

# The outlook for the use of wood products in new housing in the 21st century

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## Abstract

This paper examines recent trends in the use of wood products for housing and discusses future prospects for end uses such as framing, sheathing, and exterior siding. Projections of homebuilding and of wood products use in housing are presented for the period from 1990 to 2030. Despite substantial changes since 1950 in the proportion and nature of building materials used in residential construction, wood products have remained the dominant building material in the United States. Over 90 percent of all new houses are wood framed and most are sheathed in plywood or other wood-based paneling. For many wood products including softwood lumber, plywood, and other wood-based panel products, residential construction is the largest single market in the United States. While lumber use per square foot of floor area has declined, plywood and other labor-saving wood-based panel products have replaced lumber for many uses. Innovations such as the Permanent Wood Foundation and the plenum wood floor system may substantially increase wood use.

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Analysis of historical trends enables the identification of influences on the rate of homebuilding and on the size and amenity of houses built in the United States. The most important such influences are the economy (interest rates, the rate of economic growth) and population (rate of household formation, family size).

Real interest rates (nominal rates discounted for inflation) reached record highs of 10 percent in the early 1980s and in 1985 were still historically high at 6 to 8 percent. Correspondingly, levels of house production in the early 1980s dropped very low and recovered only moderately by 1985 (Fig. 1). However, interest rates are expected to return to historical norms of 3 to 4 percent while economic growth continues at its historical norm of about 3 percent. Thus, despite an anticipated slowing in population growth, housing production is projected to increase in the late 1980s, reaching some 2.2 million housing starts and mobile home shipments (6). After

1990, the decline in population growth may lead to lower levels of household formation, but housing starts and mobile home shipments together may still average 2.1 million units annually. Single-family housing units are expected also to be larger in response to rising general affluence and an increasing proportion of middle-aged homeowners.

Similarly, analysis of historical trends enables predictions to be made about the use of wood in housing. The number and size of houses being built has a large influence on the amount of wood used in new construction. During the past few decades more than one-third of all lumber and plywood consumed in the United States was used for the construction and manufacture of new housing. Wood products remain the dominant material used for homebuilding, over 90 percent of new single-family houses are wood-framed. Building materials used in residential construction have changed substantially since 1950, but traditional housing styles have prevailed. New building systems using plastics, metals, or cement products, or featuring unusual styles, have in general not been very successful (5). Prices of wood products relative to those of substitutes such as steel, aluminum, or concrete have recently declined. Indeed, wood products cost 20 percent less in 1984 than metal and nonmetallic mineral product groups did in 1950 (15,19). Consequently, new housing is expected to continue as the major market for wood products for the next 50 years. New wood products also will help maintain the high level of wood use in new housing.

Wood products use per housing unit also has changed substantially in the past 30 years. This measure of wood use varies widely according to the type of unit, its size, architectural style, regional location, and

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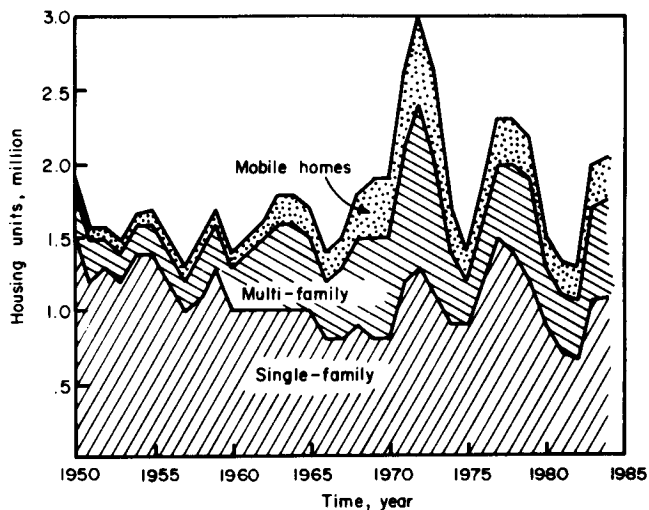


Figure 1. — New publicly and privately owned housing units started in the United States, 1950 to 1984.

