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Energy Conservation Policy Issues and End-Use Scenarios of Savings Potential--Part 5. Energy Efficient Buildings: The Cause of Litigation Against Energy Conservation Building Codes

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ENERGY CONSERVATION: POLICY ISSUES AND END-USE SCENARIOS OF SAVINGS POTENTIAL

PART 5

ENERGY EFFICIENT BUILDINGS: THE CAUSES OF LITIGATION AGAINST ENERGY CONSERVATION BUILDING CODES

September 1978

Lawrence Berkeley Laboratory
University of California, Berkeley

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ENERGY CONSERVATION: POLICY ISSUES AND END-USE SCENARIOS OF SAVINGS POTENTIAL

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FOREWORD

The enclosed work is based upon our previous research during this fiscal year, contained in "Construction of Energy Conservation Scenarios: Interim Report of Work in Progress", LBL 7834, June 1978. The focus of our current work was determined in consultation with the Director and staff of the Conservation and Advanced Energy Systems Policy Office, DOE, following their review of our interim report. At that point we agreed on several guidelines for our subsequent work:

1. Take a wholistic view of energy conservation policies by describing the overall system in which they are implemented;
2. Provide analytical tools and sufficiently disaggregated data bases that can be adapted to anwer a variety of questions by the users;
3. Identify and discuss some of the important issues behind successful energy conservation policy;
4. Develop an energy conservation policy in depth.

In addition to these guidelines, we selected five subjects to investigate.

1. Recycling: an analysis of the energy, economic, and environmental tradeoffs between landfill and combined programs of resource recovery and energy generation from waste.
2. Industrial Decision-Making: a methodology to identify potential barriers to energy conservation by analyzing how a conservation measure's attributes interact with the characteristics of an industrial subsector.
3. Recreational Travel: information strategies to effect a modal shift to public transit for the recreational trip.
4. Residential and Commercial Buildings: an examination of court cases against new energy efficient building codes and suggestions for avoiding future litigation.
5. End Use Energy Conservation Data Base: completion of energy conservation scenarios by calculating the energy conservation potential of specific measures applicable to particular end uses.

Our current work results from the application of the overall guidelines to the above subjects. For example, we have described the system in which each policy or issue is set by the use of flowcharts and accompanying text. In some cases, the flowchart describes a physical activity (constructing buildings or recycling waste materials). In other cases, it describes a decision-making process (industrial investment or transportation modal choice).

We have provided disaggregated quantitative data wherever they are relevant--recycling, recreational travel, industrial decision-making, and the end use scenarios. We have discussed several policy issues for which these data are relevant:

1. What are the tradeoffs between landfill and combined resource recovery-garbage to energy programs.
2. What are the stated and underlying causes of law suits against building codes.
3. How can the present modal distribution that is heavily weighted toward the automobile be shifted to public transit for the recreational trip.
4. What are the conditions that present barriers to energy conservation investment in the industrial sector.

In the case of recreational travel, we have developed a specific policy to link national parks with public transit.

Our results for each of the five subjects are bound separately; the subjects do not readily lend themselves to integration and the DOE staff did not think it would be useful to attempt one. We have issued a separate summary volume for those who want an overview of all the subjects investigated.

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Although a number of individuals contributed to this work, a few people were primarily responsible for researching and writing each part:

Part 2 Ricardo Codina
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SECTION 1: THE CAUSES OF LITIGATION AGAINST ENERGY CONSERVATION BUILDING CODES

I. INTRODUCTION

A. DIFFERENT PURPOSES OF ENERGY CONSERVATION BUILDING CODES

Two types of energy efficient building codes are distinguished here. The first tries to make building practices ore uniform--it requires some builders to upgrade their work, while others make few changes. In many cases, the purpose of these codes is also to protect the interests of labor groups, materials suppliers or insurance companies. Such codes have traditionally been written by professional associations of the building industry.*

The second type of code tries to achieve as much conservation as is cost effective for the home occupant. Such codes are usually more rigorous, and intend to alter const uction practice through a non-market mechanism. They are usually more disruptive to the building industry, often entail a significant rise in construction costs, and may provoke legal challenge by the affected industries. The following discussion is most relevant to the second, more rigorous, type of code.**

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* This description applies to most non-energy building codes now in effect as well as to most new energy conservation building codes. To promote uniform energy conservation codes, the American Society of Heating, Refrigeration and Air Conditioning Engineers has drafted a model code known as ASHRAE 90-75. Codes based on this model are of the first type, including the code now enacted in Massachusetts (Dinezio _et al_ 1977), and the code proposed for commercial buildings in New York State (see Flack, _et al_ 1977, Carter 1978).

