Re-evolution of resource efficient housing and The guide to resource efficient building elements

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THE RE-EVOLUTION OF RESOURCE EFFICIENT HOUSING

AND

THE GUIDE TO RESOURCE EFFICIENT BUILDING ELEMENTS

by

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Preface

The Guide to Resource Efficient Building Elements is five years old. Each year it is revised, updated and expanded, and each edition is distinct from the previous. Production of the Guide entails continuous research into building products and their application, as well as tracking of the existence and performance of companies in an extraordinarily dynamic industry. The inclusion of companies in the Guide is the result of an evaluation by staff of the Center for Resourceful Building Technology, based upon developed criteria of resource efficiency.

Each year approximately 1,500 copies of the Guide are sold to building industry professionals, individual homeowners, and governments, institutions and organizations throughout the United States and Canada.

This professional paper is written with the intent that the first portion will serve as the expanded introduction to the Sixth Edition of the Guide to Resource Efficient Building Elements.
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Introduction

It began with shelter. The houses that today sprawl across the glossy pages of a dozen design magazines are the far extreme of an American housing evolution that started when the first people to walk onto the continent tried to protect themselves from the elements. Those early North Americans built shelter from the materials they encountered as they explored and settled the country: grass, sticks, and animal hides provided temporary dwellings. As some populations became less nomadic the people built more permanent structures of bark, wood or earth. These houses were simple and modest, in addition to being smoky, drafty, and only a marginal improvement over being out in the elements.

By contrast, the modern house features every creature comfort imaginable, in a structure designed as much to impress those viewing it from outside as to serve the occupants. Today housing design and construction are not bounded by locally available materials. In fact, the opposite is usually the case. The typical U.S. house contains materials from around the world, processed in locations across the United States. This contemporary housing comes at a social and environmental cost. An increasing percentage of U.S. households can no longer afford to own a home, and at the same time the construction and operation of behemoth houses full of "amenities" damages the environment, consumes unprecedented amounts of natural resources and takes a toll upon the health of home occupants.
A growing number of building industry professionals and homeowners believe that there is a better way to house the people of the United States. Individuals and groups across the nation are finding ways to combine the modest, bioregionally appropriate architecture of the past with the best technology of modern building science. This synthesis has the potential to produce housing that is resource efficient: that uses fewer natural resources and less energy to provide comfortable, socially- and environmentally-appropriate housing.

Evolution of U.S. housing
From indigenous and vernacular to uniformity

In order to grasp the importance of re-reinstating resource efficient housing tailored to a particular bioregion and climate, it helps to understand how U.S. housing evolved so far away from such housing. The first houses built on the continent grew from, and for, a particular climate, land form and lifestyle. In the Southwest local earth made the adobe block that comprised agrarian communities sheltered from the desert sun by canyon walls. On the plains temporary grass shelters served the needs of a mobile population. Materials used in construction were native to the building site, or imported from a reasonable distance. Designs acknowledged the climate: houses were small enough to be heated effectively with minimal energy expenditure, and were cooled by design details that applied principles of natural ventilation and shading.

Even after the advent of European settlers, the people of North America built from the materials at hand. In Florida, legend has it that early Spanish colonists adopted a building system based on plentiful seashells joined
with mortar. Spanish settlers in the western part of the continent adapted the adobe block to their architectural styles and purposes. Meanwhile, the forested eastern coast of the United States offered a seemingly endless abundance of logs for building. In the absence of metal nails, hardwood pegs connected pieces of wood. Localized, vernacular building styles and details evolved based on particular climates and lifestyles.

The log cabin was the building system of choice in many parts of the growing country, but some areas called for the substitution of other building types. When, after an initial population transmigration to the forested west coast, a second wave of settlers stopped to try their fortunes on the vast central plains, they found wood supplies scarce. Drawing on their European roots, and perhaps upon the Native American shelters used in the upper Midwest, the settlers developed systems of building with prairie sod and straw, and utilized earthen excavations to the greatest extent possible.

As the country developed, the predominant method of construction began to change from round or hewn logs to sawn boards joined by metal nails. It was a societal status symbol to be able to afford the luxuries of processed building materials. Early European settlers pounded nails into their front doors in decorative patterns, just to show that they could afford the costly imported metal. Housing has always been a means of exhibiting wealth, and through the history of the United States the size and elaborateness of average houses increased apace with the national perception of prosperity.

Gradually the availability of sawn lumber and nails spread across the country, and the wood-framed house became the national standard. This "standard," however, was anything but uniform, as different regions of the country maintained elements of their vernacular design. In areas with abundant fieldstone, stacked stone foundations were common. Screened living
and sleeping porches graced areas of the country with especially warm summers. In the north, steeper roof pitches shed winter snow. The Southwest retained its flat-roofed adobe design. Enclaves of immigrants brought with them design details from their native countries, and these often characterized neighborhoods, towns, and even entire regions.

It was in the economic aftermath of World War II that the American ideal of home ownership dramatically increased the environmental impact of building construction. A prospering and expanding population demanded housing. This demand initiated harvest of timber from public lands on an unprecedented scale, to fuel a housing industry dependent on dimensional lumber. Total forest harvest on public and private lands in Montana doubled between 1945 and 1955.1 The wood products industry and the building industry boomed nationwide, as the number of households and their relative affluence increased..

A growing national transportation system, and the national communication system of network television combined with the escalating number of new homes after World War II to make possible a uniformity in housing hitherto unimaginined. Through the miracles of transportation, any home seen on TV could be built anywhere, with materials shipped thousands of miles, if necessary. These factors have continued to play on the United States housing market until today, producing a nation characterized by "planbook architecture." National building periodicals and books offer housing designs for sale to all areas of the country. Simply by mailing off an order form and a check, consumers can obtain complete working plans for any house that appeals to them, regardless of its appropriateness for their particular building site or climate. This has led both to the homogeneity of identical houses coast to coast, and to the absurdity of vernacular design detached from place. Today
Cape Cod houses appear in Las Vegas, Southwestern-style designs in Washington state, and California beach houses in central Texas.

These houses displaced from their natural location and cut off from their historical culture demand far more resources to construct than housing built from local materials for local conditions. Shipping building materials requires vast amounts of energy. Furthermore, homes designed for cooling climates demand vast amounts of energy to maintain a comfortable temperature level during northern winters. Similarly, when displaced to the desert the heat-gaining designs of the North guzzle electricity running the air conditioning needed to forestall overheating. The cheap energy and increasingly effective mechanical heating and cooling systems available in the United States have helped to foster the trend away from site-adapted housing, by making thermal comfort a matter of equipment, rather than a result of design.

Increasing square footage

The increasing homogenization and climatic inappropriateness of architecture have not been the only consumptive trends in U.S. housing. The typical U.S. house has more than doubled in size since the 1940s. The 900 square foot average has increased to more than 1900 square feet, with no end in sight. While large "mansions" were once the exception rather than the rule, today entire developments of houses in excess of 5000 square feet each are common. In fact, a study on characteristics of new houses showed that in 1993 over 30% of the houses built were more than 2400 square feet in size.²

These new larger houses contain more amenities than did older houses, as well. Almost 50% of new houses have more than 2 1/2 baths, over 30% have four or more bedrooms, and approximately 15% have a three-car-or-
larger garage. These larger houses with built-in amenities not only consume more energy and materials than their predecessors, but consume a great deal more energy and natural resources than the construction of smaller-sized houses today.

Demographic changes

The demand for larger houses has manifested itself on the American landscape in some unexpected ways. For instance, not only have house sizes gone up, but at the same time family sizes have gone down. This means that floor space per person has increased at an even faster rate than the growth in average house square footage.

The changing dynamics of the American family have also affected both the size and number of houses in the national stock. Demographic studies show a rapidly increasing number of households nationwide. The number of households is growing faster than the population in general, reflecting a rapid multiplication in single-parent households.

In fact, the housing market in general has changed, as demographic groups that previously composed only a small section of the home-buying market are growing rapidly. Builder magazine reports the demographic group of married couples with children under 18 to have grown only 2% between 1984 and 1994, while groups that experienced 25% or higher growth included single parents, other family groupings, and unrelated persons in the same household. These expanding demographic groups all seek suitable housing for their respective household compositions and lifestyles. At the same time, many singles and couples without children are moving from the rental market into home ownership. All of these factors contribute to a demand for more houses big enough for part-time families and other new household groupings.
Lifestyle changes

The increasing number of households requires more houses, and the standards of the home-buying public dictate that those houses be spacious, stylish and equipped with modern conveniences. Buyers of today's houses expect the options of air conditioning, built in media stations and computer centers, and home security systems, all of which contribute to consumption of energy and material resources at unprecedented levels and rates.

Not only the houses people want, but also the way they use them, has changed over time. People in the United States now spend more of their lives indoors than any generation before. Studies show people spending as much as 90% of their time inside, as they travel from their house into their attached garage to get into their car, which they drive to a parking garage that attaches to their workplace. Shopping and dining are indoors, and home entertainment provided by the computer or media center makes it unnecessary to leave the home for leisure activities. This recently-evolved view of the home and workplace as not only the center, but also the boundary, of human activity has contributed to the increasing size, complexity and consumptiveness of American housing.

Beginnings of the resource efficiency movement in building construction

The oil crisis and energy efficiency

Increasing energy and resource consumptiveness of housing has not been a continuous trend, however. Over the past three decades several events—the oil crisis, increasing activity in recycling, and new environmental
regulations—encouraged builders and buyers to consider reducing the consumptiveness of homes. Builders who saw the need for change altered their own practices, and a few worked to spread the concern for increasing the energy and resource efficiency of building construction. Gradually the idea of improved efficiency gained momentum across the nation, until it is routine practice for a dedicated few designers and builders, and most others have at least heard of the idea.

One event that began the movement toward efficiency was the so-called "energy crisis" of the 1970s, which awakened Americans to their dependence on foreign petroleum supplies not only for transportation, but also for heating. The rise in energy prices and the temporary oil scarcity spurred governments, individual homeowners, builders and utilities to consider ways of making more efficient use of energy resources.

The research and development that came about as a result of this 1970s scare contributed a new generation of efficient appliances and thermally resistant insulation materials to the construction industry. Not only were there new insulation materials entering the market, but also the results of research into new ways to apply those materials to advantage. Researchers explored new wall assemblies and airtight installation techniques that dramatically reduced the amount of energy needed to heat and cool houses.

Today energy efficient construction is a familiar byword in the construction industry. Not every builder practices energy efficient construction, but there is no lack of information on its effectiveness and there are many avenues for education and training in its application. Energy efficiency in building operation is a concept strongly promoted by a number of industry professional groups, from the Energy Efficient Building Association to the American Institute of Architects. In addition, many utility companies
across the nation offer financial incentives for certain standards of energy efficient building. The benefits of energy efficient homes are not lost on the consumer, either. Surveys show that 77.8% of home buyers are willing to pay an additional $2,000 or more for a home that is energy efficient enough to provide $250 per year of heating and cooling cost savings. On one front, at least, builders and buyers are aware of the amount of resources consumed by building and operating a home, and are adopting measures to decrease that consumption. The improvements achieved in energy efficiency of housing operation set a hopeful precedent for those working to bring about corresponding improvements in resource efficiency.

**Solar technology**

The oil crisis of the 1970s did not just encourage energy conservation and efficiency. It also inspired some researchers, builders, and homeowners to look for alternative sources of energy—preferably renewable sources that were in abundant supply. It seemed at first that the era of solar energy had come.

The industry divided the use of solar energy into two categories: passive and active. Passive solar captured heat energy from the sun through south-facing windows, dark colored roofs and other material elements. Active solar, on the other hand, depended on equipment to capture, collect, store and deliver the sun's energy to consumers. While the 1970s featured tremendous expansions in the awareness and acceptance of active solar technology, this trend did not take hold as it might have. Those who adopted active solar energy systems for home heating and power, encouraged by substantial government subsidies, found that the evolution of solar equipment technology was by no means complete.
The expensive and sometimes spectacular failures of active solar energy systems in housing are well documented.\textsuperscript{7} In other, less well-documented cases the solar craze ended with a whimper, as solar panels moved from prominent rooftop display into garage storage, and rooms of glass, rocks and water were separated by doors from the rest of the house when conventional heating systems were installed.

Solar technology has advanced during the past twenty years, and today photovoltaic panels provide reliable energy in many applications. Unfortunately purchase costs and a buying public with memories of poorly designed early solar energy systems prevent wide acceptance of the technology today, at least in the United States.

While active solar was stealing media attention, passive solar technology staged a quiet revolution in the construction industry. Today architects and builders across the northern tier of the country install south-facing windows coupled with dark flooring and thermal mass to foster solar gain. Meanwhile, long overhangs prevent unwanted solar gain in summer. In some cases builders even sell houses that include passive solar design elements without deeming that fact worthy of advertising. In other instances a buying public with a new environmental consciousness is eager to use renewable solar energy without the financial and personal commitment required by active solar technology. These buyers urge builders to include as many features of passive solar design as possible.

Gains in the effectiveness and acceptance of passive solar technology were made possible largely by advances in window technology. Windows that had always been net heat losers were improved in thermal efficiency until they could provide a net heat gain in heating-dominated climates. Additional layers of glazing and insulative gas fills, combined with increasingly insulative frames,
have improved the thermal resistance of windows dramatically, for application in both heating and cooling climates. Another new technology adds a thin layer of plastic between panes of glass in a window. Varieties of this plastic are specially formulated to capture incoming heat in heating climates, and to repel it in cooling climates. This demonstrates that windows, at least, are turning the tide in American housing back toward climate-specific materials.

**Recycling industry development**

Solar technology wasn't the only product of the 1970s that promoted efficient resource use. Interest in recycling during the same period spawned a materials recovery industry that floundered for several years and is just now, in the mid-1990s, showing its economic viability. Widespread public involvement in recycling began with collection of newspapers and aluminum cans. Volunteer collection programs gradually evolved into municipal programs offering curbside service in many parts of the country. Today the materials recovery industry not only offers curbside collection programs to 41% of households in the United States--108 million people in 7,265 programs nationwide--but also has the capacity to sort mixed municipal waste to recover recyclables. The category of recyclables now includes not only newsprint and aluminum, but also steel, plastic, paper, cardboard, glass, and compostable yard and food wastes.

As the recycling industry has grown, so too has the realization that the collected and processed recyclables are available for industrial feedstocks. The search by manufacturers for dependable quality and supply of manufacturing feedstocks at affordable prices has led increasing numbers of companies to recycled materials. At the same time there is a dawning awareness among consumers that the recycling "loop" must be closed by the purchase of recycled
The search by consumers for recycled materials has contributed to increased production of many different items, including building materials, from recycled material. Consideration of recycled building materials fosters an increased awareness among consumers not only of the resources used in construction, but also of the potential for substituting recycled resources for the natural resources now used.

**Timber harvest regulation and declining supply**

Finding substitutes for conventional building materials and using them more efficiently is becoming increasingly important. Most residential builders report that during the past decade the quality of lumber has been going down as the price has gone up. Despite the current dip in the market, the upward trend of the past few years has held lumber prices at the top of the list of builder concerns for much of the past year. In all likelihood volatile lumber prices and the perception of declining wood quality are caused by a complex combination of many factors. One is the change in the timber supplied to mills.

Wood products manufacturers will admit—sometimes reluctantly—that the size of the trees delivered to their mills has been declining steadily over the past fifteen years. Many manufacturers have been forced to equip themselves with new machinery capable of handling small logs, in order to deal with the only wood supply available.

While the industry is quick to blame the declining timber supply on the amount of regulation that limits timber harvest, other analysts point to logging of smaller, second- and third-growth trees, and the difficulty and expense of accessing remaining old growth trees as determining factors. Whatever the complex cause, its effect has been a significant motivator in shifting the materials if there is to be continued market for collected recyclables.
building industry toward resource efficiency. For probably the first time in U.S. history the national building industry is seriously looking for alternatives to the use of dimensional lumber.

Several possible options have presented themselves: learn to build the same type of structure efficiently using less wood, achieve more complete utilization of the fiber resource through technological advances, or substitute some other resource for wood in a totally different type of building. The current necessity to find alternatives to conventional wood-framed construction has had more impact on the building industry than any other factor. Builders and designers who have never seen the need to change current practice are beginning to see that need, and the foresighted people who have long advocated resource efficiency in construction are coming into their own.

**Trends in resource efficient building**

*Recycled materials*

Now that the building industry is beginning to perceive the need to improve its efficiency, several trends in resource efficient building are emerging. The first of these trends is an increase in the production and use of building products that contain recycled material. More companies are turning to cost-effective recycled feedstocks, and building materials manufacturers are no exception. Each year more building products with recycled content enter the market.

Builders are using more of these recycled products, often because clients demand them. Consumers are overcoming their reluctance to use recycled products, and in many cases are searching out such products. The growing environmental conscience of American consumers leads them to prefer buying
recycled products. Since a house is the largest and most durable investment many people will ever make, selecting recycled building materials provides an outstanding opportunity to demonstrate personal commitment to using recycled products.

Federal, state and even local governments have helped build and maintain the market for recycled materials by enacting procurement guidelines that specify the use of recycled materials. Many of these guidelines extend beyond specifications for office supplies and used motor oil to include the concrete, insulation and interior finishes used in all government construction, whether it be new buildings or renovations. This lead from governments has not only boosted markets, but has provided examples of recycled building materials for the general public.

**Engineered materials (doing more with less)**

While many builders are reluctant to abandon conventional designs and building materials in favor of more resource-efficient alternatives, they will adopt materials that let them do more with less. Reducing the amount of material used reduces builder costs, and often reduces the amount of labor involved in a project. Consequently a second trend toward resource efficient building has been the development and application of engineered building materials.

As one example, engineered wood products have provided a means of building in a conventional manner, yet without consuming as many resources. Engineered wood products substitute smaller pieces of wood combined with low percentages of adhesives for solid sawn dimensional lumber. In addition, some engineered wood products make use of tree species that were formerly considered undesirable for building. Although this creates a shift, rather than a
decline, in fiber demand, it does help to relieve harvest pressure on old-growth forests. Furthermore, engineered wood products make a much more efficient use of logs than dimensional lumber milling, since even small chips of logs can be used to create oriented strand board and medium density fiberboard.

Engineered wood products can promote resource efficiency in a number of other ways, as well. Substituting strong, lightweight I-joists for solid sawn lumber can result in use of 30% less wood in floor framing for a typical house. Not only that, but the I-joists are consistently straight, and actually produce a better floor. Taken as a group, engineered lumber products result in more efficient wood fiber utilization that has helped to offset the impact on forests of the rising demand for housing in the United States. In addition, the engineered wood products have a rigorous quality standard and can be produced in custom sizes, which prevents wasted wood at the job site due to culls and cut-offs. Since the engineered wood products are easily applied in conventional designs, builder acceptance and use have been on a constant rise since their introduction. In fact, the consumption of wood I-beams jumped 47% between 1991 and 1993,10 and industry acceptance of them continues to grow.

Using engineered wood products isn't the only way to do more building with less material. Practices like thin wall foundations and advanced framing make it possible for builders to achieve the same or better performance while using less material. By reconfiguring the way materials are applied, the industry is learning to build better with less.

"Healthy houses"

One of the newest and most powerful trends in building, for both homes and offices, has been the interest in non-toxic materials. Studies show that people are spending more and more of their time indoors: within their houses,
cars, offices, stores or theaters. This lifestyle change, combined with the increased tightness of buildings for both energy efficiency and security reasons, has led to increased exposure to the toxins used in the manufacture of some building materials, interior finishes and furnishings. In some cases high levels of exposure have led to severe health problems, and poor indoor air quality is also blamed for increases in the incidence of asthma and allergies, and in worker absenteeism and decreased production.

Three options have emerged as ways to make buildings healthier for their occupants. First, a number of consultants and publications have appeared, offering homeowners advice on how to outfit their homes with "natural" or "non-toxic" products. Second, building industry professionals and consumer groups have encouraged manufacturers to reduce or eliminate certain toxins from their products. Such pressure has resulted in a switch by many manufacturers from urea formaldehyde adhesives that emit formaldehyde to phenol formaldehyde adhesives that are more stable. Also, several major paint manufacturers are now offering lines of paint with low or no volatile organic compounds (VOCs). The third option for improving indoor air quality is the installation of mechanical ventilation and filtration systems. While such systems don't actually reduce the number of toxins in the house, they ensure that indoor air is exchanged with outdoor air to remove concentrations of pollutants.

Members of the building industry take the "healthy house" issue with varying degrees of seriousness, and individual builders have modified or not modified their practices accordingly. Many consumers take the issue very seriously, however, and have demonstrated their willingness to pay a premium for "healthy" construction. Consumers who aren't willing to pay extra for the health of the environment may nonetheless pay for their own health, and the
net result is a lessening of the hazardous and toxic materials used in building construction—an environmental benefit all the way around.

**Indigenous materials**

Another recent trend in resource efficient building has been a return to indigenous building materials. This trend is perpetuated largely by individuals and grassroots groups, rather than an organized industry. Indigenous materials offer not only an opportunity to avert the environmental costs of material transport, but often entail less processing and refining than other material options. These savings translate into lower materials costs, which are attractive to those seeking affordable housing. The most popular indigenous building methods are highly labor intensive, however, and this can offset any materials cost savings. At the same time, indigenous materials can often be applied by unskilled laborers, making it possible for owners to participate in the construction process or to conduct it themselves, in a "sweat equity" cost tradeoff.

By marrying the best of modern technology with ancient building techniques, people have been able to build resource efficient homes that cause much less environmental impact than conventional houses. Homes of adobe, rammed earth, earth block, stone, and strawbales are possible and environmentally practical in locations across the country. Indigenous building methods do not have widespread appeal, though, so the trend toward indigenous material use is necessarily limited in its impact upon natural resource consumption.
Theories of effectively promoting resource efficiency

Defining an audience

Considerable debate rages among the advocates of resource efficient building about how best to foster its widespread adoption. The advocates themselves include an eclectic mix of disillusioned conventional builders, visionary designers, inspired entrepreneurs, and practical environmentalists. The design and consulting firms and non-profit organizations that evolved from the beginnings of resource efficient building and lead today's trends toward more efficient building disagree even among themselves about the best way to achieve their ideals.

Some activists maintain that it is the designer's responsibility to adopt the principles of resource efficiency. The designer not only turns a concept into a working drawing, but also specifies the structural and finish materials for the job. Resource efficient materials and building practices cannot make a significant impact upon building construction until they are accepted and used by designers.

At the same time, the builder plays a crucial role in improving the resource efficiency of the construction process through procurement and installation of materials. The challenge of obtaining and working with unfamiliar materials often leads contractors to make on-site substitutions that revert to conventional practices and materials. Until builders are willing to employ new products and methods, resource efficient construction cannot make its way from the concept stage into actual buildings.

Other promoters of resource efficient building assert that while builders and designers are important in the process, it is the client who has the true...
power to move the market. Not until homebuyers demand resource efficient designs and materials will the industry incorporate them into buildings. Even so, many idealistic clients report having contacted architects and builders who knew little about resource efficient building and were unwilling to spend the time and energy required to learn about it. Many clients are dissuaded by builders and architects from choosing anything but conventional building materials and practices.

The situation appears to many insiders to be a "catch-22," for not until clients demand it will builders change, yet not until builders begin to change will clients know what is possible and be able to call for a new, more environmentally responsible type of building. In the end it appears that those who would lead the way to a more resource efficient building industry must not focus their attention on any one member of the construction triangle, but must direct their efforts toward the simultaneous education of the designer, support of the builder and inspiration of the client.

**The demonstration theory**

Advocates of resource efficient building must not only determine who their message should target, but also the most effective means of reaching that audience. One tactic which has become increasingly popular in recent years is the demonstration building. Most often a sponsor enlists a sympathetic architect and builder to design and construct an exemplary structure that can be exhibited to the public as tangible evidence that resource efficient building is possible and desirable. These demonstration buildings are often the first exposure that many consumers and building industry professionals have to resource efficient building. Demonstration buildings allow firsthand evaluation of designs and materials by many people.
Unfortunately demonstration buildings probably do not have the force to motivate significant change in the building industry. The projects, although exemplary in some senses, do not set a precedent for mainstream housing. For the most part these projects are removed from the constraints of the market: the client is able to hire designers and builders willing to provide a resource efficient product; the builder doesn't have to worry about pleasing the general buying public; sponsors often have uncharacteristically large budgets; and real costs of construction are often hidden by material donations from manufacturers seeking advertisement.

**The 90/10 builder theory**

A different approach to fostering implementation of resource efficient building is to concentrate squarely on changing practices of the mainstream building industry by educating and training builders. Construction is an extremely traditional industry in which change happens at what can only be described as a glacial rate. However, by motivating 90% of builders to improve on their current practice and reduce resource use by just 10%, dramatic environmental benefits could be attained. The U.S. housing industry has well over one million new home starts each year. In addition, the residential remodeling market is well over $100 billion yearly. Given this volume, if 90% of the builders constructing and remodeling across the nation adopt more resource efficient methods, significant reductions in both the consumption and waste of natural resources are possible. As a result, some advocates of resource efficient building consider the 90/10 theory the most effective market approach.
The revolutionary theory and the credibility issue

On the other hand, some proponents of resource efficiency are frustrated by the process of incremental change within the building industry, and favor much more radical action, for a more readily apparent result. These individuals and groups are the revolutionaries who advise building houses with minimal impact on the environment, and with minimal consumption of natural resources. Their building projects are often radically different from conventional structures, and include dramatic and sometimes drastic lifestyle adaptations for the occupants. Such projects can be individually meritorious and often provide great personal gratification to their owners. Nonetheless, they comprise less than 1% of the national housing stock, and as such have relatively little impact upon national levels of consumption. Building one or two extremely resource efficient houses each year has little effect on the environment when the one million conventional houses built each year are included in the equation.

Furthermore, groups that engage in the construction of these radical dwellings often lose credibility with the mainstream building industry. The industry requires houses that the buying public will accept, and the exemplary but revolutionary houses often fail in this regard. The total potential impact of the revolutionaries upon the industry is therefore limited, and since mainstream industry is the most significant consumer of resources, the revolutionary approach has little chance to significantly reduce the impact of building upon the environment.

The cutting edge theory

Yet another means of promoting resource efficient building is the supply-side approach. Supporters look for technology to develop new materials that
better utilize natural resources. In theory, this will allow the present scale of building to continue, with simple substitutions in materials, rather than reductions in consumer expectations.

Proponents of this theory devote their energy to the support of cutting-edge research in adhesives, composites, and fiber utilization. This approach to resource efficient building can be crucial in assisting inventors in bringing their innovations into commercial production. New resource efficient substitutes for familiar products also make change easier for the entrenched building industry.

**A combined approach**

As theories, each of the different approaches to fostering resource efficient building has some merit. Yet no one theory is adequate to precipitate sufficient change in a large and complex industry, peopled by consumers, designers and builders. Instead, the most effective approach to motivating the industry combines elements of each of the above theories, in order to encourage people in all segments of the industry to strive for improved resource efficiency.

It is this combined approach that defines the work of the Center for Resourceful Building Technology in Missoula, Montana. For five years this non-profit organization has worked to educate the public on issues relating to housing and the environment, with particular emphasis on innovative building materials and technologies which place less stress on regional and global ecosystems. The projects of the Center for Resourceful Building Technology include actual demonstration structures, training seminars and educational publications.
The rationale and role of the **Guide to Resource Efficient Building Elements**

Foremost among the publications of the Center for Resourceful Building Technology (CRBT) is the **Guide to Resource Efficient Building Elements**. This publication first appeared in 1991 as a reference for builders interested in locating the types of materials used in the first demonstration project sponsored by CRBT, ReCRAFT 90. The **Guide to Resource Efficient Building Elements** has evolved over the past five years into a tool designed to meet the needs of a changing and increasingly resource efficient building industry.

The current edition of the Guide brings the concepts and details of resource efficient building to a diverse audience. For the user unfamiliar with the technology of resource efficiency, each chapter of the book contains an introductory text summarizing the resource efficient characteristics of particular building components. The professional builders and designers already familiar with the technology can skip the introductory text and go straight to the product listings. For these frequent reference users of the book, current and detailed information is a priority. Meanwhile, the availability of user-friendly explanatory text differentiates the Guide from the many other computer and printed product directories now entering the market.

The Guide also introduces the concept of job-site recycling to owners and practicing builders. This is one of the first and easiest steps that the mainstream building industry can take to reduce waste and initiate more resource efficient practices. Information like this, combined with the product listings, assists the mainstream building industry in attaining at least a 10% improvement in resource efficiency.
Other users of the Guide are looking for ways to "push the envelope" and go far beyond conventional building designs and materials. To provide the encouragement and information that these bold experimenters require, the Guide includes sections on "Resource Efficient Design" and building from indigenous and salvaged materials. By assisting these building pioneers in their projects, the Guide helps them to build the innovative buildings they desire and chart a new course for the future of mainstream building.

Finally, the Guide assists entrepreneurs on the cutting edge of resource efficient product development, by forging a critical link between the foresighted inventor and the market that most demands resource efficient products. This not only encourages the development of new products, but helps establish markets that foster larger scale production and more widespread use of the most resource efficient building products that exist today.

The Guide contains chapters on managing resources and energy, as well. These broad background concepts help to set the topic of building construction in the wider context needed to achieve true resource efficiency. Not until the building industry and its consumers become aware of the pathway from resources to buildings and back again will society be truly motivated to reduce the resource consumption of houses and other structures.

The Guide cannot be all things to all people. The mainstream building industry sometimes criticizes it for being too radical. Meanwhile some environmental groups lambaste it for including companies with reputations of environmental degradation. Admittedly, the Guide is not the sole answer to making the construction industry and society as a whole resource efficient, for there can be no one solution to achieving such a complex objective. Instead, it is the hope of the Center for Resourceful Building Technology that this publication will encourage a huge industry to move incrementally toward
resource efficiency, while at the same time enabling already-motivated builders and homeowners to create much more resource efficient dwellings on an individual scale. We are still working toward that initial goal of appropriate shelter for people.

Endnotes

2 Drawn from graph by Center for Resourceful Building Technology. 1994.
3 Ibid.
Guide to Resource Efficient Building Elements

5th Edition

Center for Resourceful Building Technology
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Introduction

Resources for Building the Future

A Consumption Portrait

Every new building or remodeling job has an environmental impact. Both construction and continued operation of buildings require tremendous quantities of material resources and energy. Throughout the history of civilization, the size and number of buildings have grown virtually unchecked, fueled by seemingly plentiful natural resources and cheap energy supplies. Today the situation is beginning to change. The housing demand of a rapidly-increasing world population is taxing the planet's natural resource base, and the materials traditionally used for building are becoming less accessible and more expensive. The same is true of the non-renewable energy supplies that have powered construction for the past hundred years.

Meanwhile some of the costs of historical energy and resource consumption are becoming apparent. Less than 3% of the virgin old growth forest in the United States remains uncut, and global forest cover is disappearing at an unprecedented rate. Mine sites, processing areas and dumps across the United States have been declared Superfund sites; locations contaminated with toxins that require extensive remediation efforts. In many locations air quality is declining, and global concentrations of atmospheric carbon dioxide are rising. At the same time, builders are experiencing rising materials and disposal costs, and are concerned about the quality of wood available for building.

The authors of this book, the staff of the Center for Resourceful Building Technology, believe that people can begin to address these problems by examining and changing conventional patterns of building. By designing buildings in a manner that minimizes environmental impact, and constructing them from components that make an efficient use of resources, the building industry and its customers can take immediate and practical steps to provide shelter for the next century, while preserving the environment and extending the resource base into the future.

For the past five years, the non-profit Center for Resourceful Building Technology (CRBT) has worked to educate the public on a variety of issues relating to housing and the environment, with particular emphasis on innovative building materials and technologies which place less stress on regional and global ecosystems.

This publication is an outgrowth of that effort, and is a continuing project of CRBT. Research is ongoing, and a new edition of this Guide is issued yearly to provide current information on the rapidly-evolving field of building material technology.

About this book

The first section of this book contains contact information for manufacturers of resource efficient and recycled building materials. Chapters are arranged by building component, and each chapter opens with a discussion of the state of available technology. Chapters also contain contact information for the national manufacturers of recycled and resource efficient products, along with a brief description of the products.
and their availability. Readers can contact the listed manufacturer to locate distributors and obtain pricing information for their individual locations.

Readers who wish to learn more about resource efficient building design, whole-building recycling, alternative methods of building, resource management and waste reduction can find more information and additional references in the second section of the book. Readers who are interested in further research can contact one of the authors or organizations in the "Additional Information" section, or CRBT.

Every effort is made to ensure that the information included in this book is accurate and timely. Due to the nature of the industry, however, change is rapid and continual. If you find outdated information please alert us so that we can correct the problem and more effectively serve all the environmentally-aware builders, homeowners, manufacturers and designers who rely on this reference.

**Determining Resource Efficiency of Building Materials**

The products listed in this book have been determined to be more resource efficient than conventional building materials. How can the resource efficiency of a product be assessed? The Center for Resourceful Building Technology has developed the Resource Efficiency Equation to provide criteria by which to evaluate building materials. The criteria of the equation have been used to assess the products included in this book. We also include the equation itself, so that readers can use it to determine relative resource efficiency of products in a particular application, or can apply it to determine for themselves the resource efficiency of products not included here. Decisionmakers must set priorities, and recognize that the most resource efficient products may not be the most practical or cost effective.

A picture of the true resource efficiency of a product emerges only from a comprehensive assessment of the product's environmental impact. The criteria of the equation allow the cumulative total consumption caused by a product to be weighed relative to other products. This method prevents decisionmakers from being misled by claims of resource efficiency or "greenness" based upon fulfillment of a single criterion. Choice of a building material should include a consideration of the relative resource efficiency of the product's manufacture and use. Consequently, resource efficiency determinations consider the predicted very-long-term availability of all inputs to a product. This long-term availability is estimated by considering present practice and assumed advances in acquisition, efficiency and usage patterns.

Most building materials meet some of the criteria for resource efficiency but fall short in other categories. Only a few outstanding products have the potential to match closely every one of the criteria for resource efficiency. These criteria, then, represent both a goal to strive towards and a measure of the relative merits of currently available materials. By applying these criteria equally to all products in a class, the most resource efficient products currently available can be identified.

**The Resource Efficiency Equation**

Resource efficient building materials:

1. Make efficient use of limited natural resources
   + Preserve the resources, energy and labor invested in a product through longevity in application, and/or potential for reuse
   + Extend the resource base by using less material to achieve the same or better performance than other component configurations
   + Substitute a more-abundant for a less-abundant resource, and/or a renewable for a non-renewable material, and/or a recyclable for a non-recyclable material
+ Reduce cumulative environmental impacts of resource consumption:
  - air pollution and climate change and
  - water pollution and watershed damage and
  - habitat loss and loss of biodiversity

2. Demonstrate recyclability and/or renewability
   + Are made of reused or recycled constituents
   + Are readily recyclable through existing technologies and collection programs or are biodegradable
   + Are recoverable for recycling or reuse from their applied state (dismantleable)

3. Reduce energy use of buildings
   + Require comparatively low total lifetime energy inputs, including energy of:
     - Extraction and related land and water reclamation and
     - Processing and related pollution abatement and
     - Transportation and
     - Installation and
     - Lifetime maintenance and
     - Material recovery and recycling
   + Utilize a high proportion of lifetime energy inputs from renewable sources
   + Reduce the amount of operating energy a building will require

In addition, CRBT has identified a number of implementation criteria to consider for materials, as a check that they are not only resource efficient, but also practical. The most effective resource efficient materials:
1. Are monetarily affordable
2. Require labor time and skill level for installation comparable to or less than conventional products
3. Complement and substitute readily for existing building materials in design
4. Have an appearance acceptable to the consumer
5. Do not represent a health concern for installers or building occupants

The Challenge of Imperfect Information
The materials included in this Guide have been evaluated by the building technology staff of the Center for Resourceful Building Technology using the criteria listed above. Some materials meet the proposed criteria better than others. We have chosen to include a material option for each major construction application, even though in some cases no material is an especially resource efficient choice. In most cases we provide a variety of options for each application, recognizing that no two situations are exactly alike, and the best product choice for one building project is not necessarily the best choice for another.

Evaluating building materials for resource efficiency is a complex and challenging endeavor. Sometimes not even the product manufacturer understands the full impact of resource extraction involved in making a product, and the embodied energy of materials is still a little-known quantification. Some materials and manufacturing processes are better understood than others, since highly complex processes require a long-view analysis for which very little information is available. The problem is compounded by the fact that the science of life-cycle analysis is still in its infancy, but already the subject of a great deal of controversy.

Given the present level of information on product manufacture and life-cycle, it may not be possible to evaluate the performance of a product relative to all of the criteria in the Resource Efficiency Equation.
Even so, this list of criteria encourages compilation of all available information; a process that reveals where the greatest gaps in current knowledge lie. Decisions are made based upon the best information available to us, and new information sometimes changes the result of previous evaluations. Synthesizing present information and uncovering areas for further research are important steps toward defining and identifying truly resource efficient building materials.

**Reader Invitation**

The Center for Resourceful Building Technology invites you to participate in resource efficient building by learning more about design, materials, and construction practices that promote resource preservation and prevent waste, and by implementing these ideas in your own building projects. We welcome comments, suggestions, and information on new building products. Please join us in fostering efficient resource use.
Foundations

Conventional American foundations use large amounts of concrete to achieve stability, strength, and weather and pest resistance. In addition to sand and gravel, typical concrete contains about 15% portland cement, which is very energy intensive to produce. To derive this energy, kilns that cook limestone, silica and clay to produce cement are burning increasing amounts of hazardous wastes or tires for fuel. According to the American Institute of Architects, fuels burned in kilns during the manufacture of cement produce approximately 8% of all carbon dioxide emissions created worldwide. Meanwhile, the Scrap Tire Management Council estimates that as many as 100 million tires per year could be burned in kilns by 1997. This is equivalent to forty percent of present annual U.S. tire production, although it is estimated that a national stockpile of perhaps two billion worn out tires exists.

The average American home uses 42 cubic yards of concrete in its construction. The demand for full basements or deep footings drives this figure higher for many homes. Consequently the foundation is a prime area for adopting building methods that reduce total material usage or substitute a more resource efficient material for portland cement. There are a number of options for reducing the amount of concrete used in foundations. A monolithic slab foundation or shallow insulated foundation can minimize the need for concrete because foundation footings need only be 12" deep in most cases. Slabs eliminate the need for floor framing material, as well. Insulated shallow foundations prevent frost heaving beneath heated buildings by capturing heat from the building and the earth that prevents the soil underneath the structure from freezing. Canadian thin wall technology, utilizing poured concrete walls that are 6" thick instead of the standard 8", is another means of reducing the total amount of concrete used in a foundation.

In addition, foundation material requirements can be lessened by using lightweight concrete, hollow cementitious blocks, or concrete-filled foam blocks below grade. These products improve the thermal efficiency of the foundation, and most can also be used to construct above-grade walls. The first section of this chapter lists concrete block systems. Depending on the system, the blocks may be filled with insulative inserts, concrete, or site-blown foam insulation. A few concrete block products contain expanded polystyrene pellets or waste wood chips to reduce the total concrete used and improve insulative value. Most of these technologies have well-understood engineering specifications and are readily approved by building code officials.
The second section of this chapter lists systems that employ lightweight interlocking foam blocks or foam sheets as forms. In most of these systems rebar is laid in place in hollow block cores, and concrete is poured into the cores to create an insulated concrete lattice wall. The blocks come in different sizes and styles, depending on the system, and can be used for foundations or above-grade walls. Both form systems and block inserts made from expanded or extruded polystyrene provide dramatically higher thermal efficiencies than a solid concrete foundation or wall, though R-value may vary greatly from system to system. This is at least partially due to the fact that there are several different methods of measuring and calculating R-value, and the Federal Trade Commission has no standard method requirement that applies to wall systems.

Permanent foam formworks are derived from fossil fuel, and foam insulations require a great deal of energy to manufacture. The composite formed by the foam and concrete fill could be difficult to recycle when the building is demolished or remodeled, but might be reused in place. These considerations should be part of the decision to use an insulated formwork system.

In any foundation using ready-mix concrete, one resource that can be put to good use is fly ash from coal-fired power plants. The Electric Power Research Institute reports that over 75 million tons of fly ash are produced in this country each year. In standard practice this fly ash can be used as a replacement for 15% to 35% of the cement in the concrete mix by weight, depending on the type of fly ash and the application. Results of preliminary experiments demonstrate that fly ash may be successfully substituted for an even greater proportion of the cement, up to 100%. Fly ash can also provide part of the fine aggregate needed in the concrete. Fly ash adds strength and durability to the final concrete product, and reduces materials costs. Concrete containing fly ash cures more slowly than traditional concrete but is easy to work with and provides a slightly smoother finish. Coal fly ash has routinely been used in concrete since the 1960s, and recent studies show that wood fly ash also shows promise as a cement substitute. Fly ash suppliers are listed in the last section of this chapter.

Autoclaved cellular concrete (ACC) technology has great potential for reducing the amount of concrete used in block or panels, while increasing the thermal resistance of an 8-inch wall to as much as five times that of concrete alone. In ACC, small amounts of aluminum powder are added to a standard cement mix, or a mix containing fly ash. Hydrogen bubbles produced by chemical reaction expand the mass, creating a lightweight concrete. Concrete blocks are then steam cured to stabilize the cellular structure. This concrete provides a high strength-to-weight ratio and can be worked with ordinary tools. The ACC technology has been utilized in Europe for years, and is gradually becoming more available in the United States. Autoclaved cellular concrete and other types of foamed concrete products are listed in the third section of the chapter.
Blocks

Advanced Concrete Technologies Inc.
67 South Bedford Street
Burlington, MA 01803
Ph: (617) 229-5828
Fax: (617) 272-0558

Applications:
Durisol makes wall and floor forms for low and high rise buildings, as well as precast roof panels.