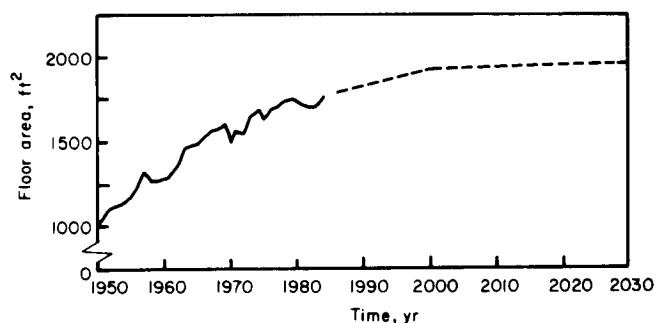


Figure 2. — Average size of single-family housing unit, 1950 to 1984, with projections to 2030.

kind of construction. For many uses in construction, plywood and other wood-based panel products have replaced lumber. Predictions of wood use must consider trends in all these variables.

Changes in construction methods and the development of engineered wood components are also important determinants of future wood use (10). Nonwood building systems have been tried many times since the 1930s, but have failed commercially. Prefabricated housing components and manufactured housing units are made predominantly of wood. In the last 20 years, the use of roof trusses has increased greatly and floor trusses are now being used in some areas in place of traditional floor joist systems (8). Other building components such as doors, windows, and cabinets are now almost universally manufactured in factories and only put in place onsite. In addition, wall systems, floor systems, and sometimes entire modules are manufactured or prefabricated in factories and assembled onsite. Better design and increased industrialization of housing production using all-wood floor systems may result in more wood use. Again, panelized houses use more wood per unit than conventional housing units (7).

In contrast, a somewhat lower use of timber products per unit might result from more efficient use of wood in conventional onsite construction, for example, by a wider spacing of studs and other structural mem-

bers (21). Changes in design and specification also give scope for savings in the use of materials. For example, a promising new design idea is the lightweight truss-framed house developed at the Forest Products Laboratory, Madison, Wis. This design utilizes a unitized frame consisting of an open-web floor system, trussed rafters, and conventional wall studs all using 2 by 4 lumber (14).

### Changing housing characteristics

Since 1950, with a doubling of per capita real disposable income in the United States, housing standards have risen and new houses have become much larger and better equipped. The size of an average single-family house increased from 983 square feet (ft.<sup>2</sup>) of finished floor area in 1950 to 1,760 ft.<sup>2</sup> in 1979. After declining slightly to 1,710 ft.<sup>2</sup> in 1982 (12,17), size grew again to a record 1,780 ft.<sup>2</sup> in 1984 (Fig. 2). As houses grew in size, the number of bedrooms and bathrooms increased. In 1950, about two-thirds of all new houses had two bedrooms or less; by 1977, this proportion had dropped to 11 percent. However, by 1984, it had risen again to 24 percent, reflecting the increasing proportion of small families and single persons in the population.

Perhaps nothing indicates the rise in housing standards so well as the increase in the number of bathrooms. In 1950, over 25 percent of existing dwelling units had no inside flush toilets and 92 percent of new houses had only one bathroom. By 1984, only 14 percent of all new houses had a single bathroom, 10 percent had 1-1/2, and 76 percent had two or more bathrooms.

Other amenities added to houses since 1950 include central air-conditioning, dishwashers, garbage disposals, and trash compactors. Central air-conditioning was installed in 71 percent of all units built in 1984. With the advent of central heating, a fireplace came to be considered a costly luxury; only 22 percent of houses were built with fireplaces in 1950 whereas 59 percent were built with them in 1984.

The significant determinants of wood products use in this expansion of homebuilding have been major structural and architectural features such as the type of foundation, number of stories, kind of garage (if any), and regional architectural style. Changes in architecture (for example, the drop in the number of porches and in the size of cave overhangs) have affected wood use through the years.

In single-family housing, the type of foundation is particularly important for wood use. A Permanent Wood Foundation has recently been developed which uses substantially larger amounts of wood (4). Conversely, houses built on a concrete slab foundation do not have conventional joist floor systems and therefore use less wood. The proportion of single-family houses with concrete slab foundations has grown from 12 percent in 1950 to 51 percent in 1984. Such foundations are most common in the South and West, nearly all houses being built in such fast-growing states as Florida, Texas, and Arizona are built on slabs. While population shifts continue to favor these areas, the proportion of houses with slab construction may rise slowly.

