MOBILE-COMPONENT HOUSING AND SOLAR ENERGY: THE POSSIBILITIES

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ABSTRACT

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<u>Mobile-Component Housing and Solar Energy: The Possibilities</u>

This paper is part of a body of work directed at enhancing the acceptance of photovoltaics in various sectors of the U.S. economy. The focus here is on residential applications. The work is funded by the U.S. Department of Energy as part of its photovoltaics program. Earlier work has considered the nature of institutional forces in the housing sector generally, including a study of several housing developments incorporating solar thermal technologies with the assistance of the HUD-DOE Solar Heating and Cooling Demonstration Program. This earlier work resulted in a series of papers summarizing the application of institutional analysis methods to housing, including a research design (Nutt-Powell, 1979), and preliminary sector explorations covering housing production (Swetky and Nutt-Powell, 1979), governmental involvement in housing (McDaniel and Nutt-Powell, 1979), research and socialization in housing (Furlong and Nutt-Powell, 1979), energy provision in housing (Reamer, Heim and Nutt-Powell, 1979), and standards in housing (Parker and Nutt-Powell, 1979). The housing development case studies are reported in three papers (Nutt-Powell et al., 1979; Nutt-Powell, 1979b; Parker, 1980.) Additionally a separate analysis was undertaken of the HUD-DOE program, focused on implications for program design of PV acceptance in the housing sector (Nutt-Powell, 1980). This analytic work has paralleled and contributed to development of specific approaches to residential acceptance, including a Residential Application Implementation Plan (MIT EL/LL, 1979).

The various studies and plans completed to date have taken a very broad view of the housing sector. As the technology develops, coming closer to cost and production feasibility on a large scale, it is appropriate to begin more detailed analyses of the housing sector. Among such detailed analyses are those considering the possibilities for acceptance of PV among different modes of housing construction. This paper is one such analysis. The focus is on that form of housing production defined as "mobile-component housing," a type of housing built in a factory to a single national construction standard administered by the U.S. Department of Housing and Urban Development.

There are four sections in this paper. The first section describes the structure of the manufactured housing industry. It provides definitions and terminology necessary to a discussion of mobile-component housing.

It then reviews the production activity and approach, distribution, consumer and financing for this mode of housing. The second section presents the product characteristics of mobile-component housing. The third section reviews solar technologies, and discusses their relation to mobile-component housing. The fourth section focuses specifically on factors influencing receptivity to solar by the mobile-component housing industry. The conclusion to this paper summarizes the analysis as it relates to the possibilities for photovoltaics in mobile-component housing.

Acknowledgements

We are appreciative of the assistance of several individuals in providing information useful to our studies of M-C housing and solar technology. In particular we would like to mention Howard Snider, President of the Western Manufactured Housing Institute, who has been most gracious in facilitating access to the industry. A group of marketing and produce development executives provided useful insights to factors influencing solar acceptance, including Chuck Smedley of Guerdon Industries; Gary Pomeroy of Golden West Homes; Bob Barnes of Pacific Living Systems; Jon Nord and Don Wichman of Fleetwood Enterprises. Jon Rosenbaum of Fleetwood was helpful in providing pertinent marketing data.

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THE STRUCTURE OF THE MANUFACTURED HOUSING INDUSTRY

Definitions and Terminology

Manufactured housing is a generic term meaning housing produced in a factory. It is distinguished from regular site-built housing, which is constructed mostly at the building site. The distinction is not rigid, however. While there is a certain amount of site work needed on most maunfactured housing, certain parts of site-built housing (roof trusses or preassembled/prehung windows and doors, for example) may be manufactured.

There are two broad distinctions in manufactured housing, which define two housing types. The first housing type is built to state-adopted building codes, which, in turn, are generally modelled on national or regional model codes such as the Uniform Building Code (UBC). The second housing type is built to a single national standard, embodied in the Federal Mobile Home Construction and Safety Standards administered by the U.S. Department of Housing and Urban Development. This latter is known as the HUD Code.

The National Association of Home Manufacturers has nine product classifications for manufactured homes which apply to housing built to state codes:

i Pre-cut and/or shell homes

ii Components

iii Panelized homes

iv Mechanical or utility cores

v Modular or sectional homes

vi Log homes

vii Geodesic dome homes

viii Multi-family homes

ix Commercial structures[1]

These classifications are based on differences in the extent of completion at the factory, on construction style, and on use of the manufactured structure.

Manufactured housing built to the HUD code is often referred to, albeit inaccurately, as "mobile homes," as a result of its evolution from travel trailers, through truly mobile homes, to include an entirely new product. In this paper the term "mobile-component housing" (M-C housing) will be used to refer to housing built to the HUD code. The term M-C housing reflects two basic characteristics of this form of housing. First, it involves three-dimensional components which are themselves mobile. Second, it becomes housing when the components are joined together at the site of occupancy and connected to appropriate services and utilities. Single-component M-C housing is structurally complete on leaving the factory. (Figure 1 shows an example of M-C housing of from one to four components.)

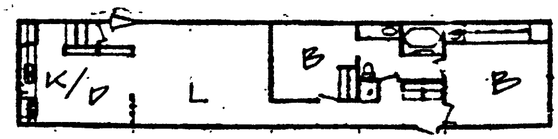
An essential part of any mobile-component is a sub-component which serves both as a chassis for transporting it and as an integral structural element. Thus, the components are mobile *per se*; they do not require additional transportation capability. However, after the initial move from factory to site the M-C house is, in most cases, no longer mobile.[2]

The components of M-C houses tend to be built to widths which conform to maximum permissible highway loads. Most states permit fourteen foot widths on their highways, some permit sixteen. California, however, allows only twelve foot modules, while Nevada allows twenty-eight. This width control had led to the industry terminology, "single-wides" and "double- (or multi) wides." A parallel usage is "single-section" and "multi-section." Figure 1 shows various combinations, including a two-component M-C house in which the second component is a small expansion of the living room.[3]

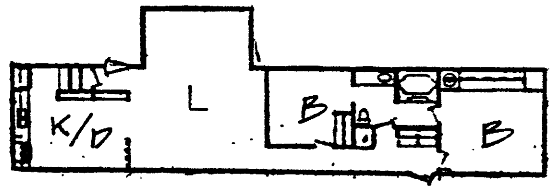
Production Activity

During the 1970s the number of M-C houses built has varied between 200,000 and 600,000 units per year, the divergence reflective of economic conditions in any given year. Table 1 summarizes manufacturer shipments during the time period 1950 through 1978, with estimates of the aggregate sales volume for each year. Nineteen-seventy-eight sales are estimated at nearly $4.5 billion. M-C homes have constituted about one-quarter of the new single-family dwelling market for the past several years. Table 2 provides a comparison for 1975-78. The relative proportion of single to multiple component M-C houses has steadily shifted toward the larger, multiple component unit. Table 3 provides a comparison of proportion of total shipments from 1972-1978. In 1972 about one-sixth of shipments were multiple component M-C homes, while in 1978 such homes constituted one-third of shipments. Shipment activity varied by state. Data for 1978 shipments is found in Appendix A.

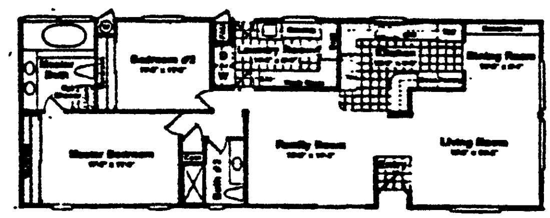
a. single-wide



b. single-wide — expandable



c. doublewide



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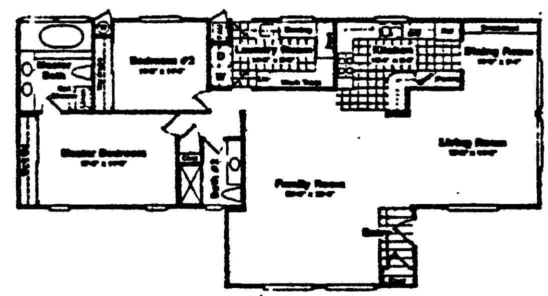
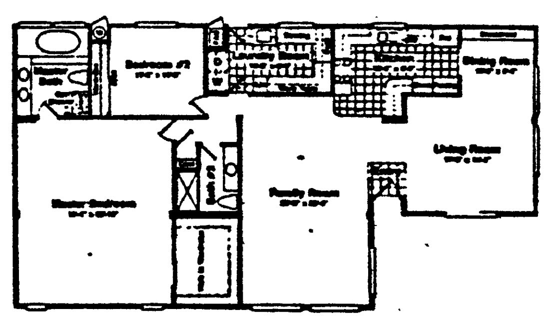


e. triple-wide



f. quadruple-wide

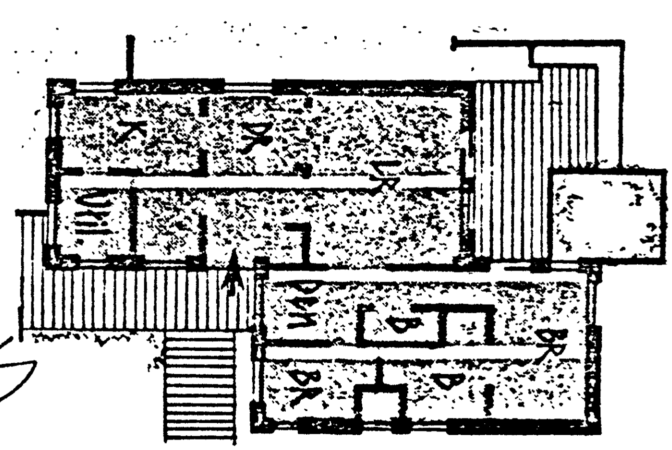


FIGURE 1.
TYPICAL FLOOR PLANS

Table 1 M-C Housing Shipments and Sales 1950-1978

Year	Manufacturers' Shipments to Retailers in U.S.	Retail Sales (ESTIMATED)
1978	274,901	$4,378,000,000
1977	265,145	3,765,000,000
1976	246,120	3,136,616,000
1975	212,690	2,432,661,000
1974	329,300	3,213,681,000
1973	566,920	4,406,382,000
1972	575,940	4,002,783,000
1971	496,570	3,297,225,000
1970	401,190	2,451,271,000
1969	412,690	2,496,775,000
1968	317,950	1,907,700,000
1967	240,360	1,370,052,000
1966	217,300	1,238,610,000
1965	216,470	1,212,232,000
1964	191,320	1,071,392,000
1963	150,840	862,064,000
1962	118,000	661,000,000
1961	90,200	505,000,000
1960	103,700	518,000,000
1959	120,500	602,000,000
1958	102,000	510,000,000
1957	119,300	596,000,000
1956	124,330	622,000,000
1955	111,900	462,000,000
1954	76,000	325,000,000
1953	76,900	322,000,000
1952	83,000	320,000,000
1951	67,300	248,000,000
1950	63,100	216,000,000

Prior to 1950, production varied from 1,300 in 1930 upward to 46,200 in 1949.

