13 Oct 1977

Improving Energy Efficiency by Federal Regulation

Barry Hyman

Burns E. Hegler
Missouri University of Science and Technology

IMPROVING ENERGY EFFICIENCY BY FEDERAL REGULATION

Barry Hyman
Program in Social Management of Technology
University of Washington
Seattle, Washington

Burns E. Hegler
Department of Engineering Management
University of Missouri-Rolla
Rolla, Missouri

Abstract

This paper examines the scope and nature of federal activities devoted to improving the efficiency of energy utilization in buildings, consumer products, motor vehicles, and industrial processes and equipment. Several forms of regulation are identified and their characteristics are explored. It is postulated that consistency of an overall policy of energy efficiency regulation can be ascertained from the examination of a regulatory policy matrix.

1. INTRODUCTION

The increasing awareness over the past several years of the importance of energy conservation as an element of a comprehensive national energy policy has led to the establishment by the federal government of an extensive set of regulations which establish energy efficiency requirements on a variety of products, systems, and processes. These new federal programs represent a substantial federal involvement in an aspect of product, system, and process design which has traditionally been devoid of governmental regulation. In this paper we will analyze those federal energy efficiency regulatory programs for the purposes of understanding the intent, form, and scope of the regulations and determining whether they comprise a consistent set of programs.

2. THE REGULATORY AGENCIES

Each of the energy efficiency regulatory programs to be examined in this paper is administered by one of the regulatory agencies of the federal government. Some general background information on the nature of these agencies and the regulatory process is provided in this section.

Conventional analysis of the structure of our form of federal government deals with the three branches: the executive, the legislative, and the judicial. However, there are some who argue that the regulatory agencies constitute a fourth branch of government. The regulations issued by these agencies affect what we eat and drink, the clothes we wear, the cars we drive, and the fuel we burn. The size of this so-called fourth branch of the government can be appreciated by considering that there

are about 100,000 people who are employed within the 50 different federal regulatory agencies. Just the basic rules of federal regulations would fill a book with 60,000 pages and occupy a shelf 15 feet long! This year the federal government will spend 3.5 billion dollars for regulatory programs, a 21 percent increase over last year (1).

These regulatory bodies promulgate rules and regulations, administer these rules, and often enforce them in a quasi-judicial manner. The source of authority for these regulatory bodies is the Congress which created the agencies to assume regulatory responsibility for certain broad areas of activity. In addition, Congress enacts laws which direct the existing agencies to regulate specific activities.

These regulatory agencies have limited power. The regulations they promulgate may be overruled by a judicial court, or Congess can amend the law which initially provided the regulatory authority. Congress also controls these agencies on a continuous basis by exercising its oversight responsibility and by appropriating funds for the operation of the agency. The President exerts control by appointing the agency chiefs subject to confirmation by the Senate.

There are two types of regulatory agencies: 1) those whose chief administrator serves at the pleasure of the President and 2) those so-called "independent" regulatory agencies administered by a multi-member commission whose members are appointed for staggered terms of fixed duration. Usually there is a requirement for a balance of political affiliation among the commission members. The first group includes agencies such as the Federal Aviation Administration, the Food and Drug Administration, the Federal Energy Administration (now part of the new Department of Energy), and the Occupational Safety and Health Administration. The latter group includes the Securities and Exchange Commission, the Federal Trade Commission, the Interstate Commerce Commission, and the Federal Power Commission (recently replaced by the new Federal Energy Regulatory Commission.)

3. ORIGINS OF ENERGY EFFICIENCY REGULATIONS

Prior to 1974, the federal involvement in energy efficiency was confined to two regulations. By far the best known was the Federal Housing Administration's insulation standards for houses covered by FHA mortgage insurance.* The other regulation was issued in 1969 by the Federal Trade Commission and required that light bulb packages disclose the amount of lumens produced as well as the wattage (the lumens/watts ratio is an appropriate measure of the energy efficiency of the bulb) (3).