Sizes:
Standard Durisol blocks are 300mm x 300mm x 20, 25 or 30cm. Corner blocks and other special forms available.

Fire rating:
Wall system has fire rating above four hours.

R-value:
R-value of the blocks is 4-1.45. An insulative insert raises the value to 2.22-3.32.

Comments:
Blocks contain 78% recycled materials. The softwood aggregate is a by-product of the lumber industry, plus recycled waste wood. Blocks have freeze/thaw resistance.

Ener-Grid
6421 Box Springs Blvd.
Riverside, CA 92507
(909) 653-3346

Applications:
Construction elements consisting of a mix of cement and recycled post-consumer styrene pellets. These 12' long block/beams are set in place with steel rods through the center and then filled with concrete to create strong, fire-resistant walls. Blocks contain recycled Styrofoam. Scrap can potentially be recycled into future blocks.

Fire Rating:
3-hour fire rating.

R-value:
R-30-33

Electrical wiring:
Not specified.

Comments:
Any type of finish such as paints, plasters, stucco, tile, and gypsum board, can be applied to the block surface.

Texas FASWALL
5025 Gesner, Suite C
Houston, TX 77041
(713) 466-5999

Applications:
Wall system consisting of wood/concrete composite blocks that are stacked dry and filled with poured concrete to create exterior walls and foundations.

Fire Rating:
2 to 4-hour ratings.

R-value:
8" width is R-19. 12" width is R-30.

Electrical Wiring:
Blocks have chases every 8" on the inside and outside faces.

Comments:
Termite and vermin proof, sound deadening, exterior and interior waterproof masonry surfaces and no infiltration of air or moisture.
| **Sparfil International Inc.**  
| P.O. Box 270336  
| Tampa, FL 23368  
| (813) 963-3794  
| 376 Watline Ave.  
| Mississauga, ON L4Z 1X2 Can.  
| (905) 507-1163  |
| **Applications:**  
| Commercial and residential. The surface bonding cement is mixed with water and applied to both sides of dry-stacked Sparfil block walls to create a hard, durable finish that is airtight and waterproof.  
| **Sizes:**  
| Available in widths from 4" to 12" in 2 inch increments.  
| **Fire Rating:**  
| Up to 4 hour resistance. According to tests conducted by the U.S. Testing Company, the products of combustion from EPS are less toxic than those produced from an equal volume of wood.  
| **R-value:**  
| Up to R-33, depending on thickness.  
| **Electrical wiring:**  
| Not specified.  
| **Comments:**  
| The EPS inserts extend 3/8" from the sides so that after installation the top of the blocks and 3/16" from the edges. Once constructed, walls are post-tension vertically reinforced.  
| **Superior Walls of America, Ltd.**  
| P.O. Box 427  
| Ephrata, PA 17522  
| (717) 626-WALL  
| Manufactured panel concrete stud walls with 7 1/2" deep insulation cavity.  
| **Applications:**  
| Used atop a monolithic footing, in conjunction with a reinforced bond beam to form insulated foundations.  
| **Sizes:**  
| Panels are custom designed to blueprints.  
| **R-value:**  
| R-5. Additional site-installed insulation can bring the wall to R-24.  
| **Comments:**  
| This wall system allows for a foundation that uses significantly less concrete than a poured-in-place foundation. However, the cost and energy of transporting the completed panels makes their use feasible only in parts of the Northeastern U.S. located near manufacturing facilities.  
| **Superlite Block**  
| 4150 W. Turney  
| Phoenix, AZ 85019  
| (800) 366-7877, (602) 352-3500  
| *Integra®* block wall system consisting of masonry units with a reduced center web, that may be open on both ends. Once constructed, walls are insulated with blown-in polyurethane foam.  
| **Applications:**  
| For load bearing and non-load bearing walls. Walls are post-tension vertically reinforced.  
| **Sizes:**  
| Blocks are available in 6" x 8' x 16", usually used for residential construction, and 8" x 8' x 16", for commercial uses. Blocks are available in architectural finishes including a variety of colors and textures.  
| **Fire Rating:**  
| 6' blocks have a 1 hour rating, 8' blocks have a 2 hour rating.  
| **R-value:**  
| Measured by parallel path method with a temperature differential equation. 6' walls are R-23 and 8' walls are R-28.  
| **Comments:**  
| The Integra system seeks to minimize thermal bridging in a masonry block wall by using an H-shaped block with a reduced center web, and by avoiding rebar reinforcement. This increases the thermal efficiency of the wall.  
| **ThermaLock Products, Inc.**  
| 4150 W. Sweeney Street  
| North Tonawanda, NY 14120  
| (716) 695-6000  
| *EnerBlock™* molded polystyrene inserts insulate the cores of concrete masonry units and between units horizontally and vertically.  
| **Applications:**  
| For use with standard block, or as a system including block.  
| **Sizes:**  
| In 1 1/4", 2", 2 1/2", or 4" inserts for use with 8", 10", or 12" masonry units.  
| **Fire rating:**  
| Flame spread 15, smoke developed 45-125.  
| **R-value:**  
| Varies with width of thermal barrier and block size.  
| **Comments:**  
| No CFC in manufacture. Closed cells contain only air. Units accept grouted reinforcing steel vertically and horizontally without losing continuity of insulation. Currently available in the upper Midwest.  
| **West Materials, Inc.**  
| 101 West Burnsville Parkway  
| Burnsville, MN 55337  
| (612) 890-3152  
| Fax: (612) 890-9341  
| *EnerBlock™* molded polystyrene inserts insulate the cores of concrete masonry units and between units horizontally and vertically.  
| **Applications:**  
| For use with standard block, or as a system including block.  
| **Sizes:**  
| In 1 1/4", 2", 2 1/2", or 4" inserts for use with 8", 10", or 12" masonry units.  
| **Fire rating:**  
| Flame spread 15, smoke developed 45-125.  
| **R-value:**  
| Varies with width of thermal barrier and block size.  
| **Comments:**  
| No CFC in manufacture. Closed cells contain only air. Units accept grouted reinforcing steel vertically and horizontally without losing continuity of insulation. Currently available in the upper Midwest.  

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**Foundations**

**Guide to Resource Efficient Building Elements**
Form Systems

3-10 Insulated Forms, L.P.
P.O. Box 46790
Omaha, NE 68128
(402) 592-7077

3-10 Polysteel Form® is a system of expanded polystyrene forms that interlock to create a continuous formwork. The forms become a permanent part of the complete building system providing insulative and sound deading values.

Applications:
Foundation and above grade exterior and interior walls

Sizes:
8" high x 48" long x 10" wide. This produces a 6" reinforced concrete wall.

R-value:
R-22+

Comments:
These forms are lightweight, easy to handle, quick to assemble, fire resistant, and can be installed using unskilled labor. The 3-10 Polysteel Form uses 25-50% less concrete to provide a 50% stronger, fully insulated wall. No CFCs (chlorofluorocarbons) were used in the manufacture of this form. It also comes with an energy savings warranty that ensures that the total energy consumption to heat and cool a similar size traditionally constructed home.

AAB Building System
23314 Crenshaw Blvd., Suite 7
Torrance, CA 90505
Ph: (310) 539-2221
Fax: (310) 539-8872

Expanded polystyrene foam permanent formwork.

Applications:
For reinforced concrete walls, both below and above grade.

Sizes:
Standard unit 48" long, 11 1/2" wide and 16 3/4" high. Seven specialty units available for corners, ends, etc.

R-value:
R-26

Comments:
AAB blocks have a three hour fire rating when filled with concrete. The blocks include vapor/air barrier and strapping 8" on center for interior and exterior finishing.

AFM® Corporation
P.O. Box 246
Excelsior, MN 55331-0246
(800) 255-0176
(612) 474-0809

Diamond Snap-Form™ expanded polystyrene insulated concrete forming system, using Perform Guard™ insulation with Diamond Snap-Tie™ every 12".

Applications:
Above- or below-grade walls.

Sizes:
Insulation in 1' x 8' sheets, prenotched at 1' intervals for ties. Factory cut 90° or 45° corners.

R-value:
Nominal R-20.

Comments:
Perform Guard insulation has an insect resistance warranty. All AFM licensed manufacturers listed in the Insulation chapter of this book also offer Diamond Snap-Forms.

American ConForm Industries, Inc.
1820 S. Santa Fe Street
Santa Ana, CA 92705
Ph: (714) 662-1100
(800)-CONFORM
Fax: (714) 662-0405

SmartBlock™ expanded polystyrene permanent modular formwork. Hollow foam blocks are filled with concrete.

Applications:
For plain or reinforced concrete foundations, interior or exterior walls.

Sizes:
Blocks are 40" long x 10 2/3" or 12 3/4" tall. Standard form width 10", variable width forms 3 3/4", 5 3/4", or 7 3/4".

Fire rating:
Flame Spread of 10.

R-value:
R-17.6

Comments:
Up to 50% stronger than standard concrete. Will not deteriorate with age. No CFC released in manufacturing.
Guide to Resource Efficient Building Elements

Core Form™
7245 West 116th Place, Suite 4
Broomfield, CO 80020-2955
(303) 460-1346

Expanded polystyrene foam block formwork.

Applications:
Foundations, wall systems, floor systems, and roof systems.

Sizes:
8" x 4' x 16' Each block weighs 32 pounds.

R-value:
Up to R-30, depending on wall finish.

Comments:
This wall uses 2/3 less concrete than a conventional 8" poured foundation. Form blocks can be cut with a hot wire tool. Large blocks allow quick assembly.

EnerG Corp, Inc.
4203 W. Adams
Phoenix, AZ 85009
Ph: (602) 470-0223
Fax: (602) 438-7876

EnerGBlock Wall System consisting of interlocking polyurethane blocks which serve as forms and insulation for a poured concrete foundation. The design of the forms creates a waffle-like area that reduces the amount of concrete required in a wall.

Applications:
Walls and foundations.

Sizes and weight:
Each EnerGBlock is 8" x 8" x 16" and has a density of two pounds per ft³.

R-value:
R-22

Comments:
Flame retardant EPS, with no CFC or HCFC used in manufacture.

Insulform Inc.
P.O. Box 17533
Austin, TX 78760
(512) 376-7170

High density expanded polystyrene permanent foam formwork that is filled with concrete to form posts 8" on center or 24" on center

Applications:
Commercial or residential construction, for exterior or interior walls, basement or above grade.

Sizes:
Standard block is 48" x 16" x 10" and weighs 4 pounds.

R-value:
R-35 with posts 8" on center and R-45 with posts 24" on center

Comments:
Blocks interlock to form an airtight wall. Job-site waste can be reused as insulation. Manufacturer claims that product is unaffected by termites.

K & B Associates
P.O. Box 35605
Monte Sereno, CA 95030
(408) 395-3394, (800) 742-0862

E-Z Form is a system of expanded polystyrene forms that interlock to create a continuous formwork. The forms become a permanent part of the complete building system providing both insulative and sound deading values. The design of the forms creates a waffle-like area that reduces the amount of concrete in a wall.

Applications:
Foundation and above grade exterior and interior walls

Sizes:
8" high x 48" long x 10" wide. Produces a 6 1/2" reinforced concrete wall.

R-value:
R-18

Comments:
These forms are lightweight, easy to handle, quick to assemble, fire resistant, and can be installed using unskilled labor. The high insulative value of the polystyrene saves energy, while the 6 1/2" wall saves concrete.

Keeva International, Inc.
1854 N. Acacia St.
Mesa, AZ 85213
(602) 827-9894

Keeva™ form expanded polystyrene foam form system.

Applications:
The two styles of Keeva form allow creation of either vertical or horizontal concrete beams. The system serves as foundation or above-grade walls.

Sizes:
Blocks are 8" x 12" x 48"

R-value:
Nominal R-34; equivalent to wood wall R-25; in-wall R-20.

Comments:
Forms have interlocking tabs to self-align. Can be concrete filled for vertical beams 8" o.c., 16" o.c. or 24" o.c., depending on structural needs. 24" o.c. fill significantly reduces the amount of concrete used.

Lite-Form, Inc.
P.O. Box 774
Sioux City, IA 51102
Ph: (712) 252-3704
Fax: (712) 252-3259

Lightweight form system consisting of ties that join two sheets of foam together to create a lightweight insulating form system.

Applications:
Foundations, basement walls, stem walls, crawl spaces and retaining walls.
**Guide to Resource Efficient Building Elements**

**Reddi-Form® Inc.**
250 Canal Road
Fairless Hills, PA 19030
(215) 295-8884
Lightweight, interlocking expanded polystyrene permanent forms for concrete walls.

**Applications:**
Foundations, basements, walls.

**Sizes:**
Blocks are 48" x 12" x 9.6" and come in corner form, closed corner form, and standard form.

**R-value:**
R-20

**Comments:**
Weigh 10% as much as traditional wood forms. This system of ties can be used with any brand of extruded polystyrene board or two-pound bead board.

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**UC Industries, Inc.**
3 Century Dr.
Parsippany, NJ 07054
(800) 863-6767
(201) 267-1605
R-FORMS® insulated foundation formwork system using Foamular® extruded polystyrene insulation with thermoplastic ties.

**Applications:**
Used for above or below grade residential, commercial or industrial walls.

**Sizes:**
System uses standard 4' x 8' sheets of Foamular insulation with Space-R-Ty™ every 16 inches. Ties can be set for walls 4" to 10" wide.

**R-value:**
R-20

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**W.A.M. Inc.**
206 South Main
Majaxeka, IA 52060
Ph: (800) 523-2525
Fax: (319) 652-5475
I.C.E. Block™, a reinforced concrete wall system consisting of expanded polystyrene forms that remain in place after the concrete is poured.

**Applications:**
Above or below grade, from single family to multi-story

**Sizes:**
Forms are 16" x 48" in widths of 9 1/4" or 11 1/4".

**R-value:**
R-22+

**Comments:**
This system has the potential to reduce job-site waste, as the forms are left in place to provide insulation. The permanent forms also allow for maximum concrete strength (due to slower curing time), reducing the volume of concrete necessary. No CFCs are used in the manufacture of these forms.

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**Woodless International, Inc.**
1550 Jones Ave., Suite G
Idaho Falls, ID 83401
Ph: (208) 529-8373
Fax (208) 529-8374
Expanded polystyrene building forms with high-impact PVC plastic furring strips located at 12" centers contiguous through block for fastening interior and exterior wall coverings.

**Applications:**
For use in foundations and walls.

**Sizes:**
48" long x 11" wide, in 16", 32" or 48" heights. The 16" block weighs 7 pounds.

**R-value:**
R-30+

**Comments:**
Extruded polystyrene is particularly moisture resistant for below-grade uses.

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**Foamed and Cellular Concretes**

**Durox Building Units Limited**
Northumberland Road
Linford, Stanford-le-Hope
Essex SS17 OPY
England

**STD Code 0375** 673344
Autoclaved aerated concrete blocks and reinforced headers. Autoclaved cellular concrete products such as these may be used to meet both the structural and thermal design requirements of a structure.

**Applications:**
Blocks and headers are suitable for both loadbearing and non-loadbearing walls. Surfaces may be painted, plastered or dry lined.

**Sizes:**
Manufactured in metric sizes.

**R-value:**
A 4" Durox wall offers the same insulation value as a wall of 23" solid brickwork. Approximately R-5

**Density:**
31 pounds per cubic foot; less than 1/4 the weight of normal concrete.

**Fire rating:**
Non-combustible. Meets the requirements for Class O surface spread of flame. The fire resistance of blocks, per 25mm (1") thickness, is one hour in non-loadbearing walls. Headers have a fire resistance of one hour.

**Comments:**
Blocks are easily sawn, drilled or chased with ordinary tools. Headers are reinforced with welded steel cages coated with a cement/latex compound. Vapor diffusion characteristics limit condensation during intermittent periods of high humidity. Ideal for earthquake resistant construction. Highly frost resistant. Durox recycles waste materials before and after the autoclaving process.

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Center for Resourceful Building Technology
Hebel Corporation
2305 Six Branches Drive
Roswell, GA 30076
Ph: (404) 552-8665
Fax: (404) 552-8087

Autoclaved aerated concrete products, including components for walls, floors, roofs, and ceilings. Made from quartz sand, cement, lime, and an aluminum paste.

Applications:
Blocks are available for all wall and load bearing applications. Wall slabs are designed for load bearing and non-load bearing walls. Roof and ceiling slabs are designed for flat or sloping roofs.

Sizes:
Standard blocks are 20" long, 10" wide, and from 2" to 16" thick. Special sizes can be made upon request. Floor, roof and wall slabs available up to 20' long, 2' wide and from 4" to 12" thick.

Fire rating:
All products are inorganic and totally incombustible.

R-value:
Provides good thermal efficiency due to the many cells of encapsulated air.

Comments:
These products use less cement and are about one fifth the weight of traditional concrete. They can be sawn, drilled and worked using normal wood working tools. Products are not sensitive to frost and are dimensionally stable. Blocks are currently imported, but US production is scheduled to begin in 1995.

Mearl Corporation
220 W. Westfield Avenue
Roselle Park, NJ 07204
(908) 245-9500

Mearlcrete foam liquid that is used to make cellular concrete and foamed concrete. This proprietary foaming agent is designed to be added to a cement mix on site or during precasting manufacturing processes.

Applications:
While used chiefly for industrial applications where light weight is desired, this technology can also be used in residential construction to create lightweight concrete suitable for load-bearing walls, floors, roofs, and foundations. Most commercial concrete mixers can be used with Mearl’s standard foam generators to mix their foam with a cement mix. The foam can be aerated in the process of precasting columns and beams.

Sizes:
A 55 gallon drum of concentrated foaming agent can be aerated to produce more than 200 cubic yards of low density insulating cellular concrete at a dry density of 30 pounds per cubic foot.

Fire rating:
Mearlcrete Cellular Concrete is listed with the UL Fire Resistance Directory.

Density:
The density can be controlled over a range from 20 to 120 pounds per cubic foot.

Comments:
The quantity of foaming agent that is introduced into a given concrete mixture affects the density, strength, thermal conductivity and cost of the end product. When precast and cured at high steam pressures in an autoclave, the cellular concrete becomes chemically altered resulting in even greater strength ratings. This product is designed to be non-hazardous and non-polluting.

North American Cellular Concrete
3 Regency Plaza, Suite #6
Providence, RI 02903
(401) 621-8108

Developing ACC products that utilize large quantities of fly-ash; in research and development stages.

Comments:
North American Cellular Concrete has been touring the country for the last two years with a mobile plant to demonstrate the production of ACC blocks from fly-ash.

Fly Ash Suppliers for Concrete
The availability and cost-effectiveness of using fly ash in concrete mixes will depend on local/ regional supplies and transportation costs. Your local concrete ready-mix company can contact one of these distributors listed below to determine the feasibility of obtaining and using fly ash.

American Fly-Ash Co.
1250 E. Diehl Rd., Suite 101
Naperville, IL 60563
(800) 323-5949

Bayou Ash, Inc.
P.O. Box 66377
Baton Rouge, LA 70896
(800) 462-2968
(504) 627-4242

Contech Admixtures
8850 Wentworth Ave. South
Bloomington, MN 55420
(800) 352-2800
(612) 884-0665

Gifford-Hill & Company, Inc.
2515 McKinney Ave, 10th floor
Dallas, TX 75201
(214) 754-5546

Holnam, Inc.
2001 Commonwealth Blvd. #303
Ann Arbor, MI 48105
(313) 663-1532

JTM Industries, Inc.
1000 Cobb Place Blvd.
Bldg. 400
Kennesaw, GA 30144
(404) 424-1900

Lafarge Corporation
P.O. Box 324
Dallas, TX 75221-0324
(214) 934-7360

Center for Resourceful Building Technology
Mid-Atlantic Ash Co.
c/o Arundel Corp.
P.O. Box 4207
Salisbury, MD 21803
(410) 742-4645

Midwest Fly Ash & Materials, Inc.
P.O. Box 3557
Sioux City, IA 51102
(712) 252-4049

Mineral Specialties, Inc.
Box 1563
Billings, MT 59103
(406) 656-2334

Monex Resources
45 NE Loop 410, Suite 700
San Antonio, TX 78216
(210) 349-4069
(800) 964-0951
Field divisions:
Auburndale, FL
Atlanta, GA
Greensboro, NC

National Minerals
855 Apollo Rd.
Egan, MN 55121
(612) 681-0470

Nebraska Ash Company
P.O. Box 80268
Lincoln, NE 68501
(402) 476-0127

Pozzolanic International
7525 SE 24th St.
Mercer Island, WA 98040
(800) 426-5171
(206) 232-9320

U.S. Ash Co.
2555 Weadock Hwy
Essexville, MI 48732
(517) 892-3521

Western Ash Company
P.O. Box 7360
Phoenix, AZ 85011
(602) 248-7946

Western Ash Company
4380 S. Syracuse St. #305
Denver, CO 80237
(800) 255-0663
Framing

Framing accounts for about 70% of the 11,000 board feet of lumber used in an average home, and over 90% of new homes built in the U.S. are wood framed. Until recently, good structural lumber has been hard to replace in applications such as wall and roof framing and floor spans. Wood performs well under tension or compression and, until recently, large solid-sawn dimension joists and rafters could be replaced only with steel or trusses made from smaller dimension lumber. Today a variety of engineered wood alternatives and new types of steel framing options are available to provide effective, efficient substitutes for solid wood framing. This chapter contains listings for engineered lumber products used in floor, roof and wall framing.

Throughout the past 200 years of home construction—from log homes through balloon framing to Western-style framing, then to the Arkansas house—builders and architects have made few concerted efforts to use wood more efficiently. During the 1980's, the attempt to create highly insulated “double” walls for energy efficiency actually created a greater demand for framing wood. Today, timber supplies do not consistently provide the straight, dimensionally stable heartwood lumber that builders value. The undependable quality and increasing cost of many traditional wood products is leading many builders to seek alternatives.

These alternatives are being provided by new technologies and products that no longer heavily depend upon a dwindling supply of large timber. They offer consistent performance, predictable quality, superior structural integrity, and less waste during construction. Glue-laminated beams, engineered I-joists, laminated veneer lumber and finger-jointed lumber are examples of available engineered wood products.

Many manufacturers are providing structural lumber milled from small trees and are adding value to smaller diameter second and third growth forest products, rather than following the old practice of milling large (and small) lumber from old-growth trees. Some engineered lumber products also make use of faster-growing tree species formerly considered undesirable. In addition, the engineering technology that combines smaller pieces of wood allows for a far more complete and efficient utilization of each log that enters lumber mills. Lumber or wood fibers bonded with adhesives, heat and pressure compose a new generation of engineered lumber.

I-joists, like steel I-beams, are named for their shape. The vertical member or “web” of the “I” is usually made from oriented strand board or plywood, while the top and bottom “flanges” are made from solid sawn, finger-jointed or engineered lumber. Oriented strand board (OSB) consists of small wood chips (averaging 4” in length) derived from young, fast growing trees, instead of the larger spruce, pine, fir and imported trees required to manufacture plywood. I-joists
have a very high strength-to-weight ratio and provide structural support for floors and roofs, using just one-
half the amount of wood fiber in a traditional solid sawn joist system.

- Finger-jointed lumber provides a more efficient use of timber that is milled for dimensional lumber. Finger-jointing allows mills to combine short lengths of lumber, formerly scrapped or burned for fuel at the mill, into standard-length dimensional structural lumber for framing, truss fabrication, or I-joist flanges. Finger-jointed lumber is as strong as non-jointed lumber of the same grade, and resists stress, warping and twisting. It can be Machine Stress Rated to guarantee strength. Finger-jointed lumber is available in the product lines of major lumber companies, and should be carried by local lumber suppliers.

- Manufactured laminated veneer lumber and laminated strand lumber efficiently use wood fiber by combining small pieces from second and third growth trees to create defect-free structural lumber. Laminated strand lumber uses wood fiber strips of around 12", longer than the chips used in OSB production, and oriented lengthwise within the final product. Laminated veneer lumber stacks narrow veneers of wood to beam dimensions. Laminated veneer and laminated strand lumber are extremely strong, and are usually used for window and door headers or beams.

Glue-laminated lumber, while still dependent upon timber larger than that required for OSB or laminated veneer lumber, is a step towards more efficient utilization of timber resources. It puts into practice the theory of creating large beams from smaller pieces of standard-size lumber. Glue laminated lumber is engineered for consistency and it creates less waste at the job-site. New technology combines glue-laminated and laminated veneer lumber in a single structural component, or laminates fibers between layers of wood for added strength without added wood.

Some builders are looking to steel framing as an alternative to wood. Steel framing has been used in commercial construction for years, but light-guage steel is just beginning to enter the residential framing market. Steel framing is durable, lightweight, insect resistant, and relatively stable in price. Standard steel contains approximately 50% recycled metal, and is also recyclable. Steel studs can also be reused in structural applications when a building is dismantled.

Some disadvantages of steel as a framing material are potential problems with condensation and the tremendous quantity of energy required for initial manufacture of the metal. In addition, steel is highly conductive, which increases potential for thermal bridging through exterior walls that can lead to heating and cooling inefficiency. Insulated exterior sheathing added to steel-framed walls can reduce heat transmission through studs and improve the thermal performance of walls. Studies on the thermal performance of steel walls are still being conducted by national testing organizations.

Steel studs are available in a variety of configurations and systems, from a number of manufacturers nationwide. The American Iron and Steel Institute offers a directory of steel stud manufacturers and framers through their “Steel in Home Construction” hotline at (800) 79STEEL. Steel framing should be utilized in designs that apply its structural characteristics to advantage, and not merely substituted into existing designs developed for wood framing. Use of residential steel framing is expected to increase in the coming years.

I-joists have a very high strength-to-weight ratio and provide structural support for floors and roofs. This uses one half the amount of wood fiber of traditional solid sawn joists.
Engineered Wood Framing

Alpine Structures Incorporated
P.O. Box 1006
Oxford, NC 27565
(800) 672-2326
(919) 693-6667

Advantage™ engineered wood products, including structural l-joists, engineerd ASI headers, and Timbermax® laminated veneer lumber. The l-joists have sawn wood flanges and plywood or oriented strand board webs. ASI headers have the appearance of an l-joist with two extra OSB skins applied to each side to create a dimensional header without a solid core. These headers provide structural integrity with less wood than a solid header.

Applications:
- L-joists are designed for roof and floor systems; headers and LVL are for a variety of structural needs.

Sizes:
- LVL available in depths from 9 1/3” up to 18”, in 1 3/4” or 3 1/2” thicknesses.

Wood species used:
- Not specified.

Moisture content:
- Not specified.

Comments:
- ASI headers are designed for medium load carrying capacity.
- L-joists provide more load bearing capacity per pound than solid sawn 2 x 10s or 2 x 12s, providing for longer unsupported spans and fewer total beams.

Boise Cascade Corporation
One Jefferson Square,
P.O. Box 50
Boise, ID 83728-0001
(800) 232-0788
(208) 384-7151

BCI™ l-joist consisting of a plywood web between laminated veneer lumber flanges. VERSA-LAM™ laminated veneer lumber

Applications:
- Headers, ridge, floor, and roof beams, roof rafters, floor joists.

Sizes:
- I-joists are available in two flange widths of 1 3/4” or 2 5/16”, and five depths from 9 1/2” to 20’ Lengths up to 66’.

Wood species used:
- Not specified.

Moisture content:
- Not specified.

Comments:
- Boise Cascade uses finger-joints in the webbing to provide greater shear capacity than l-joists with square-butt joints. BCI joists may be cantilevered up to a maximum of 2’ when supporting roof loads, although reinforcement may be necessary.

Fiber Technology
P.O. Box 858
Drain, OR 97435
(503) 836-2026

Fiber reinforced plastic glu-lam beams (FRRP). FRRP strands are oriented in a layer of plastic that is laminated into the composite wood, to add strength while reducing the amount of wood used.

Applications:
- Used for roofs and bridges at this time.

Comments:
- This new product has just entered the market and is only being manufactured at one location up to date. Glue used in lamination is phenol resorcinol. These beams are lighter than conventional glu-lams.

Georgia-Pacific
133 Peachtree St. N.E.
Atlanta, GA 30303
(404) 652-4000
(800) 447-2882

GP-Lam™ laminated veneer lumber beams and headers, Glulam beams, and Wood I Beam™ WI Series joists consisting of CDX plywood webs and machine stress rated 2” x 4” lumber. Wood I Beam™ GPI Series have OSB webs.

Applications:
- GP-Lam and Glulams are used for beams and headers, door, window, stair and furniture components. Wood I Beams are designed for roof and floor systems.

Sizes:
- GP-Lam is available in standard sizes, with depths for use with I-beams. Wood I Beams are 3 1/2” wide at flange, come in depths of 9 1/4” to 24”, and lengths up to 48’. GPI Series come in depths 9 1/4” to 16” and lengths to 60’.

Wood species used:
- GP-Lam is made from Douglas fir. Wood I Beams have southern pine plywood webs and Douglas fir flanges.

Moisture content:
- LVL is 7.5%.

Comments:
- Accepted by BOCA and SBCCI major code authorities. LVL is available with standard veneer faces. Wood I Beam joists use as much as 55% less wood fiber than solid sawn joists. The I-joists provide more load bearing capacity per pound than solid sawn 2 x 10s or 2 x 12s, providing for longer unsupported spans and fewer total beams.
Jager Industries Inc.
8835 MacLeod Trail S.W.
Calgary, AB T2H OM3 Canada
(403) 259-0700

TTS WOOD I joist and Super Joist™
consisting of a 3/8" oriented strand
board web fitted into finger-jointed
flanges. Super Joists flanges are #2
grade lumber, while flanges for TTS
Wood I joists are machine stress
rated.

Applications:
• Floor and roof joists.

Sizes:
TTS Wood I joists come with 2 x 4
flanges, and are available in lengths
from 9 1/2" to 24' long. Super Joists
flanges are available in depths of 9 1/2" and
11 1/2". Both joists come in standard
lumber lengths as well as custom
lengths up to 52'.

Wood species used:
Spruce, pine and fir.

Moisture content:
Flanges have 19% or less.

Comments:
These joists are made from kiln-dried
material to eliminate shrinkage and
are supplied custom cut and
delivered to the jobsite in bundles.
All flange finger-joints are tension
tested before final assembly. Both
joists weigh considerably less than
solid sawn 2 x 10s or 2 x 12s, yet
won’t twist, split, shrink, or warp.

Louisiana-Pacific
111 S.W. 5th Ave.
Portland, OR 97204
(800) 999-9105,
(503) 221-0800

Gang-Lam® LVL dimensional lumber
with laminated southern pine
veneers. Composite GNI™ Joists
with Gang-Lam LVL flanges and OSB
webs.

Applications:
• Designed for floors and roofs.

Sizes:
Gang-Lam LVL is available in lengths
up to 80’ and a variety of depths
GNI Joists are available in standard 1
1/2" or 1 3/4" thicknesses (as well as
custom thicknesses) in depths from
9 1/4" to 24", and lengths to 80’

Wood species used:
Southern pine for flanges and aspen
or Southern pine for OSB web.

Moisture content:
6 1/2% to 9% on flanges and LVL.

Comments:
Both products are easy to cut and
nail, and are accepted by all major
building codes. They provide more
load bearing capacity than solid
sawn lumber, and resist shrinking,
twisting, splitting, warping, and
crowning.

MITLek Industries, Inc.
P.O. Box 7359
St. Louis, MO 63177
(800) 325-8075
(314) 434-1200

Posi-Strut® open joist metal web
trusses.

Applications:
• For floor joists, roof rafters or roof
purlins. At 24" spacing the Posi-Strut
will substitute for solid wood joists
spaced at 16"

Sizes:
3 1/2" wide top and bottom chords, in
depths of 7 1/4", 9 1/4", 11 3/8" or
15 3/4" in lengths of 24" to 30'.

Wood species used:
Dense southern pine or Douglas fir
webs.

Moisture content:
Not specified.

Comments:
The deepest truss will accommodate
up to 11" ducts between chords.
Ends of trusses can be trimmed for
exact fit. Chords can utilize short
lengths of wood, which are butted
with plates on each side. MiTek
trusses are manufactured by licensed
manufacturers.

Nascor Incorporated
1212 34th Ave. S.E.
Columbus, MS 39704
(601) 327-7950

Engineered wood products, but uses
more wood than metal web trusses,
and larger pieces of wood than I-
joists.

Open Joist 2000 Inc.
P.O. Box 2778
Plattsburg, NY 12901
(800) 263-7265

Open Joist 2000™ open web trusses
with all-wood web.

Applications:
• Can replace solid-sawn wood 2 x 10
or other open-web joists.

Sizes:
• Chords are 2" x 3" or 2" x 4", with
depths of 9 3/8", 13" or 16"
available in one foot increments.

Wood species used:
Kiln-dried SPF #2 or MSR 2100 or
2400.

Moisture content:
Not specified.

Comments:
This wood truss system uses less
energy to produce than some other
engineered wood products, but uses
more wood than metal web trusses,
and larger pieces of wood than I-
joists.

Rebel Building Components
P.O. Drawer 2286
Columbus, MS 39704
(800) 844-8281
(601) 327-7950

Trim Joist™ open metal-web joists
with joist-shaped end that can be
trimmed on site for custom fit.

Applications:
• Floor joists.

Sizes:
• 3 1/2" wide chords, in depths of 11
1/4", 14", 16", or 18" Lengths from
4" to 30" available in 2-foot incre­
ments.

Wood species used:
2 x 4 young timber, not old-growth.

Moisture content:
Not specified.

Comments:
Strength of these engineered wood
products allows for longer spans and
wider spacing, that the company
claims uses 12% less board feet of
wood fiber than a conventional floor
framing system.
Applications:
For applications requiring extra load carrying capacity, in place of LVL or PSL beams.

Sizes:

Wood species used:
Douglas fir and western softwoods.

Comments:
Not specified.

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Superior Wood Systems
P.O. Box 1208
Superior, WI 54880
Ph: (715) 392-1822
Fax: (715) 392-3484

Applications:
Glue-laminated timber beams and headers, TLI joists with LVL flanges and OSB webs. TLI beams and headers are pre-insulated with expanded polystyrene between two OSB webs, with MSR flanges.

Sizes:
2" x 6" or 2" x 8" widths, with depths from 9 1/4" to 20", and standard lengths to 48' Headers have 2" x 4" or 2" x 6" widths, with depths of 7 1/4", 9 1/4", or 11 1/4".

Wood species used:
Douglas fir.

Moisture content:
Moisture content is 11% or less.

Comments:
Tec-Lambeams and headers and TLI joists are accepted by all major code authorities. These products are stronger than traditional solid-sawn lumber and use less raw materials to achieve consistent strength properties.

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Tecton Laminates Corp.
P.O. Box 587
Hines, OR 97738
Ph: (800) 678-2312
Fax: (503) 573-6474

Applications:
Studs, floor joists, and rafters.

Sizes:
2" X 6", 2" X 8", 2" X 10", and 2" X 12" dimensions in lengths up to 72'.

Wood species used:
Douglas fir and SPF.

Moisture content:
Moisture content is less than 12%.

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Trus Joist MacMillan
P.O. Box 60
Boise, ID 83707
Ph: (800) 628-3997
Fax: (888) 610-3882

Applications:
Beams, columns, posts and headers.

Sizes:
2" X 4", 2" X 6", 2" X 8", 2" X 10", and 2" X 12" in lengths up to 48'.

Wood species used:

Moisture content:
Moisture content is 12% or less.

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Tec-Lambeams and headers and TLI joists are accepted by all major code authorities. These products are stronger than traditional solid-sawn lumber and use less raw materials to achieve consistent strength properties.

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Timberweld
P.O. Box 21000
Billings, MT 59104
(406) 652-3600

Applications:
Engineered lumber including laminated timber trusses, beams, I-joists, open web joists and connections.

Wood species used:
High-grade lumber in higher stressed tension and compression zones, and lower grades dispersed in lower stress zones.

Moisture content:
Not specified.

Comments:
Engineered wood products allow for a more efficient use of wood fiber than solid-sawn dimensional lumber. Some product lines exhibit more resource efficiency than other products which consume relatively more wood and energy.

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Trus Joist MacMillan
P.O. Box 60
Boise, ID 83707
Ph: (800) 628-3997
Fax: (888) 610-3882

Applications:
Beams, columns, posts and headers.

Wood species used:

Moisture content:
Moisture content is 12% or less.
Joists for floors and roofs.
Timberstrand for light-duty headers and rim boards.

Sizes:
Parallam PSL beams and headers available in 1 3/4" to 7" widths in depths from 9 1/4" to 18". Lengths up to 66'. Microlam beams, headers, and joists are 1 3/4" in width, in depths from 5 1/2" to 18", and lengths to 80'. Timberstrand available in 1 1/4" or 3 1/2" widths in depths from 9 1/2" to 16".

Wood species used:
Douglas fir, southern pine or western hemlock. Timberstrand made from aspen in Minnesota or yellow poplar in Kentucky.

Moisture content:
11%.

Comments:
These products are stronger than traditional lumber, allowing use of less material in strong configurations. Cut, drill and nail as conventional lumber. Timberstrand is also used as a core material for windows and doors.

Truswal
1101 N. Great Southwest Parkway
Arlington, TX 76011
Ph: (800) 521-9790
Fax: (817) 652-3079

SpaceJoist™ parallel chord trusses with high-strength galvanized steel deep-V webs.

Applications:
Rafters, studs, purlins, roofs or floors.

Sizes:
Clear span lengths up to 40', with a variety of depths from 9 1/4" to 19 3/4".

Wood species used:
Southern pine or Douglas fir.

Moisture content:
Less than 19%.

Comments:
The open web design allows placement of insulation as well as electrical, heating, and plumbing material in the joists. Long clear span eliminates the need for headed studs, columns, and interior footings. Manufacture of trusses uses 65% recycled steel in webs, and can, but does not necessarily, use finger-jointed lumber. Trusses are available with one hour fire rating.

Unadilla Laminated Products
32 Clifton St.
Unadilla, NY 13849
(607) 369-9341

Structural glue-laminated columns, trusses, arches, purlins, and beams.

Applications:
Commercial and residential.

Sizes:
Beams, girders, and purlins are available from under 3' x 6' to 10' x 49' or larger; arches from 6' on 12' to over 14' on 12'.

Wood species used:
Southern pine and Douglas fir.

Moisture content:
Not specified.

Comments:
Engineered products made efficiently using smaller diameter timber.

Williamette Industries
Engineered Wood Products
P.O. Box 277
Saginaw, OR 97472
(503) 744-4664

WSI Joists™ consisting of machine stress rated (MSR) lumber flanges joined to oriented strand board webs using WSI patented finger joint. Glue-laminated beams, columns and headers.

Applications:
Floor and roof framing, garage, door, and window headers; roof rafters; columns.

Sizes:
Depths from 8" to 32" in 2" increments. Tapered joists also available. Glulams available in standard dimensions in three finish grades. Lengths to 130'. Custom sizes available.

Wood species used:
Fir, larch, or southern pine.

Moisture content:
Not specified.

Comments:
WSI joists are designed to be used under dry conditions in which the moisture content of the joists will not exceed 19%. Large dimensional engineered products are made efficiently using smaller diameter timber. Camber can be built into the beams. They are fire resistant (1 hour fire rating), dimensionally stable, store well outside, and work well with I-beams.

WSI Joists™ consisting of machine stress rated (MSR) lumber flanges joined to oriented strand board webs using WSI patented finger joint. Glue-laminated beams, columns and headers.

Applications:
Floor and roof framing, garage, door, and window headers; roof rafters; columns.

Sizes:
Depths from 8" to 32" in 2" increments. Tapered joists also available. Glulams available in standard dimensions in three finish grades. Lengths to 130'. Custom sizes available.

Wood species used:
Fir, larch, or southern pine.

Moisture content:
Not specified.

Comments:
WSI joists are designed to be used under dry conditions in which the moisture content of the joists will not exceed 19%. Large dimensional engineered products are made efficiently using smaller diameter timber. Camber can be built into the beams. They are fire resistant (1 hour fire rating), dimensionally stable, store well outside, and work well with I-beams.

Unadilla Laminated Products
32 Clifton St.
Unadilla, NY 13849
(607) 369-9341

Structural glue-laminated columns, trusses, arches, purlins, and beams.

Applications:
Commercial and residential.

Sizes:
Beams, girders, and purlins are available from under 3' x 6' to 10' x 49' or larger; arches from 6' on 12' to over 14' on 12'.

Wood species used:
Southern pine and Douglas fir.

Moisture content:
Not specified.

Comments:
Engineered products made efficiently using smaller diameter timber.
Panel Systems

Structural insulated panel systems provide a material- and labor-saving alternative to traditional stick framed and insulated walls. Insulation within the panels is uninterrupted by studs, providing a thermally efficient wall. Structural insulated panels have been in use for over 30 years, and serve as an energy efficient, structural building system that is relatively simple to erect and thus reduces on-site labor time. Panel manufacturers can custom design panel systems from building project plans, and panels are generally delivered on site pre-cut and ready for installation. Structural insulated panels can be used in floors, walls or roofs.

