**HIGH PERFORMANCE ALLOY DOMESTIC VALUE CHAIN**

Opportunities for Impact within the Fossil Energy Sector

<table>
<thead>
<tr>
<th>PROCESS</th>
<th>PRODUCT</th>
<th>INDUSTRY STRENGTHS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Alloy Production</td>
<td>Diversity of Product</td>
</tr>
<tr>
<td></td>
<td>Processing into desirable composition</td>
<td>Major Companies: Haynes International, Allegheny Technologies Inc, Special Metals Corp, Carpenter Technology Corp, Universal Stainless</td>
</tr>
<tr>
<td>2</td>
<td>Shaping</td>
<td>High Growth</td>
</tr>
<tr>
<td></td>
<td>Casting, stamping forging – controlling microstructure and stresses</td>
<td>Major Companies: Precision Castparts, ATI, Arconic, US Steel</td>
</tr>
<tr>
<td>3</td>
<td>Finishing</td>
<td>Low Imports Competition</td>
</tr>
<tr>
<td></td>
<td>Machining for tolerances, heat treatments, coatings</td>
<td>Major Companies: MIC Group, Norman Noble, Pacific Contours</td>
</tr>
<tr>
<td>4</td>
<td>Component</td>
<td>High Profit</td>
</tr>
<tr>
<td></td>
<td>Welding, brazing and joining of parts</td>
<td>Major Companies: GE, Siemens, Babcock and Wilcox, Black and Veatch</td>
</tr>
</tbody>
</table>

Fossil Energy Applications

Superalloy Market Segmented By Base Metal

- **IRON** - heat and corrosion resistant to 550 °C
  - Comparatively low cost
- **COBALT** - Hot corrosion, oxidation, wear resistance to 1100 °C
  - Comparatively low strength, but maintains properties at higher temperatures
- **NICKEL** - Chemically and mechanically stable up to 800 °C
  - High hardness, strength and corrosion resistance

---

**PROCESS**

**Alloy Production**
- Processing into desirable composition

**PRODUCT**
- **PRODUCT:** ingots, billets, rods, and powders

**INDUSTRY STRENGTHS**
- **Diversity of Product**
- **Major Companies:**
  - Haynes International, Allegheny Technologies Inc, Special Metals Corp, Carpenter Technology Corp, Universal Stainless

**PROCESS**

**Shaping**
- Casting, stamping forging – controlling microstructure and stresses

**PRODUCT**
- **PRODUCT:** semifinished/unfinished valves, airfoils, turbine components

**INDUSTRY STRENGTHS**
- **High Growth**
- **Major Companies:**
  - Precision Castparts, ATI, Arconic, US Steel

**PROCESS**

**Finishing**
- Machining for tolerances, heat treatments, coatings

**PRODUCT**
- **PRODUCT:** Finished component

**INDUSTRY STRENGTHS**
- **Low Imports Competition**
- **Major Companies:**
  - MIC Group, Norman Noble, Pacific Contours

**PROCESS**

**Component**
- Welding, brazing and joining of parts

**PRODUCT**
- **PRODUCT:** Subassemblies and components

**INDUSTRY STRENGTHS**
- **High Profit**
- **Major Companies:**
  - GE, Siemens, Babcock and Wilcox, Black and Veatch

---

**Fossil Energy Applications**

**Superalloy Market Segmented By Base Metal**

- **IRON** - heat and corrosion resistant to 550 °C
  - Comparatively low cost
- **COBALT** - Hot corrosion, oxidation, wear resistance to 1100 °C
  - Comparatively low strength, but maintains properties at higher temperatures
- **NICKEL** - Chemically and mechanically stable up to 800 °C
  - High hardness, strength and corrosion resistance

---

**Steam Turbine**

**Boiler Tubes**

---

**U.S. DEPARTMENT OF ENERGY**

**NATIONAL ENERGY TECHNOLOGY LABORATORY**
HIGH PERFORMANCE ALLOY DOMESTIC VALUE CHAIN

Regional Impacts

Mining > Alloy Production > Shaping > Finishing > Component > Fossil Energy Plant & Transmission

**VALUE**

- **$1.3B**
- **$2.5B**
- **$2B**
- **$10.7B**

**JOBS**

- **1,269** Avg Salary **$78k**
- **6,646** Avg Salary **$58k**
- **11,667** Avg Salary **$56k**
- **24,137** Avg Salary **$67k**

**TOTAL VALUE** = $16.5 Billion

**JOBS** = 43,719

**AVERAGE SALARY** = $65k per year

HIGH PERFORMANCE ALLOY SUPPLY CHAIN: REGIONAL EMPLOYMENT

GREAT LAKES
Highly Integrated advanced manufacturing economy

ATLANTIC SEABOARD
Dense in machine shops and alloy production

GULF COAST
Rapidly growing nonferrous metals industry

WEST COAST
Leader in efficient, clean and safe metal manufacturing

TOTAL JOBS

- 0 – 1,000
- 1,000 – 5,000
- 5,000 – 10,000
- 10,000 – 15,000
- 15,000 – 20,000
- 20,000 – 40,000
- 40,000 – 80,000
- 80,000 +

**SOURCES:**
1. Allied Market Research, Superalloys Market Global Opportunities Market 2017-2023
2. Source: IBISWorld
** Segment value and jobs supported estimates are derived using data from IBISWorld and EIA**