

TABLE I
Industry Income and R&D Expenditures (1975)
In Millions of \$

INDUSTRY	INCOME ^a	R&D EXPENDITURE ^b	% OF INCOME
Chemicals & Allied Products	23,843	2,410	10.1
Instruments	8,889	854	9.6
Machinery	36,857	2,286	6.2
Motor Vehicles & Transport'n Equipm't	34,708	2,003	5.8
Electrical Equipment & Communications	53,551	3,016	5.6
Energy (Projected 1979 U.S. Fuel Bill)	180,000	4,100 ^c	2.3
Primary Metals	24,523	356	1.5
Fabricated Metal Products	24,324	296	1.2
Food & Kindred Products	29,511	323	1.1

^aBureau of Economic Analysis, U.S. Commerce Department.

^bU.S. National Science Foundation, *R&D in Industry Annual*.

^c*The Energy Daily* (Jan. 24, 1978).

those have now become so expensive that the traditional systems are inadequate. Almost by default, the Federal government took over the preparation of new technical options. In the process, however, the R&D sector, the industrial vendors, and the energy option users—the electric utilities—became separated.

The U.S. invests about 2% of its gross energy expenditure on R&D, below the average expenditures on R&D in other sectors of the economy (Table I). The principal difference is that the R&D expenditures in the electric sector are paid for by the Federal government, whereas in the other sectors the expenditures are paid by the industries themselves.

Comparison with the telephone industry is particularly illuminating—both are capital intensive, deal in options for the long term, and are highly regulated. The telephone industry, however, is (mostly) a single controlled monopoly, and has persuaded regulatory commissions that substantial R&D is necessary to keep its activity viable.

From this and other evidence, we conclude that a stronger organization of the electric utilities, vendors, and other concerned organizations than now exist should be established. The alternative seems to be a further intellectual separation of option-developers from option-users which can only lead to further difficulties in terms of being prepared for the future and of gaining public acceptance. If unremedied, these difficulties will eventually lead to *de facto* or *de jure* nationalization of the generating sector.

Regarding the third major problem—failure to address important social issues—the government's record is startlingly dismal. For example, the fiscal year 1979

Department of Energy budget allocates \$63.4 million for information services, but almost all of this is for internal reports. Only \$3.1 million is allocated for information dissemination.

This failure, by both Federal and state governments, to articulate the issue of nuclear power vis-a-vis other options (coal, conservation, etc.) has been justified on grounds of the governments not wishing to intrude on the private sector, or not wishing to adopt advocacy roles. In effect, however, this has left an intellectual vacuum into which many groups with both obvious and hidden agendas have rushed. The resulting debate has been unbalanced, ill-informed, and unguided, not only about nuclear power but also about difficulties with the use of coal and other major options. The disheveled debate then contributes to public and institutional uncertainty and decisions founded on inadequate assessments.

5. Some New Considerations About Factors Affecting Public Acceptance of Nuclear Energy, Denia Hukai, Robert E. Simmons (Boston Univ), Roberto Y. Hukai (MIT & IEA)

Public acceptance of nuclear energy can be characterized as a two-stage process. First is the acceptance by utilities leading to the adoption of the innovation. The second is the subsequent acceptance by the public. The first step has been quite successful, notwithstanding some licensing problems. However, the second has encountered considerable reservations and opposition.

Figure 1 depicts the trend concerning the utilities' acceptance of nuclear energy, showing the cumulative adoption. From the point of diffusion of innovations, a

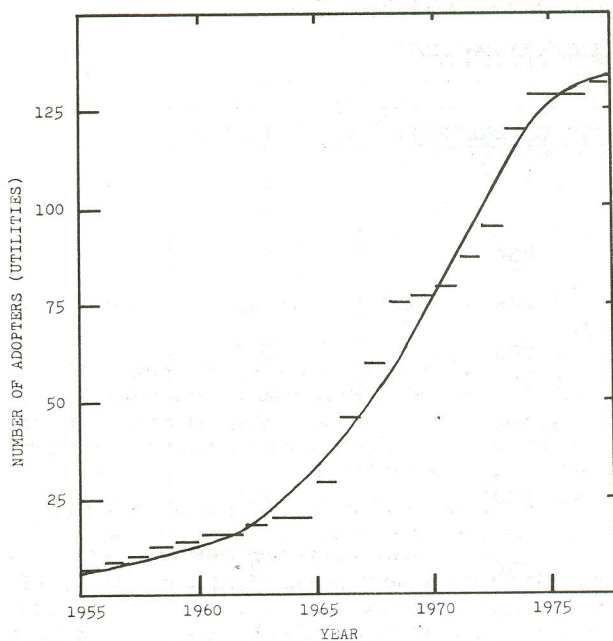


Fig. 1. Cumulative for number of utilities adopting nuclear energy. (Horizontal lines indicate first adoptions by utilities within the indicated time period.)

typical adoption S-curve emerges, with three distinct surge periods, separated by two lag periods.

