

## Nucor Refines Steel Recycling Using NI LabVIEW and National Instruments Hardware



Using hardware and software from NI, Nucor developed a variety of automation systems that have greatly reduced the amount of electricity used and eliminated potential safety issues at its Marion, Ohio facility.

"By programming with LabVIEW and PACs versus programming with PLCs and ladder logic, we have seen a ten-fold increase in efficiency and drastically reduced the costs of facility automation. "

- Dave Brandt, [Nucor Corp](#)

### The Challenge:

Developing an automation system for a steel recycling facility that reduces the amount of energy consumed to comply with statewide energy regulations while improving the safety and efficiency of the plant.

### The Solution:

Using National Instruments programmable automation controllers (PACs) and the NI LabVIEW graphical programming environment to develop plant automation solutions to accurately measure the amount of energy required to recycle steel and improve facility safety.

Author(s):  
Dave Brandt - [Nucor Corp](#)

Two out of every three pounds of steel is produced from previously used steel, making it the most recycled material in North America. Recycling steel consumes between 60 and 74 percent less energy than producing new steel from raw materials, which is equivalent to the amount of energy needed to power 18 million homes for one year.

### Improving Steel Recycling

Steel companies are constantly refining their recycling operations to make the process more efficient and environmentally friendly. At Nucor, we place a high value on being stewards of our environmental resources, and to that end we have become the largest recycler in North America. In 2005, we purchased the Marion Steel Company in Marion, Ohio, which gave us a location central to nearly 60 percent of the steel consumption in the United States. To maintain our high facility standards with this acquisition we immediately recognized the need to implement a facility automation system to improve the efficiency and safety of the plant.

### Reducing Energy Consumption with NI Software and Hardware

At the Marion facility we manufacture a full line of rebar, sign supports, delineators, and cable barrier systems using recycled steel. During the steel recycling process scrap metal is heated in an electric arc furnace (EAF) and, depending on the type of steel being produced, a combination of elements is added to the viscous steel to create the appropriate steel alloy. This process requires large amounts of energy that vary significantly depending on the amount of scrap placed in the furnace. When we purchased the Marion facility, operators relied on estimates to determine the amount of steel placed in the furnace, causing the metal to be overheated oftentimes. This results in an unsatisfactory end product that must be recycled again, which costs the company time, money, and energy.

To reduce the number of reheats, we developed a low-cost scale and weighing system using [LabVIEW](#) and [NI Compact FieldPoint controllers](#) that accurately calculated the amount of steel in each burn. Knowing the exact amount of scrap metal placed in the furnace allowed us to precisely calculate the amount of electricity required to heat the furnace. Prior to implementing this scale system, our steel measuring was hit or miss. We did not have a method of tracking the number of reheats prior to implementation of the new system, however out of the more than 6,000 batches in 2007 after deploying the new system we only performed 10 reheats, which was far less than in 2006.

### Eliminating Flicker with LabVIEW and NI CompactRIO

One risk involved in drawing the large amount of electricity required to heat the furnace for recycling is causing flicker on the power grid. Not only did we receive monetary penalties for using too much electricity, but the power grid flicker was an inconvenience to Marion residents. To reduce electricity consumption, we developed an online reactor in series with the furnace using the [LabVIEW FPGA module](#) and the [CompactRIO platform](#) that measures the amount of energy drawn from the power grid. If the furnace approaches the prescribed limit, the system can quickly change control methods to reduce the amount of power being drawn.

### Improving Facility Safety with LabVIEW

One of our core values at Nucor is employee safety, thus another goal of our facility improvements was to make the Marion location a safer place to work. We determined we needed to upgrade the method for turning the EAF on and off. Before renovating the system, an operator had to manually pull the on/off switch, which made him or her vulnerable to injury if the fuse were to blow. A Compact FieldPoint PAC and an HMI were used to create a remote power switch that does not put operators in potentially dangerous situations.

### The Benefits of Factory Automation Using NI PACs

Using NI hardware and software, we developed a variety of automation systems that have greatly reduced the electricity we use and eliminated potential safety issues at our Marion, Ohio facility. The ability to have one platform handling all of our communication protocols (Ethernet, serial, modbus, and EtherCAT), PID control loops, and sequencing algorithms saved us time and money. With LabVIEW graphical system design we were able to further simplify our development by parallelizing all of our communication and control loops, which lead to increased system performance in addition to readable and maintainable code. Months after I completed the development, I returned to the system to make some minor changes and I was able to open-up the block diagram, quickly find the task that required an update, make the change and walk away. We haven't had a single problem with the any of our systems since they've been deployed.

