EPA

OSWER Innovation Project Success Story:

DECONSTRUCTION

Deconstruction of an ongoing ReSOURCE project house by attendees of the two-week pilot-developed training course on deconstruction and building materials reuse.

EPA is continually searching for new ways to protect human health and the environment. The development of new approaches, practices, and technologies can make environmental protection more practical, more effective, and less costly. The Innovations Program in EPA's Office of Solid Waste and Emergency Response (OSWER) uses funding to support promising new policies, approaches, and/or technologies with the hope of turning promising ideas into practical realities. In the past, we have used grants as a tool to fund opportunities. More recently, we have funded projects internally through contractor technical assistance.

Innovations project funding tests new and cutting-edge technologies and programs without drawing significant resources from other EPA programs. Innovations projects and pilots provide a virtual test bed for ideas within OSWER. Many of these projects take flight and become supported OSWER programs. This series of fact sheets is meant to demonstrate how innovations projects have led to programs that address EPA's greatest environmental challenges.

The Problem with Debris

Construction activities, including demolition, produce a substantial environmental footprint—consuming significant amounts of natural resources, over-burdening landfills, and contributing to greenhouse gas emissions.

Conventional demolition underway.

It is estimated that 60 percent of the materials flow in the United States' economy (excluding food and fuel) is consumed by the construction industry.[1] According to the Environmental Protection Agency (EPA), a typical 13,300 square foot commercial demolition project generates over 155 pounds per square foot or over 2 million pounds of waste;[2] building-related projects in the U.S. alone generate an estimated 164 million tons of construction and demolition (C&D) material every year.[3] Approximately 40 percent of this material is reused, recycled, or sent to waste-to-energy facilities, while 60 percent is sent to C&D landfills.[4] Some researchers estimate that the amount of C&D waste generated in the U.S. is equivalent to the volume of municipal solid waste—e.g., garbage—landfilled every year.[5]

While diverting 40 percent of C&D material from landfills is substantial, the remaining 60 percent remains an unacceptable—and for the most part, preventable—amount of material still being merely discarded. The potential reuse benefits represented by this discarded portion are enormous. Virtually every step in a raw or virgin material cycle requires energy input for extraction, refining, transportation, and fabrication—which in turn creates carbon dioxide (CO_2) emissions, the primary greenhouse gas causing climate change. Reused and recycled materials require far less energy and resources and produce fewer emissions. For example, when one ton of steel is recycled, 2500 pounds of iron ore, 1400 pounds of coal and 120 pounds of limestone are conserved.[6]

The amount of construction space in the United States is expected to grow to nearly 430 billion square feet by 2030—which includes replacement of more than 25 percent of structures that existed in 2000.[7] An estimated 3.3 billion tons of material debris will be generated over the next 50 years.[8] Given the current estimate of only 40 percent of C&D waste being recycled or reused, this amount of resource use and waste generation may present a significant, long-term environmental problem. In recognition of this issue,

A training course attendee deconstructing lumber from the ReSOURCE project house.

EPA established an innovative program that has pioneered different approaches and solutions.

An Innovative Approach

Today, “going green” is a household term. While there are many programs in place to reduce environmental footprints, EPA has long recognized that a new, more sustainable approach to construction waste was needed. As part of its Innovations pilot grant competitions, the Innovation, Partnerships, and Communication Office (IPCO) funded proposals to explore different approaches to demolition through the concept of *deconstruction*. Deconstruction is the dismantling of buildings to maximize the reuse and recycling of building materials in a cost-effective manner, turning much of what is traditionally considered demolition waste into a valuable resource.[9]

Building materials reuse retains the energy invested in existing materials, preserves virgin resources, and reduces the pollution associated with materials production and disposal. Studies show that deconstruction can reduce construction site waste by as much as 70 percent.

IPCO’s Innovations pilots tested unique but related aspects of deconstruction, including: Building Deconstruction and Materials Reuse, Deconstruction and Building with Reused Materials Training, Deconstruction for Urban Revitalization, and Design for Deconstruction (DfD). These pilots not only produced meaningful results, they laid the groundwork for future deconstruction activities and initiatives and helped shape a more sustainable approach for C&D. These pilot case studies serve as examples of how deconstruction and materials reuse can be both environmentally sound and cost-effective—and demonstrate that there is a market for knowledge and education surrounding this issue.

Susquehanna project experimenting with “panelization”, where large sections of the row-house are removed intact for disassembly in a staging area.

Unique architectural features such as a corner turret and radiators reclaimed from the Susquehanna urban row-house and marketed through local architectural salvage businesses.