The first surge, around the late 1950's, was due to the old U.S. Atomic Energy Commission's efforts to prove the technical feasibility of nuclear reactors and finance the construction of prototypes to be run by utilities. The first lag period reflects engineering difficulties that resulted in dubious appraisal of the economic advantages of nuclear reactors. The second, and greatest, surge in utility adoption occurred around 1968-1969, when the economic feasibility was proved by the Yankee Rowe and Dresden demonstration plants. Reactor vendors' promotional efforts in that period also contributed to the surge. The next lag period was due to the extensive licensing problems and safety concerns, complicated by the beginning of the environmental movements. The relatively small third surge in adoption around 1974-1975 is attributable to recognition of a critical need for a substitute for fossil-fuel-fired plants after the international petroleum crisis.

The second stage, dealing with the utilities' communication of the innovation and its acceptance by the public, followed a different path. Up until about 1970, almost no effort was made to win public acceptance of the energy innovation. The gap between the innovation and its acceptance by the public has grown and become increasingly polarized politically. Public lobbying and demonstrations point emphatically to the need for a conceptual analysis of that acceptance problem.

This paper will apply force field analysis, the technique of social management originated by Kewin,¹ to systematize an explanation of forces acting on the nuclear power acceptance issue. Restraining and driving forces (specific variables) act on each other in social space to

create a state of quasi-equilibrium. Those forces are classified further into two subcategories: institutional and behavioral. To the extent that increased institutional driving forces for acceptance are not balanced by a modification of behavioral resistance forces, the force field will produce social strain or counteraction. Some conclusions can be drawn:

1. Because utility companies are institutions and are impersonal, the public views them as not being concerned with human values. Utility companies are most often remembered when one must pay a monthly bill to a mail address, when a letter arrives threatening a shutoff of services for nonpayment, when utility rates increase, or when there is a blackout. The individual is powerless to either control or resist in human terms.

2. Resistance against impersonal institutions serves as a release for a generalized sense of frustration over other uncontrollable institutional intrusions in daily life. Resistance assumes characteristics of an ideological movement in which every action is seen as diminishing powerlessness and reifying the individual's worth.

3. Public perception of nuclear energy demands a human dimension of risk evaluation and reporting rather than a purely scientific one,² which is not often perceived by the utilities.

4. Antinuclear activists exploit that human dimension, communicating with the larger public on the basis of homophily³ (i.e., being alike), whereas utilities, as institutions, are cast as heterophilous to⁴ (i.e., different from) the public.

5. Being heterophilous to the public, utilities are perceived as favoring technology and financial gain over human values, e.g., safety, health, and thrift.

6. The public does not cognitively differentiate nuclear power's areas of responsibilities. For example, radiation waste management is a task of the Federal government, but it is not generally recognized as a function apart from local utility management. Because of the failure to communicate such differentiated aspects, in the public mind the utilities are responsible for all problems related to the nuclear power innovation.

7. Controversial issues like nonproliferation may not affect the public acceptance of nuclear power plants directly, since the issues are diluted with international politics and the arms race, each as important or more important in terms of risk than nuclear energy.

8. The public's perception of nuclear energy as an ominous specter—e.g., linked with cancer, bombs, and invisible yet potentially lethal power—is the predominant factor in public apprehension about the innovation.

1. K. KEWIN, *Field Theory in Social Science*, DORWIN CARTWRIGHT, Ed., Harper & Brothers, NY (1951).

2. H. J. OTWAY, "A Review of Research on the Identification of Factors Influencing the Social Response to Technological Risks," International Conference on Nuclear Power and Its Fuel Cycle: Nuclear Power and Public Opinion, Salzburg (May 1977).

3. E. M. ROGERS and F. F. SHOEMAKER, *Communication of Innovations*, Free Press, NY (1972).

4. *Ibid.*