriate source materials since the pollution potential is low (and in a steady state all CO_2 is recycled in new plants). The newly developed "densified biomass fuel" looks unusually promising for storage, transportation, and handling (12). Methane gas can readily be produced from urban wastes, manure, and forest products. One interesting new process is pyrolysis stimulated by solar heat. Methanol ("wood alcohol") follows simply, too, providing a clean liquid fuel that fits well into our automotive fuel. Grain-derived ethanol, now being tried in gasoline as "gasohol" in farm belt states with current crop surpluses, is useful as fuel but appears substantially more expensive than methanol. On the other hand, its manufacture from biomass is cost-competetive with our present petroleum-derived ethanol and could supply the industrial needs with little difficulty.

Institutional Factors

It is clear by now that the opportunities for the use of SE are numerous. In the low-demand energy future that wise conservation is expected to bring about (15), these SE contributions will be substantial. Thus, one recent independent analysis concludes "from the standpoint of technology and resources, there appears to be no reason why solar energy cannot meet most of our needs, given adequate efforts to increase energy efficiency. Whether and how soon solar energy in fact becomes the mainstay of U.S. supply, depends very much on economic factors and on policy decisions by the federal, state, and local governments" (16).

Those economic factors and related policies have been the subjects of numerous studies. In many, it is expected thatSE will become price-competetive with alternative sources whose prices will continue to rise while the SE industry acquires the economies of scale and technological improvements that time will bring. For the present, incentives seem needed to encourage the use of SE while it is unfamiliar and first-costs are high. A detailed analysis of solar heating and cooling systems has shown that a 50% incentive would be provided by two federal actions: a 5% loan for 20 years and a 25% direct tax credit (17). States could supply about 10% incentive by property tax abatement on the SE additions (17). Such measures would be gradually phased out as the industry matures (around 1985) and incentives are no longer needed. For photovoltaics, a number of conceptually similar actions are being adopted to stimulate the various near-term markets mentioned above.

There are ample precedents for incentive programs to guide the nation's energy development. From 1918-1976 federal incentives were granted to other energy systems in the following amounts: \$6.8 billion for coal, \$9.2-17.2 billion for hydro-electric, \$15.1 billion for natural gas, \$15.3-17.1 billion for nuclear, and \$77.2 billion for oil; for a total of \$133.4 billion (1976 dollars) (18). There are, however, other reasons for SE incentives. Current economic comparisons are being made with conventional fuels whose prices do not reflect the <u>incremental</u> cost of added supplies; in the case of natural gas the price of imported LNG or synthetic gas is 2-3 times that of the dominant domestic supply. Also, several studies have shown that SE will create more jobs than most other forms of energy (5,16). In the case of photovoltaic purchases by the Department of Defense to replace 20% of its gasoline powered generators, it has been found that, even at relatively high mid-term prices, a \$484 million net discounted benefit would accrue (19).

The President's Council on Environmental Quality has recently concluded that solar energy could meet one-quarter of the nations energy needs by the end of the century and "significantly more than one-half" by the year 2020 "if our commitment to that goal and to conservation is strong" (16). Thus, the motivations, the technologies, and the policies for utilization of solar energy are steadily becoming clearer and more compelling.

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REACTION TO THE SHCHARANSKY CASE

by Arthur Bernstein

The case of Anatoly Shcharansky, once the barometer of Soviet attitudes towards civil rights as well as an indicator of the current state of detente with the West, is, inevitably, fading from memory. This despite the severity of the sentence he ultimately received.

Shcharansky was born in the Soviet Union in 1948 and received a technical education with a specialty in computer science. His diploma project was in the area of artificial intelligence and in particular concerned algorithms for implementing strategies for playing the end game in chess. After graduation he worked as a computer programmer.

In 1973 Shcharansky applied for emigration to Israel. His application was denied on the grounds that he possessed state secrets, a charge which he denied and which the government would not defend. In 1974 he was married and the next day his wife left the country after receiving an ultimatum that she either leave immediately or face the prospect of never being granted an exit visa. Both expected that his exit visa would be granted shortly. In the same year Shcharansky was dismissed from his job and subsequently supported himself through private tutoring. He became active in a number of ways in support of other Soviet Jews who had been denied exit visas: lecturing, writing, demonstrating and attempting to publicize their plight. He received several warnings from the KGB concerning his activities and was arrested and detained several times. The pressure on him increased in 1976 when he joined a group to monitor Soviet compliance with the Helsinki agreement.

In March 1977 he was again arrested and was held incommunicado until his trial. His family was unable to visit him or to obtain the services of a defense lawyer of their choice (one lawyer who was willing to defend Shcharansky was forbidden to take the case and later expelled from the country). After his arrest witnesses were interrogated and intimidated and he was denounced in the press. In June 1977 he was formally charged with treason based on his alleged cooperation with the CIA. His trial, to which no friendly observer other than his brother was admitted, was finally held in July, 1978. He was convicted of treason and of anti-Soviet agitation, receiving a sentence of 13 years in prison and labor camps. The message was clear: public dissent will not be tolerated and contacts with foreigners must not go beyond bounds established by Soviet policy. Despite the anti-Semitic context within which the message was delivered, it clearly applied to all dissidents.

The case evoked considerable reaction in the United States. President Carter personally denied that Shcharansky ever worked for the CIA. Thus his trial and conviction on this charge was a direct rebuke of the President. Numerous members of Congress went on record in his support. Petitions were circulated, appeals sent and rallies held on Shcharansky's behalf. Early in 1978 the Association for Computing Machinery, the central professional organization for computer scientists, passed a resolution stating, " . . . in view of Russian restrictions on scientific freedom and on the freedom of computer people, the Council of the Association for Computing Machinery hereby resolves that ACM will not cooperate with or co-sponsor any meetings to be held in the USSR and will question at appropriate times ACM participation in other international computer activities with dominant or very heavy Russian support."

