

# Cardinal Ethanol, LLC

A Plant-wide Optimization Solution from Rockwell Automation helps Cardinal Ethanol achieve significant margin gains and sustainability benefits

## Cardinal Ethanol, LLC

Cardinal Ethanol is a 100 million gallon per year natural gas fired ethanol production plant located in East Central Indiana near Union City. Its ethanol is sold across the U.S. as a clean-burning, high-octane transportation fuel additive.

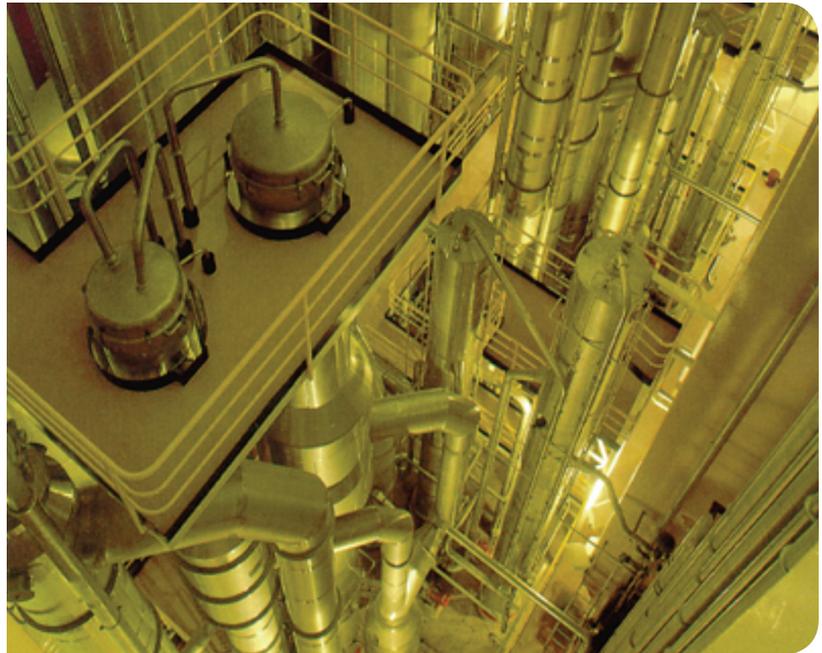
The plant processes 36 million bushels of locally grown corn and produces approximately 320,000 tons of Distillers Dry Grain with Solubles (DDGS), which is sold to livestock and poultry producers as a value-added nutritional supplement. The plant also captures 53,000 tons per year of food grade CO<sup>2</sup>.

## Key Benefits:

- 2.2% increase in ethanol yield
- 7.2% increase in ethanol production
- 7.7% decrease in energy use
- 20% decrease in residual sugars
- ROI in less than 12 months

## The Challenges

Cardinal Ethanol, LLC focuses its efforts on achieving four key objectives: (1) to maximize yield through efficient plant operations, (2) to improve productivity through the use of best-in-class practices, (3) to optimize production margins by reducing energy consumed, and (4) to fuel America's economic development. In 2009, the Indiana plant was faced with some unanticipated obstacles six months into its production start-up. The ethanol industry experienced high volatility in raw material and energy costs and reduced margins. At the same time, the industry was also feeling the profound effects of the global economic crisis that began that same year. However, regardless of the various challenges, the Cardinal Ethanol team forged ahead and ramped up production with a sharp focus on running the plant as efficiently as possible. The company maintained its position to invest in solutions to improve plant stability and margins and achieve its business objectives.



Cardinal Ethanol's dry mill plant is highly integrated. All process units – from milling to fermentation to distillation and the dryer systems – are interconnected by energy or material flow, and this causes significant interactions between these units making it difficult to control the plant.

LISTEN.  
THINK.  
SOLVE.™

# The Plant-wide Control & Optimization Solution Description

Cardinal Ethanol chose to implement the Pavilion8-based Model Predictive Control (MPC) and Plant-wide Optimization solution to help solve their operational challenges and achieve their business objectives. The MPC solution was designed to stabilize and increase the efficiencies of each of their key process units and the overall plant.

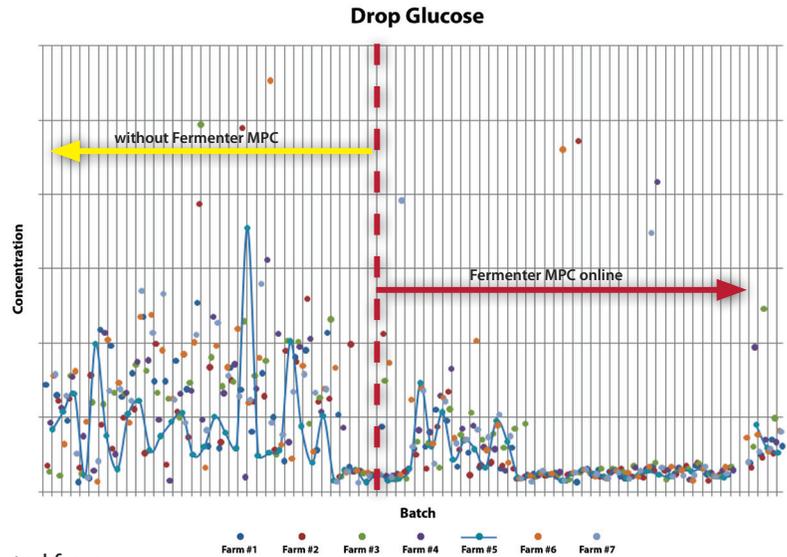
## Key Control Applications and their Benefits:

