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Life-cycle energy and greenhouse gas emission impacts of different corn ethanol plant types

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Abstract
Since the United States began a programme to develop ethanol as a transportation fuel, its use has increased from 175 million gallons in 1980 to 4.9 billion gallons in 2006. Virtually all of the ethanol used for transportation has been produced from corn. During the period of fuel ethanol growth, corn farming productivity has increased dramatically, and energy use in ethanol plants has been reduced by almost by half. The majority of corn ethanol plants are powered by natural gas. However, as natural gas prices have skyrocketed over the last several years, efforts have been made to further reduce the energy used in ethanol plants or to switch from natural gas to other fuels, such as coal and wood chips. In this paper, we examine nine corn ethanol plant types—categorized according to the type of process fuels employed, use of combined heat and power, and production of wet distiller grains and solubles. We found that these ethanol plant types can have distinctly different energy and greenhouse gas emission effects on a full fuel-cycle basis. In particular, greenhouse gas emission impacts can vary significantly—from a 3% increase if coal is the process fuel to a 52% reduction if wood chips are used. Our results show that, in order to achieve energy and greenhouse gas emission benefits, researchers need to closely examine and differentiate among the types of plants used to produce corn ethanol so that corn ethanol production would move towards a more sustainable path.