



**HOW TO**  
**combat**  
**climate change,**  
**reduce the**  
**production of**  
**greenhouse gases,**  
and **build a**  
**stronger infrastructure.**

**Specify  
fly ash**

[a recovered resource]

**as a  
replacement for  
cement  
in concrete.**

**When coal is consumed** in the power plants that generate much of our nation's electricity, a product called "fly ash" is left over. Chemically, fly ash is classified as a "pozzolan" — a material that, when mixed with water and lime, reacts to form cementitious compounds.

A ton of fly ash can be used to replace  
a ton of cement in making concrete.  
**Using a ton of fly ash  
instead of cement reduces  
carbon dioxide production by a ton.**

It's not rocket science. We used about 15 million tons of fly ash for that purpose last year alone. In the process, we made concrete that was stronger and more durable than if it had been made with cement alone. And it didn't cost any more.

We also put another 40 million tons of fly ash into landfills last year. That's right. Threw it away. Making better use of this under-utilized resource represents one of the easiest ways available to accomplish significant greenhouse gas emissions reductions, **right now**.

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**Architects and engineers designing projects**  
for public works and private developments  
**can specify that building materials**  
**incorporate the use of fly ash,**  
while **government policy makers can encourage**  
**greater use of coal combustion products**  
through regulations and incentives that support utilization and  
construction of infrastructure needed to deliver CCPs to the users.



**In today's technology-driven world**, electricity powers our lives. From computers to medical devices, appliances to power tools, and thousands of other necessities and conveniences in between, electricity is indispensable. It keeps our homes safe, warm and comfortable; our schools and hospitals running; and our businesses driving a strong economy.

Our nation's electricity comes from four main sources: coal, nuclear, natural gas and hydroelectric. Power plants fueled by coal generate slightly more than half of the nation's electric power today.

Renewable sources of electricity — including wind and solar — are growing exponentially. Conservation efforts are also beginning to check the growth in our demand for electricity. But that demand is enormous. And every year, we find new ways to use electricity and add more people to use it. Because of that, our reliance on coal for electric power generation is expected to increase to 57 percent by 2030.

Coal will continue to be a primary energy source in the United States for the foreseeable future.

**SO THE QUESTION BECOMES:**

**How do we get more value from the coal we use?**

## Getting More from the Coal We Use

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Electricity is not the only product generated by a coal fueled power plant. These facilities also produce residual materials like fly ash, which is captured from the exhaust of the boiler; and bottom ash, which is heavier and falls to the bottom of the boiler. These and other “coal combustion products” (CCPs) were originally considered waste and disposed of in landfills.

Over the past 30 years, electric utilities and forward-thinking companies like Headwaters Resources have steadily increased the amount of coal combustion products recovered for productive uses.

**In fact, Headwaters Resources was responsible for eliminating over 7 million tons of CO<sub>2</sub> production last year alone.**

These products become ingredients in concrete, wallboard, mortars, stuccos, blocks, bricks, shingles, paints and a variety of other building materials. They are also used to stabilize soils or wastes, and can be used as structural fill or road base materials.

Coal fueled power plants also produce residual materials other than fly ash. Bottom ash, boiler slag and flue gas desulfurization (FGD) products are among the other CCPs that were once treated as waste and disposed of in landfills. Like fly ash, these products can meet or exceed industry standards for ingredients in concrete, various building materials, and soil modifiers and stabilizers, saving millions of tons of natural resources.

Because of the efforts of companies like Headwaters — America’s largest manager and marketer of coal combustion products — and environmentally conscious manufacturers, engineers, architects, developers and contractors, the beneficial use of coal combustion products has increased more than 50 percent in the past decade.

**But 40 million tons of fly ash still end up in landfills each year. We can do better.**

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## What Is Fly Ash?

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When coal is used in a power plant, it is first ground into a very fine powder and blown into the power plant's boiler. Carbon and hydrogen in the coal are consumed, leaving non-combustible molten particles rich in silica, alumina and calcium. These particles solidify as fly ash — microscopic, glassy spheres that are collected from the power plant before they can escape into the environment.

This recovered resource can be used to replace a portion of cement in concrete or added to mortars, stuccos and a host of other building materials.