** Examples of the second type of code are the 1978 Farmers Home Administration Thermal Performance Standards and the 1978 California Residential Building Code.

The proposed 1979 federal standards (still being finalized) are only indirectly based on cost effectiveness--they more directly attempt to ease changes for the construction industry. The energy-efficiency mandated by the new standards is already found in at least 20% of recently constructed buildings. Compared to optimum cost effectiveness codes, the new federal standards are less rigorous, less likely to be challenged by the building industry, and will have a lesser impact on national energy consumption.

B. COST CALCULATIONS AS A BASIS FOR CODES

Even small improvements in conservation design save energy, and lax requirements do have the advantage that builders can easily adjust to them. But from both a consumer viewpoint and an energy conservation viewpoint, the best building code would require at least as much conservation as is cost effective for the building user (Rosenfeld, et al 1978). Such a code has not yet been designed for non-residential buildings. California has attempted to design such a code for residential buildings (California Energy Commission 1978).

The design of a cost effective code must weigh savings in lower utility bills, computed from projected use and future prices of energy, against the cost of building improvements amortized over the life of the building. Construction cost increases result from additional insulation, double or triple pane windows, two-by-six exterior framing (to accommodate R-19 wall insulation) and the installation of expensive, efficient heating and cooling systems. If a code is truly performance-based, and therefore permits design innovations, such costs will be highest immediately after implementation, but will decline as builders learn more efficient ways of achieving the same energy savings (Cochran 1978:4). More efficient techniques would include improved conservation methods or passive solar designs.

C. CASES REVIEWED

We have considered litigation against the following three codes:

1. The California nonresidential code (1976).

This code was challenged by a building industry interest group called Building Code Action (BCA). BCA successfully argued that, although the state legislature had mandated a performance code, the proposed code was effectively prescriptive. Although the code permitted alternative designs, the difficulties in approving alternatives would have been prohibitive. The court ordered the state both to rewrite the code to included performance "energy budgets" and to provide a computer program to calculate energy budgets (Bostick 1976).

2. The California residential code (1978).

This case, also brought by BCA, alleged that the code's cost calculations were incorrect and that BCA was deprived of adequate opportunity to analyze and rebut those calculations (Kipperman *et al* 1978). A challenge on the grounds of cost calculations carries weight in California because the state Energy Commission is prohibited from promulgating regulations which are not cost effective.* Without ruling on the accuracy of the cost calculations, the court set aside the strongest sections of the code (such as R-19 wall insulation) because public comment had not been adequately considered (Broderick 1978a, 1978b). This case is currently being appealed by the California Energy Resources Conservation and Development Commission.

3. The Farmers Home Administration code (1978).

The National Association of Home Builders (NAHB) alleged that the Farmers Home Administration (FmHA) acted unlawfully by not submitting an environmental impact statement; that the code was deficient because it did not allow for different heating systems; and that the burden of increased costs would injure both builders and low-income home buyers. The District of Columbia U.S. District Court temporarily enjoined FmHA from enforcing the standards and required an assessment of the environmental consequences of the code. The court finally ruled in favor of FmHA on every point.

D. SCOPE OF THIS REPORT

Although these three suits were brought by the building industry, this report also discusses considerations relevant to architects, bankers and building inspectors. These cases are discussed from three perspectives: 1) objections to the codes explicitly stated in court, 2) industry conditions and practices behind objections stated in court, and 3) general beliefs not stated in court.

This discussion focuses on suits intended to limit those building codes which the building industry sees as too strong. However, some energy conservation industries may sue to strengthen codes which *they* consider too weak. An example of such a case is Polrized Corporation's current suit against the lighting section of ASHRAE 90-75 (Los Angeles Federal District Court, see Murnane 1978).