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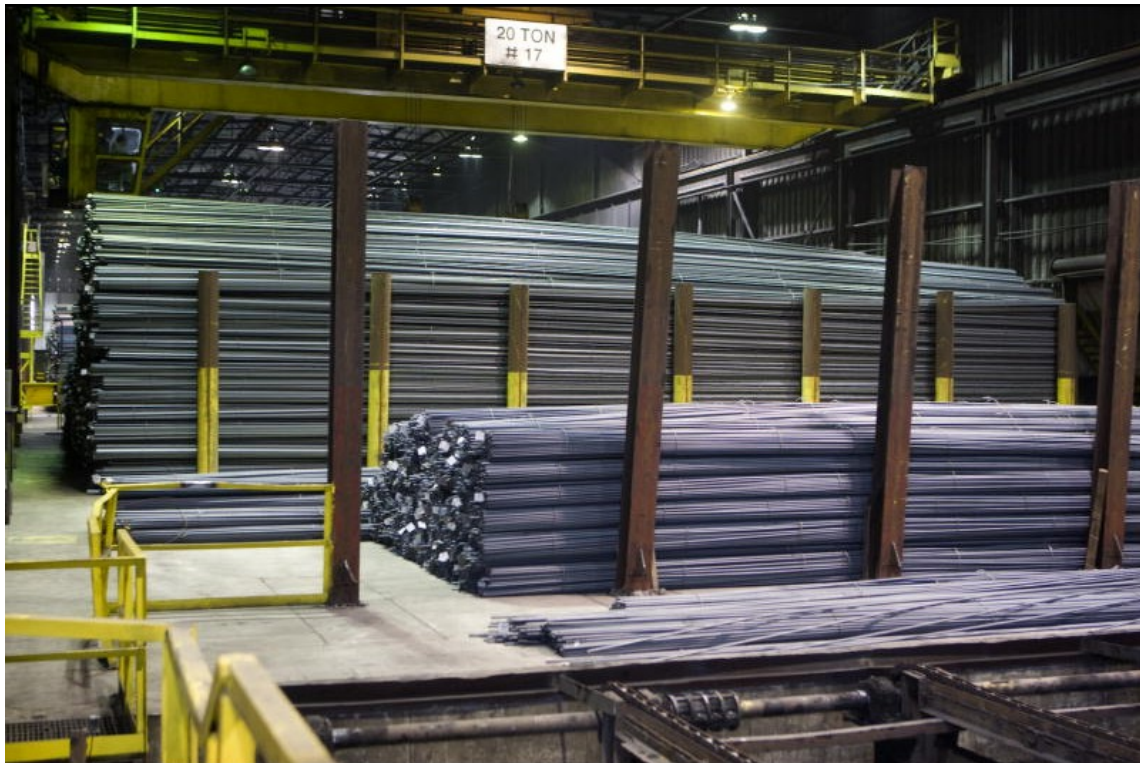
During the steel recycling process, scrap metal is heated in an electric arc furnace (EAF) which requires large amounts of energy that vary significantly depending on the amount of scrap placed in the furnace.



