# Steel Success Story

# Ironmaking: Quality and Supply Critical to Steel Industry

The manufacture of steel involves many energy intensive processes that consume raw or recycled materials, such as iron ore and scrap metal, from around the world. Global competition requires that steelmakers apply new technologies that can produce high-quality iron with lower capital and manufacturing costs, faster production times, and reduced emissions.

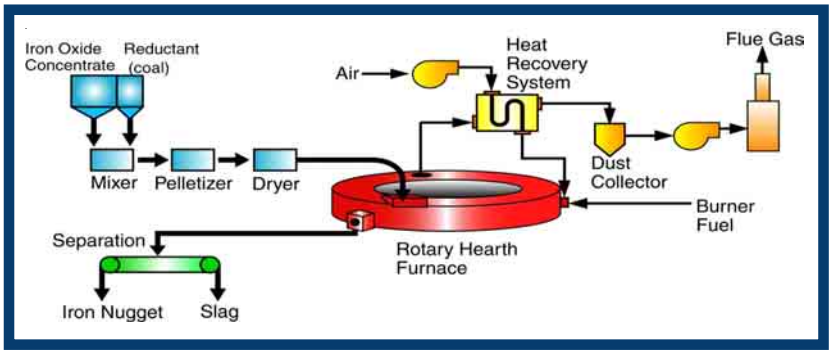
The primary method of producing pig iron is the blast furnace, but tightening environmental regulations, aging blast furnaces, and plant shutdowns have reduced production capacity and significantly increased prices. Recently, growing worldwide demand for scrap has caused scrap prices to considerably increase as well. The sharp price increases and tight supply problems have greatly enhanced the need to develop other metallic iron sources alternative to pig iron and scrap.

For the past two years, the U.S. Department of Energy's Industrial Technologies Program (ITP) has supported the refinement and demonstration of a remarkable new process for making iron that has the potential to revolutionize the industry's ironmaking capabilities – the ITmk3® process. The process is capable of using low grade ore to produce iron nuggets of superior quality to DRI and similar quality to pig iron. The iron nuggets are suitable for use in electric arc furnaces (EAF), basic oxygen furnaces (BOF), and foundry applications.

### Mesabi Nugget Research Project - New Ironmaking Technology of the Future High Quality Iron Nuggets Using a Rotary Hearth Furnace

The Mesabi Nugget Project is a large-scale pilot project which successfully demonstrates the innovative ITmk3® ironmaking technology developed by Kobe Steel for the North American scenario. The ITmk3® process uses a rotary hearth furnace to turn iron ore fines and pulverized coal into high nugget purity (96-98% metallic iron content). Reduction, melting, and slag removal occur in only 10 minutes.

## Process Flow of ITmk3®




*ITmk3® process flow sheet reveals a one-step furnace operation.*



## The ITmk3® Process

## ITmk3® in Brief:

- High nugget purity with 96-98% metallic iron content
- Potential 30% energy savings over current three-step process for integrated steelmaking
- Potential 10% energy savings when used in EAF steelmaking
- Environmentally friendly process potentially reduces emissions by more than 40%
- Produces high quality iron without coke and agglomeration steps
- Excellent operational reliability
- Utilizes low-grade ore
- FeO reduced to less than 2%, minimizing attack to refractories
- Gangue-free nuggets
- Low capital and operating costs
- Iron nuggets suitable for use in all melt shops at BOF, EAF, and foundry operations

## Project Equity Partners

Mesabi Nugget, LLC
Silver Bay, MN
(Principal Investigator)

Ferrometrics, Inc.
Two Harbors, MN

Ferrous Resources, LLC
Fort Wayne, IN

IronUnits, LLC
Cleveland, OH

Kobe Iron Nugget, LLC
New York, NY

## Other Stakeholders

Iron Range Resources
Eveleth, MN

Minnesota Department of Employment and Economic Development
St. Paul, MN

## Technical Accomplishments

The Mesabi Nugget Project is part of a DOE *Grand Challenge* R&D effort, that holds the potential to produce dramatic improvements in energy efficiency, environmental performance, and product yield. The Mesabi Nugget Research Project consists of the operation of a pilot plant to demonstrate and optimize the new ironmaking technology to confirm the benefits of the process in North America.

**ITmk3 pilot demonstration plant**

- Produced high quality iron nuggets (96-98% metallic iron content)
- Four individual production months with availability in excess of 93% with two months at 99% uptime
- Iron nugget average monthly production rate of 1764 tons
- Successfully processed a variety of iron ores and materials, including eastern coals and Powder River Basin coal. Western coals and western Canadian high carbon coals will also be tested
- Successfully recycled key process materials
- Operated continuously for at least 80 days

**Iron nugget performance in a modern EAF steel making melt shop**

- At 30% scrap usage, emissions reductions are greater than 40% for all emission components considered: CO, NOx, PM10, $SO_2$, VOC and $CO_2$
- Improved iron output
- Excellent operational reliability

## Commercialization Activities:

- Iron nuggets currently purchased by Indiana steelmaker, Steel Dynamics
- Construction of first commercial 500,000-ton annual capacity plant begins spring 2005 in Hoyt Lakes, Minnesota
- Plans also include construction of two or more production facilities in Minnesota, totaling 1.65 million tons annually

## Iron Nuggets from the Pilot Plant



## For Additional Information, Please contact:

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## References

*Steel Industry Technology Roadmap*, American Iron and Steel Institute (December, 2001)

*Project Fact Sheet: The Mesabi Nugget Research Project*, U.S. Department of Energy, Industrial Technologies Program (April, 2003)

*A Comparison of Various Criteria Pollutant Emissions Between the Traditional Blast Furnace Route to Steel and the Iron Nugget Route to Steel,* Lehtinen, Larry J., Mesabi Nugget, LLC (June, 2004)

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