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* "Such [building] standards shall be economically feasible in that the resultant savings in energy procurement costs shall be greater than the cost of the energy conserving requirements amortized over the economic life of the building." (Warren-Alquist 1974: Chapter 5, Section 25402a, also cited in Broderick 1978a: 2-4).

II. OBJECTIONS TO CODES STATED IN COURT

A. HIGHER CONSTRUCTION COSTS

Higher first cost of housing, caused by higher construction costs, has been a major objection cited in all three lawsuits. Both first cost and operating costs are important to the occupant of a building, but the construction industry is more attuned to minimizing first cost. In the past, builders have not suffered from higher operating costs, and have not been very aware of them. Builders anticipate the following effects of higher first costs:

1. Low Appraisals

In the FmHA suit, NAHB claimed that appraisals of the new houses would not reflect the increased costs of construction. Appraisals, and thus sale price, are limited by the terms of the FmHA loan program to the value of "comparable buildings," regardless of construction costs. NAHB expressed concern that their builders would not be able to recover higher construction costs.

2. Fewer Buyers

If at all possible, builders will pass their increased costs on to buyers. But if builders raise prices, they say they are concerned that lower-income home buyers will be priced out of the market, resulting in reduced housing starts.

3. Loans Not Available

Capital shortages in the loan market and higher costs may mean both fewer construction loans to build and fewer mortgages to buy houses.

B. INFLEXIBLE PRESCRIPTIONS

Any building code can discourage innovation. Prescriptive codes explicitly require specific components or devices to conserve energy--thus making innovation impossible. Performance codes written to allow "alternative designs" may in practice prohibit them because of excessive red tape or the uncooperativeness of local building inspectors.

C. LACK OF MATERIALS

The greatest possible shortages are in glass fiber and mineral wool insulation (Mongoven 1977). Even if they can be obtained, delays in delivery can be costly to a builder holding construction loans and keeping contractors waiting. Glass fiber manufacturers are expected to expand production substantially in 1979 and 1980, while new cellulose insulation plants are now opening at the rate of 12 per month nationwide. Substitution of cellulose for fiberglass will be limited due to more difficult installation in new buildings and the quality control problems associated with such rapid expansion.

D. LENGTHY PAYBACK PERIODS

In the FmHA case, NAHB suggested that the first buyer should be able to recoup the entire investment. It reasoned that, since conservation improvements will have little effect on house appraisals, any investment not recouped through savings in energy bills will be lost when the first buyer sells his home. Given current energy prices and the awareness of appraisers and lending institutions, this assertion is probably correct.

E. COLLAPSE OF CERTAIN INDUSTRIES

In particular, manufacturers of electric resistance heating devices will be severely hurt by performance-based codes. If such industries have not diversified, some negative impacts are inevitable.

III. INDUSTRY CONDITIONS BEHIND OBJECTIONS STATED IN COURT

A. PREDOMINANCE OF SMALL INDEPENDENT BUILDERS

The industry is characterized by many small independent businessmen who are not in close contact with professional associations. These independents are difficult to reach in education programs; consequently they are not likely to understand the rationale behind new codes, and adjustment to the new codes will be difficult. For the same reasons, change through other means, such as market forces or information from professional associations, would be expected to take place slowly. Thus building codes, which mandate change, may be the only mechanism for rapid alteration of construction practices.

B. SLOWLY CHANGING BUILDING PRACTICES

Building practices change slowly, and builders can experience unexpected hardships in the transition to new code-mandated practices. The requirment of R-19 wall insulation and thus two-by-six framing provides an example. Some analysts have predicted that there will be no increased cost in converting from two-by-four to two-by-six exterior framing. Such analysis assumes that the structural integrity previously achieved by 16 inch center-to-center framing can now be obtained with 24 inch center framing. Thus, it was predicted that the same amount of lumber and less labor would be required. However, other aspects of construction such as standard layouts, cost calculation formulas, and top plate sizing are all oriented to 16 inch centers. Thus, the first reaction by contractors to a new code may be to put two-by-six framing on 16 inch centers, raising construction costs considerably. Another example is the sizing of heating and air conditioning equipment--better weatherized buildings usually allow smaller equipment, but builders may continue to install the same size.*

C. BIASES OF ARCHITECTURAL TRAINING

Architectural training is aimed primarily at creative visual design rather than the solution of social problems. Many architects are critical of any building code because it restricts their creativity (Nader <u>et al</u> 1977). Architects interested in energy efficiency or solar designs are especially critical of prescriptive building codes. Given the specific site, microclimate and occupancy, they can usually design a more efficient building for lower cost. Another problem is that architects are frequently working for a client who will not be the building's user and who is not interested in minimizing operating costs.

