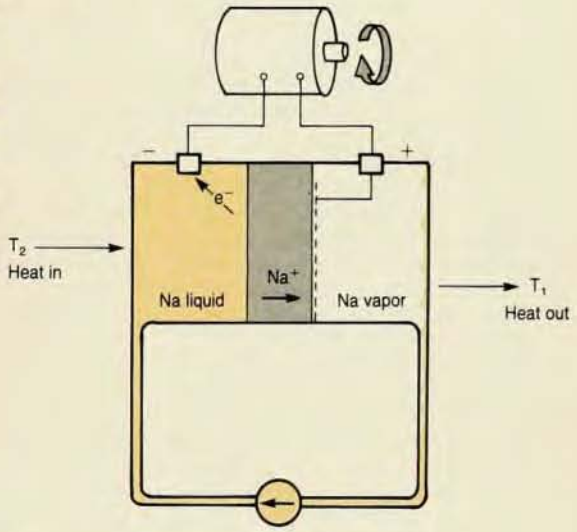
DOE advanced energy division funds exploratory research

Some of the most innovative research being funded by the Department of Energy is sponsored by a small division within the Office of Basic Energy Sciences that most physicists have never even heard of. It is the Division of Advanced Energy Projects, and it specializes in high-risk, exploratory research. Currently, for example, AEP with a budget under $10 million, is sponsoring work on free-electron lasers (Andrew Sessler of Lawrence Berkeley Lab and Don Prosnitz of Livermore are working on one project and Arie van Steenbergen of Brookhaven is working on another using the 700-MeV electron storage ring at the new National Synchrotron Light Source), an ionization front accelerator (being developed by Craig Olson of Sandia) and a low-cost, low-power cryocooler to reach 4.0 K (being developed by Ronald Sager at the S.H.E. Corporation).



Sodium heat engine developed by Thomas Hunt and Neill Weber (Ford Motor Co.) with support from the AEP division at DOE. The engine is essentially a concentration cell for sodium atoms, which are driven by a heat gradient against an electric field.

AEP plays a unique role within the spectrum of DOE research programs. Ryszard Gajewski, the Division's director, is responsible for research projects that he describes as "infants and orphans." The "infant" projects are those novel concepts that look promising but whose practical feasibility is still very much in question. In 1976, for example, a proposal from Terry Cole, Neill Weber and Thomas Hunt (Ford Motor Co.) to develop a sodium heat engine for the direct conversion of heat to electricity was submitted to the Energy Research and Development Administration's conservation division. The proposal was deemed too speculative and was not funded. The next year, the researchers made a second unsuccessful attempt for funding from the division of solar energy. Finally, in 1978, AEP agreed to fund the work, and last year a laboratory scale model of a device based on this principle was built. The sodium heat engine is essentially a concentration cell for sodium atoms, which are driven by a heat gradient against an electric field; the electrical gradient can be maintained because the electrolyte, β''-alumina, conducts sodium ions but not electrons.

The "orphan" projects are those that are multidisciplinary in nature, and so fall under the jurisdiction of no one DOE office. "These are the projects about which everyone says, 'It sounds like a great idea—there must be *someone* out there who can support it,'" Gajewski says. "The buck stops on my desk."

Technology transfer. The aim of AEP, then, is to test the scientific and practical viability of some of the new technical concepts related to energy generation, conversion, storage and conservation that are continuously emerging from basic research. Unlike its sister divisions at the office of Basic Energy Sciences, AEP does not support ongoing research programs. Once the feasibility of a concept is established, the investigators have to look elsewhere for funding. Typically, this initial exploratory phase takes about three years.

"I try to give a new concept some visibility and help it get off the ground," Gajewski says. "I hope that within the three-year period that I am supporting it, there will be enough interest generated so that somebody will continue supporting it when our funding expires."

Gajewski estimates that about 25% of his projects find support after they leave his division. Given the high-risk nature of the projects he funds, Gajewski says he is satisfied with that track record. Ongoing support for AEP projects has come from other parts of DOE, other Federal agencies, and from private industry. A dramatic example of the latter case occurred with a project exploring the practical implications for batteries and photovoltaics of polyacetylene's conducting and semiconducting properties. Basic research on polyacetylene by Alan Heeger and Alan MacDiarmiad at the University of Pennsylvania (PHYSICS TODAY, September 1979, page 19) was supported by NSF and the Office of Naval Research. Subsequently AEP supported Heeger and MacDiarmaid's research that had possibilities for batteries and photovoltaics. As an outgrowth of the Penn work, Allied Corporation has announced a $5-million program in polyacetylene battery development based on a patent license negotiated with Penn. BASF, the German chemical company, has bought the license for Europe.

AEP is highly supportive of such opportunities for transferring technology from the laboratory to the marketplace. In an attempt at expediting this transfer, for example, Gajewski put

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together an exhibit for last February's Energy Technology Conference and Exhibition. He chose three AEP projects that he felt were ready to be brought to the attention of the technological community: a liquid membrane for oxygen enrichment of air, a fully stationary solar collector that uses newly developed principles of non-imaging optics, and the Ford sodium heat engine. As a result of that exhibition, negotiations for further support of all three of these concepts is underway, said Gajewski.

Taking chances. Because the projects that AEP supports inevitably involve a high degree of risk, Gajewski usually looks for a high potential payoff in the projects he chooses to fund. For example, AEP supports several projects exploring entirely new, untried approaches to heat-to-electricity conversion. They are all based on newly discovered properties of solid materials such as ionic conductors, solid electrolytes and ferroelectrics. If even one of these schemes leads to a technologically viable method of direct conversion, it could revolutionize the present-day approach to electricity generation.