Of the houses built in 1984, 32 percent, principally in the Northeast and Midwest regions, have basements, and 17 percent have crawl spaces. The proportion of new single-family houses with garages has grown from 40 percent in 1950 to 75 percent in 1984 (56% having garage space for two or more cars).

The proportion of two-story houses built annually has increased greatly, rising from about 10 percent in 1950 to 40 percent in 1984. Correspondingly, one-story houses have declined from 86 percent in 1950 to 54 percent in 1984 (17,18).

Split-level houses accounted for 6 percent of those built in 1980. This type of construction reduces the roof area substantially and reduces lumber use per square foot of finished floor area. Two-story construction permits the house to be enlarged without increasing the size of the building lot.

Porches, which were once a feature of nearly all single-family houses, have declined in importance, however, recently porches have begun to reappear; also, many houses have been built with wooden decks that serve many of the purposes of earlier porches. Another architectural change is that today roof overhangs are returning to houses in many parts of the country to provide more shade, to cut cooling cost, and save energy.

Housing production is now greatest in the fast-growing population centers of the South and West regions. In 1984, for example, 49.5 percent of housing starts were in the South, 24.9 percent in the West, 13.9 percent in the Midwest, and only 11.7 percent in the Northeast. In 1984, California, Florida, and Texas alone accounted for about 35 percent of all housing built in the United States (16). In 1985 and 1986 there has been a resurgence in housing starts in the Northeast and Midwest, and a relative decline in the South.

### **Trends in lumber use**

Lumber continues to be the dominant framing material for new housing construction except for a small number of highrise building units. Recently, lumber increased its dominance as a framing material at the expense of masonry walls. The proportion of wood-framed exterior walls in new single-family houses rose from 82 percent in 1959 to about 92 percent in 1982, while masonry walls fell from 18 percent of new housing units to 7 percent in 1982, and only 1 percent of exterior walls were poured concrete and steel studs or other framing systems. Steel and aluminum framing systems have been developed, but their use has been limited. Wood still has a lower cost in use. Should lumber become unavailable or extremely costly, however, metal framing systems could become competitive and threaten lumber's dominance in residential framing (9,13).

Framing accounts for about 70 percent of lumber used in single-family houses. The remaining 30 percent is applied to miscellaneous uses including sheathing, siding, stairways, trim, millwork, garage doors, decks, and manufactured doors, windows, and cabinets (11).

The use of board lumber in subflooring, sheathing, and siding has been drastically reduced as a result of

competition from panel products, chiefly softwood plywood and particleboard, but nonveneer structural panels such as waferboard also have become important in the past 5 years. In millwork, lumber's position has declined moderately. In doors and cabinetry, the use of particleboard and other panel products has increased at the expense of lumber.

There have been substantial regional variations in lumber use. The Midwest and the Northeast regions have the highest wood use because of the lumber used in wood floor systems for houses with basements or crawl spaces. Wood use in the South has usually been the lowest because many houses are built on concrete slabs and a high proportion are built with concrete or masonry walls.

Lumber has been effectively eliminated in markets for sheathing, subflooring, and soffits by a variety of more effective products. Better design and efficient lumber use, and the use of trusses and other composite designs of structural products such as plywood I-beams could further reduce dimension lumber use.

Trends that may work to increase lumber use in housing include the Permanent Wood Foundation (PWF) and the plen-wood system, both designed to compete with concrete systems (1). The PWF, in particular, has gained a foothold in the market and has potential for steadily rising use. It is easy to install, generally costs less than concrete, and can be erected in freezing weather (4). Over 100,000 new houses have been built on the PWF since its introduction in 1970, suggesting substantial builder and consumer acceptance. The widespread adoption of this system at the expense of concrete foundations could boost lumber use greatly.

The plen-wood system is more economical than a poured concrete slab, but the system is relatively new with little marketing success to date. Few homes have been built on it, but a study has indicated it to be more economical than concrete slab flooring (22). The system involves insulating the space between the ground and the floor. Air is heated and circulated throughout the house through openings in the floor, so that the need for ductwork is eliminated. The system is likely to gain impetus from recurring cement shortages.

