$1.50

SHAPING ALTERNATIVES AT LAWRENCE LIVERMORE LABORATORY: A Prelimary Analysis

SHAPING ALTERNATIVES AT LAWRENCE LIVERMORE LABORATORY: A Preliminary Analysis

Wendy Batson
David McFadden
Diane Thomas-Glass
Jim Watson
for
University of California
Nuclear Weapons Lab Conversion Project

Wendy Batson
David McFadden
Diane Thomas-Glass
Jim Watson
for
University of California
Nuclear Weapons Lab Conversion Project

UC Nuclear Weapons Labs Conversion Project

PREFACE

This analysis has been prepared by the Conversion Group of the UC Nuclear Weapons Labs Conversion Project. We have been working for three years toward the conversion of Lawrence Livermore Laboratory from weapons to non-weapons work. It is our belief that continuing nuclear arms research and development increases the risk of nuclear war and that the US has a responsibility as the leader of the arms race to take the initial steps to turn it around. We also believe the nuclear work at LLL represents a health and safety hazard to the workers and the surrounding communities.

We have made efforts to open up public discussion and debate about the lab and to increase public awareness of LLL's leading role in the arms race. We have had communication with LLL employees and Livermore Valley residents and found many of them open to discussion of alternative work for LLL.

This study is a more focused attempt to put conversion on the public agenda, to encourage the Livermore community and LLL employees to take a stronger role in planning for their future and their security, and to challenge the responsible agencies, the University of California and the Department of Energy, to take the needed steps to produce sound plans leading to the conversion of LLL. We believe these efforts will lessen the economic underpinnings of arms buildup in this country and help to create a political climate for ending the international arms race.

We hope by our example as concerned non-experts to encourage others to discuss economic conversion of LLL, thus helping to break down the scientific-technological elite's hold on the imagination of the American public.

We had difficulty obtaining much important, unclassified data for this analysis. Hence, this effort is necessarily incomplete. We view it as the first step in a much longer process in which we hope many others will join us. Please send all comments to: Conversion Study Group, UCNWLCP %Ecumenical Peace Institute/CALC 944 Market Street, Room 509, San Francisco, CA 94102 (415) 391-5215.

Second Edition Printing
October, 1979

U.C. NUCLEAR WEAPONS LABS CONVERSION PROJECT

War Resisters League West
1360 Howard Street
San Francisco, CA 94103
(415) 626-6976

Ecumenical Peace Institute/CALC
944 Market Street, Rm. 509
San Francisco, CA 94102
(415) 391-5215

Berkeley Students for Peace
608 Eshleman Hall,
UC Berkeley
Berkeley, CA 94720
(415) 642-7783

UCNWLCP Office
944 Market, Rm. 508
San Francisco, CA 94102
(415) 982-5578

SUMMARY

It is our belief that continuing nuclear arms research and development increases the risk of nuclear war and that the U.S. has a responsibility as the leader of the arms race to take the initial steps to turn it around. We also believe the nuclear work at Livermore lab represents a health and safety hazard to the workers and surrounding communities.

We have made efforts to open up public discussion and debate about the lab and to increase public awareness of Livermore's leading role in the arms race. We have had communication with Livermore Valley residents and found many of them open to discussion of alternative work for the lab.

This study is a more focused attempt to put conversion on the public agenda, to encourage the Livermore community and LLL employees to take a stronger role in planning for their future and their security, and to challenge the responsible agencies – the University of California and the Department of Energy – to take the needed steps to produce sound plans leading to the conversion of LLL to non-weapons purposes. We believe these efforts will lessen the economic underpinnings of arms buildup in this country and help to create a political climate for ending the international arms race.

We hope by our example as concerned non-experts to encourage others to discuss economic conversion of LLL, thus helping to break down the scientific-technological elite's hold on the imagination of the American public.

INTRODUCTION

After talking about conversion of the weapons labs since the inception of the Labs Project almost four years ago, Project members decided to take the first steps towards long-range conversion planning. This study calls for the orderly, planned conversion of the jobs, equipment, and plant space at LLL from nuclear weapons research to alternate energy research. We do not mean to imply by this simply the addition of more non-weapons work at LLL, but rather a fundamental change in the shape of LLL's national security mission that would mean the end of weapons research. We also do not wish to see the lab's nuclear weapons work moved to Los Alamos, or to another facility.

Nuclear weapons work comprises the largest part of the LLL budget – $134.2 million for Fiscal Year 1979. Adding in weapons-related work at the Lab, nearly two-thirds of the 1979 budget is for nuclear weapons purposes. This includes such "energy" work as the laser fusion project, which is funded by the Armed Services Committee because of its near term weapon's applications.

In FY 1978, 4,601 people were employed in weapons-related areas at the lab. Another 1,825 jobs were in non-weapons categories, although most of this was related to nuclear energy. Only 220 jobs, a mere 3.4% of the LLL workforce, were in alternate energy work. The lab projects that for FY 1984, only 4.2% will be employed in renewable non-nuclear energy and conservation research.

50% of LLL's current 6,900 employees live in the Livermore Valley, making the local economy extremely defense dependent. As such, the community is highly vulnerable to changes in U.S. foreign policy. In the case of Livermore, the event most likely to alter "business as usual" is a comprehensive test ban (CTB) treaty. The Labs Project has repeatedly asked the lab to make public its plan in case of a CTB. But the likelihood of a treaty being signed in the very near future is a political reality the LLL management seems unwilling to address. A CTB would have enormous impact on the workers at LLL, with lay offs inevitably occurring as a result. LLL jobs could be secured with the proper planning. But the lab management has refused to do this planning and has instead acted in a shortsighted and irresponsible manner.

Conversion of military facilities and defense industries is not a new idea. Other plants, often with the assistance of the federal government, have pursued conversion when their funds for military work were cut. This experience and other studies have shown that converting LLL to alternative energy work is possible and would provide more jobs per dollar to the community – jobs that would be less environmentally hazardous, too.

This is a preliminary analysis and as such is incomplete. Our data base is insufficient at this time to do the kind of in-depth study which is needed on all aspects of converting LLL. We view this as a first step towards a more detailed study. We welcome any suggestions or criticisms and ask for any support to help complete a further study.

LLL: A DRIVING FORCE IN THE ARMS RACE

The Lawrence Livermore Laboratory was begun in 1952 to compete with the Los Alamos lab in hopes that this competition would speed up development of the hydrogen bomb. The lab succeeded in that development and has since gone on to develop many of our strategic and tactical nuclear warheads, including the neutron bomb.

Today LLL represents a significant vested political interest of its own and acts to preserve its weapons work by seeking ever-increasing funds and by discouraging moves toward arms limitation. The record shows that lab directors play an aggressive role in shaping U.S. priorities in weapons development, such as their lobbying efforts for a neutron bomb and against every test ban treaty over the last twenty years. The lab plays a crucial role in the institutionalization of the arms race.

Lab management is proud of the synergistic connection between weapons and nonweapons work at LLL. Several of LLL's most highly publicized "advanced energy programs" are in reality weapons programs. The largest and most important of these is inertial confinement or laser fusion. Energy decisions currently made at LLL are all made in a predominantly nuclear framework. Until this synergistic connection between weapons and energy is broken, the tremendous resources of LLL cannot be properly directed to alternative energy research to serve long-term U.S. energy needs.

THE PLIGHT OF NON-WEAPONS RESEARCH AT LLL

LLL has always had a dual mission to do weapons work and other work on problems of a national scale. In recent years the amount of energy work has increased dramatically at the lab, but within the nuclear and weapons framework. Certain Department of Energy criteria limit the amount and type of nonweapons work at LLL. These criteria, biased toward nonweapons work which compliments weapons work, have been criticized as inadequate in recent governmental studies. Officials in Washington, lab employees, and the general public have all complained about the imbalance which favors nuclear over non-nuclear work at the lab. Funding for alternative energy research ought to be sought as aggressively in the future by lab management as they have sought weapons funding in the past.

ALTERNATE ENERGY RESEARCH: One Conversion Possibility

The United States faces an energy crisis. Fossil fuels, on which we have relied for so many years, are running out, and we are increasingly reliant on foreign sources of oil. Nuclear fission, with its attendant risks and complex technology, faces an increasingly uncertain future. Fusion, highly touted as the safe, clean, inexhaustible energy supply of the future, is running into problems.

Various renewable energy sources based on the sun offer the best hope of new sources of fuel, electricity, and transportation, although some problems remain in the effort to make them competitive with current energy sources. Only a major commitment to research and development of conservation and renewable energy sources will make them viable on a large scale and insure a self-sufficient, renewable U.S. energy path for the 21th century.

Lawrence Livermore Laboratory is the world's largest research laboratory, with the world's biggest computer complex and some of the most skilled scientific and engineering talent in the country. As such, the lab is urgently needed to begin research and development of alternate energy sources for the Department of Energy.

Specifically, we call on the laboratory to utilize its resources and talent to solve the following problems in alternative energy development:

- finding new materials for photovoltaic (solar) cells;
- developing new ways of making fuels from biomass;
- reducing the cost of extracting hydrogen from water;
- developing ways to use hydrogen as a fuel;
- finding better means for energy storage and transfer;
- improving the safety and reliability of wind energy systems;

- developing cheaper, more efficient fuels for transportation;
- developing computer modeling for integrated alternative energy systems for cities, homes, and industry.

Large amounts of basic energy research are also needed to undergrid specific projects.

Two 1978 studies, conducted by the General Accounting Office and the President's Office of Science and Technology, have strongly criticized the Department of Energy for its over-emphasis on nuclear research. The studies urged a stronger commitment to non-nuclear energy research. We think the time is right for the lab to begin making a change to this kind of work.

THE IMPACT OF CONVERSION ON LLL

Of the 6,900 employees at LLL in October 1978, 2,400 work as scientists and engineers and 3,000 are technicians and craftspeople. The remaining 1,500 function as administrative and support personnel. The LLL 1978 Institutional Plan states, "Together, these groups represent a broad expertise across nearly the whole whole spectrum of research."

What effect would a major shift from weapons and nuclear research to non-nuclear alternative energy have on the lab staff? We were unable with the limited information and resources made available to us to do a thorough job skills analysis of Livermore. However, a careful study of available information combined with past studies by others of job skill transfer and conversion at similar facilities, paints a hopeful picture. The bulk of the employees at the lab are technicians, craftspeople, and support personnel, rather than highly trained and highly specialized engineers, scientists, or administrators. The LLL 1978 Institutional Plan contains a chart that shows 7 out of 9 areas of technical expertise within the Defense program are transferrable to other non-defense programs.

The shift of scientists and engineers to alternate energy work presents the greatest difficulty. Some nuclear physicists and engineers will be needed to deal with the enormous problems of already existing nuclear wastes and disposal of nuclear weapons as arms reduction proceeds. A 1967 Stanford Research Institute study of the transferability and conversion of defense engineers found no insuperable barriers to transferring and reorienting individual engineers, but more problems arose when large numbers of engineers were involved. A large retraining program would be needed to convert the skills of these scientists and engineers.

Difficulties may also arise in converting the buildings and equipment at LLL. However, this is not necessarily insuperable, nor should it deter us from what is basically important in the alternate use planning process – the conversion of *people* and *research*. A careful study of job skills, equipment and plant space can only be done by a conversion planning committee at the community level, with full access to information, resources and the cooperation of the laboratory and the Department of Energy.

Various lab employees, scientists, and others have suggested that LLL's national security mission would more appropriately focus on the question of meeting our basic energy needs. These people feel that the greatest threat to our nation's security today lies in not having a sufficient research and development base for our energy future.

Conversion of Livermore to such work is clearly desirable, and we believe would be technically possible. It appears equally clear that conversion is politically difficult, with many obstacles standing in the way – from resistance by lab management to strong objections from pro-military forces.

The involvement of all of us – lab employees and concerned citizens – in calling for the conversion of Livermore to a leading alternative energy research facility is the only way to make such a vision a reality for the future and overcome these obstacles.

IMPLEMENTING CONVERSION AT LLL

We have briefly outlined in this summary a case for conversion of Lawrence Livermore Laboratory from nuclear weapons and power research to alternate and basic energy research. As we have said earlier, much work remains to be done.

Further alternate use planning requires two major components. First, available options must be developed that a) employ the LLL workforce, b) utilize the plant and equipment, or modify it, and c) benefit the nation

and the Livermore area. Second, we must insure that the plans drawn up will be carried out. The most technically competent plans in the world can go nowhere if the responsible agencies are not committed to carrying them out.

At least two models for such alternate use planning currently exist:

- Lucas Aerospace Combine Shop Stewards committee – Over a period of two years, large numbers of workers at various skill levels at Lucas Aerospace, Britain's largest defense firm, have been involved in detailed planning for alternate uses of their skills and equipment. 150 alternate products were suggested in the committee's plan for the 17 Lucas plants that employ a total of 12,000 workers.
- Rocky Flats – Colorado Governor Richard Lamm has established the Rocky Flats Monitoring Committee which has begun tentative investigation of alternate uses for the Rocky Flats nuclear weapons plant.

Legislation also exists on both the state and federal levels which support our call for alternative use planning. The federal Defense Economic Adjustment Act is currently being considered in both the Senate and the House. This bill would provide a framework for conversion planning and worker security. It would mandate the establishment of Alternate Use Committees at all major military plants and facilities, set up a national committee to coordinate civilian contracts, and set up a worker assistance trust fund to provide up to two years of salary, medical, pension and retraining benefits for affected workers. California Assembly Speaker Leo McCarthy is currently finalizing legislation which would establish an interagency task force for California to encourage and facilitate local alternate use planning in areas of heavy defense dependency and to provide liaison between such local committees and state and federal agencies and sources of funds for planning.

Considering these examples and legislation, we call for a tri-partite alternate use committee to be set up at Lawrence Livermore Lab, whose focus would be to plan for eventual shifts in U.S. policy away from nuclear weapons research and development. This committee would be composed of Livermore community members, lab employees, and DOE and LLL management. It would be their task to analyze data, think through problems, and make conclusive recommendations for alternate research at LLL. The McGovern-Mathias bill provides a good framework for how this committee would be established and function.

We call on the Department of Energy, the University of California, and the LLL management to use the vast public resources at their disposal to begin this vital process of planning for the orderly conversion of LLL. We challenge them to loosen the grip of nuclear technology currently binding our scientific potential.

We call on the Livermore community and the lab employees to become involved in every step of the process. We call into question the view that any other group of people is more appropriate to shape the future directions for LLL research.

We call on others to study the issues, to make informed and careful judgements concerning the economic and environmental questions involved in choosing an energy future. We will continue to resist and oppose the continued research and development of nuclear weapons by this or any other nation, while working to convert Livermore.

We are under no illusion that the development of simple alternative ideas and plans for what might be will necessarily bring about change. But we need a concrete vision of what we are discussing – a vision that includes a caring committment to all those affected by the situation.

Please join us in this process.