The most common type of panel has an expanded polystyrene foam core, faced with oriented strand board (OSB) made from fast growing trees such as aspen and alder. The OSB skins distribute and carry the loading stresses of a structure, while the bonded foam core provides insulation and keeps the two skins aligned. Non-structural panels, such as those designed for use with timber framing, may be faced on one or both sides with drywall. The foam core in structural insulated panels may consist of expanded polystyrene (EPS) or isocyanurate or urethane foam, depending on the manufacturer. The higher initial R-value per inch of urethane may decline over time, unlike the R-value of EPS, which remains constant.

A few companies are making EPS panels with steel structural framework and no facing. Also listed in this chapter are two systems that employ expanded polystyrene panels and wood I-studs to create structural walls with a minimum of wood framing. A new company will begin producing structural insulated panels faced with OSB in which compressed straw, rather than foam, acts as insulation.

Structural insulated panels are a relatively resource efficient building component. The sheathings provide an efficient use of wood fiber while the foam core material is highly insulative. Testing by the Florida Solar Energy Center found that a house built with foam core panels had a heating energy savings of 12%-17% compared to a stud-frame house of equal size and R-value. Insulation is virtually continuous, and panels allow little air leakage.

An average wall section constructed of stress-skin panels contains 25 percent less wood than a similar wall framed with 2x4s placed 16" on-center. Panels can structurally cover large spans, requiring very little supplemental framing (such as sill plates and top plates).
Although the foam core is derived from a non-renewable resource, it is a relatively efficient use of this resource. One quart of an oil-refining byproduct is expanded to create forty quarts of EPS foam. Scrap can be recycled, and the EPS could potentially be recycled at the end of its useful life. Metal-framed panels eliminate the need for wood fiber skins altogether, and the metal frames have some recycled metal content.

Panels can be joined in a number of different manners, depending on the system used by the manufacturer. Some panels connect with dimensional lumber or steel splines. One company uses recycled plastic studs to join panels. Other manufacturers use OSB splines in combination with expanding foam at panel seams. One company offers recycled plastic cam-lock systems that seal with expanding foam. Some panels join in a ship-lap configuration, to prevent thermal bridges through the wall.

Pre-cut electrical chases are standard in some systems, but must be specially requested in others. Most panels require at least 1/2" interior gypsum drywall to meet fire codes. According to tests conducted by the U.S. Testing Company, the products of EPS combustion are less toxic than those produced from an equal volume of burning wood.

A different type of structural panel utilizes an interior structure of kraft paper in a honeycomb configuration. Originally developed for use in aeronautical engineering, honeycomb panels perform like multiple I-beams, with the facings performing as the flanges, which withstand bending loads, and the honeycomb acting as the web, which absorbs the shear loads placed on the panels. These panels can be laminated to virtually any skin material, and provide a very high strength-to-weight ratio. Honeycomb panels are an efficient use of material, as the average honeycomb core consists of 5% paper and 95% air. When faced with a material such as OSB, this honeycomb provides structural integrity that is suitable for a variety of wall, roof and floor applications. This technology is little used in the housing industry, despite its great potential, due to a lack of materials suppliers. A few honeycomb core and honeycomb panel manufacturers are listed in this chapter, although their primary business is not necessarily the manufacture of building products.

Panel Systems

Structural panel systems provide a material and labor saving alternative to traditional two-by-four or two-by-six stick framing, and have been in use for over 30 years.

Stress-skin panels serve as an energy efficient, structural building system that is relatively simple to erect, reducing on-site labor time.
Structural Insulated Panels

Advanced Building Systems, Inc.
324 N. Bowen Rd.
Arlington, TX 76012
(800) TO-PANEL

Structural insulated expanded polystyrene foam-core building panels.
Applications:
- Walls and roofs.
- Sizes:
  - Foam core in 4 1/2", 6 1/2" or 8 1/2" thicknesses. Panels are 8' by up to 24' long.

Fire Rating:
- Interior surfaces must be covered by 1/2" gypsum wallboard to meet fire codes.

R-value:
- 4 1/2" panel is R-16, and 8 1/2" panel is R-31 at 75°.

Electrical wiring:
- Not specified.

Comments:
- Panel faces are 7/16" waferboard.
- No urea formaldehyde is used in these panels.

AFM Corporation
24000 W. Hwy. 7, #201
Shorewood, MN 55331
(612) 474-0809
(800) 255-0176

R-control® structural foam-core building panels consisting of a core of EPS bonded between two OSB facings.
Applications:
- For walls and roofs.
- Sizes:
  - Available in sizes from 4' x 8' to complete 8' x 28' wall and roof sections. Standard thicknesses are 3 1/2", 5 1/2", or 7 1/2". Ceiling and roof panels can be made to 11 1/2" thickness.

Fire Rating:
- ASTM E 119 - 20 minute and 1 hour duration rating for roof, ceiling and wall construction. ICBO corner room burn - 15 minute thermal barrier verification test. ASTM E 108 - external fire propagation testing.

R-value:
- Five standard core thicknesses provide R-values from 14.88 to 44.71 at 75°.

Electrical Wiring:
- Factory-cut electrical chases.

Comments:
- Will not twist, warp or be subject to racking. EPS foam core contains no CFCs, HFCs, or formaldehyde. Panels are listed by Underwriters Laboratories and come within a 20 year warranty on the R-value of the core material. These panels are not affected by moisture or temperature. R-value is stable for the life of the structure.

Associated Foam Manufacturers (AFM) include the following franchised production facilities:

- Advance Foam Plastics, Inc.
  5250 North Sherman Street
  Denver, CO 80216
  (303) 297-3844

- All American Foam Products
  301 Eubank Southeast
  Albuquerque, NM 87123
  (505) 299-7653

- Allied Foam Products, Inc.
  1604 Athens Highway
  Gainesville, GA 30503
  (404) 536-7900
  (800) 533-2613

- All Foam Products
  15 Arden Drive
  Belgrade, MT 59714
  (406) 388-4146
  (800) 766-3626

- Branch River Foam Plastics
  15 Thurber Boulevard
  Smithfield, RI 02917
  (401) 232-0270

- Big Sky Insulations Inc.
  1418 Cow Palace Rd.
  Newton, KS 67114
  (316) 283-1100
  (800) 835-2161

- Contour Products, Inc.
  100 Powers Court
  Sterling, VA 20166
  (703) 450-4886

- Dalmatian Industries, Inc.
  4580 Airwest Drive S.E.
  Kentwood, MI 49512
  (616) 698-2001

- Mid-America Industries
  RR 1, Box 101
  Mead, NE 68041
  (402) 624-6611

- Pacemaker Plastics Co., Inc.
  126 New Pace Road
  Newcomerstown, OH 43832
  (614) 498-4181
  (800) 446-2188

- Poly-Foam Inc.
  116 Pine Street South
  Lester Prairie, MN 55354
  (612) 395-2551

- Premier Building Systems
  8939 South 190th St.
  Kent, WA 98032
  (206) 251-9277

- Premier Building Systems 1155 Industrial Place
  Dixon, CA 95620
  (916) 753-4010
  (800) 275-7086

- Thermal Foams, Inc.
  2101 Kenmore Ave.
  Buffalo, NY 14207
  (716) 874-6474
  (800) 333-6267

- Wisconsin EPS, Inc.
  90 Trowbridge Drive
  Fond du Lac, WI 54936
  (414) 923-4146
  (800) 236-5377
Applications:
Anchorage, AK 99502-7111

Electrical Wiring:
Alchem Inc.
3617 Strawberry Rd.
Anchorage, AK 99502-7111
(907) 243-2177

Applications:
Structural insulated panels with a core of strawboard between OSB faces. The plant is scheduled to begin production in 1995.

Sizes:
Panels are 8 3/8" thick, in 48" widths and various lengths.

Fire Rating:
Tightly compressed straw is fire resistant due to density.

R-value:
Wall is R-26.

Electrical Wiring:
Not specified.

Comments:
These panels substitute the highly renewable resource of wheat straw for the petroleum-based foam usually used in structurally insulated panels. Straw is highly insulative, and is usually a waste by-product of agriculture.

Agriboard Industries
P.O. Box 645
Fairfield, IA 52556
(515) 472-0363

Applications:
Panels are marketed as a complete building package for pre-fabricated units.

Sizes:
Panels are 8 3/8" thick, in 48" widths and various lengths.

Fire Rating:
Not specified.

R-value:
Not specified.

Electrical Wiring:
Not specified.

Comments:
These panels substitute the highly renewable resource of wheat straw for the petroleum-based foam usually used in structurally insulated panels. Straw is highly insulative, and is usually a waste by-product of agriculture.

Alchem Inc.
3617 Strawberry Rd.
Auburn, WA 98001
(800) 745-2724
(206) 735-5709

System 3 insulated building panels with expanded polystyrene foam core.

Applications:
For use as floor, wall, roof or ceiling panels.

Sizes:
Core thicknesses of 3", 5", 7", 9", or 11" in sizes to 8' x 24'

Fire Rating:
Meets ASTM E119 one hour fire wall test. Requires 1/2" gypsum wallboard on interior surfaces.

R-value:
Values from R-24 to R-56 depending on thickness and application.

Electrical Wiring:
Factory-formed electrical chase.

Comments:
Company claims no shrinkage, warping, twisting or cracking.

BARRIER System
P.O. Box 346
Canastota, NY 13032
(315) 697-7224

BARRIER System® of rigid, foil-faced polyisocyanurate insulation panels assembled on-site between engineered i-studs. The 2-inch thick foiled-faced foam board is placed between studs, creating two dead air spaces within each stud cavity, providing both sound and thermal insulation. The i-studs use less timber than dimensional lumber, while the insulation panels are 40% recycled plastic and 100% recycled aluminum.

Applications:
Exterior walls.

Sizes:
I-studs are 7 1/4" wide and 9' long. Insulation panels are 2" thick.

Fire Rating:
Not specified.

R-value:
R-33.8

Electrical Wiring:
Allows installation of outlets without penetrating the insulation envelope.

Comments:
This system ensures 100% insulation coverage within a wall. Framing, insulation, vapor barrier, and building wrap are assembled in one step. The high R-value combines with low infiltration ratings to reduce energy consumption by 30% over conventional 2" x 6" wall construction. These building components resist warping, bending, and moisture absorption. Two dead air spaces within the panel provide sound abatement.

Eagle Panel Systems
P.O. Box 748
Florissant, MO 63032
(314) 653-0205
(800) 643-3786

Foam-core wall panels with 3 5/8" or 5 5/8" expanded polystyrene sandwiched between two structural 3/8" oriented strand board skins to create a 4" or 6" wall. One stud is contained in the center of each panel, or two studs spaced 16" o.c. panels are joined together with stud splines inserted in recess between panels, which combined with the integral panel studs, creates a 16" or 24" on-center stud system.

Sizes:
Basic panels are 4' x 8'. Available in lengths up to 24', in thicknesses of 4", 6" and 8".

Fire Rating:
Meets 1 hour fire standards. According to tests conducted by the U.S. Testing Company, the products of combustion from EPS are less toxic than those produced from an equal volume of wood.

R-value:
R-17 to R-33. These panels provide excellent protection against air infiltration.

Electrical Wiring:
Wiring chases are located 24" o.c. vertically (and optional horizontal 13" off floor.)

Comments:
This technology developed from concepts used in the commercial refrigeration industry. Brick or any other exterior finish can be installed on site.
## Electrical Wiring

**R-value:**
- Enercept super-insulated building system offers basement panels, above grade wall panels, roof panels, and support beams in one package. Panels are expanded polystyrene laminated to various sheathing materials.

**Applications:**
- Panels combine exterior sheathing, insulation and framing.

**Sizes:**
- Wall panels have 5 5/8" EPS core, roof panels have 7 3/8" EPS core.

**Fire Rating:**
- Flame spread of EPS is rated 5.

**R-value:**
- Comparable to a traditional house of R-40.

**Electrical Wiring:**
- Passageways are predesigned and provided by the factory.

**Comments:**
- Panels are perimeter nailed to prevent delamination. The system is several times as strong as conventional 2 x 6 construction, and eliminates 75% of thermal shorts in walls and roof.

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## Foam Laminates of Vermont

**P.O. Box 102**

**Hinesburg, VT 05461**

**(802) 453-4438**

- Structural insulated panel with expanded polystyrene core. Panels have a waferboard exterior face and a gypsum wallboard interior face, and are designed for use with poststructural insulated construction.

**Applications:**
- Wall, ceiling or roof panels, in structural or non-structural styles.

**Sizes:**
- Foam cores in thicknesses of 3 5/8", 5 5/8", or 7 3/8", with panel sizes 4' x 8', 4' x 9' and 4' x 10'-16'

**Fire Rating:**
- Not specified.

**R-value:**
- Not specified.

**Electrical Wiring:**
- Electrical chase optional.

**Comments:**
- Panels join with interlocking tongue and groove, or with double OSB splines.

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## FischerSipsTM

**1843 Northwestern Parkway**

**Louisville, KY 40203**

**(502) 778-5577**

- FischerSips structural insulated panels with expanded polystyrene foam core and OSB faces.

**Applications:**
- Walls and roofs.

**Sizes:**
- Foam cores in 3 5/8", 5 5/8" and 7 3/8" thicknesses, in sizes from 4' x 8' to 8' x 24'.

**Fire Rating:**
- Not specified.

**R-value:**
- Not specified.

**Electrical Wiring:**
- Factory precut chase is an option.

**Comments:**
- FischerSips has done extensive testing of thermal performance of houses built with their panels, and can provide energy savings calculations.

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## Futurebilt, Inc.

**A-104 Plaza del Sol**

**Wimberley, TX 78676**

**(512) 847-5721**

- Structural insulated panels consisting of a core of expanded polystyrene laminated between two skins of structural waferboard.

**Applications:**
- Floors, walls, and roofs.

**Sizes:**
- Available in sizes from 4' x 8' to 8' x 24'; fabricated for construction, in thicknesses of 1 1/2", 2 1/2", 3 1/2", 4", 6 1/4" and 11 1/4".

**Fire Rating:**
- Not specified.

**R-value:**
- R-15 through R-45 depending on thickness of core.

**Electrical Wiring:**
- A standard 1" x 1" chase for wiring is provided either horizontally or vertically.

**Comments:**
- These panels will not twist, warp, or be subject to racking. The labor time required to "dry-in" a building shell is greatly reduced. Panels contain no urea formaldehyde or CFCs.

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## Harmony Exchange

**Route 2 Box 843**

**Boone, NC 28607**

**(704) 264-2314**

- Stress-skin panels with EPS block sandwiched between OSB or gypsum facings.

**Applications:**
- Floor, wall, or roof panels.

**Sizes:**
- 4' x 8' to 4' x 24' and 8' x 8' to 8' x 24', in core thicknesses 3 5/8' to 9 3/8'.

**Fire Rating:**
- Not specified.

**R-value:**
- R-18 to R-40 depending on core thickness. EPS foam is R-4.17 per inch.

**Comments:**
- This company carries a wide variety of wood products, including glue-laminated beams. A few selections on their product line are resource efficient.

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## Homasote Company

**P.O. Box 7240**

**West Trenton, NJ 08628-0240**

**(800) 257-9491**

**(609) 883-3300**

- TUPS™ stress-skin panels designed as an insulated structural load-bearing roof system. These panels have a bottom surface of 440 Homasote board, top surface of 1/2" Homasote panel base, and a core of isocyanurate foam. Top and bottom plies are made from 100% recycled newsprint cellulose.

**Applications:**
- Most types of finish roofing materials can be applied directly to TUPS panels.

**Sizes:**
- 4' x 8', 10' and 12' lengths.

**Fire Rating:**
- Isocyanurate foam has a flame spread - 50 and smoke developed - 205; Homasote substrate has a Class C flame spread rating.

**R-value:**
- 4" thickness R-20.6, 5" R-29.0.

**Comments:**
- Also available with a bottom surface of UL Class "A" rated NCFR board for superior fire protection. All panels have tongue and groove joints along the long edges. TUPS panels provide good dimensional stability (no more than 2% change).
Insulspan
Structural insulated panels with OSB face and expanded polystyrene cores, made by licensed manufacturers across the United States.

Applications:
Wall and roof panels. Some companies offer both structural panels and non-load bearing panels.

Sizes:
Core thicknesses of 3 5/8", 5 5/8", 7 3/8" and 9 3/8".

Fire Rating:
Fire resistance rating of 60 minutes with interior gypsum board finish.

R-value:
R-l 7 to R-40, depending on panel thickness.

Electrical Wiring:
Factory-installed wiring chase.

Insulspan includes the following licensed production facilities:

Engineered Panel Technologies
P.O. Box 120427
Nashville, TN 37212
(615) 254-1381

Foam Products Corporation
2525 Adie Rd.
Maryland Heights, MO 63043
(314) 739-8100

North American Panel Systems, Inc.
RD 1 Box 56B
Westmoreland, NH 03467
(603) 352-9994

Ursa Structural Systems, Inc.
Big Pasco Industrial Park, Bl. T-1-79 Bay 2
Pasco, WA 99301
(800) 577-6560
(509) 547-9503

Insteel Construction Systems Inc.
2610 Sidney Lanier Dr.
Brunswick, GA 31525
(800) 545-3181
(912) 264-3772

Insteel 3-D® panel building system, including an expanded polystyrene foam panel with steel wire mesh faces to which shotcrete is field applied to form a finished wall.

Applications:
Insulated load-bearing or non-load bearing walls.

Sizes:
Panels are 4’ wide in lengths 6’-24’. Foam core thicknesses can vary from 1 1/2” to 5”.

Fire Rating:
Ratings depend on thickness of concrete finish. 1 1/2” gives 1 1/2 hour rating; 2” gives 2 hour rating.

R-value:
Not specified.

Electrical Wiring:
Electrical conduit and plumbing route between wire mesh and foam core.

Comments:
This building system is claimed to withstand weather and seismic activity. Steel wire has recycled content, but recyclability of the wall system at the demolition of the structure may be difficult. Scrap panel can be reused by wiring it together.

Korwall Industries, Inc.
326 N. Bowen Rd.
Arlington, TX 76012
(817) 277-6741

Structural insulated panels made from expanded polystyrene with wafer board faces.

Applications:
Roof, exterior wall and floor panels for one- and two-story dwellings.

Sizes:
Foam cores in 3 9/16", 5 9/16" or 7 5/16" thicknesses. Panels are available in sizes 4’ x 8’ or 8’ x 28’.

Fire Rating:
Code requires 1/2” gypsum board on interior walls.

R-value:
Not specified. Although infiltration testing results are available.

Comments:
Korwall offers panels in house kits, or as panels alone.

The Murus Co. Building Systems
P.O. Box 220, Route 549
Mansfield, PA 16933
(717) 549-2100

Structural insulated panels with urethane foam core, faced with OSB.

Applications:
Wall and roof panels. The company also sells pre-cut l-jolst floors, rafter and roof systems for complete shell packages.

Sizes:
Thicknesses of 4 1/2", 5 1/2", and 6 1/2" in 4’ widths up to 20’ long.

Fire Rating:
Class I

R-value:
4 1/2” panel is R-28, 5 1/2” is R-35, 6 1/2” is R-42.

Electrical Wiring:
Electrical chase built in.

Comments:
Cam-locks that join panels are recycled ABS plastic. 50% of urethane foam is recycled plastic. No studs are used in this system.
Guide to Resource Efficient Building Elements  

Nascor Incorporated  
1212 34th Ave. SE  
Calgary, AB T2G 1V7 Canada  
Ph: (403) 243-8919  
Fax: (403) 243-3417  

NASCOR-III System™ solid expanded polystyrene infill panels and wood I-beams that are factory-assembled and delivered to the construction site in panels. The wood I-beams can be set on 16" or 24" centers and use less wood fiber to achieve structural framing integrity while allowing longer spans in floors and ceilings, reducing the overall amount of material. The light weight of the infill panels and the I-beams reduce energy expended in transportation.

Applications:  
For walls, floors and ceilings. Nascor wall components are attached top and bottom to lumber plates by end nailing through the plates into the Nascor I-stands. Splines (1 1/2" square) are used to join the infill panels to the I-beam columns.

Sizes:  
5 1/2" or 7 1/4" thick.

Fire Rating:  
Not specified.

R-value:  
5 1/2" panels are R-20, 7 1/4" panels provide R-30.

Electrical Wiring:  
Electrical Wiring recesses are designed into infill panels and columns.

Comments:  
NASCOR-III System is a structural building system that offers high energy efficiency, design flexibility, and potential for less construction time than conventional wood framing systems. Delivered in packaged bundles or complete modular sets.

Perma "R" Products, Inc.  
P.O. Box 5235 EKS  
Johnson City, TN 37603
Ph: (800) 251-7532  
Fax: (615) 929-8007  

Panels with expanded polystyrene core and OSB exterior face and gypsum board interior face  
Applications:  
Insulated panels are for use with timberframe construction.

Sizes:  
Foam cores in 3 5/8", 5 5/8" or 7 3/8" standard thicknesses.

Fire Rating:  
Not specified.

R-value:  
Not specified.

Comments:  
Panels spike or screw to timberframe, and join one another with OSB splines and expanding foam.

W.H. Porter, Inc.  
4240 North 136th Ave.  
Holland, MI 49424
(616) 399-1963  

Insulated panels with expanded polystyrene core, in both structural and nonstructural types.

Applications:  
Type A panels with structural sheathing on both sides. Type B panels with gypsum wallboard on one side, structural sheathing on the other. Type B panels are used with timberframe or steel frame buildings.

Sizes:  
Thicknesses 3 5/8", 5 5/8", or 7 3/8"; in sizes 4' x 8' to 4' x 24'

Fire Rating:  
Maximum flame spread not more than 75. Smoke developed not more than 450.

R-value:  
R-15 for 3 5/8"; R-23 for 5 5/8", and R-30 for 7 3/8".

Electrical Wiring:  
Not specified.

Comments:  
Panels join with dimensional lumber splines, and are bonded with urethane adhesive.

Radva Corporation  
Drawer 2900 FSS  
Radford, VA 24143
(703) 639-2458  

Thermastructure® and Wallframe™ panels with expanded polystyrene insulation bonded to galvanized steel framing members.

Applications:  
Walls, floors and roofs.

Sizes:  
Thicknesses 3 1/2", 5 1/2", or 8 1/4", in sizes 4' x 8' to 4' x 12'

Fire Rating:  
EPS core has flame retardant added.

R-value:  
R-14 for 3 1/2" panel and R-22 for 5 1/2".

Electrical Wiring:  
Factory molded vertical or horizontal chases.

Comments:  
Steel channels do not provide continuous thermal breaks, so thermal performance is improved. Panels make an efficient use of recyclable materials.

Schmucker Manufacturing Co.  
417 E. Fourth St.  
Derry, PA 15627
(412) 694-8082  

Structural insulated panels with expanded polystyrene core and OSB faces.

Applications:  
Residential, commercial and light industrial walls and roofs.

Sizes:  
Panel thicknesses of 4 1/2", 6 1/2", or 8 1/4", in sizes to 8' x 24'

Fire Rating:  
Not specified.

R-value:  
R-17 for 4 1/2", R-25 for 6 1/2" and R-32 for 8 1/4" panels.

Electrical Wiring:  
Standard in 6 1/2" panel and optional in other styles.

Comments:  
Panels join with OSB splines. Manufacturer will supply panels alone, or installation package.

Shelter Enterprises  
P.O. Box 618 Saratoga St.  
Cohoes, NY 12047
(518) 237-4101  

Stress-skin panels consisting of expanded polystyrene core sandwiched between builder's choice of substrates such as 7/16" oriented strand board, 1/2" plywood, 1/2" gypsum and Kraft paper.

Applications:  
Designed for exterior walls.

Sizes:  
Available with standard EPS core thicknesses of 3 1/2", 5 1/2", 7 1/2" and 9 1/2". Panels are available in 4' x 9' through 4' x 16' sizes. Custom panels can be made to builder specifications.

Fire Rating:  
Not specified.

R-value:  
Average value of R-23 for a 5 1/2" core panel with plywood skins. Guaranteed stable R-values.

Electrical Wiring:  
Not specified.
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Comments:
All of the manufacturing by-products are recycled and used again in the manufacturing process by Shelter Enterprises. No CFCs used in manufacture or contained in the final product.

Stramit USA, LLC
Box 885
Perryton, TX 79070
(806) 435-9303

Easibuild compressed straw panels with paper facing.

Applications:
Interior wall panels, partitions, and roof decking.

Fire Rating:
Meets codes in England, being tested in Texas.

Comments:
This product has been manufactured and used in England for 50 years. The straw core of the product contains no binders. The Texas plant is just starting production.

Techbuilt Systems, Inc.
941 Clark Ave.
Cleveland, OH 44113
(216) 621-4340

Thermotech 21™ structural insulated panels with expanded polystyrene insulation and galvanized steel tubing as frame.

Applications:
Wall and roof panels. Door and window openings are custom cut.

Sizes:
Wall panel is 7 1/4" thick and roof panel 12" thick, in 48" widths and lengths 4' to 32'.

Fire Rating:
1/2" - interior
3/8" wall added to panel provides a W1 system that surpasses requirements for ASTM 1191-hou application.

R-value:
Finished wall R-32; finished roof R-50.

Electrical Wiring:
Pre-cut wire chase.

Comments:
This system uses 18 gauge galvanized steel, and is an efficient application of recyclable materials.

U.S. Building Panels, Inc.
10901 Lakeview Ave. SW
Tacoma, WA 98499
Ph: (206) 581-0288
Fax: (206) 581-0344

Stress-skin panels with an expanded polystyrene core between two sheathings of Sturdi-Wood®

Applications:
Floors, roofs, and walls.

Sizes:
Available in 3 5/8" to 11 3/8" thicknesses, in 4' widths up to 20' in length.

Fire Rating:
Not specified.

R-value:
In walls 3 5/8" panels provide R-15.5.

Electrical Wiring:
Panels come with pre-drilled wiring chases.

Comments:
The labor time required to "dry-in" a building shell is greatly reduced. Panels contain no urea formaldehyde or CFCs.

Vermont Stressskin Panels
RR #2, Box 2794
Cambridge, VT 05444
(802) 644-8885

Structural insulated panels with expanded polystyrene insulation, and OSB, or OSB and wallboard faces.

Applications:
Walls, roofs, or curtain wall option for wallboard-faced panel.

Sizes:
Core thicknesses of 3 5/8" to 9 1/4".

Fire Rating:
Not specified.

R-value:
R-17 for 3 5/8" panel; R-41.25 for 9 1/4".

Electrical Wiring:
Channels optional.

Comments:
Panels join with OSB splines.

Wallframe, Inc.
1502 East Opp St.
Wilmington, CA 90744
(800) 969-1983
(310) 518-4848

Wallframe™ structural insulated panels with expanded polystyrene bonded to light gauge galvanized steel frames.

Applications:
Residential or commercial walls, roofs and floor panels.

Sizes:
3 1/2" or 5 1/2" thick, in 4' x 8' to 4' x 12' sizes.

Fire Rating:
Class A. Flame spread: 5-20.

R-value:
"Net R-15 for 3 1/2" and Net R-23 for 5 1/2".

Electrical Wiring:
Chases molded in.

Comments:
Panels join in shiplap with screws. Metal top and bottom channels or wood plates can be used. Product is ICBO and BOCA rated. Thermal break exists, and no structural sheathing is needed.

Winter Panel Corp.
R.R. 5, Box 168B
Brattleboro, VT 05301
(802) 254-3435

StructureWall™ foam-core building panels consisting of a core of polyisocyanurate foam insulation sandwiched between two OSB skins.

Applications:
Walls and roofs.

Sizes:
4' wide panels up to 28' long; 4 9/16" thick, including two 7/16" OSB faces.

Fire Rating:
Greater than 15 minutes with required 1/2" drywall finish.

R-value:
Minimum R-26.5.

Electrical Wiring:
Optional horizontal chases.

Comments:
No vapor barrier necessary. Freon gas is currently used as the foam blowing agent, but Winter Panel plans to produce freon-free foam in the near future. Panels join with dimensional lumber splines.

Center for Resourceful Building Technology
Honeycomb Panel and Core

Hexagon Honeycomb Corp.
7980 Clayton Road, Suite 201
St. Louis, MO 63117
(314) 647-0701

Structural kraft paper honeycomb core material for commercial applications. Hexagon does not manufacture laminated structural panels. They manufacture the honeycomb core.

Applications:
For floor, roof and wall panels.

Sizes:
Made to final producer specifications.

Weight:
Not specified. Honeycomb is inherently lightweight (average of 5% material by volume), yet very strong when laminated between panel skins.

Fire Rating:
Flame resistant in panel (U/L rated material available).

Comments:
Honeycomb cells are impregnated with phenolic resin to impart greater strength, resistance to moisture, long-term aging and durability characteristics, as well as immunity from decay, rot, fungi, termites and insects. Hexagon has been in the honeycomb business for thirty years, and provides construction and assembly machinery for new panelized housing manufacturers.

Hexacomb
9700 Bell Ranch Drive
Santa Fe Springs, CA 90670-2981
Ph: (800) 323-9163
Fax: (213) 802-8924

Manufacturers of kraft paper honeycomb core material suitable for panel fabrication.

Applications:
Floor, roof and wall panels.

Sizes:
Made to final producer specifications.

Weight:
Not specified. Honeycomb is inherently lightweight (average of 5% material by volume), yet very strong.

Fire Rating:
Flame resistant in panel. (U/L rated material available)

Comments:
The honeycomb is available with regular and phenolic resin impregnated kraft paper. The core can be faced with paper, aluminum, steel, plywood, particleboard, hardboard, gypsum board, fiberglass and a variety of other materials.

Tri-Cell Corporation
3841 Swanson Court
Gurnee, IL 60031
(708) 336-1321
(800) 352-3300

Manufacturers of kraft paper honeycomb core material suitable for panel fabrication.

Applications:
Commercial displays, partitions and potentially structural floors and walls.

Sizes:
Available in a variety of panel dimensions and honeycomb cell sizes.

Weight:
4' x 8' panel weighs 110 lbs.

Fire Rating:
Not specified.

Comments:
These panels can be laminated with virtually any skin material, and provide a very high strength to weight ratio. Can be cut with a knife, hand or power saws.
Sheathing & Wallboard

Sheathing is ordinarily one of the most wood-fiber-intensive aspects of construction. Some wall systems reduce or eliminate the use of exterior sheathing, and this can reduce the total amount of wood used in a construction project. Where sheathing is used, there are several material choices that are more resource efficient than traditional sheathing.

The switch from 1 x 6 and 1 x 8 ship-lap sheathing boards to plywood in the 1930s and 40s signalled a diminishing resource base and manufacturing advances. Plywood has been the most common exterior sheathing material used over the last few decades. It is manufactured from veneers that are peeled from large diameter trees and laminated together. Oriented strand board (OSB), which can be made from smaller diameter, fast growing tree species, allows for a more efficient utilization of harvested timber, and use of OSB sheathing is now an accepted industry practice.

Another sheathing innovation combines three wood veneer layers sandwiched around two inner layers of coarse particle board. This uses fewer veneers than plywood, which in turn reduces dependence on large diameter timber. At least one company offers an exterior sheathing made from gypsum and cellulose fiber. Another company offers a structural sheathing made from recycled wood fiber with foil facing.

Some of the fiber-cement composite manufacturers (see Exterior Siding & Trim) offer their products in sheet stock. These can be used in "shear wall" applications to prevent rack, and they offer excellent fire resistance. Some wall systems require the use of structural sheathing, while others can utilize non-structural sheathing. Structural sheathing is sometimes replaced by non-structural sheathing with rack metal or braces to meet structural codes.

This chapter also contains products that can be used as interior wallboard. They either contain recycled material or utilize waste resources. For instance: a hardboard product that is manufactured from waste wood; a new type of sheetrock made from perlite, gypsum, and recycled post-consumer newsprint; and fiberboard made from agricultural by-products or recycled newsprint. Fire codes often require at least 1/2" drywall on interior walls. Several companies make gypsum drywall with recycled content, although the quantity of recycled content varies widely between companies.

One of the problems associated with particleboard and fiberboard in the past has been urea formaldehyde outgassing. A new generation of board is now available that is made with phenolic resins that do not offgas formaldehyde and are stronger than their predecessors.
## Guide to Resource Efficient Building Elements

### CanFibre Group Limited
Suite 100-1500 W. Georgia St.
Vancouver, BC V6G 2Z6
(604) 685-2430

- **Applications:**
- **Sizes:**
  - Sheets: 4' x 8' x 3/4'' Custom thicknesses up to 4'' are possible.

### Domtar Gypsum
122 Old Dover Road
Newington, NH 03801
(800) 366-8274

- **Applications:**
- **Sizes:**
  - 3/8'', 1/2'' and 5/8'' in 4''x8'' and 4''x12'', 4''x4'' and 2''x8'' or 2''x12'' panels.

### Evanite Fiber Corporation
P.O. Box E
Corvallis, OR 97333
(503) 753-1211

- **Applications:**
- **Sizes:**
  - Thickness ranges from 4 mm to 16 mm (1/16'' to 63").

### Georgia-Pacific
133 Peachtree St. NE
Atlanta, GA 30303
(404) 652-4000

- **Applications:**
- **Sizes:**
  - 32 sq ft panels. Evanite hardboard is also used as a facing over laminated veneer lumber to create core material which is then wrapped in vinyl for window frames.

### Homasote Company
P.O. Box 7240
West Trenton, NJ 08628-0240
(800) 257-9491
(609) 883-3300

- **Applications:**
- **Sizes:**
  - Homasote 4-way® floor decking is available in four thicknesses: 1/2'', 3/4'', 5/8'', and 1'', and 4' x 8' sheets: 5/8'' in 4' x 8', 4' x 12'' and 8' x 12'' sheets.
available in 1 3/4" and 1 11/32" thicknesses in 2' x 4' and 4' x 8' sheets.

**Fire Rating:**
These products have a Class C flame spread rating.

**R-value:**
- Easy-ply: 1" = R-2.4, 1 3/8" = R-3.27, 1 7/8" = R-4.46, and 2 3/8" = R-5.0.
- Homasote fiberboard: 1/2" = R-1.2, and 5/8" = R-1.33. 4-way floor decking: 1 11/32" = R-3.27, 1 3/4" = R-4.46.

**Comments:**
All Homasote products are protected against termites and fungi. The above listed panels can easily be handled on-site by two workers, and may be cut with handsaws or power saws. See also Floor Coverings, and Panel Systems.

**Iowa Recycled Plastics**
322 North Main
Sioux Center, IA 51250
Recycled plastic sheets for use as agricultural building sheathing.

**Applications:**
Livestock barn sheathing. May also be used as shelving.

**Sizes:**
4' x 8' sheets. In marbled white or multicolor combinations.

**Comments:**
Panels are made from 100% post-consumer HDPE plastic, and are moisture resistant.

**Louisiana-Pacific**
111 S.W. Fifth Avenue
Portland, OR 97204
(503) 221-0800

Inner-Seal® OSB. Louisiana Pacific achieves an efficient harvest of wood fiber from small, fast-growing tree species, such as aspen, to manufacture a variety of wood products including these siding materials.

**Applications:**
Sheathing used on walls and roofs.

**Sizes:**
Available in standard sheathing dimensions in standard thicknesses.

**Fire Rating:**
Class C or 3 rating.

**R-value:**
7/16" = R-0.57

**Comments:**
This product is dimensionally stable and durable, and provides structural integrity for added shear strength and rigidity in exterior walls. LP strives to fully utilize the available fiber in all trees harvested from their private forest lands or their seven-year-rotation wood fiber plantations. See also Siding, Insulation, and Framing.

**-and-**
FiberBond™ fiber-reinforced gypsum panels made from three blended layers of gypsum, perlite and cellulose fiber from recycled newsprint and telephone directories.

**Applications:**
Three styles for underlayment, wallboard, and sheathing. Can be nailed, screwed and stapled easily. Higher density than conventional gypsum wallboard.

**Sizes:**
Available in 3/8", 1/2" and 5/8" thicknesses in sheets of 4' x 8', 9', 10', and 12' Lengths available to 24'.

**Fire Rating:**
Type X. 1/2" panels are rated for 45 minutes and 5/8" panels are rated for one hour.

**Comments:**
FiberBond provides uniform strength and superior nail, screw and staple holding characteristics. Resists surface abrasion and impact damage. No taping required. Fully scrubbable. Provides good sound control and thermal insulation. An excellent use of recycled newsprint, that when combined with gypsum and perlite in the manufacture of these panels, provides a more sustainable use of our natural resources. See also Insulation, Framing, and Siding.

**Meadowood Industries, Inc.**
33242 Red Bridge Road
Albany, OR 97321
(503) 259-1331

"Meadowood" wall and ceiling board made from ryegrass straw—an agricultural byproduct. One of a new generation of products that uses agricultural waste fiber to be put to use in the final product. The wood fiber cores allow for non-veneer grade wood to be utilized.

**Applications:**
Walls, floors, and roofs.

**Sizes:**
Available in standard 4' x 8' dimensions in seven thicknesses. Edges can be tongued and grooved or square.

**Comments:**
More expensive than waferboard or OSB. COMPLY is sold as a top value, solid core product. It is moisture resistant and guaranteed not to delaminate. COMPLY Rated Sheathing provides excellent fastener-holding ability. See also Exterior Siding & Trim.

**Oregon Strand Board Co.**
34363 Lake Creek Dr.
Brownsville, OR 97327
(503) 466-5177
(800) 533-3374

COMPLY® sheathing consisting of three veneers of Douglas fir and two thick inner layers of reconstituted wood fiber that are bonded together, creating a solid-core sheathing that is strong and durable. This product exemplifies an efficient use of virgin wood fiber by allowing a greater percentage of the harvested fiber to be put to use in the final product. The wood fiber cores allow for non-veneer grade wood to be utilized.

**Applications:**
Walls, floors, and roofs.

**Sizes:**
Manufactured in 4' x 8' sheets in a variety of thicknesses.

**Fire Rating:**
Class C fire rating.

**Comments:**
This board can be made from the waste of an annually grown crop—a good alternative to burning this resource in the field, as is currently done. Has a density of 40 lbs. per cubic foot. Meadowwood is not yet in full production and is available in very limited quantities.

**Sheathing & Wallboard**
Guide to Resource Efficient Building Elements

Rodman Industries
P.O. Box 76
Marinette, WI 54143
Ph: (715) 735-9500
Fax: (715) 735-6148

Resinco® particleboard made of sawdust, phenolic resin, and wax. Also ResinFloor™ industrial floor made from blended hardwood fibers and phenolic resins.

Applications:
- Particleboard for non-structural sheathing. Flooring is an alternative to hardwood strip flooring for factories and warehouses.

Sizes:
- Particleboard in 55# with thicknesses from 1/2" to 1"; and 45# with thicknesses from 5/8" to 1 3/16". Flooring comes in 4' x 8' x 3/4" predrilled sheets.

Comments:
- These products use phenolic resin and contain no formaldehyde. Phenolic resin is water resistant and is stronger than UF resin board, so thinner board can be used. ResinFloor is twice as hard as oak.

Simplex Products Division
P.O. Box 10
Adrian, MI 49221-0010
(517) 263-8881

Thermo-ply exterior sheathing made from 100% recycled wood fiber, faced with aluminum foil or polyethylene.

Applications:
- Structural or non-structural exterior wall sheathing applications.

Sizes:
- 48" wide by 96" long (custom lengths available). Three thicknesses, .078", .113", and .137", for standard grade, structural grade and super strength grade.

Fire Rating:
- Class C flame spread.

R Value:
- R-20 (Thermo-ply is designed to function within a wall system to reduce the R-value loss caused by infiltration.)

Comments:
- Thermo-Ply core contains 80% post-consumer recycled material from cardboard boxes, office waste, etc., and is recyclable. The bonding agent is polyvinyl alcohol, not a hazardous material. Thermo-ply has racking and shear strength necessary to meet building codes.

Weyerhaeuser
4111 East Four Mile Road
Grayling, MI 49738
(517) 348-2881

Structurwood® made from small, fast growing trees which are flaked and then bonded with waterproof adhesive. Structurwood EDGE for floors.

Applications:
- Walls, floors, and roofs.

Sizes:
- Available in standard dimensions in thicknesses of 3/8", 7/16", 1/2" and 5/8", 23/32" and 3/4". Custom orders to 8' x 24' x 1 1/4".

Fire Rating:
- Class C.

R Value:
- R-1.6

Comments:
- Structurwood is commonly used as a web material by other i-joist manufacturers.

Center for Resourceful Building Technology

Sheathing & Wallboard
Roofing

Homeowners want a durable, attractive roof. Many people admire the textural beauty of cedar shakes and slate or tile roofing. These materials are handsome, but do not necessarily provide for efficient resource use. Concerns of resource efficiency call for a roofing material to be lightweight, recycled and/or recyclable, and durable. At the same time, practicality dictates that roofing should be fire resistant and affordable.

The manufacture of good quality cedar shakes (with their straight grain and knot-free characteristics) is dependent upon the few remaining old-growth cedar trees in the Pacific northwest and western Canada. Cedar is a very slow growing climax species that is difficult to harvest efficiently. Furthermore, despite their textural beauty, cedar shakes last only about 25-30 years in dry climates and 10-15 years in moist climates. Cedar shakes also demand a high level of maintenance. Furthermore, cedar shakes are a very unwise choice in areas prone to fire, since they are highly combustible when dry.

By contrast, two roofing materials with good fire ratings are tile and slate. Both are very durable, yet they have deterrents. The extreme weight of these materials creates the need for larger dimensional roof framing and trusses to support the roof. This increases the resource demand and materials cost for the roof system. The cost of tile and slate themselves may also be prohibitive.