For some concepts, however, the exact nature of the payoff is difficult to establish. For example, AEP has funded four projects in new sources of short-wavelength electromagnetic radiation. One is an attempt by Raymond Elton at the Naval Research Lab to generate an extended-ion source for short-wavelength lasers. The second is Charles Rhodes's experimental determination (at the University of Illinois, Chicago Circle) of the feasibility of generating high-brightness soft x rays by nonlinear optical processes involving both direct excitation and wave mixing. The third project, by Szymon Suckewer (Princeton Plasma Physics Lab), is an investigation of an x-ray laser based on a magnetically confined plasma column that is heated by a powerful laser and cools rapidly by radiation losses. The fourth project, by Raymond Dukart (Physics International), uses an imploding plasma source to produce laser transitions in the soft x-ray region. The first three of these projects were discussed at a session on short-wavelength lasers during the spring APS meeting last April. "To try to estimate, either in dollars and cents or in qualitative terms, what the payoff of these projects might be would be very difficult," says Gajewski. "But past experience indicates that new sources of electromagnetic radiation turn out to be very useful, so we support this work."

Sometimes the economic practicality of a concept is considered in AEP's decision making process, and sometimes it is dispensed with, says Gajewski. For example, in making a recent decision to support work on quartz-catalyzed fusion, economics was not a consideration, Gajewski says, because the concept is at too early a stage of technical definition. George Zweig at Los Alamos and Charles Hendricks at Livermore will attempt to isolate quarks on liquid droplets formed by the ink-jet technique and then use them as "nuclei" in "atoms" with two deuterons playing the role of "electrons." The Bohr radius for such "atoms" is so small that the two deuterons would fuse almost instantaneously, leaving the "nucleus" free to capture the next deuteron pair.

Budget. AEP is a relatively young program. Its first fiscal year of operation was 1978. Since then, it has funded over 50 projects with its modest but steadily growing budget. The AEP budget has risen slightly faster than the overall budget of DOE since 1978, an indication that AEP's importance to DOE's overall research program has not been overlooked. The FY 1982 budget for AEP is $7.6 million. If the presidential budget request for 1983 is approved by Congress, the office will have $8.6 million to work with. Although this budget is not large (in fact, AEP is one of the smallest divisions within the Office of Basic Energy Sciences), AEP does have one fiscal advantage, which is that each year roughly one-third of its research projects are completed, freeing up that fraction of the budget for new initiatives. "Normally, a program of this size does not have that much freedom to start new projects," Gajewski says.

It was originally intended that the program would fund about 20 new projects each year. Budget realities being what they are, however, AEP has been able to initiate only about a dozen projects per year. Of these, a relatively large fraction (almost 30%) have been proposals from small businesses, though the source of a proposal is not considered in the decision-making process, according to Gajewski.

The projects AEP supports generally cluster into seven "areas of concentration," according to Gajewski. They are:

- radically new approaches to fusion (with emphasis on the radical)
- new sources of electromagnetic radiation
- direct heat-to-electricity conversion
- efficient heat engines
- new methods of particle acceleration
- advanced solar collectors
- exotic photovoltaic materials and processes

However, AEP supports many projects that do not fall into any of these categories. "We will explore any novel, promising, technically sound idea," Gajewski says.

Physicists will soon have the opportunity to learn more about some of the concepts being pursued with AEP money. The APS Committee on Applications in Physics has decided to hold a symposium on Advanced Energy Projects at the March 1983 meeting. Speakers will include: Thomas Hunt (Ford) on the sodium heat engine; Harold Lonsdale (Bend Research, Inc) on the enrichment of air with oxygen; Roland Winston (University of Chicago) on high-performance solar energy collection; Ronald Sager (S.H.E. Corporation) on cryocooler applications, and Derek Tidman or Shyke Goldstein (GT-Devices) on mass accelerators as drivers for impact fusion.

More information about the AEP program can be obtained from Ryszard Gajewski, Director, Division of Advanced Energy Projects, Office of Basic Energy Sciences, ER-16, GTN, Department of Energy, Washington, D.C. 20545; the telephone number is (301) 353-5995. The office accepts research proposals throughout the year; so there is no application deadline. According to Gajewski, "good, strong proposals have an excellent chance of being funded."

—MICHAEL JACOBS

DOD university research on the rise

In a time of ever-tightening fiscal constraints, the FY 1983 budget request for Department of Defense research, development, testing and evaluation would represent an almost startling growth of 21.3% over last year. Simultaneously, R&D budgets for other agencies are being cut or barely held to stable levels against inflation (PHYSICS TODAY, April, page 55; May, page 77). According to Leo Young, who replaced George Gamota as director of Research and Technical Information at the Defense Department, the funds available for university research will increase by an even larger percentage. Young told us, "Approximately 45% of the RDT&E budget in Defense is spent at universities; in-house DOD labs get about 35%, and the balance goes to industrial labs doing defense contract research. Since we anticipate zero growth for in-house expenses, any increase in the previous year's research budget that is approved by Congress will be spent for university research."

Young has master's degrees in both mathematics and physics from Cambridge University and a PhD in electrical engineering from Johns Hopkins University (in 1958). From 1960 to 1973 he was at Stanford Research Institute. He then went to the Naval Research Laboratory, where he was asso-