INTRODUCTION

The University of California Nuclear Weapons Labs Conversion Project (UCNWLCP) is a coalition of groups and individuals who organized in 1976 to oppose the spiralling arms race, specifically manifested in the University of California's (UC) operation of Lawrence Livermore Laboratory (LLL) and Los Alamos Scientific Laboratory (LASL). In the nearly three years since the group's inception, UCNWLCP has done much study on the work of LLL and its role in weapons research, design, and policy making. UCNWLCP has focused on three goals: 1) The immediate cessation of weapons research and development at LLL and LASL, and their conversion to peaceful, socially useful research; 2) severance of all ties with the University of California; and 3) a complete and independent study of health hazards at LLL and LASL and surrounding communities, especially with regard to low level radiation. *

This preliminary analysis of the conversion potential of LLL is directed toward the first goal. We realize that a large number of employees (6900) work at LLL and the Livermore valley community is to a large extent economically dependent upon the Lab.[1] According to the Draft Environmental Impact Statement for LLL, "the economic impact of the Laboratories on the City of Livermore is very strong;" 50% of lab staff live in Livermore and about 25% of the city's population is directly dependent on the Department of Energy.[2] Furthermore, the impact of LLL is strongly felt in the Livermore schools as Federal ". . . aid received still depends heavily on the laboratories and their existence in the school district."[3] If there is a substantial cutback in the lab's workforce, the effects on the Livermore community could be disastrous. More detailed plans to devise "alternative uses" for LLL must be 1) open to public scrutiny; 2) drawn up by a committee composed of a wide base of lab employees and community members as well as DOE and lab management, and 3) careful to make provisions to insure job security for workers, retraining personnel where advisable. Not all job skills or equipment are immediately transferable to non-weapons research. In no case, however, should LLL let capital investments deter employee transfer or retraining for other work.

Advocacy of peace conversion at LLL does not mean that weapons research and development should be shifted to Los Alamos or any other location. We believe the principles of this study are applicable to all national weapons facilities. We are concerned about the increasing acceleration of the nuclear arms race – both in quantity and quality – and we believe that the skill, talent, and some of the equipment currently in use at LLL for developing new and more sophisticated weaponry could better serve humanity if put to work on peaceful, socially useful research. The increasing vulnerability of specialized military and defense facilities to changes in national policy will lead to economic disaster for the surrounding communities as well as to the workers at such sites. Alternative plans must be developed now for lab staff and resources.

Conversion of military facilities and defense industries is not a new idea. Plants, closed in the past by necessity, pursued conversion efforts after the fact. Massive adjustments were required, for instance, among aerospace contractors when B-1 bomber production was scrapped; 13,000 layoffs resulted in Southern California alone.[4] Nearly every area of the country has experienced some similar crises. To cope with such problems caused by the closing of military bases, the Department of Defense (DOD) created the Office of Economic Adjustment (OEA). Until recently, however, the OEA contained no mechanism for *advance* planning. No such agency, however inadequate, exists for the DOE, even though its contracts are subject to the same variables. Senators McGovern and Mathias have introduced legislation in Congress which would mandate local advance planning and provide benefits and retraining for affected defense workers.[5] It is unclear whether this legislation would apply to DOE weapons facilities.

*Statement of Goals on page 9

Only recently has advance planning for economic conversion been given much attention publicly. According to a report by the Social and Economic Analysis Corporation of Boulder, Colorado, prior planning best prepares plants and communities for cutbacks due to changes in national policy.[6] Two years ago, a Livermore Lab physicist said, "It looks like we're going to have to stop weapons eventually (see test ban treaty section). No matter what your feelings, it's best to plan for it rather than getting caught by the politicians." The same physicist termed "foolish" arguments that rapid changes in technology make it impossible to plan for contingencies. "You lose nothing," he said. "by planning. The question is what you gain."[7] Advance planning also shortens the recovery period after such a conversion.

Too often in the past, especially in the defense industry, planning for conversion has been neglected. We have allowed misconceptions about how to maintain economic stability to cloud judgements on defense policy.[8] Government authorities often adopt weapons systems, whether in the national interest or not, to create jobs and keep contracting companies in business; thus economics fuels the arms race. An LLL employee has said that no one wants to put themselves out of business; this logic keeps LLL going. At present 13% of the national workforce is involved in defense-related work.[9] We find it unthinkable that no other employment can be found for these people. If the United States is to break this cycle of cart-before-the-horse illogic, we must be prepared with viable alternatives for all phases of our military-industrial complex and we must restore objectivity to our decision-making about what is in the national interest.

Overview of the LLL Budget

Nuclear weapons work comprises the largest part of the LLL budget, $134.2 million for FY1979. Weapons-related research at Lawrence Livermore Laboratory includes several categories of the budget: defense programs, a portion of energy technology and resource applications and some reimburseables, for a total of $216.1 million. Some explanation follows:

Defense programs. In addition to nuclear weapons ($134.2 million) and verification technology and safeguards ($6.0 million), inertial confinement (laser) fusion, $39.4 million, is included in the defense programs. Often hailed as the energy hope of the future, laser fusion is included in defense programs because its only near term application is as a weapons modeling system. The total defense programs for FY1979 is $179.6 million, 55.8% of the total budget.

Energy technologies. Several other parts of the budget are also weapons related because of their nuclear weapons applications. The uranium resource assessment category, $3.7 million in FY1979, ties in with the search for nuclear warhead as well as nuclear power material. The advanced isotope separation program, $12.4 million, enriches unranium for weapons as well as power plants. The "nonproliferation analysis and special materials production" ($0.4 million) would not exist were it not for nuclear weapons development.

Reimburseables. The Lab's "reimburseable category" – work for other government agencies like the Department of Defense and the Nuclear Regulatory Commission – includes a total of $20 million direct work for the Department of Defense on weapons applications.

The combined total of all of these categories comes to $216.1 million, two thirds of LLL's work in 1979.

In the non-weapons categories, Livermore Lab spent a total of $104 million, including $53.5 million for energy technology (including fossil, solar and geothermal); $4.5 million for conservation and solar applications, $13.8 million for environment, $3.0 million for basic energy research, and $29.2 million for non-DoD reimburseables (primarily for the Nuclear Regulatory Commission). Of the non-weapons work, non-nuclear research at LLL only includes a few categories (solar, geothermal, environment, transportation), totaling $33.9 million, a mere 11% of the total budget.[10]

Overview of the LLL Workforce*

A look at a breakdown of the workforce into its various categories at Livermore is instructive. In FY 1978, the last year for which we have actual figures, there were 4,601 jobs in weapons-related areas (defense programs, DoD reimburseables, and nuclear research with weapons applications), comprising 71.6% of the total workforce at LLL. In non-weapons areas, there were 1,825 jobs engaging 28.4% of the workforce. Of the non-weapons category, however, only a small part is directed toward non-nuclear alternate energy research. In FY 1978, the total of all solar, geothermal, energy storage, conservation, and transportation research provided only 220 jobs, or a mere 3.4% of the LLL workforce. Projections for FY 1984 show a gain of 243 weapons-related jobs (total 4,844) and 90 jobs in alternate energy (total 310). Thus, LLL projects for FY 1984 to employ 65.5% of its personnel in weapons-related areas and still only 4.2% renewable, non-nuclear energy and conservation research. [11]

LLL and a Comprehensive Test Ban Treaty

In the case of LLL, surely the event most likely to alter "business as usual" is a comprehensive test ban (CTB) treaty. Such an agreement has been discussed in the past: An above-ground testing limitation was reached in 1963, and negotiations were furthered with SALT I. SALT II negotiations (which do not limit testing) are almost completed and CTB talks are progressing in Geneva with chief negotiator Herb York, a former LLL director, representing the U.S. Negotiators originally considered a five year moratorium on testing; partly due to lab directors' lobbying efforts, this was reduced to three years. No limitation has been reached for laser work or computer modelling of weapons. Although no date of agreement is set as yet, it is reasonable to assume that there will be a CTB in the near future. If so, what is LLL's state of preparedness to meet the occasion?

UCNWLCP has repeatedly asked the lab to make public their plan in case of a CTB, and to set up a broadly-based committee to study alternative uses for the facility. We have received no response. The Livermore *Independent*, a local paper, echoed community concern, pointing out that if test or arms limitation treaties are signed, LLL faces the loss of considerable funds and the lay off of some of its 6,000 employees. "To date," according to the *Independent*, "the Lab's only plans for such an eventuality are focused on finding ways to circumvent the treaties so nuclear weapons development may continue." [12] The paper also called called LLL management's approach dangerously shortsighted and a clear example of the military domination of what is supposed to be a University of California-operated research laboratory. "The University and LLL administrators," said the *Independent*, "should carefully prepare plans for conversion of the Lab to peaceful research, which may give America and the world alternatives to widespread death and destruction." [13]

Michael May, Associate Director of LLL, has said that a ban on testing will have a "big effect on the output of work" at the lab, but employees in the weapons program would "continue working on the state of the art." [14] The Livermore *Independent* quoted a lab physicist, who asked to remain anonymous, as saying, "I think they're (LLL weapons program management) scared stiff. They don't know what to do if there's a test ban." [15] Although he did not envy the management's task of trying to face a CTB, the physicist suggested that the lab's devotion to short range programs with immediate weapons applications would be harmful in the event of a test ban. Long range, fundamental physics research, however, is needed, the physicist felt. [16]

Recently, Roger Batzel, Director of LLL, stated: "A comprehensive test ban, should one occur, would add to the difficulty of meeting our responsibilities." [17] In the Director's statement attached

*See chart beginning on page 6.

to the 1979 Institutional Plan for LLL, Batzel recommended that safeguards accompany a CTB, to allow the construction of ". . .additional facilities for allowed experiments, and meaningful programs to retain and exercise the essential cadre of weapons designers and their supporting technologies."[18] He did not, however, state specifically *what* LLL plans in case of a CTB. An LLL physicist who wishes to remain anonymous, speculates that a CTB would "eventually have a rather drastic effect on LLL"; in the short-term he forsees more emphasis on theoretical weapons calculations, and in the long term concentration on other weapons, such as lasers and particle beams. A CTB would definitely displace people who are now involved in testing, and these employees are not likely to "drop into theory" work. This physicist concludes that LLL would try to shift people to other areas, but that he "wouldn't be at all surprised if LLL laid off some people."[19]

In hearings before the Senate Foreign Relations Committee, Harold Agnew, then Director of Los Alamos Lab, was asked by Senator Pell what percentage of LASL's present workload would no longer be carried out if there were no testing. Agnew answered, "Assuming that we still maintain a weapons capability, I would say that of the 50% of the laboratory which is weapons, about 20% or perhaps one-third of that is directly connected with specific weapons tests."[20] A CTB, then, according to staff at both labs, would make some cutbacks in personnel probable. LLL, the sister lab of LASL, holds a similar percentage of weapons work, and would have similar problems. The 10% of total work affected at LASL by the CTB does not include the general slow down to be expected in the "pipeline" of new systems yet to be tested in the event of a CTB. LLL management has not addressed the long range impact of a CTB on lab personnel, according to what information is available.

Even *without* a CTB or a major decrease in nuclear weapons work, lab employees are not secure in their jobs. From 1971-73, hundreds of lab employees were laid off, due to the stabilization of weapons development work. This period saw the beginning of an increase in two areas of lab work to minimize such layoffs: the research and design of a new generation of U.S. nuclear weapons (for the planned Trident, cruise missile, M-X and B-1 Bomber), and the expansion of Livermore energy work, primarily the fusion program. Such periods of flux in contract work can be expected in the future, and can only be mitigated through conversion planning.

UCNWLCP is committed to an immediate US moratorium on all nuclear testing as a step toward a CTB. Such a development may come soon; we are concerned with the effect of a test ban – especially in the long run – on employment and job security at the labs. Ineffectual efforts at circumventing a CTB by shuffling employees, and desperate last-minute conversion planning can be avoided. We believe it prudent and necessary for the Livermore community, the UC community, and all those involved at the Lab to form an "alternate use committee" to change the direction of work at LLL, thus preparing a constructive response to a CTB and further peace initiatives.

A Call For Conversion Planning

It is in this spirit that we offer the following preliminary analysis, which includes:

- an analysis of current weapons-related research at LLL
- non-weapons research at LLL
- a projection of new and expanded alternative energy research possibilities for the lab
- a brief plan on how to implement conversion of LLL

Overall, we will look at what work the Lab currently undertakes, what work we feel the Lab should be doing, and why they are not. We will also detail some of the national alternative energy requirements which lab researchers could meet if the political choice to do so were made. Finally, we will

show why LLL cannot and will not, under their present organization, pursue non-nuclear energy options as vigorously as they should.

We found the Lab's management generally unhelpful in responding to our requests for unclassified documents with which to research this preliminary analysis. Consequently, our data base is small or non-existent in certain areas. We are unable to include a detailed job analysis or specific comments on plant space and equipment transfer. Many of the Lab employees who did help us on their own time wish to remain anonymous to the Lab's management; we believe this reveals a negative political attitude toward conversion planning on the part of LLL administrators.

We are under no illusion that the development of simple alternative ideas and plans for what might be will necessarily bring about change. But we need a concrete vision of what we are discussing; a vision that includes a caring commitment to all those affected by the situation. A writer on conversion once asked ". . .whose business is it to come up with sophisticated conversion proposals?" Ultimately, the responsibility lies ". . .at the source of the funding, the limitless funds which threaten the quality of life by making quality unimportant. . . real stoppage and conversion will take place when the federal government's research budget readjusts to the needs of Americans."[21] The unique talents and incredible human potential at LLL and in the Livermore community will be constructively utilized to its fullest only when this readjustment occurs.

We hope this survey will be the first step in an ongoing investigation into the work of the Lab and in the development of a conversion plan which emphasizes peaceful research. We urge DOE to organize immediately an open committee with broad citizen representation to draft a more complete alternative use plan for Lawrence Livermore Laboratory. We hope the lab management will cooperative with such an endeavor.

A condensation of "Revised Institutional Plans & Long Range Resource Projections FY 1980-FY 1984, Operating Programs (FTE) with Indirect Manpower Distributed" from Table II of the LLL Institutional Plan FY 1978-FY 1984.