In late 1973 and early 1974, additional federal regulations in the name of energy efficiency were adopted as the result of the passage of the Emergency Daylight Saving Time Energy Conservation Act of 1973 (P.L. 93-182) and the Emergency Highway Energy Conservation Act (P.L. 93-329). The former increased the number of days per vear that Daylight Savings Time was operative while the latter established the 55 m.p.h. speed limit.

Beginning in 1975, the extent of federal regulation of energy efficiency increased enormously. In Dec. 1975, the Energy Policy and Conservation Act (EPCA, P.L. 94-163) was enacted. EPCA, the first of several comprehensive energy laws, established programs for improving energy efficiency of automobiles, household appliances, industrial processes, and for encouraging state governments to accelerate their own energy efficiency efforts.

In 1976, the Energy Conservation and Production Act (ECPA, P.L. 94-385) extended several of these programs and established a federal effort aimed at improving the energy efficiency of new buildings.

President Carter's National Energy Plan extends and modifies the efforts established under EPCA and ECPA. However, as of this writing, the final form of that legislation is still in doubt.

4. FORMS OF ENERGY EFFICIENCY REGULATION

The energy consumption associated with any particular activity can be considered to be equal to the

*Originally promulgated in accordance with the National Housing Act, the standards have since been strengthened several times (2).

energy consumed per unit of the activity multiplied by the extent of the activity:

$$\text{Energy Consumption} = \frac{\text{energy consumed per}}{\text{unit of activity}} \times \frac{\text{extent of}}{\text{activity}}$$

There are obviously many alternative ways to specify the appropriate "unit of activity," depending on the purpose of the analysis. For example, the energy consumed for space heating of residences may be represented as the energy consumed for space heating per residence multiplied by the number of residences. The energy consumption for production of steel might be written as the energy consumption per ton of steel produced times the number of tons produced. As another example, the annual gasoline consumption of an automobile can be represented as the gasoline consumption per mile multiplied by the number of miles driven annually.

If we define the energy efficiency of a given activity as the inverse of the energy consumed per unit of activity, we can write that

$$\text{energy consumption associated with an activity} = \frac{\text{extent of the activity}}{\text{energy efficiency of the activity}}$$

This arrangement illustrates that conservation measures can focus either on reducing the extent of an activity or on increasing the energy efficiency of the activity. Proposals such as gasoline rationing, increasing the gasoline tax, and subsidizing mass transit are aimed primarily at reducing the extent of automobile usage, while a "gas guzzler" tax is aimed primarily at improving the energy efficiency of the typical automobile. It has recently been shown that focusing on improving energy efficiency is considerably more effective in saving energy than focusing on reducing the extent of the activity(4). In the remainder of this paper we will focus only on regulations explicitly aimed at improving energy efficiency.

4.1 DIRECT REGULATION

We introduce the term direct regulation of energy efficiency to mean those regulations that are explicitly aimed at improving the energy efficiency of specific classes of products, systems, and processes by encouraging or mandating design changes in those products, systems, and processes.

A good example of direct regulation is the automobile fuel economy standards. The law explicitly establishes performance targets for new automobiles that manufacturers must meet. In addition, EPCA requires that specific rules defining measurement, calculations, and disclosures of fuel economy levels are to be promulgated by the Environmental Protection Agency, while fuel economy levels for 1981-84 are to be established by regulations issued by the Secretary of Transportation.

Another example of direct regulation is the issuance (pursuant to EPCA) of a target for an improvement by 1980 in the energy efficiency of household furnace equipment (5).

4.2 INDIRECT REGULATIONS

Indirect regulations are defined as regulations aimed at encouraging or mandating improvements in energy efficiency but which do not satisfy the definition of direct regulation.