D. INTEREST GROUP MOMENTUM

Faced with new and complex building codes, the industry may form groups to evaluate and combat such legislation. Once established, such a group will naturally want to prolong its existence. Such quasi-independent litigation-oriented groups might try to sell the need for lawsuits to the building industry in order to provide continued work and prestige for themselves.

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* Oversizing is also encouraged by the practice of giving contractors a percentage of the sale price of the equipment.

IV. GENERAL BELIEFS NOT STATED IN COURT

A. LAISSEZ-FAIRE ECONOMICS

Most individuals in the building industry feel that the market should determine what is built. Government regulations generally are seen as restricting freedom. For example, a building code that is uniform across a large area may prohibit techniques appropriate in particular local areas. "Excessive regulations" may be seen as a means of expanding governmental power and bureaucratic control. Such views are encouraged by those building inspectors who follow the letter but not the spirit of regulations. The belief in a free market is not extended to federal subsidies and lending regulations which currently assist the industry.

B. LACK OF DEMAND FOR MORE EFFICIENT BUILDINGS

Builders are in contact with realtors and buyers and say they have seen little evidence of demand for the levels of efficiency required by the most rigorous codes.

This apparent lack of market signals may be misleading for several reasons. Since almost no highly efficient houses have been built, the public has no way of choosing or even knowing that there is a choice. Furthermore, buyers do not necessarily purchase for cost effectiveness. They may buy additional insulation for comfort (Drossler Research 1975) or solar heating for prestige or ecological concerns.* In general, the industry likes to consider itself as responding to demand, rather than admitting that demand for efficient homes is determined in part by availability and advertising.

C. RAMIFICATIONS

If the building industry assumes that the market should decide and that buyers do not want more efficient buildings, then many of their specific allegations made in court logically follow. For example, since buyers have not asked for highly weatherized buildings, a builder might conclude that such buildings are not cost-effective. If there is no demand and the buildings are not cost-effective, builders naturally expect that appraisals will not rise as much as construction costs. To insure cost-effectiveness for the client and to overcome the problem of second sale price's

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* A recent real estate marketing study found 30% of Southern California home shoppers willing to buy houses with solar additions, including solar equipment which is uneconomic at todays energy prices (Clay 1978).

not reflecting higher costs, they argue that payback should be computed for only the first occupant and not for the life of the building. Unfortunately for national energy goals, these arguments will continue to be persuasive as long as efficient buildings are not widely available and energy prices remain at artificially low levels.

V. RECOMMENDATIONS

A. MAKE CODES TRULY PERFORMANCE BASED

Codes which contain performance sections may in fact be prescriptive because they require prohibitively difficult calculations or lengthy application procedures. The suit against the California nonresidential code demonstrates that these problems can be sufficient to enjoin enactment of such codes.

Future codes should be explicitly based on performance "energy budgets" as required by the Energy Conservation Standards for New Buildings Act of 1976 (P. L. 94-385). However, since _ost builders will not bother with their own energy budget calculations, codes must also include a prescriptive section giving specific components and techniques which can be used to meet the energy budget.

But "performance codes" alone are not enough. At present, local building inspection departments are unable to evaluate properly many proposed designs, such as passive solar plans. At the time performance codes are implemented, special staff and facilities must be allocated for plan checks, to inspect and approve new designs. Another possibility would be for local building departments to contract out plan checks to independent engineering firms.

Building inspectors do not want to take responsibility for plans or techniques with which they are unfamiliar. This caution will inevitably impede the approval of new designs, and can make a performance code *de facto* prescriptive. If a licensed engineer (either from the state or from an independent firm) signed plan checks, the local building department officials would be relieved of such responsibility.