	Actual FY1978	FY1979	FY1980	FY1984
Defense Programs				
Inertial Confinement Fusion	732.0	747.0	747.0	826.0
Weapons Activities	3,132.0	2,923.0	2,880.0	3,098.0
Intelligence & Arms Control	102.0	134.0	134.0	134.0
Weapons Nuclear Material Security & Safety	7.0	8.0	8.0	8.0
Total Defense Programs*	3,973.0	3,812.0	3,769.0	4,066.0
Energy Technology				
Fossil (Coal, Oil, Gas)#	143.0	164.0	171.0	180.0
Solar Electric Applications+	17.0	30.0	30.0	37.0
Geothermal+	74.0	45.0	44.0	44.0
Magnetic Fusion#	636.0	732.0	815.0	906.0
Nuclear Research & Applications*	228.0	245.0	252.0	270.0
Utilities--Electrical Energy Systems, Power Systems Structures, Conservation+	5.0	-	-	-
Energy Storage+	28.0	53.0	63.0	67.0
Improved Conversion Efficiency, Conservation Research & Technology+	8.0	-	-	-
Weapons--Special Material Program Waste Management (Defense)*	10.0	7.0	10.0	13.0
Total Energy Technology	1,149.0	1,276.0	1,385.0	1,517.0
Resource Application				
Uranium Resource Assessment*	55.0	24.0	-	-
Total Resource Application	55.0	24.0	-	-
Conservation & Solar Applications				
Solar Thermal Applications & Technical Support & Utilization+	18.0	15.0	15.0	15.0
Transportation Energy Conservation+	17.8	19.0	18.0	18.0
Solar Heat. & Cool. Demonstration+	.2	-	-	-
Total Conservation & Solar	36.0	34.0	33.0	33.0

A condensation of "Revised Institutional Plans & Long Range Resource Projections FY 1980-FY 1984, Operating Programs (FTE) with Indirect Manpower Distributed" from Table II of the LLL Institutional Plan FY 1978-FY 1984. Page 2

	Actual FY 1978	FY 1979	FY 1980	FY 1984
Environment				
Environmental Resources and Development#	265.0	259.0	316.0	342.0
Life Sciences Resources and Biomedical Applications#	39.0	38.0	38.0	46.0
Total Environment	304.0	297.0	354.0	388.0
Director of Energy Research				
Basic Energy Science+	52.0	71.0	107.0	129.0
Nuclear Physics*	2.0	2.0	3.0	3.0
Total Dir. of Energy Research	54.0	73.0	110.0	132.0
Other#	219.0	219.0	167.0	177.0
Total DOE Programs	5,790.0	5,735.0	5,818.0	6,313.0
Reimbursable Work				
Department of Defense*	333.0	429.0	431.0	492.0
Nuclear Regulatory Commission#	134.0	273.0	310.0	339.0
Other#	169.0	202.0	231.0	253.0
Total Reimbursables	636.0	904.0	972.0	1,084.0
Total Programmitic	6,426.0	6,639.0	6,790.0	7,397.0

KEY: *Items indicate weapons and weapons-related work
#Items indicate non-weapons work, a part of which is alternative energy
+Items indicate non-weapons work that is concerned with non-nuclear energy alternative research only

A condensation of "Revised Institutional Plans & Long Range Resource Projections FY 1980-FY 1984, Operating Programs (FTE) with Indirect Manpower Distributed" from Table II of the LLL Institutional Plan FY 1978-FY 1984. page 3.

	Actual FY 1978	FY 1979	FY 1980	FY 1984
Construction/Fabrication	295.0	443.0	458.0	373.0

(It is beyond our ability to break down the figures for "Construction/Fabrication" into weapons or non weapons areas; therefore, our comments on LLL personnel projections will be based on the aforementioned program categories only, though it might be resonable to assume that the weapons and non-weapons percentages of this area would follow program areas.)

New Initiatives (Proposed)				
Defense Programs				
Weapons Simulation	-	37.0	74.0	28.0
Isotope Separation	-	9.0	19.0	28.0
Test Treaty Verification	-	52.0	83.0	54.0
Underground Detection	-	16.0	32.0	68.0
Proliferation	-	39.0	93.0	93.0

UC Nuclear Weapons Labs Conversion Project

STATEMENT OF GOALS AND OBJECTIVES
October, 1979

We are part of a growing worldwide movement of people opposed to nuclear weapons and nuclear power. These technologies, developed under U.S. leadership and now controlled by international military, economic and political interests, pose the greatest threat to the survival of humanity. Our struggle to eliminate these threats is part of a larger movement against economic exploitation, racism and sexism, as well as against war.

Our Project focuses on the two federal laboratories, operated by the University of California, where all U.S. nuclear warheads have been developed. As a grass roots movement, begun in 1976, we have achieved much success in educating the public about the dangers of the nuclear arms race and in challenging the management of these weapons facilities.

WE ARE RESOLVED TO CONTINUE WORKING THROUGH EDUCATION AND NONVIOLENT ACTION FOR THE FOLLOWING GOALS:

1. An end to all nuclear weapons related work by Lawrence Livermore Laboratory (LLL) and Los Alamos Scientific Laboratory (LASL) and their conversion to socially constructive uses as a step toward global disarmament.

Important steps toward this goal include:

- seeking with Livermore valley community members and LLL workers the establishment of a Livermore-based Alternate Use Committee to define socially useful options for LLL. We support similar work by local groups at other weapons facilities.
- joining with others to expose the economic and human cost of the arms race as a step towards coalitional efforts to change the economic priorities of our country.
- participating in national and international campaigns to end the arms race and shape a non-nuclear future.
- monitoring the Comprehensive Test Ban Treaty and building a base of informed public support for an effective test ban.

2. An end to the non-democratic management of Lawrence Livermore Laboratory and Los Alamos Scientific Laboratory, providing for rigorous public scrutiny and insuring public control.

Important steps toward this goal include exposing and challenging:

- the abuses of power that allow officials in the labs and the Department of Energy (DOE) to shape U.S. weapons policy in their own interests.
- the pervasive secrecy which denies the public the information necessary for intelligent debate and decisions on nuclear nuclear issues.
- the distortion of U.S. energy programs at the labs due to the dominance of military and corporate priorities.

3. An end to the University of California's ties to nuclear weapons development.

We remain committed to conversion of the labs as our long-range goal, but feel severance of UC ties is necessary because after three years of pressure:

- the University has failed to commit itself to work for conversion of the labs to non-weapons work.
- the University has allowed lab officials to use their University positions and public funds to promote weapons systems like the neutron bomb and to oppose arms limitation agreements such as the comprehensive test ban treaty.
- the University has shown clearly it will not exert any influence or control over the labs.
- the University has resisted attempts to set up public debates inside the labs and failed to provide relevant unclassified information to concerned citizens about the labs' research.
- the University continues to serve as a cloak of legitimacy to the labs' nuclear weapons research work.

4. An end to all work by the labs which involved radioactive material posing a threat to the health and safety of lab employees and residents to surrounding communities.

Nuclear weapons work involved insurmountable health hazards. In order to expose to the public the true nature of these hazards, we will work for:

- an accurate assessment of the health risks due to the radioactive emissions, both routine and accidental, at the laboratories.
- establishment of stricter controls over the transport of radioactive substances to and from the Livermore lab.
- greater public awareness of the inadequacy of emergency plans for dealing with radiation accidents.
- an accurate assessment of dangers posed by the nuclear wastes which the labs have produced in the past and are continuing to produce.

FOOTNOTES

[1]Roger Batzel, "The State of the Laboratory," printed in *Energy and Technology Review,* Lawrence Livermore Laboratory, July 1978, pp. 1

[2]U.S. Department of Energy, *Draft Environmental Impact Statement for Livermore Site (DEIS),* September, 1978, Section 5, pp. 2

[3]Ibid., Section 3, pp. 44

[4]*B-1 Bomber Mitigation Strategy.* California Business and Transportation Agency, Sacramento, December, 1977.

[5]*Defense Economic Adjustment Act.*

[6]Social and Economic Analysis Corporation, "An Assessment of Issues Concerning the Future of Rocky Flats," (unpublished), Boulder, Colorado, March, 1979, pp. 34-35

[7]*The Livermore Independent,* October 14, 1977, pp. 1-2

[8]See Seymour Melman, *The Permanent War Economy,* New York, 1974, and also Richard Barnet, "Exploding the Myths of National Security," *New York Times,* April 1, 1979

[9]*Livermore Valley Times,* November 6, 1977

[10]Lawrence Livermore Laboratory, *Institutional Plan, FY1978-FY1984,* December 18, 1978, pp. 1

[11]Ibid., pp. 1

[12]*The Livermore Independent,* October 12, 1977, pp. 1-2

[13]Ibid., pp. 1-2

[14]*Livermore Valley Times,* May 6, 1977

[15]*Livermore Independent,* October 14, 1977, pp. 1-2

[16]Ibid., pp. 1-2

[17]Roger Batzel, "The State of the Laboratory," pp. 5

[18]LLL *Institutional Plan,* pp. 2

[19]Private discussion with LLL scientist, March, 1979

[20]*Threshold Test Ban and Peaceful Nuclear Explosions Treaties Hearings Before the Committee on Foreign Relations and the Subcommittee on Arms Control, Oceans and International Environment of the Committee on Foreign Relations,* United States Senate, 95th Congress, U.S. Government Printing Office, September 8, 1977, pp. 75

[21]Nancy Kennedy, "What Else Is New?" Fellowship of Reconciliation, Nyack, New York 10960

LLL: A DRIVING FORCE IN THE ARMS RACE

Lawrence Livermore Laboratory was organized in September, 1952, under the direction of Ernest Lawrence and Edward Teller. Established to compete with Los Alamos in hopes that this competition would speed the development of a hydrogen bomb, the two labs' scientists introduced the world to the thermonuclear age. LLL's contributions to weapons work over the years include fundamental advances in nuclear weapons technology in the 1950s that led to the miniaturization of strategic warheads. Livermore developed the original warheads for Polaris, Poseidon, and Minuteman ICBMs that made multiple, independently targetable reentry vehicles (MIRVs) possible, which will shortly be upgraded to MARVs (maneuverable reentry vehicles). The lab also provided the leadership in the conception and design of ballistic missile defense (ABM), an extremely expensive idea that was ultimately rejected as unfeasible.

Today, the main support for continuing nuclear development and testing programs centers in the research and development section of the Department of Energy and the two major weapons laboratories, LLL and LASL.

In the last seven years, LLL has reduced the side effects for tactical warheads, provided for the conservation of "special nuclear materials," provided new understandings of the physics of thermonuclear explosions, and developed and conducted very high yield experiments, in anticipation of the threshhold test ban. This last effort resulted in new, high yield designs for bombs for missiles and aircraft. Today, lab directors forsee major technical thrusts along four lines: (1) ensuring safe handling and storage of weapons; (2) safeguarding weapons against unauthorized use; (3) tailoring an explosive's output to specific military requirements; and (4) conserving special nuclear materials, reducing weapon maintenance, and increasing the flexibility of military applications.

Lab administrators currently define their primary responsibility as advising "DOD on the feasibility and effects of new weapons concepts."[1]

The lab, however, plays a more active role than one of response to direct orders from Washington. During World War II, for the first time in history, weaponry developed during the course of a war became a significant factor in its outcome. The search for the atomic bomb during the 1940s, spearheaded by the Manhattan Project, created a new, closely knit relationship between the military services and scientific management. A new dependence on rapidly developing technology caused the emergence of scientific administrators as men of political power. The importance of scientists' role in weapons policy formation is often obscured by the lingering myth of the dispassionate, objective professional offering technical (i.e., non-political) advice to a grateful U.S. government. Careful analysis of the seemingly technical advice of Livermore Lab administrators often reveals its political substructure. Robert Gilpin, in *American Scientists and Nuclear Weapons Policy*, points out that "even though the expert may present his advice in terms of the technical what is, the advice may be important politically because explicit or implicit in the reported technical data are numerous non-technical assumptions including political assumptions concerning what ought to be done."[2] Several recent programs developed at Livermore exemplify this phenomenon.

During the last decade, LLL designed a tactical nuclear weapon for striking specific localized targets as opposed to the older strategic systems for mass destruction. Michael May, an associate lab director, described this work as follows: "This (tactical emphasis) is an area where we did go off without a request from the Defense Department and do some experiments to establish the credibility and to establish that indeed those weapons could be built in reasonable sizes."[3] Behind this seemingly technical piece of advice about feasibility rests a number of assumptions about the

nature of the nuclear arms race, the nature of Russian intentions, and directions for US foreign policy in general. One of the lab's most recent contributions to the nation's tactical nuclear arsenal is the "Lance warhead," which, say lab designers, "gives the Army its first modern missile warhead."[4] These weapons are, among other possibilities, for use in Europe by the Army. That the lab itself instituted the development of these weapons highlights the substantive nature of their political role.

INSTITUTIONALIZATION OF THE ARMS RACE

LLL, far from being independent of any particular political constituency, represents a significant political vested interest of its own. Like any other vested interest, it acts to preserve its work through seeking increased funding and through discouraging any moves toward arms limitation. For over twenty years, the lab has opposed or weakened every nuclear test ban treaty proposed by Congress or the President, including the current effort to secure a comprehensive test ban treaty (CTB). Both lab directors have testified before Congressional committees on a number of occasions against both the Threshold Test Ban Treaty (which is now in effect and limits underground testing to 150 kilotons) and the CTB. LLL Director Roger Batzel declared that a test ban "would end any effective nuclear weapons program in the United States and undermine confidence in the nuclear weapons stockpile. It's going to take a few generations for the world to change that much."[5]

Even when arms control treaties have been negotiated, the overall effect seems to stimulate the arms race rather than retard it. This phenomenon is known as "squeezing the balloon. If treaties limit it in one place, it bulges in another."[6] The weapons laboratories, dedicated to self-perpetuation, constantly develop new devices which fall outside treaty specifications. *Scientific American*, in 1975, announced that the main effect of the then latest step in bilateral arms control (SALT I) would be to increase military spending on both sides. The ceiling set for long-range delivery systems was substantially higher than the present strategic arsenals of both superpowers. James Schlesinger, then Secretary of Defense , said that a restructuring of the US strategic arsenal necessitated by SALT I would entail some upward adjustment in the strategic arms budget.[7] President Carter recently announced that SALT II would not stop the U.S. from building a variety of new and more deadly weapons. The urge to develop and build new weapons systems that escape treaty limitations is fueled by lab personnel, one of whom recently exclaimed, "When you realize the wealth of developments that are possible in the nuclear arena, it is hard to foresee an end to our work."[8]

WEAPONS AND ENERGY RESEARCH: THE SYNERGISTIC CONNECTION

The following statement by Harold Agnew, former director of LASL, speaks directly to the highly synergistic relationship between weapons research and energy research at both Los Alamos and Livermore Laboratories:

> The fact that LASL's nonweapons work is so preponderantly nuclear in character permits an almost instantaneous response to any new weapons related initiatives because so much of LASL's personnel, equipment, and facilities can be rapidly converted from nonweapons (nuclear) to weapons (nuclear) activities. On the other hand, it is also important to recognize that the extremely wide range of disciplines necessary to carry out our weapons R & D, coupled with our experience in meeting fixed schedules, provides an excellent base for attacking many of this nation's high technology, energy-related problems as well.[9]

Not all the weapons work at Livermore is direct research on new warheads, or work on nuclear weapons effects for the Department of Defense. Several of LLL's most highly publicized "advanced energy" programs are in reality weapons programs.

The most important of these is the "inertial confinement" or laser fusion program, highly touted as the answer to U.S. energy needs in the 21st century. Laser fusion is a method for creating miniature thermonuclear explosions by hitting pellets of hydrogen with converging laser pulses of enormous power, in effect creating a miniature sun. Over the past few years, laser fusion has been presented to the public as a potential shortcut to ultimate energy: cheap electric power from thermonuclear fusion.