An example of indirect regulation is the 55 m.p.h. speed limit established by P.L. 93-239. As is well known, the speed limit has not been totally effective since it has not been well accepted by the general public and has not been rigidly enforced by the states; however, it has reduced the average speed and thus has achieved significant energy savings. Although the regulation was explicitly designed to take advantage of the improved energy efficiency of automobiles at the reduced speed, it fits our definition of an indirect regulation because it is not explicitly aimed at changing the design of automobiles.

Another example of indirect regulation of energy efficiency would be a proposal to regulate thermostat settings in building heating systems. For a given building and outdoor temperature, a lower thermostat setting would reduce the rate of heat loss and thus increase the energy efficiency of the structure. However, this improved energy efficiency is accomplished without explicitly affecting the design of the building or the heating sys-

tem used in the building.

4.3 COMPARISONS BETWEEN DIRECT AND INDIRECT REGULATIONS

It may be argued that direct regulations are more effective because they operate on the problem at the source rather than at the point of use. Using the examples described in the two preceding subsections, it is clear that administration and enforcement of direct regulations are simpler because it is much easier to deal with a small number of automobile and furnace equipment manufacturers than with the millions of car and home owners who will be controlled by the adoption of one of these indirect forms of regulation.

Further, since direct regulations of energy efficiency concentrate on the design and manufacture of equipment rather than on the manner in which the equipment is utilized, they are more likely to spur technological changes in the regulated industries than indirect regulations.

A more detailed examination of direct regulations is provided in the following sections.

5. CHARACTERISTICS OF DIRECT REGULATION

For purposes of policy analysis, it is useful to try to identify the important characteristics of direct regulation. In this section, three independent characteristics are defined and briefly discussed.

5.1 STRENGTH

The strength of a regulation can be defined as the extent to which engineering design decisions are dictated by the regulation. "Strong" regulations consist of specific governmental rules affecting detailed design decisions while "weak" regulations permit industry greater design freedom. Obviously, a determination of the strength of a specific regulatory action requires comparing the anticipated influence of the government in the design process as the result of the regulation to the situation which would exist in the absence of the regulation. This situation, the absence of a direct federal regulation of energy efficiency, shall be called the "base line" condition. The base line is not necessarily a free-market condition since a variety of non-free market forces may be operative. Examples of departures from a free market state are inadequate information, presence of a cartel or monopoly, failure to adequately account for social or environmental costs of energy consumption, presence of other forms of regulations such as regulations affecting other than the energy consumption, energy regulations focusing on the extent of activity rather than on efficiency, and indirect forms of energy efficiency regulation. We therefore characterize the strength of direct regulation according to the degree to which the regulation modifies the role of the federal government in the design process relative to the base line condition.

5.2 EFFECTIVENESS

A second characteristic of direct regulation of energy efficiency that must be considered is some measure of the energy savings attributable to the regulation. We introduce the term effectiveness, defined as the ratio of the anticipated annual energy savings to the total energy consumed in the regulated area. It seems appropriate that the equivalent annual rate at which savings are to occur be incorporated into the definition of effectiveness so that we can distinguish between regulations which are designed to achieve savings quickly and those that provide long lead times to achieve the same savings.

5.3 CERTAINTY

A third characteristic of direct regulation is the degree of certainty that the anticipated energy savings will be realized. The level of certainty for any specific regulation can be estimated by examining the nature and severity of the penalties for noncompliance with the regulation. That is, regulations which are backed up by strong enforcement programs are more certain to achieve the anticipated energy savings than regulations which have weak or non-existent penalties for noncompliance.

5.4 IMPACT OF REGULATION

The overall impact of a regulation may be consid-

ered to be some measure of benefits resulting from the regulation and the costs associated with the regulation. The distribution of the benefits and costs among different groups needs to be considered. We offer the preliminary hypothesis here that the impact of a direct regulation may be expressed as a function of the characteristics of strength, effectiveness, and certainty. An examination of the form of this functional relationship and the possible inclusion of additional characteristics of regulations in the equation are left for future study.