In summary, the prospects for lumber-framing use in residential construction are for continued moderate decline because of material savings from better design. This may be offset by the use of 2 by 6 in place of 2 by 4 exterior wall framing for energy conservation purposes and an increased use of wood foundations. Higher energy costs are likely to prevent nonwood materials from displacing lumber. On the contrary, lumber may displace more energy-intensive concrete in floors and foundations. The use of wood trusses is likely to continue to increase as new and better designs are developed. Overall, lumber use was projected to decline to 6.3 board feet per square foot by 2030 in a 1979 assessment of the timber situation in the United States (21). However, recent data indicate that lumber use per square foot has been increasing because of a trend to larger, higher quality houses, which use more wood.

### **Trends in the use of wood-based panel products**

Wood-based panels are used extensively in the construction of single-family houses in the United States. Major uses are for roof and wall sheathing, floor decking, exterior siding, and interior decorative wall paneling (2). In addition, substantial amounts of panels are used for doors, cabinets, shelving, and miscellaneous uses. Wood-based panel use varies substantially in different regions of the United States, because of differences of climate and architectural style.

Roof sheathing is one of the most important uses of wood-based panels in residential construction. Having displaced lumber boards in the 1950s, softwood plywood has become the dominant material for roof sheathing. In 1982, 86 percent of all roofs used plywood and the remainder used nonveneer panels and solid or spaced boards. This high proportion of plywood roof sheathing is fairly consistent in all regions except the Pacific, where wood shingles are often applied over lumber sheathing. When single-family housing construction expands again (3), as is predicted for the late 1980s, structural particleboard and veneer composite boards are expected to gain a share of the roof sheathing market.

The exterior wall sheathing market has changed dramatically since 1974 as a result of the energy crisis. In 1974, wood-based panel products accounted for 85 percent of the exterior wall sheathing used, gypsumboard 14 percent, and 1-inch-thick lumber boards 1 percent (7). Since then, several types of plastic foam sheathing and an aluminum foil-faced sheathing have been developed which offer relatively high insulation values per unit of thickness. By 1982, the plastic foam sheathing products had gained a 26 percent share of the single-family construction market, and the aluminum foiled-faced sheathing a 12 percent share, with a corresponding reduction of wood-based product to a 54 percent share and a reduction of gypsumboard to 8 percent. Recently developed structural particleboards gained 6 percent of the roof sheathing and 2 percent of the exterior wall sheathing market in 1982. Further gains are anticipated in the future as housing construction increases.

Floor decking is a major market for wood panel products. Wood products were used for subfloors in over 99 percent of all single-family houses built on nonslab foundations. Wood floor systems are popular in the Northeast and the Midwest. In 1982, plywood was used for subflooring in 94 percent of nonslab foundation houses, lumber boards in 3 percent, and structural particleboard in 3 percent. Wall-to-wall carpeting is the dominant floor-covering material. Wood flooring accounted for only about 5 percent of the finished floor area in 1982. The floor decking market is likely to continue to be served primarily by plywood, particleboard, and waferboard; with new types of structural composite boards also gaining a share of the market.

Wood use for exterior wall siding has shown gradual gains in recent years. In 1974, 32 percent of all new houses had some type of wood product for exterior siding, in 1984 the proportion was 42 percent. Most of the

gain in wood products use for siding came at the expense of brick and other masonry finishes. Wood panel products are expected to continue to gain in popularity in the future because of the relatively high cost of bricks and other masonry.

Interior decorative panel products are also used widely in new residential construction in the United States. About one-third of all new houses use some type of prefinished panel. Most of this paneling is some type of plywood. This market is expected to remain about the same in the future.

Wood-based panel products are expected to continue to be the major sheathing material for residential construction. However, wood fiber insulation board is expected to have a declining share of the market because of an increasing use of plastic foam insulation boards. The development of structural composite panels made of wood flakes or fibers is expected to provide competition for softwood plywood in these markets (3). The production of nonveneer structural panel products is currently based on low-cost hardwood resources in the Midwestern and eastern United States and Canada. Their production costs are generally substantially lower than those for plywood and their performance is equivalent. Therefore, nonveneer structural panel products are likely to gain a 10 to 20 percent share of the sheathing market in the next 10 years, as it is approved by building codes and is accepted by consumers. Use of these products is likely to continue to grow into the 21st century.