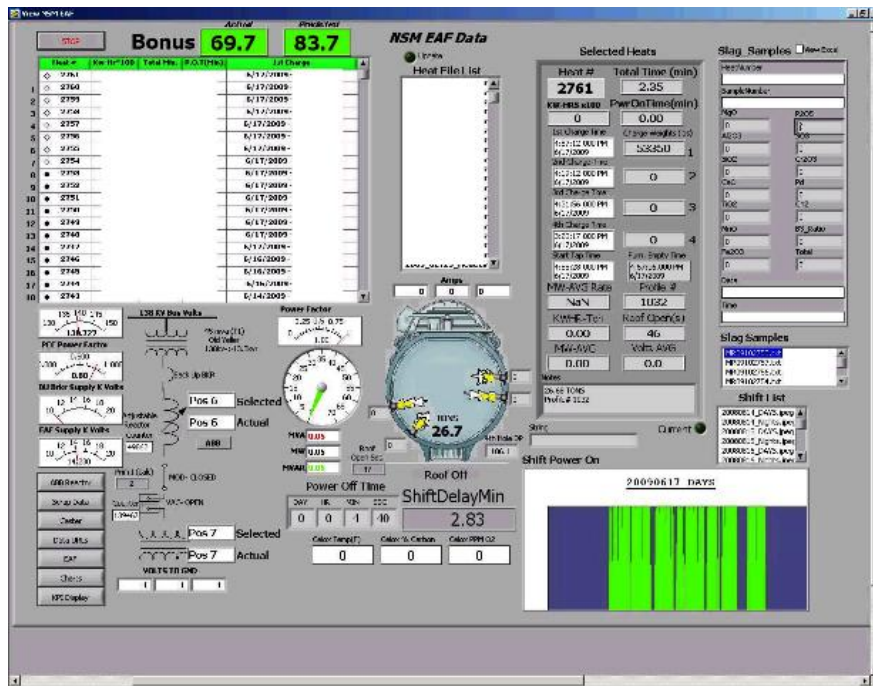
Knowing the exact amount of scrap metal placed in the furnace allows Nucor to precisely calculate the amount of electricity required to heat the furnace.



To reduce electricity consumption, Nucor developed an online reactor in series with the furnace using the LabVIEW FPGA module and the CompactRIO platform that measures the amount of energy drawn from the power grid.



Nucor is the largest rebar manufacturer in the U.S.



A Screenshot of our Real-Time Production Data Application



IRWIN CAR AND EQUIPMENT



# NSM Car #1

NSM Diesel Powered Scrap Car -Version 8.6.1

The screenshot displays the following key elements:

- Navigation Tabs:** IO, Configure, Scales, Position, Remote, **PLC Enabled**, **Engine Run**, Master OK, IO OK.
- Status Indicators:**
  - LED A (Blink-Program Run)
  - LED B (20 A CB OK)
  - LED C (Laser OK)
  - LED D (MasterEnable)
  - MasterStop ?
- Gauges and Readings:**
  - 5G-140 mv/v: 0.27662938
  - Battery VDC (AI-100, S2, CH0): 12.0
  - Position Error: 13.3406
- Input/Output Matrix:**
  - Inputs-Slot 3 (0-7):** Remote Control, 0-K1 Enable, 1-K2 Disable/Teach Position, 2-K3 Scrap Position, 3-K4 Mill Position, 4-K5 Lime 1, 5-K6 Lime 2, 6-K7 Car Jog FWD (In), 7-K8 Car Jog Rev (Out).
  - Inputs-Slot 3 (8-15):** Engine Status, 8-Engine Run, 9-Low Fuel, 10-Engine Fail, 11-Engine Temp, 12-Oil Pressure, 13-Hyd. Filter Dirty, 14-Hyd. Low Level, 15-Hyd. Low Temp.
  - Inputs-Slot 3 (16-23):** Configure IO, 16-PLC Enabled, 17-Stop Prox West Track, 18-Stop Prox East Track, 19-Spare, 20-Car 1,2, 21-Car 1,3, 22-Car 2,3, 23-Spare.
  - Inputs-Slot 3 (24-31):** Unwired Spares, 24-IO Power CB2 OK, 25-Spare, 26-Spare, 27-Spare, 28-Spare, 29-Spare, 30-Spare, 31-Spare.
  - Outputs-Slot 4 (0-7):** Unwired Spares, 0-Engine Run /Start, 1-Engine Fast Speed, 2-Hyd. Forward Dir, 3-Hyd. Reverse Dir, 4-Light, 5-Spare, 6-Int. Speed, 7-Fast Speed.
- Right Panel Controls:**
  - Add Time: Seconds (33), Min (0), Hours (0), Days (0), millisec (0).
  - Use Time:
  - Laser Blocked:
  - Pos Calculate:
  - Late Scans: 0
  - CarPosition: 98.1
  - Control Position: 211.3
  - Inputs Test:  E Track Stop Prox,  W Track Stop Prox,  Obey Stop Light?,  Save,  Configure File Ok.
  - Position Mode: , , , , .

Dave Brandt - Nucor Steel Marion 20071030

Another Screenshot of the Data Acquisition Application

### Legal

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