

# An Overview of Energy Efficiency and Future Needs for Aluminum Industry in Process Heating



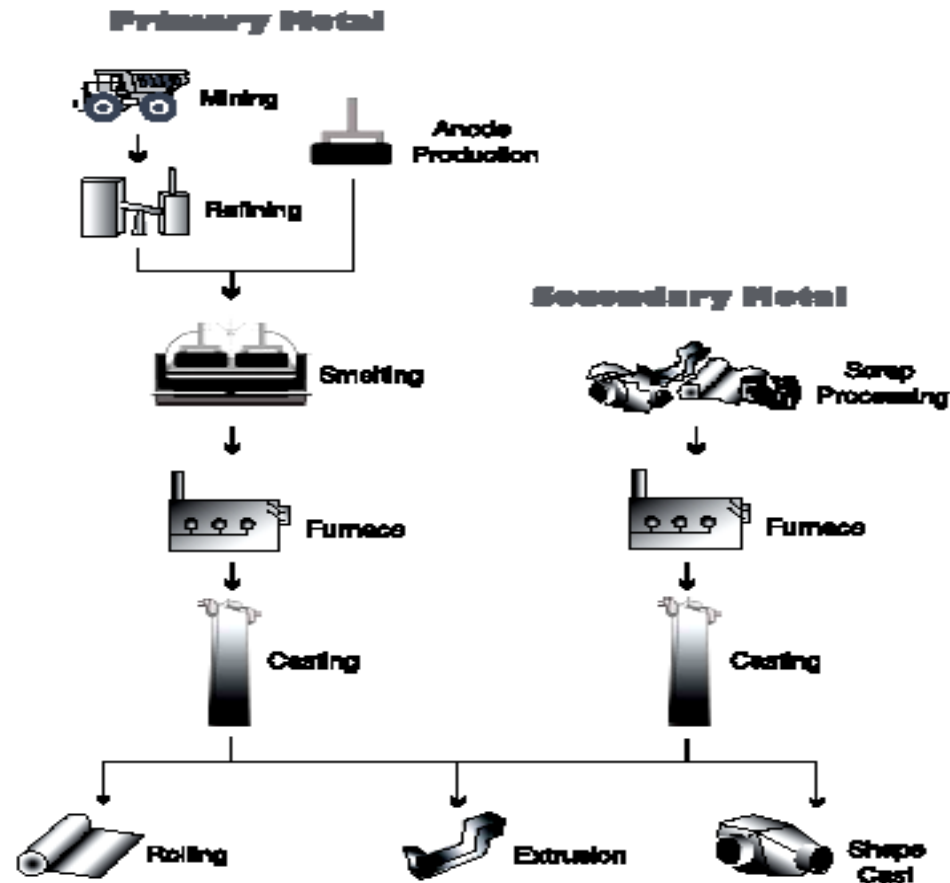
By

**Dr. Subodh Das**

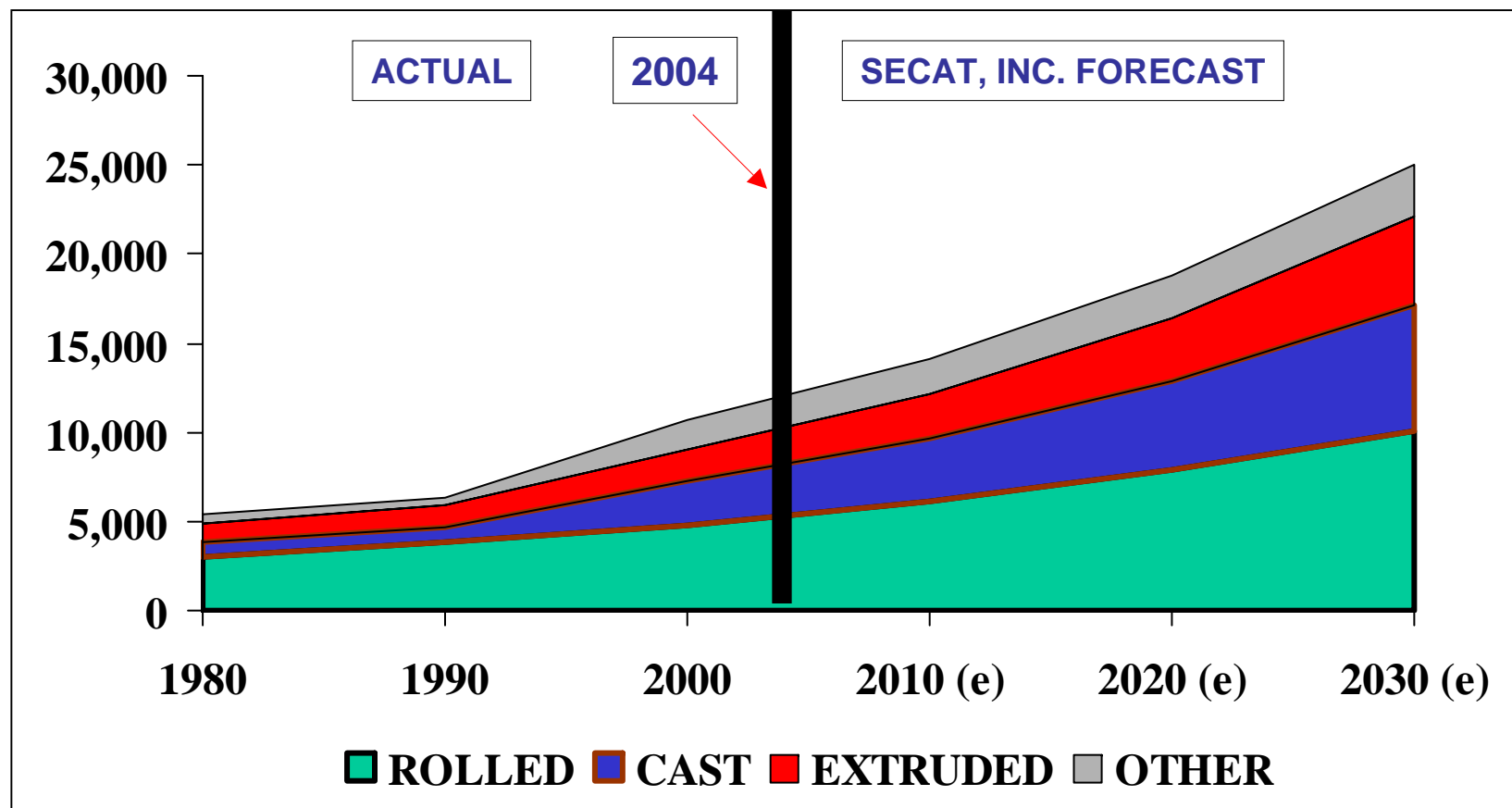