..ORK WITH LENDING INSTITUTIONS

Lenders should be made aware of the mortgage advantages of efficient homes. With lower utility bills, a larger percentage of the buyer's income will be available for mortgage payments (Booz-Allen and Hamilton 1977). Such mortgages will also be more predictable and stable. The lender determines mortgage payment schedules, but has no control over future energy prices. Finally, a mortgage is paid evenly through the year, while in northern climates the large seasonal fluctuations in energy costs can precipitate mortgage default.

A cost-effective building code minimizes adverse financial impact on the buyer, since higher mortgage payments are balanced by lower utility bills. However, if lenders do not recognize the buyer's increased ability to pay, they may not be willing to make the slightly higher loans necessary to buy more expensive efficient houses. Prior to implementation of building codes, the implementing agency should inform lenders about the financial advantages of efficient housing, so that lenders can offer the appropriate incentives to buyers of such houses. In the resale of old buildings, lenders would have more information if they could easily obtain records of utility bills before making loans. Favorable reaction by lending institutions would eliminate many builders' concerns about higher costs.

C. MAKE COST CALCULATIONS UNDERSTANDABLE TO THE PUBLIC

Policy makers drafting building codes consider both the entire lifespan of a building and anticipated energy prices. Builders, on the other hand, see that the new codes are a great departure from accepted practices and object that buyers do not want the required modifications. Houses meeting new codes are widely described as "overinsulated" by construction industry people. We spoke with one contractor who incorrectly supposed that cost calculations from the Lake Tahoe area had been used to determine requirements for the milder San Francisco climate. In the past, such perceived discrepancies between actual needs and mandated building codes have been attributed accurately to pressures from interest groups.

If the public (including builders) is to accept rigorous new codes, the cost efficiency calculations they are based on must be made comprehensible. For example, public information could compare today's average annual heating bill with that expected in 1988 for a similar house. The 1988 heating bill could then be compared to that of a house built according to the new building code. The cost of upgrading during new construction could also be compared to the cost of retrofitting an existent house.

Low government credibility could reduce the effectiveness of such an information program. But if the building code is well written, it would be supported by environmental and consumer groups which currently enjoy relatively high credibility. Energy conservation building codes offer a common solution to the goals of diverse public-interest groups--one example is the Amici Curiae filed in support of the FmHA standards by Rural America, Inc, and Natural Resources Defense Council (Lash and Roisman 1978).

Conservation building codes answer public concerns for both the development of energy policy and the reduction of the cost of living. Special-interest groups would be more reluctant to impede publicly the implementation of such codes if they were widely recognized as reducing waste, energy use, and consumer expenses.

VI. UNDERLYING ISSUES

A. WILL THE MARKET MAKE THE NECESSARY ADJUSTMENTS?

If market operation can change building design, conservation building codes are unnecessary and counter-productive. Many considerations argue against the market's adequacy in making the necessary adjustments: 1) Although most buildings will last more than 30 years, current building market decisions are based on current energy prices--codes can more easily be based on projected prices. 2) With respect to energy, most homebuyers do not fit the model of the rational economic actor: while some may choose special energy features for comfort, prestige or out of ecological concern, the majority do not consider utility bills when buying a house. 3) New conservation building techniques will usually require a rethinking of building procedures, higher costs in the transition period, and temporary shortages of materials. But even if new techniques are cost effective, builders make cost estimates from what they know--current conditions--so they may overestimate long range costs and choose not to change. 4) Given current energy prices and public awareness, the seller of a higher-priced efficient home is at a competitive disadvantage. This problem disappears if all buildings must meet the same efficiency standards.

B. SHOULD BUILDING CODES BE USED FOR LONG-RANGE PLANNING?

In the past, building codes have been used to protect industry interests and to regularize building practices. Building codes which maximize cost effectiveness for the occupant depart from such past purposes and intend to bring about a non-market <u>change</u> in building practice. The failure of market forces, the longevity of housing stock, and the large amount of energy involved argue for such mandated change.

