The Future vision of Ferro-Alloy Plants
1. What is Ferro-Alloy?
2. Market Status
3. Outlook of the Ferro-Alloy plant
4. Provision of Technology
What is Ferro-Alloy?
What is Ferro-Alloy?

1 shot of Espresso needs 7g of Coffee beans

1 ton Of steel Making needs 20kg Ferro-Alloy

Typical Ferro-Alloys:
- Fe-Mn: Crude steel Additive
- Si-Mn: Crude steel Additive
- Fe-Si: Crude steel Additive
- Fe-Cr: Stainless Steel & Additive
- MG-Si: Semiconductors & Solar Industry
The Five Major Ferro-Alloys

Fe-Cr 20%
Fe-Mn 12%
Si-Mn 22%
Fe-Si 18%
MG-Si 5%
Fe-Ni 4%
ETC 19%

5 items accounted for 77% of the Ferro-Alloy products

Source: 2010 Minerals Yearbook / USGS
- BHPB, Eramet, etc which produces High Quality Ore operates concurrently In-House Ferro Alloy Plant.
- Steel Maker actives quota participation or JV investment to secure a stable Ferro Alloy.
Fe-Mn Applications & Used Industry

**HC FeMn (Widely used in Steel Maker)**
- To remove Oxygen & Sulfur and add Manganese
- To manufacture general steel plates
- Most commonly used Ferroalloy

**MC/LC FeMn (Refined Alloy)**
- Usually used in the manufacture of high-grade steel (Automobile, ship, etc.)
- To remove Oxygen and add Manganese
- To manufacture high-grade steel for automobile and ship
- Essential in producing high-grade steel / a high demand from steel maker

<table>
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<tr>
<th>Product</th>
<th>Mn(%)</th>
<th>Si(%)</th>
<th>C(%)</th>
<th>P(%)</th>
<th>S(%)</th>
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<td>0.2 ↓</td>
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<td>0.8 ↓</td>
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<td>0.02 ↓</td>
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Source: Dongbu Metal
Fe-Mn Applications & Used Industry

ULPC (Ultra Low Phosphorus Carbon FeMn)
- Alternative alloy of Manganese Metal
- Used to make **highly light** but strong steel
- Light but strong alloy with **no impurities** / the highest value-added product
- **Flexible** due to Low Carbon Content
- **Good for automobile steel** and the steel is targeted to reduce noise and vibration
- Makes a car lighter and stronger / a **cost-efficient and environment-friendly product**
- Good for **Oil country Tubular Goods (OCTG)** which is used in developing an Oil well (petroleum or Natural Gas)

**Source: Dongbu Metal**

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<tr>
<th>Product</th>
<th>Mn(%)</th>
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<th>C(%)</th>
<th>P(%)</th>
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<td>2.2</td>
<td>0.1</td>
<td>0.05</td>
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ULPC FeMn is used to manufacture steel products such as steel plates.

SAC ULPC (Ultra Low Phosphorus Carbon)

[Joint Development SAC–Dongbu Metal]

[In Operation Dongbu Metal]

[SAC Independent Technology & SAC own brand]

[Import Substituting Effect]

[SAC Unique Technology]

[Few Companies Possession of Technology]

[Useful in making light automobile sheet and all pipe for polar regions]
Si-Mn Applications & Used Industry

**SiMn**
- Commonly **used by Electric Furnace** steel makes in order to **add Silicon and Manganese** to steel
- To **remove Oxygen and Sulfur**
- To produce **section steel and reinforcing bar**

**LC SiMn**
- To **remove Oxygen and add components**
- To produce **stainless steel and steel rods** such as **welding rod**
- Commonly used in making the steel which **requires Silicon**

<table>
<thead>
<tr>
<th>Product</th>
<th>Mn(%)</th>
<th>Si(%)</th>
<th>C(%)</th>
<th>P(%)</th>
<th>S(%)</th>
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<td>LC SiMn</td>
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<td>20~35</td>
<td>1.0</td>
<td>0.10</td>
<td>0.01</td>
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**Source:** *Dongbu Metal*
Diversification of Ferro-Alloy

- The Semiconductor/Solar energy field will cause an increase in Silicon production

- Automobile weight reduction trends will cause an increase in the production of Fe-Cr/Fe-Ni.
Ore Reserves World-wide

- Manganese (5,400 million tonnes)
- High Purity Quartz Sand
- Nickel (143 million tonnes)