Lawrence Livermore Laboratory pioneered laser fusion research and is currently experimenting with Shiva, the most powerful laser in the world. Lab officials argue that laser technology is funded both for its military and civilian applications. It appears in LLL's budget, however, under defense programs. Laser fusion can be utilized in the immediate future only for weapons modeling and simulation of some aspects of nuclear testing. The lab's hope is that the laser fusion program will be useful in bringing many, although not all, aspects of nuclear weapons testing into the laboratory. As Major General Edward Giller, former chief of national security for the Energy Research and Development Administration (ERDA), the Department of Energy's predecessor, has described it, "Really, this is a military program, and it always has been. It would be a very useful thing to have in a comprehensive test ban . . . It would keep the weapons labs busy for 5 to 10 years anyway. [10] Laser fusion is also used to study weapons physics and to develop new designs for nuclear warheads through the help of the LLL computer complex.

Looking beyond the present Shiva, Livermore describes the use of an advanced Shiva, or "Shiva Nova," as follows: "Concurrently with this laser system we will begin to do experiments which relate to the military applications of laser fusion. The extension of this technology to achieve civilian power production is a much more remote goal, a goal which will surely require as yet unvisualized and highly advanced technologies in lasers, in fuel pellets, and in fusion reactor engineering." [11]

The coming use of the laser for the production of fissile material such as plutonium and enriched uranium represents yet another military-related use of laser fusion about which very little has been said. This technology involves the building of a hybrid fission/fusion breeder reactor using lasers. Dr. Ray Kidder, the originator of the laser fusion project at Livermore and the director of the program from 1963 to 1970, says about the plutonium production potential, "I'm not suggesting that the Shiva itself could be used for that purpose. The point is that the laser fusion approach can produce plutonium at about ten times the rate that a fast breeder reactor can do, given that they both operate at the same level of power." [12]

A second "energy" program with tremendous weapons potential is the laser isotope separation program. Lab researchers say that laser isotope separation will provide an easier, cheaper, method of enriching uranium fuel for nuclear power generation. But Barry Casper, writing in the January, 1977 *Bulletin of the Atomic Scientists*, warns that laser enrichment could be a new path to unchecked, worldwide nuclear proliferation. Casper quotes a LASL scientist who says, "The world had better be a little bit uneasy, because it will be a whole lot easier to make bombs." [13]

Laser fusion and laser isotope separation are only the two most prominent examples of the interconnections between energy and weapons work. The management of Lawrence Livermore Laboratory is proud of the relationship between nuclear weapons and energy research. Lab administrators recently pointed out that

> The various weapons and energy programs at the Laboratory depend in large part on the same underlying scientific disciplines, engineering disciplines, and laboratory capabilities. This synergism between the weapons and the energy programs is an asset to both. We continue to put major emphasis on the nuclear weapons program due to its great importance to national security. We also intend to make major contributions toward developing new large-scale sources of energy important to the nation's well-being. [14]

All but $20.1 million of the energy research currently undertaken at Livermore takes place within a nuclear and weapons-related context. The lab, during the past ten years, has diversified into some non-weapons work, but the nature of that research has remained within the nuclear and weapons framework that is the lab's primary *raison d'etre.* If U.S. long-range energy needs are researched by LLL in such a framework, the nation will become increasingly dependent on centralized nuclear technology. In the light of events at Three Mile Island, this is a frighten-

ing prospect. Before the tremendous resources of Livermore can be properly directed to alternative energy research for the nation, the synergistic connection between weapons and energy research must be broken.

FOOTNOTES

[1]Lawrence Livermore Laboratory, *Institutional Plan, FY1978-FY1984,* December 18, 1978, pp. 5

[2]Robert Gilpin, *American Scientists and Nuclear Weapons Policy,* pp. 15

[3]"A Five Year Plan for Picking Up the Arms Race," *San Francisco Sunday Examiner-Chronicle,* March 27, 1977, pp. 18

[4]"The Job Is Far From Finished," Lawrence Livermore Laboratory *Newsline,* September-October, 1976, pp. 8

[5]"Five Year Plan," pp. 18

[6]Jed Duvall, CBS Evening News. Special on the Arms Race, March 19, 1979

[7]"The Arms Race Institutionalized," *Scientific American,* March, 1975, pp. 47

[8]*Newsline,* September-October, 1976, pp. 9

[9]Harold Agnew, Director, Los Alamos Scientific Laboratory, *Institutional Plan,* 1978, pp. 4

[10]Robert Gillette, "Laser Fusion: an Energy Option, but Weapons Simulation Is First," *Science,* April 4, 1975, pp. 30

[11]Lawrence Livermore Laboratory, *Long Range Resource Projections, 1976-1982*

[12]Transcript, *Laser Con-Fusion,* KPIX-TV, March 17, 1978, pp. 18-19

[13]Barry Casper, "Laser Enrichment: a New Path to Proliferation?" *Bulletin of the Atomic Scientists,* January, 1977, pp. 28

[14]Lawrence Livermore Laboratory, *Institutional Plan,* pp. 4

THE PLIGHT OF NON-WEAPONS RESEARCH AT LLL

Lawrence Livermore Laboratory has been involved in a small amount of non-weapons work since its establishment. The Director's statement in the LLL *Institutional Plan*, dated December 18, 1978, points out that "LLL was established in 1952, primarily to strengthen the research and development base of the nation's nuclear weapons program, but with a companion responsibility to perform scientific research on other national problems."[1]

About 33% of the lab's programmatic resources are devoted to energy and environmental work. We will examine briefly four basic categories of work in this section: energy technology, environmental and biomedical, conservation and solar applications, and basic energy science. We will also comment on the LLL computer complex, the world's most powerful.

According to a 1978 General Accounting Office (GAO) study of the non-nuclear research potential of the multiprogram DOE laboratories, the following criteria, developed by the Energy Research and Development Administration (ERDA), are still used by the DOE in accepting or rejecting non-weapons work at Livermore, Los Alamos, and Sandia:

- "Work should be limited to work that can be accomplished in the laboratories.
- "Work should be limited to that which requires the laboratories' unique capabilities and cannot be accomplished elsewhere.
- "Nonweapons work is not to unduly hamper weapons work.
- "Nonweapons work undertaken should complement weapons work.
- "The capability should be retained to transfer the resources from nonweapons to weapons work if necessary." [2]

The GAO report concluded that the laboratories have the scientific and technical resources, manpower, and plant facilities to make a major contribution to alternate energy research. Only 6% of LLL's $265 million budget in 1977, however, went for non-nuclear research.[3]

New York Rep. Richard Ottinger, concerned about research allocations and priorities at the national laboratories, said to Livermore director Roger Batzel:

> I don't know of anything that's come out of these laboratories that has actually gone into use. That is one area in which I think we ought to be greatly concerned. We need to begin to get some of the breakthroughs in technology into use to solve the very critical problems that we have.. .
>
> I think you are using the taxpayers' money essentially to cooperate with the large energy companies, which already have an excessive stranglehold on our society . . . what comes up through the DOE to us is a lot of . . . huge dollar proposals to extend the work in these very high capital-intensive, high-technology fields. When it comes to solar, we have to be the instigators, or when it comes to fuel cells, or when it comes to other alternative technologies.[4]

ENERGY TECHNOLOGY

Magnetic Fusion Energy

Magnetic Fusion Energy (MFE) research has been carried on at LLL since 1952. LLL describes itself as one of the major world centers of MFE research. MFE research explores the generation of

electricity through nuclear fusion in super-hot hydrogen gases confined magnetically. Fusion is the process by which hydrogen nuclei, heated to at least 100 million degrees centigrade, join and release energy. LLL currently conducts three MFE experiments: 2X11B, the Tandem Mirror Experiment, and the Large Mirror Fusion Test Facility.

As with nuclear fission energy, MFE research developed out of the technologies of weapons work. Having detonated the H-bomb, scientists turned their attention to the elusive hope of a "safe, clean, inexhaustible supply of electrical power. . ." [5]

Most experts agree that MFE research will not produce useable energy in this century. Some feel the economic life of MFE doesn't justify the investment. Others are concerned about safety issues like the release of radioactive tritium, or the disintegration of the concrete containment vessel. Fundamental safety studies are just now being done on MFE. Some scientists are also concerned over MFE's capability to convert low-grade uranium (U-238) into plutonium (Pu-239), raising the possibility that fusion research will contribute to the proliferation of nuclear materials and nuclear weapons.[6]

Vast amounts of money and talent have gone into 27 years of MFE work. To continue in this field, LLL has asked for $60 million for FY 1980 operations and equipment. And yet, there is no clear belief that useful energy will ever result. Iowa Rep. Tom Harkin, until recently on the House Scientific and Technology Committee which reviews the lab's energy work, stated on KPIX TV in March of 1978,

> Back in the late 40s and early 50s fission energy was the answer to all of our energy problems. We were going to drive cars on nuclear energy. We were going to run our homes on it, our watches, our factories. . . so we poured a lot of money into it, but we know now that it's not possible. . . . I have a feeling that most of this is being done in the fusion end. All of the energy you need. No waste products—which is not true, by the way. One of the problems we're having with fusion is that the walls become irradiated. . . so there may be as much potential waste material and problems of waste disposal with fusion as we had with fission . . . to tout it as the ultimate energy source that's going to solve all our problems is being totally unrealistic, and I think is. . . pulling the wool over the eyes of the people of this country.[7]

Fossil Fuel Research

Insitu Coal Gasification. This technology explores the possibility of converting into a burnable gas the west's deep-lying coal deposits while *in-situ* (in place underground). LLL's goal is to develop a commercial process for injecting steam and oxygen into deep thick coal seams to produce medium yeild energy products which are suitable as chemical synthesis gas which may also be upgraded to pipeline quality.[8]

The effect of this technology on underground water is not clearly or completely understood, nor have the technical, environmental, and economic predictions been verified on a large enough scale to allow commercial operations. The projected FY 1980 budget contains $4.6 million for operations and equipment.

Insitu Oil Shale. This process involves mining oil shale through underground blasting. The same environmental, economic and technical issues raised in goal gasification have not been answered for oil shale. In FY 1980, $4.8 million is projected for this program. In the LLL *Institutional Plan*, Director Roger Batzel suggests that "if the DOD and DOE were to jointly pursue a U.S. oil shale oriented back up capability for providing oil to our military, LLL could play the technical management role for this project. . ."[9]

Like most other work at LLL, both of these technologies have grown out of the weapons work. As Roger Batzel pointed out in the aforementioned Congressional hearings:

> "We've had a wealth of experience in what I would call underground engineering as a consequence of our nuclear weapons test program, which has been conducted underground over the last 15 years. We've had to establish a real geological-geochemical capability within the Lab and to develop techniques for measuring and determining what's going on in a nuclear experiment deep underground. This past experience . . .have led directly to our insitu work in the fossil energy areas."[10]

Geothermal. Geothermal energy work extracts heat from under the ground and uses it for power. According to the *Institutional Plan*, the overall objective of LLL's geothermal project is "the development and demonstration of technical solutions impeding the utilization of geothermal brines for commercial production of electric energy."[11] Problems include scale control, corrosion, erosion, solids handling, fluids production, and injection. Public concern does exist about long-term effects on the environment, noise control, and hydrogen sulfide emissions. The FY1980 budget projects a $2.6 million budget for this project with increases suggested through 1984.

LLL is also involved in a hydrothermal project with the DOE and San Diego Gas and Electric Company to develop high-temperature, high-saline brine resources for commercial use.

Solar

LLL has two solar projects in its energy technology division. One is a photovoltaic energy conversion project, which involves working to improve thin film copper-cadmium sulfide solar cell efficiency and establishing a low cost mass production technique for solar cell manufacturing. This program, funded at $304 thousand in 1978 (with nine staff) jumped to $950,000 in 1979 with 24 staff – still a very small program for the lab.

Livermore's other solar technology program is in wind energy conversion. This is a very small project (recently reduced from $241,000 to $100,000 and from seven to three staff) attempting development of general methods of regional wind energy resource assessment, collecting weather data, and analyzing wind measurements.

ENERGY STORAGE SYSTEMS

Four areas of work, with a projected FY1980 budget of $5.4 million, currently exist at LLL under the energy storage systems category.

Batteries and Electro-Chemical Storage

Researchers in this area hope to develop and evaluate a functional and relatively cheap aluminum type air power cell for automotive propulsion as well as to develope an integrated system for using such a battery.

Chemical/Thermal

The goal of this work is the development of thermochemical cycles to produce hydrogen from water. LLL has also proposed a study to examine various hydrogen storage methods.

Advanced Physical Methods

The engineering properties of materials in flywheels for energy storage for transportation are being tested for resistance to extreme velocity and stress. The research focuses on rotor design and testing as well as materials stress testing.

Applications Analysis

Applications analysis attempts to integrate data on material properties, technological characteristics, and energy modeling into an overall system to analyze various energy programs.

ENVIRONMENT AND BIOMEDICAL

Biomedical

The overall projected budget for environmental and biomedical work in FY1980 is $2.4 million. LLL researchers in these fields specialize in the investigation of mutagenic, pre-cancerous and cancerous conditions at the cellular level. In the Long Range Resource Projection (1976-1982) lab capacities in this field are described as follows:

> ". . .we have the housing and equipment for laboratory experiments on animals ranging from marine organisms to large domestic mammals. We have state-of-the-art and often unique equipment for microscopical image analysis, for flow-systems analysis of cells, for mobile, marine and stationary radiation detection, and for elemental analysis at the gross and microscopic levels." [12]

Thirty-four small projects in this catagory are currently funded. In particular, researchers concentrate on studying cells of embryos, eggs and sperms which seem to be the most sensitive to chemical toxins and radiation. Over the last few years they have designed or developed several pieces of new equipment necessary for this work. However, this is a very small program, with only 36 full-time employees in 1978, and with *no* increase in that number projected through 1983.

The *Institutional Plan* states that work on mutagens, carcinogens, and reproduction problems must increase. [13] LLL's biomedical work takes for granted that levels of toxins and carcinogens in our environment will inevitably increase, thus assuming that our future society *must* rely upon nuclear and other toxin-producing technologies.

The Environment and Safety Program

The Environmental and Safety program employs about 5% of total laboratory staffing and focuses on three main areas.

Water Studies. Researchers are concentrating on the wide variety of ways in which nuclear and non-nuclear pollutants affect aquatic systems. Specific programs include:

- A study of the water and the seabed off San Francisco's coast to determine the effects of radioactive waste disposed there 20-30 years ago.
- Research into the aquatic effects of hot brine geothermal development.
- Work focusing on the transport and biogeochemical cycling of aquatic radionuclides.

Terrestrial Studies. Terrestrial studies aim at understanding ecosystems and the effects that pollutants or technological processes have on those systems. Areas of research cover:

- An Imperial Valley study of subsidence and seismic effects in conjunction with the geothermal program.
- The establishment of test gardens in the Marshall Islands to check on the residual effects of radioactive pollutants on local food crops.

Atmospheric Studies. Researchers in this area hope to model the distribution of atmospheric pollutants and to map the global ozone distribution. This area has made good use of the excellent computer facilities at Livermore. Using the computer, the Atmospheric Release Advisory Capability has been developed to provide assessments of the impact of release of pollutants in the atmosphere. The lab could usefully expand its atmospheric modelling work. LLL has both the large,

fast computing capability and the highly trained scientists necessary for such an expansion. In general, given LLL's expertise in geophysical phenomena (from underground test work) it seems probable that the lab could do fine work on understanding not only the atmosphere but also the geosphere, both surface effects and deep structural features.