SOURCE: MHI, 1979.

Table 2 Comparison of M-C House Shipments and Sales of Single Family Site-Built Houses 1975-1978

All Prices

	1975	1976	1977	1978
Site-Built Houses				
Houses Sold	550,000	647,000	820,000	817,000
Percent of total Site-Built Houses sold M-C Houses Shipped	72%	72%	76%	75%
M-C Houses				
Houses Shipped	212,690	246,120	265,145	274,901
Percent of Total Site-Built Houses Sold & M-C Houses Shipped	28%	28%	24%	25%
Total New One-Family Site-Built Houses Sold & M-C Houses Shipped	762,690	893,120	1,085,145	1,091,901

SOURCE: MHI, 1979

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Table 3 Comparison of Single and Multiple Component M-C House Shipments 1972-1978

	1972	1973	1974	1975	1976	1977	1978
Single Component	85.2%	81.6%	77.5%	74.1%	72.8%	70.0%	69.0%
Multiple Component	14.8%	18.4%	22.5%	25.9%	27.2%	30.0%	31.0%

SOURCE: MHI, 1979

Production Approach

Analysis of the residential building industry is typically restricted to site-built housing. Such analyses consider the requisite skills of the labor pool, the seasonality of construction activities, the variability of applicable regulations, the multiplicity of entrepreneurs, and the disaggregation of the market. It is useful to compare site-built and mobile-component housing in relation to each of these factors.

Skills: Site-built housing involves skilled labor, especially to the extent that the house is custom built. Moreover, if a given builder is producing any volume of units annually, many tasks will be sub-contracted to a specialty trade (plumber, electrician, roofer, and so on). Though M-C housing involves similar building processes, the regularity with which these processes occur permits training of crews to repeat only certain tasks, and to repeat them under factory-supervised conditions. Thus any given worker need not be skilled in a trade. The differences in skill requirements is reflected both in the trade unionization of those working on site-built housing versus the industrial unionization of employees in the M-C housing industry, and in the fact that labor input in a site-built home runs to 55% of the total production cost, while for M-C housing it is only 11%. (Realtors Review, May 1978, p. 9).

Seasonality: Site-built housing tends to proceed in seasonal spurts, more being produced in the warmer seasons than in winter. By comparison M-C housing can proceed irrespective of weather conditions because construction occurs inside. Thus, those fluctuations in production which do occur are more a function of normal business cycles.

Regulations: The 1974 legislation which led to the June 15, 1976 implementation of the HUD Code means that M-C housing construction is subject to a single standard. This contrasts sharply with the situation applying to site-built housing, which must meet a different code in each state, and must deal with differing interpretations of codes by building inspectors at different jurisdictional levels. The regularity of application of the HUD Code is ensured by a process which first involves approval of the design and specifications for a new M-C housing model, and then has in-plant inspectors at each factory monitoring construction. In-plant inspection permits immediate review on completion of a construction stage. While the site-built home also has prior approval of home plans, it is given separately for each home, with only periodic inspection of the site, scheduled to approximate estimated completion of activities.

Entrepreneurs: Housing, especially single-family housing, is cited as an economic activity which provides for ease of entry for the entrepreneur. The National Association of Home Builders estimates that there are 127,000 builders, with 40 percent of them building 10 or fewer units per year. By comparison, there are only about 190 firms producing M-C housing from about 450 factory sites (MHI, Quick Facts, p. 3). Production of M-C housing is a much more corporate activity, with the major firms in the industry trading their stock publicly. Several of the largest firms are listed among Fortune's 500. While the corporate dimension of M-C housing limits ease of entry, it does provide for more secure financing, internal planning, research and development, and the ability to benefit from economies of scale.

Market disaggregation: Perhaps the single most significant aspect of the building industry is its fragmentation, a consequence of the highly disaggregated nature of the market. Consumer preferences are said to vary highly among localities, requiring a close connection of producer and consumer. This then leads to undercapitalization, discontinuities of production team activity, limited capability for research and development (or even for learning from experience) and general inefficiencies. All of these limitations are passed on to the consumer in housing price. By comparison M-C housing depends on market aggregation. Plant efficiencies demand production of at least four components daily (1,000 annually). Routines of production necessitate similarities in design and materials. Given an economically optimum transportation distance of no more than 350 miles, M-C housing manufacturers can build for regional and sub-regional markets, and respond to consumer preferences by providing for variations in basic floor plans, addition of optional elements (for example, fireplace, central air conditioning), and choice among a limited array of furnishing materials (carpeting, for example).

Distribution

M-C housing reaches its market through a network of dealers. The units are located in a variety of settings, with different land tenure arrangements. This section briefly reviews the dealer system, and the various land/unit relationships.

Dealers: Most M-C housing is purchased from retail dealers, of which there are approximately 12,000 in the U.S. The system is quite similar to that which serves the automobile industry. The vast majority of dealers operate from a single outlet, typically having franchise arrangements with several manufacturers. A dealer will have a range of display homes, though most sales are orders to the manufacturers resulting from particular consumer specifications. Outlets are located in commercial zones, and often have conspicuous site advertising. Dealers will arrange financing with financing institutions. They will also arrange unit setup. Many maintain service departments, and also stock parts and materials. Service requirements are the result of the inclusion of M-C housing sales under various product warranty statutes, partly because the interstate sales nature of this housing form permits federal government intervention. In addition to active monitoring by the Federal Trade Commission, HUD's standards program provides a complaint system through its network of State Administrative Agencies.

Parks: The best known form of land tenure for M-C housing is the "mobile home park." The prevailing, essentially negative, park image is a vestige of the trailer tradition of the industry, and is supported by the frequent location of parks adjacent to sales outlets in "commercial" rather than residential sections of towns. Though there are parks which fit this negative image (small lots, high densities, narrow streets, limited parking and so on), the contemporary park is usually well designed and maintained, and provides a variety of services. Most parks rent lots to persons owning their own M-C home, though some do rent units as well. Conditions of tenure vary, as do lot rentals. Some parks cater to specific clientele, the most frequent example being the elderly.

Individually-owned sites: According to data from the 1976 Annual Housing Survey 51% of M-C houses were located on a site owned by the unit owner. The opportunities for individual siting in residential zones are often limited by local zoning regulations. Many jurisdictions prohibit M-C housing altogether in residential zones, limiting it to zoned park areas. Others exclude M-C housing altogether.

M-C housing developments: Despite zoning restrictions, the most rapidly growing type of location of M-C housing is the M-C housing development. Essentially this is no different from any other large-scale housing development effort (subdivision, Planned Unit Development, horizontal condominium and so on) except for the exclusive use of mobile components. A developer (often a dealer, sometimes in a joint venture relationship with a manufacturer) will develop and sell the house and lot together. In most respects this locational type, as with the individually-owned site, is indistinguishable from the conventional single family dwelling. The houses are usually built on foundations (sometimes with crawl-spaces or basements) and on regular sized lots.

Consumer

The data from which a useful consumer profile could be derived are severely limited in terms of availability, uniformity of definition, and gaps in time. This section briefly reviews such as are available.

Given the rapid changes in the nature of the M-C housing industry, Census data are of very limited use. The 1970 Census counts those who live in "mobile homes and trailers" (MH/Ts). These are defined purely in terms of the perception of the interviewer, or of the respondent.

If the MH/T is of the modular-component variety, and is perceived as a permanent home, it may not be recorded as a "mobile home or trailer." Insofar as this definition limits the validity of the data it gives no clear indication of the true size, or demographic characteristics of the occupancy of M-C housing. The 1980 definition will continue this confusion, even when these data are available.

The Annual Housing Survey, also conducted by the Bureau of the Census, presumably would provide more current data. Unfortunately, its definition of MH/T is based on the same methods as are used for the decennial census. Consequently AHS data have limitations similar to Census data.[4] The most recent AHS data available are for 1976. Table 4 provides a brief summary. Of the 3.6 million occupied MHs, about one-third were in urban areas. The most pertinent demographic comparison is the median income of owned and rented MH/Ts compared with the tenure status of all households. The median income for owner-occupied MH/Ts was $10,000, compared with $14,400 for all owner-occupied households. For renter-occupied households the comparison is $6,900 for MH and $8,100 for all renter-occupied households. Data of this type suggest that the average MH/T occupant belongs to a lower income group than the average site-built home occupant, contributed to by the large proportion of retirees and young couples, as well as by the inclusion of trailers and the absence of some of the "best" M-C houses from the AHS.

A detailed consumer profile was compiled for Fleetwood Industries, based on survey responses by purchasers in the 2nd through 4th quarters of 1978. Because Fleetwood is a large manufacturer selling a full range of M-C housing nationally, the profile has some presumptive validity.

Table 4

Mobile Home Households: 1976

All Occupied Mobile Homes	3,627,000
Location	
Urban	31%
Rural	69%
Siting	
Group of 6 or more (Rental Park or Subdivision)	49%
Individual	51%
Home Ownership	
Home Owned	82%
Home Rented	18%
Home Acquired (Owned Homes)	
New	51%
Resale	49%
Land Ownership	
Site Owned	24%
Site Rented	76%

Income of Household Heads	Owner Occupied	Renter Occupied
Less than $5,000	21.8%	32.8%
$5,000 to 6,999	11.1%	18.4%
$7,000 to 9,999	16.9%	18.9%
$10,000 to 14,999	27.0%	16.7%
$15,000 to 24,999	17.7%	10.9%
$25,000 or more	5.5%	2.3%
Median	$10,000	$6,900

Source: AHS, 1976.