Countries with significant reserves:
- Canada
- United States
- Mexico
- Brazil
- Australia
- Russia
- China
- South Korea
- Japan
- Indonesia
- South Africa
- Gabon
- Norway, Finland
- Germany, Slovakia
- Hungary
- Belgium
- UK
- France
- Spain
- Italy
- Bulgaria
- Egypt
- Iran
- Turkey
- New Caledonia
- Kazakhstan
- Ukraine
- India
- India
- Indonesia
- Australia
- Chile
- Cuba
- Brazil
- United States
- United States
- Mexico
- Cuba
- Brazil
- Chile
2

Market Status
Relationship Between Steel & Ferro-Alloy Products

Amount of Ferro-Alloy Produced Increased by 8.1% in 5 years

Crude Steel production increased accordingly as Ferro-Alloy production increased

Source: Minerals Yearbook / USGS
Present Ferro-Alloy Production Market

Total Ferro-Alloy Production In 2013 (Compared to 2012)

- **North America**: 370 K mt (-12%) Decrease in local production due to reduced electricity tariff negotiations.
- **Brazil**: 266 k mt (-11%) Some furnaces reduced production because of the energy restrictions.
- **Asia(other) & Oceania**: 3,309 k mt (3%)
- **China**: 11,972 k mt (18%)
- **CIS**: 1,298 k mt (-20%) Production decrease due to high electricity tariffs.
- **Europe**: 722 k mt (4%) Electricity supply problem.
- **India**: 2,066 k mt (2%) Rupee depreciation.
- **Africa & Mid East**: 502 k mt (-7%)

*Source: IMNI*
Ore Price Movement

**Manganese** Price Movement
(2.25 USD/kg)

**Nickel** Price Movement
(6.95 USD/lb)

*Source: InfoMine*
Ferro-Alloy Price Movement

International Ferro Alloy Price Movement

Source: CRU
3 Outlook of the Ferro-Alloy Plant
Market Prospects for Ferro-Alloy Plants

A Growth of 8 billion USD is expected by 2022
Current Situation Ferro-Alloy and Plants Market

Ferro-Alloy Production Movement

Production decreased by 10.5% in 2013 compared to 2012

Ferro-Alloy Price Movement

Decreasing Price

Ferro-Alloy Plant Market

Growing Plant Market

Fe-Mn, Fe-Si, Si-Mn, Mg-Si & Fe-Cr Plant facilities

Unit: Billion USD


4.91 4.73 5.06 5.30 5.63 5.93 6.29 6.25 7.19 7.56

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Key-Challenges of New Plant Development

1) Eco-Friendly
- Fossil Fuel
- Greenhouse Gas
- Emissions Business
- Carbon Tax

2) High-Efficiency
- Electric Power
- Labor
- High Quality Procurement
- Operation
- Maintenance

3) Government Regulation
- Obsolete Plant
- Restriction of Ore Export
- Strict pollution norms for new plants
1) Eco-friendly

**CO2 Generation during Ferro-Alloy Production**

<table>
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<tr>
<th>CO2 Generation (t-CO2 / t-metal)</th>
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</thead>
<tbody>
<tr>
<td>Pig Iron</td>
</tr>
<tr>
<td>2.1</td>
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</tbody>
</table>


- **Fuel Use, Environmental Controls, Air & GHG Emissions**
- **Water Usage and Quality, Dust Emissions, Solid waste, Generation, Slag Recycling**

**Increasing demand for eco-friendly facilities**
China plans to shutdown
On poor condition equipments
“276 Unit SAF”

China Government announced on 4th Sep, 2013
“To be de-mobilized on facilities from 67 companies”

- Settlement on Oversupply Productive Capacity
- Prevention of Air Pollution

2013, “12th 5-Years Plan” Target to throw out or
Replaces falling behind equipment
2) High-efficiency

**Cost of Electric Power, Water, Labor, etc**

More efficient plants are preferred due to increasing energy & labor cost

Large capacity plants are preferred due to the advantage of low electricity cost

Over 30% of the total cost of production goes into Electric Power. New plants are emerging in developing countries where the cost of electricity is cheaper. Moreover, in order to reduce the cost of production, new plants are being set up near ore mines & ports

**Increasing demand for high-efficiency facilities**
Composition of Cost (Ferro-Alloy Production)

Industrial Electric Charges (OECD)

Unit: US¢/kWh, %

<table>
<thead>
<tr>
<th>Country</th>
<th>2007</th>
<th>2012</th>
<th>Rate of Annual Average Rise (From 2007 to 2012)</th>
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<tr>
<td>USA</td>
<td>1.57</td>
<td>3.95</td>
<td>1.42</td>
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<td>UK</td>
<td>13.67</td>
<td>15.85</td>
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<td>France</td>
<td>5.69</td>
<td>6.75</td>
<td>1.06</td>
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<td>Germany</td>
<td>12.21</td>
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<tr>
<td>Italy</td>
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<td>Japan</td>
<td>19.36</td>
<td>21.37</td>
<td>1.99</td>
</tr>
<tr>
<td>South Korea</td>
<td>9.14</td>
<td>11.60</td>
<td>2.46</td>
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</table>

*Malaysia Electric Charges 4 US¢/kWh*
3) Changing Government Regulation

Plants under 10MVA capacity have been closed.
All plants must have environmentally friendly facilities.