Competition from low-cost structural board products will continue to reduce the relative cost of wood-based panel products and encourage their use. The relative cost of plywood has declined by 48 percent from 1950 to 1984. Wood-based panel consumption on a square foot basis is expected to increase moderately by 2030 as panel and composite products continue to be substituted for solid lumber.

Wood use for exterior siding is expected to increase moderately because of improved wood siding products and the high labor cost of brickwork. In addition, wood is becoming more popular because homebuyers like its natural appearance.

In summary, the wood-based panel product market is likely to maintain or expand its current uses for residential construction, and substantial competition will develop between the various types of products.

### **The housing outlook**

This section summarizes long-term projections of potential housing demand for the period 1990 to 2030, and discusses how this level of demand will affect the demand for wood products. (These projections serve elsewhere as a partial basis for the 1984 supplement to the 1979 assessment of the forest and rangeland situation in the United States (6).) projections of housing demand are made for each type of unit and region of the country. Estimates of housing unit size and trends in wood products use for each type of unit are added to make projections of the total wood requirements for new housing construction.

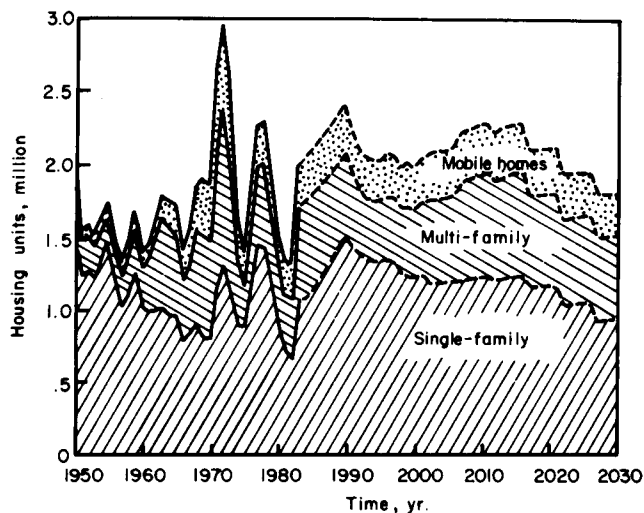


Figure 3. — New publicly and privately owned housing units started in the United States, 1950 to 1984, with projections to 2030.

The projections presented here are based upon assumptions of continued economic growth, rising average per capita personal disposable income, and a continuing trend toward lower population growth. The Bureau of Economic Analysis has projected that economic activity (as measured by the gross national product in constant dollars adjusted for price changes (real GNP)) will continue to grow at the historical rate of about 3 percent annually, and will nearly quadruple between 1985 and 2030. It projects that total income, which is closely related to real GNP, will increase similarly, and that per capita income of consumers, adjusted for price changes (real disposable personal income), will nearly triple by 2030. Future population numbers are based upon the U.S. Census Bureau's most recent projections (20). Their middle projections show population will continue to grow at a declining rate to 2030. Total population will grow from 238 million in 1985 to about 305 million in 2030.

National housing demand is projected to reach a peak in the late 1980s with about 2.2 million housing starts and mobile home shipments annually. When combined with actual housing start data from 1980 to 1984, housing demand for the 1980s is expected to average 2.0 million housing starts and mobile home shipments annually (Fig. 3). This is slightly below the annual average housing starts and mobile home shipments of the 1970s (2.2 million units), but above that of the 1960s (1.7 million units). In the 1990s, housing demand is projected to average about 2.1 million units.

After the turn of the century, total housing demand (including housing starts and mobile home shipments) is projected to increase slightly to 2.2 million housing units annually from 2010 to 2020, and then to decline moderately because of declining population growth to 1.8 million in 2030. Favorable economic conditions, such as low real interest rates or an unexpected surge in population, could increase housing demand.

The proportion of single-family housing is projected to increase in the 1990s to 65 percent of total demand.