A very rough comparison is possible between certain of the categories for the AHS and Fleetwood data. Two categories -- income and age of head of household -- stand out. The more recent data, Fleetwood's, would suggest that there is an increase in ownership among the middle-age cohorts (Table 5). In Fleetwood's data both under 25 and 25-34 proportions are smaller compared to AHS figures for 1976. Moreover, an analysis of age of head of household by household size shows that nearly one-quarter of all households of three or more persons (that is, families with children) are headed by persons 35-44, though heads of household of this age constitute only 13% of the sample. Nearly two-thirds of all households of three or more are headed by persons age 25-44, though this group is less than one-half of the sample (Table 6). The Fleetwood data also show a much higher income profile (Table 7). The median income of $15,170 is much higher than that of the AHS, even allowing an increase for inflation and assuming definitional comparability. Only one-fifth of the sample had an income less than $10,000, while one-quarter of the sample had an income of $20,000 or more. About one-eighth of the sample had an income of $25,000 or more. Thus, it would appear that the income profile of the average M-C home consumer is shifting upwards. The locational trend toward private siting is also led by families. Two-thirds of households of three or more live in private sites or M-C home developments, while nearly two-thirds of households of 2 or less live in "mobile home parks" (Table 8).

Table 5

Age of Head of Household
M-C House Owners
AHS & Fleetwood

Fleetwood

	%
under 25	14.4
25-34	23.6
35-44	13.1
45-54	15.7
55-61	13.0
62 and over	20.1

AHS

(owner occupied, 2 or more person households
male head, wife present, no non-relatives)

	%
under 25	15.9
25-34	28.4
35-44	13.3
45-64	26.2
65 and over	16.2

Sources: Fleetwood, 1978
AHS, 1976

Table 6

Age of Head of Household
by Household Size
M-C House Owners

	All Respondents	Household Size: Two or Less	Household Size: Three or More
Sample Size	1869	1053	772
Under 25 Years	14.4%	15.1%	13.6%
25 to 34	23.6	12.2	39.3
35 to 44	13.1	6.6	22.1
45 to 54	15.7	14.3	17.0
55 to 61	13.0	18.9	4.8
62 and over	20.1	33.0	3.1
No Answers	32	19	7
Median	43.15	54.68	33.33

Note: Percentages are based only on those responding.

Source: Fleetwood, 1978

Table 7

Total Annual Family Income, by Household Size
and Age of Head of Household, M-C House Owners

		Household Size		Age of Head of Household		
	All Respon-dents	Two or less	Three or more	Under 35 yrs.	35 to 54 yrs old	55 yrs or over
Sample Size	1869	1053	772	699	529	609
Under $8,000	11.3%	17.0%	4.0%	4.3%	4.7%	26.2%
$ 8,000 to $ 9,999	8.5	10.8	5.6	7.6	5.8	12.2
$10,000 to $11,999	11.2	12.8	9.0	13.9	7.2	11.4
$12,000 to $13,999	11.7	10.8	12.8	15.8	9.9	8.0
$14,000 to $15,999	12.6	9.8	16.0	15.0	14.0	3.2
$16,000 to $17,999	9.3	7.8	11.4	10.8	10.5	6.2
$18,000 to $19,999	9.1	7.0	12.0	12.1	9.5	5.0
$20,000 to $24,999	13.2	12.0	15.0	13.2	17.7	8.8
$25,000 and over	13.2	11.8	14.4	7.3	20.6	14.0
No Answers	230	148	70	53	44	109
Median	$14,170	$13,724	$16,475	$15,113	$17,588	$12,050

Note: Percentages are based only on those responding.

Source: Fleetwood, 1978

Table 8

Placement of M-C House by Household Size,
Age of Head of Household and Total Annual Income

		Household Size		Age of Head of Household			Total Annual Income		
	All Respondents	Two or less	Three or more	Under 35 yrs.	35 to 54 yrs old	55 yrs or over	Less than $12,000	$12,000/ $19,999	$20,000 or more
Sample Size	1869	1053	772	699	529	609	508	698	433
Mobile Home Park	50.2%	58.9%	38.8%	48.1%	43.1%	59.2%	62.6%	46.1%	44.1%
Private Property	43.9	35.1	55.8	48.3	50.2	32.7	33.0	49.1	45.5
Mobile Home Subdiv.	5.9	6.0	5.4	3.6	6.7	8.1	4.4	4.8	10.4
No Answers	36	22	10	9	7	16	8	6	9

Note: Percentages are based only on those responding.

Source: Fleetwood, 1978

Financing

Financing, and financial institutions, have impacts on M-C housing at two levels. First, the financial community deals with the large manufacturers of the relatively consolidated M-C housing industry quite differently from the way it deals with the numerous small producers in the highly fragmented site-built housing industry. On the other hand, while the M-C producer is relatively well treated in the financial marketplace, the M-C home consumer is not quite so well off, although this situation is changing.

Manufacturers: While the M-C housing industry, like the rest of the housing industry, can be subject to large fluctuations in production, reflecting changes in the economy, it is, by virtue of its industrial structure, capable of avoiding the worst of the effects of external forces. It is certainly able to avoid many of the seasonal impacts suffered by site-built housing producers. Moreover, even the effects of broad shifts in the economy can be cushioned somewhat by the ability of the industry to shift its production mode quickly, with almost no effect on the plant as an institution. It is also able to make long-term corporate financial plans, hence anticipating and smoothing the effects of shifting circumstances in the financial market. The ability to change product line quickly in response to market demand means that there is relatively little inventory-swallowing capital. This permits capital investment in production facilities, which is vastly more appealing to the financial community.

Consumers: Historically M-C housing has been financed as personal rather than as real property. Perceptions of mobility, lower-income occupancy, and absence of durability (exacerbated by the historical annual introduction of "new and better" models) all contributed to a financial pattern based on the assumption that this form of housing was "consumed" (hence, depreciated rapidly) rather than maintained (hence, appreciated).[5] The continuing impermanence of land tenure arrangements, exemplified by the "mobile home park" system, reinforces these negative perceptions and, therefore, this financing system, despite current evidence of technical durability and practical immobility.

However, the increase in numbers of M-C homes located on self-owned sites and in M-C housing developments has been accompanied by the beginnings of a shift in financing practices. The increase in average price, and the increased frequency of combined financing of unit and land have made the M-C home investment attractive in dollar volume and durability. Table 9 presents cost and size data on M-C homes for the period 1973 to 1979. Both average square footage and total cost have increased during this time period.

By the end of 1979, the total value of M-C housing retail paper outstanding was just over $17.4 billion. Based on Federal Reserve Board reports, the distribution of this paper by lending institution type is as follows:

* Commercial banks 57%
* Finance companies 19.4%
* Savings and Loan Associations 20.3%
* Federal credit unions 2.9%.

The Manufactured Housing Institute does an annual sample survey of financial

Table 9

Cost and Size of M-C Houses
1973-1979

	1973	1974	1975	1976	1977	1978	1979
Average Sale Price (All Lengths & Widths)	$ 7,770*	$ 9,760*	$11,440*	$12,750*	$14,200*	$15,925*	$17,700
Cost Per Square Foot	$8.84*	$10.63*	$11.98*	$13.09*	$14.20*	$15.77	$16,80
Average Square Footage	882 sq.ft.	910 sq.ft.	952 sq.ft.	966 sq.ft.	1,000 sq.ft.	1,010sq.ft.	1,050 sq.ft.

*Includes furniture, draperies, carpeting and appliances but excludes land as well as costs of steps, skirting, anchoring, and any other applicable set-up charges (approximately 15% of home cost)

Source: MHI, 1979.

institutions, to assess financing trends. Table 10 summarizes the results of the most recent survey, and presents data on the previous four years. S&Ls are showing the most rapid increase in financing, with a 33% increase in 1979 over 1978. The trend analysis also shows a large increase in average account value over the five-year period.

One reason for the increase in S&L activity in M-C housing was a liberalization, in 1979, by the Federal Home Loan Bank Board of the terms and conditions of lending by these institutions. Similar improved conditions for loan guarantee programs by the FHA and VA have increased use of these programs. (Current terms are found in Table 11.) Increases in interest rates, loan maturities, guarantee amount, and related costs have made these programs more attractive to the financial community. Moreover, FHA and VA insured loans can be pooled by lenders and sold on the secondary mortgage market.

In addition to improved financial conditions for puchase of M-C housing, the federal government has improved its rental subsidy programs, notably by providing for use of Section 8 subsidy funds for lot rental. Some states provide for financing of rental housing using this housing type through their housing finance agencies, while others provide ownership or renter subsidy programs on a state-funded basis.

Nevertheless, in comparison to site-built housing, the cost, conditions, and means of acquiring financing for M-C housing remain less attractive (in most cases).

Table 10

VALUE OF MOBILE HOME RETAIL PAPER OUTSTANDING AND NUMBER OF ACCOUNTS OF REPORTING INSTITUTIONS

Total of All Institutions:	1979	1978	1977	1976	1975
Reporting Institutions	389	406	425	449	419
Dollar Value	10,085,252,000	8,230,671,000	6,613,352,000	6,319,908,000	5,368,556,760
Average Account Value	13,905	12,373	9,975	9,518	7,769
Accounts Outstanding	725,294	665,195	662,948	664,068	690,595

Accounts Outstanding Financed by Banks, Finance Companies, and Savings and Loan Associations

BANKS	1979	1978	1977	1976	1975
Reporting Institutions	285	309	307	315	321
Dollar Value	3,683,167,000	3,316,223,000	2,045,515,000	2,258,628,000	2,297,150,000
Average Account Value	12,748	11,978	10,279	8,963	7,949
Accounts Outstanding	288,920	276,851	199,431	251,861	288,685
FINANCE COMPANIES					
Reporting Institutions	28	22	29	40	34
Dollar Value	5,185,802,000	3,893,833,000	3,474,297,000	3,254,333,000	2,624,485,000
Average Account Value	14,561	12,329	9,143	9,245	7,190
Accounts Outstanding	356,139	315,817	379,971	351,545	364,801
***SAVINGS AND LOAN ASSOCIATIONS**					
Reporting Institutions	76	75	89	94	64
Dollar Value	1,216,283,000	1,020,615,000	1,093,540,000	806,947,000	446,921,000
Average Account Value	15,159	14,072	13,018	13,229	12,079
Accounts Outstanding	80,235	72,527	83,546	60,662	37,109

Number of Loans Made in 1979 by Banks, Finance Companies, and Savings and Loan Associations

	Total	%	Banks	%	Finance Companies	%	Savings & Loan Associations	%
Reporting Institutions	337		245		22		70	
Total Loans Made in 1979	151,256	100.0	53,392	100.0	80,689	100.0	17,175	100.0
Total Direct Loans	23,972	15.8	19,345	36.2	429	0.5	4,198	24.4
Total Indirect Loans	127,287	84.2	34,050	63.8	80,260	99.5	12,977	75.6

*Savings and Loan Associations are relative new-comers to mobile home financing. This is the most probable reason for the high average account value.