Strict environmental policies for New plants by Ministry of Environment.

Government regulation on Ore Export.

According to environmental regulations, unproductive plants will be eventually closed. All plants should invest in eco-friendly equipment - CERs.

**Increasing demand for New Policy**
The Fe-Ni ore export limitations will increase the need for facilities.
A number of companies are already underway to invest in Indonesia.
New Projects and Developments

- Fe-Mn, Fe-Mn Plant
  - Mott MacDonald
  - Si-Mn 3Unit * 22.5 MVA
  - Fe-Mn 1Unit * 22.5 MVA

- Fe-Cr, Fe-Si Plant
  - TAKAMUL
  - 165,000 ton/year

- Fe-Si Plant
  - Somani Group
  - 36,000 ton/year

- Fe-Mn, Si-Mn Plant
  - Mine Development
  - Power Plant
  - ENRC
  - Fe-Mn (200,000MT/month)
  - Si-Mn (140,000MT/month)

- Fe-Cr, Fe-Si Plant
  - HATCH
  - 300,000 ton/year

- Fe-Si Plant
  - ZWA
  - 21MVA

- Fe-Si Plant
  - FESICO
  - 12,000 ton/year

- Fe-Si Plant
  - Hatch
  - 300,000 ton/year

- Fe-Si, Fe-Mn Plant
  - ASG Tariq Trading
  - Fe-Si 1Unit * 6MVA
  - Fe-Mn 1Unit * 6MVA

- MG-So Plant
  - FerroAtrantica
  - 100,000 ton/year

- Fe-Ni Plant
  - HANKING Group
  - 15,000 ton/year

- Fe-Ni Plant
  - 30,000 ton/year

- Fe-Mn Refining Furnace
  - Hira Steel
  - 12 ton
Provision of Technology
Schematic Layout of Ferro Alloy-Plant
Technology for the Environment

Needs

- High efficiency
- Safety
- Long life span
- Eco-friendly Technology
- CO reduction
- Maintenance
- Durability

Engineering
Manufacturing
Control system

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Advanced technology

- Electrode system
  - Electrode system for Si-alloys
  - Three Single-phase Variable ratio Transformer

- Closed Type Roof
  - Electrode - Roof Sealing Tech.

- Refining process
  - SAC-ORP
  - ULPC

- Recycling waste resources
  - Slag Reducing Furnace
Engineering ability

Basic Design

Analysis of Structures

Flow Simulation/CFD

Detail Design
References

Dongbu Metal SAF * 9 Units

Simpac Metal 20MVA * 3 Units

POSHI Metal 40MVA, 30MVA
References

Dongbu Metal

Simpac Metal 20MVA * 3 Units

AML 33MVA * 6 Units
References

Initial start-up

Product handling

ULPC Process
References

SAF Casting
References

Tapping

Tilting

Refining
Production is scheduled to start in early 2015 (Fe-Si & Si-Mn production)
SAC has provided Ferro-Alloy manufacturing facilities from 1983 to 2014

Total References: 41 Projects (SAF 19 Units, Refining Furnaces & Supplementary Installation 22 Units)

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<tr>
<th>No.</th>
<th>REF</th>
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<th>APPLICATION</th>
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<td>150</td>
<td>Twoins</td>
<td>SAF</td>
<td>P/S</td>
</tr>
</tbody>
</table>
Future Technical Road Map

- **Short term (2013~2015)**
  - Technology improvement
  - Next generation
  - Technical Development

- **Intermediate term (2016~2019)**
  - Technical Development of eco-friendly facilities
  - Energy Reduction
  - Over 30%

- **Long term (2020~)**
  - Provision of total solution
  - Restrictions on CO₂
  - Enriched to over 95%
SAC promises to Secure Advanced Technology which is eco-friendly & Competitive in Price. To gain 13% Ferroalloy Plant Market share globally. SAC promotes Green Technology for better environment.
Thank you.