5.5 MEASUREMENT OF CHARACTERISTICS

One of the requirements for further understanding of the direct regulatory process is the establishing of units of measurements for the independent variables (characteristics) identified in the preceding paragraphs. The basis for an appropriate measure of effectiveness is contained in the definition of that characteristic. However, depending on the specific wording of the regulation, it may be difficult to obtain reliable estimates of anticipated savings and the equivalent annual rate at which they are expected to occur. The certainty characteristic might be quantified by establishing a relative ranking system in terms of the nature of the enforcement mechanisms available to the regulatory agency. A more detailed examination of this question definitely merits further study, but is postponed for future consideration. The following section is devoted to the establishment of a metric for the strength characteristic.

6. RELATIVE STRENGTHS OF DIRECT REGULATORY MECHANISMS

In this section we identify six specific mechanisms for direct regulation of energy efficiency and establish a ranking system based on their relative strengths.

6.1 PROCUREMENT STANDARDS

This is considered a weak form of regulation since the government is acting as any private customer would in specifying to the potential vendors the characteristics of the products being considered for purchase. Specification of a minimum level of energy efficiency for certain products to be purchased for government use represents a continuation of a well-founded and long-standing government practice of issuing procurement product specifications. Energy efficiency characteristics are a relatively minor addition to an already long baseline list of physical, economic, and performance characteristics such as size, color, weight, purchase price, strength, etc.

There is certainly the possibility that the government might be a large enough customer for some industries that the issuance of government procurement specifications concerning energy efficiency would strongly influence design practices within the entire industry. This, however, would not alter the characterization of this form of regulation as weak, since in such a situation the strong influence of the government on practices within those industries is already reflected in the base line condition.

6.2 ELIGIBILITY REQUIREMENTS FOR FINANCIAL ASSISTANCE

The regulatory approach which is next weakest to procurement standards is one in which the federal government offers a financial incentive to a non-federal energy user to purchase or otherwise utilize products and systems which meet certain standards of energy efficiency. The financial incentive may take the form of tax deduction or credits, accelerated depreciation schedules, loan guarantees or loan interest subsidies, or grants. This form of regulation provides an economic benefit to those parties who voluntarily choose to satisfy the eligibility requirements. The purely voluntary nature of this regulatory approcah, and the fact that eligible parties receive a financial subsidy, qualify this as a weak regulation. It is nothing more than the "carrot" which the federal government frequently employs to encourage changes in market behavior.

Establishment of efficiency standards as eligibility requirements for financial assistance is deemed to be a stronger form of regulation than the use of procurement standards, since the former is designed to appeal to a much broader constituency than the

latter, which is limited to companies that sell goods and services to the federal government. An example of the application of this particular regulatory technique is the insulation requirement for FHA-approved mortgage loans.

6.3 MANDATORY DISCLOSURE OF ENERGY USAGE INFORMATION

Next up the ladder of regulatory strength are regulations which require disclosure of energy use information by manufacturers of energy-consuming equipment and by large industrial users of energy. Energy labeling of appliances is illustrative of a federal program which utilizes this regulatory tool. Since no action beyond disclosure of information is required, it might be argued that this is actually an indirect form of regulation. However, the evolution of the particular federal programs which require mandatory disclosure of energy use information makes it clear that the explicit objective of these efforts was to encourage manufacturers and large industrial users to improve energy efficiency (6,7). The argument was made that if disclosure of energy information were made mandatory, equipment manufacturers and large industrial users would compete with each other to achieve the best energy efficiency, and in fact they would use energy efficiency as a marketing device.

Mandatory disclosure of energy-usage is a stronger form of regulation than the two previous regulatory techniques discussed in this section because the disclosure requirement affects the behavior of an entire industry, while both the procurement standards and the standards for elgibility for financial assistance only affect those who voluntarily choose to participate in an arrangement whereby they receive some direct benefits from the federal government.