Other environmental projects undertaken by LLL include a study of the internal combustion engine by computer modelling to find ways of improving the fuel efficiency and reducing pollutants. The lab also does "integrated assessment", involving development of data bases, information systems and computer models to assess the total effects of products, pollutants, technologies and accidents.

In light of the lab's biomedical and environmental concerns, the absense of any on going research into the effects of low level radiation on human populations appears odd. The past history of LLL's studies in this area include the alleged suppression of findings by then-head of the biomedical division, Dr. John Gofman and his associate Dr. Arthur Tamplin. Their findings on cancer predictions in the northern hemisphere as a result of above ground testing of nuclear weapons far exceeded previous estimates by the Atomic Energy Commission (AEC). The AEC was unwilling to have the Gofman/Tamplin studies published and a nasty fight ensued in which LLL sided with the AEC. Since Gofman and Tamplin left LLL, no further work has been done in this area. As one employee told us, "The lab management won't touch it."

CONSERVATION AND SOLAR APPLICATIONS

Livermore has two main projects in Conservation and Solar applications. The first is solar thermal applications: the design, development, and testing of solar thermal collector systems which will provide cost competitive process heat to industrial and agricultural users. There are two specific Livermore-developed demonstration projects in this field. The first is the shallow solar pond – a low cost, large area collector to provide large quantities of low temperature hot water (130 to 140 degrees F) for industrial processing. Ironically, its present major experimental use is for uranium processing. The second demonstration project is an inflated cylindrical concentrator collector for industrial process steam in the 300-350 degree Farenheit range. The solar thermal program employs 15 staff and has a budget (FY1979) of $575,000.

Transportation represents LLL's major conservation effort. This primarily focuses on developing electric and hybrid vehicles, as well as other alternatives to petroleum consuming vehicles. Some LLL staff also work on new propulsion systems and better batteries. Total employees numbered 19 for FY1979, with a budget of $1.5 million.

Overall, the conservation and solar applications budget is projected to decrease from $2.1 million in 1979 to 1.6 million by FY1984.

THE DIVISION OF BASIC ENERGY SCIENCES

The objective of Basic Energy Sciences is the advancement of basic knowledge through research programs in selected areas. LLL currently has fifteen funded Basic Energy Sciences Research projects in areas ranging from engineering, mathematical science and statistics, geoscience, materials, chemical and nuclear sciences.

LLL also has a category called "Advanced Energy Projects," defined as high risk, high pay-off basic research projects in energy areas. One of the latest ideas in this category is a new program to assess the technical and economic feasibility of recovering uranium from seawater. [14]

The role of basic energy science research in meeting the nation's energy needs is vital. Federal government studies have called for a clearer commitment on the part of the lab to this kind of basic research. LLL's current projection indicates a DBES program growth in five years to approximately double the 1978 level.

THE COMPUTER COMPLEX

The computer complex at LLL serves all programs to varying degrees and could easily be transferred from weapons to non-weapons work. LLL's computer complex is the largest such system in the world. Currently, it is used primarily for weapons codes and modelling, much of it classified work. One model policy for meeting the energy needs of the country was worked out on the computer in 1978 and is an example of the way the system could be utilized after conversion.

In summary, there are restrictions on the type and amount of non-weapons work which currently can be done at LLL. These restrictions pertain primarily to the work's compatibility with the on-going weapons work. Lab management have directed little agressive effort toward solar and other non-nuclear energy work, despite concerns expressed in various recent governmental studies about this lack. Certain kinds of large scale energy programs with questionable safety and utility records continue to receive massive support. Our brief investigation of non-weapons work at LLL shows that such research is always developed within or held subservient to a nuclear weapons framework.

FOOTNOTES

[1] *Lawrence Livermore Laboratory Institutional Plan, FY 1978 - FY 1984,* December 18, 1978, p. 1. Unless otherwise cited, technical data in this section is taken from this document.

[2] Comptroller General of the U.S., Report to Congress, *The Multiprogram Laboratories: A National Resource for Nonnuclear Energy Research, Development and Demonstration,* May 22, 1978, p. 50.

[3] Ibid., p. 50.

[4] "The Role of the National Laboratories in Energy Research and Development," hearing before the Subcommittee on Fossil and Nuclear Energy Research, Development and Demonstration of the House Committee on Science and Technology, U.S. House of Representatives, 95th Congress, November 2-3, 1977, U.S. Government Printing Office, Washington, D.C. 1977, p. 2.

[5] "Energy Research at Lawrence Livermore Laboratory," Available from the LLL Visitor's Center, University of California, P.O. Box 808, Livermore, CA 94500.

[6] Conversation with Professor Charles Schwartz, Univeristy of California, Berkeley.

[7] Transcript of "Laser Con-Fusion," People's 5: KPIX-TV Group W, Westinghouse Broadcasting Company, 1978, p. 26-27.

[8] Op cit., *LLL Institutional Plan,* p. 45.

[9] Ibid., p. 2.

[10] Op cit., GAO *Report to Congress,* p. 35.

[11] Op cit., *Institutional Plan,* p. 51.

[12] Lawrence Livermore Laboratory *Long-Range Resource Projections, 1976-1982,* October, 1976.

[13] Op cit., *Institutional Plan,* p. 3 & p. 70.

[14] Ibid., p. 77.

ALTERNATE ENERGY RESEARCH: One Conversion Possibility

> In sum, we are relying on precisely those sources of energy–fossil fuels and uranium–which, with alarming consistency, violate the essential requirement of the ecosystem, the production system, and the economic system. Because the present energy sources are nonrenewable and technologically complex , they demand progressively more capital; because the demand for capital grows faster than energy production itself, this vital sector of the production system has lost its capability to regenerate. . . Meanwhile, we are failing to draw upon the one source of energy which is renewable; is not subject to diminishing returns; is technologically simple; is compatible with the environment; and is economically capable of counteracting the inflationary effect of conventional energy production–the sun.
>
> - Barry Commoner, *The Poverty of Power* [1]

The United States faces an energy crisis. Fossil fuels, on which we have relied for so many years, are running out, and we are increasingly reliant in the interim on foreign sources of oil. Nuclear fission, with its attendant risks and complex technology, faces an increasingly uncertain future. Fusion, touted as the safe, clean, inexhaustible energy supply of the future, is running into problems. Not only can fusion enrich uranium and thus contribute to weapons proliferation, it also creates nuclear waste products. Moreover, the production of usable energy through fusion is still decades away, and many experts believe that it may never deliver more energy than it has taken to develop it.

Various renewable energy sources based on the sun offer the hope of new sources of fuel, electricity, and transportation, although some problems remain in the effort to make them competitive with current energy sources. The United States has committed to exploration of solar and solar-related energy only a fraction of the time, money, and effort so far spent on fossil and nuclear energy. Although President Carter made a verbal commitment to increased solar research, and the Council on Environmental Quality and some within the Department of Energy called for a massive solar program, these new priorities are not reflected in the nation's energy budget. The proposed Department of Energy budget for FY 1980 calls for an increase for solar programs–but to a total level of only $650 million annually, a small fraction of the total DOE budget and only 25% of the funding level for nuclear weapons research alone.

Only a major commitment to research and development of conservation and renewable energy sources will make possible a self-sufficient, renewable US energy path for the twenty first century.

Lawrence Livermore Laboratory is the world's largest research laboratory, with the world's biggest computer complex and some of the most skilled scientific and engineering talent in the country. This lab is needed to begin research and development of alternate energy for the Department of Energy. In this section, we will detail some of the ideas we have for what research is needed in alternate energy, and the best role we see for LLL in that research. There are other avenues of research besides energy, such as medical, which Livermore might pursue but which we do not detail in this report. Ultimately, the decisions over the best mix of research for the lab can only be decided through a careful, detailed planning process, involving the Department of Energy, scientists and engineers at the lab, energy specialists at the University of California, and the citizens of Livermore and the state of California. We hope that the following ideas will get the process started.

THE BEST ROLE FOR LIVERMORE

Lawrence Livermore Laboratory, established as a nuclear weapons laboratory, has retained nuclear weapons research as its "primary mission" under the Department of Energy. What is

the best role in *alternative energy research* for a high-technology lab used to dealing with complex problems and using sophisticated machinery?

DOE insistence that the lab's alternate energy work "complement the weapons work" has restricted the nonweapons energy research undertaken by LLL.[2] Within the last year, however, two major government studies have taken direct issue with the restrictions placed on major laboratories like Livermore in helping to solve the nation's energy crisis. A General Accounting Office (GAO) report on the Multiprogram Laboratories, analyzed, at the request of Congress, the enormous scientific and technical potential of the eight DOE multiprogram laboratories in alternate energy technologies. The GAO assessment was that the laboratories have the scientific and technical resources, manpower, and plant facilities to do the requisite research—but they are not being properly utilized by the Department of Energy.[3]

The GAO study found that the labs have developed excellent multidisciplinary capabilities in their work on nuclear energy and weapons since their inception. The nonnuclear energy tasks undertaken by the labs, however, have been relatively small and fragmented, without a seriousness on either the part of the laboratories or the Department of Energy. Although an ERDA study in 1975 recommended that the multiprogram laboratories be assigned major missions in nonnuclear energy areas, such assignment of specific missions had not occurred by the time the GAO conducted its study in the spring of 1978, and various roles for the labs in nonnuclear research were not defined. This lack of definition and serious assignment of tasks have kept the labs' nonnuclear work restricted to small, isolated projects, and new program development in these areas has been constantly deferred.[4]

The President's Office of Science and Technology Policy (OSTP) completed a second important study in June, 1978. Entitled the "Report of the Office of Science and Technology Policy Working Group on Basic Research in the Department of Energy," it focused on the DOE's research capabilities as a whole. A number of its conclusions and recommendations apply quite directly to the laboratories. In general, the OSTP criticized the DOE for its lack of basic energy research and its overemphasis on development, engineering, and demonstration projects which tended to favor nuclear weapons and nuclear energy research. The report found "that the Department has placed such high priority on certain near-term programs that it has neglected longer-term fundamental work, thereby jeopardizing its mission of securing for our nation adequate supplies of energy over the long term. . . the dearth of research is especially evident in the solar and fossil-fuel programs."[5]

The OSTP agreed strongly with the GAO that the multiprogram laboratories' missions in energy work had to be redefined and clarified. Basic research got lost in the focus on applied research and advanced engineering development. As a result, whole areas of research in alternate energy were inadequately coordinated, funded, and pursued by the DOE laboratories. According to the OSTP, "innovative," or "potentially revolutionary" research is given very little support, and an emphasis on technological problems overshadows the importance of grappling with political, economic, institutional, sociological, or environmental obstacles to development of new energy technologies.[6]

The OSTP study called for more basic research in a number of alternate energy areas, including solid state physics and chemistry, optics, biomass, combustion, energy storage, transportation, small scale technologies, conservation, fluid dynamics, and electrochemistry.

William D. Metz, writing in *Science* magazine on the OSTP conclusions, clearly identifies the central message of the report: "In the rush to expand alternative energy sources, the sort of research that can be counted on to spark new directions and provide the data needed for long-term gains has been unaccountably overlooked."[7]

In general, the lab's best role is in long-term efforts utilizing its multidisciplinary nature and considerable plant space, equipment, and skilled talent. According to the GAO study, the labs need to perform a great deal of basic research in order to obtain new scientific and technical data in support of their applied research.[8]

LLL research in energy for the future can go in two possible directions. The first direction is to pursue major, long term research in advanced and sophisticated energy systems, such as magnetic and laser fusion. The second direction is a combination of long-range basic energy research, cross-disciplinary energy studies, and a creative proliferation of scientific talent tackling the thorny problems now preventing the adoption of many facets of alternative energy.

We have not done a complete critique of the fusion programs at the laboratories. But we are convinced that a great deal of time, effort, money and energy have gone into very expensive, centralized, complex experiments which have to date yielded no energy for the American people while other smaller, surer technologies have been ignored or slighted. Many questions about fusion and its effects and by-products are as yet unanswered. The glib assurances that it is completely clean are now known to be untrue. As Rep. Tom Harkin has pointed out, the walls of the container become irradiated. Fusion can potentially be used to produce plutonium. Perhaps most important, absolutely no assurance exists that fusion will actually produce more energy than is put into it! As one lab scientist said to us, "Someone will probably receive a Nobel Prize for fusion, and it will be the most expensive Nobel Prize ever bought by the American people."[9] Nor have the environmental and health hazards of fusion been fully studied. We reject this first path as being overly centralized, fraught with dangers, and promising no sure energy.

Instead, we call on the laboratory to take the second path: long range, basic, and creative research projects utilizing the best of our physicists, chemists, engineers, and technicians. Such talent could solve the following problems in alternate energy development: finding new materials for photovoltaic (solar) cells, developing new ways of making fuels from biomass, reducing the cost of extracting hydrogen from water, developing ways to use hydrogen as a fuel, and developing computer modeling for integrated alternate energy systems for cities, homes, and industries.

The Society of Professional Scientists and Engineers at Livermore has repeatedly called for a strengthening of basic and basic energy research at Livermore. In a statement to the University of California special Research Projects Committee, February 15, 1979, the SPSE Board of Directors (representing 400 scientists and engineers at the lab) decried LLL's lack of basic research, pointing out that "the capacity for innovative basic scientific research which characterized the lab some years ago is being steadily lost." [10]

Andrew McGall of the *Livermore Independent* thinks he knows the reason why: the lab's "research style is dominated by the nuclear weapons development program. It is a highly mechanistic approach which devalues independent creativity. . . Such a highly directed mechanized research system leaves very little room for creative scientific research."[11]

Just a few years ago, the labs would not consider accepting any contracts under $250,000. This inhibited creative research and individual scientific talent—both sorely needed for alternative energy research. In the most recent LLL Institutional Plan, Director Roger Batzel stated why the lab would not pursue large numbers of small projects:

> We have also concluded that we should not dilute attention and strain management by taking on a large number of small programs, but rather should continue to concentrate on a small number of reasonably large programs which have the potential to produce important national benefits and which exhibit an appreciable degree of mutual synergism.[12]

ALTERNATE ENERGY RESEARCH NEEDS

We believe the following list of alternate energy research is sorely needed in this country. Lawrence Livermore Laboratory could profitably concentrate on:

1. *Solar research*, including photovoltaic cells, concentrating collectors, thermal electric systems, and industrial process heat.
2. *Wind energy systems.*
3. *Resource Recovery/biomass.*
4. *Fuel cells.*
5. *Transportation and energy.*
6. *Energy storage and transfer.*
7. *Basic energy research and long-range energy projections.*

1. Solar Research

The amount of solar energy falling on the earth's surface in a fortnight is equivalent to the world's initial supply of fossil fuel. [13]

In this preliminary analysis of renewable energy technologies (with an emphasis on solar), we focused on those that could be researched using the skills, talent, and equipment of Livermore.