To minimize material requirements in roof framing, a roofing material should be relatively lightweight, yet durable. Several roofing products meet these criteria in varying degrees. This chapter contains fiber-cement composite roofing slates, as well as shakes, tiles, and panels made from recycled metal or recycled plastic. There is a selection of recycled rubber composite roofing and accessories for flat roofs. A small selection of companies producing traditional organic asphalt shingles with recycled content are also listed here.

Most organic asphalt shingles available today contain recycled "mixed" waste paper in their base. Some contain reclaimed mineral slag as part of the surface aggregate. The recycled content of these traditional shingles merits acknowledgment, even though the shingles themselves have relatively short life spans (15 to 25 years) and are not yet easily recycled. (Note: see the chapter on Job-Site Recycling for information on efforts to recycle asphalt shingles.) Some roofing materials can be applied over an old asphalt-shingle roof which postpones the need to dispose of the shingles.

Fiber-cement composite slates or shakes are long-lasting (up to 60 year warranties), fireproof, and make efficient use of wood fiber. Although the fiber source for the listed manufacturers is not clear, the wood used in this type of product can be harvested from small diameter and fast-growing species, or reclaimed from wood waste. These slates weigh between 325 and 600 pounds per square (100 square feet make up a roofing "square") and can be used on standard roof structures. The blend of fiber with ground sand...
and cement yields a durable product that can be ground up into a sand/mineral dust at the end of its life.

Fiber-cement shingles may not perform as well in freeze-thaw climates, and some manufacturers don’t warranty their roofing products in northern regions or at higher altitudes. Check with individual manufacturers for product suitability in particular climates. Many companies that manufacture fiber-cement composite slates for roofing also make similar exterior siding products, and these are usable in any climate. Listings for those products are in the Exterior Siding and Trim chapter. Fiber-cement composite slates characteristically require hand nailing and more installation time than other roofing systems. The slates have a somewhat brittle consistency and installers must be careful to avoid breakage, as done during installation of natural slate.

Like some fiber-cement roofings, other roofing products may be vulnerable to repeated freeze-thaw cycling. Most manufacturers of such products limit their distribution and sales area, but homeowners in northern climates should be aware of the problem, and make sure that a roofing product is suited to the climate where it will be installed.

Metal roofing is durable and low maintenance. Most metal roofing products have a high percentage of recycled materials, as they are manufactured in electric furnace mills which are designed to use recycled stock. Metal roofs are lightweight, and can contain up to 100% recycled material. While there is a great deal of embodied energy in the extraction and refining of metal products, their high recycled content and ready recyclability somewhat offset their energy cost. At the end of its useful lifetime, most metal roofing is recyclable, unless it is coated with a non-metallic substance such as PVC, which is difficult to separate from the metal.

Metal panel roofing, generally steel or aluminum, is a standard product readily available from a number of manufacturers and distributors nationwide. This chapter provides listings for manufacturers of less ubiquitous metal roofing products, such as interlocking copper shingles, steel shingles and aluminum shakes.

Roof shingles made from recycled plastic resins provide an extremely lightweight roofing alternative. The recycled plastic roofing materials listed here weigh less than asphalt shingles, and their use diverts material from landfills. They may be recycled again at the end of their useful life.

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Square:
A measure of roof area equal to 100 square feet.
Guide to Resource Efficient Building Elements

American Cem-Wood Products
P.O. Box C
Albany, OR 97321
(503) 928-6397
(800) 367-3471

Cemwood Shakes™, Trieste Tile™ and Permatek™ shakes composed of roughly 2/3 portland cement and 1/3 wood fiber derived from sawmill chips.

Applications:
Can be applied over solid or spaced sheathing.

Sizes:
Cemwood Shakes are bundled in random widths of 12", 7" and 5", and are 22" long with simulated wood texture on lower 11"

Permatek shakes are 14' x 14 1/2"

Colors:
Cemwood Shake, Tile and Permatek each in two colors.

Weight:
Cemwood Shakes, 580 pounds per square; Permatek and Trieste Tile 450 pounds per square.

Fire Rating:
Class A rating depending on underlayment used.

Comments:
A lightweight, non-combustible, composite product which can be nailed and sawn similar to wood shakes. Comes with a 50 year warranty.

Cal-Shake, Inc.
P.O. Box 2265
Irwindale, CA 91706-2265
(800) 736-7663
(818) 969-3451

Cal-Shake, Cal-Slate, and Cal-Clay, roofing shake, slate and clay shingles made from cement, perlite, synthetic iron oxides, synthetic polyester fiber and recycled cardboard.

Applications:
New or reroof applications on sloped roofs.

Sizes:
Cal-Slate and Cal-Clay 6" wide. Cal-Shake in 5", 7", 10" 11" wide, 22" long with 10" exposed detail.

Colors:
Shake and slate each come in four different colors.

Weight:
560 pounds per square.

Fire rating:
UL Class A.

Comments:
This is a relatively heavy roofing material and is only sold in the Sunbelt. It is not recommended for areas with high occurrence of freeze/thaw cycles.

Celadon
P.O. Box 309
New Lexington, OH 43764
(800) CEL-SLATE
(800) 699-9988

Celadon™ Ceramic Slate™ clay shingle that acts as replacement for slate roofing.

Applications:
Simulates appearance of slate with lighter weight on sloped roofs of 6.12 minimum.

Sizes:
108 pieces per square. Pieces are 10 7/8" x 15 3/4" with 3/4" thickness and 10 1/8" x 13 1/4" exposure.

Colors:
Five colors, fired in.

Weight:
580 pounds per square.

Fire rating:
Impervious to fire.

Comments:
60 year limited warranty. This roofing product is relatively heavy, but is impervious to freeze/thaw and suited to use in northern climates.

CertainTeed Corporation
Roofing Group
P.O. Box 860
Valley Forge, PA 19482
(800) 782-8777

Variety of organic felt-based shingles that incorporate recycled paper and recycled waste slag with a resulting 20% to 25% recycled content.

Applications:
New and reroof uses.

Sizes:
Most common size available is 12" x 36" with 5" exposure.

Colors:
Many colors and patterns available.

Weight:
Approximately 215 - 230 pounds per square.

Fire Rating:
Class C fire resistance.

Comments:
The recycled content of traditional shingles such as these made by CertainTeed is often overlooked.

Conklin Metal Industries
P.O. Box 1858
Atlanta, GA 30301
(404) 688-4510

Diamond pattern metal roofing shingles, in galvanized and copper.

Applications:
Metal roofings shingles, for new or reroofing.

Sizes:
Shingles are 10" x 14" in a diamond pattern.

Weight:
Galvanized 103 pounds per square; copper 132 pounds.

Fire rating:
Will not burn.

Comments:
Metal shingles are recyclable. Conklin also offers alloy shingles, but these contain lead, and may affect the suitability of these roofs for rooftop water catchment.
Crowe Industries Ltd.
116 Burris St.
Hamilton, Ont L8M 2J5 Can.
(905) 529-6818
Applications:
As an alternative to slate roofs, almost as easy to install as asphalt shingles.
Sizes:
Tiles 12'' x 18'', with exposures 6'' to 8''
Colors:
Black, cast in patterns of actual slates.
Weight:
50-80 pounds less per square than asphalt type shingles. Requires no additional supports.
Fire rating:
Not specified
Comments:
Authentic roof is fastened with standard nails to any roof deck. Tiles are completely recyclable, and have a 50-year warranty

Eiger Building Products
4770 biscayne Blvd., Suite 1020
Miami, FL 33137
Ph: (305) 573-7778
(800) 45-EIGER
Fax: (305) 573-7775
Applications:
A cedar shake appearance, with interlocking installation, for new or reroofing. Can be installed over asphalt with no retrussing.
Sizes:
Panels 20'' x 40'', each equivalent to 13 cedar shakes.
Colors:
In three colors.
Weight:
90 pounds per square.
Fire rating:
Meets Class A flame protection standards when installed per manufacturer's recommendations.
Comments:
This product has a 50 year limited warranty. It passes 130 mph wind tests, and meets codes in the U.S. and Canada.

Eternit
P.O. Box 679
Blandon, PA 19510-0679
Ph: (800) 233-3155
(610) 926-0100
Fax: (610) 926-9232
Applications:
In addition to conventional roofing applications, other uses include fascias, mansards, facades and industrial cladding. Corrugated style recommended for commercial and industrial structures.
Sizes:
Slates are 3/16'' thick and 10 5/8'' x 15 3/4'' in dimension. Corrugated roofing comes in a variety of widths to 42'', lengths to 12'' and thicknesses of 3/32'', 1/4'' and 3/8''
Colors:
Available in blue black, grey green, and rose grey. Corrugated styles in natural grey only.
Weight:
Average 430 pounds per square. Corrugated weight depends on style with average product weight of 3 pounds per square foot.
Fire Rating:
Class A rating when installed over 5/8'' sheathing.
Comments:
Eternit Slates are very durable, asbestos-free, and come with a 30 year non-prorated warranty. They can be cut and punched with a slate's hammer, and come pre-drilled. As they cannot be air-stapled, however, they require a bit more installation time than other roofing materials. See also siding.

Everest Roofing Products
P.O. Box 2430
Industry, CA 91746
(800) 767-0267
(310) 692-1446
Applications:
The polymer shake substitutes for cedar or slate roofs. It is molded for random appearance and suitable for
reroofing or new roofs, with a 4-way interlock.
Sizes:
15 1/2'' x 13'', 1 1/4'' thick at front.
Colors:
3 "cedar" styles and 5 "slate" styles.
Weight:
150 pounds per square
Fire rating:
Class A
Comments:
Product has lifetime warranty and manufacturer claims it won't split or warp. Everest is a relatively light-weight roofing that provides a shake look.

Georgia-Pacific
133 Peachtree St. N.E.
Atlanta, GA 30303
(404) 652-4000
(800) 447-2882
Applications:
New and reroof; residential and commercial.
Sizes:
Available in 3-tab style with 12'' or 12 1/4'' width and 36'' length; "no cut-out" style with 12 1/4'' width and 36'' length, and T-lock style with 21 1/2'' width and 19'' length.
Colors:
Many colors available.
Weight:
Approximately 215 - 230 pounds per square.
Fire rating:
Class C
Comments:
The recycled material in traditional shingles such as these is often overlooked. These shingles offer the consumer a good roofing product with recycled content.

Gerard Roofing Technologies
955 Columbia Street
Brea, CA 92621-2927
(714) 529-0407
(800) 841-3213
Applications:
Roofing tiles and shakes with a base of pre-painted galvanized steel and a coating of graded stone granules.

Guide to Resource Efficient Building Elements
rafters. Wood or steel battens are used under roofing.

Sizes:
- Tiles are 45 3/4" x 15 1/2"; shakes are 44 3/4" x 15 1/2".

Colors:
- Available in eight solid colors and seven Mediterranean blends.

Weight:
- 140 pounds per square.

Fire rating:
- Class A.

Comments:
- These panels interlock to create a continuous, weather-resistant barrier. The metals used in the manufacture of this product come largely from recycled stock. Comes with a 40-year warranty on weatherproofness.

Humane Manufacturing Co.
805 Moore St.
Baraboo, WI 53913-2796
(800) 369-6263
(608) 356-8336

Roof-Gard™ recycled rubber walk pad for rooftops.

Applications:
- To protect roofs from foot traffic.

Sizes:
- 4' x 6', 2' x 6', or 3' x 4', in thicknesses of 3/8", 1/2", or 3/4" in low diamond or button patterns.

Comments:
- Virtually maintenance free, manufactured from recycled tires with no filler added.

Innovative Formulations Corporation
670 W. 33rd Street
Tucson, AZ 85713
Ph: 602-628-1553
Fax: 602-628-1580

A continuous filament, single-ply, water-based, fluid applied roofing system that acts as both an insulator and reflector for flat roofs.

Applications:
- Mirrorseal is combined with Mirrorfab, a white spunbond polyester backbone fabric, and a reflective topcoat which can be applied over virtually any sound roof surface, reducing demolition waste.

Fire Rating:
- Has no flash point.

Comments:
- This system is designed to withstand extreme temperatures while retaining structural flexibility. Can support a 3500 pound footprint-sized load.

James Hardie Building Products
10901 Elm Ave.
Fontana, CA 92337
(909) 356-6300
(800) 426-4051

Hardishake® fiber cement composite roofing slates with a wood shake texture. Made from portland cement and wood fiber cellulose.

Applications:
- New and reroof. Can be installed over existing roof without additional structural reinforcement.

Sizes:
- 1/4" thick, 22" long in widths of 6", 8" and 1/2".

Colors:
- Available in seven colors.

Weight:
- When laid with a 10" exposure, Hardishake has a dry weight of approximately 380 pounds per square.

Fire Rating:
- Can be installed to achieve a Class A rating.

Comments:
- When properly installed, Hardishake is covered by a 50-year transferable, limited warranty. Can be walked on without damage.

Louisiana Pacific
111 SW Fifth Ave.
Portland, OR 97204-3601
(800) 777-0749

Nature Guard® fiber cement roofing shakes.

Applications:
- New or reroof applications.

Sizes:
- In 5", 7" and 1/2" widths, 22" long with 3/4" butt thickness.

Colors:
- 3 integral colors.

Weight:
- Approximately 575 pounds per square.

Fire rating:
- Non-combustible; will meet California fire codes.

Comments:
- Product contains 10% fly ash and is new this year.

MaxiTile, Inc.
17141 S. Kingsview Avenue
Carson, CA 90746
(800) 338-8453

Met-Tile
P. O. Box 4268
Ontario, CA 91761
(909) 947-0311

A continuous filament, single-ply, water-based, fluid applied roofing system that acts as both an insulator and reflector for flat roofs.

Applications:
- New and reroof uses. Can be installed over virtually any sound roof surface, reducing demolition waste. Minimum headlap of 4" is recommended. Transferable 50-year limited product warranty.

MaxiTile consists of Portland cement, silica and cellulose fiber. Designed to achieve the look of 2-piece Mission tile (corrugated profile).

Applications:
- Appropriate for new and reroof uses.

Sizes:
- Available as 36.5" x 24" shingles as well as hip and ridge caps. 1/4" thick.

Colors:
- Terracotta Red, Autumn Brown, Clay, Marble Gray (light), and Oxford Gray (darker).

Weight:
- 340 pounds per square.

Fire Rating:
- Class A.

Comments:
- MaxiTile includes a one-mil thick backer coat for weather resistance.
Metal Sales Manufacturing Corporation
6260 Downing
Denver, CO 80216
(800) 289-7663

Stile™ tile-like metal roofing panels with a base of hot-dipped galvanized recycled-content steel.

Applications:
- Designed to simulate the look of clay tiles for residential, commercial and mansard-type roofs.

Sizes:
- 26 guage panels in 4’ widths and lengths 3’ to 16’ in 1’ increments.

Colors:
- Available in five colors.

Weight:
- 100 pounds per square

Fire rating:
- Class A.

Comments:
- These panels have an epoxy-based undercoat and a primed and painted top surface that is durable against ultraviolet light. They are overlapped roughly 5” on each side (one tile “wave”) to provide a weather-tight roof. 20-year limited warranty.

Re-Con Building Products, Inc.
Box 1094
Sumas, WA 98295
(800) 347-3373

Fire Free™ fiber cement roofing, in rustic shake, colonial shingle, or quarry slate styles.

Applications:
- New or reroof applications for minimum pitch 3:12.

Sizes:
- Length 22.5”; shake widths 5”, 7”, or 12”; slate width 12”
- Maximum exposure 10”

Colors:
- Several tan and gray integral colors.

Weight:
- Slate and shake 395 pounds per square, shingle 375 pounds per square.

Fire rating:
- Class A.

Comments:
- 50-year limited warranty, non-prorated. These fiber cement products are freeze/thaw approved for application in northern climates.

Revere Copper Products, Inc.
P.O. Box 300
Rome, NY 13442-0300
(800) 490-1776

Revere copper shingle metal roofing.

Applications:
- For installation over solid substrate on roofs or walls with 3:12 pitch or greater.

Sizes:
- 4’ lengths of shingles, with 9” exposure and .019” thickness.
- Coverage per shingle is 3 sq. ft.

Weight:
- 143 pounds per square.

Fire rating:
- Class A.

Comments:
- Copper can be expensive up-front, but provides a durable roof and is not only recyclable, but may also have high recycled content.

RTS Company
1805 Newton Ave.
San Diego, CA 92113
(619) 696-0102

Nine roofing systems consisting of steel or aluminum shingles. Manufactured from recycled metals.

Applications:
- Commercial and residential. Can be installed over most existing roofs without removing old roofing.

Sizes:
- Sizes vary by style. Mission Tile design is 8” x 17”, while the “long-run” tile panel designs average 60” long in a variety of widths.

Colors:
- Ten standard colors with custom colors available.

Weight:
- Aluminum ranges from 35 to 60 pounds per square. Steel ranges from 80 to 140 pounds per square.

Fire rating:
- Class A, depending on installation.

Comments:
- These lightweight roofing materials reduce the need for a heavy superstructure below. 25-year warranty.

Supradur
P.O. Box 908
Rye, NY 10580
(800) 223-1948
(914) 967-8230

Supra Slate® II fiber-cement composite roofing shingles available in slate, shake and traditional styles. Made from portland cement and wood fiber cellulose.

Applications:
- New and reroof.

Sizes:
- Available in thicknesses of 155”, 18” and 22” in rectangular, square and pentagonal shapes. Available dimensions range from 1.5” x 16” to 1 1/2” x 24”

Colors:
- A variety of colors to choose from including black, grey, red, brown & green.

Weight:
- Depends on style chosen. Ranges from 240 to 500 pounds per square.

Fire Rating:
- Class A and B ratings.

Comments:
- Slates are cured in a high-pressure steam autoclave to ensure dimensional stability. They come with pre-drilled hole nails, and will not warp, curl or shrink. All Supradur roofing products are covered by a forty-year non-prorated warranty.

Zappone™ Manufacturing
N. 2928 Pittsburg
Spokane, WA 99207
(800) 285-2677
(509) 483-6408

Recycled copper and recycled aluminum shingles, made of pure metal.

Applications:
- Four-way interlocking design allows installation on roofs with minimum pitch of 3” over 12”

Sizes:
- Single dimension is 15” x 9 1/8”

Colors:
- Aluminum comes in seven color finishes of oven-baked paint, wood grain embossed.

Weight:
- Copper is 94 pounds per square. Aluminum is 42 pounds per square.

Fire rating:
- Both are Class A, B, C.

Comments:
- Roofing passes wind and wind-driven rain tests to 110 mph. Aluminum is 100% recycled, copper is a minimum of 85% recycled. Both are recyclable. Aluminum shingle has a 50-year guarantee, plus a 20-year warranty on the finish.
Exterior Siding & Trim

Over 50% of the residential siding bought today consists of wood or wood composites. Most solid-sawn wood siding materials require considerable maintenance and have a limited useful lifetime. Weathering and installation problems that cause cupping and checking lead to frequent siding replacement that demands more resources and produces more tear-off waste than longer-lived sidings. Furthermore, installing solid wood siding often results in increased job-site waste, as checked or poor quality pieces are culled, and pieces are cut to end on studs. Wood siding is also highly combustible. There are many alternatives to solid wood siding that either provide for a more efficient primary use of wood resources or that contain recycled materials.

Engineered and composite wood siding products achieve a more efficient use of wood fiber than traditional solid-sawn wood siding, while providing a textural replica of solid wood. Composite wood products such as hardboard can use wood fiber recovered from other wood processing operations. Wood fiber can be mixed with a variety resins to create a durable composite. Some engineered and composite wood sidings are coated and pre-finished to enhance their weather resistance and durability.

Fiber-cement composites offer an extremely durable, attractive and fire-proof alternative to wood or metal siding. The wood fiber in these products can be harvested from small diameter fast-growing species, or reclaimed from wood processing waste. They also require less energy to manufacture than steel, aluminum or vinyl siding. Fiber-cement siding can be textured to exhibit a wood-grain appearance. Some fiber-cement siding requires painting before use, and installers should be aware that cutting the siding produces a great deal of dust.

Although metal siding has a high embodied energy, it often includes a high recycled content. Most metal products available today to the housing industry contain more than fifty percent recycled metal, and can be recycled again at the end of their use. While metal requires a great deal of energy to manufacture, its durability and recyclability reduce the total energy involved in producing several generations of products.

Vinyl (polyvinyl chloride) is a well-known siding alternative, and is readily available from a number of manufacturers. Vinyl siding is available in wood-grain textures, and requires little maintenance. A few manufacturers reincorporate a small percentage of post-industrial scrap into the manufacturing process, but PVC is difficult to recycle, and none of the sidings contain post-consumer vinyl. At present, vinyl siding is not recyclable at the end of its useful life. Some environmental groups express concerns that the manufacture of PVC is the cause of excessive environmental degradation, and advise against using vinyl products.

Another exterior finish option is stucco. Conventional stucco has a cementitious base, although in some regions and climates traditional adobe stucco or asphalt-stabilized adobe provide a viable, low embodied energy alternative. A new generation of stucco finishes combine synthetic fibers or acrylic compounds in an exterior finishing system.
Trim traditionally has been made from high-quality, clear wood from large diameter trees. While wood remains the primary component for most interior and exterior trim, engineered wood products such as veneers and composites offer consistent quality, improved durability, and more efficient use of wood fiber. A number of companies offer exterior trim molded from urethane or polyester resin. This trim provides a durable, low maintenance alternative to exterior wood trim for applications such as attic vents and louvers. Interior trim products are listed in the Interior Finishes chapter.

**ABT Co. Building Products**
P.O. Box 98, Hwy 268
Roaring River, NC 28669
(800) 334-3551
A variety of molded hardboard siding products including panels, lap siding and simulated shake siding.

**Applications:** Residential and commercial.

**Sizes:** Siding is 7/16" thick and is available in a number of widths in 4', 8', 9' and 16' lengths.

**Finish:** These products contain a heat and pressure applied resin and linseed oil overlay as well as an acrylic primer. Available in natural cedar and redwood textures.

**Comments:** Free of the imperfections commonly found in solid sawn siding, these products resist splitting and checking. Plain ungrooved products can be used as soffit.

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**Georgia-Pacific**
133 Peachtree St. N.E.
Atlanta, GA 30303
(404) 652-4000
(800) 447-2882
PrimeTrim™ exterior and interior trim is a high resin, high temperature cured all-wood fiber composite. This product provides an efficient use of wood fiber by allowing a higher percentage of harvested wood fiber to be used in the final product.

**Applications:** Developed for non-structural uses such as fascia, rake board, corner board, band board and exterior trim. Can be applied directly over other materials such as siding, or nailed directly to structural framing.

**Sizes:** 16' lengths with no fingerjoints. Two thicknesses, 5/8" and 1", in eight widths from 3 1/2" to 11 1/4".

**Finish:** Factory-primed face and two edges.

**Comments:** Field-tested for over four years, PrimeTrim resists warping, cupping, twisting, splitting and checking. Contains no isocyanurate or urea formaldehyde resins. Can be cut with a fine-toothed hand saw or power saw with a combination blade.

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**Catawba® Hardboard siding made from wood chips.**

**Applications:** Residential exterior siding, in lap and panel styles.

**Sizes:** Pieces 1/2" x 12" x 16' with either 4" or 6" lap style. In 7/16" thickness there are panels 4' x 7', 8', or 9', and 8' x 16' pieces.

**Finish:** Siding are available primed, in smooth or textured finish. Some styles are available unprimed.

**Comments:** Many styles of this siding are available.

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**Eternit**
Box 679
Blandon, PA 19510-0679
(610) 926-0100
A complete line of asbestos-free, fiber-cement building products used for fascias, facades and interior walls.

**Applications:** Uses include exterior and interior wall claddings, soffits, fascias, partitions, and as a skin for laminated panels. Also for components in prefabricated wall panels, substrate for the application of stone aggregate, ceramic tile or architectural metal panels. For use in on-site studwall assemblies.

**Sizes:** Most of Eternit's wall panel products are available in standard 4' x 8' and 4' x 10' sheets in many thicknesses.

**Finish:** Factory applied finish is a solid-color stain with 15-year warranty

**Fire Rating:** Class III. The EPS is bromine treated.

**Comments:** With prescriptive corner bracing this product can provide exterior sheathing, supplementary insulation and exterior finish.
Guide to Resource Efficient Building Elements

James Hardie Building Products
10901 Elm Ave.
Fontana, CA 92337
(909) 356-6300
(800) 426-4051

Applications:
Harditex sheets are designed as an efficient alternative to stucco. Sheets are nailed to house frame, primed, and then textured with acrylic-based coating. Lap and vertical siding can be applied directly to wood or steel studs up to 24" on center.

Sizes:
Harditex sheets are 1/4" thick, in 4' x 8', 4' x 9' and 4' x 10' sizes.
Hardiplank™ Lap Siding is 5/16" thick, in widths of 7 1/2", 8" and 9 1/2" and lengths of 12' and 14'.
Hardi panel™ Vertical Siding is 1/4" or 5/16" thick in 4' x 8', 4' x 9', and 4' x 10' panels.

Fire Rating:
Zero flame spread, 0 fuel contributed. Class A (1).

Comments:
Harditex sheets are tapered on three edges, and can be cut with a power or hand saw, or cut-scored with knife. Immune to permanent water damage, rot, and termites. Very little expansion and contraction when exposed to moisture or temperature extremes. Textured coating systems using Harditex Base Sheets have been used throughout Australia and New Zealand for over 25 years.

Louisiana-Pacific
111 S.W. Fifth Avenue
Portland, OR 97204
(503) 221-0800
Inner-Seal® lap and panel siding, exterior trim, and soffit panels consisting of oriented strand board with a finished weather-proof surface. Louisiana-Pacific achieves an efficient harvest of wood fiber from small, fast-growing tree species to manufacture a variety of wood products such as these siding materials.

Applications:
Lap siding can be applied to either sheathed or unsheathed walls (with studs at least 24" o.c.). Panel siding may be applied directly to studs, or over existing sheathing.

Sizes:
Lap siding is available in 6", 8", 9 1/2" and 12" widths, in 7 1/2" thickness, in 12" and 16" lengths. Panel siding is 7 1/2" or 19/32" thick, available in standard 4' x 7' and 4' x 8' panels as well as oversized panels. Exterior trim is available 3/4" or 5/4" thick, in six widths from 4" to 12" in 16" length. Soffit panels are available in 4" x 8' size and oversizes up to 8' x 24'.

Finish:
The siding products are finished with an exterior-grade resin overlay and primed to create a protective skin.

Fire Rating:
Class C or 3 on substrate.

Comments:
Products are dimensionally stable and provide structural integrity for shear strength and rigidity in exterior walls. LP strives to fully utilize the available fiber in all trees harvested from their private forest lands or their seven-year-rotation wood fiber plantations.

Masonite Corporation
1 South Wacker Drive
Chicago, IL 60606
(800) 255-0785
OmnWood™ engineered hardboard siding, made from Southern yellow pine OSB and treated fiber overlay.

Applications:
Residential lap and shingle siding.

Sizes:
Available in widths 5" to 8" and in 16" lengths. Also in 4" x 8" panels.

Finish:
Factory-finished colors in pine and cedar textures.

Comments:
These hardboard products are 50% denser than natural sawn wood, resist splitting and checking, and are free of the imperfections commonly found in solid sawn siding, thereby reducing waste at the job site. 25-year limited warranty on substrate, 5-year warranty on finish.

Oregon Strand Board Co.
34363 Lake Creek Dr.
Brownsville, OR 97327
(503) 466-5177
(800) 533-3374
COMPLY® Lap siding and Versatile V-Groove lap siding consisting of three veneers of Douglas fir and two thick inner layers of reconstituted wood fiber that are bonded together creating a solid-core siding that is strong and durable.

Applications:
Comply Lap Siding can be installed directly to 24" o.c. stud framing, reducing the amount of exterior studs required. Versatile V-Groove lap siding can be installed in vehicle, horizontal or diagonal patterns.

Sizes:
Versatile V-Groove lap siding available in 8' lengths (clear or knoty) in 6" or 8" widths. Comply lap siding is available in 6", 8", and 10" widths. Both come in thicknesses of 19/32" and 5/8".

Comments:
Comply uses fewer veneers than plywood, allowing for lower grade wood fiber to be utilized. This provides a more efficient use of harvested fiber. Moisture resistant and guaranteed not to delaminate. These products provide excellent strength, stiffness and fastener-holding ability.
**Ply-Trim**

1524 Center St.
Tacoma, WA 98409
(800) 956-6746
(206) 572-7300
P.O. Box 2336
Youngstown, OH 44509
(800) 759-8446

Ply-Trim® Douglas fir plywood joined into panels, then cut to standard board widths.

**Applications:**
For use as exterior trim with brick, wood, aluminum, or vinyl siding.

**Sizes:**
Standard widths up to 12", in thicknesses of 5/8", 3/4", 1", or 1 1/2". In 16' standard lengths. Custom sizes available for volume orders.

**Finish:**
Sections sealed and primed for painting with acrylic-base house paint or opaque stain.

**Comments:**
Ply-trim is stronger and more stable than natural wood, and holds paint 2-3 times longer. Even a 2' piece can be used without splitting, so there is less jobsite waste.

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**Temple-Inland Forest Products**

P.O. Drawer N
Diboll, TX 75941
(800) 231-6060
(409) 829-5511

TrimCraft™ engineered wood trim product made from wood chips that are refined into individual fibers, and formed under heat and pressure into a uniformly dense material.

**Applications:**
For exterior window or door trim, corner, band and rake board as well as for fascia and soffits. This product can also be used for interior door, window, base and ceiling trim, and can be applied directly over other materials such as siding or brick, or nailed directly to structural framing.

**Sizes:**
3/4" thick, available in five widths from 4" to 12" in lengths of 16'.

**Finish:**
Comes with a moisture resistant, oven-baked, factory applied primer.

**Comments:**
This is an excellent example of how wood fiber can be put to use in an efficient manner through value added technology, reducing waste in the process. TrimCraft is a non-structural product that is easy to work and has consistent board characteristics. Comes with a 10-year warranty against product defects, as well as a 5-year warranty on the factory applied primer.

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**Smurfit Newsprint Corp.**

427 Main St.
Oregon City, OR 97045
(800) 547-6633
(503) 650-4274

Cladwood® exterior siding, a resin-bonded particle board substrate with both-side fiber overlay.

**Applications:**
Exterior siding. Cladwood requires a continuous vapor barrier of one perm or less on the warm side of the wall to which it is applied.

**Sizes:**
Thicknesses of 7/16" or 1/2", both in 48" x 96" and 48" x 108", or shiplap 48 3/8" x 96" and 48 3/8" x 108'.

**Fire Rating:**
Class C.

**Finish:**
No primer needed. Surface must be finished with paint or solid color stain.

**Comments:**
This is an excellent example of how wood fiber can be put to use in an efficient manner through value added technology, reducing waste in the process. TrimCraft is a non-structural product that is easy to work and has consistent board characteristics. Comes with a 10-year warranty against product defects, as well as a 5-year warranty on the factory applied primer.

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**Werzalit of America, Inc.**

P.O. Box 373
Bradford, PA 16701
(800) 999-3730
(814) 362-3881

Werzalit Cladding combines hardwood fiber and melamine resin in a compression molding process. Core is covered with phenolic laminate and thermostet acrylic coating.

**Applications:**
For new and retrofit construction. Prepunched, tongue and groove, shiplap exterior siding.

**Sizes:**
In four styles: Heritage, 6 1/8", Americana, 4", 6" or 8", Allegheny 8", and Colonial 8”. Thicknesses are 1 1/16” except for Colonial, which is 1 3/16”. Lengths are 12’ except for Heritage, which is 8’ 10 3/16’.

**Finish:**
Factory baked finish needs no painting. Available in 12 colors.

**Fire Rating:**
Flame spread 45 for standard products, 15 for fire retardant products.

**Comments:**
Werzalit core material is made from a mix of hardwoods including Black Cherry seconds and otherwise unusable byproducts. The manufacturing process is suitable to almost any raw material, and has been used worldwide with a number of different agricultural fibers.

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**Weatherstone vinyl siding manufactured from preconsumer recycled vinyl through a process of co-extrusion, in which virgin PVC and internal reclaimed PVC are fused together.**

**Applications:**
Residential and commercial.

**Sizes:**
Standard lap siding sizes available in seven colors.

**Comments:**
Requires no maintenance; comes with a 50-year transferable warranty.
Insulation

Choice of an insulation material is usually based on resistance to heat flow (R-value), availability, toxicity and cost, but resource efficiency also deserves consideration. There are a number of insulation products made from secondary resources that were partially processed in the manufacture of other products, or from recycled products such as paper, glass, or plastic packaging.

Partially processed materials contain varying amounts of embodied energy—the energy expended during extraction, refinement and manufacture. Rather than being buried in a landfill or incinerated, these resources can be further processed to create products such as insulation, soundproofing and fireproofing.

One example of partially processed material use is mineral wool insulation. Some mineral wool insulation is slag wool made from a waste by-product of steel production. Other mineral wool insulation is made from rock. The mineral wool insulation is non-combustible, with a melting point above 1200°C, is non-corrosive, exudes no odor, and does not support the growth of fungus or bacteria. Steel production uses a great deal of energy—more than production of glass or paper—and yet, once this energy is expended, further processing of the mineral by-products can provide an additional product. Mineral wool insulation has an R-value of between 3 and 4 per inch.

Another product, cellulose insulation, is made from post-consumer recycled wood fiber in the form of newspapers or telephone books, which are ground or shredded and processed for use as insulation. Cellulose insulation is comparatively low in embodied energy, yet provides an R-value between 3.2 and 3.7 per inch. The insulation can be dry-blown or poured in a loose-fill application into enclosed cavities. More commonly, the insulation is applied in a wet-spray method, in which it is mixed with water as it is sprayed into the wall or ceiling cavity. Sprayed cellulose insulation leaves few voids, filling in well around studs and wiring, and thus reducing problems of air infiltration. Some manufacturers spray-apply cellulose mixed with an adhesive, as an insulative surface finish. A number of cellulose insulation manufacturers appear in the second section of this chapter.

One concern with cellulose insulation has been its fire resistance. Cellulose is usually mixed with boric acid or sodium borate as a fire retardant. Either of these treatments requires boron, a non-renewable resource which exists in limited quantities. There are also some
R-value:
The measure of a material's ability to resist the flow of heat through it; insulative value.

U-value:
The measure of conductance; the inverse of R-value.

concerns about the longevity of the fire-retardant in application, since it is water soluble.

Another concern with wet spray cellulose insulation is the need for the insulation to dry completely before being enclosed in the wall. It is important to achieve an appropriate mix of water and insulation, or the insulation can either settle or take an inordinately long time to dry. Lack of thermal efficiency and moisture problems leading to structural damage are potential results of overly wet cellulose insulation. Look for a qualified installer to practice proper installation procedures for wet-applied cellulose insulation.

The cellulose insulation industry and mineral insulation manufacturers (including fiberglass manufacturers) are extremely competitive. Both industries tend to provide highly subjective information on the superiority of their products over competing types of insulation. In truth, both types of insulation have merits and limitations.

Fiberglass is still the most common insulation material, and some manufacturers are including increasing amounts of recycled glass in their manufacturing processes. The third portion of the chapter provides a selection of fiberglass insulation companies that use significant percentages of recycled glass in their production processes.

Fiberglass insulation requires far more energy to manufacture than cellulose, but weighs less. Fiberglass insulation must be installed carefully, using proper precautions. A common concern with fiberglass stems from the indoor air quality problems and possible carcinogenic effects that may be caused by small glass fibers. There are few opportunities to recycle fiberglass at the end of its useful life, although fiberglass insulation batts can sometimes be reused.

Foam insulation provides excellent R-values, but expends by far the most energy in manufacture of the insulation types listed here. Products with recycled foam content reduce the overall energy expended for manufacture while providing a use for an otherwise wasted secondary resource. A number of foam insulation manufacturers recycle their own scrap and other post-industrial scrap, and at least one company recycles post-consumer foam. One problem with recycled foam insulation has been its geographically limited availability.

Some types of foam insulation, including extruded polystyrene (XPS), were originally expanded using CFCs. Most of these manufacturers are now shifting to HCFCs, which reportedly have less than 5% of the effect on the ozone than the CFC standard had. One manufacturer listed here uses HFC-134a, which contains no chlorine, and has “Zero Ozone Depletion Potential.” By contrast, expanded polystyrene (EPS) foam is usually expanded with carbon dioxide in a CFC-free manufacturing process. Entries for foam insulation appear in the fourth section of this chapter.

Other resource efficient or recycled insulation options exist, and a selection of alternatives appears in the last section of this chapter. Cementitious foam insulation is respected for the indoor air quality it promotes. A relatively new insulation product utilizes recycled cotton textile scrap to produce a batt insulation with performance similar to that of fiberglass, yet without some of the concerns associated with fiberglass.

Center for Resourceful Building Technology
The first section of this chapter lists recycled-content ventilation baffles. Ventilation baffles are usually installed between the roof rafters, spanning from eaves to vent, before insulation is applied. The baffles create a channel for air to flow in the roof cavity, in order to remove problematic moisture buildup. Ventilation also helps to keep the roof cool and thereby extend the life of roofing materials.

### Ventilation Baffles

**ADO Products**  
7357 Washington Ave.  
Edina, MN 55439  
(800) 666-8191  
(612) 943-2190  

Attic ventilation chutes made from recycled high-density polyethylene.  
**Applications:** For retrofit and new construction.  
**Sizes:** 48" long, in widths of 11", 14" and 22". Provides vent channel of 1 4"  
**Comments:** These rigid ventilation chutes are installed with staples, and will not break during nor dislodge after installation, or deform when exposed to moisture.  

**Insul-Tray, Inc.**  
E. 1881 Crestview Drive  
Shelton, WA 98584  
(206) 427-5930  

Water-resistant corrugated cardboard panels made from recycled mixed waste paper.  
**Applications:** Panels are designed to be stapled into walls, ceilings, and floors to form cavities that can be filled with blown-in cellulose insulation.  
**Sizes:** 4' long, 200# test.  
**Fire Rating:** Panels have a Class 1 fire rating.  
**Comments:** These baffles are designed to be used with recycled cellulose insulation.

### Cellulose Insulation

**All-Weather Insulation Co., Inc.**  
5309 Barnestown Rd.  
Springfield, KY 40069  
(606) 336-3931  

**Applications:** For retrofit and new construction.  
**Sizes:** 4' long, 200# test.  
**Fire Rating:** Panels have a Class 1 fire rating.  
**Comments:** These baffles are designed to be used with recycled cellulose insulation.