EPA IPCO’s Innovations Pilots—Demonstrating the Benefits of Deconstruction

Region 1

DECONSTRUCTION AND BUILDING WITH REUSED MATERIALS TRAINING

With approximately $53,000 in EPA funding, the Deconstruction and Building with Reused Materials Training pilot led by ReSOURCE developed curricula on deconstruction and building materials reuse for a free, two-week training course attended by representatives from the building industry, educators, architects, and other related areas. Based on the program’s success, a course entitled Deconstruction and Materials was created by the Yestermorrow Design/Build School in Vermont in July 2008; enrollment for the course taught in 2008 and 2009 was full.

Region 3

DECONSTRUCTION FOR URBAN REVITALIZATION

The Susquehanna Avenue Row-House Deconstruction Project, Deconstruction for Urban Revitalization, used approximately $73,600 in EPA funding to evaluate the cost-effectiveness of panelization—an innovative technique that involves cutting roof and floor panels into sections that can be easily processed and reused. Panelization and other techniques for deconstructing urban row houses were implemented to reclaim and reuse the maximum amount of structural materials. This pilot demonstrated that deconstruction can be cost-competitive with demolition methods when there are sufficient recoverable materials with market value to offset higher labor costs. The project diverted more than $7,500 worth of bricks, lumber, and metal from disposal.

Region 4

DESIGN FOR DECONSTRUCTION

Using approximately $69,000 in EPA funding, the Design for Deconstruction (DfD) pilot organized a

The DfD case study home (left) features repositionable interior walls (right) and disentangled heating and cooling system (not pictured).

group of experts to formulate DfD principles; design and build a case study using those principles; promote the "cradle to cradle" approach for residential building design; and document all research and results. This first known study of its kind asserts that residential homes can be designed both for increased longevity and for eventual disassembly and building materials reuse—by incorporating techniques such as moveable walls, disentangled utilities such as heating and cooling systems, and waste reduction. The study led to development of a "best practices" toolkit, *Design for Disassembly in the Built Environment: A Guide for Closed-Loop Design and Building*, for DfD in residential construction, and has become a learning tool for testing the viability of DfD.

DECONSTRUCTION AND MATERIALS REUSE

Using approximately $37,000 in EPA funding, the Wesley House/Reichert House Deconstruction and Materials Reuse pilot deconstructed a typical wood-framed house, and designed and reconstructed its constituent materials into new neighborhood building projects. The pilot conducted a comprehensive study, *Final Report: Deconstruction and Reuse*, that demonstrated and documented the environmental and economic value of deconstruction and design for reuse principles. In this example, deconstruction proved five percent less expensive than the demolition estimate. Aside from that savings, 44 percent of the total mass of the Wesley House was salvaged for reuse, and 20 percent of the material recovered was used to construct the new Reichert House—diverting 8.84 tons of material from landfills. Overall, the project avoided 41.77 Million British Thermal Units (MMBTU) of energy use, 2.68 Metric Tons of Carbon Equivalent (MTCE) of greenhouse gas emissions; and 9.83 Metric Tons of CO2 Equivalents (MTCO2E) of greenhouse gas emissions.

Turning Promising Ideas into Practice

The approaches proven effective by IPCO's deconstruction pilot projects have created lasting momentum, and are used routinely in real-world scenarios—making much-needed progress toward reducing the percentage of discarded materials. The deconstruction principles and practices demonstrated by the pilots have taken on a life of their own—not only within EPA, but for local governments, states, nonprofits, and across the private sector.

For example, based on the pilot-developed training, the trial deconstruction course offered by Vermont's Yestermorrow Design School has become a regular part of their curriculum, due to growing demand. In Philadelphia, the Deconstruction for Urban Revitalization pilot staff is working with the City of Philadelphia's Sustainability Director to include architectural salvage and deconstruction practices as part of the city's developing Sustainability Action Plan. Kevin Brooks Salvage (KBS), the deconstruction contractor for the Urban Deconstruction project, has since expanded beyond the Philadelphia area and reports that its deconstruction techniques have been adapted by environmental contractors across the state.

Further examples of the momentum generated by the IPCO pilots are easy to find. The deconstruction practices developed by the Wesley House/Reichert House Deconstruction and Materials Reuse pilot have become a model for the State of Florida. The pilot continues to be one of the most frequently requested studies from stakeholders seeking to initiate a deconstruction project. It also led to North America's leading supplier of construction cost information, RSMeans, to add a cost estimate category for deconstruction projects—validating the importance of recognizing deconstruction techniques throughout the industry.

The Design for Deconstruction principles developed through the DfD pilot have also had far-reaching impacts—becoming a widely recognized template for architects, engineers, academia, and other stakeholders. These principles were used to formulate the design of the Chartwell School in Seaside, California, a project that incorporated deconstruction methods such as modular framing and visible utility networks.

Wesley House prior to deconstruction (left). Deconstructed building materials from the Wesley House such as brick (center) and heartpine lumber from the main floor beams (right) used to build the library and lobby of the new Reichert House.