6.4 PERFORMANCE TARGETS

The next strongest regulatory instrument utilized is the establishment by the government of energy efficiency targets to be met by specific companies or industries. Since these targets apply to an entire energy-consuming industry, or to an entire line of energy-consuming products produced by an industry or company, this form of regulation still allows considerable design flexibility to remain within the regulated sector. For example, the automobile fuel economy regulations instituted under EPCA specify the fleet-wide average fuel economy to be achieved by each automobile manufacturer. Under this arrangement, a manufacturer can continue to produce gas guzzlers, as long as enough fuel-efficient models are produced so that the sales-weighted average fuel economy of all models meets the performance target.

6.5 PERFORMANCE STANDARDS

Performance standards, whereby individual products, systems, and processes are required to meet energy efficiency requirements, are the next strongest regulatory mechanism. They impose a constraint on design decisions which is more severe than that imposed by performance targets. For example, the minimum fuel economy standard recently adopted by the U.S. Senate (8) would (if signed into law) prohibit gas guzzlers outright. However, manufacturers still have many design options available to them in order to achieve the performance level dictated by the regulation.

6.6 DESIGN STANDARDS

The strongest regulatory tool available is the design standard. This form of regulation, which dictates design characteristics, removes design options which would be present under any of the weaker forms of regulation. Design standards aimed at improving automobile fuel economy could take many forms, including regulations dictating maximum vehicle weight, engine horsepower or displacement, mandatory use of radial tires, or prohibiting certain features such as air-conditioning or automatic transmissions. So far there is little evidence of the use of this mechanism at the federal energy regulatory level, although it has been used by some state and local governments. An example is the required use of electric igniters to replace pilot lights for gas-burning appliances in California.

7. EVALUATION OF REGULATORY POLICY

In this section we will examine the set of existing and proposed direct regulations of energy efficiency by utilizing the system of relative strengths established in the previous section and constructing a regulatory policy matrix in which the regulations are arranged in accordance with the level of energy consumption within the regulated sector and in accordance with the strength of the regulation.

7.1 CONSISTENCY OF REGULATORY POLICY

We advance the proposition that a consistent regulatory policy with respect to the strength characteristic of different regulatory mechanisms is a policy in which the stronger mechanisms are applied to the larger energy-consuming areas. We further propose that a measure of the consistency of the overall regulatory policy is provided by the extent to which the entries in the regulatory policy matrix lie on the main diagonal. Both of these propositions are admittedly oversimplified since they ignore the other characteristics of the regulations (e.g., effectiveness, certainty) and do not account for the possible presence of indirect regulations within a given sector. However, it is worthwhile exploring the potential usefulness of even this limited concept of consistency as a policy analysis tool. Further refinements of the concept such as increasing the dimensionality of the matrix, and accounting for indirect regulations, should increase its usefulness.

7.2 REGULATORY POLICY MATRIX

The regulatory policy matrix is shown in Figure 1. The various strength levels discussed in the previous section are arranged equidistantly in a vertical column. This implies that the strength levels identified in this paper are separated by equal increments (the validity of this assumption deserves durther study). The areas affected by direct regulation are arranged in increasing numerical order along the horizontal axis, in accordance with the amount of the energy consumed in that sector. The notation for the entries in the regulatory policy matrix distinguishes between regulations which were promulgated prior to 1975, regulations authorized under either EPCA or ECPA (several of the regulations authorized under these two laws have not yet been promulgated in their final form), and regulations proposed in President Carter's National Energy Plan.

7.2.1 Pre-1975 Regulations

The two direct regulations of energy efficiency in effect prior to 1975 are the labeling requirements for light bulbs and the insulations standards for residential building construction. The strength of the light bulb labeling requirement is obviously at level 3. Since the regulation applies only to general service incandescent bulbs of less than 150 watts, an estimate of the energy consumption is obtained from the total energy consumption for lighting in the residential sector (9) by assuming that the average flourescent lamp uses one-fourth of the energy consumed by the average incandescent bulb (10), and using sales figures for the two kinds of lights (11).