**American Environmental Products**  
P.O. Box 38  
Elkwood, VA 22718  
(800) 489-5565  
(703) 825-8000  

**American Insulation, Co.**  
P.O. Box 91  
Bloomer, WI 54724  
(715) 568-3898  
(800) 633-3179  

**Applegate Insulation Manufacturing**  
P.O. Box 292  
Okemos, MI 48805  
(517) 349-0466  

**Arctic Insulation, Inc.**  
1218 North 11th Ave.  
Greeley, CO 80631  
(970) 353-2392  

**Bonded Insulation Company, Inc.**  
P.O. Box 337  
Hagaman, NY 12086  
(518) 842-1470  

**CAN-CELL Industries, Inc.**  
16335-130 Ave. N.W.  
Edmonton, AB T5V 1K5 Canada  
(403) 447-1255  

**Cell-Pak Inc.**  
P.O. Box 1023  
Decatur, AL 35602  
(205) 350-3311  

**Cellin Manufacturing, Inc.**  
Elkwood, VA  
(703) 825-8000  
(800) 825-5565  

**Central Fiber Corporation**  
4814 Fiber Lane  
Wellsville, KS 66092-0749  
(913) 883-4600  
(800) 654-6117  

**Champion Insulation**  
301 Pleasant Hill Ave.  
Lomira, WI 53048  
(414) 269-4311  

**Chayville Insulation**  
P.O. Box 713  
Burley, ID 83318  
(208) 678-9791  

**Energy Control, Inc.**  
P.O. Box 327  
Ossian, IN 46777  
(219) 622-7614
### Guide to Resource Efficient Building Elements

#### Energy King
14235 SE 98th Court  
Clackamas, OR 97015  
Ph: (503) 653-5000

#### Energy Zone Manufacturing, Inc.
Buffalo, MN 55313  
(612) 682-5755

#### Fiber Master/ ThermoCon
P.O. Box 1712  
Monroe, LA 71210  
(318) 323-1337

#### Fiberwood, Incorporated
5854 88th St.  
Sacramento, CA 95828  
(916) 387-9754

#### Hamilton Manufacturing, Inc.
118 Market Avenue  
Twin Falls, ID 83304  
(208) 733-9689

#### IN-CIDE TECHNOLOGIES, Inc.
50 N. 41st Ave.  
Phoenix, AZ 85009  
(602) 233-0756

#### IN-CIDE Insulation Manufacturers:

<table>
<thead>
<tr>
<th>Company Name</th>
<th>Address</th>
<th>Phone Numbers</th>
</tr>
</thead>
<tbody>
<tr>
<td>American Cellulose Manufacturing, Inc.</td>
<td>Rte. #1 Box 162, Minook, IL 61760</td>
<td>(309) 432-2507</td>
</tr>
<tr>
<td>CraftMaster</td>
<td>Allentown, PA</td>
<td>(215) 264-7541</td>
</tr>
<tr>
<td>Nu-Woll Insulation</td>
<td>2472 Port Sheldon Rd., Jenison, MI 49428</td>
<td>(616) 669-0100</td>
</tr>
<tr>
<td>P.K. Insulation Mfg. Co.</td>
<td>Box 281, Joplin, MO 64802</td>
<td>(800) 641-4296</td>
</tr>
<tr>
<td>Suburban Insulation</td>
<td>Hagerstown, MD 21740</td>
<td>(301) 791-7360</td>
</tr>
<tr>
<td>Tennessee Cellulose</td>
<td>Limestone, TN</td>
<td>(615) 257-2051</td>
</tr>
<tr>
<td>Insul-Mor Manufacturing, Ltd.</td>
<td>Oregon, IL 61061</td>
<td>(815) 732-7973</td>
</tr>
<tr>
<td>International Cellulose</td>
<td>P.O. Box 45006, Houston, TX 77245-0006</td>
<td>(713) 433-6701</td>
</tr>
<tr>
<td>Louisiana-Pacific</td>
<td>Fenton, Missouri</td>
<td>(314) 343-9103</td>
</tr>
<tr>
<td>Notes:</td>
<td>Louisiana-Pacific also manufactures cellulose insulation to meet iN-Cide Technologies specifications. They are two separate products.</td>
<td></td>
</tr>
<tr>
<td>Modern Insulation Inc.</td>
<td>P.O. Box 157, Spencer, WI 54479</td>
<td>(715) 659-2446</td>
</tr>
<tr>
<td>Mountain Fiber Insulation</td>
<td>P.O. Box 337, Hyrum, UT 84319</td>
<td>(801) 245-6081</td>
</tr>
<tr>
<td>Northern Insulation Products</td>
<td>Gibbon, MN 55335</td>
<td>(507) 834-6519</td>
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<tr>
<td>ParPac</td>
<td>4545 E. 56th Ave., Commerce City, CO 80022</td>
<td>(800) 850-8505</td>
</tr>
<tr>
<td>Perma Flake Corporation</td>
<td>Greenville, MS 38701</td>
<td>(601) 334-9852</td>
</tr>
<tr>
<td>Redi-Term Insulation Inc.</td>
<td>3061 South, 3600 West, Salt Lake City, UT 84119</td>
<td>(801) 972-6551</td>
</tr>
<tr>
<td>Regal Industries</td>
<td>Route 1, Box 46, Crothersville, IN 47229</td>
<td>(812) 793-2214</td>
</tr>
<tr>
<td>Southern Cellulose</td>
<td>6057 Boat Rock Blvd., Atlanta, GA 30336</td>
<td>(800) 666-3590, (404) 344-3590</td>
</tr>
<tr>
<td>Suncoast Insulation Manufacturing Co.</td>
<td>7102 N 30th St., Tampa, FL 33610</td>
<td>(813) 238-0486</td>
</tr>
<tr>
<td>Tascon, Inc.</td>
<td>7607 Fairview St., Houston, TX 77041</td>
<td>(713) 937-0900</td>
</tr>
<tr>
<td>Thermoguard Insulation Co.</td>
<td>451 Charles St., Billings, MT 59101</td>
<td>(800) 821-5310, (800) 252-1938</td>
</tr>
<tr>
<td>-or-</td>
<td>North 125 Dyer Rd., Spokane, WA 99212</td>
<td>(800) 541-0579</td>
</tr>
<tr>
<td>Thermo-Kool of Alaska</td>
<td>P.O. Box 230085, Anchorage, AK 99523</td>
<td>(907) 563-3644</td>
</tr>
<tr>
<td>Thermo-Pak Mfg., Inc.</td>
<td>P.O. Box 115, Vergas, MN 56587</td>
<td>(800) 627-5190</td>
</tr>
<tr>
<td>United Fibers</td>
<td>4280 Iowa St., Unit J, Benicia, CA 94510</td>
<td>(707) 746-5060</td>
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**Center for Resourceful Building Technology**

**Insulation**
Mineral Wool Insulation

American Rockwool, Inc.
P.O. Box C
Nolanville, TX 76559
Ph: (817) 698-2233
Fax: (817) 698-2234

Loose-fill fiber insulation made from mineral slag.

Applications:
Can be blown into any area that requires insulation, such as between ceiling joists, cross bracings, truss bracing and other uneven spaces difficult to insulate with batt insulation.

R-value:
Ranges between R-3.89 and R-4.15 per inch.

Fire Rating:
Flame spread of 10 smoke density of 10.

Comments:
Contains no asbestos, cellulose, or phenols. It is noncombustible, noncorrosive, permanent, odor free, will not absorb moisture, nor support mildew or fungus. Will not rot, decay, or break down.

FIBREX Inc.
P.O. Box 1148
Aurora, IL 60507
(708) 896-4800
(800) 342-7391

Insulation blankets made from 92% recycled rock wool fiber from mineral slag—a waste by-product from the production of steel.

Applications:
These insulation blankets are designed to fit between exterior or interior wall studs for sound and thermal insulation.

R-value:
R-4 per inch.

Density:
2.0 pounds per cubic foot.

Fire Rating:
Class A. Composed of inorganic, non-flammable materials with a high melting point of 2000° F

Comments:
These insulation blankets reduce air flow leaks within walls. Chemical and asbestos-free. Very effective for reducing sound inflation.

Roxul, Inc.
551 Harrop Dr.
Milton, ON L9T 3H3, Canada
(800) 265-6878

Mineral wool insulation made from volcanic rock and recycled steel slag.

Applications:
Provides thermal and sound insulation, is available in batt and board forms.

R-value:
5 1/2" of mineral wool insulation is R-21.5.

Sizes:
Product is available in various types, configurations and sizes.

Fire Rating:
Mineral wool has high resistance to fire, and can withstand temperatures in excess of 1832° C without melting.

Comments:
Mineral wool insulation is lightweight, consisting of 1% fibers and 99% air.

Fiberglass Insulation

CertainTeed Corporation
Insulation Group
P.O. Box 860
Valley Forge, PA 19482
(610) 341-7739
(800) 523-7844

Fiber glass batts made with 5% pre-consumer and 20% post-consumer recycled glass.

Applications:
Designed for application in walls and ceilings and floors.

R-value:
R-3.0 to 4 per inch.

Sizes:
Available in a variety of thicknesses and widths, in rolls and batts.

Fire Rating:
Can be installed to achieve 1-hour and 2-hour fire ratings.

Comments:
Contains some recycled material. Ask for Insulation Group to find information on regional manufacturers.

Owens Corning Fiberglas Canada, Inc.
4100 Yonge St.
Willowdale, ON M2P 2B6, Canada
(416) 733-1600

Baseclad™ rigid glass fiber board insulation.

Applications:
Baseclad is an exterior insulation for foundations.

R-value:
2" thick Baseclad is R-8.5, 3" is R-13.

Sizes:
2" or 3" thicknesses in 48" x 96" sheets.

Comments:
Owens Corning Fiberglas Canada uses 35% post-industrial recycled glass in their manufacturing operations. Baseclad serves as an alternative to rigid foam for foundation perimeter insulation.
Ottawa Fibre, Inc.
Box 415, R.R. 4
Ottawa, ON K1G 3N2
(613) 736-1215
Fiberglass insulation products utilizing recycled glass.

Applications:
Residential batts, rolls, and noise control, semi-rigid and rigid boards, ceiling tiles, blankets, exterior sheathing.

R-value:
Varies by product from R-3.3-4.4 per inch.

Sizes:
Various thicknesses and sizes, depending on product.

Fire Rating:
Conforms to Canadian standards.

Comments:
These fiberglass insulation products include all colors of post-consumer recycled glass. The insulation averages 75% recycled content, which is a very high percentage for fiberglass.

Amoco Foam Products
375 Northridge Road, Suite 600
Atlanta, GA 30350
(800) 241-4402
(312) 241-4402
Amofoam®-RCY extruded polystyrene insulation board with a minimum of 50% recycled polystyrene content.

Applications:
Can be used on perimeter foundations, cavity walls, slab-on-grade, and exterior sheathing.

R-value:
R-5.0 per inch.

Sizes:
Available in 2' x 8' or 4' x 8' sheets in thicknesses of 1", 1 1/2", and 2".

Fire Rating:
Flame spread rating of 10, and smoke developed rating of 60-100.

Comments:
The recycled polystyrene content is a blend of post-consumer and pre-consumer. This product is foamed with HCFCs rather than CFCs, to reduce the potential for ozone depletion.

Schuller International, Inc.
717 17th Street
Denver, CO 80202
(800) 654-3103
(303) 978-2785
Fiberglass insulation batts with 20% recycled glass content.

Applications:
For residential and commercial use.

R-value:
R-3.0 to 3.3 per inch.

Sizes:
Available in batts, blankets, insulating boards, as well as loose fill.

Fire Rating:
Depends upon insulation type and installation method.

Comments:
15% post consumer re-melted bottle glass.

Environmentally Safe Products, Inc.
313 W. Golden Ln.
New Oxford, PA 17350
(800) 289-5693
(717) 624-3581
Low-E and Micro-E Insulation™ made of polyethylene foam bonded to two exterior faces of pure polished aluminum.

Applications:
For installation anywhere traditional insulation would be used. Improves the performance of mass insulation when installed in conjunction. Low-E and Micro-E block convective currents and provide a barrier against air and vapor infiltration.

R-value:
Horizontal R-7.75, Up R-7.55, Down R-10.74.

Sizes:
Low-E is 1/4" thick, Micro-E is 1/8" thick. Both come in 16" o.c. with tabs x 75', 24" o.c. with tabs x 100', or 4' x 125'.

Fire Rating:
Flame spread rating 0, and smoke developed rating 20.

Comments:
Polyethylene foam contains up to 40% pre-and post consumer recycled foam. Post consumer component comes from plastic milk jugs. Low-E stops 97% of radiant energy transfer.

Celfortec
C.P. P.O. Box 310
Valleyfield, PQ J6S 4V6, Canada
(514) 377-1725
Celfort Codeboard extruded polystyrene insulation in rigid board form. Board is extruded using HCFCs and the company adheres to the Montreal Protocol.

Applications:
Insulation can be used in foundation, wall and roof applications.

R-value:
R-5 per inch.

Sizes:
2' x 8', 4' x 8' and 4' x 9' pieces in thicknesses from 1" to 4".

Fire Rating:
Fire codes require 1/2" gypsum wallboard covering interior surfaces of insulation.

Comments:
The company regrinds and reuses their own scrap, and purchases scrap from other manufacturers. Recycled polystyrene constitutes 6% of the manufacturer's total consumption. This use of insulation allows construction of an R-20 wall with 2 x 4 studs rather than 2 x 6 studs.

Foam-Tech
P.O. Box 87, Route 5
North Thetford, VT 05054
(802) 333-4333
Supergreen™ Foam and Class II closed cell polyurethane foam insulations. Field applied.

Applications:
New and retrofit wall, roof and foundation insulation, providing insulation value, vapor resistance, structure and infiltration control.

Environmentally Safe Products, Inc.
313 W. Golden Ln.
New Oxford, PA 17350
(800) 289-5693
(717) 624-3581
Low-E and Micro-E Insulation™ made of polyethylene foam bonded to two exterior faces of pure polished aluminum.

Applications:
For installation anywhere traditional insulation would be used. Improves the performance of mass insulation when installed in conjunction. Low-E and Micro-E block convective currents and provide a barrier against air and vapor infiltration.

R-value:
Horizontal R-7.75, Up R-7.55, Down R-10.74.

Sizes:
Low-E is 1/4" thick, Micro-E is 1/8" thick. Both come in 16" o.c. with tabs x 75', 24" o.c. with tabs x 100', or 4' x 125'.

Fire Rating:
Flame spread rating 0, and smoke developed rating 20.

Comments:
Polyethylene foam contains up to 40% pre-and post consumer recycled foam. Post consumer component comes from plastic milk jugs. Low-E stops 97% of radiant energy transfer.
R-value:
   "Aged" R-6.7 per inch.
Fire Rating:
   Flame spread 25, smoke development 15, smoke developed 155-250.
Comments:
   Supergreen Foam uses HFC-134a, which contains no chlorine, as a blowing agent. Because it is field applied by company representatives, this insulation is available only in Northern New England.
Icynene, Inc.
376 Wateline Ave.
Mississauga, ON L4Z 1X2, Canada
(905) 890-7325
   Urethane spray foam insulation, expanded with CO₂, applied on site by certified contractors.
Applications:
   Can be sprayed onto flat surfaces or injected into encased spaces. Icynene is usually installed in open wall cavities of new construction.
R-value:
   R-3.6 per inch.
Fire Rating:
   Zero flame spread, zero fuel contribution.
Comments:
   Icynene is unusual among urethane insulations in that it is not expanded with ozone-layer-depleting CFC or HCFC, but instead with CO₂. The resulting foam is soft, rather than stiff like other plastic foams. Once a cavity has been sprayed full of insulation, excess insulation is scraped off flush with the surface of the studs. At present this excess insulation is not recycled, causing the Icynene product to have significant potential for production of job-site waste that decreases its overall resource efficiency.
Palmer Industries, Inc.
1061 Old Annapolis Rd.
Frederick, MD 21701
(301) 898-7848
   Airkrete®, an ultralight cementious foam insulation with cellular structure.
Applications:
   Designed for installation in cavity fill applications. Can be installed in any cavity through a 1 1/2" to 3" diameter hole. Can be used in both new and existing masonry block, wood or steel stud construction. In new construction, foam is troweled into open stud cavities.
R-value:
   R-3.9 per inch at standard installed density of 2 pounds per cubic foot.
Fire Rating:
   Zero flame spread, zero fuel contribution.
Comments:
   Airkrete® is 98% inorganic, chemically stable, and contains no formaldehyde or asbestos. It has good acoustical absorbance, but will not support compressive loads at "standard" density. This insulation is often recommended by "healthy house" builders for its promotion of good indoor air quality.

Other Insulation Products

American Sprayed Fibers Inc.
1550 E. 91st Drive
Merrillville, IN 46410
(800) 824-2997
(219) 769-0180
   Dendamix™ spray-applied fireproofing made from a mixture of recycled paper, stone and plastic. Sound-Pruf™ spray-applied acoustical insulation made from rock wool and cellulose and a liquid adhesive.
Applications:
   Both can be applied directly to steel, wood, concrete, and other surfaces. Primarily used for commercial and industrial applications.
R-value:
   Both products, R-3.0 to 3.5 per inch.
Fire Rating:
   Both products, flame spread 5 and smoke developed 5.
Comments:
   These products contain no asbestos or corrosive materials. They are non-toxic and do not support the growth of bacteria or fungus.

Greenwood Cotton Insulation Products, Inc.
P.O. Box 1017
Greenwood, SC 29648
(800) 546-1332
   Kraft-faced batts and loose fill insulation made from recycled cotton textile scrap.
Applications:
   Residential and commercial construction, for use in walls or attics.
R-value:
   R-3.1 per inch
Sizes:
   Available in blow-in form. Batt insulation is available in 15", 16", 23" and 24" widths, in thicknesses from 2 1/2" to 12".
Fire Rating:
   Paper-faced batts are Class C, Type II.
Comments:
   Greenwood Cotton Insulation is biodegradable and requires little energy to produce. Gloves are not required for installation and the insulation does not cause itching.

Huertas Fiberboard, Inc
E. Morgan St., P.O. Box 167
Boonville, MO 65233
(316) 882-2704
   Two wood-fiber roof insulation boards, made from 15% recycled magazines and newspapers, and 85% waste mill wood chips.
Applications:
   Both of these insulation boards are recommended for use on flat roofs.
R-value:
   Roof Insulation Board R-2.78 per inch. High Density R.I. PLUS R-1.25 per inch.
Sizes:
   Roof Insulation Board in 2' x 4', 4' x 4' and 4' x 8' sheets in thicknesses of 1/2", 3/4" and 1" (solid), and laminated thicknesses of 1 1/2" and 2". High Density R.I. PLUS roof insulation available in 1/2" thick, 2' x 4' sheets.
Fire rating:
   Not specified. Should not be exposed to open flame.
Comments:
   These products are designed to be used in conjunction with single-ply membrane systems that require a Class E underlayment.
**International Permalite, Inc.**
300 N. Haven Ave.
Ontario, CA 91761
(909) 983-9591
(800) 858-8868

Tapered roof insulation boards made from expanded perlite, recycled cellulose binders, and waterproofing.

**Applications:**
For new and re-roof applications on flat roofs. Can be used to protect foam and soft roof insulation materials from a top coat of hot asphalt.

**R-value:**
2.78 per inch.

**Sizes:**
Standard size is 2' x 4'. Available in eight thicknesses (averaged over width of tapered board) from 3/4" to 4". Available with slopes of 1/16", 1/8", 3/16", 1/4", and 1/2" per foot.

**Fire Rating:**
Class A

**Comments:**
Finished system is ready for application of bituminous roofing. The lightweight and recycled content of this system offer a resource efficient approach to flat roof insulation.
Windows & Doors

Windows have always lowered the thermal efficiency of even the best-insulated wall. Poor installation and the low insulative value of the window glass and frame combined to make windows a net heat loser in cold climates, and an unwanted heat gainer in warm climates. Fortunately, vast strides have been made in window technology during the past decade. Windows are now available that can provide a net solar gain where heating is desired or prevent heat gain in cooling-dominated climates. Research is underway on even more advanced windows, but many high-performance window systems are already commercially available, and experiencing ever-increasing usage.

Current technology combines insulative frames, multiple glazings, gas filling, thermal break spacers and window coatings to dramatically improve the thermal performance of windows. Double-pane glass windows with low-emissivity (low-E) films are becoming common. Argon, an inert gas, is often used between panes for lowered conductivity and increased R-value. The combination of argon with double low-E films can produce center-of-glass R-values of R-8.

This chapter includes manufacturers of window film treatments which greatly enhance the thermal efficiency of window glass. Different types of glazing and films are available for different applications, and selecting windows appropriate for the climate and orientation of a building can dramatically reduce heating and cooling bills. Even if a building is not a "solar" design, it makes good energy sense to design window placement and create window specifications with thermal performance in mind.

As window glazings become more efficient, proportionally more energy is lost through the frame. New types of low-conductivity window glass spacing, called "thermal break spacers," help to improve the thermal efficiency at the window edge by interrupting heat conduction across the frame. This raises the overall R-value of the window. Thermal break spacers are available by request in the product lines of several major window manufacturers. It is important to consider the overall or "unit" R-value, rather than just the center-of-glass value, when selecting windows. The best readily available windows may be R-4 to R-5.

Traditionally, the finest clear-grained wood has been used for doors and window frames. Wood products such as these can weather the elements fairly well if properly primed, painted, treated and maintained. However, the availability of clear heartwood lumber has declined in recent years, with a resultant increase in cost. The window and door manufacturing industry has responded by using substrates of finger-jointed pine or edge-glued scraps of lower value wood, and putting high-value veneers on the finish surface. A few companies are using wood composites of scrap fiber and resin in window frames. These options are
becoming more common as good wood becomes scarce. Metal, vinyl or fiberglass clad wood window frames are becoming increasingly popular as a way to enhance the durability of wood without sacrificing its aesthetic appeal. Although all of these methods make more efficient use of wood, they still have a relatively low thermal efficiency.

Wood window frames are usually chemically treated to resist moisture and rot. The wood preservatives commonly used in windows can pose a health concern for some chemically sensitive individuals, and can cause environmental damage in large quantities.

Like wood and clad wood, aluminum window frames have relatively low thermal efficiency. They are durable, but, like any aluminum product, require enormous energy to produce. Another option is fiberglass window frames. Insulated fiberglass frames are much less conductive than metal or wood, and provide improved thermal performance. A new generation of fiberglass frames combines fiberglass and wood to achieve both weather resistance and the appearance of wood. This chapter lists fiberglass and wood composite frame windows.

Vinyl windows are another option. Vinyl is less conductive than metal, but is not as durable. Vinyl windows are pre-finished, and the extrusion process for vinyl requires less energy than production of other window frames. At the same time, some environmental groups recommend against the use of vinyl due to concerns about the chlorine content and the processes used in production of PVC. Vinyl windows are produced by a number of national manufacturers, and are readily available.

For doors, fiberglass or metal skins provide a durable alternative to wood faces made from clear-grain heartwood found only in old-growth hardwood and softwood trees. The lightweight foam cores available in exterior fiberglass and steel doors provide good insulation. Most of the fiberglass door skins available today replicate the texture of traditional solid wood doors. Doors with composite wood fiber skins are also available. Most doors, including those with metal or fiberglass skins, contain wood stiles and rails, and may also contain a wood-fiber core. This chapter lists manufacturers of wood composite interior doors, and fiberglass and metal entry doors.

Because most of the heat that is lost through exterior doors is from air leakage, energy efficiency can be improved by choosing entry doors that are pre-hung with compression-type or magnetic weather-strips. Following recommended installation procedures can also help to prevent poorly-fitted doors that allow air leakage.
Castlegate Entry Systems
911 E. Jefferson St. P.O. Box 76
Pittsburg, KS 66762
(800) 835-0364
Fiberglass entry doors and patio doors with foamed-in-place polyurethane core.
Styles:
- Oak woodgrain in stile-and-rail pattern
- Wide selection of styles and finishes
- Glass available in ice crystal, beveled, tinted, and romantic old vintage styles.
Comments:
- Neutral surface color ready for oil base stain or paints.
- A durable alternative to a solid wood door.

Georgia-Pacific
P.O. Box 105605
Atlanta, GA 30348-5605
(404) 652-4000
Grand Passage® exterior doors and coordinated sidelites. In wood textured fiberglass or with steel shell.
Styles:
- Various sizes and designs with decorative or clear glass.
- Six panel, seven panel and flush styles available.
- Steel doors are paintable, and fiberglass are paintable or stainable.
Comments:
- These doors have polyurethane foam cores with wood stiles and rails. The R-value is 5 to 6 times that of a wood door. The company claims.

Jeld-Wen
P.O. Box 1329
Klamath Falls, OR 97601-0268
(800) 877-9482
(800) 535-3936
Elite® molded wood fiber doors, with 1/8" composite wood fiber skins over a variety of frames including medium density fiberboard, solid core particleboard, and laminated veneer frame with polyurethane core.
Challenger® insulates steel entry doors.
Styles:
- Passage doors, bifold doors, narrow doors, and exterior doors, in standard sizes.
- Choice of finish textures; door arrives primed, ready for paint or stain.
Comments:
- Process uses heat and pressure to bond door skin and frame together to prevent delamination and warping. Molded doors have a five-year warranty. Steel doors have polyurethane core and one to five-year warranty.

Marvin Windows and Doors
Warroad, MN 56763
(800) 862-7587
Integrity™ wood and Ultrex™ fiberglass pultrusion frame windows.
Styles:
- One-, two-, and three-wide case-
- ments, awnings and pictures, as well as bows, bays and multiples.
- In white or gray baked-on finish.
Comments:
- The Fibron frames can be painted and will not rot, warp, corrode, shrink, or swell.

Notes Corning Fiberglass Co.
Fiberglass Tower
Toledo, OH 43659
(419) 248-8000
(419) 248-6089
A complete line of windows including Fibron™ fiberglass-frame and sash filled with fiberglass insulation.
Styles:
- Double-hung, picture, casement, and awnings. Come with standard double-pane insulating glass, with low-E and gas-fill windows.
Comments:
- A durable alternative to a solid wood door. The steel skins are made with a high percentage of recycled metal. Peachtree utilizes AERT's Moistureshield™ substrate material (see Miscellaneous) for subsills and bottomrails.

Peachtree Doors, Inc.
Box 5700
Norcross, GA 30091-5700
(800) 447-4700
(404) 732-2499
Complete line of polyurethane-core doors and windows with fiberglass or steel skins.
Styles:
- Leaded glass options for sidelites and transoms.
Comments:
- A durable alternative to a solid wood door. The steel skins are made with a high percentage of recycled metal. Peachtree utilizes AERT's Moistureshield™ substrate material (see Miscellaneous) for subsills and bottomrails.

Henry Industries, Inc.
7100 Dixie Hwy.
Fairfield, OH 45014
(800) 883-6677
(513) 870-3600
Fiberglass door systems with a solid polyurethane core and adjustable sill. Insulated steel entry doors.
Styles:
- A variety of styles and sidelite designs available. Single or double doors.
- Fiberglass are wood grain; steel are smooth finish.
Comments:
- A durable alternative to a solid wood door. These doors and entry systems can be stained or painted. Steel door has wood stiles and rails.
Guide to Resource Efficient Building Elements

Simpson Door Company
P.O. Box 210
McCleary, WA 98557
(360) 495-3291
Advent collection composite wood exterior and interior doors.
Styles:
Interior doors in several face styles, 2' to 3' 6" wide and to 8' tall. Exterior doors in several face styles, 2' 6"-3' 6" wide and to 8' tall.
Comments:
Doors have a wood veneer skin over a substrate of 95% preconsumer wood residue in a 3/4" composite panel.

Southwall Technologies
1029 Corporation Way
Palo Alto, CA 94303
(800) 365-8794
(415) 962-9111
Manufacturers of Heat Mirror™ clear, colorless insulating glass with Heat Mirror suspended film.
Styles:
Heat Mirror is available in six different performance categories, geared to different climates. Also available in a variety of glass types and colors.
Comments:
Heat Mirror is manufactured by 28 companies across North America, and available from several major window makers. Southwall Technologies also produces the HeatSeal Thermal Break Spacer, and XIR® Solar Control Window Film, a clear retrofit film which reflects heat while passing visible light.

Suntek
6817A Academy Pkwy. East
Albuquerque, NM 87109
(505) 345-4115
Window film which turns reflective white when temperature activated, to block 90% of solar heat.
Styles:
On-demand or passive, with transition temperatures set anywhere between 60°F and 150°F in widths up to 4'.
Comments:
For skylights, greenhouses, and non-view windows. Film turns clear when temperature drops. Illumination through window stays at a nearly constant level, and is always diffuse.

Taylor Perma-Door
P.O. Box 457
West Branch, MI 48661
(800) 842-3667
Fiberglass doors with a composite core of insulative urethane and a honeycomb substrate.
Styles:
Available in 6 and 9 panel styles with variety of sidelite, transom, and lite options.
Comments:
These doors can be stained or painted and have a 25-year warranty.

Therma-Tru Corporation
P.O. Box 8780
Maumee, OH 43537
(800) 537-8827
(419) 882-5625
Fiber-Classic™ compression-molded fiberglass entry door systems with solid polyurethane insulating core. Classic-Craft™ compression-molded composite skins with Oakover jambs. Also insulated steel doors.
Styles:
A variety of styles with sidelites framed in zinc or brass leading.
Comments:
These doors and entry systems come with a limited 25-year warranty. Available with a wood grain pattern that is easy to paint or stain.

Wenco Windows
P.O. Box 1248
Mt. Vernon, OH 43050-8248
(800) 458-8227
(614) 397-1144
Eliminator-PF double hung window with Werzalit® wood fiber and resin composite frame and UltraGlass™ insulated glass. All Wenco JX-7® series windows have Werzalit sills.
Styles:
Variety of styles, sized to fit rough openings from 1' 10" x 3' 11 1/2" to 5' 2" x 5' 5 1/2".
Comments:
Eliminator-PF comes with a prefinished exterior in white, beige, or earth tone. Prefinished interior sash replicates ponderosa pine look. No need for paints or stains. 2 1/2 times the insulation value of wood sash. Eliminator-PF is currently available only in Northeastern U.S.

Winter Seal Vinyl
1300 Dussel
Maumee, OH 43537
(419) 897-9500
Fiber Frame™ fiberglass patio doors and fiberglass reinforced composite windows.
Styles:
Variety of styles and custom colors.
Comments:
Fiber-Frame will not expand, contract, twist, bow, crack, rot, warp, rust or corrode. Low-E glass available in all door lites and windows.
Interior Finishes

Many alternatives to conventional interior finishing products exist. Some contain recycled materials, while other products claim to be natural or non-toxic. Recycled products on the market include paints and textural finish materials. Wallpaper made from recycled paper and wood chips is available. Acoustic ceiling tiles with recycled newsprint are a common product. Latex paint is recycled as a part of "household waste cleanup" programs in cities with aggressive recycling programs. Many companies are marketing recycled paint on a regional basis. People who live in regions without a paint recycling operation can order recycled paint direct from the larger companies listed in this chapter, for shipment to their building sites. Recycled paint was formerly offered only in limited colors and styles, but the selection is expanding, and recycled paint is generally significantly cheaper than its virgin counterpart.

This chapter also lists interior finishes and trim that extend the natural resource base by replacing clear softwood or expensive hardwoods with other materials. For example, trim can be made from fingerjointed soft lumber covered by a hardwood veneer. Non-wood trim is another option. Lightweight and refinished plumbing fixtures, and surfacing products which can be used as countertops are also listed in this chapter. Finish floor coverings can be found in the "Flooring Coverings" chapter.

Indoor finishes and accessories such as fabrics and furniture with recycled content are beyond the scope of this book, but some specialized references for them are listed at the end of this Guide.

Many people are interested in identifying "healthy" or non-toxic interior finishes that do not degrade indoor air quality. Several reference guides devoted to "healthy materials" have been published. This guide lists only those natural and non-toxic products which also meet criteria for resource efficiency, and makes no claim to evaluate the relative toxicity of products.

Center for Resourceful Building Technology
ABTco, Inc.
3250 W. Big Beaver Rd.
Troy, MI 48084-2982
(800) 521-4250
Prime Molding™, Canterbury™, Pine Plus™ and Ultra Oak® non-wood paintable and stainable trim and molding.
Applications:
Interior architectural trim and molding.
Sizes:
Many profiles available in each style.
Finish:
Paintable without sanding, priming and sealing.
Comments:
Trim is made from extruded polystyrene that is blown with H-134a, a non-CFC blowing agent. Trim is available in consistent lengths, finish and quality, so causes less waste than wood trim.

American Standard
Box 6620, 1 Centennial Plaza
Piscataway, NJ 08855
(800) 821-7700 ext. 4023
(201) 980-3000
Bathrooms and whirlpools manufactured with a porcelain enameled surface bonded to an enameling grade metal and structural composite material. The manufacturing process requires 50% of the energy required to manufacture cast iron tubs and the final product is half the weight of cast iron.
Comments:
The tub also retains water heat better than cast iron.

Armstrong World Industries
P.O. Box 3511
Lancaster, PA 17604
Ph: (717) 397-0611
Fax: (717) 396-2126
Ceiling tile made from recycled newspaper, mineral wool, perlite and clay
Applications:
For commercial and residential use.
Sizes:
12” x 12”, 24” x 24” and 24” x 48”
Fire Rating:
The tiles themselves are not rated. Approved for use in UL fire rated assembly
Comments:
This is an example of a company using recycled material in the manufacture of their product, but only recently promoting this fact, as consumers recognize that recycled products are not necessarily inferior.

Bathcrest, Inc.
2425 S. Progress Dr.
Salt Lake City, UT 84119
(801) 972-1110
Glazecote™ synthetic porcelain that chemically bonds to bathroom surfaces, giving a shiny finish.
Applications:
For bathtubs, sinks and tiles.
Colors & patterns:
In a full line of colors, and can match colors from most major lines of fixtures.
Comments:
Glazecote must be applied by a company representative. The company has franchises in many states and Canada. The process can repair finish damage or change fixtures to new colors. It presents an alternative to fixture replacement, and is warranted for 5 years.

Buchner Panel Manufacturing
1030 Quesada Ave.
San Francisco, CA 94124
(800) 483-6337
(415) 822-8540
EcoPanels, certified sustainably managed hardwood veneers over substrates of Medite II or Gridcore.
Applications:
Panels for walls, cabinet, millwork and other interior finishes.
Styles:
Maple, cherry and oak veneers, as well as other woods from certified sustainably managed forests.
Comments:
Panels with Gridcore substrate may vary in thickness up to 1mm, due to Gridcore manufacturing, and may change dimension as a result of fluctuations in atmospheric humidity. EcoPanels are an innovative product using both sustainable veneers and recycled substrates.

Contact Lumber
1881 S.W. Front Ave.
Portland, OR 97201
(800) 547-1038
A variety of jamb, molding and other trim products made from thin veneers of finish wood laminated over a core of finger-jointed lumber in the Pine-Neer® line or over softwood for the Oak-Over® line.
Applications:
Door stiles, moldings, jamb and window trim.
Sizes:
A wide variety of dimensions are available.
Finish:
Available either pre-finished or sanded and ready for finish.
Comments:
While veneers have seen much use elsewhere, these products utilize the finger-joint and composite technologies in the substrate to offer an efficient use of wood fiber. These composite trim materials do not warp or twist like solid wood.

The Green Paint Co.
P.O. Box 430
Manchaug, MA 01526
(800) 477-1992
(508) 476-1992
Recycled collected paint, reprocessed to meet or exceed standards for virgin paint.
Applications:
Variety of paint types, including urethane reinforced alkyd floor enamel, exterior oil-based primer, solid exterior oil stain, exterior latex house paint, interior latex eggshell finish and interior latex flat finish.
Colors:
Variety of colors, with samples available.
Comments:
This product is made from a minimum 90% post consumer waste. Packaging is recycled and recyclable. Paint is available in New England, or may be ordered directly from the company.

Gridcore
5963 La Place Court, Suite 207
Carlsbad, CA 92008
(619) 431-8494
Honeycomb-style panels that can be made from up to 100% recycled cellulose fibers. Panels are molded as a slurry and water is vacuumed out to produce a strong, lightweight panel.
Applications:
Gridcore has many potential applications ranging from furniture construction to interior partitions. Currently the company retails the...
Guide to Resource Efficient Building Elements

Marlite

Applications:
Major Paint Co.
Dover, OH 44622

Comments:

Colors:
A variety of colors.

Comments:
Available direct from the company

Marlite

202 Harger St.
Dover, OH 44622
(316) 343-6621

Marlite® Plank wallcovering made of engineered substrate with a melamine top coat.

Applications:
Designed for high-traffic commercial interiors.

Sizes:
1 1/2” x 24” x 36” modules, in 35 different finishes, including colors, woodgrains, and patterns.

Fire Rating:
Class C. Marlite Firetest™ plank is Class A.

Comments:
The wood fiber substrate uses a high percentage of post-manufacturing recycled wood byproducts. The finished product is more durable than drywall.

Phenix™ Biocomposites, Inc.
151 N. Gault
St. Peter, MN 56082
(800) 324-8187
(507) 931-9787

A composite building material called Environ™ made from soybean flour and waste paper.

Applications:
Can be used to make paneling, furniture, flooring, cabinets, molding, doors, and other structural or decorative components.

Sizes:
Four colors, in sheets 24 1/2” square or 4” x 48” or 36” x 72”

Comments:
Environ is colored to have the appearance of granite. It can be milled, glued, sanded and shaped in the same manner as wood. Every 22 board feet of Environ uses about one bushel of soybeans and 55 pounds of waste paper

Rasmussen Paint Co.
12655 S.W. Beaverton Road
Portland, OR 97005
(503) 644-9137

Recycled latex paint collected through Portland Metro’s household hazardous waste facility.

Applications:
Interior and exterior recommended as a primer and surface coating for residential, office and industrial uses.

Sizes:
Available in two and five-gallon buckets.

Comments:
For information on the recycling program, contact Portland Metro’s Associate Solid Waste Planner at (503) 221-1646, ext 351

Santana

P.O. Box 2021
Scranton, PA 18501
(800) 233-4701

Plastic sheets made of HDPE, consisting of virgin plastic caps on a recycled core, heat molded into one homogeneous sheet.

Applications:
Toilet compartments, shower compartments, vanity tops. Usually used in public restroom facilities.

Sizes:
1” thick sheets, preformed into products.

Colors & patterns:
A variety of solid colors and marble finishes.

Comments:
This plastic may contain 50-90% recycled materials, depending on their availability at time of manufacture. The plastic is moisture resistant and requires little maintenance.

Solomit Strawboard

26 Glomar Court
Dandenong 3175
Victoria, Australia
03-793-3088

Compressed strawboard panels reinforced with galvanized wire held in place with wire stitches. A product that puts agricultural waste fiber to good use.

Applications:
A rigid ceiling material for non-structural use in interior walls and ceilings.

Sizes:
25mm and 50mm (roughly 1” to 2”) thicknesses in a variety of widths, in lengths from 1200mm to 5000mm (roughly 4’ to 16’ 6”).

Fire Rating:
Solomit complies to the latest Australian building codes and can be used in public buildings.

Comments:
Provides R -1.24 and good sound absorption. This product creates a beautiful textured ceiling. While not readily available in the U.S., products such as this one will inevitably find a place in the market. In the near future, Solomit will be manufacturing panels out of waste thinnings of Australian plantation forests

Syndesis Studio

2908 Colorado Avenue
Santa Monica, CA 90404-3616
(310) 829-9932

Solid pre-cast lightweight cement-based Syndecrete™ products made to custom order. Production process can incorporate recycled aggregate material such as stone, wood, plastic chips and shavings to achieve custom patterns and designs.

Applications:
Counter and table tops, cabinets, bathtubs, floor tiles, stair tread and wall panels. Suitable for interior and exterior use.

Styles:
Ten standard and custom colors.

Comments:
Weighing 75 pounds per cubic foot, Syndecrete is half the weight of conventional concrete and is more resistant to potential chipping and cracking. Can be cut and tooled with common wood cutting tools.

Center for Resourceful Building Technology

Interior Finishes
Floor Coverings

This chapter lists durable, resource efficient floor coverings in a variety of textures, styles and materials. They can be used in a wide variety of interior and exterior applications, in either residential or commercial buildings.

Some floorings are produced from renewable resources. Cork flooring comes from the bark of the Cork Oak tree in the Mediterranean region, which is able to replenish its outer bark when the bark is harvested on a nine-year rotation. Cork is fire resistant, acoustical, non-allergenic, easy to install, and cork tile creates a minimum of waste during installation. Cork is lightweight, but has a comparatively high embodied energy due to the distance it must be transported before installation. Other renewable flooring products include traditional linoleum made from materials such as linseed oil, cork, jute, wood flour and pine resins. This true linoleum is very durable and abrasion resistant, and can last 40 years or more.

Mats and carpets can also be made from durable, renewable fibers such as sisal, coir, jute, seagrass, and wool. Sisal fibers are extracted from the leaves of the henequen plant which is cultivated in parts of Central and South America and Africa. Coir fibers come from tough coconut husks. Both plants are hardy species that do not require artificial fertilizers, pesticides or herbicides. Jute is an annual crop grown on the flood plains of Bangladesh and processed in that country. Seagrass grows in South China, and is considered to be the strongest grass plant.

Floor coverings with recycled content, such as the tiles and carpets listed in this chapter, also represent an efficient use of resources. Discarded resources such as waste glass from the manufacture of windshields and PET plastic from post-consumer soft-drink bottles are being reprocessed into durable and attractive flooring products. Recycled tire rubber and recycled textiles are put to good use as carpet pad. Many commercial and industrial floorings contain recycled tire rubber or tire cord. Some rubber flooring materials are suitable for exterior, as well as interior, use.

Several companies use recovered post-consumer waste PVC in industrial and agricultural flooring tiles that resist chemical damage and provide drainage. Some of the recycled-content commercial and industrial flooring products have residential applications as well. They may be used for exercise rooms, laundry rooms, entryways or for exterior stairs and outdoor walkways.

We encourage reuse of materials for as many components of the home as feasible, and floors present a fine opportunity to reuse wood. It is possible to create a beautiful wood floor without using virgin old-growth timber or increasingly rare hardwoods. Used wood flooring can be recovered from remodeling and demolition projects in local communities, or purchased from one of the companies listed in the Salvaged Materials chapter.
Jute, Cork, Sisal, Coir & Linoleum

Dodge-Regupol
P.O. Box 989
Lancaster, PA 17608-0989
(717) 295-3400
(800) 322-1923
Cork flooring tiles.
Applications:
Residential and commercial use.
Sizes:
Thicknesses of 3/16" or 5/16"
Colors & Patterns:
Available in shades and finishes such as polyurethane or wax coated.
Comments:
Cork is a renewable resource.

Eco - Container Corporation
14651 Ventura Blvd, Suite 340
Sherman Oaks, CA 91403
Ph: (800) 327-3060
Fax: (818) 788-9844
Jute rugs and carpets. Non-toxic dyes.
Applications:
For commercial and residential use.
Sizes:
Many thicknesses and sizes available.
Comments:
The dyes used in the carpets and rugs are supplied by members of the Ecological and Toxicological Association of Dyestuffs Manufacturers.

EX: Inc.
400 East 56th St.
New York, NY 10022
(212) 758-2593
A variety of cork products.
Applications:
Wall and floor tile underlayment and soundproofing.
Sizes:
Vary by product. Tile is available in a number of sizes.
Colors & Patterns:
Tiles come in many of textures, and in natural finish or ecological varnish.
Comments:
EX: Inc is the export office for a consortium of Sardinian cork producers.

Fibreworks
1729 Research Dr.
Louisville, KY 40299
(800) 843-0063
(502) 499-9944
Sisal floor and wallcoverings, with no backing.
Applications:
Covers problem or rough surfaces including concrete block.
Sizes:
In widths of 4' or 8', length 100'
Colors & Patterns:
Available in 19 colors.
Comments:
Sisal is a durable covering good for high use areas.

Forbo North America
P.O. Box 667
Hazelton, PA 18201
(800) 233-0475
(717) 459-0771
Linoleum flooring.
Applications:
Recommended for industrial (due to its durability) as well as residential use.
Sizes:
Available in 79" x 105" rolls in thicknesses of 8/10", 1/10" and 1/8"; or 1/10" thick tiles in two sizes, 12" x 12" and 24" x 24"
Colors & Patterns:
Lightly marbleized patterns in 36 colorations.
Comments:
Linoleum has a very long life span - it is often referred to as a "40-year floor" - and resists indentation, abrasions and cracking.