The demonstrated success and environmental benefits of building the Leadership in Energy and Environmental Design (LEED) certified Chartwell School sustainably, led to the creation of the Life Cycle Building Challenge. This annual competition seeks innovative projects that conserve construction and demolition materials and reduce greenhouse gas emissions by designing buildings for adaptability and disassembly. In addition, the Center for High Performance Schools in California, which oversees the nation's first green building rating program for K-12 schools, added criteria on design for deconstruction to its rating system based both the DfD pilot and the Chartwell School project.

These initial pilots also served as the primary body of knowledge for the *Lifecycle Construction Resource Guide* developed by EPA, a document that advances the concept of deconstruction by demonstrating the economic and technical feasibility of such practices. They also led the way for the creation of entities such as the Building Materials Reuse Association (BMRA) and building material reuse stores (e.g., Habitat for Humanity ReStores, Construction Junction).

The knowledge gained from the Innovations pilots helps to address some of EPA's greatest environmental challenges—from developing an integrated waste management program, to sustainable redevelopment of contaminated land, to green building approaches. It also complements other EPA OSWER programs and initiatives, such as the Resource Conservation Challenge (RCC), Brownfields and Land Revitalization, One Cleanup, Design for the Environment, and initiatives within the construction and demolition sectors.

Looking Ahead

As the U.S. advances toward a more sustainable and environmentally friendly future in terms of reducing and recycling all manner of waste products, EPA's Innovations Pilots have helped to stimulate creative ideas in support of deconstruction. Some state and local governments are addressing the large volumes of C&D materials entering the waste stream by passing ordinances that restrict C&D materials disposal or provide time for the often lengthier deconstruction process to occur. Some entities are implementing Demolition Material Management Plans and issuing Requests for Proposal that specify solicitations for deconstruction contactors. On a federal level, EPA is collaborating with the U.S. Green Building Council to include deconstruction in its LEED Green Building Rating System; as more and more builders and developers seek LEED certification, they will in turn be introduced to the benefits of deconstruction.

Reducing construction and demolition materials from the country's waste stream is an important, long-term environmental goal for EPA. The benefits of the approach to recycling building materials are multi-fold: supporting EPA's goals by reducing environmental and energy impacts of buildings; assisting the building industry in reusing millions of tons of building-related construction and demolition materials that would otherwise be sent to landfills; and reducing the energy and greenhouse gas emissions associated with the production and transportation of new materials. For example, if all concrete and asphalt pavement generated annually in the US were recycled, it would save the energy equivalent of 1 billion gallons of gasoline or the removal of more than 1 million cars from the road.[10] The IPCO-funded Innovations Pilots helped to incorporate this original approach to building material reuse into the American mainstream, and stand as successful, real-life examples of how to incorporate deconstruction and materials reuse into a variety of projects.

Endnotes

1 Wagner, L. Materials in the Economy: Materials Flow, Scarcity, and the Environment, US Geological Survey Circular 1221, US Department of the Interior, Denver CO: US Geological Survey Information Services, February 2002.

2 U.S. EPA. 1998. Characterization of Building-Related Debris in the United States, accessed at: *http://www.epa.gov/osw/hazard/generation/sqg/c&d-rpt.pdf*.

3 U.S. EPA. 2007. Draft Final Report, Waste and Materials Flow-Benchmark Sector Report: Beneficial Use of Secondary Materials—Construction and Demolition Materials.

4 U.S. EPA. 2007. Draft Final Report, Waste and Materials Flow-Benchmark Sector Report: Beneficial Use of Secondary Materials—Construction and Demolition Materials.

5 David Malin Roodman and Nicholas Lenssen, "A Building Revolution: How Ecology and Health Concerns Are Transforming Construction," Worldwatch Paper 124 (Washington, DC: Worldwatch Institute, March 1995), p. 24.

6 The Steel Recycling Institute. Brochure: Buy Recycled With Recycled Steel. Accessed at: *http://www.recycle-steel.org/PDFs/brochures/buyrec.pdf*.

7 U.S EPA 2007. Lifecycle Construction Resource Guide, accessed at *http://www.lifecyclebuilding.org/files/Lifecycle%20Construction%20Resource%20Guide.pdf*.

8 Nelson, A.C., "Toward a New Metropolis: The Opportunity to Rebuild America", Discussion paper prepared for The Brookings Institution Metropolitan Policy Program, December 2004.

9 Browning, P., B. Guy, and B. Beck. 2006. Deconstruction: A Cottage Industry for New Orleans, Working Paper from Pennsylvania State University's Hamer Center for Community Design and Mercy Corps Gulf Coast Hurricane Recovery.

10 U.S. EPA. 2007. Draft Final Report, Waste and Materials Flow-Benchmark Sector Report: Beneficial Use of Secondary Materials—Construction and Demolition Materials

More information on EPA's Innovations projects can be found at:

www.epa.gov/oswer/iwg/pilots/index.html

More information on lifecycle building can be found at:

www.lifecyclebuilding.org