The housing insulation standards are in fact eligibility requirements for FHA mortgage loan insurance, and are displayed in the matrix row corresponding to a strength level of 2. The size of the regulated area is given by the amount of energy lost through the shells of residential structures, and to account for furnace inefficiencies and flue losses, is taken to be 80% of the energy consumed for residential space heating and cooling (12).

7.2.2 EPCA Regulations

Title III, Part B of EPCA establishes a system for labeling of appliances, automobiles, and home heating and cooling equipment with energy consumption information. In addition, major energy-consuming industries are required to make annual reports of the energy efficiency of their production operations. EPCA goes beyond the labeling requirement in these sectors and also establishes performance targets for improved energy efficiency.

The size of the area affected by the appliance regulations is determined from the energy consumption

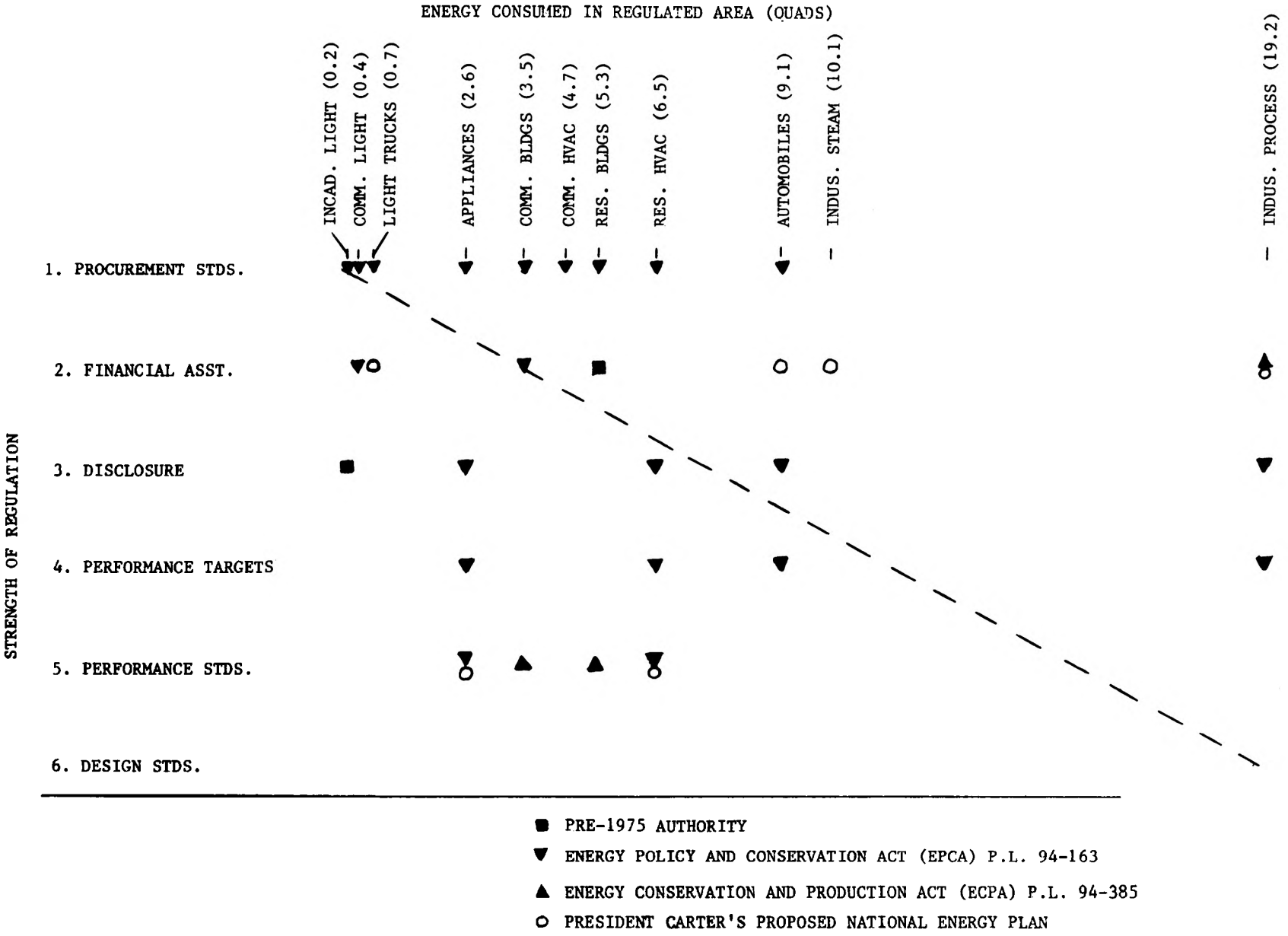

FIGURE 1 REGULATORY POLICY MATRIX

attributed to the eight types of appliances which are explicitly covered by EPCA (12). The size of the area affected by the regulation of home heating and cooling equipment is determined from the energy consumed for single family residential space heating and cooling (12). The provisions of EPCA covering industrial energy efficiency apply to the ten largest energy-consuming industries (12). In addition, authorization to establish performance standards for major household appliances and heating and cooling equipment is provided in EPCA (Sec. 325) if it is determined that the performance targets are not likely to be achieved in the absence of a standard.

Under Section 301 and 381(a) of EPCA, federal agencies were directed to institute energy conservation principles in their procurement and leasing activities. The sectors affected include automobiles (13), appliances, and buildings.

Section 362 of EPCA sets up a system of grants to states for the purpose of establishing state-wide conservation programs. In order for a state to be eligible for the federal grants, the proposed state program must include energy efficiency standards for all new and renovated buildings, including lighting efficiency standards for commercial structures.

7.2.3 ECPA Regulations

The major new regulatory program instituted by ECPA was the directive to the Secretary of Housing and Urban Development to promulgate energy conservation performance standards for new buildings. These standards, because they apply to commercial as well as residential construction, affect a larger area than the FHA insulation standards discussed earlier in this section.