**Secat, Inc**

October 19<sup>th</sup>, 2004

# Energy Intensive Production Processes for Aluminum Industry



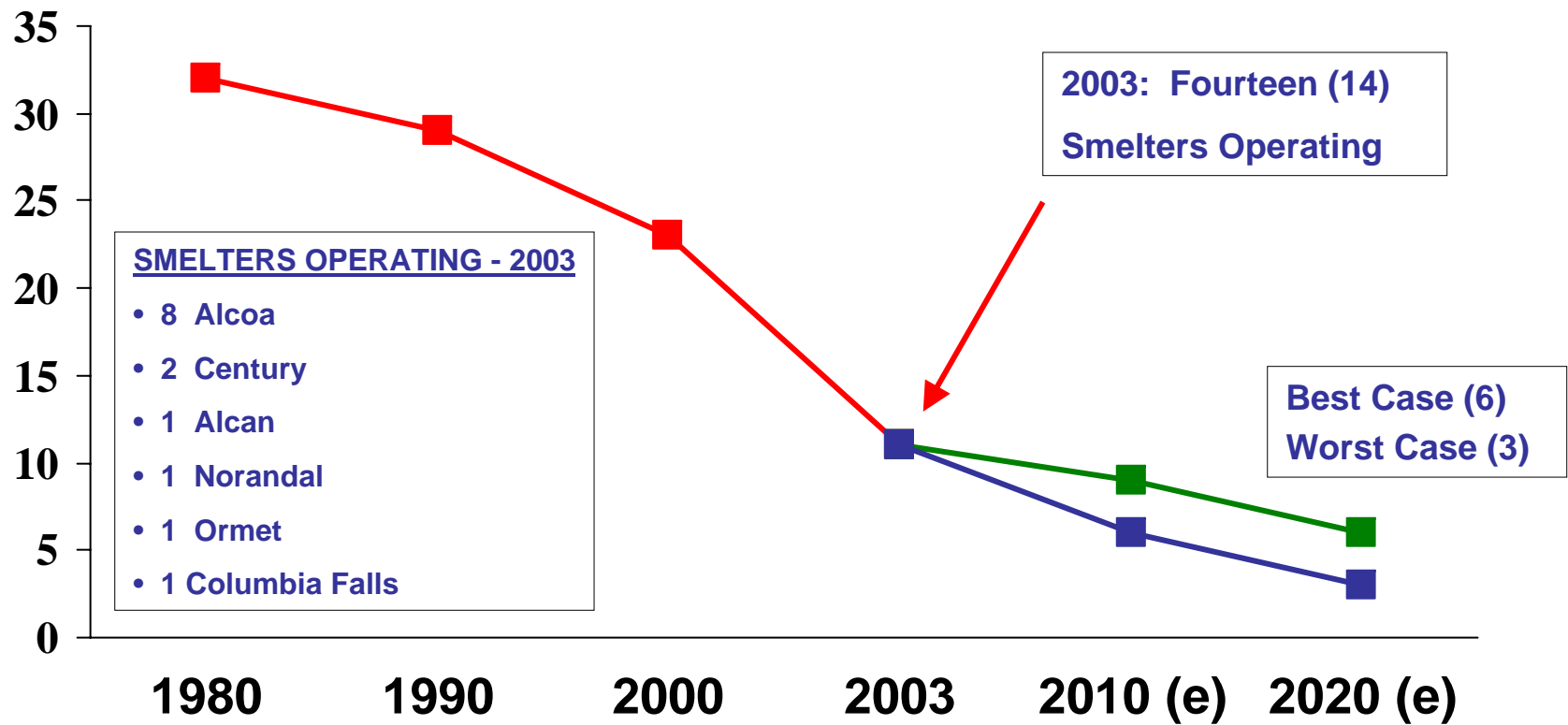
# U.S. FORECASTED GROWTH OF ALUMINUM INDUSTRY SHIPMENTS (000 METRIC TONS)