SOURCE: MHI, 1980

Table 11

FHA & VA FINANCING OF M-C HOUSING

New M-C Homes	VA	FHA
o Single-C Term	No maximum 20 Years	$18,000 20 Years
o Multi-C Term	No maximum 20 Years	$27,000 20 Years
o Maximum Guarantee	$17,500 or 50% of loan amount whichever is less	
o Rate Ceilings	16 1/2% simple	16 1/2% simple
o Down Payment	None required	5% of first $3,000 10% over $3,000
M-C Home Plus Improved Land		
o Single-C Term	$20,000 15 Years	$23,500 15 Years
o Multi-C Term	$27,500 20 Years	$31,500 20 Years
o Rate Ceilings	15 1/2% on package	11 1/2%
o Down Payment	None required	5% of first $10,000 10% over $10,000

PRODUCT CHARACTERISTICS

The contemporary M-C house is, to all intents and purposes, visually indistinguishable from conventional single family detached housing (see Figure 2). Though this is the only market for which M-C housing is currently built, there is no intrinsic reason why it cannot be used in a variety of structural configurations. Indeed, a recently published major work focused on this possibility (Bernhardt, 1980).

Structural Properties

While the completed M-C house may appear to be indistinguishable from a site-built house of the same design, its structural system is radically different. Each mobile-component is not only designed to support the same loads as (or heavier loads than) the regular house, it must also be capable of resisting the constantly changing shear forces which it suffers in its moves from factory to site. It is, in effect, "with its large cross-sectional dimensions, (a) box beam design especially resistant both to twisting or lateral buckling (in transport) and to wind or roof forces... at the owner's site" (Bernhardt, 1980, p. 98). In the case of the mobile-component the skin doubles as an enclosure and a load distributing element, unlike the site-built house in which load is carried by its frame. A comparison of the HUD code with those applied to site-built housing reveals similarities in specific standards (See Appendix B).

Thus, the perception that mobile components are of inferior construction is false, whatever its history and the reasons for its persistence. To some extent these perceptions may result from the use of certain materials, which, while contributing to the structural quality of the stressed skin, are unlike those used in a regular house. The M-C house is therefore

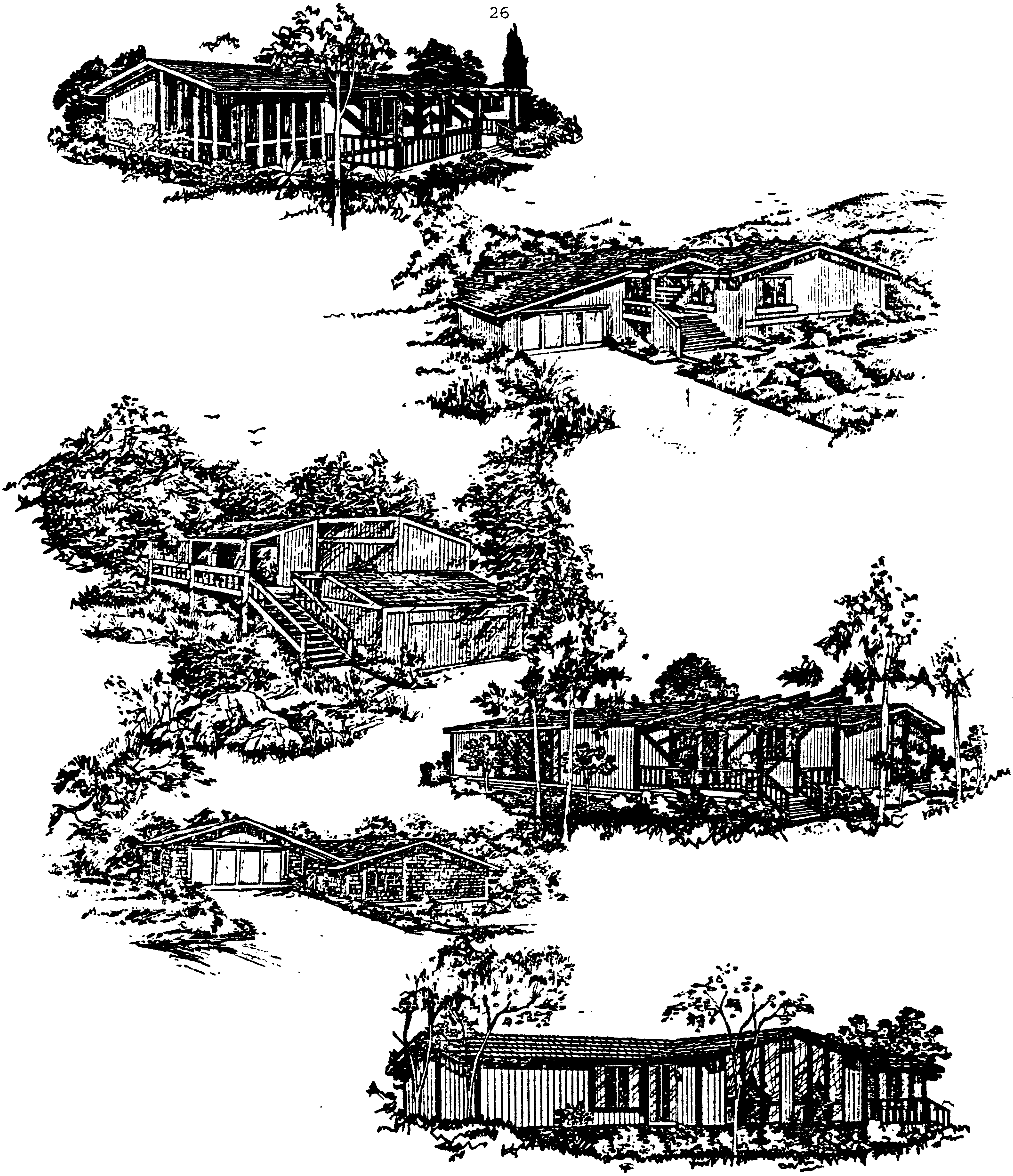

FIG. 2 MOBILE-COMPONENT HOUSING

perceived as structurally inferior (instead of structurally superior) not because of any knowledge about its structure, but because it does not look like a regular house or because, even if it does, it is known to be an M-C house. The perception derives from the emotionally laden assumption that difference implies inferiority.

Factory Assembly

Mass produced housing is not new; witness tract housing. The difference between tract mass production and M-C housing production is that materials, equipment and workers are brought together at the tract site rather than at a factory. In essence it is the "factory" which moves. In the case of M-C housing the product moves. It travels along a production line and work is performed by specialized teams of workers sequentially. Only on completion is the mobile-component brought to the site.

Many of the advantages of factory assembly, which are so well-known in the automobile industry, have been applied in the M-C housing industry. However, the factory system as an institution is quite different in this industry because of the use of work teams, and the dispersed locations of factories. The economic limitation on how far a completed mobile-component can be moved for siting precludes the centralized location of the industry in one or a few sites, *à la* Detroit. On the average, each module is transported about 350 miles, with the result that many relatively small factories are needed. Thus, in M-C housing the routinization of the separate tasks rarely, if ever, descends below the "work team" concept. Groups of men and women work on producing a side or end wall unit, install a bathroom or kitchen, and so on. One worker does not spend a working day connecting, for example, faucets to sinks. Thus the M-C producer, compared to the site-built producer, enjoys many of the benefits of industrial production while avoiding many of the problems, such as worker boredom.

Unionization of the M-C housing industry is limited. Where it does occur, it is primarily along industrial lines, thus permitting workers to be classified as assemblers rather than craftsmen (Bernhardt, 1980). In addition to the lower average wage level for industrial *vs.* craft workers the assembler work teams can be shifted among tasks without regard for possible jurisdictional disputes or cost impact.

Product Role

For decades there have been "schools" of architecture which have sought to develop a viable system of industrialized housing. In most cases they restricted themselves to the two-dimensional component so as to lessen the constraint on form which a three-dimensional module was felt to inflict. Moshe Safdie, in his early design for Habitat '67, introduced a module in three dimensions which fit a separate structural frame. This idea was abandoned, however, for a module with inherent structural properties, effectively destroying the concept of industrialized standardization, because each module had to bear different loads.

While designers sought, in vain, to develop a workable industrial housing system, the M-C housing industry, almost unintentionally, evolved one successfully. Its system is based on "vernacular" (or anonymous) design, rather than on "grand" (or architectural) design. This is, in fact, the source of most marketable design - for the pragmatism of the vernacular is so strong that in the marketplace it filters out much of the conceptualism of grand design.

This pragmatism, insofar as it applies to the M-C housing industry, together with the structural properties of the industry's product and its means of production, suggests that there is a growing role for M-C housing. The present favorable cost comparison, coupled with the industry's capability to respond to market preferences in design, suggests that there are real potentials here.

SOLAR ENERGY TECHNOLOGIES

Definitions

"Solar" architecture is an attempt at minimizing dependence on external energy sources, other than sunlight, for the maintenance of human comfort in buildings. A solar building is defined as "passive" when the methods of energy collection, storage, and distribution are totally independent of mechanical systems. "Active" solar energy, on the other hand, relies on mechanical systems to bridge the gaps between collection, storage and consumption. A system is hybrid when one of these two gaps is bridged mechanically. A more "active" hybrid system links collection and storage mechanically; it is more "passive" when the mechanical link is between storage and the locations of energy consumption.

Solar Technologies and Building Design

While "passive" solar design is unquestionably a more architectural approach, the facility with technical knowledge on the part of the architect which is required for the integration of collection, storage and distribution into the fabric of the building is considerable. The extent of the technical facility required for solar design is clear when one compares it with the architect's normal design routine in relation to heating and cooling. In essence prevailing practice cedes responsibility to a mechanical engineer, who fits an HVAC system to a "picture" of the structure, thus establishing certain structural constraints on the final design. By comparison, "passive" solar design is absolutely integrated into architectural design. It cannot be handed over to an expert external to the design process. Unless an architect acquires the requisite technical facility, s/he cannot do "passive" solar design, as "passive" solar design entails much more than the application of a few rules of thumb to a "regular" design. It is for this reason that many architects have found it easier to "go solar" with "active" systems.