Most of the work needed to commercialize solar space heating and cooling and solar domestic water heating is in education of the public as to its practicality, and reduction of cost. Research needs are few, since a well-developed and generally cost-competitive technology already exists.

Other solar technologies, however, need further research and development to overcome technical problems and to make them less expensive. These include photovoltaic cells, concentrating collectors, solar thermal electric systems (solar power boilers), and industrial process heat. These four technologies could be used together in factories and communities. Development of such integrated systems could be quite challenging. Ultimately, for our society to become solarized, we will require advances in solar equipment for two critical areas of an advanced industrial society: electricity and industrial process heat. Without these two, solar will remain an important but limited energy source for home hot water and space heat.

Solar electricity. Solar energy can be converted into electricity in several ways: (1) by direct conversion via solar (photovoltaic) cells, in which certain specially constructed semi-conductor materials, similar to the silicon chips produced by the electronics industry, when exposed to sunlight develop an electrical voltage potential. This potential can be tapped just like the voltage of a flashlight battery. Photovoltaic cells (pvs) are the simplest and cleanest operating devices known to produce electricity. They have no moving parts and are consequently quiet, pollution free, extremely reliable , and easy to operate; (2) indirect conversion by generating steam through a series of focusing mirrors or lenses on water, then used in a conventional turbine-generator; (3) thermionic generation–electrons are released when certain materials are heated; (4) thermo-electric generation–electric current is produced when two dissimilar materials are in contact and heated; (5) magnetohydrodynamic (MHD) generation in which hot gases containing ionized particles rush through a nozzle containing a current in an exterior electric coil, releasing electrons. [14]

Both photovoltaic cells (1) and solar boilers (2) are working today, at various stages of development. Although currently too expensive to compete with conventional sources of electricity, pv's are now used in satellites and other remote locations. Price reductions and efficiency increases are needed for broad commercial applications in this century, necessitating major techno-

logical advancement. Three general approaches are being pursued to achieve price reductions: (1) material cost reductions; (2) more efficient materials; and (3) development of concentrator systems to focus more sunlight on each cell.[15]

The American Physical Society recently commissioned a special study on "Solar Photovoltaic Energy Conversion" which assessed the federal DOE program for research, development, and demonstration of pv's, and concluded that major specific scientific and/or technological advances were needed to develop pv's into an economically competitive and significant power source. But the society found that DOE pv research to be incorrectly focused on demonstration projects rather than on research and development, and called for significant changes in the program:

> The development of an economically competitive pv technology is inhibited by the absence of an adequate scientific and technological knowledge base. In principle, solar flux is convertible into a variety of useful forms of energy, including fuels, by the pv and photoelectrochemical (PEC) effects . . .
>
> The need for a balanced and adequately funded research program, emphasizing the search, synthesis and characterization of all kinds of pv materials is clear. . .
>
> A long-term and innovative R & D program is needed, which must include:
>
> (a) the search for and development of new photosensitive materials;
>
> (b) basic research on the interfacial phenomena that control photovoltaic conversion;
>
> (c) investigation of non-biological methods for direct production of fuels from sunlight; and
>
> (d) development of novel photovoltaic technologies and devices . . . to aid in identifying the critical materials problems limiting performance.[16]

The President's Office of Science and Technology Policy's special report detailing the shortcomings of basic research in the Department of Energy had several recommendations concerning pv research, including basic research in solid state physics and chemistry, applications of advanced semiconductor fabrication techniques, and basic work on optics for focusing concentrator collectors.

Solar boilers. This technology, in which the sun's heat is reflected and focused by mirrors to boil water which drives a steam turbine, is being considered for use in desert areas since large open space is required for the solar mirrors (heliostats) and boilers. Pilot plants now function in Barstow, California and in France. The success of these systems depends in part on the efficiency of concentrator collectors and mirrors, and in part on the efficiency of heat transfer. Besides the Barstow test equipment, many other configurations and designs could be investigated including smaller systems for use in communities with the waste heat utilized by factories or homes.[17]

Industrial process heat. Industrial process heat represents another critical area for solar development. Heat is required in industrial processes at low temperatures (under 120 degrees F), medium temperatures (120 to 400 degrees F) or high temperatures (over 400 degrees F.) Industrial, commercial, and agricultural sectors need steam, hot water and hot air for everything from paper manufacturing to food drying. Higher temperatures require complex concentrating collectors, and industrial solar heat is currently more expensive than conventional energy sources. Lower costs, the discovery of new methods and materials, and the integration of complete systems demands more research. High and medium temperature storage systems and ways to move high temperature heat, such as heat pipes, remain to be developed.

Energy Secretary James Schlesinger recently highlighted the need for an industrial process heat program, "Where solar technology can be most effectively applied is for low- and medium-grade heat requirements. We should put a great deal of emphasis behind an industrial process heat program. There is substantial potential demand, a substantial market, and by golly, it's nearly here, or should be nearly here." [18]

2. Wind Energy Systems

Wind, an indirect form of solar energy, results from the uneven heating of the earth's surface by the sun. Modern 2- or 3-bladed wind generators are sophisticated machines designed to convert the

maximum amount of wind energy to electricity. A number of models are on the market, both large and small, but they are not yet in widespread use.

The California Energy Commission sees wind energy as a major factor in the future of California's electricity production. Both the state and the federal government are increasing the amounts of money invested in research, development, and testing to spur commercialization of wind electric systems, but many people feel it is still inadequate.[19]

Marv Gustafson, associate director at Livermore, recently worked as a consultant for the Mitre corporation and extensively studied the potential of wind energy. He conservatively estimates that 75% of the current U.S. total energy consumption rate could be met with wind energy. This source could produce more energy by a factor of 20 than is currently consumed in the entire world. Gustafson points out that wind concentrates in sites where capture is readily effected. In a recent article in *Science*, he concludes that "should the large-scale capture of wind energy prove economically rewarding and otherwise acceptable, this tabulation makes it clear that wind energy has a magnificent potential."[20]

A number of problems exist, however, currently unexplored by LLL. One problem is safety. Aerofoils can go supersonic under gale force winds and wrench free from their axles. Fail proof automatic braking systems or feathering systems still remain to be developed. The main problem is not in blade design but in conversion of mechanical to electrical energy. Great inefficiency exists due to friction in rotating machinery and conversion to electricity . Most systems rely on expensive alternators to produce power. Another problem is the variability of wind and therefore the variability of electricity generation. More research is needed into energy storage devices, such as batteries, flywheels, compressed air, and pumped water (see below).

The Lucas Aerospace Combine Shop Stewards Committee in Britain, in their comprehensive alternative energy plan, have identified 3 major areas needing research in wind energy systems, all of which could be explored by LLL: "(1) windblade choice and design–comparison of sail/aerofoil propeller types in terms of safety, efficiency, and cost. Comparison of vertical axis machines. (2) Improvement of dynamos/alternators and associated electrical gear; (3) mechanical and aerodynamic brakes, gearing systems, transmission units, clutches and systems for matching prop and dynamo torques."[21]

3. Resource Recovery/Biomass

Resource recovery is the process of retrieving valuable materials (or recycling) from our solid waste, and the conversion of the organic materials remaining to usable energy. *Biomass* refers to the conversion of organic matter, whether waste (agricultural, livestock and timber) or specially grown fiber, into usable energy. In addition to the opportunity for development of a renewable energy source, resource recovery offers the added benefit of cleaning up the environment and getting rid of garbage.

Researchers have developed many different methods of biomass conversion. These include pyrolysis (chemical decomposition in the absence of oxygen) for agricultural or municipal solid waste (MSW), which creates an oil/charcoal mix, anaerobic digestor creating methane gas, fermentation, which produces methyl or ethyl alcohol, and incineration, producing steam and process heat. Energy efficiency ratios range from the Union Carbide Purox pyrolysis process rating of .748 (most efficient) to the anaerobic digestor (.375).[22]

Were a vigorous effort made to develop a biomass-based synthetic fuels industry in California, the total energy potential could be very high. Biomass methane generation and gasohol produc-

tion (alcohol mixed with gasoline) are part of the answer to the fuel crisis for transportation. Cars and other transportation vehicles can be retrofitted to run on methane and adjusted to burn gasohol. Transportation fuels now represent 35% of total energy demand, an enormous factor which only biomass or other synthetic fuel generation can begin to meet.

Already on a small scale, methane is being recovered from sanitary land fills. P,G & E, the Environmental Protection Agency, and the city of Mountain View, California initiated a joint methane recovery project in 1977, with hoped-for production in 1979. Most of the resource recovery systems, like pyrolysis for MSW waste, are still enormously expensive, and need research to develop new techniques to bring the costs down to an affordable level for cities, towns, and communities. [23]

4. Fuel Cells

A fuel cell is a device similar to a battery in which a combined fuel and an oxidant cause a chemical reaction which generates an electric current. Fuel cells often use hydrogen and oxygen as the fuel and oxidant, but other gases and mixtures can also be used. Fuel cells require pure fuels (like hydrogen); otherwise impurities build up and ruin the cell. Although still expensive and generally less efficient than batteries, fuel cells are silent, efficient at low temperatures and clean. Hydrogen, otherwise a superb source of fuel, is expensive in its pure form and highly inflammable.

Sunlight can be used to electrolyze water into hydrogen and oxygen, which are then recombined in a fuel cell, generating electricity and releasing reusable water vapor. This technology represents but one system for the future. Much more research must be done, both on various fuel cell designs and on the hydrogen fuel cycle. Livermore has the scientific talent and resources to tackle precisely this kind of extensive, cross-disciplinary research. [24]

5. Transportation and energy

Transportation is a key energy area. 35% of our current energy needs are for ground transportation. In the near term, we need to develop more efficient and environmentally sound engines which drastically cut fuel consumption. In the long term, we must find synthetic and renewable fuels for transportation. Methanol, which can be made both from natural fibers and from biomass digestion, is a natural candidate. Its major problem remains cost.

An alternative to the liquid fuels is the increasing use of battery powered and electric vehicles, or hybrid vehicles using small gasoline or diesel engines running at a steady rate, fueling a generator driving an electric engine. The key areas needing research in electric or hybrid vehicles include: increased efficiency, decreased weight, increased range, lower costs. The major problem remains the need for a better battery and better energy storage and transfer (see below).

Future transportation possibilities also include hydrogen engines and steam power.

Livermore is working on several small projects on transportation, including a combustion program, using computer modeling studies of the hydrodynamic and kinetic processes of combustion; flywheel development (see below), and three system studies on alternate fuels planning, regenerative braking (taking energy normally wasted in the heat of braking and putting it back into storage), and a systematic and comprehensive evaluation of storage systems for electric and hybrid vehicles. [25]

6. Energy storage and transfer

A major factor in generating supplies of energy is energy storage, conversion, and transfer. A great deal of energy is lost due to waste, and other energy is simply unavailable where needed because of inadequate transfer or storage. Heat, mechanical, kinetic, electrical and water storage, and the properties of various materials for storage need to be carefully researched. Other areas for research and development in storage include improved conventional batteries, fuel cells, small and large scale hydrogen producing techniqes, long range electricity transfer, prevention of high temperature heat loss through use of heat pipes and superconducting materials. Transportation vehicles and high temperature industrial solar heat require effective storage systems.

Livermore is working on flywheel development for energy storage for vehicles. Developed from weapons technology fiber-composite materials of exceptional strength, its flywheel "may be able to increase the performance and double the range of electric vehicles." [26]

7. Basic energy research and long range energy projections

The energy crisis demands the talents of all major scientific disciplines. Both the GAO and OSTP studies have pointed out the critical need for major amounts of basic energy research to undergird specific projects. The kind of research needed includes work on the properties of metals and gases under heat, states of matter at high density, physics, chemistry, heating and cooling, and heat transfer and storage.

Another area of particular need in the United States is long range energy planning: the accurate prediction of the mix of various factors in the energy field, and the geographic distribution mechanisms necessary for the entire system to function. Livermore's computers are set up for just such work on integrated systems. Instead of being used for weapons simulation and modeling, they should be put to work on the energy problem, developing energy systems and integrated distribution models.[27]

It should be apparent from the above that there is a clear and vital role for LLL to play in this country's effort to rise and meet the enormous challenge of finding safe energy paths which insure a secure future for all of us.

FOOTNOTES

[1] Barry Commoner, *The Poverty of Power,* New York, Bantam, 1977, pp. 203

[2] See Comptroller General of the U.S., *The Multiprogram Laboratories: A National Resource for Nonnuclear Energy Research, Development, and Demonstration,* (U.S. General Accounting Office) May 22, 1978, pp. 50

[3] Ibid., pp. vi

[4] Ibid., pp. vi

[5] *Report of the Office of Science and Technology Policy Working Group on Basic Research in the Department of Energy,* June, 1978, pp. 3-4

[6] Ibid., pp. 3-4

[7] William D. Metz, "OSTP Faults Energy Research Quality: Fossil and Solar Found Wanting," *Science,* October 20, 1978

[8] Comptroller General of the U.S., *Multiprogram,* pp. 67

[9] Private discussion with lab scientist, February 21, 1979

[10] "Statement of the Board of the Society of Professional Scientists and Engineers Livermore Laboratory to the Regents of California Special Research Projects Committee," February 15, 1979

[11] Andrew McGall, "LLL's Problems," *Livermore Independent,* March 16, 1979

[12] Lawrence Livermore Laboratory, *Institutional Plan, FY1978-FY1984,* December 18, 1978, pp. 1

[13] Lucas Aerospace Combine Shop Stewards Committee, "Alternative Energy Technologies," in Alternate Corporate Plan, London, 1976, pp. 54

[14] Ibid., pp. 63

[15] Robert DeGrasse, et. al., *Creating Solar Jobs: Options for Military Workers and Communities,* Mountain View, CA: Mid-Peninsula Conversion Project, 1978, pp. 19-20

[16] American Physical Society study group on Solar Photovoltaic and Energy Conversion, *Congressional Record,* March 15, 1979, pp. E 1141-1142

[17] See "A Helioelectric Farm" and other unpublished materials from Otto J. Smith, Professor of Electrical and Computer Engineering, University of California, Berkeley, CA 94720

[18] "We Are Working on a New Solar Strategy," Interview with Energy Secretary James Schlesinger, *Business Week,* October 9, 1978, pp. 91

[19] See William Metz, "Wind Energy: Large and Small Systems Competing," in *Science,* September 2, 1977, pp. 972; California Energy Commission, "Wind Energy for California: A Proposal for the Energy Development Authority," draft report, March, 1978; *Federal Wind Energy Program,* U.S. Department of Energy, Division of Solar Technology, DOE/ET 0023/1; and G. Miller, "Systems Descriptions and Engineering Costs for Solar-Related Technologies," Vol. VI, *Wind Energy Conversion Systems.* The Mitre Corporation, Metrek Division, for the Energy Research and Development Administration, 1977

[20] Marv Gustafson, "Limits to Wind Power Utilization," *Science,* April 6, 1979, pp. 17

[21] Lucas, "Alternate Energy Technologies," pp. 62

[22] Scientists Institute for Public Information, *Resource Recovery: Energy and Economic Impacts in California,* draft report, February, 1979, Chap. 7, pp. 15

[23] Ibid., pp. 15

[24] See Lucas, "Alternate Energy Technologies," pp. 95-102 and *Business Plan,* Solar Hydrogen Development Company, Los Angeles, CA, 1978

[25]See Lawrence Livermore Laboratory, *Institutional Plan, 1978-1984,* December 18, 1978, and LLL *Energy and Technology Review,* March, 1977

[26]*Energy and Technology Review,* March, 1977, pp. 7

[27]Ibid., pp. 7

THE IMPACT OF CONVERSION ON LLL

One of the purposes of the "Draft Environmental Impact Statement" for the Livermore site, released by the Department of Energy for public comment on September 25, 1978, is to consider various "alternatives" to the continued operation of LLL and Sandia Laboratory at Livermore. The DOE, in its examination of alternatives, briefly considered four possibilities: 1) plant shutdown and site decommissioning; 2) total or partial plant relocation; 3) scaling down those operations having the greatest potential for adverse environmental impact; and 4) use of alternate technologies having reduced environmental impact."[1]

It is appalling that the fourth possibility, the use of alternate technologies, is dismissed by the DOE draft with the following statement:

> "Since DOE's operations at Livermore are of a research nature and are subject to change with programmatic requirements, there is usually little opportunity to choose between technologies. Often it is because a technology has been developed that an operation can be undertaken at all. Each new operation is reviewed for possible adverse environmental impacts, and procedures are incorporated to minimize any such possible effects.
>
> LLL and SLL have been quick to shift to alternate equipment or methods when technological or environmental advantages appeared. In fact, these two laboratories have been innovative in devising better techniques and in finding improved technologies."[2]

In fact, in this report of over three hundred pages, the DOE does not outline in any detail alternatives for Livermore Laboratory. The DOE and LLL management clearly do not consider major change, conversion, or transfer of research to alternatives an option.