Hendricksen Natürlich Flooring
6761 Sebastopol Avenue, Suite 7
Sebastopol, CA 95472-3805
(707) 829-3959
Natural linoleum and cork flooring. Sisal, jute and seagrass rugs and carpets.
Applications:
Virtually all areas of the home, or commercial use.
Sizes:
Available in standard sized rolls.
Colors & Patterns:
Many textures, colors & patterns.
Comments:
A variety of durable natural fiber floor coverings, with low toxicity

IpoCork
1280 Roberts Blvd. Suite 403
Kennesaw, GA 30144
(404) 421-9567
(800) 828-2675
Vinyl covered cork tiles.
Applications:
Residential and commercial.
Sizes:
Comes in standard 12" x 12" tiles and 3" x 36" planks, with custom sizes available by special order.
Colors & Patterns:
No two tiles are identical in pattern or color. Pieces may vary slightly in tone and grain configuration, and should be mixed or shuffled to achieve desired floor pattern.
Comments:
Very strong, resilient, and comfortable. Should not be installed where excess moisture is expected.

Ceramic Tile

Metropolitan Ceramics
P.O. Box 9240
Canton, OH 44711-9240
(216) 484-4887
Quary tile made from recycled in-house materials that would normally be waste. #814 Ironrock Special and #81X Ironrock Special X , with granular iron slip resistant additive.
Applications:
Indoors or out, in any climate.
Sizes:
Nominal 8" x 8" x 1/2".
Comments:
This product is not listed in the company catalog because it is a non-standard color, but it is first-grade quality. This is not the same product as their standard line.
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Summitville Tiles, Inc.
Summitville, OH 43962
Ph: (216) 223-1511
Fax: (216) 223-1414

Four styles of impervious glazed porcelain pavers made from a by­product of feldspar mining.

Applications:
Suitable for heavy traffic areas in commercial and residential settings, indoors or out.

Sizes:
8" x 8" and 12" x 12" squares in thickness of 5/16". One style is available in 2" x 2", 3" x 3", 2" x 4" and 4" x 4" sizes.

Colors & Patterns:
Eleven colors available in solid and granite-like patterns.

Comments:
Summitville has created a manufacturing system that reuses 100% of its own solid wastes.

Terra-Green Technologies, Inc.
Stoneware Division
1650 Progress Drive
Richmond, IN 47374
(317) 935-4760

Durable, glass bonded Traffic Tiles™ that are made with glass recycled from the auto windshield manufacturing process. Comprised of over 70% recycled glass, Traffic Tiles are an innovative use of a very specific waste material. Their Craftsman Line also incorporates recycled glass and scrap tile.

Applications:
Interior or exterior floors and interior walls. Installed like any standard ceramic tile.

Sizes:
Traffic Tiles™ 3/8" thick in nominal 4" x 4", 4" x 8", 6" x 6" and 8" x 8" sizes. Trim pieces are also available. Craftsman Line 1/2" thick.

Colors & Patterns:
Nineteen colors available in Traffic Tiles™, an additional ten in Craftsman Line.

Comments:
These tiles are freeze/thaw proof, fully vitrified and have a low porosity. They are fire-sealed and have an embossed back to ensure good adhesion. Meet or exceed all industry standards for commercial tile.

Tile Cera
300 Arcata Blvd.
Clarksville, TN 37040
(800) 782-TILE

Ceramic tile manufactured in a closed-loop process.

Applications:
Floor and wall tile.

Sizes:
12" x 12", 16" x 16", 8" x 10" and 6" x 8"

Comments:
In-house scrap and cul tiles are reincorporated into the manufacturing process. The finished tile contains approximately 5% recycled material. Although this is a low recycled content, the company's closed-loop manufacturing process is noteworthy. No tile body solid waste is produced, and water used in manufacture is recycled within the plant.

Carpet

Hendrickson Natürlich Flooring
6761 Sebastopol Ave. Suite 7
Sebastopol, CA 95472-3805
(707) 829-3959

Natural wool carpets.

Applications:
Virtually all areas of the home, or for commercial use. Can be installed wall-to-wall or used as area rugs.

Sizes:
Sold by square yard.

Colors & Patterns:
Many patterns, textures and colors.

Comments:
These carpets have durable, renewable natural fibers with low toxicity.

Image Industries
P.O. Box 5555
Armuchee, GA 30105
(404) 235-8444
(800) 722-2504

Wearlon® carpets with 100% recycled PET plastic fibers (soft drink and ketchup bottles) as carpet face fibers. Duratron® carpets made from combination of PET fibers and nylon.

Applications:
New and remodeling installations.

Sizes:
Standard carpeting roll dimensions.

Colors & Patterns:
A variety to choose from.

Comments:
Bottle-grade PET resins provide a more durable fiber for carpeting than virgin carpet-grade PET resins. PET fibers are naturally stain resistant and do not require the chemical treatments commonly used on nylon carpets.

Talisman Mills, Inc.
6000 Executive Dr.
Mequon, WI 53092
(800) 482-5466

Environ™ carpets made from 100% post consumer recycled PET plastic.

Applications:
Commercial quality carpet for new or remodeling installations.

Colors & Patterns:
Thirteen styles in a variety of colors.

Comments:
Is stain resistant and rates higher than nylon carpet in durability testing.

Carpet Pad and Floor Underlayment

W.R. Bonsai
P.O. Box 241148
Charlotte, NC 28224
(800) 334-0784

WECU cork underlayment, made from the renewable bark of the cork tree.

Applications:
Underlayment for tile or hardwood flooring. Cork provides stress crack protection and sound control.

Sizes:
In rolls or sheets in thicknesses 3/32", 1/16" or 8mm.

Comments:
1/4" WECU provides R-2.6.

Chris Craft Industrial Products
P.O. Box 70
Waterford, NY 12188
(518) 237-5850

A variety of carpet padding made from reclaimed and recycled fibers such as jute, hemp, acrylics and cotton.

Applications:
For residential and commercial use.

Center for Resourceful Building Technology

Floor Coverings
Sizes: Available in 6' and 12' wide rolls in a variety of thicknesses.

Fire Rating: Varies by fiber and thickness. Check with Chris Craft for listing.

R-value: About R-2.7 per inch.

Comments: These pads are an excellent use of reclaimed fibers from industrial textile mills and recycled Jute and hemp from burlap and rope. Surface coated for enhanced durability and ease of application.

Dodge-Regupol
P.O. Box 989
Lancaster, PA 17608-0989
(717) 295-3400
(800) 322-1923

Carpet pad made from 100% recycled tire rubber

Applications: For residential and commercial use. Can be used on under-floor heating systems.

Sizes: Available in standard rolls in thicknesses of 3-10 mm.

Fire Rating: Not specified.

Comments: This recycled rubber underlayment can withstand temperatures from 40° C to 120° C. Free of toxic materials such as PCB, mercury and formaldehyde. Provides excellent sound absorbtion.

DURA Undercushions Ltd.
8525 Delmeade Road
Montreal, PQ Can.
(514) 737-6561

Carpet pad manufactured in a cellular structure from ground tire scrap rubber granules bonded with latex.

Applications: For residential and commercial use. Can be installed using either conventional " tackless " method or by the double-stick method.

Sizes: Width 4’6”. Thicknesses: Protector 5 mm, DuraCushion 6 mm.

Fire Rating: Passed FF-70 (Flr Test); Class I ASTM E-648 Radiant Panel.

Comments: This product is made from 90% recycled tire rubber and was originally developed in the United Kingdom in the 1950’s.

Georgia-Pacific
P.O. Box 105605
Atlanta, GA 30348-5605
(800) BUILD-GP
(404) 652-4000

Particleboard underlayment made from resin-bonded wood shavings and chips.

Applications: For use as a floor underlayment. Not for exterior, damp or below-grade installations.

Sizes: 4’ x 8’ panels in 1/2”, 5/8” and 3/4” thicknesses.

Comments: This underlayment uses recovered wood fiber.

Homasote Company
Box 7240
West Trenton, NJ 08628-0240
(800) 257-9491
(609) 883-3300

440 CarpetBoard and Comfort Base™ carpet underlayments made from 100% recycled newsprint cellulose.

Applications: 440 CarpetBoard can be installed over wood floors or wood subflooring, to deaden impact noise and provide comfort when used under carpet and pad. Comfort Base high-density fiberboard is recommended for application over concrete slabs or concrete floors as an underlayment for carpet or other floor coverings.

Sizes: Available in 4’ wide panels in 4’ and 8’ lengths, in 1/2” and 5/8” thicknesses.

Fire Rating: Class III (C).

Comments: These underlayments are termite, rot and fungi protected, and contain no urea formaldehyde or asbestos additives. They can be applied using a glue-nail method or with nails only.

RB Rubber Products
904 E. 10th Ave.
McMinnville, OR 97128
(503) 472-4691
(800) 525-5530

Rubber matting made from 100% recycled waste tire rubber

Applications: 1/2” or 3/8” thicknesses are recommended as carpet underlayment.

Sizes: Available in four thicknesses. 1/4”, 1/2”, 3/8” and 3/4” Many widths available in lengths up to 96’

Comments: Tires are one of this country’s most problematic waste resources. This product offers a solution to the problem of what to do with the 240 million tires discarded each year in the U.S. These mats provide excellent shock absorption and durability. See also Landscaping (walkways).

Durable Mat Company
75 North Pleasant St.
P.O. Box 290
Norwalk, OH 44857
(800) 537-1603
(419) 668-8138

A variety of floor tiles and mats made from recycled rubber from truck tires.

Applications: For entranceways and workshops.

Sizes: Available as stand alone mats with an approximate 3/4” thickness, or continuous pattern flooring with a thickness of 3/8”

Colors and patterns: Continuous pattern Dura-Tile II floor tiles have a chenille-like textured surface

Comments: These mats are similar to those seen in many commercial applications. Entrance mats are suitable for exterior use. Dura-Tile II is installed to create a carpet-like surface suitable for entrances or as a wall-to-wall floor covering.
**Eagle One Golf Products**  
1201 W. Katella Ave.  
Orange, CA 92667  
(800) 448-4409  
(714) 997-1400

Recycled rubber interior and exterior safety matting.  
**Applications:**  
Exterior pathways and stairs, where non-slip surface is desirable. Interior use in locker rooms.  
**Sizes:**  
Exterior matting in 4' x 6' x 3/4" mats. Interior in 38" x 38" x 3/8" mats.  
**Colors & Patterns:**  
Ten colors available, all as color flecks in a black background.  
**Comments:**  
100% recycled car tire rubber

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**El Dorado Velvet Tile**  
2876 South Vail Ave.  
City of Commerce, CA 90040  
(213) 727-1935

Recycled rubber flooring tile made of nylon cord from tires vulcanized to rubber, fabric reinforced backing.  
**Applications:**  
High traffic areas, indoor or outdoor doorways, stair landings, and docks.  
**Sizes:**  
Standard 10" squares. Available in 12", 6", 5" or 4" squares, or 3" x 9" strips.  
**Comments:**  
The product carries a five-year guarantee against surface wear

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**Flexco Co.**  
P.O. Box 553  
Tuscumbia, AL 35674  
(800) 633-3151  
(205) 383-7474

Flex-Tuft™ rubber floor tile made from reclaimed commercial tire components reinforced by nylon scrim, then bonded to vulcanized rubber backing.  
**Applications:**  
For areas of commercial traffic, including indoor and outdoor use on ramps, steps, or concourses.  
**Sizes:**  
in tiles 12" square, or 6" x 12", or in 12" x 30' rolls. All 3/8" thick.  
**Comments:**  
Limited five year warranty. Resistant to organic deterioration and damage from the elements

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**Global Recycled Products**  
P.O. Box 301  
Kittery, ME 03904-0301  
(207) 439-5080

Eco-Tile™ industrial floor tiles made of 100% recycled PVC.  
**Applications:**  
Flooring for heavy-duty traffic areas. Tiles lock into place, for hard surface.  
**Sizes:**  
Tiles are 19 1/2" square, 3/16" thick.  
**Colors & Patterns:**  
Black or gray, custom colors available.  
**Comments:**  
More durable than rubber

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**Lancaster Colony Commercial Products**  
P.O. Box 630  
Columbus, OH 43216  
(800) 292-7260

Rubber and PVC tiles and matting, made from recycled materials.  
**Applications:**  
Industrial flooring.  
**Sizes:**  
Depends on specific products.  
**Comments:**  
Lancaster has a wide variety of products, not all of which have recycled content.

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**Multi-Tech Ltd.**  
2318 E. 3rd St.  
Sioux City, IA 51101  
(800) 452-4374

Duro-Guard 9000-B commercial industrial flooring made from post-industrial PVC with various additives.  
**Applications:**  
For exterior or interior applications over any dry and hard surface, for areas of wet and heavy use. This is a welded panel monolithic system.  
**Sizes:**  
In commercial and industrial thicknesses, with three finishes and a variety of colors.  
**Comments:**  
The flooring is resistant to abrasion and chemicals.

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**No Fault Industries, Inc.**  
11325 Pennywood Ave.  
Baton Rouge, LA 70809  
(800) 232-7766  
(504) 293-7760

Saf-Dek™ poured rubber decking surface. Seamless, porous, resilient, slip resistant.  
**Applications:**  
Playgrounds, pool decks, active traffic areas.  
**Colors & Patterns:**  
Four standard colors, custom colors.  
**Comments:**  
A majority of the rubber used in this surfacing material is post-consumer tire rubber

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**Oscoda Plastics, Inc.**  
731 Morley Dr.  
Saginaw, MI 48601  
(800) 545-3876  
(517) 754-9120

Protect-All and Legsaver vinyl floorings made from post-industrial vinyls. Legsaver has a virgin cap sheet over recycled base.  
**Applications:**  
Protect-All is for interior and exterior use in weight rooms, workshops, garages, entryways, and industrial applications. Legsaver is for interior use in classrooms, offices, hallways and retail stores.  
**Sizes:**  
Both styles come in 12" x 12" x 1/4" tiles. Protect-All is also available in various size sheets or interlocking tiles.
Guide to Resource Efficient Building Elements

Colors & Patterns:
- Protect-All in light or dark gray, Leg saver in standard colors.

Comments:
- These floorings are resistant to many chemicals. Protect-All may be installed without adhesives.

Pacific Mat Co.
6807 South 216th St., Bldg. A
Kent, WA 98032
(800) 345-6287
(206) 395-6287
Recycled tire rubber floorings, mats and tiles, and recycled PVC floorings, mats and tiles.

Applications:
- Durable floor and surface coverings for agricultural buildings, sports facilities and playgrounds, industrial work areas, and other areas needing drainage.

Sizes:
- Various sizes and styles available.

Comments:
- Pacific Mat Company also offers products without recycled content. Product descriptions usually mention recycled content if it is included.

Turtle Plastics
2366 Woodhill Rd.
Cleveland, OH 44106
(216) 791-2100
Turtle Tiles and Grit Top Tiles, interlocking grid-surface tiles made of 100% recycled PVC. Grit Top uses recycled carbide grit.

Applications:
- Workspaces that require drainage, barns, pools and showers.

Sizes:
- 12" x 12" x 3/4" tiles, with 12" x 2" edge ramps.

Colors & Patterns:
- Standard black, twelve custom colors.

Comments:
- Five year replacement warranty. Tiles stand up to solvents, chemicals and sunlight. Made from 100% recycled PVC.

RCM International
P.O. Box 327
Elk River, MN 55330
Ph: (800) 328-9203
Fax: (612) 421-4501
Interlocking floor tiles manufactured from recycled polyvinyl chloride (PVC).

Applications:
- For commercial and industrial use.

Sizes:
- Contact RCM.

Comments:
- PVC is usually a problem for recycling programs. If it can be source separated, products such as this can provide a durable reuse.

Center for Resourceful Building Technology

Floor Coverings
Salvaged Materials

Reuse of building materials is highly resource efficient. Reuse not only requires far less energy than recycling, but also preserves the cultural and historic value inherent in used materials. In addition, reuse diverts waste from landfills. The high quality of many historic building materials enhances their suitability for use in new building projects. Older building materials often show fine craftsmanship and offer a unique and distinctive look. Used wood offers access to large pieces of quality wood from rare tree species, at a low environmental cost. Even if used materials require cleaning or minimal reworking, they can still provide an energy and resource savings over new materials.

Some companies specialize in supplying a particular line of used building materials on a regional or national scale. A sampling of the many companies that sell specialized types of salvaged building materials for reuse appear in this chapter. Many types of building materials can be salvaged for reuse. Don’t overlook the potential to salvage and reuse materials from demolition and remodeling jobs within your own community. Examples of materials that can be reused include metal roofing, tile roofing, bricks, fixtures, hardware, beams, dimensional lumber and flooring. Materials salvage and reuse are closely tied to construction waste reduction practices, and more information on materials salvage can be found in the chapter on job-site recycling.

The most common commercially salvaged and reused building component is antique wood from beams in turn-of-the-century industrial buildings. Documentation of the wood’s history may be available from the supplier. In addition, a few companies listed in this chapter salvage lumber by recovering virgin logs cut years ago and then lost when they sank to river bottoms during raft transport to sawmills. At least one company salvages wood from trees cut during urban landscaping and orchard maintenance. Wood can also be salvaged from residential buildings, barns, and even railroad cars.

Reusing premium quality timbers exemplifies an appropriate and efficient approach to managing a valuable resource that otherwise would be wasted.

This reduces the demand placed on virgin stands of timber.

Center for Resourceful Building Technology

Salvaged Lumber
Southeast, the Mid-Atlantic region and the Pacific Northwest. A few companies salvage wood from demolition projects across the nation. The wood recovered in the Pacific Northwest is primarily Douglas fir, while the southern and eastern wood is predominantly antique heart pine. This wood came from the longleaf pine, which was so popular for construction that it was harvested nearly to extinction by the early part of this century. The longleaf pine grows straight and tall, producing a highly desirable wood, but it takes 200-400 years to mature. The conditions necessary for regeneration aren't present in most of its former range, so the longleaf pine is rare today, but the supply from old buildings is relatively plentiful.

Other species of antique salvaged wood are also available, including cypress, chestnut and oak, as well as a selection of exotic woods. Some companies which offer salvaged wood also have product lines made from virgin wood. It is important to distinguish between product offerings.

A few companies that supply other types of salvaged building materials, such as bricks and roofing tiles, are also listed in this chapter. Other materials may be available from local reuse centers and salvage operations.

Although the supply of reclaimed antique lumber is certainly not inexhaustible, it makes sense to reuse good wood rather than burying or burning it.

Many other building materials can be salvaged from demolition or remodeling projects and reused.
Aged Woods
2331 E. Market St.
York, PA 17402
(800) 233-9307
(717) 840-0330
Antique planks retrieved from 75-200-year-old structures.
Applications:
Company supplies tongue and groove flooring, paneling, molding profiles and stair parts.
Sizes:
A number of different grades are available, based on wood character and patina. Board widths are available in styles from 3” to 7”.
Comments:
Wood species available include oak, poplar, American chestnut, white pine, yellow pine, heart pine, cypress and hemlock.

Albany Woodworks
P.O. Box 729
Albany, LA 70711-0729
(504) 567-1155
Reused longleaf heart pine flooring salvaged from pre-1900 buildings throughout the southeastern U.S.
Applications:
New construction and remodeling. For paneling, cabinet stock, facings, moldings, exposed beams, stair treads and risers.
Sizes:
3/4” x 3”, 4”, 5” and 5 1/4” in premium, number one, and country-cabin grades. Wide plank available in 1 1/2” x 11” or better
Comments:
Some lengths and grades available in limited supply.

Big Timberworks
P.O. Box 368
Gallatin Gateway, MT 59730
(406) 763-4639
Timberframing company that reuses lumber for trusses and framing on building projects.
Applications:
Custom timberframing, as well as remilled flooring and millwork.
Comments:
Big Timberworks uses primarily recovered Douglas fir, but may also use recovered redwood or Southern yellow pine.

Blaine, Inc.
2410 Linden Lane
Silver Spring, MD 20910
(301) 565-4949
Blaine offers replacement door and window hardware.
Applications:
Company stocks replacement parts and hardware for windows, patio doors, closet doors and window screens.
Comments:
Blaine’s motto is “Any part for any window.” The material for repair of existing windows allows their continued use, and the availability of parts can foster reuse of salvaged windows.

The Brickyard
P.O. Box A
Harrisonville, MO 64701
(816) 887-3366
The company supplies cinder blocks in the form of stockpiled cinder blocks from an abandoned brick plant that was used between 1919 and 1968.
Applications:
The company specializes in matching existing construction. Bricks can be used in fireplaces, chimneys and walls, or as accent in other brick walls.
Sizes:
No two bricks are exactly alike. Styles available include solids, ten-hole, three-hole and oversized brick. A variety of colors are offered.
Comments:
This company has a limited supply of brick available from this site, and will cease operations there when the supply is exhausted. Similar operations could be possible elsewhere.

Centre Mills Antique Wood
P.O. Box 16
Aspers, PA 17304
(717) 334-0249
Antique wood with documentation, from wreckage and salvage of old buildings by the Centre Mills company.
Applications:
Hand hewn barn beams and joists, original log houses, flooring and wall boards, other house and barn parts.
Comments:
Salvaged wood is available in a variety of species including oak, chestnut, white pine, poplar, hemlock, yellow pine and cypress.

Coastal Millworks
1335 Marietta Blvd. N.W.
Atlanta, GA 30318
(404) 351-8400
Resawn pre-1900 antique heart pine structural beams, reclaimed from non-historical structures slated for demolition.
Applications:
New construction and remodeling. Flooring, paneling, stair parts, mantles, exposed beams and architectural millwork. Over 1000 profiles in stock.
Sizes:
Three tongue and groove flooring styles in standard thickness of 25/32” and widths from 3” to 14”. Thicker planks are available.
Comments:
After resawing, the lumber is kiln or air dried to achieve moisture content between 6% and 8%. All defects are then removed. Coastal Millworks flooring is available in four grades of antique heart pine and eleven other wood species.

Conklin Authentic Antique Barnwood
R.D. #1 Box 70
Susquehanna, PA 18847
(717) 465-3832
Pine, hemlock, chestnut and heart pine flooring made from remilled antique beams.
Applications:
New construction and remodeling. Flooring, stair components, paneling, moldings and mantles.
Sizes:
Available in sorted or random mixed sizes, 2” to 12” in a number of widths and thicknesses
Comments:
All material is from old barns. Timber is trimmed, denailed and ready for use. Availability may vary.
Guide to Resource Efficient Building Elements

Delta Lumber & Millwork Co.
4701 East 5th St.
Austin, TX 78702
(512) 385-1812
Delta offers millwork from reclaimed lumber, including information on reclamation of lumber.
Comments:
Species available include long leaf yellow pine, sinker cypress, yellow pine and fir.

Duluth Timber Company
3310 Minnesota Ave.
Duluth, MN 55802
Ph: (218) 727-2145
Fax: (218) 722-7446
Reused lumber reclaimed from the recycling of buildings, bridges and other salvagable materials.
Applications:
For framing, trim, flooring, stair components, etc.
Sizes:
A wide variety of beams and sawn lumber available.
Comments:
Duluth's stock consists primarily of Douglas fir and southern yellow pine. Lumber is sold as is or resawn. All nails are removed by Duluth.

Goodwin Heart Pine Company
Route 2 Box 119-AA
Micanopy, FL 32667
(904) 373-9663
(800) 336-3118
Flooring, dimensional lumber, molding and beams milled from virgin heart pine and cypress logs that Goodwin reclaim from riverbeds in the South.
Applications:
Flooring, stair parts, cabinetry and trim.
Sizes:
Different patterns, grades and milling options, in custom dimensions.
Comments:
Goodwin reclaim the densest logs of timber rafts that sank while being floated downstream to mills in the late 1800s. Logs are preserved by cool water and lack of oxygen.

G.R Plume Company
1301 Meador Ave.
Suite B-11 & 12
Bellingham, WA 98226
(206) 676-5658
Reclaimed architectural timbers, and millwork.
Applications:
Timbers, flooring, paneling, furniture.
Sizes:
Various.
Comments:
Douglas fir timbers salvaged from turn-of-the-century structures.

Into the Woods
300 North Water St.
Petaluma, CA 94952
(707) 763-0159
A wide variety of exotic woods, gathered from urban forests, orchard trees, and native, local hardwoods. Some reused wood.
Applications:
Counters, cabinets, closet linings, baseboards, doors, windows, flooring and trim work.
Sizes:
A variety of wood species and cuts are in stock at any given time.
Comments:
Into the Woods offers many unusual woods from orchard trees, as well as offering alternative look-alikes for rare woods, such as black locust for teak, or acacia for rosewood.

Jefferson Lumber Company
P.O. Box 696
McCloud, CA 96057
(916) 235-0609
Timbers, beams and lumber milled from timbers reclaimed from old buildings in the Pacific Northwest.
Applications:
Framing, trim and flooring.
Sizes:
Custom milled to specifications.
Comments:
The reclaimed timbers are naturally dry and dense. Jefferson provides an in-house grading system and guarantees all orders to fit specifications.

J.J. Powell & Co., Inc.
600 South Madison St.
Whiteville, NC 28472
(800) 227-2007
Salvaged antique heart pine from factories and warehouses built prior to 1900.
Applications:
Flooring and paneling, each in four grades, as well as stair parts and moldings.
Sizes:
Widths 2"-9" in 4/4 thickness.
Comments:
Heart pine and cypress available.

The Joinery Co.
P.O. Box 518
Tarboro, NC 27886
(919) 823-3306
Flooring made from reused antique longleaf heart pine.
Applications:
Residential and commercial uses.
Sizes:
Select Prime grade comes in 4/4 thickness, in widths from 3" - 7". Customer specified widths also. Several grades available.
Comments:
Remilled from timbers salvaged during demolition of "Early American" buildings.

Center for Resourceful Building Technology
Salvaged Lumber
Maxwell Pacific  
P.O. Box 4127  
Malibu, CA 90264  
(310) 457-4533  
Reclaimed previously used lumber,  
custom milled.  
Applications:  
Timbers, flooring, paneling, molding,  
siding, decking and component parts.  
Sizes:  
Various, and to specifications  
Comments:  
Many species available, including  
Douglas fir, redwood, cedar and  
pine.

Mayse Woodworking Co.  
319 Richardson Rd.  
Lansdale, PA 19446  
(215) 822-8307  
Heart pine flooring remilled from  
buildings built before 1900.  
Applications:  
Flooring and stair parts.  
Sizes:  
Boards are 7/8" thick with offset  
tongue and groove, in widths 3" to  
12"  
Comments:  
Mayse is selective in its wood use.  
The company removes defects from  
the wood, and uses all heartwood.

Mountain Lumber Co.  
P.O. Box 289  
Ruckersville, VA 22968  
(800) 445-2671  
(804) 985-3646  
Antique longleaf heart pine, re- 
trieved from pre-1900 structures  
around the country, prior to their  
demolition.  
Applications:  
Flooring (offset tongue and groove),  
stair parts, beams, paneling, wain- 
scot and moldings.  
Sizes:  
In nominal thicknesses of 3/4" or 1"  
Widths range from 3" to 10",  
depending on style. Call the  
company for availability of specific  
widths. Pine comes in seven grades.  
Comments:  
Antique American oak, antique  
American chestnut and antique  
French oak are available.

New England Slate Co.  
Burr Pond Rd.  
Sudbury, VT 05733  
(802) 247-8809  
Company offers used slate recovered  
from the roofs of old buildings.  
Applications:  
Slate can be used for repair or  
restoration of existing slate roofs.  
Coarse slate tiles are used as  
flooring. A cobble slate veneer is  
available for use on hearths or  
counter tops.  
Sizes:  
Roofing is available in 12"-24"  
heights of random width. Flooring  
is various sizes, 1/4" thick and veneer  
is 3/16" thick.  
Comments:  
Slate is non-combustible, easy to  
maintain, and does not need to be  
sealed. The company will custom  
cut roofing slates to match an  
existing roof.

North Fields Restorations  
Wethersfield St.  
Rowley, MA 01969  
(508) 948-2722  
Offers antique wood flooring,  
salvaged lumber and used windows,  
as well as complete dismantled  
buildings and salvaged architectural  
details.  
Applications:  
Flooring is available in tongue and  
groove style.  
Sizes:  
Flooring in styles 8" to 14" wide,  
with some types 20" or 24" wide.  
Comments:  
Wood species available in flooring  
include antique pine, heart pine, oak  
and chestnut.

On Track, Inc.  
P.O. Box 651  
Hillsboro, OR 97123  
(503) 693-1613  
Apitong hardwood recovered from  
the transportation system. Sources  
include antique railroad cars.  
Applications:  
Flooring.  
Sizes:  
2" x 1/2" or 5/8" tongue and groove  
style, or 4" x 1/2"  
Comments:  
Apitong is a low moisture content  
wood with a natural resistance to  
staining.

P & N Recycling  
140 Mariposa Terrace  
Medford, OR 97504  
(503) 772-4132  
(916) 987-0697  
Recycled dimensional lumber from  
dismantled structures - including old  
lumber mills - in the Pacific North- 
west. Mostly Douglas fir  
Applications:  
Beams, headers, trim, casings and  
flooring.  
Sizes:  
Depends on current inventory;  
includes 3" x 12" to 12" x 12" beams  
in lengths from 12' to 46.' Custom  
milling available.  
Comments:  
These people have worked with  
northwest timber supplies for many  
years, first in the timber industry and  
now with their P & N Recycling  
business, making sure these old yet  
valuable timber resources are not  
burned and wasted. This top quality,  
tight growth lumber is remilled.

Pioneer Millworks  
1755 Pioneer Rd.  
Shortsville, NY 14548  
(716) 289-3090  
Timbers, lumber, flooring and  
millwork resawn and milled from  
material salvaged and reclaimed  
from dismantling of commercial and  
industrial buildings, bridges and  
barns.  
Applications:  
Flooring, interior trim and millwork,  
structural and decorative timbers and  
beams.  
Sizes:  
Wide variety of sizes available,  
custom milled.  
Comments:  
Call or fax materials lists to them for  
a quotation. Support and consulta­  
tion for installation and design is  
available.

Renaissance Roofing Inc.  
P.O. Box 5024  
Rockford, IL 61125  
(815) 874-5695  
Maintains a computer inventory of a  
national supply of salvaged clay  
roofing tiles and roofing slate from  
demolished buildings.
Applications:
Tiles can be used in restoration roofing or repair.

Sizes:
Many sizes, colors, types and brand names of tile are available, and the company can locate most types of tile.

Comments:
This company buys tile and slate salvage from demolition contractors across the United States, and with enough advance notice may buy materials outright and perform removal and salvage themselves.

Superior Hardwoods
1900 Grant St.
Missoula, MT  59801
(800) 572-9601
(406) 728-4976

Salvaged used wood from the Pacific Northwest.

Applications:
Wood is remilled for use as flooring.

Comments:
Inventory depends on availability of local salvage wood.

Sylvan Brandt
651 East Main St.
Lititz, PA. 17543

(717) 626-4520

"Architectural Artifacts" quarterly newsletter on antique building materials, and a changing inventory of salvaged doors, windows, wood and hardware.

Comments:
The company specializes in antique building materials from 1750-1850, but has many materials available.

Tile Roofs, Inc.
P.O. Box 177
Mokena, IL  60448
(815) 544-4141

Used tile and slate roofing for restoration projects, with an inventory dating to the late 1800s.

Comments:
This company also sells new tile.

Tile Search, Inc™
P.O. Box 580
Roanoke, TX  76262
(817) 491-2444

Salvaged roof tile and slate.

Applications:
For roofing repair, restorations, additions or new construction.

Sizes:
Company can match manufacturer, profile, color, texture and age for most tiles.

Comments:
Tile Search will find tile and slate, or sell recovered slate and tile roofing, on their computer network.

Tiresias, Inc.
P.O. Box 1864
Orangeburg, SC  29116-1864
(803) 534-8478
(803) 534-3445

Flooring made from reused antique heart pine remilled from timbers salvaged during demolition of "Early American" buildings.

Applications:
Residential and commercial uses.

Sizes:
Comes in widths of 3", 4", 6", and 8", in thicknesses of 3/4" or 5/4"

Comments:
Nearly 75% of the pre-1900 houses and commercial structures in the Carolinas, Georgia and Florida were built largely with heart pine.

What It's Worth
P.O. Box 162135
Austin, TX  78716
(512) 328-8837

Antique longleaf heart pine salvaged from building demolition.

Applications:
Flooring (offset tongue and groove), and 'Rustic Grade' for ceilings.

Sizes:
Flooring in 3 1/4", 4 1/4", or 5 1/4" widths, 3/4" thick.

Comments:
This company also has Louisiana virgin tidewater cypress, recovered from river beds.

The Wood Cellar
(A division of Atlantic Wood)
1206 Laskin Rd., Suite 202
Virginia Beach, VA  23451
(800) 795-9114
(804) 428-9114

Reclaimed and reprocessed heart pine from turn of the century warehouses and factories.

Applications:
Flooring, in unfinished, prefinished, long strip or parquet styles.

Sizes:
Flooring 3/4" x 3" or 5", random length. Long strip panel 5/8" x 7 3/8" x 7'10 1/2", in two strip or three strip style. Parquet flooring in 12" squares.

Comments:
This flooring has the same hardness as red oak.

Woodhouse
P.O. Box 7336
Rocky Mount, NC  27804
(919) 977-7336

Reclaimed antique Southern yellow longleaf pine, fir, white spruce, and heart pine from abandoned factories and textile mills.

Applications:
Interior use for flooring, stair parts, beams, moldings, cabinetry, or panel doors. Exterior uses also.

Sizes:
Nominal widths 3" - 9", 3/4" or 3/8" thick.

Comments:
In plainsawn or quartersawn styles, in a number of grades. This company also sells virgin wood as a separate product from the antique wood.

The Woods Company
2357 Boteler Rd.
Brownsville, MD 21715
(301) 432-8419

Remilled antique lumber from barns, log houses or old industrial buildings.

Applications:
Flooring, cabinet lumber, staircase materials, beams, paneling and molding.

Sizes:
Flooring in random width pattern, lengths 4' - 12' with center match tongue and groove.

Comments:
Wood species available are heart pine, chestnut, fir, oak, poplar, hemlock, white and yellow pine.
Houses utilize natural resources in both their structure and siting. Residential landscaping can add significantly to the resource consumption associated with a dwelling, since in many areas conventional lawn and garden landscaping is resource intensive to produce and maintain. The popularity of non-native lawn grasses places an ever-increasing demand on scarce water supplies, particularly in the arid West. Techniques such as rooftop rainwater catchment systems, native plant landscaping, and xeriscaping can help relieve the pressure on water supplies, and provide a means of maintaining native vegetation and habitat for wildlife.

Preventing excessive stormwater runoff is another important function of landscaping. Water that runs off of parking lots, streets and other paved areas usually does not soak into the ground, but can instead cause overloading problems at water treatment plants or contaminate surface water supplies with chemical residues from roads. Porous paving systems, vegetation strips, and land contours are all means of slowing runoff and capturing rainwater for irrigation and aquifer recharge.

Another means of reducing the high resource demands of conventional landscaping is to use recycled-content products for drainage structures, paving, fences, retaining walls, and outdoor furniture. This chapter lists some examples of recycled products designed for those purposes. Recycled rubber pavers or bricks made from oil-contaminated soils are available for exterior walkways.

Recycled plastic lumber or plastic/wood composite lumber provide durable alternatives to solid wood for exterior applications such as fences, benches, decking, docks, retaining walls, picnic tables, and landscape borders. Plastic lumber is currently approved for use only in non-structural applications, since it does not have strength comparable to wood lumber. Plastic lumber can readily substitute for treated wood in non-structural applications, however, due to its weather- and insect-resistant nature. Plastic lumber is rot and corrosion proof, and will not crack, splinter, or chip. It has a long life expectancy in exposed, sub-grade or marine applications, and does not leach chemicals into ground or surface water or soil as treated wood can.

Plastic lumber resists vandalism and does not require painting. It is available in a variety of colors, including white, although many companies have a standard color of either brown or black, and produce...
colored lumber only for custom orders. These products can be nailed, screwed, sanded, glued or turned on a lathe with standard woodworking tools. One challenging aspect of working with plastic lumber is its high expansion coefficient, which must be considered during installation.

Plastic lumber manufacturers have proliferated recently, and they offer a wide variety of products. Some companies use only HDPE plastic, while others utilize commingled plastic waste which may include small quantities of paper and metal, as well as many different types of plastic resin. A few manufacturers mix plastic with recycled tire rubber. Some plastic lumber contains wood fiber, which helps strengthen the lumber and reduce expansion, works more like wood, and can hold paint or stain.

Plastic lumber is available in a variety of profiles and sizes. No standards exist yet for plastic lumber, so quality and product performance may vary by manufacturer. Many manufacturers make available the results of independent testing of their products. Plastic lumber manufacturers have recently formed a trade association to set industry standards and define applications for future structural use of some products.

The other landscaping products in this chapter include soaker hoses made from recycled rubber, drainage tubing with recycled PVC, drainage aggregate made from recycled glass or recycled EPS beads, recycled plastic stepping stones, and recycled rubber retaining blocks. Landscape ornaments made from cement mixed with recycled fiberglass, polystyrene and tire rubber are also included.
Guide to Resource Efficient Building Elements

Exterior Walkways

Recycled Rubber Products

American Tire Recyclers
302 N. Lane Ave.
Jacksonville, FL 32254
(800) 741-5201
(904) 786-5200

Rebound, Sportsturf and Equestri-Foot recycled tire rubber in crumb form for outdoor surfaces.

Applications:
Rebound is a soil amendment of crumb rubber and composted organics that promotes better turf growth, requires less water and provides better drainage for sports fields and lawns. Sportsturf is fiber reinforced rubber granules used on jogging and walking trails, in parks and playgrounds. Equestri-Foot is a top surface for indoor and outdoor arenas that enhances footing.

Comments:
This product turns problematic tire waste into beneficial additives for heavy use areas, addressing problems of soil compaction.

Bomanite Corporation
P.O. Box 599
Madera, CA 93639-0599
(209) 673-2411

FlexTech resurfacing material made from recycled rubber granules and virgin resins which are mixed on-site and troweled in place.

Applications:
For resurfacing damaged pool decks, walkways, driveways and patios.

Weight:
About one pound per square foot.

Comments:
Adheres to concrete, asphalt, metal and other surfaces. When used in exterior applications, it should be periodically resealed to retain color and luster.

Carlisle Tire & Rubber Company
P.O. Box 99
Carlisle, PA 17013
(717) 249-1000
(800) 851-4746

Softpave™ resilient tiles molded from recycled tires and a rubber binder. They are slightly textured and water permeable to provide an all-weather surface. These floor tiles offer a use for some of the over 200 million tires discarded each year in the U.S.

Applications:
Patio, decks, walkways, weight rooms, exercise floors. Can be installed over concrete, asphalt, wood, gravel, or crushed stone bases.

Sizes:
- I-block shaped tiles, 12" x 9 1/2".
- And patio tiles 24" x 24", both are 1" thick.

Colors & patterns:
Red, black, green, grey, flecked.

Comments:
Softpave tiles can be installed loose or adhered directly to substrate for a secure, long-term bond. They may be cleaned with a leaf blower, broom, hose, vacuum, or mop. Mild detergent can be used if desired. These tiles provide excellent traction.

Dodge-Regupol
P.O. Box 989
Lancaster, PA 17608-0989
(717) 295-3400
(800) 322-1923

Everlast flooring is made from 100% recycled tire rubber.

Applications:
Everlast flooring is recommended for athletic rooms and high use areas such as exercise rooms and walkways. Also for use as exterior pavers.

Sizes:
Rubber flooring comes in 18" or 36" square tiles as well as sheets and rolls up to 36" wide.

Colors & patterns:
The rubber flooring is available with a wide variety of colored patterns on a black background.

Comments:
Every five square feet of Everlast rubber flooring uses approximately one scrap tire.

Mat Factory
760 West 16th Street, Suite E
Costa Mesa, CA 92627
(714) 645-3122

Interlocking floor mats made from 100% recycled tire rubber.

Applications:
For residential, industrial and commercial uses such as playfields and for handicapped access.

Sizes:
Contact Mat Factory

Comments:
A good use of recycled rubber.

Promat
P.O. Box 967
Richmond, IN 47375
Ph: (317) 935-7541
(800) 428-6573
Fax: (317) 935-4685

Rubber mats made from reclaimed auto and truck tires.

Applications:
Fatigue mats and runners.

Sizes:
Available in a number of thicknesses in widths up to 48" and lengths up to 12'.

Comments:
A good use of recycled rubber.

RB Rubber Products
904 E. 10th Ave.
McMinnville, OR 97128
(503) 472-4691

Rubber matting made from recycled waste tire rubber.

Applications:
Suggested for entryways.

Sizes:
Available in three thicknesses, 1/2", 3/8" and 3/4". Many sizes available from 4' x 4' square to continuous custom pieces up to 90' in length.

Colors & patterns:
Standard charcoal color.

Comments:
Provide excellent shock absorption and durability. See also Floor Coverings (carpet pads).
Paving Bricks

Cunningham Brick Company, Inc.
Route 2, Cunningham Brick Road
Thomasville, NC 27360
(919) 472-6181

Brick nuggets made from reprocessed oil contaminated soils. The reclaimed soil is processed and baked to create rough red-colored nuggets.

Applications:
- An excellent material for xeriscaping, decorative walkways and driveways.

Size:
- Average of 3 3/4" in overall width.

Comments:
- Also sold for use on baseball infield running paths.

