State of Oregon
Department of
Environmental
Quality

Briefing Paper:
Residential Green Building

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Background

DEQ's green building research and policy efforts are rooted in DEQ's Waste Prevention Strategy, which identifies the design, construction, remodeling and demolition of buildings as one of four focus areas to prevent solid waste generation in Oregon. Construction, remodeling, and demolition debris comprises 20-30% of all waste generated in Oregon annually. Data also suggests that approximately 50% of the waste is from the residential building sector. DEQ chose to focus its waste prevention efforts on the residential sector because of its significant contribution to the waste stream, relative lack of attention compared to the commercial green building sector, and limited staff resources.

DEQ Research Efforts

In September 2010, DEQ completed a Life Cycle Assessment that prioritized residential waste prevention building practices based on lifecycle environmental benefits. The research focused on ways to REDUCE and REUSE materials (waste prevention) over the life of a home. We also examined the benefits of current recycling practices in Oregon as a means to understand the relative benefit of various REDUCE, REUSE, and RECYCLING practices.

Research Results

The average new home in Oregon

1) More than 80 percent of greenhouse gas emissions over a home's 70-year life occur during occupancy and are attributed to electricity and fuel consumption.
2) Approximately 14 percent of lifecycle greenhouse gas emissions are tied to producing the original and replacement building materials.
3) Constructing and maintaining the home account for about 2 percent of lifecycle greenhouse gas emissions and the transportation of building materials accounts for less than 1 percent of lifecycle greenhouse gas emissions.
4) Oregon's existing material recycling and energy recovery system (for building materials) reduces greenhouse gas emissions by 4 percent over the typical 70-year life of a home.

Materials

1) The production and transportation of materials contribute 10 to 40 percent of impacts to human health and ecosystem quality over the life of the home. The impacts of producing materials contribute more to human health and ecosystem quality impacts relative to greenhouse gas emissions.
2) For greenhouse gas emissions, the production of all materials was 70 times more impactful than the impact of landfilling those materials at the average rate in Oregon.
3) Replacement materials accounted for almost double the greenhouse gas emissions compared to the original materials used to build the home. This is largely due to the frequent carpet and asphalt roofing replacements.

4) Only a small amount – about 6 percent – of building material-related waste generated occurs during home construction, with about 50 percent of waste generation occurring during 70 years of home repairs and maintenance. The remaining 44 percent of waste generation occurs at the time of the home's demolition.
5) Material reuse prevented the most amount of waste and has potential for significant benefits in reducing the human and ecological impacts associated with producing materials. Material reuse, however, provides relatively smaller greenhouse gas reduction benefits because it does not typically affect the operational energy consumption of a home.

Reduce home size

1) Of the 30 different material reduction and reuse practices evaluated, reducing home size achieved the largest greenhouse gas reductions along with significant reductions in human health and ecosystem quality impacts.
2) Reducing home size by 50 percent results in a projected 36 percent reduction in lifecycle greenhouse gas emissions.
3) Reducing home size can be a significant leverage point to reduce environmental impacts and can be more effective than achieving minimum levels of current "green" certification programs.
4) Reducing home size can reduce the initial cost of the home, utility bills, and cost to maintain/repair the home over time.

Density – *The ability to fit more people into a given area by increasing the number of occupants within a home, or building a greater number of smaller homes in that area.*

1) New and existing homes of any size could incorporate internal accessory dwelling units (sometimes known as "mother-in-law apartments") within the home as an option to increase density and reduce the square foot/ person ratio, provide flexible living spaces, and achieve the environmental benefits of both small and multi-family living.
2) Various sizes of multi-family housing show significant lifecycle reductions in greenhouse gases and most other pollutants.

Wall framing

1) For wall framing practices, waste prevention is a poor predictor of total environmental benefits. Wall framing systems that use more materials to conserve energy typically create more waste but have overall benefit due to their energy saving properties.

Outcomes and Next Steps

DEQ's research has already been used to inform green building initiatives in the private and public sectors, including changes to Oregon's residential building code and the Earth Advantage Green Building Rating System. In the short term, DEQ is working with stakeholders to increase the adoption of top-ranked practices, which include decreasing average home size, promoting the reuse of building materials, and improving material selection guidance for homeowners and builders.

Discussion of Emerging Issues

1) **Operational energy use** dominates the environmental impacts of the average Oregon home today. However, as our homes get more energy efficient, the relative impact of materials gets larger. Material selection policies may play an increasingly important role over time. How can materials management influence the production and selection of materials with better lifecycle attributes?

2) **The limitations of DEQ's research** include the inability to compare a larger variety of building materials and the lack of indoor air quality impacts on the home's occupants. Both of these limitations

are driven by the lack of transparent information on building products. One example is spray polyurethane foam. This product, which has excellent insulation properties, has a wide range of embodied energy values based on blowing agents, fire retardants that are being phased out by law in the European Union, and a recent EPA Health Advisory on the potential long-term toxic health effects of off-gassing foam. Additionally, other foam products, such as rigid expanded and extruded polystyrene, which are very popular for their energy efficient properties, are being questioned by the green building industry due to the toxic nature of their fire retardants and primary component, styrene, which was recently classified as "reasonably anticipated to be a human carcinogen" by National Toxicology Program of the US Department of Health & Human Services.

3) **Durability of building materials** is often perceived to be a good thing. DEQ's research, however, showed that a small selection of durable product alternatives reduced environmental impacts in some categories and increased the impacts in other categories. Thus, the selection of durable materials needs to take a lifecycle approach and also include concepts of appropriate durability. If people change their countertops out every 10-15 years, do we need granite countertops that will outlast civilization? Additionally, many durable materials today, such as fiber-cement siding and plastic-wood composite decking have no beneficial use at the end of their life.

4) **The environmental benefits of waste prevention** (reduce, reuse) are generally greater than the benefits of waste recovery (recycle, energy recovery, compost). Nevertheless, the residential building sector needs to consume materials to provide shelter and there will inevitably be a certain amount of waste generated that's not able to be reused. DEQ's research showed that carpet, asphalt roofing shingles, drywall, and fiberglass insulation are all products that have high green house gas impacts and waste generation, low reuse potential, and very little recycling options. These are some products that could either benefit from a material substitution or a future expansion of recovery options. But either of these approaches need to be evaluated to make sure that they actually benefit the environment; simply substituting materials or increasing recovery may have unintended consequences.

5) **Restorative building techniques and materials** is a growing area of interest. There is interest in how to change the resource consumptive paradigm of our buildings. How can buildings help restore the natural environment around them? How can landscaping help local air quality? Can a building replenish an aquifer or supply energy to the electric grid? Can a building's design and operation increase worker productivity and reduce sick days? Can neighborhood scale utilities (or eco-districts) share and manage natural resources better than central or site specific systems?