Andrei Sakharov, the Nobel Prize winning physicist and the most prominent of dissenting Soviet scientists, responded to this resolution in a letter to the ACM (coauthored by Nohim Meiman) saying, "We would like to express to you our deep gratitude for your resolute actions on behalf of Anatoly Shcharansky. You have hit just the right nail. The Soviet authorities extremely appreciate the cooperation in science and technology, thus there is nothing to induce them so factually and effectively as a refusal to maintain this cooperation... Your courageous and noble stand is not simply ethically best, but the only practical one. Do not believe and do not take seriously any assertion that your decision allegedly could only embitter the Soviet authorities and aggrevate the situation of Soviet scientists. Do not doubt that your humane and professional solidarity will bring positive results."

The question remains: What is an appropriate response for scientists and engineers in the West? Some argue that no action is called for, that Shcharansky acted foolishly and that he knew full well what the consequences might be. But surely a law-abiding person should be allowed freedom of movement, and surely a scientist in particular should be allowed to gather and disseminate facts. Others hesitate because they feel they may not know the entire truth and that perhaps Shcharansky, after all, did work for the CIA. But considering the preponderance of opinion in the other direction and the severity of the sentence, inaction for this reason would be criminal.

To the proposal that Western scientists and engineers cut off all ties and communication with Soviet scientists and engineers some argue that this simply punishes our Soviet counterparts who are, after all, not responsible for Shcharansky's treatment and might even prefer to see him freed. But as Soviet citizens they share the responsibility for the actions of their government. Shouldn't they, therefore, be protesting the treatment of their colleague? And if it is too dangerous for them to protest, shouldn't they welcome a protest from the West? Does our obligation to promote international technical communication transcend our obligation to protest injustice? Should Soviet technology reap the benefits of that communication?

A more persuasive argument is that continued exchanges in all areas may in the long run serve to moderate Soviet policy. Such a position has a good deal of appeal, particularly since, if technical exchange can be justified only between societies which are totally blameless, it would be difficult to find any worthy of participation. Clearly a certain amount of tolerance and moderation is required, but just as clearly the treatment of Shcharansky and others is inhuman. Some measured response is called for. The Soviet authorities must be made to understand that their actions are outrageous and that scientists and engineers in the West will not go on conducting business as usual. A break in technical communication is a measured response by the technical community here to the treatment of a fellow scientist there.

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A Boycott Bandwagon

By Richard C. Lewontin and Richard Levins

MARLBORO, Vt.—One of the ways in which a government pursues its objectives is by co-opting communities of intellectuals into direct action on its behalf. Sometimes this action is concrete, as during the Vietnam War when the National Academy of Sciences conducted war research whose existance and content was kept secret from most members.

At other times, intellectuals serve on a more ideological plane by direct participation in diplomatic struggles clothed in intellectual or moralistic guises. The current actions of the American scientific establishment in furtherance of the Cold War policies of President Carter and Zbigniew Brzezinski, his national security adviser, is a case in point.

The interchange between American scientists and those in socialist countries has been rather free and open recently. Even China and Cuba have been opened to exchange. Almost overnight, however, there has been a reversal of policy. In May, a delegation of physicists from the National Academy of Sciences cancelled a trip to the Soviet Union and only a month later a number of prominent geneticists announced a boycott of the International Congress of Genetics that will begin in Moscow on August 21.

American scientists, it seems, are using what political power they have to uphold the cause of human freedom. Yet there is a curious inconsistency that should give us pause.

American scientists who suddenly boycott the Soviet Union in May and June were not born in April. They have known the nature of Soviet society and are surely aware that socialist societies have a very different understanding of political and cultural heterodoxy.

For many years, poets, writers and artists have asserted their opposition to Soviet norms and some have been tried and convicted for their activities. Yet the widely publicized trials of these intellectuals did not appear to stir the moral senses of American geneticists who have planned and advertised the Moscow Congress for several years.

Worse yet, the question of "human rights" appears to arise only when elite intellectuals are involved, but not when it concerns poor peasants and workers. The 1976 International Congress of Human Genetics in Mexico City was attended by many of this years' boycotters despite the Mexican Government's armed eviction of poor *campesinos* from land granted to them through Government "land-reform" measures.

It is remarkable too, what fine political distinctions one's moral sense can make. In West Germany, no one who opposes "the basis of the state" is allowed to teach at any level. Yet our colleagues have taken no steps against that repressive policy. Moreover, many have worked in Franco's Spain, Iran, junta-ruled Greece and other such repressive states.

And what about the other end of the political spectrum? While scientists are boycotting the Soviet Union, as Science magazine reported on June 30, in response to "unofficial advice from individuals at the NAS and the State Department," the Carter Administration announces a high level visit of scientists to China.

The brazen contradiction between the attitude of the scientific establishment toward China and the Soviet Union gives the show away. Partly because of real or imagined power struggles in Africa, President Carter and Mr. Brzezinski have intensified the Cold War against the Soviet Union. They have exploited the "human rights" issue in a selective way to line up American liberal opinion for an essentially reactionary campaign, "playing the China card" in a terrifying game of political poker. The scientific establishment is not only a direct instrument of this policy, but is using its internal power to enforce acquiescence.

With academic jobs scarce, how many young geneticists will dare to attend the Moscow Congress and risk being accused of complicity in the suppression of freedom? They are being coerced into becoming tools of a dangerous and adventurist foreign policy masked as a moral crusade. It is the morality of convenience.

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