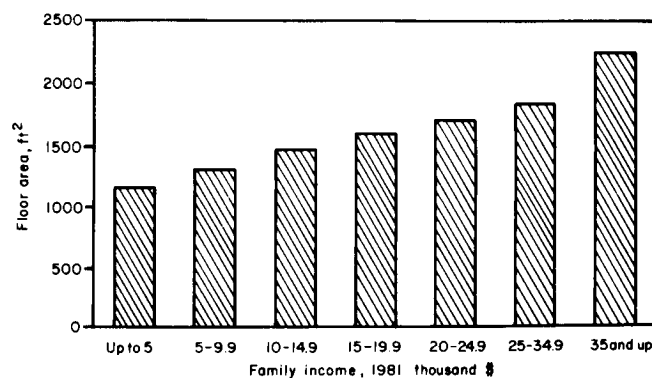


Figure 4. — Increase in size of house with family income, 1981.

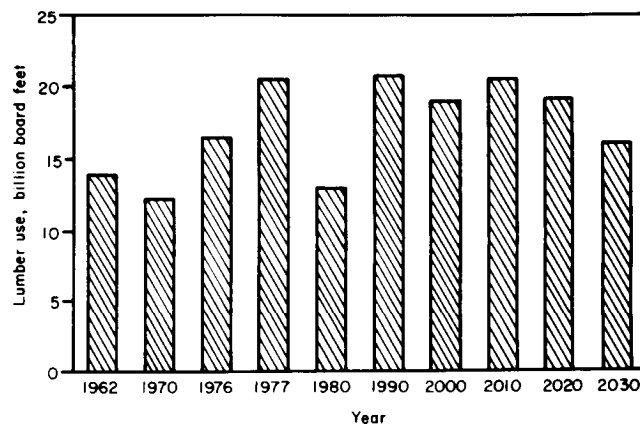


Figure 5. — Lumber consumed in new housing in selected years between 1962 and 1980, with projections to 2030.

After 2000, the share of single-family housing will decline to about 60 percent, while the share of multi-family housing units rises from 22 percent to 25 percent and the share of mobile homes rises from 13 percent to 15 percent.

Housing size is projected to increase moderately to 1,850 ft.<sup>2</sup> in 1990 and 2,000 ft.<sup>2</sup> by 2030. Recent data from the U.S. Department of Energy Residential Energy Consumption Survey of households shows that in 1982 the average existing house size in the United States was about 1,700 ft.<sup>2</sup>, and that even housing built during the 1940s and 1950s had been upgraded to about 1,500 ft.<sup>2</sup> (Fig. 2). As one would expect, a strong positive correlation exists between house size and family income (Fig. 4). Thus, with a family income rising from an estimated \$18,300 in 1981 to \$50,000 (constant 1981 dollars) by 2030, a modest increase in house size seems likely.

### The outlook for wood products consumption

Consumption of wood products for new housing reached a peak in 1977 and 1978. Lumber usage rose from 12 billion board feet (BBF) in 1970 to about 21 BBF in 1977 to 1978 and then declined to 13 BBF by 1980. Lumber production is expected to again reach 21 BBF by 1990 (Fig. 5). Total lumber usage is projected to remain on average between 19 and 20 BBF until 2020

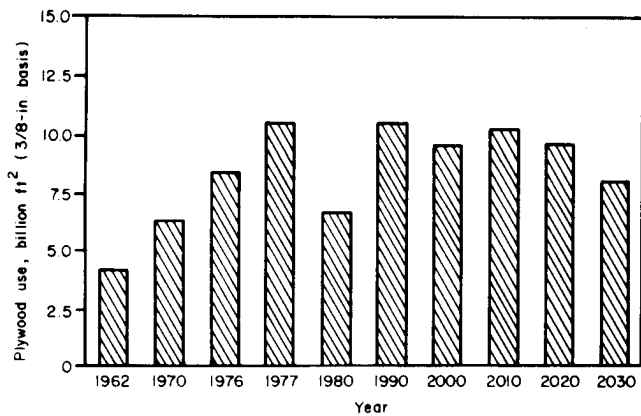


Figure 6. — Plywood consumed in new housing in selected years between 1962 and 1980, with projections to 2030.