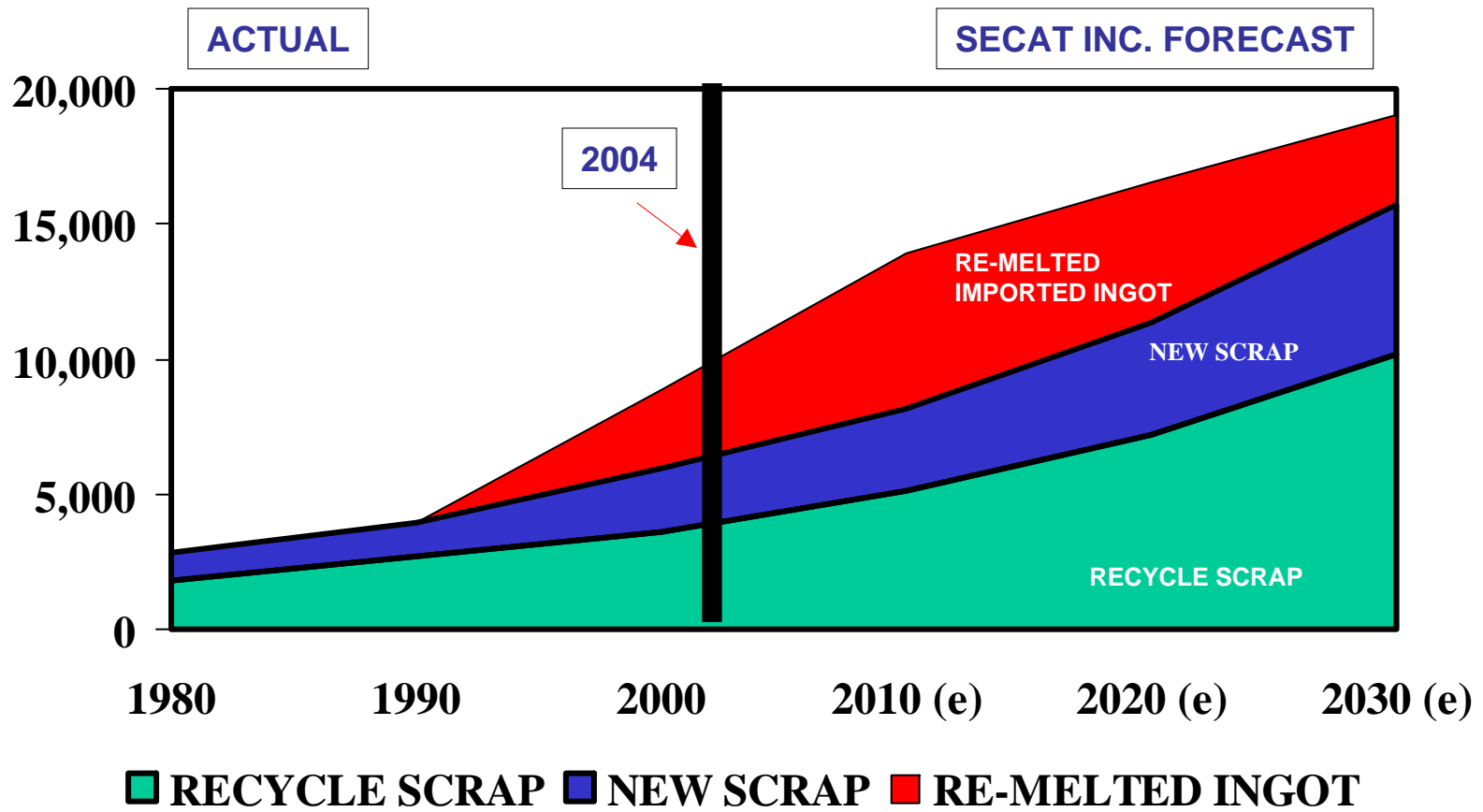
# U.S. ALUMINUM INDUSTRY TRENDS

- **CLOSED: All bauxite mining.**
- **DECLINING: 3 alumina refineries operating.**
- **CURTAILED: Only 14 smelters operating.**
  - 7 Smelters are operating at full capacity.
  - 7 Smelters are operating at 63% of combined capacity.
- **REMAINING: Re-melting/Casting/Fabrication.**