Maryland Clay Products
7100 Muirkirk Road
Beltsville, MD 20705
(301) 419-2214

Paving bricks that incorporate oil-contaminated soil in manufacture.

Applications:
- Walkways, driveways and brickwork.

Comments:
- Brick manufacturers routinely add oil in the manufacturing process to produce high quality brick. This partial solution to the management of oil-contaminated soils holds great potential. The petroleum in the soil is used as a fuel in the heating process that turns clay into brick, and the soil is recycled. Maryland Clay is also looking at manufacturing bricks using sewage sludge.

Phoenix Scientific
3670 N. High St. Suite 203
Columbus, OH 43214
(614) 945-0326

Paving bricks made from municipal incinerator ash.

Applications:
- For driveways and walkways.

Sizes:
- Can be made in a variety of colors.

Comments:
- This is a viable use for incinerator ash. When fired into bricks [after being mixed with clay], the components of the ash become insoluble as they are fused into a unified ceramic material. Phoenix Brick can be produced to exceed all ASTM standards regarding freeze-thaw resistance and compressibility.

Recycled Plastic Lumber

A.E.R.T.
P.O. Box 1237
Springdale, AR 72765
(501) 750-1299

Lifecycle decking made from recycled low and high density polyethylene plastic and cedar fibers from recovered mill waste. Lifecycle is not a commingled plastic lumber. It substitutes for treated wood in decking and can be stained. Lifecycle has a low coefficient of lineal thermal expansion.

Aeolian Enterprises
One Lloyd Ave. Pl., Suite 201
Latrobe, PA 15650
(412) 539-9460

Hollow profile plastic lumber, made from 100% recycled industrial and post-consumer HDPE.

Aldan Lane Company
Box 990 Hwy 22W
Kalona, IA 52247
Ph: (319) 656-3620
Fax: (319) 656-3656

Plywood laminated with recycled high density polyethylene and formed in a corrugation, for use under shingles, or to line garages and outbuildings. Plastic lumber for tables, pallets, etc.

Bedford Industries
1659 Rowe Ave, Box 39
Worthington, MN 56187-0039
(800) 533-5314
(507) 376-4136

Plastic lumber, from recycled post-consumer and industrial HDPE with paper binder.

BTW Industries, Inc.
2000 S.W. 31st Avenue
Pembroke Park, FL 33069
(305) 962-2100

Envirowood™ benches, picnic tables, decking and railing made from 100% recycled commingled post-consumer plastics.

Cascade Re-Plast Inc.
1350, Chemin Quatre Saisons
Notre-Dam-du-bon-Conseil
PQ JOC 1AO
(819) 336-2440

Plastic lumber and outdoor furniture made from 100% post-consumer and post industrial thermoplastics gathered in curbside collection.

Collins and Aikman
P.O. Box 1447
Dalton, GA 30721
(800) 241-4902
(706) 259-2125

Recycled plastic lumber picnic tables, park benches, birdhouses and trash receptacles, made from the company’s Powerbond RS carpet, collected from consumers for recycling as part of the company’s cradle-to-cradle philosophy.

Dura Post and Dura Bord
P.O. Box 492
Puyallup, WA 98371
Ph: (800) 676-4091
Fax: (206) 588-3039

DuraPost for fences, DuraBord plastic lumber. Made from 100% post-consumer recycled plastic.
<table>
<thead>
<tr>
<th>Company Name</th>
<th>Address</th>
<th>Phone</th>
<th>Fax</th>
</tr>
</thead>
<tbody>
<tr>
<td>Duratech Industries, Inc.</td>
<td>P.O. Box 536, Lake Odessa, MI 48849</td>
<td>(616) 374-7443</td>
<td>(616) 374-3170</td>
</tr>
<tr>
<td>Eagle Recycled Products</td>
<td>1900 Betmor Ln., Anaheim, CA 92805</td>
<td>(714) 939-8400</td>
<td></td>
</tr>
<tr>
<td>Earth Safe</td>
<td>P.O. Box 2861, Hyannis, MA 02601</td>
<td>(508) 420-5681</td>
<td></td>
</tr>
<tr>
<td>Environmental Plastics, Inc.</td>
<td>4981 Keelson Dr., Columbus, OH 43232</td>
<td>(614) 861-2107</td>
<td></td>
</tr>
<tr>
<td>Envirowood, Inc.</td>
<td>501 W. Algonquin Rd., Mt. Prospect, IL 60056</td>
<td>(800) 323-0800</td>
<td>(708) 981-0315</td>
</tr>
<tr>
<td>Field Support and Supply</td>
<td>509 NE 165th St., Seattle, WA 98155</td>
<td>(206) 361-6197</td>
<td></td>
</tr>
<tr>
<td>Hammer's Plastic Recycling Corporation</td>
<td>RR 3 Box 182, Hwy 20 &amp; 65 North, Iowa Falls, IA 50126</td>
<td>(515) 648-5073</td>
<td>(515) 648-5074</td>
</tr>
<tr>
<td>Jeannell Sales Corp.</td>
<td>P.O. Box 537, Sharon, TN 38255</td>
<td>(901) 456-2681</td>
<td></td>
</tr>
<tr>
<td>Kept, Inc.</td>
<td>18574 S. Hwy. 99E, Oregon City, OR 97045</td>
<td>(503) 655-0758</td>
<td></td>
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<tr>
<td>Kept, Inc.</td>
<td>Mobil Chemical Company</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Plastic Lumber Company</td>
<td>520 S. Main St., Suite 2446, Akron, OH 44311</td>
<td>(216) 762-8989</td>
<td>(216) 434-7905</td>
</tr>
<tr>
<td>Plastic Pilings, Inc.</td>
<td>8560 Vineyard, Suite 205, Rancho Cucamonga, CA 91730</td>
<td>(909) 989-7685</td>
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</tr>
<tr>
<td>Phoenix Recycled Plastics, Inc.</td>
<td>4601 Market Street, Suite 4000, Philadelphia, PA 19139</td>
<td>(215) 748-3430</td>
<td></td>
</tr>
<tr>
<td>Plastic Recycling</td>
<td>83 North Edmore Lane, West Islip, NY 11795</td>
<td>(516) 669-2037</td>
<td>(516) 981-2234</td>
</tr>
<tr>
<td>Plastic Pilings, Inc.</td>
<td>81 Winant Pl., Staten Island, NY 10309</td>
<td>(718) 984-7272</td>
<td></td>
</tr>
<tr>
<td>Plastic Lumber Company</td>
<td>8560 Vineyard, Suite 205, Rancho Cucamonga, CA 91730</td>
<td>(909) 989-7685</td>
<td></td>
</tr>
<tr>
<td>Recycled Plastic Industries, Inc.</td>
<td>1820 Industrial Drive, Green Bay, WI 54302</td>
<td>(414) 468-4545</td>
<td>(414) 468-4765</td>
</tr>
</tbody>
</table>

And stain, can also be left unfinished. In two colors. Works like wood.

**Obex, Inc.**

- **P.O. Box 1253**, Stamford, CT 06904
- **(203) 975-9094**

Novawood landscape ties from recycled plastics #1-7, including plastic bags and foam from residential, industrial and commercial sources.

**Phoenix Recycled Plastics, Inc.**

- **4601 Market Street, Suite 4000**, Philadelphia, PA 19139
- **Ph: (215) 748-3430**

Trex composite lumber made from waste wood fiber and recycled post-consumer plastics. Accepts paint and stain, can also be left unfinished. In two colors. Works like wood.

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Guide to Resource Efficient Building Elements

Recycled Plastic Man Inc.
P.O. Box 3368
Venice, FL 34293
(813) 497-1020
- Plastic lumber and outdoor furniture, made from 100% recycled plastic.

Recycled Polymer Associates
152 West 26th St.
New York, NY 10001
(212) 463-8622
- Hollow profile fencing, and plastic lumber. Made from 95% combined recycled polyolefins and 5% coloring agents and inert materials.

Renewed Materials Industries
621 W. Division St.
Muenster, TX 76252
(817) 759-4181
- "Rumber" made from old tires, waste rubber, and waste plastic. The product is tongue and groove, for use as a flooring or in retaining walls.

RePlas Products, Inc
411 B Southgate Court
Mickleton, NJ 08056
(609) 423-2607
- A variety of lumber products made from recycled plastic.

Sanders Enterprises, Inc.
3019 Nash Rd.
Scott City, MO 63780
(314) 334-9600
- Recywall retaining wall and sound barrier system, and Recy-Tile paving tile. Made from mixed plastic waste. The Recywall contains crushed glass, and is filled with compost and organic waste and planted with living plants.

Superwood
P.O. Box 2399
Selma, AL 36702-2399
(205) 874-3781
- Lumber made from plastic from milk jugs, bread bags, and plastic toys.

Trimax of Long Island
2076 Fifth Avenue
Ronkonkoma, NY 11779
Ph: (516) 471-7777
Fax: (516) 471-7862
- Trimax lumber made from reinforced foamed polyolein resin from recycled polyolefin domestic and industrial scrap. Used in outdoor structures.

Other

AquaPore Moisture Systems
610 S. 80th Avenue
Phoenix, AZ 85043
Ph: (602) 936-8083
Fax: (602) 936-9040
- Moisture Master soaker hoses made from recycled tire rubber
- Applications: For above or in-ground drip irrigation of gardens and landscapes.
- Sizes: Available in 1/2" and 5/8" diameters, in lengths of 25, 50, and 75'
- Comments: These hoses are porous throughout to distribute a controlled amount of water through the entire hose. A recycled product that also provides for efficient use of water resources.

ARRC, Inc.
500 Industrial Rd.
Mankato, MN 56001
(507) 345-1375
- Multi-Bloc Interlocking blocks made from recycled tires
- Applications: Blocks stack into panels to use for landscaping and terracing, or reinforcing hillside retaining walls.
- Sizes: Various sizes and densities. Standard color is black, custom colors available.
- Comments: Blocks are coated with fire retardant.

Glass Aggregate Corporation
1085 Oakleigh Road N.W.
Grand Rapids, MI 49504
(616) 791-0793
- R.E.D. - PAK (Reduce Environmental Damage - Pak)
- A self-contained underdrain unit, consisting of a geotextile non-woven fabric sleeve filled with crushed, recycled glass. Uses 99.6% recycled mixed glass (including ceramics, pottery, etc.) which doesn't have to be washed or sorted, and can include minor contaminants such as lids and labels.
- Applications: Underdrain systems for highways, roads, streets, parking lots, building foundations, and water table stabilization. Can also be used for erosion control.
- Sizes: One unit is 6" in diameter and 40" long, to be used in a series.
- Weight: Each unit weighs 40 to 45 pounds.
- Comments: The company hopes to develop licensing agreements with private firms and other organizations throughout the country, as the manufacturing process is designed to allow the operator to collect, produce and distribute the product near the materials source.
Invisible Structures, Inc.
14704-D East 33rd Place
Aurora, CO 80011
(800) 233-1510
(303) 344-2233
Gravelpave® and Grasspave™, porous paving systems made from 95% recycled post-consumer plastic from film canisters and pop bottle bottoms.
Applications:
Gravelpave maintains porosity and keeps gravel spread evenly in areas too heavily traveled for grass.
Grasspave prevents compaction and promotes drainage for seeded or sodded areas used for infrequent parking or low traffic access drives.
Sizes:
Each block is 20" x 20" x 1"
Comments:
Porous paving helps to capture rainwater and prevent stormwater runoff. Grasspave can also reduce temperatures around individual buildings. These systems can handle heavier loads than standard asphalt and concrete, and standard snow removal equipment can be used on them.

Mandish Research International
5055 State Road 46
Mims, FL 32754
Ph: (407) 267-2561
Fax: (407) 268-1972
Precast lightweight Donolite concrete products made from cement mixed with recycled fiberglass, polystyrene, and/or tire rubber. The recycled polystyrene comes from a foam sheathing manufacturer and the fiberglass comes from old boats.
Applications:
Can be used for cast birdbaths, fence posts, landscape timbers and landscape ornaments.
Comments:
Mandish is interested in licensing others and providing the equipment and technology necessary to set up manufacturing. They also sell molds to landscapers from their plant.

Plastic Tubing Inc.
P.O. Box 878
Roseboro, NC 28382
(800) 334-6602
(919) 525-5121
Corr-A-Flex recycled plastic flexible tubing for site drainage.
Applications:
Drainage. Tubing comes in slotted, solid, or double wall.
Sizes:
10' or 20' lengths, or coils, in diameters from 4" to 15"
Comments:
The tubing is made with 0-70% recycled HDPE, from post-industrial and post-consumer sources. Recycled content varies with application, and the customer may specify tubing with a high recycled content.

Presto Products Co.—
Geosystems Division
P.O. Box 2399
Appleton, WI 54913-2399
(800) 548-3424
Geoblock porous pavement system made from high strength reinforced plastic with a minimum of 50% post-consumer recycled content.
Applications:
For utility access lanes, driveways, highway medians, and approaches to monuments, etc. The system creates a load bearing pavement yet allows drainage and grass.
Sizes:
Blocks are 12" x 36" with a depth of 1.25" or 2" and a tongue and groove interlock on all edges.
Comments:
Blocks provide over 80% open area for water penetration. Seating blocks may require sand/gravels/topsoil mix on a sub-base.

United Resource Recovery
Route 2, Box 265
Jonesboro, AR 72401-9560
(501) 932-3500
Recycled plastic stepping stones, made from 100% post-consumer plastic, faced with rock.
Applications:
Exterior walkways.
Sizes:
12" square or 12" round stones, with a variety of finishes. Stones can be custom designed with numbers or letters molded in.
Comments:
Each stone weighs approximately 5 pounds.
Miscellaneous

Most of the entries in this chapter contain high percentages of recycled post-consumer or post-industrial waste. Others are simply more resource efficient than products now in common use. Manufacturers of construction materials such as recycled plastic sheets, shims, and nail fins are included. Producers of aggregate for concrete and masonry are found here, as well.

This chapter contains listings for alternative wood preservatives. Wood used in outdoor or subsurface applications is extremely vulnerable to the elements, and treated wood is generally specified for these applications. There are concerns about the longevity of treated wood, and particularly the environmental impacts of chemicals used in the treatment process. Wood preservatives often include chromium and arsenic, and these chemicals may leach out of the wood in marine or wet sub-grade applications and contaminate groundwater or soil. This chapter lists wood treated with less-toxic alternatives such as borate.

For some applications more durable and sustainable substitutes for wood are available. Recycled plastic lumber is a viable alternative to wood for landscaping or fences. Decks and patios can be constructed from materials other than wood such as plastic lumber, stone, tile, or rubber pavers. Choosing a weather-resistant material eliminates the need for harsh preservative treatments.

<table>
<thead>
<tr>
<th>A.E.R.T.</th>
<th>Bomanite Corporation</th>
<th>Catrel USA</th>
</tr>
</thead>
</table>
| P.O. Box 1237  
Springdale, AR 72765  
(501) 750-1299  
-or-  
P.O. Box 172  
Junction, TX 76849  
(915) 446-3430 | P.O. Box 599  
Madera, CA 93639-0599  
(209) 673-2411  
"FlexTech" resurfacing material made from recycled rubber granules and virgin resins which are mixed on-site and troweled in place.  
Applications: For resurfacing damaged pool decks, walkways, driveways and patios.  
Weight: Approximately one pound per square foot.  
Comments: Adheres to concrete, asphalt, metal and other surfaces. When used in exterior applications, it should be periodically ressealed to retain luster.  
- or -  
P.O. Box 599  
Madera, CA 93639-0599  
(209) 673-2411 | 3638 Camino del Rio N. Ste. 203  
San Diego, CA 92108  
(619) 285-1188  
-or-  
Raritan Plaza II, CN 3106  
Edison, NJ 08818  
(201) 225-4849 | Conversion of municipal solid waste into products that can be incorporated into building materials.  
Applications: Aggretel™ spheres and pellets can be used in the manufacture of concrete bricks and blocks. Fibretrel™ has insulating and adhesive properties suitable for the manufacture of plasters and mortars.  
Comments: Catrel plant operations do not involve refuse combustion and do not consume any water for waste processing and conversion. Catrel waste processing plants are designed to be locally built, and according to Catrel USA, cost 80% less to build than a comparable incineration facility. |
C-Max Technologies
2140 W. 12th Ave.
Vancouver, BC V6K N2N Can.
Ph: (604) 738-0505
Fax: (604) 738-0505

Contumax products made from waste wood and plant fibers, which are bonded with a magnesium oxyphosphate cement to create a variety of products that are strong, dimensionally stable, insoluble in water, and have excellent fire and insect resistance.

Applications:
For the manufacture of continuous-press processed boards, expanded rigid foams, as well as molded or extruded products such as shingles.

Comments:
The fiber content in Contumax products is 60-90% by volume of each C-MAX formulation. Different formulations of the fiber ingredients produce a variety of densities, strengths and other properties resulting in many different final products.

Environmental Specialty Products
P.O. Box 1114
Guasti, Ca 91743-1114
(909) 390-8800

Innovative Plastic Products Inc.
P.O. Box 898-109
Greensboro, GA 30642
(706) 453-7552

InnoPlast GPM™ sheets manufactured from recycled commingled plastic waste.

Applications:
Designed to be used as reusable concrete forms. Possible other uses as exterior sheathing or sub flooring.

Sizes:
Standard size is 40” x 48”, available in thicknesses of 1/4”, 3/8”, 1/2”, and up to 1 1/2”

Comments:
InnoPlast uses a 50% thermoplastic portion of polyethylene as a carrier element into which various plastics and impurities are imbedded.

EZ-Shim
123 Santa Barbara St.
Santa Barbara, CA 93101
(800) 788-8945
(805) 963-9098

EZ-Shim™ recycled plastic shim with precut break points.

Applications:
For setting doors and windows and hanging cabinets.

Sizes:
1 1/4” x 8” each, in break away sheets of ten. Shims will snap off to length at any given set point.

Comments:
BOCA and UBC approved, these shims are of consistent quality and experience no shrinkage. They also offer a use for a problematic waste product.

Medite Corporation
P.O. Box 4040
Medford, OR 97501
Ph: (503) 773-2522
Fax: (503) 773-2522

Medite, a formaldehyde-free medium density fiberboard made from pre-consumer wood waste.

Applications:
Designed for exterior non-structural uses for high moisture areas. Can also be used for interior applications such as cabinets, window and door parts and mouldings. Not designed to be used in contact with soil. Also Medite II, an MDF, formaldehyde-free, for dry areas.

Sizes:
Average thickness of 3/4” in a variety of dimensions up to 5’ x 12’

Comments:
The resins used in Medex cure into a formaldehyde-free polyurethane. Available with a factory prime coat on two sides.

The Millenium Group
121 South Monroe St.
Waterloo, WI 53594
(800) 280-2304
(414) 478-2304

The Nailer®, a drywall fastener made from 100% post-consumer recycled plastic.

Applications:
Replaces conventional wood lath catcher or drywall clips. The Nailer® is used for preparing inside corners for drywall hanging. It attaches to the top plate of the wall with staples.

Comments:
This drywall hanging system saves labor and materials. Twenty Nailers will replace 4 vertical studs, or 26 linear feet of wood, when installed 16” on center.
Neutralysis Industries
550 Frontage Road Suite 291
Northfield, IL 60093
(312) 441-9444
Neutrality is a non-toxic concrete aggregate made from municipal waste. This patented process combines municipal solid and liquid wastes with clay to produce a pelletized feed stock that is then kiln-fired to produce an inert lightweight ceramic aggregate which can then be used in the building industry. This is an excellent example of putting waste resources to work in building materials.

Applications:
Structural lightweight aggregate for concrete and masonry

Comments:
Provides a complete processing of the waste stream, without the high volume of gas emissions associated with conventional incineration.

Acunet Envirotech Inc. of Saginaw, Mich, plans to operate the first Neutralysis plant in the U.S. soon.

Recycled Plastics, Inc.
Rt. 1 Box 95A
Garfield, MN 56332
(612) 834-2293
Recycled plastic sheets from 100% post-consumer HDPE or from 100% post-industrial regrind.

Applications:
Sheets are used for foundation forms, below-grade sheathing, furniture, cabinet doors, trim and baseboards.

Sizes:
4' x 8' sheets, in thicknesses 1/8" to 1 1/4" Custom colors available.

Comments:
Panels can be welded to join. When using these panels the expansion of 3/16" per 4' per 40°F temperature must be considered.

RePlastec
Erie Industrial Park
Port Clinton, OH 43452
(419) 635-4000
Recycled plastic nail fins/drain troughs.

Applications:
Nail fins are used for new door and window installation. Drain troughs for basement waterproofing system.

Comments:
Products are extrusions from 100% recycled plastic.

Sorbilite
5721 B Bayside Rd.
Virginia Beach, VA 23455
(804) 464-3564
Sorbilite Composite Molding system, a high pressure press that uses a binding agent, a catalyst and fibers under pressure and heat to create medium-density fiberboard components.

Applications:
This press can produce components for furniture or panels for cabinetry, as well as other products, from fibrous waste.

Comments:
The Sorbilite press makes use of wood waste, and other fibrous waste including carpet fibers and peanut shells. The Sorbilite press is the core of a fast, low-energy system available in different sizes.

Sure Fit Shims
P.O. Box 35225
Greensboro, NC 27425-5225
Ph: (800) 225-0848
Fax: (919) 668-7790
Shims manufactured from recycled plastics.

Applications:
For general construction use wherever shims are needed.

Sizes:
Standard size is 1 1/4" wide with upper height of about 1/2".

Comments:
These shims are employed by sliding two wedge-like components together until the desired height/lift is attained.

United McGill Corp.
P.O. Box 820
Columbus, OH 43216-0820
(800) 624-5535
(614) 443-5520
Seal-n-Save™ water base duct mastic.

Applications:
Used to seal residential duct systems, both old and new. Applied with a caulking gun or brush.

Comments:
About 95% of all homes have enough duct leakage to require sealing. Mastic reduces energy consumption and improves indoor air quality.

The Weather Company, LTD
1013 Pleasant Ave., Suite B
Wyndmoor, PA 19038
(800) 795-2040
(215) 233-0404
WeatherRx™ zero VOC water-based siloxane concentrate sealant for concrete masonry, stucco and wood.

Applications:
For use on sidewalks, driveways, patios and vertical masonry surfaces.

Sizes:
Concentrates in 6.4 ounce 32 ounce and 2.5 gallon sizes, that mix to provide 1 gallon, 5 gallons, and 50 gallons, respectively.

Comments:
This sealant is one of a new generation of water-based sealants with low or zero VOC emissions. The concentrated form of WeatherRx5 reduces packaging waste.

Yemm and Hart Green Materials
RR 1, Box 173
Marquand, MO 63655-9610
(314) 783-5434
Recycled plastic panels, sheeting, and furniture.

Comments:
Yemm and Hart produces a wide variety of recycled plastic products, some of which are suitable for use in building and landscaping.
Job-Site Recycling

Building demolition and remodeling produce significant amounts of waste as existing structures and finishes are removed. New construction also produces waste in the form of scrap, defective and damaged material, and empty packaging. Much of the construction and demolition waste produced is sent to landfills by owners and builders. At present only a small fraction of construction waste is recovered for reuse or recycling, although the potential exists to recycle or reuse a high proportion of construction waste. In fact, through implementation of job-site recycling options waste can be prevented altogether, or at least diverted from landfills. Alternatives to landfill disposal help to recover part of the value in materials formerly considered waste.

The waste stream as a whole generally consists of 20 to 25 percent construction and demolition waste. On average, at least 25% of discarded construction material is dimensional lumber, 15% is drywall, 12% is masonry and tile and 10% is waste from manufactured wood products. The other 38% is divided between cardboard, paper and plastic packaging, asphalt, fiberglass, metals and other miscellaneous materials. The magnitude of wasted material is impressive. One of the most comprehensive and referenced studies on job-site waste was done by REIC Consulting Ltd. in Toronto, Canada ((416)841-5551). Their analysis showed that the construction of an average house results in discarding the equivalent of 200 2 x 4 studs, 400 standard bricks, and 10 to 12 sheets of drywall.

Many builders are beginning to find that disposing of construction waste can be problematic. In Toronto and other municipalities, cardboard, fine paper, clean wood, concrete and rubble, drywall and scrap metal are banned from the landfill. More restrictions are being enacted in other urban areas as well. Elsewhere builders are finding the costs of disposal increasing as landfill space decreases and tipping fees rise. Paying for the disposal of construction “waste” makes up, on average, 3 to 5 percent of a builder’s overall budget.

According to the National Solid Wastes Management Association, tipping fees rose an average of 30 percent in all regions of the country from 1988 to 1990, and they continue to rise. Much of the increase is attributed to the stringent requirements that the EPA’s Resource Conservation and Recovery Act (RCRA), subtitle D, places upon landfill owners. Given the rising costs, builders are learning that avoiding the creation of construction and demolition waste, reusing materials and implementing jobsite recycling programs can make money, rather than adding to disposal costs.

Some contractors assume that recycling costs more in increased labor than it will save in tipping fees, and will not pursue job-site recycling unless it is required in the bid. Specifying recycling in the contract will put competing contractors on a level footing for bidding, and a contractor that offers recycling can
negotiate with the owner to have it included in all bids, to illustrate relative costs. Many references indicate, however, that recycling can be cost effective for the builder even in instances where it is not required in the specifications or by the contract.

When materials are salvaged for reuse or recycling, the owner or builder can sell those materials to offset recovery expenses. In addition, waste avoidance strategies initiated in the design phase and carried through at the construction site can reduce the materials costs of a job. Examples of such strategies are standard dimension designs on two-foot modules, accurate materials take-offs, and "just in time" delivery. When fewer materials are used at the site, the builder also has less waste to dispose of, which reduces hauling and tipping fees associated with a job.

Salvaging materials from demolition or remodeling sites requires advance planning, to locate potential markets for materials and to ensure that components are removed with as little damage as possible, and not mixed with non-reusable demolition debris. Removing materials for reuse may require more labor time during the demolition phase of a project, but some salvaged materials are high-value items that can be sold at a profit if carefully removed. (For ideas, see the chapter on Salvaged Materials.) In some areas, non-profit materials reuse facilities accept used construction materials as a tax-deductible donation.

Construction materials that are not recoverable for reuse may still be readily recyclable. At present the primary barriers to recycling are the high cost of construction labor and the perception many builders have that sorting through cut-piles and separating wastes is labor intensive and too expensive. However, many workable and profitable methods for efficient recycling have been demonstrated, and sources for information on those methods are included in this chapter.

Waste is generated by many construction activities, including not only demolition, but also framing, drywall hanging, finishing and installation of electrical and mechanical systems. When an on-site disposal system mixes a variety of discards in one "waste" bin, it cancels their recycling value by adding re-sorting cost. On-site workers should be trained to understand the proper procedures for sorting waste, and keeping the different types of waste separate. Source separated, or "clean", construction waste generally has a much higher market value than mixed waste.

Finding space on the job-site to locate separate recycling bins for each type of material can be a challenge. Materials usually have to be stored on site until a full load is available for pickup or hauling to the recycling facility. The extra cost that limited space can incur needs to be specified in the bid and contract, or recycling can become difficult for the builder. Bins also need to be located in a secure area to avoid contamination by unauthorized use. The property owner should be made aware of the materials separation and storage requirements involved in a comprehensive job-site recycling program.

The final barrier that builders must surmount is locating markets for recycled materials. Many metropolitan areas have compiled listings of haulers, materials recovery facilities, private recyclers and salvage dealers. Time spent finding out what each operation will accept and at what price is a wise investment for the competitive builder.

For every locale, different options for materials disposal, recycling and reuse will be available, and with materials sorting the options become more accessible. Disposing of wood waste becomes much easier when the wood is not mixed with drywall, cans of adhesive, or broken windows. Builders should be able to locate people or organizations willing to receive or pick up a bin of mixed dimensional lumber, trim and plywood. Present packaging methods produce many items that are inherently difficult to recycle. Cans with a residue of adhesive in them may be difficult to remove from the waste stream. Many composite materials, if not reusable, will also be relegated to the dump, due to the difficulty of separating constituent parts for recycling.

CRBT provides consulting services for builders, representatives of municipalities or manufacturers and others who wish to implement a detailed recycling plan. We also have additional information and technical briefs on job-site recycling and building material reuse.
General Construction & Demolition Waste

Greater Toronto Home Builders' Association
Attention: Steven Dupuis
20 Upjohn Road
N. York, ON M3B 2V9 Canada
(416) 391-3445

The GTBBA is actively seeking ways to implement the three Rs in residential construction and has put out a 27-page guide called Making a Molehill Out of a Mountain II. A "disposal-costs" comparison chart in the guide indicates the stimulus for their efforts, listing tipping fees in Toronto as being substantially higher than most other areas in Canada. Molehill II provides information on the various elements involved in setting up a waste reduction plan specifically for builders.

Innovative Waste Management Waste Reduction Consulting
137 Steeles Lane
Apple Valley, MN 55124-9337
(612) 432-7038

Innovative Waste Management has published a Construction Materials Recycling Guidebook which identifies barriers and suggests solutions to C & D waste reduction and recycling in the Twin Cities area. This guide includes worksheets for figuring the costs and benefits of recycling on the job site as well as a directory of haulers and recyclers in the area.

Metro Solid Waste Department
600 NE Grand Ave.
Portland, OR 97232-2736
(503) 797-1650

Portland, Oregon has conducted extensive studies of construction and demolition waste and opportunities for job site recycling. A number of guidebooks, fact sheets and published studies on job site recycling are available from Metro.

Recycling Construction and Demolition Waste in Vermont
Solid Waste Division
103 S. Main, Laundry Building
Waterbury, VT 05671
(802) 244-7831
A report compiled for the State of Vermont by C.T. Donovan Associates Inc., full of statistics on the past, present, and future of C & D recycling in Vermont. The information could serve as a useful reference for other solid waste managers and planners throughout the county.

Urban Ore, Inc.
David Stern, Information Services
1333 Sixth St.
Berkeley, CA 94710
(510) 559-4460

Urban Ore, Inc. works in conjunction with the local waste management facility in Berkeley, California, to salvage usable materials. Urban Ore has a Building Materials Exchange, which deals in construction materials dropped off by individuals or businesses, or picked up at local job sites. Urban Ore pays cash for some materials, and charges a fee to accept others. Reusable post-consumer materials are diverted from landfills through this effort. Contact Stern to learn more about Urban Ore's local program.

WasteBusters, Inc.
Attention: Robert Langeland
1390 Richmond Terrace
Staten Island, New York 10310
(718) 351-1936

Founder Robert Langeland is salvaging doors, plumbing and lighting fixtures, hardware and other durable goods and selling them through his WasteBusters News newsletter. Robert hates to see valuable materials go to waste and would like to see similar ventures established elsewhere.

Wood

Big City Forest, Inc.™
1809 Carter Ave.
Bronx, NY 10456
(718) 299-1183

Big City Forest accepts both discarded wood and used pallets and reclaims the lumber to make new pallets, furniture, flooring, and other value-added wood products. In 1995 they expect to reclaim about 3 million board feet of lumber. Local initiatives like this one offer important opportunities for high-value dimensional lumber recycling.

Urban Forest Wood Works
585 West 3900 South, #6
Murray, UT 84123
(801) 266-5650

Urban Forest Wood Works uses city trees cut from the urban forest to fabricate value-added specialty wood products. Salt Lake City discards more than 500,000 board feet of wood from urban trees annually, much of it consisting of hardwood or exotic species. Urban Forest Wood Works recovers and utilizes this valuable wood. Businesses such as this one could thrive in metropolitan areas with extensive urban forest, and help to recover value from the trees cut and divert usable wood from landfills.

Wood Recycling Inc.
300 Forest Street, P.O. Box 6087
Peabody, MA 01961
Ph: (508) 535-4144
Fax: (508) 535-4252

Wood makes up roughly 25% of the waste generated at construction sites. Wood Recycling Incorporated is recycling wood fiber into composite wood products, fiber-reinforced cement mixtures, and roofing substrate. This is a good substitute for or supplement to virgin wood fibers which are commonly used in particle board.

Gypsum

New West Gypsum
20321 80th Avenue
Langley, BC V3A 4P7 Canada
Ph: (604) 888-2282
Fax: (604) 888-5126

Reclamation Technologies, Inc.
115 East Bagdad Road
Round Rock, TX 78664
(512) 388-9677

Domtar Gypsum
122 Old Dover Rd.
Newington, NH 03801
(800) 366-8274

Scrap gypsum comprises about 15% of C&D waste. If disposed of improperly it can combine with anaerobic bacteria and organic matter in a moist environment to...
produce hydrogen sulfide gas. Landfill tipping fees in the U.S. and Canada are increasing at a rate which makes recycling of materials such as gypsum more attractive. These companies are finding ways to recycle gypsum waste into new wallboard and other products.

**Carpet**

Environmental Recycling Services Inc.
14601 W. 101st Terrace
Lenexa, KS 66215
This company offers regional collection of used carpeting and bales it for recycling. Collection services like this one are a vital link in the recycling chain, as they help to centralize recyclable materials for markets.

**Partnership for Carpet Reclamation**
Du Pont Flooring Systems
Carolyn Wilhauer
P. O. Box 80,722
Wilmington, DE 19880-0722
This is a membership organization. Members receive containers for post-consumer carpeting. When full, these containers are collected for a fee, and the carpet is sorted and then sent to Du Pont and fiberized. The carpet fiber can be used for reinforcing plastic or asphalt, or as a component of carpet cushion.

**Asphalt Shingles**

American Reclamation Corp.
225 Turnpike Road
Southborough, MA 01772
Ph: [508] 624-7006
Fax: [508] 481-5393
American Reclamation Corporation produces asphaltic paving mixtures from recycled mineral aggregates, recycled asphalt pavings, crushed asphalt shingles, and asphalt. These mixtures, which include 90% recycled components, are created using a cold mix asphalt emulsion process. Testing reveals that AmRec mixtures do not leach any hazardous materials. Contact them to find out more about these products.

ReClaim Inc.
8001 N. Dale Mabry Hwy
Suite 101
Tampa, FL 33614-3211
Ph: (813) 935-8533
(800) 448-5307
Fax: (813) 933-9713
ReClaim, Inc. recycles asphalt roofing materials collected from construction and demolition projects into RePave, a permanent asphalt road patching material. ReClaim currently has two plants in New Jersey and plans to open two more each year for the next five years in major metropolitan areas. Each plant recycles 20,000 to 30,000 tons of asphalt per year. In the past five years, ReClaim has recycled 180,000 tons of asphalt. ReClaim works with the community to identify sources and quantities of roofing debris; the material is collected and converted into a valuable product. This is a good example of a product made from a material which would otherwise go to a landfill.

**Other Roofing**

Renaissance Roofing Inc.
P. O. Box 5024
Rockford, IL 61125
(815) 874-5695
Renaissance Roofing purchases used clay roofing tiles and slates from demolition contractors across the nation, and is available for roof demolition with adequate prior notice. See Salvaged Materials chapter.

**Paint**

Innova
P. O. Box 1747
Boyes Hot Springs, CA 95416
(707) 938-4450
Innova offers The Commercial Paint Recycler, equipment that blends usable latex paint leftovers for use as primer, base coat or top coat. The Commercial Paint Recycler requires 27 square inches of floor space, and operates on 120-volt power. It can mix up to 60 gallons of paint per batch, and provides painters and builders with a means of reusing leftover paint.

**Insulation**

Big Green Marketing
P. O. Box 510
Bend OR 97709
(503) 383-0095
The Big Green Machine™ is an insulation reprocessor that allows builders and demolition contractors to grind used or scrap fiberglass batt insulation into bagged loose insulation suitable for blowing or pouring. The machine provides a means of reusing fiberglass insulation that cuts landfill costs and represents a savings over the cost of new insulation.

These are just a few of the many organizations currently recovering resources and preventing waste generation during residential and commercial construction.

Through such efforts, the building industry can decrease the amount of landfill space it uses and save money and materials.

Please contact CRBT if you know of similar recycling programs. We'd like to help our industry make the transition from "wasteful" to "resourceful" job-site practices.
Designing for Resource Efficiency

The essence of resource efficiency is the conscious reduction of our use of natural resources. Careful design and planning are imperative for successful implementation of resource efficient construction principles and practices. Three primary aspects of resource efficiency intertwine to form the basic design considerations: space efficiency, energy efficiency, and cost efficiency. An effective resource efficient design will combine these concepts with creativity, common sense, and forethought to conserve resources and energy and reduce the costs of building and maintaining a structure. Employing all the aspects of resource efficient design will produce houses that serve society's shelter needs without causing an undue demand on natural resources.

Space Efficiency

Perhaps the most obvious approach to resource efficiency is to build a smaller house. Although smaller houses generally cost less to build and operate in terms of money, resources, and energy, the national trend has been toward larger houses. In 1949, the average residence in the United States was less than 900 square feet and housed 4.2 people. The 2,000 square foot house typical in 1991 housed only 2.6 people. As our desire for personal space swells, the financial and ecological costs of construction and maintenance of that space increase dramatically. Only by reversing the trend toward larger houses can society achieve meaningful reductions in the amount of resources we allocate to constructing the built environment.

Small houses can be made space efficient, functional and livable through careful layout and design. Efficient and clever use of space can make a small house seem spacious. Long views and open plans make small houses seem larger, while including some enclosed space in designs adds necessary privacy. Not only does eliminating most interior walls and partitions make your home feel larger, but you also save the material and labor costs of framing and finishing the extra walls. Additionally, wasted space in hallways can be eliminated through design changes, and typically underutilized space can be employed for efficient built-in storage.

Besides the size of a house, the shape of a house is one of the main factors in the expense of construction. The basic rectangle is the most efficient shape for a house, and the most efficient rectangle is the square. These shapes enclose the greatest amount of floorspace with the shortest perimeter, which means less wall has to be constructed. When deciding the shape of your footprint, try to avoid complicated angles because it is much easier and less expensive to build straight walls. Thus, the fewer angles and corners there are in the plan, the less expensive the house will be, in terms of materials, labor and, consequently, money. Keep in mind that it is typically cheaper to build up than to build out. Building a two-story house generally costs less per square foot of floor area because you only have half as much foundation and half the roofing per square foot of floorspace. Starting out with the most appropriate size and shape for your house will reduce the costs of almost all aspects of construction, including the foundation, framing, roofing, and the costs of interior and exterior finish work.

Modest lifestyle changes can have a large impact on how a feeling of spaciousness or overcrowding is
perceived. Multiple uses of space and thoughtful planning of storage areas can help to create a quick-to-
clean and easy-to-maintain abode that is eminently livable, yet resource efficient. We have included refer­
ences for several titles on small house design that offer examples of the principles of space efficiency at
work.

**Making Space: Design for Compact Living**
Overlook Press
Lewis Hollow Rd.
Woodstock, NY 12498
(914) 679-6838

**Small Home Plans**
The Garlinghouse Company
P.O. Box 1717
Middletown, CT 06457
(800) 235-5700

**Small Houses**
A Fine Homebuilding Book
Tauton Press
Box 5506
Newtown, CT 06470-5506

**Energy Efficiency**

Energy efficient building gained significant popularity during the oil shortages of the 1970’s. Homeowners looked for ways to reduce heating and cooling costs, and adopted strategies like weatherstripping and adding insulation to walls and attics. Now a whole new generation of energy efficient building materials exists, ranging from structural insulated panels to super-insulated windows. Since the 1940s the thermal efficiency of insulation materials has improved steadily. Mechanical systems and appliances have also become more energy efficient over the years, and today efficient furnaces, refrigerators and other appliances offer reduced energy usage. Heat recovery systems help prevent the loss of conditioned air while providing necessary whole-house ventilation.

Energy efficiency is not only a result of materials choices, however. Design principles can also be employed to enhance the energy efficiency of buildings. Attention to window and overhang placement and orientation of a building promote daylighting and passive solar heating. Earth bermsing can buffer climatic extremes. Enclosed porches provide transition zones between inside and outside that reduce the loss of conditioned air. Cooling towers and well-placed windows provide opportunities for effective natural ventilation that contributes to reduced cooling costs.

The operating energy used for heating, cooling, lighting and appliances is not the only energy consumed by buildings. Buildings also represent a huge energy investment that includes the energy used in locating, extracting, processing, transporting and installing building materials. This embodied energy should be considered as part of the energy consumption attributed to a building. In an individual house embodied energy can equal as much as 30 years of operating energy.

Designers and owners can take several actions to reduce the embodied energy included in a building design. Minimally processed building materials have far less embodied energy than highly refined materials. Local products require less transportation energy than imported ones. Recycled materials generally have less embodied energy than new materials, and salvaged and reused materials require even less energy than recycled materials. Products that have a long life expectancy, yet require little maintenance, usually have less embodied energy over the life of a house than high-maintenance or short-lived products.
Cost Efficiency

Cost-effective design results from a considered combination of space efficiency and energy efficiency, blended with the selection of appropriate materials for each function. Achieving cost efficiency is integrally related to reducing the amount of material used in building. Sensible application of the ideas of resource efficient design makes building modest, comfortable, healthy and affordable homes possible.

In addition to the principles of space efficiency stated above, there are a variety of practical building techniques which reduce the overall cost of the project by reducing the amount of materials used. Clustered plumbing, for example, reduces the length of pipe required for plumbing because the rooms which require plumbing share a wall, or are in close proximity to each other. Savings can be achieved by installing the minimum required number of electrical outlets and switches, and wiring costs can be reduced by locating switches as close to fixtures as possible. In many cases, money and materials can be saved in framing by using 24 inch spacing of framing members instead of the conventional 16 inch spacing. Using premanufactured roof trusses is less expensive than stick-framing rafters, results in the use of less wood overall and reduces jobsite waste. Cost-saving strategies such as these typically use less materials than conventional building techniques, resulting in benefits to the builder and to the environment.