If the building is small, and the architect is designing the "active" system the result will be a building with a mechanical system similar to the one it replaces or supplements, with (for example) pipes and pumps used in the same way. The major difference is the impact on building form of the flat plate collector, which is not a difficult design constraint, as powerful as its impact may be. If the building is large, the "active" solar system will be designed by an engineer. Within the constraints of this routinized setting, the architectural impact of the flat plate collector is basically similar to other technological impacts (elevator housing, cooling vents, and so on). The architect designs around an "add on" technology, the understanding of which can be left to the technical expert. The innovation of "active" solar energy is, thus, immediately routinizable at the level of the design professions.

In contrast, "passive" solar energy is a completely architectural concept. Because of the integration of energy collection, storage, and distribution with the structure, function and aesthetic aspects of the building, "passive" solar energy building design separates the architect from routine reliance on external technical experts.

Photovoltaic (PV) solar technology is a solar/electric technology. It has application in any setting where electricity is used, and is, unlike "active" and "passive," not simply a technology for controlling comfort in buildings. But PV is a particularly effective energy technology system for buildings in several respects. First, the energy can be used for any purpose requiring electricity, not just for heating and cooling. Second, most buildings (especially smaller residential structures) have a solar collection area which has an acceptable relationship to the energy demands of the volume enclosed by the skin. Third, PV can combine effectively with the latest "passive" solar technology and with energy conservation design approaches.

Solar Technology and M-C Housing

For reasons to be discussed later, it appears that the ideal solar system in M-C housing is a PV/passive hybrid. However, to place this assessment in context, it is necessary first to consider the requirements of "active" systems in relation to M-C housing.

"Active" systems are quite compatible with M-C housing, with three crucial exceptions: (1) storage, (2) roof loads, and (3) plumbing.

Storage: An "active" system collects heat in one area, transports it to another for storage and, when needed, transports it to yet another for use. "Active" systems typically use a relatively large volume of rocks, or a smaller (though still large) volume of water, for thermal storage in a well-insulated location. Storage is invariably beneath the house. Water storage involves a large tank area while dry storage calls for an even larger volume of rocks. Rock storage is incompatible with both production and siting of M-C housing, as is water storage if it involves "basement" space. If the water storage is not "basement," it demands a large floor area, reducing available space for other household purposes and calls for structural changes to support the load.

Roof loads: "Active" systems, particularly those using water for heat transport, require higher load-bearing capacity from roofs. Beyond the additional loading, the slope for winter heat collectors is ideally latitude plus 15°, a pitch much steeper than that of present M-C houses. While changes to accommodate both loading and slope are possible, external factors (for example, bridge heights) establish other limiting constraints. Moreover, the cost implications of such changes would have to be assessed.

Plumbing: M-C housing provides heating and cooling by air duct systems. Plumbing is limited to household uses (kitchen, bathroom, laundry and so on). Thus, any "active" system using water would require major additions to the unit's plumbing system, in both size and distribution. Thus, the distribution, as well as collection and storage systems, are additions to current design and materials. Moreover, assuming that the collection, storage and distribution systems could be incorporated into the mobile components, they would also have to be engineered to meet the stress of transport.

This review of the three areas in which "active" solar technologies are incompatible with the present routines of M-C housing shows the extent of incompatibility. Adoption of "active" systems would entail major restructuring of the industry.[6]

"Passive" solar technologies, using neither mechanical heat transportation nor thermal storage separate from the structure, do not present the sorts of problems in M-C housing that "active" systems present. It was noted earlier that "passive" solar design demands that architects have a technical capability not presently considered an essential quality for designers to have. The site-built house is often individually designed or, where a design is repeated, it must be modified for particular situations. This demands further technical input, as the impact on energy consumption of structure, function, aesthetics and location must be considered for each design. A consequence is either higher cost because of added design activity, or (more usually) the forgoing of the solar technologies. By comparison the M-C house can absorb the higher initial design effort because its impact can be spread over many repetitions. Indeed, because M-C housing must undergo DAPIA review for compliance with design and engineering criteria, it is not at all clear that there would be any increase in design cost because of "solar."

As noted in the discussion of structural properties of M-C housing, the HUD code already makes this form of housing more readily responsive to energy conservation criteria than site-built housing is. Because of this, the integration of "passive" solar technologies into M-C housing is already close to the industry's routine, for the demands of the "passive" system are reduced by the insistence on energy conservation already reflected in the HUD code's concentration on insulation and infiltration.

Recent shifts in "passive" solar technology make this integration with existing routine an even more likely possibility. "Passive" systems attempt to maximize thermal potential, collecting and storing it as heat in cold weather, and "cool" in warm weather. Thermal potential gain is achieved by the controlled exposure of large areas of glass in windows and clerestories. Keeping the heat inside or outside (depending on the season) is usually handled by some non-conveying barrier. For example, movable insulation for cloudy days and night time has been used, requiring someone to move it as needed. Storage for release of heat to maintain comfort levels typically has demanded large spaces. Large volumes of water in tanks exposed to insolation, (thereby obscuring views) were sometimes used. Such technologies call for a shift in aesthetic values, to say nothing of living habits, and have tended to cause "passive" solar approaches to be identified with atypical housing consumers. However, recent changes in materials (such as glazing with inherent thermal barrier qualities, and storage materials which can be installed in ceiling and floor spaces) have minimal impact on aesthetics, make no demands on space, and require no changes in living habits.[7] Insofar as such materials merely replace existing materials, and require minimal (if any) changes in production technology, the potential for "passive" solar acceptance in M-C housing is significantly enhanced.

A hybrid PV/passive system provides a particularly appealing mix for M-C housing.[8] The size requirement for the PV array is decreased by the efficiency of the passive system and the conservation techniques used.[9] The regularity of unit design and defined market areas of M-C housing provides for an optimization in the relationship of structure, function, aesthetics and the climatic demands of the region.

The most complicating aspect of the hybrid is the placement of the PV array. If the different demands for energy to both heat and cool a building are roughly similar, the ideal slope for an array is the latitude of the site. U.S. latitudes range from 25° to 49°. In cold climates, where limited cooling is required, latitude plus 15° is ideal. In hot climates, where heating demands are infrequent, the ideal slope is latitude minus 15°.

In warm regions the slope poses minimal constraints, requiring as little as 10°. But cold climates can require a slope of as much as 65°. Insofar as arrays maintain their current material configurations (approximately 2'x3'), this necessitates roofs pitched to the maximum angle. This in turn creates transportation problems, with height limitations imposed by overhead barriers such as bridges. Similarly, if present array configurations and materials remain constant, there are additional roof load concerns. Though M-C housing already meets certain loading standards (often higher than site-built), substantial weight additions could create some difficulty.

Either of these issues could be resolved by materials development focusing on design requirements. For example, a ribbon technology (silicon crystals in a continuous ribbon, rather than small circular cells sliced from crystal rods) would allow, as an architectural solution, a number of rows of ribbons in a saw tooth array behind a screening fascia, providing the appearance of a flat roof while meeting slope requirements. Similarly, advances in materials could incorporate the cells into the basic roofing structure. Insofar as M-C housing is now shifting its approach to roof materials and appearance, with sloped and composition roofs only recently becoming common, there is considerable potential to experiment with new materials consistent with this industry-wide shift.

FACTORS INFLUENCING RECEPTIVITY TO SOLAR BY THE M-C HOUSING INDUSTRY

The preceding sections have described the structure of the M-C housing industry, reviewed the characteristics of the product, and discussed various solar technologies in relation to this form of housing. This section briefly reviews and summarizes those factors which will most influence the receptivity of the industry to solar technology of whatever form, and to the PV/passive hybrid in particular.

Price sensitivity. Though the changing profile of the M-C buyer indicates that the average consumer belongs to a higher socio-economic category than was once the case, the bulk of the market for this form of housing remains in the low- to middle-income bracket. Indeed, a primary sales argument has always been lower price. Thus, the impact on housing price of structural or material changes is a matter of considerable importance to both producer and consumer. Given a lower average sales price, the marginal impact of an additional dollar of cost on potential market share is much more severe than it would be on higher priced site-built housing. Any of the solar technologies discussed earlier has the potential of increasing unit production cost (and therefore purchase price), particularly "active" solar systems. What is not clear is the extent to which housing cost will be affected by solar technology. Any of the solar technologies reduces demand on external energy sources. Thus, to the extent that home purchase considerations involve a calculus of monthly housing costs (principal, interest, taxes, operating expenses) as opposed to initial cost, the impact of higher production costs of solar will be lessened.

Production Process. Quite apart from the direct impact on unit price of solar technology materials, their potential impact on the production process is important. There are two dominant considerations in a manufacturing approach to housing: simplicity and speed. Though the work team does not go as far as the repetition of a single task characteristic of auto assembly processes, M-C housing production still requires simplicity of construction tasks. Any material or production change which entails a complication in the assembly procedure will, therefore, be resisted. Similarly an uncomplicated but time-consuming task will also be resisted, as the industry routine and pricing structure requires regularity in component completion. For example, although it is a simple process, spray coating of ceilings has not been readily accepted because the drying time which is needed significantly slows down the total production process. Thus, one can see that the latest "passive" systems, which involve significant substitution of one material for another, will readily fit industry production routines. PV systems which involve new equipment and complicated wiring might be resisted, while those which replace current roofing with PV roofs, and which are "plugged in" to existing electrical systems, might be more readily accepted. Finally, the plumbing and storage requirements of "active" solar thermal systems clearly complicate current production approaches, and increase the probability of resistance.

Single code. The presence of a single code governing construction of M-C housing throughout the nation should prove to be a positive factor in enhancing the probability of acceptance of any innovation, not just solar. Where most building industry innovations follow an unwieldy and protracted dissemination path through "leader" states, in terms of building codes, the HUD code and its related administrative structure provide a single source and a focused mechanism for determination of innovation acceptance. This has advantages not only in definitiveness of decision, but also in ability to produce a product in volume, because it need meet only one standard.