## Why Use Fly Ash?

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**There are two main reasons to use fly ash** as an ingredient in concrete and other building materials:

First, it **improves the quality of the finished products.** Second, it **creates significant environmental benefits.**



## **Improving Product Quality**

Fly ash has both mechanical and chemical properties that make it a valuable ingredient in concrete and concrete-based products. Its spherical shape makes concrete easier to work with during mixing and placing—fly ash acts like tiny ball bearings moving the aggregates and other components into voids. And when concrete hardens, the chemical properties of fly ash provide greater strength, reduced permeability, and improved resistance to several types of chemical attack. The result is a concrete product that lasts longer – a key sustainability consideration. And fly ash can be used to replace upwards of 40% of the cement in concrete depending on mix requirements.

## **Improving Environmental Performance**

Conserving landfill space by utilizing fly ash is an obvious environmental benefit. But there is much more. Using recovered fly ash conserves natural resources by eliminating the need to produce new raw materials. Concrete can also be produced using much less water when fly ash is in the mix.

Fly ash use can also significantly decrease greenhouse gas emissions related to climate change. When fly ash is used to replace cement, it reduces the need for cement production — a highly energy-intensive process that also creates significant amounts of greenhouse gases.

Reducing cement production reduces greenhouse gas emissions on almost a ton for ton basis. Production of one ton of cement emits about one ton of carbon dioxide. In many circumstances, a ton of fly ash can be used to displace a ton of cement. Concrete enhanced with fly ash can be designed to last 80, 100 or even 1000 years. By simply doubling or tripling the design life of concrete, valuable natural resources are preserved, and the environmental footprint is dramatically reduced.

Experts estimate that cement production accounts for about 5 percent of carbon dioxide emissions from human sources.

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**If all of the fly ash**  
generated in the United States each year  
**were used** to replace cement in producing concrete,  
**the reduction in carbon dioxide**  
released because of decreased cement production  
**would be equivalent to eliminating 25 percent of**  
**the world's motor vehicles.**

## Making an Already Sustainable Product Even Greener



Even before adding fly ash, **concrete is an environmentally sound building material** for several reasons.

First and foremost, concrete is durable while being recyclable. Roads and structures built from concrete last longer and require less maintenance than other materials. But when it's necessary to remove concrete, as much as 80% of crushed concrete is usable as aggregate in new construction. In addition, when used in paving, concrete can result in less vehicle fuel consumption due to reduced resistance. Finally, because concrete reflects light, less energy is needed to illuminate paved surfaces at night.

**Using lighter colored reflective concrete products instead of asphalt pavement can help reduce excessive temperature, further conserving energy.**

Additional benefits include concrete's reflectivity and thermal mass. Recent studies conducted by the Environmental Council of Concrete Organizations have determined certain metropolitan areas experience higher overall temperatures than surrounding less-developed areas. But even with excessive temperatures – hot or cold – concrete serves as an insulator. In structures built with concrete, the thermal mass moderates temperature swings and energy needed for heating and air conditioning.

## Fly Ash Use and LEED

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Building with concrete that contains fly ash can contribute to earning points in the U.S. Green Building Council's (USGBC) Leadership in Energy and Environmental Design (LEED) program, which recognizes sustainable use of materials, land, water, and energy, as well as ergonomics and innovative design.

Fly ash, in combination with other qualifying building materials, can contribute to points earned for recycled content, using regional materials, and/or innovative design. The key to maximizing points is for the project team (owner, architect, engineer, contractor and concrete supplier) to work together as early in the construction process as possible. Green building must be a collaborative effort.

Headwaters Resources offers  
**extensive technical assistance to  
professionals** interested in developing  
concrete mix designs that **maximize  
performance.**

## Is Fly Ash Safe to Use?

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Use of coal fly ash in concrete has long enjoyed the support of a wide range of government agencies, including the U.S. Environmental Protection Agency, the Federal Highway Administration, the U.S. Army Corps of Engineers and the U.S. Bureau of Reclamation. All 50 states allow or mandate the use of fly ash in state-funded projects.

## for more information

about fly ash use, including Technical Bulletins, Case Studies and more, visit the Resource Library at [www.flyash.com](http://www.flyash.com), or the American Coal Ash Association's website at [www.acaa-usa.org](http://www.acaa-usa.org)

Based in Salt Lake City, Utah, and operating coast to coast, Headwaters Resources is a subsidiary of Headwaters Incorporated (NYSE:HW), a diversified growth company providing products, technologies and services to the energy and building materials industries. With contracts to manage coal combustion products from more than 100 coal fueled facilities across the nation, Headwaters Resources is a leader in increasing the use of these reclaimed products. The company has constructed a coast-to-coast network of terminals and transportation equipment to provide reliable service to its coal combustion products customers while providing a comprehensive suite of services to utility and industrial users of coal.



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