

# Evergreen Energy & Global Warming

## How K-Fuel® Reduces Greenhouse Gas Emissions



K-Fuel® Helps Reduce Greenhouse Gasses

*“A key challenge is to maximize energy production efficiency while minimizing carbon dioxide emissions. The use of K-fuel will contribute to that goal.”*

*Dr. Patrick Zimmerman,  
Director, Institute of  
Atmospheric Science*

The combustion of K-Fuel® refined coal produced by Evergreen Energy Inc. reduces carbon dioxide output when compared to unprocessed coal. Carbon dioxide (CO<sub>2</sub>) released into the atmosphere through the combustion of fossil fuels like coal is a contributing factor to global warming.

Past attempts to reduce the CO<sub>2</sub> emissions from coal have failed. Now, however, with its commercial proprietary and patented K-Fuel® process, Evergreen Energy can provide a “refined” coal that when burned has a significant beneficial effect on carbon dioxide emissions per kilowatt-hour generated.

Reducing greenhouse gases, such as CO<sub>2</sub> emissions from coal plants, is important because as world demand for electricity increases, coal will remain a principle source of electric power generation for decades to come.

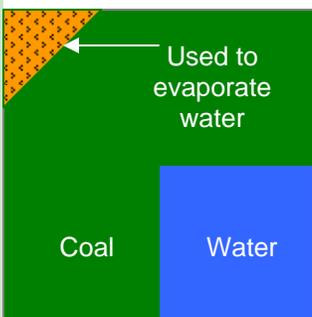
### Background - Types Of Coal

All coals contain water of varying amounts. The anthracite and bituminous coals mined principally in the eastern United States have relatively low amounts of water and high heat contents of approximately 12-14,000 Btu’s per pound. Sub-bituminous and lignite coal, also known as “brown coal” or “low rank” coal, of the type mined principally in the western United States, has a higher water content, usually at 30 to 40 percent. It also has less heat content: approximately 6,000 to 9,000 Btu’s per pound. Western low-rank coal has lower sulfur levels. Sulfur is a root cause of acid rain; that is one reason why consumption of western U.S. low-rank coal has grown significantly and is projected to continue. Western coal consumption is also growing due to the increasing cost and difficulty of mining eastern high grade coals.

### Finding CO<sub>2</sub> Savings

Anyone who has ever tried to start a campfire with damp wood knows that it is hard to ignite and keep burning. That is because the campfire must expend heat energy to boil off water instead of casting a warm glow.

The same is true for western coal with high water content. Heat energy is used to convert water from a liquid to a gas before any power is produced. From a different perspective, each chunk of coal burned in a power plant will spend part of its own energy vaporizing its internal water instead of using that energy to make electricity.



## EVERGREEN ENERGY INC.

Cleaner Energy For Today and Tomorrow

### The K-Fuel® Solution for CO<sub>2</sub> reductions

If the coal fed to the power plant has less water, the plant will make more electricity for every ton of coal consumed and CO<sub>2</sub> produced. This increased efficiency is one of the keys to K-Fuel® CO<sub>2</sub> savings.

With the K-Fuel® process, raw coal enters a large vessel that subjects it to higher temperatures and pressures, much like a pressure cooker. Coal is porous, not solid, and when exposed to the right combination of heat and pressure it becomes malleable. The pores collapse and the heated water is squeezed out. The result: K-Fuel® has up to 70 percent less water when compared to raw low-rank coals from Wyoming's Powder River Basin or Texas lignite.

At the same time, the heat and pressure force some of the coal's tar to its surface. This coats and seals the outside of the coal and helps prevent it from reabsorbing the lost moisture.

Finally, during the K-Fuel® process the coal undergoes a molecular change called "decarboxylation" that also incrementally increases its heat content.

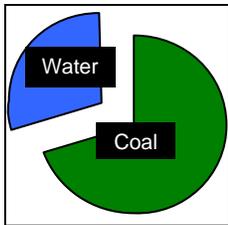
### Energy Efficiency Adds to CO<sub>2</sub> Savings

The amount of energy used in the K-Fuel® process to remove water is about half of what it would take to evaporate the same amount of water in a coal boiler.

Evergreen Energy is currently conducting tests on various sub-bituminous and lignite coals to generate coal-specific CO<sub>2</sub> emission reduction factors. This information will be shared with clients to verify and substantiate credits in the existing and emerging markets for global carbon emissions.

Meanwhile, the underlying CO<sub>2</sub> reduction benefits may help address global warming. "Coal will remain a significant energy source for decades," says Dr. Patrick Zimmerman, director of the Institute of Atmospheric Sciences in Rapid City, S.D. Dr. Zimmerman also serves as chief executive officer of C-Lock Inc., a company that focuses on developing methods to stimulate the private sector to take action to slow down climate change. "A key challenge is to maximize energy production efficiency while minimizing carbon dioxide emissions. The use of K-fuel® will contribute to that goal. "

Raw Coal



K-Fuel®