Industry aggregation. Compared with the fragmented site-built housing industry, M-C housing is an enormously aggregated industry. There are relatively few manufacturers, and of this limited set an even smaller number accounts for a large volume of all M-C production. Thus, acceptance by a single manufacturer means rather substantial market penetration. Given the competitiveness of the industry, advances in materials or processes are quickly adopted by all. Acceptance by any manufacturer means a sizable order from materials suppliers, enabling both to enjoy the concomitant economies of scale. Industry-wide acceptance increases those economies to an even greater extent.

Quality control. Factory assembly increases the probability of proper construction and installation and avoids the system breakdowns which are not uncommon in individual site-built housing. Because of in-plant inspection, and subsequent manufacturer liability (through both HUD and FTC processes), manufacturers tend to be hesitant about changes. While, initially, this is a barrier to acceptance, it eventually contributes to product confidence once changes have been accepted. Since one of the difficulties encountered in consumers' acceptance of solar thermal has been uneven system performance, variously attributable to design and installation, this assurance of quality, once consumers become aware of it, should be a desirable feature of M-C housing.

CONCLUSION

The intent of this paper was to describe one segment of the housing industry -- mobile-component housing -- and to discuss the possibilities for acceptance of photovoltaics in this housing form. The preceding sections have described the structure of the M-C housing industry, reviewed the product characteristics of this housing form, assessed solar technologies relative to M-C housing, and considered factors influencing receptivity of solar in M-C housing. This section summarizes the body of the paper in the form of a set of conclusions on the possibilities for PV in M-C housing.

The possibilities for PV in M-C housing are greater than are the possibilities for "active" solar thermal. Further, these possibilities are even greater when combined with "passive" solar in a PV/hybrid. This ranking is the result of the extent to which these three general forms of solar technology mesh with existing routines of the M-C housing industry. Solar thermal has the fewest possibilities as its use would entail new and complicated systems for the M-C housing unit, requiring training for new skills on the production line and the probable increase in initial housing costs. PV would not require new systems, especially if one can assume sufficient development of the technology to provide for interaction with the grid, and simplified inverter systems enabling the DC production to be converted to AC. Passive solar is ranked highest in its possible acceptance by the M-C housing industry because it would involve minimal change in design or production approaches. Moreover this industry is already attuned to energy efficiency in its product. To the extent that either PV or "active" solar thermal are combined with "passive," their possibilities for acceptance will be enhanced by the more favorable disposition of the M-C housing industry to "passive."

A number of characteristics of M-C housing and its industry bode well for the possibilities of PV acceptance, while some other characteristics tend to decrease the possibilities. Both the opportunities and the constraints derive from the industrial characteristics of this segment of the housing sector. Specifically, industry aggregation, single standard for construction, and design capability are all characteristics which increase the possibilities of acceptance. Price sensitivity, and the labor and time demands of the production process constrain them.

Because the M-C housing industry has relatively few producers, with those producers manufacturing houses for aggregate markets, the possibilities for rapid acceptance of PV in large quantities is enhanced. A positive decision by a single manufacturer can mean initial annual orders for PV materials for hundreds or thousands of housing units. Volume production, even for a single producer, can provide for economies of scale generally not attributable to the housing industry. Such economies are made even more possible because of the single construction standard for M-C housing. A frequent constraint on introduction of new products in housing construction is the limitation of differential standards. Though state codes tend to be somewhat regularized by their derivation from national or regional model building codes, each state code is different, or, at least, administered by a different body. Thus even though a product may meet industry standards (say an ANSI code for glass), its incorporation into housing construction may vary. By comparison the single construction standard and administering authority for M-C housing reduces the uncertainties created by potentially differing code standards. Finally because M-C housing is produced in volume at central locations by manufacturers with staff functions for design and production control, the design, engineering and production monitoring difficulties inherent in any new product (and especially true for either PV or solar thermal) are reduced. Simply put, M-C housing manufacturers, by virtue of the nature of the industry (and its regulation), have the capability to deal with technically demanding new products. Thus, other factors being equal, technical complication will not be a barrier to acceptance of PV.

Because M-C housing has tended to be oriented to a lower-income market and make a major part of its selling pitch its price advantage, manufacturers are very sensitive to impact on unit price. The marginal impact of a dollar of additional cost is greater for M-C housing than site-built housing. Thus any product which increases first cost has a reduced possibility of acceptance. This will remain so for solar technologies, even though they may reduce annual energy consumption, so long as the routines for home lending do not consider life-cycle costing. Apart from the cost impact of new products, their potential impact on the production process also is a potential obstacle. In the case of PV the impact is not yet clear. Insofar as PV increases the need for sophistication in the labor force, or prolongs the amount of time needed to complete mobile-component, it will be a factor reducing the possibilities of acceptance. Improving the ease of installation and reducing the skill requirement for the installer will each enhance the possibilities of acceptance. Of course, this is as true for other forms of housing as well, though the precise implications of ease of installation and labor-force skill requirements will vary among segments of the housing industry.

Though the general nature of the M-C housing industry suggests there are many attributes which increase the possibility of acceptance of PV, this conclusion is reached only by comparing PV and M-C housing attributes in the broadest sense. A more precise conclusion can be reached only after the nature of PV for specific housing use evolves. However, this analysis has suggested areas for the development of PV (in both product characteristics and in the approach to the M-C housing industry) which would enhance the probability of rapid acceptance.

NOTES

1. NAHM defines the nine classifications in the following way:

i. Pre-cut and/or shell homes -- the most basic package for small builders and the handyman who wants to save money by doing most of the work himself.

ii. Components -- wall panels; roof and floor trusses for builders of residential and commercial projects.

iii. Panelized homes -- open or closed wall, complete home packages built either to the customer's design or from one of the manufacturer's designs.

iv. Mechanical or utility cores -- modules which generally contain the home's kitchen and bathroom fixtures, heating equipment and electrical service panel.

v. Modular or sectional homes -- three dimensional living units shipped to the customer's foundation nearly 95% complete.

vi. Log homes -- log home packages.

vii. Geodesic dome homes -- spherically-shaped structures formed from a series of triangular-shaped panels.

viii. Multi-family homes -- apartments, condominiums and townhouses.

ix. Commercial structures -- schools, churches, offices, restaurants, and all other commercial structures.

NAHM (1980), pp. 66-67.

2. Of course, it <u>is</u> technically feasible to move a mobile-component home, assuming retention of wheels and axle. However, such mobility has dramatically decreased in the recent past with the growth of multi-component houses, and is almost exclusive to single-component M-C houses. Recent data suggest only 1-3% of M-C homes are moved other than from factory to site.

3. This is a slight exception to our definition. This second component is not itself mobile, but is carried within the first. Such a two-component M-C house is referred to as an "expandable."

4. A further limitation in AHS data is the fact that vacant MH/Ts are not considered housing units, nor are those which are used for vacation homes.

(Fleetwood Industries data suggest this use to be about 6% of current sales.) Moreover, the Census Bureau itself reports, in Appendix B of the 1976 AHS, inefficiencies in the listing procedure for finding "mobilehomes" placed outside "mobile home parks." Since such units constitute an estimated 50% of all M-C homes occupied, this deficiency seriously biases AHS data.

5. The best M-C houses are "invisible" as M-C houses per se and so cannot contribute to a perception of their equivalence to site-built housing, as they are perceived as site-built houses.

6. A Colorado firm, Suntrek, has developed and recently introduced an "active" solar system for mobile-components which can either be incorporated into the original component, or retrofitted to an existing M-C house. It consists of vertical exterior collector panels which are used on a south-facing wall. An air-to-air system, Suntrek's collectors heat air for interior distribution, and a storage option is available. Although the efficiency is reduced at this angle they are reported to contribute as much as 30% of the annual heat requirement.

A major problem, which reflects the incompatibility of "active" with M-C housing is that this sort of efficiency could be improved by the use of storage facilities, but the structural changes, or site-work, necessary for this make it too complicated or prohibitively expensive. Without storage, when the panels raise the interior temperature to uncomfortable levels, the heat is ventilated out (i.e. wasted).

7. The solid state "passive" solar energy system works in the following way.

a. Collection. A double pane glass window with one of the interior surfaces coated with a transparent material which reflects heat (unlike normal glass which absorbs it) permits light to enter. Once the light has been transformed into heat, which happens when it is absorbed by solid materials, the window acts as the equivalent of a stud wall with 2 1/2" of fiberglass insulation. Unshaded windows, therefore, act to gain heat over a day, rather than lose it. This glass is expected to be on the market by the end of 1980 at an incremental cost over regular glazing such that, (in Boston) the payback period will be under three years. (Exact square foot costs are not available yet.)

b. Storage. The storage system (which "stores" both heat and cool, depending on the season) is based on the heat of fusion of a eutectic salt. When a substance melts or solidifies it does so at a constant temperature, absorbing or releasing a relatively enormous amount of energy to change state. (For example, a pound of water solidifying or thawing at a constant freezing point uses 144 times the energy it needs to rise or fall 1°F after the state change.)

Eutectic salts follow this pattern, and a mixture based on Glauber salt ($NaSO_4 . 10H_2O$) has been developed which changes state at 72°F. A quarter inch thick pad absorbs 180 BTU per square foot, equivalent to the heat capacity of nine inches of concrete of the same area with the additional advantage that heat is reused or absorbed at a constant temperature in the center of the human comfort range. The relationship between the window areas, the amount of salt storage, and the external climate can be calculated to hold the interior temperature fairly constantly near this point, except for periods of extremely bad weather, when an efficient fireplace can supply most of the back-up heat needed. (If any further heat is called for, electric resistance coils can put it directly into the salt storage from where it is released, again at 72°f. Photovoltaics and storage batteries can supply this energy.)

The salt is stored in flat plastic bags, or pads, in the ceiling, at an additional load of 5 lbs. per sq. ft. The pads are marketed at a cost of $1.80/sq. ft. and, in a house in Massachusetts equivalent in size and design to a two-component M-C house, the total cost of the solar components plus the electrical back-up system was $6,000 (1979), an amount equal to the cost of a gas-fired warm air system. Using off-peak electric resistance as back-up (and no fireplace) the 1980 electricity bill for heat is estimated to be less than $200. Without taking into account the contribution from the kitchen, the lights and the people the fraction of heating energy required, which is contributed by the sun is 60%. (An additional benefit is that shading devices, working with the "mass equivalent" storage, will keep the house relatively cool in summer. The storage system is equally effective using a back-up cooling method, which in turn could be run from a P.V. array.)