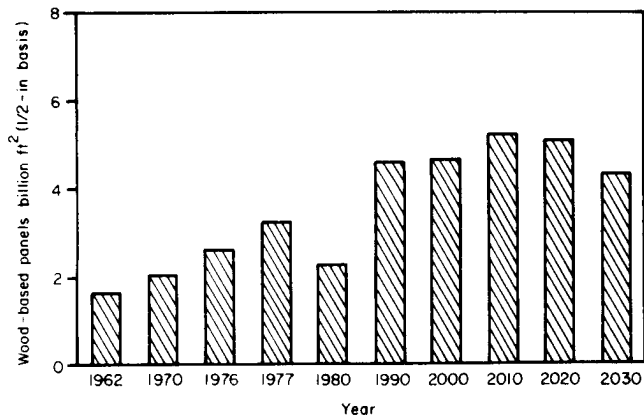


Figure 7. — Other wood-based panels consumed in new housing in selected years between 1962 and 1980, with projections to 2030.

and then decline to 16 BBF by 2030, as housing demand declines as a result of slower population growth.

In 1977 and 1978, total plywood consumption for new housing (including both hardwood and softwood) reached a peak of about 11 billion ft.<sup>2</sup> (3/8-in. equivalent), then declined to less than 7 billion ft.<sup>2</sup> in 1980. The future outlook for plywood use is obscured by the possibility of its displacement by nonveneer structural panels. However, assuming that plywood limits the market penetration of these panels, plywood use for residential construction could again reach 11 billion ft.<sup>2</sup> by 1990 (Fig. 6), and thereafter would decline moderately to about 8 billion ft.<sup>2</sup> by 2030.

Other wood-based panel consumption reached a peak of about 3.5 billion ft.<sup>2</sup> (1/2-in. equivalent) in 1976 and 1978, before declining to 2.3 billion ft.<sup>2</sup> in 1980. Other wood-based panel use is predicted to increase to 4.6 billion ft.<sup>2</sup> by 1990 and to over 5.3 billion ft.<sup>2</sup> by 2010,

<sup>1</sup>Unpublished comments to the Forest Service from the Weyerhaeuser Company.

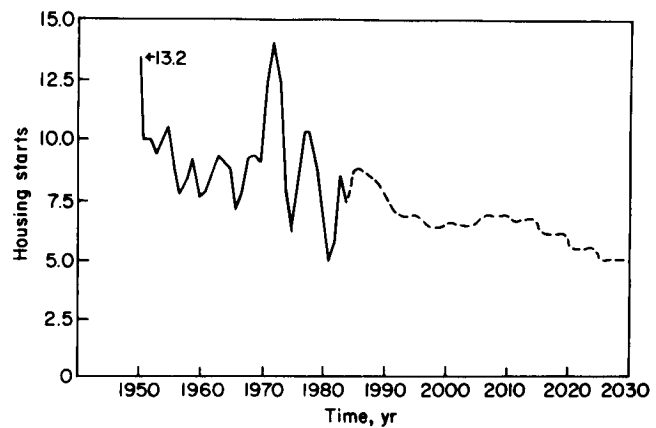


Figure 8. — Housing starts per 1,000 population in the United States, 1950 to 1984, with projections to 2030.

by displacing plywood and fiberboard (Fig. 7). Future consumption could increase even more if the current cost advantage of waferboard and structural particleboard should continue even after the current oversupply of aspen passes in the Midwest (which is expected within the next 20 years).

### Conclusion

Wood products consumption for new housing may again reach the levels of the late 1970s as the deferred demand of the baby boom generation is realized in the late 1980s and 1990s. Upgrading of the existing housing stock and replacement of older units with new energy- and technology-efficient housing units (such as the Electronic Smart House developed by the National Association of Homebuilders) will maintain demand despite falling household formations. However, strong economic growth with low real interest rates or a dramatic new housing product to encourage replacement of existing stock is needed to increase the level of housing demand and wood consumption for housing beyond the 1.7 million housing start level of the mid-1980s. Housing starts per 1,000 population are projected to decline from 13 in 1950 to 5 in 2030 (Fig. 8). Future increases in wood consumption are likely, therefore, to come from other market sectors. In fact, some observers judge these projections to be too high and assume a lower housing demand with starts no larger than 1.5 million by 1990, falling to 1 million by 2030.<sup>1</sup>

The position of wood products as the dominant homebuilding materials in the United States is likely to continue into the foreseeable future because of tradition and the cost advantage of wood. Competition seems most likely to be *among* the various wood products. Better engineered and designed trusses and composite wood products should displace dimension lumber and softwood plywood for some uses and promote lumber use for others. Overall wood use per new house may increase as house size increases and more luxurious houses are built for a more affluent older population in the 21st century.

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