LLL consistently puts the best face possible on its energy work, and yet refuses to consider any direct challenge to weapons predominance in its research. On the one hand, Roger Batzel states in a 1977 LLL promotional piece, "We are an applied science research facility with powerful resources for solving large scale national problems. As the view in Washington of those problems changes, so do our programs and responsibilities."[3] Yet, on August 10, 1977, LLL's Associate Director, Richard Wagner, told his fellow Gerberding Committee members that conversion of LLL away from weapons work to anything else was "impossible." The following quote from the 1978 LLL Institutional Plan, however, illustrates Batzel's claim:

> "Today LLL is a strong, multidisciplinary, goal-oriented, applied science and engineering laboratory with a staff of about 6,900, of whom about 2,400 are scientists and engineers . . . a support staff makes the human resources, the computing capability, the longer range supporting research and the physical plant available and deployable in a flexible way which is responsible to the changing needs and relative priorities of the programs . . . The synergism between weapons, energy and environmental programs is an asset to each. The Laboratory encourages employees to transfer among the Laboratory's research programs so that all projects can benefit through the application of multiple, technical, and diverse personnel skills."[4]

It would appear from these and other statements in the Institutional Plan that LLL is open to and capable of doing any number of different kinds of energy work on a national level.

As of October, 1978 LLL employed 6,900 people. Of these 6,900, 2,400 work as scientists and engineers and 3,000 are technicians and craftsmen; the remaining 1,500 function as administrative

and support personnel. As the Lawrence Livermore Laboratory's Institution Plan states, "Together, these groups represent broad expertise across nearly the whole spectrum of research." [5]

The Government Accounting Office report, *Multiprogram Laboratories*, gives a breakdown of staffing by professional category as of March 31, 1977 (total employees 6,512) as follows:

Engineering	850	13.0%
Physical and chemical science	997	15.3%
Math and computer science	282	4.4%
Life and environmental science	82	1.3%
Social science	23	0.3%
Other professionals and support	4,278	65.7% [6] *

If LLL made a significant shift in research from weapons and nuclear to non-nuclear alternative energy, how would it affect the staff at the lab? What kind of orientation, retraining, or refocusing would have to take place? We were unable, with the limited information and resources made available to us, to do a thorough job skill analysis at Livermore. A careful survey of the above figures, together with knowledge gleaned from past studies of job skill transfer and conversion, however, paints a very hopeful picture. The bulk of the employees at the labs are technicians, craftsmen, and support personnel, rather than highly trained and highly specialized engineers, scientists, or administrators. The technicians and craftsmen often shift from one program to another within the lab depending on the need and the contracts. They require training only in their new research support function in the laboratory and in any new computer equipment. The LLL Institutional Plan contains a chart entitled, "Interprogramatic Technical Expertise," showing that seven out of nine areas of technical expertise within the Defense programs area are transferable to other non-defense programs. Explosive technology and non-destructive testing are applicable only to weapons. Systems analysis, instrumentation and measurement, mechanical fabrication, materials research and fabrication, computation and simulation have especially broad application in non-nuclear research areas. [7] The clerical and support staff at the lab can be readily transferred from nuclear and weapons-related work to alternate energy support since their skills are not specific to the weapons work. A few highly trained clerical personnel and unusual support jobs might require some minimal retraining.

The management and administrative personnel at the lab, especially those in the weapons-related divisions (and the top level lab directors and associate directors) will have to be reoriented to non-weapons work, and to the concept of pursuing greater numbers of smaller contracts, both with the Department of Energy and with other government agencies.

This leaves 2,400 highly trained scientists and engineers, all specialists in their fields, who will need to make a shift in the event of the conversion of LLL to alternate energy work. The GAO chart (above) shows that about 400 of these are trained in math, computer science, environmental science, and social science – all areas which will be in greater demand under our plan for LLL than under the current situation. The 1,000 physicists and chemists and nearly 1,000 engineers may present the greatest transfer problem. Obviously, if nuclear work is phased out at Livermore, we will need fewer nuclear physicists or nuclear engineers. Conversion may necessitate some broadening of focus or shifting of research specializations. Chemists and physicists, however, will be needed. Of course, were a decision made to phase out nuclear weapons, fission and power research, the U.S. will require nuclear physicists and engineers to cope with the enormous problems of nuclear waste disposal over coming years.

Transferring engineers. Scientists, military and nuclear engineers have the most difficult time transferring their skills to civilian research. This is partly due to their extremely specialized design

*For a more detailed job breakdown, see chart on pp. 35

work, especially for nuclear weapons and weapons systems. Secondly, nuclear weapons research requires larger numbers of engineers, with a greater ratio to scientific and technical/support talent than in civilian research. The Stanford Research Institute completed a detailed study of the transferability and conversion of defense engineers for the Arms Control and Disarmament Agency in 1967. This study found no insuperable barriers to transferring and reorienting individual engineers. Major problems do arise, however, when groups of engineers or whole sections of companies or institutions attempt to make the transition to commercial work. Defense engineers are best suited to research and development, systems design and analysis work, and team approaches to major problems. [8]

Plant space and equipment. We have not been able to do an analysis of alternate uses of the plant space and equipment at LLL. This may, however, be a major problem. Many of the weapons and nuclear programs at LLL utilize specific equipment (witness the Shiva laser) basically not suited for other work. The Livermore computer complex, immediately useable for energy systems modeling and other work, and the general office and research labs, represent two obvious exceptions. The DEIS on the Livermore site points to the physical plant problem: "Finding alternate utilization for the physical plant facilities would pose a problem. With the exception of the office type structures, most of the DOE buildings have special design features unique to a given program requirement. For the most part, these buildings would require major modification for nonnuclear application." [9] With the proper planning and funding, however, such modifications appear possible in many buildings. Moreover, the lab is always in the process of constructing new facilities and has ample unused, or open space for additional buildings or experiments requiring open space.

The difficulty in converting the buildings and equipment at Livermore should not be seen as insuperable, however, nor should it deter us from what is basically important in the alternate use planning process – the conversion of *people* and *research*. A careful study of job skills, equipment and plant space can only be done by a conversion planning committee at the community level, with full access to information and the cooperation of the Laboratory and the Department of Energy.

Standing in the Way of Conversion

> The basis of advanced technology is innovation and nothing is more stifling to innovation than seeing one's product not used or ruled out of consideration on flimsy premises involving public or world opinion.
>
> - Harold Agnew, former Director of LASL, March 27, 1967[10]

A Livermore employee recently told UCNWLCP that he believed that the major security issue for this country now and in the next decade was energy. He went on to say that he believed that LLL should be focusing its efforts on energy research and development, but that for a number of reasons it would be very hard for LLL to make that change.

This is not an isolated point of view. We have talked with various scientists and engineers at the lab, and have seen how both the Government Accounting Office and the President's Office of Science and Technology Policy have called for a greater commitment of the lab to basic energy research. Many lab employees believe LLL's weapons-oriented management opposes further diversification of the lab. An even greater sense of opposition exists to an enlarged role for scientists and other employees at the lab, or the greater community in helping shape Livermore research directions. Management opposition to employee attempts to get collective bargaining rights at LLL represents a good example of this resistance. Lab management has gone so far as to write letters to some mem-

bers of Congress opposing collective bargaining rights for LLL employees, a practice of questionable legality. Strong pressure from Congress and the state legislature, however, forced management to accept the principle of collective bargaining for employees.

Funding for alternate energy research should be sought as aggressively as the lab managers have sought funding for contracts in weaponry. The arbitrary limits now placed on non-weapons research should be lifted, so that all these areas can be actively and fully explored. The lab has recruited a work force uniquely combining a variety of disciplines and skills, and housed them in superbly equipped surroundings. Many members of this work force are willing and anxious to turn from weaponry to more constructive and satisfying research alternatives.

This willingness, and the potential availability of funding for such work, were described to the University of California's Gerberding Committee at a public hearing in Livermore by Terry Rossow an LLL engineer and then President of the Livermore chapter of the Society of Professional Scientists and Engineers (SPSE). Rossow stated unequivocally that funding for substantially more energy research at the lab did in fact exist, but that it was rejected by the Department of Energy and lab managers, due to the arbitrary ceilings and criteria placed on such work. [11]

We do not believe that conversion of Lawrence Livermore Laboratory is technically difficult. It appears clear, however, that it is politically difficult. Nevertheless, we believe that the involvement of all of us, lab employees and concerned community citizens, in calling for Livermore to play a leading role in alternative energy research, can provide a vision for the future. A part of that vision was summarized by the Government Accounting Office in its report on the Multiprogram Labs:

> . . . a holistic approach to energy R D & D is needed so that all ramifications of energy technologies are adequately considered and well understood prior to making major commitments to their development. [12]

FOOTNOTES

[1] "Draft Environmental Impact Statement: Livermore Site," Livermore, California, September, 1978, U.S. Department of Energy, Section 5, p. 1.

[2] Ibid., Section 5, p. 4.

[3] *Energy and Technology Review,* LLL, July, 1978, p. 5.

[4] *Lawrence Livermore Laboratory Institutional Plan,* FY 1978 - FY 1984, Dec. 18, 1978, p. 5.

[5] Ibid., p. 5.

[6] Comptroller General of the United States, Report to the Congress: *The Multiprogram Laboratories: A National Resource for Nonnuclear Energy Research, Development, and Demonstration,* May 22, 1978, Government Printing Office, p. 13.

[7] Op cit., *Institutional Plan,* p. 120.

[8] Carl Rittenhouse, *The Transferability and Retraining of Defense Engineers,* Stanford Research Institute, November, 1967, p. 16.

[9] Op cit., "Draft Environmental Impact Statement," Section 5, p. 2.

[10] *Aviation Week and Space Technology,* March 27, 1977, p. 11.

[11] "The University of California's Operation of the Lawrence Livermore and Los Alamos Scientific Laboratories," An Analysis and Proposals by the UC Nuclear Weapons Labs Conversion Project – February 13, 1978, p. 12.

[12] Op cit., *The Multiprogram Laboratories,* "Digest," p. v.

Jobs at Livermore

GRAND TOTAL	**7043**	**100%**
SCIENTISTS*	**1187**	**16.9%**
Physicists	774	
Chemist	296	
Metallurgist	35	
Biologist	45	
Biochemist	14	
Biophysicist	14	
Physiologist	4	
Physician (M.D.)	5	
SCIENTIFIC SUPPORT	**192**	**2.7%**
Technical/scientific coordinator	164	
Photographic specialist	25	
Medical lab technologist	3	
ENGINEER	**944**	**13.4%**
TECHNICIANS, CRAFTS	**1831**	**26.0%**
Technician	853	
Technical Associate **	217	
Electronic Fabrication Tech.	48	
Engineering assistant	83	
Design Associate **	111	
Draftsman	168	
Technician/draftsman trainee	31	
Machinist	157	
Assembly machinist	17	
Machine Repairer	26	
Metal Fabricator	20	
Material Handler	78	
Property Control specialist	5	
Mechanical Inspector	13	
Sub-Foreman	4	
MATH AND COMPUTER SCIENCE	**460**	**6.5%**
Mathematician	36	
Computer Science	275	
Digital Computer Operator	89	
Programming Technician	60	
PHYSICAL PLANT	**854**	**12.1%**
Facilities Worker	623	
Facilities Worker Trainee	8	
Protective Services Officer	187	
Assistant Chief of Police	2	
Fire fighter	30	
Fire chief	4	
MANAGEMENT/SUPERVISORS	**616**	**8.7%**
Management	52	
Supervisor	134	
Superintendent	9	
Division/Department Adminis.	124	
Division/Department Specialist	237	
Facility supervisor	32	
Material supervisor	10	
Office Supervisor	18	
OFFICE WORKERS	**882**	**12.5%**
Technical editor/writer	46	
Technical information spec.	16	
Classification advisor	7	
Patent advisor	5	
Technical illustrator	27	
Communications attendant	26	
Office assistant	298	
Secretary	353	
Compositor	5	
Cryptographic operator	3	
Keypunch operator	21	
Mail carrier	14	
Library assistant	25	
Printer	10	
Print Room Operator	26	
OTHER	**27**	**0.4%**
Occupational Health Nurse	7	
On-the-job trainee	3	
General Helper	17	
UNKNOWN	**50**	**0.7%**

*** Two additional scientist job categories were added January 10, 1979: biomedical scientist and environmental scientist.**

**** The job categories Technical Associate and Design Associate are for people who are working at the level of a scientist or engineer but who lack a baccalaureate college degree.**

Compiled by Randy Schutt for the Plowshare Press from "General Provisions, Classification Titles, Codes, Ranges and Job Descriptions,", Appendix A, Contract 48, Lawrence Livermore Laboratory; and "LLL Employees by Job Classification and Name," Lawrence Livermore Laboratory

IMPLEMENTING CONVERSION AT LLL

We have outlined in the previous sections a case for conversion of Lawrence Livermore Laboratory from nuclear weapons and fusion research to alternate and basic energy research. As we have shown, the potential is there and the need is great. Much work remains to be done; we have only been able to scratch the surface in terms of concrete detail.

Alternate use planning requires two major components. First, available options must be developed that a) employ the LLL workforce, b) utilize the plant and equipment, and c) benefit the Livermore community. Second, we must ensure that the plans drawn up will be carried out. That is, a commitment must exist on the part of the Department of Energy, the University of California, and the state of California to adequately fund alternate research. Lacking that commitment the most technically complete plans in the world can go nowhere.