### Batch Fermentation Control

The fermentation process takes place in seven large batch fermenters where starch is converted to ethanol. The Batch Fermentation Control application adjusts the temperature and helps to ensure that enzyme levels are added using the optimum dynamic ratio to feedstock, as well as the best trajectories, for both temperatures and enzymes, that respond to changes in feedstock quality. By reducing overall variability in the fermentation process and minimizing residual sugars by 20%, the plant experienced a 53% reduction in the standard deviation of ethanol and produced 2.2% more ethanol from each bushel of corn.

### Distillation/Sieve Control

In the distillation/sieve process units, ethanol is separated from stillage solids and water. This control application reduced the variability of energy use by 50%, while optimizing the energy trade-offs between the molecular sieve operation, evaporator energy constraints and the distillation train. This efficient use of energy contributed to an 7.7% reduction in processing energy.



## Slurry/Water Balance Control

Water balance controls the need for make-up fresh water to the fermenters versus the availability of backset from the distillation and evaporators, which is recycled back to the fermenters. Water balance is critical because it impacts the economy of the operation. More water in the plant's process units results in higher energy costs. The Slurry/Water Balance application used the recycled water more efficiently and therefore, reduced the plant's fresh water requirement, contributing to an overall reduction in energy consumption.

## Drying/Evaporation Control

The dryer and evaporator process units remove moisture out of the stillage to form Dry (DDGS), a high protein cattle feed. This application controls evaporator solids and dryer moisture, while managing stillage inventory and syrup usage. It also controls the DDGS quality. The application reduced moisture variability in the two parallel dryer units, by 38% in one train and by 25% in the other. The dryers were then able to operate with a more consistent DDGS from both units.

## Plant-wide Optimization

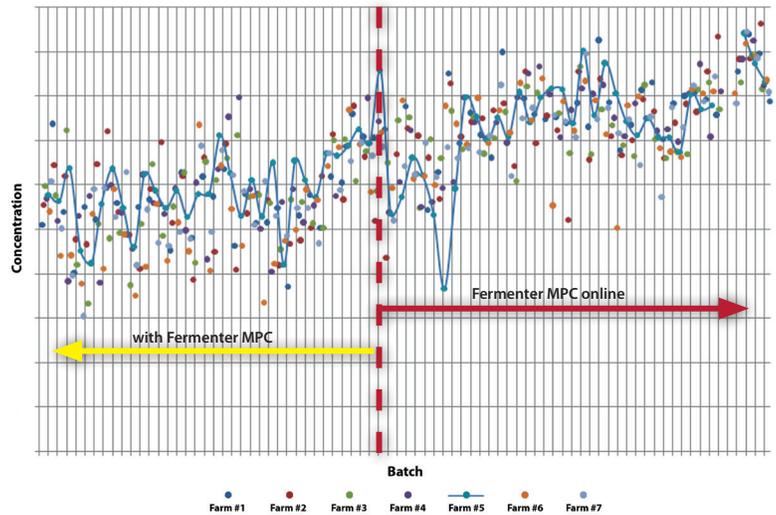
Overall, the plant-wide optimization solution better coordinated and stabilized the entire plant. Cardinal Ethanol was then able to reduce waste and increase ethanol yield from the same amount of corn, thereby contributing to the plant's bottom line and improving its sustainable production goals.

### Customer testimonial:

"The Rockwell Automation Ethanol Solution has exceeded our expectations by uncovering process factors that were restricting our ability for greater production, yield and energy efficiency."

Jeremy Herlyn,  
Plant manager, Cardinal Ethanol

### Drop Ethanol



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**Power, Control and Information Solutions Headquarters**

Americas: Rockwell Automation, 1201 South Second Street, Milwaukee, WI 53204-2496 USA, Tel: (1) 414.382.2000, Fax: (1) 414.382.4444

Europe/Middle East/Africa: Rockwell Automation NV, Pegasus Park, De Kleetlaan 12a, 1831 Diegem, Belgium, Tel: (32) 2 663 0600, Fax: (32) 2 663 0640

Asia Pacific: Rockwell Automation, Level 14, Core F, Cyberport 3, 100 Cyberport Road, Hong Kong, Tel: (852) 2887 4788, Fax: (852) 2508 1846