Summary of Resource Efficient Design Criteria

Finally, resource efficient building design comes back to a central principle: smaller houses cost less to build, in terms of money, resources and energy. Effective application of this central principle and other important facets of resource efficient design requires a comprehensive approach.

Developing a building design is a complex process that involves consideration of the energy and material resources the building will consume in its construction, operation and maintenance. Resource efficient designs reduce the amount of energy and material consumed by a building during its construction and use. The resource-conscious designer should plan for the future, as well, by considering the design’s ability to adapt to changing use requirements and how the building lends itself to dismantling or remodeling at the end of its useful life.

The criteria below provide a means of evaluating the resource efficiency of a building design, as well as suggesting means of reducing the environmental cost and resource consumption of a building. These criteria offer a standard toward which a designer can reach, even if a particular design does not fulfill every criterion. This comprehensive approach allows decision makers to avoid relying on fulfillment of a single criterion as the measure of “green-ness” in a building design. If a design choice is based on “practicality” or “cost-effectiveness” or “market demand”, the criteria below allow an assessment of the resource cost of that decision.

Given the relatively complex nature of the variables involved, it may not be possible to evaluate the performance of a structure relative to all of the listed criteria. Even so, this list of criteria allows at least a cursory consideration of all resources consumed through the life of the structure, and identifies areas where design improvement is desirable.

Resource efficient building designs:

1. Make efficient use of limited resources
   + Create a new building only when an existing building is not available for modification and reuse
   + Reduce total resource consumption by utilizing space-efficient design principles
   + Incorporate resource efficient building materials appropriately
   + Apply materials efficiently; avoid over-engineering
   + Utilize existing infrastructure [roads, water, sewer and power lines, etc.]
+ Employ dimensions based on standard component sizes to reduce the amount of waste generated in construction
+ Enhance structural longevity by withstanding local climatic conditions and extreme events such as fire, earthquakes, hurricanes, floods.
+ Include measures for water conservation, capture and reuse
+ Preserve existing native site vegetation, and restore native vegetation where lacking
+ Combine structural products of comparable longevity, to lessen probability of having to demolish or dismantle due to failure of a single element

2. Demonstrate recyclability or reusability
+ Recycle whole buildings or incorporate individual salvaged materials
+ Allow for future adaptability or dismantling by employing screws, bolts, panels and gaskets, rather than adhesives, nails, and permanent structures
+ Include features to promote recycling of occupant waste (composting, storage of recyclables, etc.)

3. Lower energy use
+ Use less operating energy than conventional designs
  - Include efficient mechanical systems and/or
  - Have highly insulated complete structure, including doors and windows and walls and roof and floor/foundation and/or
  - Make use of natural ventilation, heating (earth berming, passive solar etc.) and daylighting and energy efficient landscaping (shading, breeze channeling) and/or
  - Use renewable energy for electricity generation and/or heating
+ Utilize materials with a comparatively low total of lifetime energy inputs
+ Site building to require minimum additional transportation energy for materials and installers

Implementation Criteria
1. Are monetarily affordable
2. Have an appearance acceptable to homebuyers
3. Require labor and skill levels comparable to conventional designs
4. Meet applicable building codes for occupant safety
5. Are appropriate for the location, both culturally and socially
Indigenous Resources for Housing

Half of the world’s houses are made of earth: clay, caliche, wattle and daub, adobe or rammed earth. Not only earth, but a variety of indigenous materials—the materials native to a particular area—can be used to build bioregionally appropriate structures. The use of indigenous resources minimizes the amount of energy required for building material transportation and can reduce the energy costs of processing, as well. Historically, houses built from indigenous materials have created design vernaculars: they share distinctive basic style or particular details with their neighbors. Local or regional styles evolved over many generations and these structures are well matched to their regional resource base, climate and cultural setting. Like historical structures, contemporary indigenous buildings draw on materials at hand, including local surface or quarried stone, the building site’s excavated soil, or local wood or agricultural waste fiber. Native materials such as clay or uncut stone that require little energy or technology to process are also used.

There are many creative ways to include principles of resource efficient indigenous building in home design and construction. Innovative builders have combined ancient wisdom and new technology, lessons from both nature and modern engineering in indigenous material structures of exemplary resource efficiency. A few of these systems represent an eclectic synthesis of the best of “high” and “low” technology. Some innovations are widely replicable, and this chapter relays information on particularly resource efficient indigenous building systems that can be adapted to many situations.

The systems presented in this chapter are, in some cases, radically different from conventional stick-framing or even foam-core panel construction. These are not one-to-one substitutions of a resourcefully produced building component for a conventional one in a standard design. Instead, some of these listings represent completely different methods and structural systems of building, using simple, abundant materials. Some of these building methods hearken back to ancient ways of building, and reflect systems that evolved when quick transportation and cheap energy were not readily available. By contrast, a few “indigenous” building methods make inventive use of abundant waste materials discarded by our consumer society. These resource efficient systems utilize “waste” materials such as straw or tires as building elements.

Part of the recent resurgence of interest in alternative building systems has been the perception that they are inexpensive. While houses built from indigenous materials do offer the potential of lower materials costs, the design as a whole, including roof, foundation, mechanical systems and hardware, as well as labor expenses, will govern the cost of a building project. Expensive custom homes can and have been built with indigenous materials. Low cost is not a guaranteed result of choosing indigenous materials. Most indigenous systems, as traditionally built, share the trait of being labor intensive. This can add substantially to the cost of building. Fortunately many of the indigenous building methods are easy to learn, which allows the owner the option of reducing costs by providing all or part of the required labor in a kind of “sweat equity,” or hiring low-cost underskilled labor.
Although constructed of simple materials, indigenous buildings need not be utilitarian to the point of ugliness. In fact, houses of indigenous or salvaged waste materials can be elegant, unique and distinctively beautiful custom dwellings. Many of these indigenous building systems can be used to produce fairly conventional houses, and most can be applied to conform to standard building codes. Even so, indigenous materials do have some limitations and particular characteristics that the designer and builder should recognize. CRBT strongly recommends professional design and engineering for residential structures, particularly those that utilize unusual building methods. Safety and durability of structures are primary considerations.

While indigenous-material houses can be quite resource efficient, the use of indigenous building materials is not without environmental consequences. Stone and clay quarries have very site-specific impacts. The large-scale removal of fiber biomass from forest and agricultural soils also has a potential cumulative impact upon soil health, biological diversity and watersheds. Even so the use of indigenous materials can be relatively environmentally benign, compared to conventional types of building. The indigenous materials often require little processing energy beyond that contributed by human muscle power. A great potential exists to wed the best of ancient construction technologies with new materials and engineering knowledge, in order to produce affordable, durable and attractive resource efficient housing that is also bioregionally appropriate.
Adobe and Rammed Earth Buildings
The University of Arizona Press
1230 N. Park Ave., Suite 102
Tucson, AZ 85719

Adobe/Solar Associates
847 E. Palace Ave.
Santa Fe, NM 87501

Applications:
Adobe is most economical and resource efficient when excavated on site, which requires clay soil. Suitable for one- and two-story walls.

Comments:
Eminently suitable for use in desert climates with clay soils. Adobe builders in the Southwestern U.S. are numerous. Adobe construction is perhaps the most widely used building technique in the world. It is labor intensive when using manual labor, but has been mechanized by many builders. Adobe is unfired clay pressed into blocks, sun-dried, stacked, and mortared with clay. To improve resistance to water, asphalt emulsion can be added as a stabilizer.

Dwelling on Earth
Rammed Earth Works
1350 Elm St.
Napa, CA 94559
(707) 224-2532

Dwelling on Earth is a text on building with rammed earth. Rammed earth building utilizes the earth of excavation, with some additives and stabilizers if needed, to create massive and dense wall structures. Skilled crews can prepare foundations, erect forms and compact earth in the walls with relative efficiency.

Applications:

Comments:
This system is potentially labor intensive, but can be mechanized. Earth can be spray applied and pneumatically compacted.

Earthen Building Materials:
A Bibliography
Center for Maximum Potential Building Systems
8604 FM 969
Austin, TX 78724
(512) 928-4786

Earthen Building Materials:
A Bibliography
Center for Maximum Potential Building Systems
The University of Arizona Press
1230 N. Park Ave., Suite 102
Tucson, AZ 85719

Earthen Building Materials:
A Bibliography
Center for Maximum Potential Building Systems
8604 FM 969
Austin, TX 78724
(512) 928-4786

Earthwood
366 Murtagh Hill Rd.
West Chazy, NY 12992

Earthwood is a text and workshops. Cordwood Masonry or Stackwood construction is a building system that creates walls by ricking cordwood and cementing it with mortar. The wood used can be of any type. Cull or small logs can be bucked to length and used. When internal voids are filled with insulation, walls provide R-values comparable to stud walls, with good internal thermal mass.

Applications:
One- and two-story walls. Has been used below grade.

Element size:
8 - 24" long log ends.

Fire rating:
Good fire resistance.

Comments:
By using cull wood and judiciously applying cement mortar, the resource intensity of these walls can be improved. It is reported that a number of cordwood structures built in the 1800s are still in use and parts of 1000 year old buildings are in evidence.

Indigenous Building Materials:
An Overview
Center for Resourceful Building Technology
P.O. Box 100
Missoula, MT 59806
(406) 549-7678

Mansion Industries, Inc.
14425 Clark Avenue
P.O. Box 2220
City of Industry, CA 91746
(818) 968-9501
(800) 423-6589

ENVIRONCORE™ panels made from waste agricultural fibers. Panels are compression extruded at high temperature and bonded with kraft paper using a film of thermo-setting resin adhesive. Panels are cut to be used in the PYRAMOD™ structural system. Manufactured from rye or wheat straw, or sugar-cane rind, these panels provide a method of avoiding the burning of these agricultural resources.

Applications:
The panels serve as roof and walls, eliminating the need for structural framing. Pyramod houses are built from factory-prepared kits of precut Envirocor panels and adhesives.

Element sizes:
Panels are 4 3/4" thick by 4' wide in various lengths.

Resistance to decay:
Envirocor panels are resistant to mold and decay, and are immune to termite infestation.

Fire Rating:
Six inch panels achieve a 1 1/2+ hour fire rating.

Comments:
Panels have an R-value of 1.8 per inch. Pyramod houses are strong and durable, and according to Mansion Industries, they perform slightly better than stick-built houses in high winds and earthquakes. Mansion industries focuses primarily on low-cost housing for developing countries, but also provides technology for those interested in setting up manufacturing facilities.

Center for Resourceful Building Technology
Indigenous Resources
Monolithic Constructors, Inc.
P.O. Box 479
Italy, TX 76651-0479
(214) 483-7454
Concrete domes made from an air-inflated fabric form insulated with polyurethane foam, embedded with rebar and sprayed with shotcrete.
Applications:
For homes, churches, shops, or stores. Sold as a kit including airform and rebar hangers.
Sizes:
Variable. Domes are available in custom design.
R-value:
Domes are approximately R-60.
Comments:
This building method is fairly resource intensive and uses many nonrenewable resources, but it is an interesting design concept appropriate for some applications. These structures should be extremely long lasting.

"The Last Straw"
Out on Bale (un) Ltd.
1037 East Linden Street
Tucson, Arizona 85719
(602) 624-1673
- or -
Plastered Straw Bale Construction
The Canelo Project
HCR Box 324
Canelo, AZ 85611
- or -
The Straw Bale House
Chelsea Green Publishing Company
P.O. Box 428
White River Junction, VT 05001
Several publications on strawbale construction are available. A number of organizations offer workshops on strawbale building, and there are professional designers and builders who specialize in strawbale structures. Strawbale construction utilizes bales as building blocks in wall assemblies. The bales are stacked on a solid foundation, secured together and protected with stucco.
Applications:
A low cost, low technology approach to home construction. This technology is well suited for areas with high seismic risk, extreme climate, and where straw resources are available.
Element sizes:
Uses standard straw bales of approximately 60 pounds.
Resistance to decay:
Straw bale houses built at the turn of the century in Nebraska show very little sign of decay.
R-value:
2' thick walls can provide R-45.
Fire Rating:
Unlike wood, straw contains up to 60% silica which acts as a natural fire-retardant and the density of the compressed bale walls further prevents combustion. Fire and pest resistance is quite high once the walls are stuccoed.
Comments:
Straw is a byproduct of annually renewable crops that is often burned as agricultural waste. The "Nebraska style" construction uses bales in a load-bearing wall. The ease of strawbale construction lends this method to owner-building and also to underengineering. Professional engineering consultation is advisable.

Solar Survival Architecture
Michael Reynolds
P.O. Box 1041
Taos, NM 87571
(505) 758-9870
"Earthship" earth-sheltered, adobe-finish houses use recycled tires, cans and bottles as substrate for exterior and interior walls. Rows of tires are packed with earth and set in place in a staggered fashion to create a thermal-mass structure for the three-foot thick exterior walls. The tires are stacked around window and door frames. Interior walls use cans as "bricks" to create sculptured surfaces. All surfaces are finished with adobe. These houses, conceptualized by architect Michael Reynolds, use one of this country's most problematic waste resources - tires, as well as bottles and cans.
Applications:
These houses seem best-suited to southern regions where rainfall is low and adobe construction has been used for centuries, although work has been done to adapt the design for wet and cold climates.
Resistance to decay:
Excellent.
Fire Rating:
Not mentioned.
Comments:
Waste tires are plentiful, and it seems these homes could be built at relatively low material cost, using unskilled labor, with locally available earth and tires.

Stone Container Corporation
2021 Swift Drive
Oak Brook, IL 60521
(708) 574-9551
Low cost housing units made from corrugated fiberboard panels assembled with nuts and bolts. A cost-effective housing solution to inadequate housing caused by disasters, low economic conditions or emergency relocations.
Applications:
These structures are attached to 2" x 6" lumber set upon a level foundation surface such as concrete.
Element sizes:
Panels are 2' wide in lengths of 5 1/2' or 8'
Fire Rating:
Not specified.
Comments:
Basic shelters can be assembled in 1/2 day by three workers. Panels are wax impregnated for water resistance, and further weather protection can be achieved by painting the exterior. Board components are bonded with an acrylic adhesive.

Center for Resourceful Building Technology
Managing Resources

The construction of buildings necessitates the consumption of resources. What kind of resources are used depends both on societal tastes and upon which resources are available, at what price. How long the supply of a given resource will last is in turn dependent upon the rate of consumption and the way resources are managed. Current consumption patterns dictate that supplies of some conventional construction resources will be exhausted in the not-too-distant future. If society hopes to have long-term continued use of these resources, we must carefully examine the implications of our resource utilization, and craft management strategies that provide for both responsible use and resource safeguarding. This section explores some of the issues and opportunities involved in the management of the resources most applicable to construction: wood, agricultural fiber, minerals and waste resources.

Forests and Timber

As North America was settled, plentiful wood supplies over much of the continent fostered the development of wood-intensive building methods that have evolved over time into today's accepted industry standards. Yet the nature of the wood resource base is changing, and the timber industry is necessarily advancing from historical production practices to new harvest methods, more efficient wood utilization and new generations of wood-based products. These changes are affecting the way forests are managed, as well.

A History of Forestry in the U.S.

The pre-colonial American forests covered over 850 million acres of the country in unbroken stands of conifer and deciduous trees. The first European colonists had little regard for the dark impenetrable forests and used fire to push back their domain. Eventually some enterprising people cut boards using whipsaws and between 1625 and 1631 sawmills began to appear in Virginia and Maine. Lumber became a major commodity for trade with Europe in exchange for weapons and other manufactured goods. During this time the growing lumber industry also supplied materials for a booming shipbuilding industry. By the time of the Revolutionary War, colonial shipyards were producing 100 ships per year.

With the rapidly expanding colonial population, wood gained new importance as fuel. The iron furnaces and glass factories, as well as home heating and cooking, needed large amounts of wood. Ben Franklin commented in 1774 that "wood, our common fuel which within these three hundred years might be had at any man's door, must now be fetched near [160 kilometers] to some towns, and makes a considerable article in the expense of families".

By the turn of the 19th century, the US used more wood for fuel than any other purpose. By the year 1880, nearly 400 cubic feet of wood were burned for fuel by each US resident. With the high demand for fuel wood and millions of acres being cleared for agriculture, the US forest land base was reduced to less than 580 million acres in 1900.
The US Forest Service

Public outcry over the fate of American forests slowed cutting by the turn of this century. With the arrival of European forestry ideas and the subsequent creation of forest reserves, the US Forest Service was born through the actions of Gifford Pinchot and Theodore Roosevelt in 1905. The Forest Service conserved forest, but also managed for timber harvest and watershed concerns. After World War II demand for lumber boomed and the Forest Service shifted to a timber production management approach. As part of this approach, new policies were developed to reduce the annual acreage lost to fire.

The National Forest Management Act of 1976 changed management policies again by mandating multiple use and sustained yield, the concepts that ensure the simultaneous protection of fish and wildlife, soil, watershed, outdoor recreation, range, timber and wilderness. They require that each of these uses receive full and equal consideration in the management of the national forest, so that the benefits of each will continue over time.

Too often in the past, sustained yield has been thought of only in the context of timber. However, just as it means the cutting of only as much timber as will grow back in the current cycle, it also implies sustained maintenance of wildlife, watersheds, range, and other forest values. A related concept, non-declining even-flow, limits the amount of timber cut during a planning period to an amount which can continue to be harvested through successive planning periods without interruptions or fluctuation. Old growth forests, however, create a problem for forest managers. Old growth stands are viewed as unproductive, but problems arise with converting those unproductive stands to vigorous young stands while still upholding the principles of sustained yield. The sheer volume of wood in old growth forests makes non-declining even-flow management virtually impossible. In addition, over the years we have come to better understand the undisturbed old growth community and its ecological role, and have come to recognize the rich and unique biological diversity of this forest.

Private Industry-Owned Forest

The U.S. Forest Service estimates that 483 million acres of land in the U.S. are "commercial timberland", meaning that they are capable of producing industrial volumes of wood. The ownership of this vast timber base is comprised of four groups:
1. The Forest Service: steward of the National Forests
2. Other public: including Bureau of Land Management, other federal agencies, Native American tribes, and states
3. Industry: forest products companies intensively managing lands for timber output
4. Other Private: families and individuals who own forested land

Many wood products companies depend at least in part on public land timber sales but, generally speaking, the private wood products industry owns the nation's most productive timberland. Although the forest industry manages only about 20% of the nation's timber base, they are responsible for supplying the bulk of wood products used by society.

The wood products industry is incredibly diverse with market shares spread between 45,000 competing large and small companies. The forest products they provide are divided into two major categories: solid wood and paper. Most companies focus on just one product, but in recent years large wood companies have diversified because the demand for paper has remained strong in spite of economic conditions, while the demand for lumber is extremely sensitive to economic cycles. Secondly, raw material demands for paper are low, while lumber and plywood manufacturing require trees of certain minimum size and age. As the forests are being cut over the percentage of wood available and suitable for manufacture into solid wood products is falling.

The two major timber producing regions of this country are the Pacific Northwest and the Southeast. Major differences and economic rivalries exist between the regions. The Southeast, with fast growth rates,
flat terrain, and relative closeness to the timber market (the Northeast and Central United States), can produce lumber more cheaply than the Pacific Northwest. The Northwest, however, still contains old growth timber and thus produces "clear" tight grained lumber, desirable in many applications of wood working and construction. In the coming years with the shrinking average size of Northwest trees, the Southeast may take the upper hand.

In general, industry lands are intensively managed and harvested. Yet even these practices do not supply enough logs to satisfy demand, particularly when the voracious international market is added to the equation. In Washington, for example, where no restrictions on the export of private raw logs exist, foreign ships made 229 stops at Grace Harbor in 1988. More than one-third of Washington's timber went overseas without any processing in domestic mills. Export of raw logs from industry-owned lands creates a domestic supply void that increases demand for logs from public lands.

Forest Management for Production

What is forest management? According to Lawrence Davis and K.N. Johnson: Forest Management aims at increasing growth and protecting against losses. Meeting these objectives involves fire management, insect and disease management, stand regeneration, stocking control, and fertilization. This paradigm regards the trees as the sole component of the forest, usually ignoring wildlife, water quality, and other forest values. Forest management is usually substituted for natural succession in order to increase a forest's output. Generally speaking, the interest of the landowner dictates desirable forest outputs and what management regimes are used to obtain them. For example, a forest managed for saw logs will differ greatly from a forest managed for paper pulp.

Intensive forest management changes the character of a forest. While natural succession relies on fire as an agent of change — clearing brush and dying organic material, creating diversity and genetically strong forests—timber harvesting is the agent of change in the managed forest. Harvesting creates change but cannot establish new forest as quickly and efficiently as fire. Furthermore, diversity is greatly reduced when an even-aged, single species managed forest grows in the place of a natural stand. In addition, logging operations often select the largest and strongest trees leaving the poorer ones to regenerate the forest. However, today second growth forests are beginning to meet the demand for much of the country's wood fiber, and consequently more attention is being directed toward maintaining long-term forest health.

Timber Utilization Contrasts

Due to easy availability and the relatively low price of timber, American lumber manufacturers have historically wasted a large amount of wood. Today with higher prices and demand, nearly all parts of the tree are used in some form or another, but a disproportionate amount of each tree — usually one third to
two thirds – is turned into lower-value pulp or chips. This is in part due to thick saw blades with a wide kerf and also due to low demand for structural lumber smaller than two by two inches, that could be produced from small-diameter trees. The typical sawmill in the West recovers only about 6.5 board feet for every cubic foot of log entering the mill. Log sizes are smaller in the East, and it is more difficult to cut dimensional lumber from smaller logs, so the recovery factor there is less than 6.0 board feet per cubic foot. On average, then, about half of the volume of saw timber milled in the U.S. is wasted or used for low value products.

In Japan, by contrast, where wood is scarce, saw blades are very thin and structural lumber may be smaller than one inch by two. Recovery there is typically 90 to 95 percent of the whole log. This means that US mills require three or more logs to produce the same volume of lumber the Japanese can produce from two logs, according to Cascade Holistic Economic Consultants. This is the main reason the Japanese market will pay two to three times more for imported whole logs than for US-milled dimensional lumber.

Lumber Consumption in the US

In the United States more than 60 percent of lumber and 75 percent of plywood go to build and remodel homes and offices. Over 90 percent of new single family homes are wood framed. North America is one of the few places in the world where such a large percentage of homes is built of wood. According to studies, construction of the average single family home uses approximately 12,500 board feet of wood. Larger dimensional lumber that has traditionally been used for building, such as 2 x 10s and 2 x 12s, is becoming more expensive due to the decreasing national inventory of large trees.

Dimensional lumber consumption has not significantly increased over the past 80 years in the U.S. because plywood has replaced many lumber uses. Now new and more efficient technologies such as oriented strand board are in turn replacing plywood, and engineered wood beams serve as a substitute for solid wood beams. Steel and aluminum have also been substituted in many structural applications where wood was once used. The wood products and construction industries are learning to make effective use of smaller, younger and fast-growing trees. Technology must be kept up to date in harvesting, milling and utilization practices in order to reduce environmental damage and waste and maximize many values to be gained from the national timber base.

Agricultural Resources

Given the increasing concern over sustainability of timber harvest levels and the expected rise in cost of wood products, people are looking to other resources that could supply fiber for building materials. Agricultural fibers, derived from both alternative and commonly grown crops, show much promise as raw material for the manufacture of building products. At present the potential of agricultural fiber products is largely unrecognized, and in fact some useful agricultural fibers are currently considered waste.

One example of an underutilized agricultural fiber with construction applications is cereal straw. This straw, a by-product of wheat, oat, rice, barley and other crop harvest, is often burned in the field because there is little market for it and tilling it back into the soil is laborious. This straw burning practice contributes to air pollution problems in many heavily agricultural regions. These problems can be averted by harvesting the straw for use in building.

Standard straw bales can be used as structural building blocks, or as insulative infill in post and beam structures. The insulation value of the air in the hollow straw stems is also utilized by innovative systems that use straw as the insulation in structural panel systems. Smaller straw fibers form natural lignin bonds under heat and pressure to produce sheet-style products similar to the medium-density-fiberboard made from wood fiber. These straw products show potential as sheathing and in finish applications such as cabinetry. Still other products combine straw fiber with materials such as cement, to take advantage of the insulation, workability and light weight the straw offers.
Other crops also produce fibers with potential applications in construction. Kenaf and hemp are both plants with long, strong fibers that could be utilized in the manufacture of composite building products currently made from wood fiber. Many potential uses for these crops are only beginning to be identified. Additional plant fibers, such as sisal and jute, are used to make durable natural floor coverings. Soybeans can be used to make plastic, and other agricultural products and byproducts have adhesive properties that may be useful in building product manufacture.

Technology utilizing agricultural fibers in the production of new building materials shows much promise, but it is still important to consider the relative resource efficiency of these materials. Just as careful stewardship of the forests is vital to the continuity of the wood resource, stewardship of the soil is necessary to ensure the long-term viability of crop production. In many cases straw is considered an agricultural waste and burned in the field, so harvesting this fiber and using it to manufacture building products is relatively resource efficient. However, the continued harvest and removal of this biomass contributes to depletion of soil fertility, and eventually to decline in soil health. It is important to ensure that harvest cycles are alternated with cycles of biomass return, to promote soil health and continued productivity.

Straw and other fibrous crops are usually grown as large-area monocultures that decrease local biodiversity and require supplemental irrigation, fertilizers and pesticide application. Industrial agriculture mines the land similar to the way early industrial timber companies mined the forest. In order for agricultural fibers to provide a long-term resource-efficient building material supply, agriculture must be conducted in a resource-efficient manner that allows for long-term stewardship of the soil resource. Practices such as crop rotation, cover cropping and organic farming all contribute to the viability of long-term cultivation and fiber utilization.

Mineral Resources

Most buildings are made up of a variety of materials, including not only renewable fibers, but also mineral resources such as metals, glass, concrete and petroleum-based plastics. In addition, the energy required to process raw resources into building materials is derived largely from fossil fuels, which are another type of mineral resource. Geologist John Wolfe estimates that extracting the different types of mineral materials and fuels used for construction of an average-size house produces a cumulative excavation equal to the volume of the house.

The mineral resources and fossil fuels extracted and used for building are non-renewable, and in some cases the supplies of virgin resources are dwindling. As supplies of some mineral resources decline, more-abundant alternatives are being sought, as well as ways to use limited materials in an efficient and selective manner. Fortunately, not all the mineral resources used in construction are rare. Seventy-five percent of the structures on Earth are made from earth, demonstrating that plentiful substances such as clay and stone have practical applications in construction. Modern technology allows builders to combine efficient and limited use of rare non-renewable materials with abundant materials, in order to provide practical housing that performs well.

If the building industry is to continue to use non-renewable materials, the concern of recyclability becomes paramount. Limited resource supplies can be stretched dramatically by reuse or recycling of the products fabricated from that resource. Unfortunately, recycling rates for most materials are presently far lower than the rates required to sustain current levels of consumption, and recycling is difficult or impossible for some material configurations or following some types of consumption. Yet recycling is a vital aspect of prolonging the supply of non-renewable materials, and avoiding waste of limited resources.
Waste Resources

The perception of abundant natural resources has contributed to the United States becoming one of the most wasteful countries in the world. Figures from the US Environmental Protection Agency show that the per capita generation of waste in the United States was 4.4 pounds per day, up significantly from the 1960 level of 2.2 pounds. For a national population of 261 million, this amounts to a yearly waste production of 206.9 million tons.

Well over half of this waste is currently sent to landfills for disposal by burying. Landfill disposal has become increasingly expensive and problematic in recent years, however, as leachate and contamination problems with existing landfills are revealed, and communities band together to resist siting of new landfills. Interstate, and even international, trade in garbage is becoming more common as governments look for somewhere to dump the waste generated by their citizenry. Yet the answer may not lie in building bigger, safer landfills. The materials in the waste stream can be viewed as underutilized resources, and methods sought to recover these resources.

One resource traditionally recovered from waste has been energy. Incineration of waste produces heat energy that can be harnessed to provide power, and this is the fate of around 15% of the nation’s municipal solid waste. Yet not all waste is suitable for incineration, and many health concerns arise from the pollution produced by waste incinerators. Today incineration consumes only half the percentage of the waste stream that it accounted for in 1960.

Some materials are diverted from the waste stream for recycling or composting. The percentage of goods in municipal solid waste recovered for recycling or composting has been steadily increasing, and in 1993 accounted for 21.7% of the total waste generated. Materials recovered from waste for second uses include aluminum, steel, glass, paper and paperboard, yard trimmings, and plastic packaging. Recovery rates for these materials range from a high of 53% for aluminum to only 4% for plastic packaging. Clearly, then, many recyclable materials are still left in the waste that goes to landfills.

Apart from recycling, the amount of waste going to landfills can be reduced by achieving a more efficient initial utilization of materials. The amount of waste generated per capita can be reduced by consciously “precycling.” Precycling involves selection of durable, reusable materials with minimal packaging. Reusing materials instead of disposing of them is another aspect of precycling. Finally, increased efficiency in manufacturing processes themselves prevents industrial waste. Combined precycling and effective recycling help to avoid the creation of waste and foster the efficient use of resources.
Energy

Energy is something that Americans consume every day in vast quantities, mostly without considering its source. Yet the production of energy causes huge environmental impacts, ranging from open pit coal mines and dammed rivers to oil spills and air pollution. The majority of the energy used by Americans is supplied by fossil fuels that are environmentally costly to extract, and that cause serious air pollution through their combustion. Furthermore, these fuels are a finite resource. By cutting the amount of energy consumed, society has a chance to extend the fossil fuel resource, and to reduce the environmental degradation caused by energy production and consumption. In order to reduce energy consumption, especially by improving energy efficiency, we as a nation must first recognize how we use energy.

One of the major uses for energy is building construction and operation. According to the Environmental Resource Guide produced by the American Institute of Architects, more than 30% of the energy consumed in the United States goes to making and maintaining buildings. This energy total includes both operating energy – the energy required for space heating and cooling, water heating and utilities for a building – and embodied energy in the physical structure.

Most people are familiar with the concept of improving the energy efficiency of buildings by reducing the operating energy they use. It is a common claim that energy efficiency measures can reduce the operating energy of an individual building by 60% or more over a conventional building. While many countries have directed major efforts toward reducing operating energy, comparatively little attention has been focused on recognizing or reducing the embodied energy of structures.

Embodied energy is an assessment that includes the energy required to extract a resource, plus the energy used in primary and secondary manufacturing activities to provide a finished product. There is embodied energy in any processed product, from a plastic drinking cup to a car. In embodied energy terms, buildings represent a huge, relatively long duration energy investment.

Reducing the embodied energy of buildings has the potential to significantly reduce energy consumption, because every building is a complex combination of many processed materials, each of which contributes to the building’s total embodied energy. The energy required to extract and process the raw material for an individual component, as well the energy used to transport the finished product to the job site and install it, all become part of the embodied energy cost of the completed structure. Furthermore, energy involved in maintaining an individual building component, and finally removing it and disposing of it or recycling it at the end of its useful life, can all be part of the embodied energy equation for a particular building material, depending on how the embodied energy is quantified.

The quantification of embodied energy for any particular material is an inexact science, requiring a “long view” look at the entire manufacturing and utilization process, and filled with an infinite number of potentially significant variables. Consequently, the complexity of embodied energy calculations is frustrating even for scientists, and it is easy for the individual homeowner, builder, designer or government specifier to become discouraged at the difficulty of obtaining accurate figures. As though the figures for materials weren’t confusing enough, calculations of embodied energy will be different for each job site. Factors such as distance of the site from manufacturer, distance from railhead, and even distance that tradespeople must travel to and from the site during construction are all part of the embodied energy equation. Furthermore, the type of fuel used in processing and transporting materials can affect the amount of embodied energy contained in the final product. Two products of identical appearance may have very different embodied energies, depending on where and how they were made, and where and how they will finally be used.

Given these complexities, the builder bent on reducing energy consumption is faced with learning as much as possible about the potential materials options, and then basing decisions on the probable relative embodied energies of these materials given the information available. Fortunately, precise figures are not
absolutely necessary for informed decisions on which building materials to use in order to lower the embodied energy in a structure. The specifier or builder need only recognize the potential differences in relative embodied energy to make wise material and system choices. A few general rules of thumb apply, and some conclusions about embodied energy content can be reached with only a small amount of information on the products involved.

For example, the embodied energy in recycled building materials is generally less than that contained in new materials. Recycling provides easily obtainable manufacturing feedstock. In other words, there is very low extraction energy associated with recycled materials. Although manufacturing with recycled feedstocks can involve transporting, cleaning and sorting the recycled materials, this often requires far less energy than manufacturing with a virgin resource. In addition, the embodied energy of a manufactured material can be lowered by reducing the energy required in any stage of its production. For example, the processing energy of lumber is greatly reduced by air drying it instead of kiln-drying it.

Reusing materials, or even reusing entire buildings by retrofitting them, reduces the total amount of embodied energy even more than using recycled materials. Although reusing materials often requires intensive cleaning and frequently entails repair, it represents a means of attaining significant embodied energy savings, as well as resource savings. Builders and specifiers can achieve significant embodied energy savings in buildings by incorporating as many salvaged and reused building components as practical.

Another means of reducing the embodied energy in a building over its lifetime is to choose durable, long-lived building materials. Durable materials tend to have lower embodied energy than disposable or short-lived materials. Although less-durable materials may not involve as much energy in their manufacture, the need for frequent replacement, combined with the need to dispose of the product following removal, result in a higher total embodied energy over the life of the structure.

Embodied energy of a structure can also be reduced by building with indigenous, or local, materials. In addition to their lower transportation energy costs, indigenous materials usually involve less processing energy than conventional construction materials. Using materials like local stone for patios involves less embodied energy than concrete or treated wood patios and decks. Some builders go so far as to build entire structures of indigenous materials, such as adobe, strawbales, straw-clay mixes or rammed earth. These forms of building tend to have significantly less embodied energy than conventional stick-framed construction.

After all the rules of thumb have been applied, the best hope of reducing embodied energy in buildings comes down to the reasoned actions of responsible individuals. Environmentally-aware builders, designers and homeowners can usually identify building products with relatively low embodied energy. Building components made from recycled materials, or minimally processed local materials, tend to have less embodied energy than building products that are highly engineered, imported, or made from virgin resources. Choosing durable building products that require little maintenance will also help builders reduce the amount of embodied energy in a structure. It is only by addressing both components of energy usage—the operating and the embodied—that Americans can reduce the vast amount of energy consumed by buildings.
Additional Information Sources

Please send us information you may have on resource efficient materials, systems, or organizations that you do not find in this Guide.

Alternatives to Lumber and Plywood in Home Construction
Prepared by NAHB for
U.S. Department of Housing and Urban Development,
Washington, D.C. 20410

American Solar Energy Society
2400 Central Avenue, Unit G-1
Boulder, CO 80301
(303) 443-3130

Builders for Social Responsibility
Contact: Chuck Reiss
RR 1, Box 1953
Hinesburg, VT 05461
(802) 482-3295

Building With Nature Networking Newsletter
Contact: Carol Venolia
P.O. Box 369
Gualala, CA 95445
(707) 884-4513

Center for Maximum Potential Building Systems
8604 F.M. 969
Austin, TX 78724
(512) 928-4786

Canada Mortgage and Housing Corporation
682 Monral Road
Ottowa, Ontario K1A 0P7
Canada
(613) 748-2000

Cost Effective Home Building
National Association of Home Builders
Home Builder Press
1201 15th St. NW
Washington, DC 20005

Eco-Home Network
4344 Russell Ave.
Los Angeles, CA 90027
(213) 662-5207

Energy Source Directory
Iris Communications
258 East 10th Ave., Suite E
Eugene, OR 97401-3284
(503) 484-9353

Environmental Building News
RR 1, Box 161
Brattleboro, VT 05301
(802) 257-7300

Environmental By Design
Kim Leclair and David Rousseau
Volume I: Interiors
Hartley & Marks, Inc.
79 Tyee Drive
Point Roberts, WA 98281

Environmental Resource Guide
American Institute of Architects Committee on the Environment
1735 New York Avenue, NW
Washington, DC 20006
(202) 626-7463

Green Builder Program
City of Austin Environmental and Conservation Services Department
206 E. 9th St., Suite 17.1021
Austin, TX 78701

International Institute for Bau-Biologie & Ecology, Inc.
P.O. Box 387
Clearwater, FL 34615
(813) 461-4371

Loompanics Unlimited
Building with Junk and Other Good Stuff
P.O. Box 1197
Port Townsend, WA 98368
(206) 385-5087

National Center for Appropriate Technology
P.O. Box 3838
Butte, MT 59702
(406) 594-4572

Pacific Northwest Ecobuilding Network
Jeffrey Learned
P.O. Box 6465
Kent, WA 98031
(206) 850-7456

Rocky Mountain Institute
1739 Snowmass Creek Rd.
Snowmass, CO 81654-9199
(970) 927-3128

Solar Energy International
P.O. Box 715
Carbondale, CO 81623
(970) 963-8855

Information Sources

Center for Resourceful Building Technology
So, how well do these new products work?

ReCRAFT 90 is the first of the Center for Resourceful Building Technology’s demonstration projects. ReCRAFT 90 was built in Missoula, Montana, and was completed in the spring of 1992. It demonstrates new products and systems that exemplify an efficient use of resources in their manufacture.

ReCRAFT 90 is an attractive, very energy efficient custom home. This 2400 square foot house was designed specifically for a cold northern climate and is bermed into a southwest facing hillside. This orients the high-performance windows to allow natural daylighting, while optimizing energy efficiency. ReCRAFT 90 has a low-infiltration design, which includes a whole-house ventilation system to provide fresh indoor air. The careful selection of interior finish materials also promotes a healthy living environment.

We have published a booklet about the construction of this house, entitled ReCRAFT 90: The Construction of a Resource Efficient House. This 56-page booklet recounts the experiences of working with the more than forty different products that were used in the house. We found out which ones were fragile and which ones were so tough they required special saw blades. We found some that we liked and some that we wouldn’t recommend. This hands-on knowledge was not easy to come by. We hope that our experience can help you to achieve favorable results on your building project by anticipating differences that could otherwise turn into difficulties.

You can order the ReCRAFT 90 handbook for $12.50 (including shipping and handling) from CRBT.
Throughout this house are products that:

- Demonstrate a more efficient use of wood
- Provide an alternative to traditional wood products
- Are manufactured from recycled resources
- Have been re-used instead of being thrown away
- Provide water and energy efficiency in the house
- Are healthy to live with
CRBT Services

Professional Services

We offer professional services in the following areas:

- Building Design and Construction
- Public Involvement and Awareness Programs
- Building Industry Demonstration Projects

I. Building Design and Construction

Resource Efficient Materials and Products:

Our services support a resource efficient approach to building by using appropriate building design, materials, and construction. CRBT can:

- Review plans and suggest cost-competitive resource efficient materials
- Recommend products made from recycled materials such as municipal recyclables, or agricultural and industrial wastes
- Recommend appropriate replacements for dimensional lumber and means of using less lumber and other materials
- Recommend sources of wood products from sustained yield forests and demolition and salvage

Energy and Water Efficiency:

We provide technical assistance and support in all aspects of building energy and water conservation, including:

- Fresh air ventilation / Infiltration control
- Draft free construction
- Sun tempered designs
- Solar technologies
- Water conserving designs and materials
- Efficient appliances

Healthy and Non-Toxic Environments:

We can recommend affordable strategies for maintaining clean indoor air and water. Our approach stresses:

- Reduction of pollutant sources
- Effective air filtration and controlled ventilation
- Natural, comfortable daylighting
- Ensuring clean, safe water
- Selection of materials which are non-toxic in use and manufacture

Environmentally Responsible Buildings and Sites:

We can assist in developing an integrated approach which protects the environment through a set of best management practices. These have been field tested in construction projects and found to be effective and workable. They include:

- Construction waste minimization and recycling
- Surface water management
- Low-impact site preparation
- Erosion control and pollution prevention
- Naturescaping

II. Public Involvement and Awareness Programs

CRBT understands the importance of establishing partnerships with public and private organizations, including city and regional governments, electric utilities, building trade associations and neighborhood associations to support and promote public awareness of sustainable building. We offer expertise in public educational programs from the informal to the formal, including:

- Seminars and workshops on resource efficient and indigenous building
- Educational and informational text creation
- Program and curriculum development
III. Demonstration Projects

CRBT, emphasizing a hands-on team building approach, supports local demonstration projects. Our services include:

- Defining project goals and objectives
- Assisting with building and site design
- Identifying and selecting materials
- Information on low-impact construction techniques
- Assisting to identify local sponsors and supporters
- On-site and remote technical assistance
- Project documentation, evaluation and analysis

Our services support a resource efficient approach to building by using appropriate building design, materials, and construction.

Publications

- ReCRAFT 90: The Construction of a Resource Efficient House, $12.50
- Indigenous Building Materials: An Overview, $8
- Strawbaies as a Building Element, $8
- Affordable Resource Efficiency, $8

All prices include shipping/handling. Send for a current list of titles and prices.

Library

The Center for Resourceful Building Technology maintains a reference library of books, periodicals, research reports and other information on resource efficient building. Information on topics including recycled materials, energy efficiency, indigenous building materials, job-site recycling, and materials research is available to the public during office hours. Staff members may be available to respond to information requests by phone or to refer callers to other appropriate information sources.
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