ALTERNATE USE PLANNING

Alternate use planning insures advance preparation of other uses for any workforce, plant space, and equipment at a weapons facility which may face a change of focus due to a redefinition of national priorities, such as an arms reduction or test ban treaty, a closure of a facility, or a contract cancellation. The shifting nature of DoD and DOE needs, from one weapon system to another and from one force level or emphasis to another, makes such planning necessary whether or not the military or energy budgets are cut. Changes in demand in geographic or skill areas will occur regardless of the overall level of nuclear weapons funding.

The focus of alternate use planning should be to create jobs for affected workers in their own communities, utilizing their skills,and producing goods or accomplishing research needed by the society at large. The most comprehensive program of government relocation, retraining, and assistance cannot replace the need to create specific jobs for displaced workers in their own communities.

Effective alternate use planning in a community like Livermore requires the interaction of groups of people whose interests are most directly affected: lab scientists, engineers, and technical and support staff; Livermore community residents and community groups; planners and economists from city and county government; representatives of the Department of Energy and the University of California; and relevant trade unions or professional associations. The job of such a grouping includes the following tasks: (1) providing advance warning of national decisions which could affect Livermore (like a CTB); (2) identifying possible events that could affect the continued operations at the lab (health and safety, environmental, funding levels); (3) development of detailed contingency plans for jobs for the workforce and the economic health of the community.

Contingency planning would need to assess Livermore Laboratory, its workforce and capabilities far beyond our sketchy outline. Such assessment should include: (1) an analysis of the existing contracts LLL has with the DOE, DOD, and any other government agencies; (2) an analysis of the workforce at Livermore: numbers , job skills, and transfer potential to other work; (3) analysis of the plant space and equipment and its possbility for other uses; (4) investigation of alternate research possibilities, markets (contracts), both from the DOE and other government agencies, and the possibilities of private funding; (5) investigation of federal or state legislation or existing agencies which can assist in both planning and funding.

Existing Models of Alternate Use Planning

Lucas Aerospace Combine Shop Stewards Committee. Over a period of two years, substantial numbers of workers at all skill levels at Lucas Aerospace, Britain's largest defense firm, have been involved

in detailed planning for alternate uses of their skills and equipment. The Lucas Aerospace Combine Shop Stewards Committee drew up a detailed plan for converting jobs from military to socially useful production at the 17 Lucas plants, with a combined workforce of 12,000. The Combine Committee, a cross-union committee representing workers in 13 unions, began an intensive process in 1975 to develop an alternative to the Lucas management's "corporate plan" for the future of Lucas. A corporate planning committee was set up at each of the 17 Lucas sites to make a detailed analysis of the design, development, and production capabilities and activities of the plant. A questionnaire was sent to all 12,000 workers, asking them to analyze their own skills and their machinery as well as to propose alternative products. Mass meetings and smaller committees were held for discussion. As a result, a vast amount of information was collected and analyzed in a year. The complete plan, announced in January 1976 and updated since that time, contains detailed proposals for 150 new products and a number of proposals for completely reorganizing Lucas production. [1]

Among the 150 alternative products in the Combine Committee corporate plan are a number of products already produced in small volume by Lucas, as well as some totally new products. These products include such diverse devices as retarders or secondary braking sysems for buses and other heavy vehicles, combination electric-diesel engines, solar heating components, fuel cells, medical devices such as kidney machines and pacemakers, and industrial ball screws. In each case the proposal is carefully outlined, showing how the present work force and machinery at Lucas can be used to produce the product. The section of alternate energy is particularly intriguing, outlining six major areas in 200 pages. [2]

The Shop Stewards Combine Committee has been working over the last two years to persuade both the British government and Lucas management to accept the plan. Only recently, one of the Lucas unions, the Confederation of Shipbuilding and Engineering Unions (CSEU) has endorsed the plan, and has begun to negotiate parts of it with Lucas and the government. Initial negotiations managed to halt certain layoffs and to consider a number of alternative products to be manufactured in Liverpool, an area of high unemployment. [3]

In addition, several local Shop Stewards Committees have managed to get a couple of products into production on a small scale. At Burnley, for example, the Shop Stewards Committee negotiated with the local plant manager for a small scale production of heat pumps. [4]

The significance of the Shop Stewards Combine effort clearly reaches beyond the ultimate success or failure at Lucas. In concrete terms, it points out the possibility of major workforce involvement in the assessment of their own job skills and the development of alternative conversion plans.

Rocky Flats. In Colorado, the Rocky Flats Monitoring Committee, established by Governor Richard Lamm, has begun tentative investigation of alternate use planning for the Rocky Flats nuclear plant, which manufactures plutonium triggers for the Department of Energy's nuclear weapons program. As a part of that process, the Social and Economic Analysis Corporation (SEAC) has completed a draft report for the Monitoring Committee, "An Assessment of Issues Concerning the Future of Rocky Flats," which calls for the development of contingency plans to protect job security of the workers and the local economy should Rocky Flats be closed or its mission changed. [5] If such a plan for "conversion contingency planning" is adopted, it could provide plant workers, management, and community groups a way to get involved, and to have access to important information necessary to future decisions about Rocky Flats. The issues around converion planning for Rocky Flats are unique in comparison to other existing conversion plans because of the plant's nuclear character and its existence as a government-owned, contractor-operated facility. To date, there have been no studies of the conversion potential of a nuclear plant to non-nuclear uses. The only study of conversion of a nuclear weapons plant, A.P. Christodoulou's feasibility study of Hanford, Washington, stuck to new applications in the nuclear arena. [6]

National Mechanisms for Conversion Assistance

Two agencies of the federal government are available to help, at least minimally, with conversion planning. The *Office of Economic Adjustment (OEA)* is a small office in the Department of Defense established in the early 1960s to help communities adjust economically following the closures of military bases or facilities. In the 15 years since that time, the OEA has assisted nearly 300 communities in creating nearly twice as many jobs as were lost from the base closings. However, the OEA until recently has had no authority to begin planning in advance; it could act only after the layoffs or closure had been announced. This meant that many workers lost their jobs, while others took their places months or years later. In March of 1978, President Carter signed an Executive Order strengthening and enlarging the OEA's role in adjustment assistance. For the first time, the government made available limited funds, $700,000, for advance planning. [7]

The Economic Development Administration, in the Department of Commerce, was established to stimulate industrial growth and create job opportunities. Title IX provides funds for communities hit heavily by unemployment, and has been used in several cases for assistance for conversion and diversification.

Legislative Proposals

The *Defense Economic Adjustment Act*, first introduced in 1978 by Senators George McGovern and Charles Mathias, and co-sponsored in the House by Rep. Ted Weiss and 27 others, would establish a comprehensive plan for national conversion planning and worker security. It would mandate the establishment of alternate use planning committees at all major military plants and facilities, set up a national commission to coordinate civilian contracts, and set up a worker assistance trust fund to provide up to two years of salary, medical, pension and retraining benefits for affected workers.

The *Defense Dependency and Economic Diversification Act*, introduced by Rep. Christopher Dodd (D-Conn) seeks ways for defense-dependent communities, like many in California and Connecticut, to obtain state and federal assistance to help diversify their economies.

California State Legislation. California Assembly Speaker Leo McCarthy has recently introduced a bill which would establish an interagency task force composed of the California Departments of Business and Transportation, Employment Development, and the Governor's Office of Planning and Research to encourage and facilitate local alternate use planning in areas of heavy defense dependency, and to provide liaison between such local committees and state and federal agencies and sources of funds for planning. [8]

Conclusion

Any serious concern about the future of the Lawrence Livermore Laboratory demands a thorough process of alternate use planning. We call on the University of California, the Livermore community, the state legislature of California, the Department of Energy, and the Congress of the United States to establish a tripartite alternate use planning group for LLL. Livermore employees (scientists, engineers, technicians, support), LLL and DOE management, and Livermore community residents should be represented in a comprehensive effort at analysis, assessment, and proposals for alternate uses for the skills, equipment, and plant space now being used at Lawrence Livermore Laboratory.

FOOTNOTES

[1]Lucas Aerospace Combine Shop Stewards Committee, *Alternative Corporate Plan,* London, 1976. For more information on the Lucas workers' campaign, see Dave Elliott, *The Lucas Aerospace Workers' Campaign,* Fabian Society, London, 1977; and Mike George, "Lucas Aerospace Workers' Campaign, " in *Labour Monthly,* July/August, 1978, p. 273-278.

[2] Lucas Aerospace Combine Shop Stewards Committee, "Alternate Energy Technologies," in the *Alternate Corporate Plan,* London, 1976.

[3]Andrew Haines, "Workers Plan Recognized," *Plowshare Press,* March-April, 1979, p. 1.

[4]"Harassment and Lip-Service for Lucas Alternative Planners," *New Scientist,* February 16, 1978, p. 446.

[5]"An Assessment of Issues Concerning the Future of Rocky Flats," unpublished report of the Social and Economic Analysis Corporation, Boulder, Colorado, March, 1979.

[6]Aris P. Christodoulou, *Conversion of Nuclear Facilities to Civilian Uses: A Case Study of Hanford, Washington,* New York, 1970.

[7]For more information on the Office of Economic Adjustment, write OEA, The Pentagon, Washington, DC 20305 or see Bruce Birchard, ' 'Converting Military Bases to Civilian Uses," in *Plowshare Press,* Spring, 1978, p. 4-5.

[8]For more information on national conversion legislation, contact SANE, 514 C Street, NE, Washington, DC 20003. For updates on California conversion legislation, contact the Friends Committee on Legislation, 1107 9th Street, Rm. 1015, Sacramento, CA 95814.

BIBLIOGRAPHY

American Physical Society Study Group, "Solar Photovoltaic and Energy Conversion," Congressional Record, March 15, 1979

California Business and Transportation Agency, "B-1 Bomber Mitigation Strategy," December, 1977

California Energy Commission, "Wind Energy for California: A Proposal for the Energy Development Authority," Draft Report, March, 1978

Christodoulou, Aris P., *Conversion of Nuclear Facilities to Civilian Uses: A Case Study of Hanford, Washington,* New York, 1970

Commoner, Barry, *The Poverty of Power,* Bantam, New York, 1977

Comptroller General of the United States, Report to Congress, *The Multiprogram Laboratories: A National Resource for Nonnuclear Energy Research, Development and Demonstration,* May 22, 1978, Washington, D.C.

DeGrasse, Robert, et al, *Creating Solar Jobs: Options for Military Workers and Communities,* MPCP, Mountain View, CA, 1978

Elliott, David, *The Lucas Aerospace Workers Campaign,* Fabian Society, 1977

Gilpin, Robert, *American Scientists and Nuclear Weapons Policy,* New Jersey, 1962

Hearing before the House Appropriations Subcommittee, "Public Works for Water and Power Development and Energy Research Appropriation Bill," Washington, D.C., 1977

Hearings before the Committee on Foreign Relations and the Subcommittee on Arms Control, Oceans and International Environment of the Committee on Foreign Relations, *Threshold Test Ban and Peaceful Nuclear Explosions Treaties,* United States Senate, 95th Congress, U.S. Government Printing Office, September 8, 1977

Hearing before the Subcommittee on Science and Technology, U.S. House of Representatives, "The Role of the National Laboratories in Energy Research Development," House of Representatives, 95th Congress, Nov. 2-3, U.S. Government Printing Office, Washington, D.C.

Lawrence Livermore Laboratory, "Institutional Plan, FY1978-FY1984," December 18, 1978

Lawrence Livermore Laboratory, "Long Range Resource Projections, 1976-1982," October, 1976

Lucas Aerospace Combine Shop Stewards Committee, "Alternative Energy Technologies," in *Alternate Corporate Plan,* London, 1976

May, Michael, "Department of Applied Science Lecture," Lawrence Livermore Laboratory, October 24, 1978

Melman, Seymour, *The Defense Economy: Conversion of Industries and Occupations to Civilian Needs,* New York, Praeger, 1970

- - - - - - - - - *Planning for Conversion of Military, Industrial Military Base Facilities,* United States Department of Commerce, Washington, D.C., 1972

- - - - - - - - - *The Permanent War Economy,* New York, Simon & Schuster, 1974

Miller, G., "Systems Descriptions and Engineering Costs for Solar-Related Technologies," Vol. VI, *Wind Energy Conversion Systems.* The Mitre Corporation, Metrek Division, for the Energy Research and Development Administration, 1977

Report of the Office of Science and Technology Policy Working Group, "Basic Research in the Department of Energy," Washington, D.C., June, 1978

Rittenhouse, Carl, *The Transferability and Retraining of Defense Engineers,* Stanford Research Institute, Palo Alto, CA, November, 1967

Scientist Institute for Public Information, *Resource Recovery: Energy and Economic Impacts in California,* Draft Report, February, 1979

Shearer, Derek, "Swords Into Ploughshares: A Program for Conversion," in "Working Papers for a New Society," Summer, 1973

Smith, Otto, "A Helioelectric Farm" and other unpublished material. University of California, Berkeley

Social and Economic Analysis Corporation, "An Assessment of Issues Concerning the Future of Rocky Flats," (Unpublished), Boulder, CO 1979

United States Department of Energy, "Draft Environmental Impact Statement for Livermore Site (DEIS)," September, 1978

United States Department of Energy, Division of Solar Technology, *Federal Wind Energy Program,* DOE/ET 0023/1

Webre, Phil, *Jobs to People: Planning for Conversion to New Industries,* Exploratory Project for Economic Alternatives, 1978

ACKNOWLEDGMENTS

The authors wish to gratefully acknowledge the following individuals and groups who lent their viewpoints, technical expertise, funds, facilities, or patience to us while we worked on this study. Responsibility for the views expressed herein remains that of the authors and the UC Nuclear Weapons Labs Conversion Project.

Groups

Agape Foundation
American Friends Service Committee
Ecumenical Peace Institute
Limantour Fund
Lucas Aerospace Combine Shop Stewards Committee
Mid-Peninsula Conversion Project
Rocky Flats Action Group
Social and Economic Analysis Corporation
Society of Professional Scientists and Engineers
at Lawrence Livermore Laboratory

Individuals

Gwen Alley Hunter
Bob Barish
Carol Bowen
Emily Brown
Bob DeGrasse, Coalition for a New Foreign and Military Policy
Lloyd J. Dumas, Professor of Industrial and Management Engineering, Columbia University
Andrew Haines, M.D.
Dan Jackson
Paul Jolly
Jack Klinger, Solpower Industries
Steve Ladd, War Resisters League/West
Andrew McGall, the Livermore *Independent*
Louise McNeilly
Joan McIntyre
Joy Napier
Michelle Pritchard, Scientists Institute for Public Information
Harlan Rotblatt
John Saemann
Randy Schutt
Charles Schwartz, Professor of Physics, UC Berkeley
Otto Smith, Professor of Computer Science, UC Berkeley
Phyllis Smith
Bill Taylor
Ron Thomas-Glass
Lee Trampleasure
Scott Ullman