8. A PV system is composed of an array of silicon cells which, when exposed to light, transform it into direct current (DC) electricity. This electricity can be further transformed into alternating current (AC) for household use. Excess DC current can be stored in batteries. Excess AC current can be sent into the regional power grid, with appropriate modifications in the household electric bill. An interactive grid-household system assumes the possibility of some household use of power from the grid.

9. While the same argument holds for site-built housing, the argument from economies of scale in design and installation costs for M-C housing make the PV/passive hybrid especially compelling for this housing form.

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SUMMARY OF SHIPMENTS TO STATES

APPENDIX A

STATE	JANUARY SW	JANUARY MW	JANUARY TOTAL	FEBRUARY SW	FEBRUARY MW	FEBRUARY TOTAL	MARCH SW	MARCH MW	MARCH TOTAL	APRIL SW	APRIL MW	APRIL TOTAL	MAY SW	MAY MW	MAY TOTAL	JUNE SW	JUNE MW	JUNE TOTAL	TOTAL SW	TOTAL MW	TOTAL TOTAL
ALABAMA	422	120	542	531	85	616	663	145	808	569	163	732	714	157	871	627	155	782	3,526	825	4,351
ALASKA	52	2	54	64	5	69	71	11	82	87	10	97	40	8	48	73	12	85	387	48	435
ARIZONA	286	261	547	325	268	593	396	265	661	324	244	568	359	270	629	306	307	613	1,996	1,615	3,611
ARKANSAS	134	26	160	167	25	192	184	35	219	205	38	243	242	42	284	253	37	290	1,185	203	1,388
CALIFORNIA	465	1,859	2,324	381	1,562	1,943	449	1,958	2,407	367	1,573	1,940	445	1,710	2,155	[illegible]	1,623	2,056	2,540	10,285	12,825
COLORADO	257	105	362	219	129	348	265	136	401	252	89	341	263	118	381	331	110	441	1,587	687	2,274
CONNECTICUT	11	1	12	18	0	18	21	1	22	36	0	36	33	0	33	36	2	38	155	4	159
DELAWARE	72	11	83	69	15	84	119	17	136	116	16	132	125	20	145	103	10	113	604	89	693
FLORIDA	709	1,137	1,846	693	1,035	1,728	729	1,089	1,818	614	929	1,543	616	1,044	1,660	616	1,141	1,757	3,977	6,375	10,352
GEORGIA	410	265	675	411	258	669	521	357	878	477	359	836	542	320	862	568	336	904	2,929	1,895	4,824
IDAHO	181	94	275	176	77	253	198	122	320	216	105	321	203	113	316	171	119	290	1,145	630	1,775
ILLINOIS	189	32	221	241	59	300	331	78	409	345	92	437	436	88	524	411	99	510	1,953	448	2,401
INDIANA	171	20	191	263	24	287	442	59	501	436	66	502	521	65	586	609	87	696	2,442	321	2,763
IOWA	107	14	121	99	13	112	189	20	209	183	16	199	205	34	239	201	26	227	984	123	1,107
KANSAS	177	38	215	173	30	203	220	46	266	197	43	240	205	51	256	226	69	295	1,198	277	1,475
KENTUCKY	215	50	265	241	60	301	388	69	457	431	95	526	621	164	785	609	116	725	2,505	554	3,059
LOUISIANA	769	66	835	745	51	796	1,002	104	1,106	1,006	93	1,099	1,080	89	1,169	1,072	98	1,170	5,674	501	6,175
MAINE	38	0	38	67	0	67	135	3	138	142	2	144	176	6	182	180	3	183	738	14	752
MARYLAND	64	7	71	64	4	68	105	10	115	107	14	121	91	13	104	123	15	138	554	63	617
MASSACHUSETTS	8	1	9	34	2	36	47	2	49	48	3	51	78	4	82	82	3	85	297	15	312
MICHIGAN	303	38	341	500	42	542	751	79	830	688	96	784	830	124	954	881	125	1,006	3,953	504	4,457
MINNESOTA	208	18	226	277	25	302	313	59	372	336	75	411	334	60	394	360	56	416	1,828	293	2,121
MISSISSIPPI	226	35	261	235	57	292	352	46	398	298	74	372	343	73	416	396	66	462	1,850	351	2,201
MISSOURI	207	65	272	214	47	261	296	108	404	343	91	434	366	106	472	339	111	450	1,765	528	2,293
MONTANA	182	27	209	172	30	202	243	58	301	214	54	268	272	58	330	235	61	296	1,318	288	1,606
NEBRASKA	123	32	155	94	22	116	114	25	139	74	37	111	128	32	160	123	36	159	656	184	840
NEVADA	128	146	274	95	120	215	127	180	307	130	185	315	105	175	280	82	183	265	667	989	1,656
N. HAMPSHIRE	43	1	44	45	5	50	86	5	91	98	9	107	116	8	124	121	4	125	509	32	541
NEW JERSEY	31	11	42	43	10	53	69	18	87	59	16	75	67	18	85	66	17	83	335	90	425
NEW MEXICO	348	80	428	340	65	405	435	80	515	406	71	477	384	83	467	315	90	405	2,228	469	2,697
NEW YORK	134	8	142	129	16	145	333	43	376	376	59	435	432	60	492	431	45	476	1,835	231	2,066
N. CAROLINA	701	192	893	636	183	819	783	245	1,028	664	216	880	850	268	1,118	780	274	1,054	4,414	1,378	5,792
NORTH DAKOTA	70	10	80	70	15	85	99	17	116	132	20	152	142	30	172	150	42	192	663	134	797
OHIO	230	50	280	368	50	418	475	100	575	472	110	582	661	108	769	646	163	809	2,852	581	3,433
OKLAHOMA	388	44	432	307	45	352	418	44	462	476	66	542	484	54	538	522	46	568	2,595	299	2,894
OREGON	326	387	713	302	363	665	311	415	726	281	364	645	282	470	752	241	440	681	1,743	2,439	4,182
PENNSYLVANIA	261	55	316	380	59	439	564	73	637	635	103	738	795	117	912	764	119	883	3,399	526	3,925
RHODE ISLAND	2	0	2	5	0	5	6	0	6	12	0	12	14	0	14	5	0	5	44	0	44
S. CAROLINA	334	183	517	335	162	497	363	153	516	379	155	534	397	182	579	430	186	616	2,238	1,021	3,259
SOUTH DAKOTA	59	4	63	92	3	95	68	19	87	100	14	114	99	24	123	103	15	118	521	79	600
TENNESSEE	227	50	277	245	52	297	348	96	444	365	100	465	476	101	577	445	112	557	2,106	511	2,617
TEXAS	1,818	218	2,036	1,610	225	1,835	2,190	303	2,493	1,891	253	2,144	2,161	293	2,454	2,047	310	2,357	11,717	1,602	13,319
UTAH	103	55	158	106	58	164	99	48	147	85	57	142	107	56	163	112	61	173	612	335	947
VERMONT	16	1	17	12	0	12	50	0	50	58	0	58	72	0	72	53	2	55	261	3	264
VIRGINIA	242	62	304	226	57	283	379	83	462	326	101	427	408	142	550	437	114	551	2,018	559	2,577
WASHINGTON	478	508	986	469	496	965	571	553	1,124	477	528	1,005	475	633	1,108	437	628	1,065	2,907	3,346	6,253
W. VIRGINIA	121	27	148	147	33	180	329	47	376	359	74	433	477	102	579	473	89	562	1,906	372	2,278
WISCONSIN	155	12	167	197	15	212	294	28	322	221	26	247	359	29	388	351	38	389	1,577	148	1,725
WYOMING	115	28	143	105	26	131	130	21	151	128	24	152	143	45	188	159	45	204	780	189	969
DC & US TERR.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
EXPORT	24	0	24	0	0	0	3	0	3	1	0	1	4	0	4	1	1	2	33	1	34
DEST. PEND.	50	4	54	20	6	26	35	7	42	39	5	44	23	5	28	47	6	53	214	33	247
TOTAL	12,390	6,460	18,850	12,757	5,989	18,746	17,109	7,400	24,509	16,281	6,933	23,214	18,801	7,772	26,573	18,582	7,853	26,435	95,920	42,487	138,407