7.2.4 Proposed Regulations

The final form of President Carter's National Energy Plan has not been determined at the time of this writing. However, the direct regulations of energy efficiency as proposed by the President are displayed in the regulatory policy matrix. Included are the proposed rebates to purchases of fuel-efficient automobiles and light trucks (this proposal almost certainly will not be adopted by Congress), tax credits for installation of energy conservation and solar energy equipment in residences and in industry, financial incentives for industrial adoption of cogeneration (joint steam and electric power production), and strengthening of the performance standards provisions of EPCA and ECPA as they pertain to applicances, heating and cooling equipment, and building construction.

If we accept the proposition that a consistent policy of direct regulation of energy efficiency involves application of the stronger regulatory instruments to the larger energy consuming sectors, then an indication of consistency of present and proposed policy is obtained by examining the extent to which the regulations lie along the main diagonal of the regulatory policy matrix.

It is apparent that our present energy efficiency regulatory policy does not meet this ideal consistency criterion. There is an excessive amount of strong regulation in the low consumption areas, such as household applicances, and relatively weak regulatory efforts in the highly consumptive steam generation and industrial process sections. Obviously, there may be a substantial economic or political rationale for this disparity, but the concept of consistency deserves considerably more thought and attention if we are to establish a comprehensive national energy policy.

8. SUMMARY AND CONCLUSIONS

The past few years have seen a rapid increase in federal government regulatory activities in the area of energy utilization. There are strong indications of further involvement in this area. Hence, there is a need for a methodology for analyzing the scope, nature, and characteristics of the individual regulations, and for examining the consistency of an overall regulatory policy.

In this paper we have established a typology for energy regulations. Three classes of regulation are discussed: 1) regulations over the extent of energy-consuming activities; 2) indirect regulations of energy efficiency; and 3) direct regulations of energy efficiency.