Depending on factors such as those discussed in this paper, strict government standards may be seen either as an unfair burden on builders and home buyers, or as protection for the home occupant and an effective component of energy policy. If they are perceived as unfair, then many of the objections that have arisen in the past are likely to be made again. Initiators of such codes should be prepared for these objections.

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PERSONAL CONTACTS

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SECTION 2: A DESCRIPTION OF THE BUILDING PROCESS

I. EXPLANATION OF THE FLOWCHART: DIAGRAM 3

The large flowchart provides an overview of the building process and can be used to assess the impact of proposed policies. The chart is composed of two major elements: a base chart in blue line form and a transparent overlay chart. The base chart diagramatically portrays the current building process from inception through construction, occupation and eventual demolition. Included are the links, the actors, resources, policies, decisions, information and regulations of the process with an emphasis on how information about energy efficient buildings is currently incorporated. The flowchart has blank spaces where other relevant factors, such as environmental concerns, could be added. As an aid to reading the flowchart, simplified versions are included at the end of this section. The overlay reveals the points in the building process affected by policies designed to increase the energy efficiency of the buildings. A more detailed discussion of the three policies illustrated on the overlay is presented in "Construction of Energy Conservation Scenarios: Interim Report of Work in Progress," LBL 7834, June 1978.

THE BASE CHART is ivided both horizontally and vertically. The vertical divisions represent the major sequential activities in the building process: a) programming, b) development planning/design, c) construction, d) completion/delivery, e) occupancy/maintenance, and h) destruction and replacement. The horizontal divisions both above and below represent the inputs flowing to these stages of the building process: Policies/regulations/standards, actors and motivations lead to the provision of either the resources (odd numbered) or the information (even numbered) necessary for the completion of any stage in the building process.

For the actors who provide the resources and information, the diagram presents the factors that both motivate and constrain their decisions. The diagram also indicates the relationship between primary and secondary actors. The diagram expands only some areas, emphasizing points where a change could encourage energy conservation. Once such a point is identified, the policy designer can trace the consequences of this change back through the actors providing the information or resource, the policies and standards affected, etc. For example, one may discover that the resources or information are not being provided in the existing system and need to be created. In the following discussion references to labelled points on the chart are underlined and two horizontal sections are in quotations. This section is written to elaborate on the flowchart and should be read while examining it.

In the programming phase, it becomes important to integrate energy considerations into the decision making processes. The diagram reveals that virtually the only way that energy considerations have been integrated into the process is through "Standards, Policies or Regulations" (section 6) in the form of energy codes. This is one form of information (input section 2) that has been incorporated. User needs exhibit no formal means of being integrated. Other social concerns might also be added on that level, such as environmental or health and safety. Energy concerns were once left unconnected, just as user needs presently are. The inclusion of one information input and not the other can be explained in terms of a "reward". Energy is topical; energy efficiency potentially enhances the marketability of a building, in contrast to environmental concerns or user needs. The crucial actor is the entrepreneur who makes decisions on the basis of the project's expected profitability; this is noted in the diagram by profit motive. In order for energy to become an important variable, it should be present as an information input in as many points as possible that affect the entrepreneur.

The next effective point of integrating energy considerations in the programming phase is at the "resource" level (section 1) by affecting outside investments. The entrepreneur relies on an outside source of money to construct a building. Mortage bankers are quite conservative in their lending practices. If they could be persuaded that energy efficient design is a "good" investment, this would influence the entrepreneur's decisions.

A third conduit for injecting energy into this process is the designers ("actors", section 4). Energy codes do not affect the designer directly but rather affect program feasibility. However, Licensing does have a direct influence on the designer as do professional codes. If these latter two inputs were oriented toward energy concerns designers could more readily design an energy efficient building. Continuing education or formal training (level 6) would provide a firmer base for such designs.

AT THE DEVELOPMENT PLANNING/DESIGN phase, the inclusion of energy concerns depends on 1) availability of adequate and credible information and 2) time necessary to integrate this information into the building process. The idea of the information source was discussed in the previous section on PROGRAMMING and is quite similar here. The difference lies in the degree of specificity of the information: in this phase, it needs to be more detailed and concrete, for example, prototypical building designs with projected energy consumption. Similarly the information that is used can be traced back through the chart to reveal points of influence. On the "policies" level (level 6) energy codes again appear--here they directly affect design. It is important that the designers be motivated to use the codes and that the codes be flexible and easy to use.