SUMMARY OF SHIPMENTS TO STATES

1978

SOURCE: NCSBCS

REVISED 6/20/79

1978

SUMMARY OF SHIPMENTS TO STATES

STATE	JULY SW	JULY MW	JULY TOTAL	AUGUST SW	AUGUST MW	AUGUST TOTAL	SEPTEMBER SW	SEPTEMBER MW	SEPTEMBER TOTAL	OCTOBER SW	OCTOBER MW	OCTOBER TOTAL	NOVEMBER SW	NOVEMBER MW	NOVEMBER TOTAL	DECEMBER SW	DECEMBER MW	DECEMBER TOTAL	TOTAL SW	TOTAL MW	TOTAL TOTAL
ALABAMA	495	106	601	802	168	970	644	158	802	509	165	754	546	143	689	403	98	501	3,479	838	4,317
ALASKA	24	7	31	7	6	13	17	5	22	5	3	8	11	2	13	3	1	4	67	24	91
ARIZONA	249	239	488	313	365	678	356	402	758	437	422	859	432	455	887	448	409	857	2,235	2,292	4,527
ARKANSAS	167	33	200	212	36	248	207	47	254	247	44	291	193	28	221	134	26	160	1,160	214	1,374
CALIFORNIA	336	1,227	1,563	465	1,576	2,041	367	1,236	1,603	413	1,328	1,741	291	1,110	1,401	239	904	1,143	2,111	7,381	9,492
COLORADO	259	81	340	301	133	434	292	119	411	312	116	428	351	106	457	235	98	333	1,750	653	2,403
CONNECTICUT	37	3	40	51	4	55	34	1	35	40	0	40	19	1	20	18	0	18	199	9	208
DELAWARE	67	11	78	97	26	123	118	14	132	127	16	143	61	11	72	48	2	50	518	80	598
FLORIDA	479	745	1,224	805	1,300	2,105	694	1,278	1,972	773	1,413	2,186	939	1,397	2,336	913	1,303	2,216	4,603	7,516	12,119
GEORGIA	441	251	692	552	358	910	434	308	742	490	332	822	381	266	647	273	196	469	2,571	1,711	4,282
IDAHO	149	76	225	171	135	306	181	80	261	179	85	264	184	89	273	156	65	221	1,020	530	1,550
ILLINOIS	336	77	413	498	87	585	399	80	479	409	90	499	336	56	392	166	35	201	2,144	425	2,569
INDIANA	545	60	605	693	88	781	604	63	667	610	72	682	457	54	511	267	28	295	3,176	365	3,541
IOWA	125	21	146	221	27	248	157	25	182	188	26	214	138	28	166	125	12	137	954	139	1,093
KANSAS	143	38	181	204	57	261	217	38	255	229	47	276	215	38	253	151	41	192	1,159	259	1,418
KENTUCKY	382	87	469	538	122	660	463	93	556	461	74	535	344	59	403	227	31	258	2,415	466	2,881
LOUISIANA	834	73	907	1,129	92	1,221	882	98	980	1,136	81	1,217	932	112	1,044	762	71	833	5,675	527	6,202
MAINE	159	2	161	197	2	199	137	4	141	116	2	118	69	1	70	52	1	53	730	12	742
MARYLAND	72	8	80	93	17	110	100	14	114	108	10	118	95	12	107	87	9	96	555	70	625
MASSACHUSETTS	53	4	57	80	3	83	82	10	92	66	10	76	41	9	50	25	3	28	347	39	386
MICHIGAN	754	88	842	1,009	104	1,113	838	97	935	856	125	981	612	103	715	417	59	476	4,486	576	5,062
MINNESOTA	317	47	364	379	67	446	275	73	348	275	66	341	157	29	186	132	27	159	1,535	309	1,844
MISSISSIPPI	307	55	362	373	71	444	323	59	382	376	66	442	262	62	324	238	45	283	1,879	358	2,237
MISSOURI	242	77	319	340	89	429	358	99	457	393	110	503	348	81	429	205	59	264	1,886	515	2,401
MONTANA	215	53	268	250	60	310	184	44	228	182	48	230	159	29	188	118	11	129	1,108	245	1,353
NEBRASKA	84	33	117	122	36	158	67	42	109	112	33	145	89	21	110	67	15	82	541	180	721
NEVADA	85	139	224	119	218	337	111	148	259	140	181	321	111	175	286	63	160	223	629	1,021	1,650
N. HAMSPHIRE	76	8	84	102	10	112	84	10	94	77	1	78	55	4	59	57	2	59	451	35	486
NEW JERSEY	41	17	58	110	33	143	84	23	107	75	27	102	78	27	105	51	13	64	439	140	579
NEW MEXICO	275	50	325	337	78	415	381	82	463	333	81	414	324	65	389	278	65	343	1,928	421	2,349
NEW YORK	280	54	334	413	57	470	296	46	342	278	41	319	191	21	212	148	24	172	1,606	243	1,849
N. CAROLINA	630	181	811	855	273	1,128	764	250	1,014	855	268	1,123	758	285	1,043	542	181	723	4,404	1,438	5,842
NORTH DAKOTA	115	27	142	127	32	159	94	28	122	92	31	123	66	28	94	45	8	53	539	154	693
OHIO	471	105	576	745	134	879	635	119	754	653	132	785	474	88	562	270	55	325	3,248	633	3,881
OKLAHOMA	399	42	441	633	56	689	540	56	596	547	71	618	486	81	567	354	35	389	2,959	341	3,300
OREGON	231	354	585	295	477	772	237	466	703	240	434	674	247	345	592	172	276	448	1,422	2,352	3,774
PENNSYLVANIA	576	86	662	816	118	934	706	106	812	598	75	673	425	56	481	289	36	325	3,410	477	3,887
RHODE ISLAND	8	1	9	7	0	7	10	0	10	13	2	15	1	0	1	2	0	2	41	3	44
S. CAROLINA	337	144	481	472	199	671	374	169	543	444	198	642	380	219	599	319	154	473	2,326	1,083	3,409
SOUTH DAKOTA	86	16	102	103	18	121	65	14	79	94	16	110	65	8	73	35	7	42	448	79	527
TENNESSEE	328	92	420	385	104	489	360	90	450	451	101	552	325	101	426	249	43	292	2,098	531	2,629
TEXAS	1,636	262	1,898	2,190	357	2,547	1,917	313	2,230	2,228	343	2,571	1,953	289	2,242	1,458	238	1,696	11,382	1,802	13,184
UTAH	106	49	155	92	71	163	115	43	158	97	64	161	108	36	144	78	40	118	596	303	899
VERMONT	51	2	53	65	2	67	53	2	55	55	1	56	23	0	23	17	0	17	264	7	271
VIRGINIA	307	95	402	440	101	541	348	91	439	367	96	463	293	75	368	219	53	272	1,974	511	2,485
WASHINGTON	334	474	808	483	684	1,167	409	577	986	464	661	1,125	481	505	1,086	302	418	720	2,473	3,419	5,892
W. VIRGINIA	305	76	381	476	93	569	361	74	435	314	54	368	226	46	272	165	25	190	1,847	368	2,215
WISCONSIN	259	33	292	346	34	380	295	19	314	280	20	300	174	10	184	121	14	135	1,475	130	1,605
WYOMING	111	25	136	177	35	212	170	38	208	137	39	176	177	25	202	96	22	118	868	184	1,052
DC & US TERR.	1	0	1	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	2	0	2
EXPORT	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DEST. PEND.	41	16	57	39	20	59	50	23	73	69	46	115	207	54	261	298	61	359	704	220	924
TOTAL	14,360	5,850	20,210	19,729	8,313	28,042	16,889	7,274	24,163	18,011	7,767	25,790	15,290	5,945	22,235	11,537	5,479	17,016	95,836	41,628	137,464

SOURCE: National Conference of States on Building Codes and Standards

SUMMARY OF SHIPMENTS TO STATES

1978 SOURCE: NCSBCS

APPENDIX B

COMPARISON OF DESIGN CRITERIA
SINGLE FAMILY DWELLING
FEDERAL MOBILE HOME STANDARD
UNIFORM BUILDING CODE

Design Elements	Design Criteria	
CODES	Federal Mobile Home Construction and Safety Standards	UBC 1976 UPC 1976 NEC 1978
ZONING		
Occupancy	One Family Dwelling	R-3 (residential single family)
Type of Construction	Per local jurisdictions	V-N (wood frame construction combustible)
Fire Zone	Per local jurisdictions	3 (residential)
Location on Property	Per local jurisdictions	Over 3' to prop. line for unprotected opening in walls
STRUCTURAL DESIGN LOADS		
Roof Live Load	20 PSF (1)	20 PSF (1)
Wind Load - horizontal	15 PSF	15 PSF
Wind Load - uplift	9 PSF	11.25 PSF
Floor Live Load	40 PSF	40 PSF
Horizontal Load on Int. Walls	5 PSF	None specified
Live Load Deflections:		
Floor	L/240	L/240
Side Wall	L/180	L/120
Roof/Ceiling	L/180	L/180
Test Load Requirements	2.5 x L.L.	2.5 x L.L.
ARCHITECTURAL DESIGN - BUILDING PLANNING		
Glazed Area	8% of floor area	10% of floor area
Vent Area	4% of floor area	5% of floor area
Minimum Room Size:		
One Room	150 square feet	150 square feet
Bedroom (2 persons)	70 square feet	70 square feet
Bedroom (min.)	50 square feet	70 square feet
Min. Room Dimension	5 feet	7 feet
Closet Depth (required in each bedroom)	22 inches	None specified
Toilet Compartment	30" wide with 21" clear	30" wide with 24" clear
Hall Width	28 inches	None specified
Ceiling Height - General	7 feet	7 feet, 6 inches
Exterior Wall Covering	Weather resistive and corrosion resistant fasteners	Prescribes minimum materials and fasteners

Comparison of Design Criteria
Page 2

Design Elements	Design Criteria	
FIRE SAFETY		
Exit Doors	2	1
Specify Ext. Door Locations	Yes	No
Bedroom Egress Window:	Yes	Yes
Min. Size	5 square feet	5.7 square feet
Min. Sill Height	36 inches	44 inches
Furnace Compartment Lining	Gyp. bd. + 25 FS max.	Not specified
Water Heater Comp. Lining	Gyp. bd. + 25 FS max.	Not specified
Furnace/Water Heater Compartment - Sealed from living area environment	Required or use sealed combustion appliance	Not required
Kitchen Range Back Wall	Gyp. bd. + 50 FS max.	Not specified
Protect Cabinets Above Range	Yes	Yes
Smoke Detector(s)	Yes	Yes
Fire Blocking in Walls	8 feet	10 feet
Flamespread in Living Areas:		
Walls	200 or less (Class III)	Class III (2)
Ceiling	200 or less (Class III)	Class III (2)
THERMAL ENERGY CONSERVATION		
Condensation Control:		
Walls	Vapor barrier	Vapor barrier
Ceiling	Vapor barrier	Not specified
Air Infiltration Control	Specified	Not specified
Max. Heat Loss	Specified	Not specified
Double Glazing or Storm Windows	Mandatory	Not mandatory
Requires Listed Appliances	Yes	Yes
Interior Heated to 70°F	Required	Required
PLUMBING		
Hot and Cold Supply:		
Pipe Sizing	No. of fixtures	No. of fixture units
Plastic Pipe	Yes	No
DWV System:		
Drain Pipe Size	Comparable	Comparable
Horizontal Wet Vent	Yes	No
Cleanouts	Over 45° each, 360° total	135° total
Listed Materials and Fixtures	Yes	Yes
Gas Piping	Comparable	Comparable
Vertical Wet Venting	Yes	Yes

Comparison of Design Criteria
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Design Elements	Design Criteria	
ELECTRICAL		
Require Listed Material and Devices	Yes	Yes
Aluminum Wire in Branch Circuits	Not permitted	Permitted
Receptacle Locations	Comparable	Comparable
Load Calculations	Comparable	Comparable
Separate Neutral and Ground on Appliances and Equipment	Yes	No
SITE DEVELOPMENT		
Grading	Per local jurisdictions	Specified
Foundation Design	Per local jurisdictions	Specified
Anchorage to Foundation	Specified	Specified

(1) Building official or home manufacturer may adopt higher loads to meet local conditions.

(2) Not applicable to finishes in kitchen or bathroom.

SOURCE: Fleetwood Enterprises.

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