Focusing on direct regulations of energy efficiency, we identified three independent characteristics of that class of regulation and labeled them as strength, effectiveness, and certainty. The strength characteristic was explored further through the establishment of a relative ranking system for the strengths of six specific direct regulatory mechanisms.

A regulatory policy matrix was established in which specific existing or proposed direct regulations of energy efficiency were arranged in accordance with their strength and the amount of energy consumed in the regulated sector. It was argued that a consistent regulatory policy involved application of the stronger regulatory mechanisms to the larger energy consuming sectors, and thus a measure of consistency is the extent to which the regulations displayed in the regulatory policy matrix fall along the main diagonal. According to this criterion, the most apparent inconsistencies in the nation's energy efficiency regulatory policy are the presence of excessive strong regulation in low consumption sectors such as appliances and lighting, and the use of relatively weak regulations in large energy consuming sectors such as industrial processes.

The methodology outlined in this paper for the analysis of energy regulations has the potential for developing into a powerful policy analysis tool. Some areas which require further refinement before this potential can be fully realized are: determining quantitative measures for the certainty characteristic increasing the dimensions of the regulatory policy matrix through inclusion of the certainty and effectiveness characteristics in addition to the strength characteristics, developing a quantitative measure of consistency, and extending the analysis to include indirect regulations and regulations on the extent of energy-consuming activities.

9. ACKNOWLEDGEMENT

The preparation of this paper was supported by a grant from the General Electric Foundation to the Program in Social Management of Technology at the University of Washington.

REFERENCES

(1) "Federal Regulators: Impact on Every American," U.S. News and World Report, May 9, 1977, p. 61.

(2) U.S. Congress, House Committee on Science and Astronautics, Conservation and Efficient Use of Energy 93rd Congress, 2nd Session, December 18, 1974, pp. 67-68.

(3) Code of the Federal Register, Title 16, Chapter 1, Part 409.

(4) A.J. Lichtenberg, "Energy Efficiency and Energy Savings," Energy, Vol. 2, No. 3, September 1977, pp. 283-286.

(5) Federal Register, September 30, 1977, p. 52426.

(6) U.S. Senate Commerce Committee, Energy Labeling and Disclosure, Hearings on S.349 and S.594, title X, February 24-25, 1975, p. 55.

(7) P.L. 94-163, Sec. 2.

(8) National Energy Policy Act, Congressional Record, September 9, 1977, p. 14555.

(9) Project Independence Task Force Report, Residential and Commercial Energy Use Patterns, Federal Energy Administration, Nov. 1974, pp. 114-115.

(10) Craig B. Smith, ed., Efficient Electricity Use: A Handbook for an Energy Constrained World Pergamon Press, Inc., 1976, p. 493.

(11) Federal Energy Administration, Energy Conservation in New Building Design: An Impact Assessment of ASHRAE Standard 90-75, Conservation Paper 43B, 1975, p. 153.

(12) Energy and Environmental Aspects of U.S. Transportation, MITRE Corporation, MTP-391, Feb. 1974, p. 37.

BIOGRAPHIES

Dr. Hyman has engineering degrees from Rensselaer, St. Louis University, and Virginia Tech. He has held a variety of professional engineering positions, including serving as staff engineer for the U.S. Senate Committee on Commerce, where he played a key role in the development of energy legislation. Prior to joining the Program in Social Management of Technology at the University of Washington in 1975, he taught for 12 years at The George Washington University. His current research and teaching activities focus on energy technologies and associated public policies.

Dr. Hegler received his engineering education at Kansas State University and taught there for 10

years before joining the faculty at University of Missouri-Rolla in 1968. He is a member of several engineering professional societies, and has done extensive teaching, research, and consulting in the fields of safety engineering and industrial management. This is the third straight UMR-DNR energy conference in which Dr. Hegler has presented a paper.