At the CONSTRUCTION phase, successful energy conservation depends upon the availability of appropriate materials and trained personnel to implement the design. Reliable materials are necessary in order to avoid problems such as those caused by inadequate fireproofing of cellulose insulation. Building materials and manpower appear on the "Resources" level (level 1) and can be affected by "actor groups" and "actors" (levels 3 and 5). Interim construction loans, also on the "Resource" level, may be required if adding energy conserving materials increases the initial costs. Marketing and advertising (level 2) can help to offset the additional costs that may be incurred during construction. For example, the promoter of the building can emphasize the increased energy efficiency of the home or its decreased life cycle costing as selling points. An educated public's tendency to purchase such buildings would be a further incentive to the entrepreneur, who is still the primary decision maker at this phase of the process.

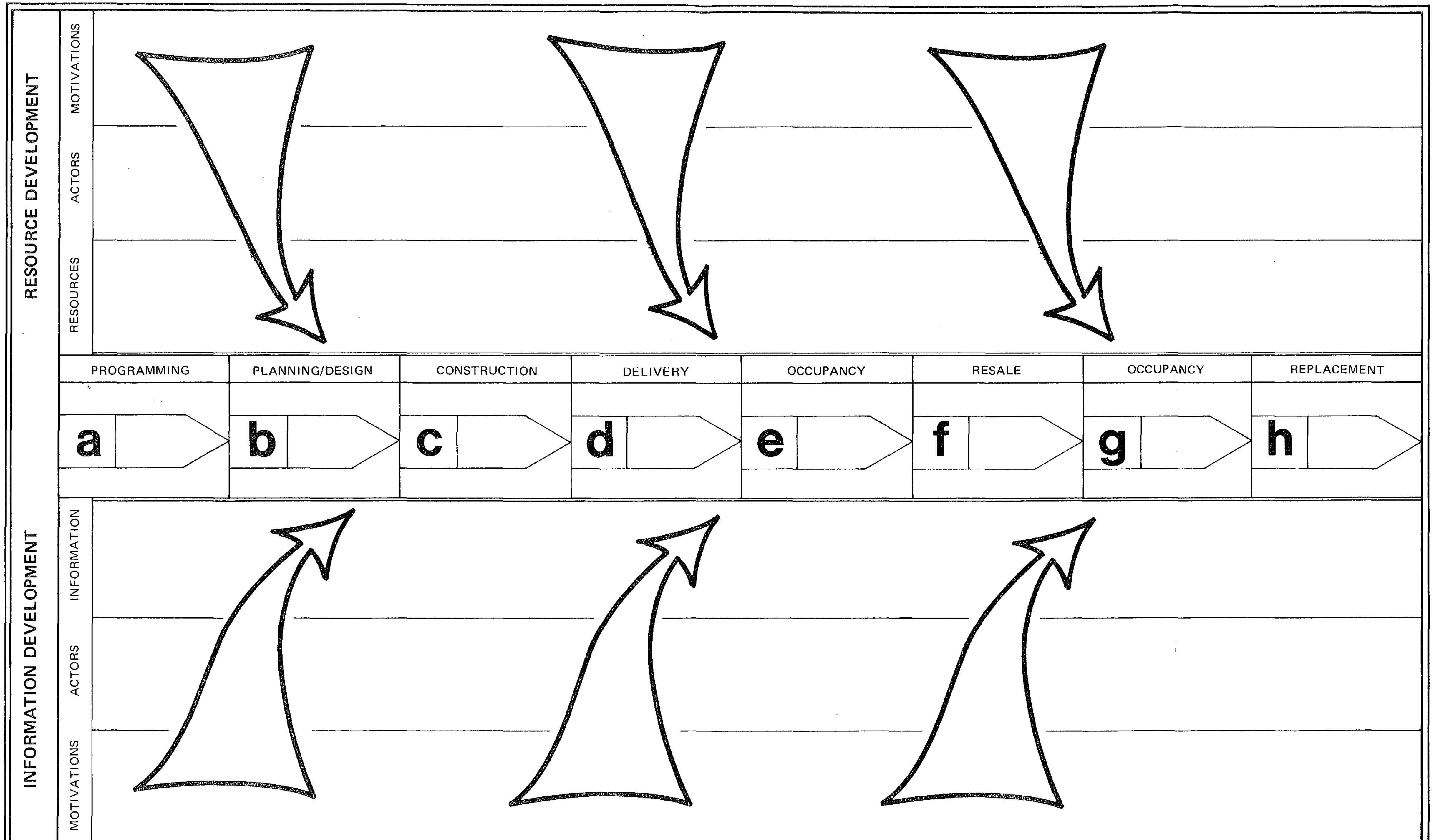
The choice of appliances becomes critical in terms of the overall energy consumption of the building at the COMPLETION/DELIVERY phase. By this time, the building envelope is complete and will probably not be changed until the next phase of the process. Appliance equipment appears on the "Resource" level (level 1) and can be traced to supply companies. This diagram does not elaborate the effect of regulation on the production of equipment. The availability of money is again crucial at this phase as noted by the permanent loan and mortgage box on the "Resource" level. Tracing this resource through the diagram reveals the potential impact of FHA or general banking decisions.

At the OCCUPANCY phase, the same actors and resources of the COMPLETION phase are still important since residents are likely to purchase new appliances during their occupancy of the building. These decisions need to be informed and supplied with capital should the initial cost of an energy conserving device be higher than that of a standard one. At the "information input" level (level 2), property management program refers to the behavioral impact that the particular lifestyle of a resident may have on the energy consumption of a particular building. The best design and choice of appliances can be defeated if the occupant is ignorant of energy use consequences of his/her behavior.

II. SIMPLIFIED FLOWCHARTS: DIAGRAMS 1 AND 2

BUILDING PROCESS

DIAGRAM I



BUILDING PROCESS

DIAGRAM 2

		PROGRAMMING	PLANNING/DESIGN	CONSTRUCTION	COMPLETION/DELIVERY	OCCUPANCY/MAINTENANCE	RESALE	OCCUPANCY/MAINTENANCE	DESTRUCTION/REPLACEMENT
RESOURCE DEVELOPMENT	POLICIES STANDARDS REGULATIONS EDUCATION 11								
	ACTORS 9								
	POLICIES STANDARDS REGULATIONS EDUCATION 7								
	ACTORS 5								
	ACTOR GROUP 3								
	RESOURCE 1	MONEY, LAND	MONEY, LAND	MONEY, LAND, ENERGY, MANPOWER, MATERIALS, EQUIPMENT	MONEY, EQUIPMENT, APPLIANCES	SERVICES, MONEY, ENERGY, APPL, EQUIP, MAT	MONEY, MATERIAL	SERVICES, MONEY, ENERGY, APPL, EQUIP, MAT	MANPOWER, EQUIPMENT, ENERGY
		PROGRAMMING a →	DEVELOPMENT PLANNING b →	CONSTRUCTION c →	COMPLETION DELIVERY d →	OCCUPANCY MAINTENANCE e →	RESALE f →	OCCUPANCY MAINTENANCE g →	DESTRUCTION REPLACEMENT h →
INFORMATION DEVELOPMENT	INFORMATION 2	NEEDS, COSTS, RETURNS, MARKET, CODES, REG	CODES, COSTS, DESIGN, SALES STRAT, MASTER PLAN	SCHEDULING, PERMITS, FEES, INSPECTION, INSURANCE, MARKETING PROGRAM	PERMITS, INSURANCE, LEGAL	PROPERTY MANAGE MENT, COST MANAGE MENT	MARKETING, ASSESSMENT	PROPERTY MANAGE MENT, COST MANAGE MENT	PERMITS, FEES
	ACTORS 4								
	POLICIES STANDARDS REGULATIONS EDUCATION 6								
	ACTORS 8								
	POLICIES STANDARDS REGULATIONS EDUCATION 10								
	UNIT OF TIME	4X TO 8X ⇒	X/2 ⇒	X ⇒	X/2 ⇒	X/5 TO 20X ⇒	X/2 ⇒	5X TO 10X ⇒	⇒

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