# NUMBER OF PRIMARY SMELTING PLANTS IN THE U.S.

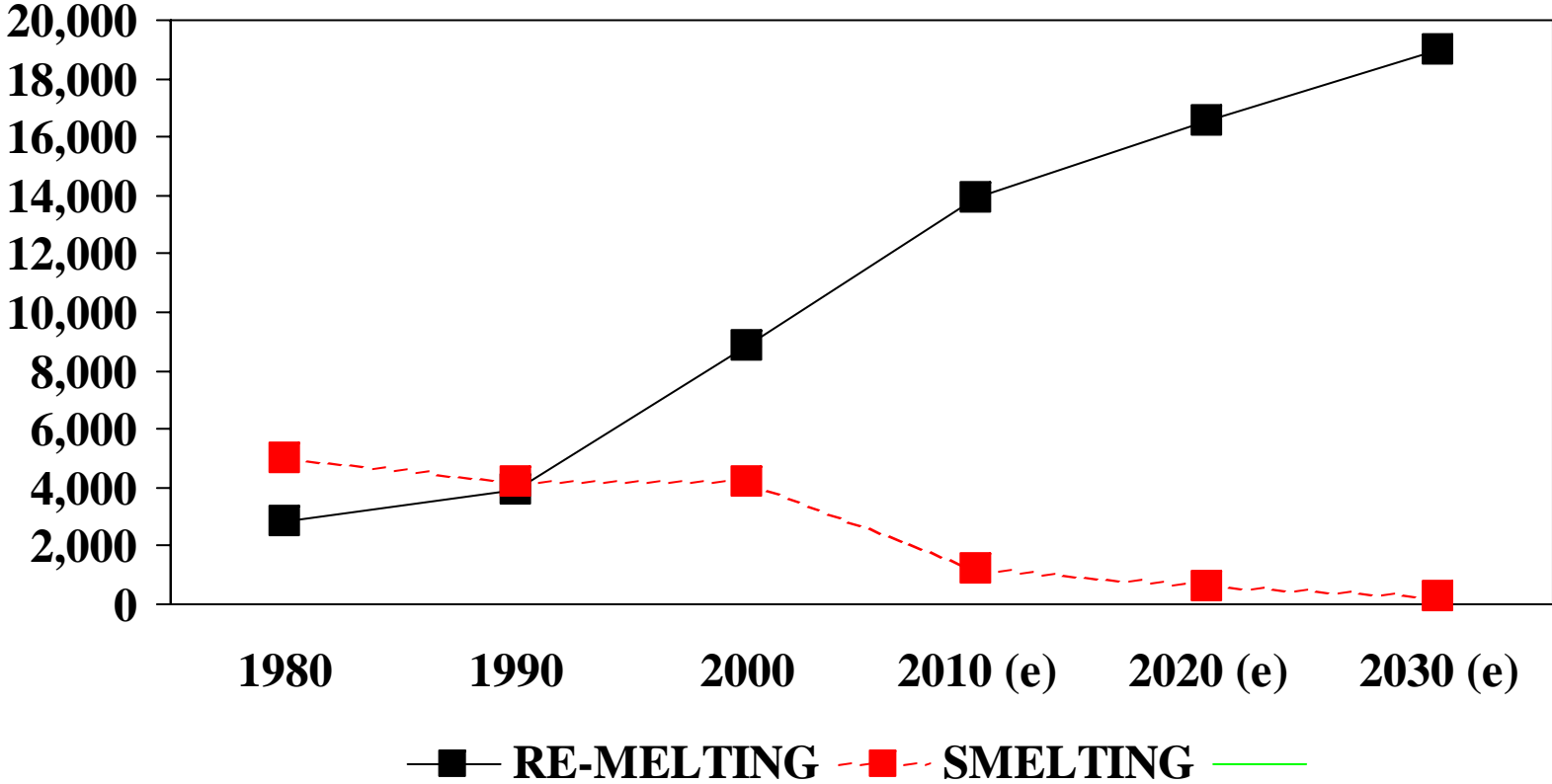


# THE U.S. GROWTH IN RE-MELTING (000 METRIC TONS)



# GROWTH OF RE-MELTING IN THE U.S.

(000 METRIC TONS)

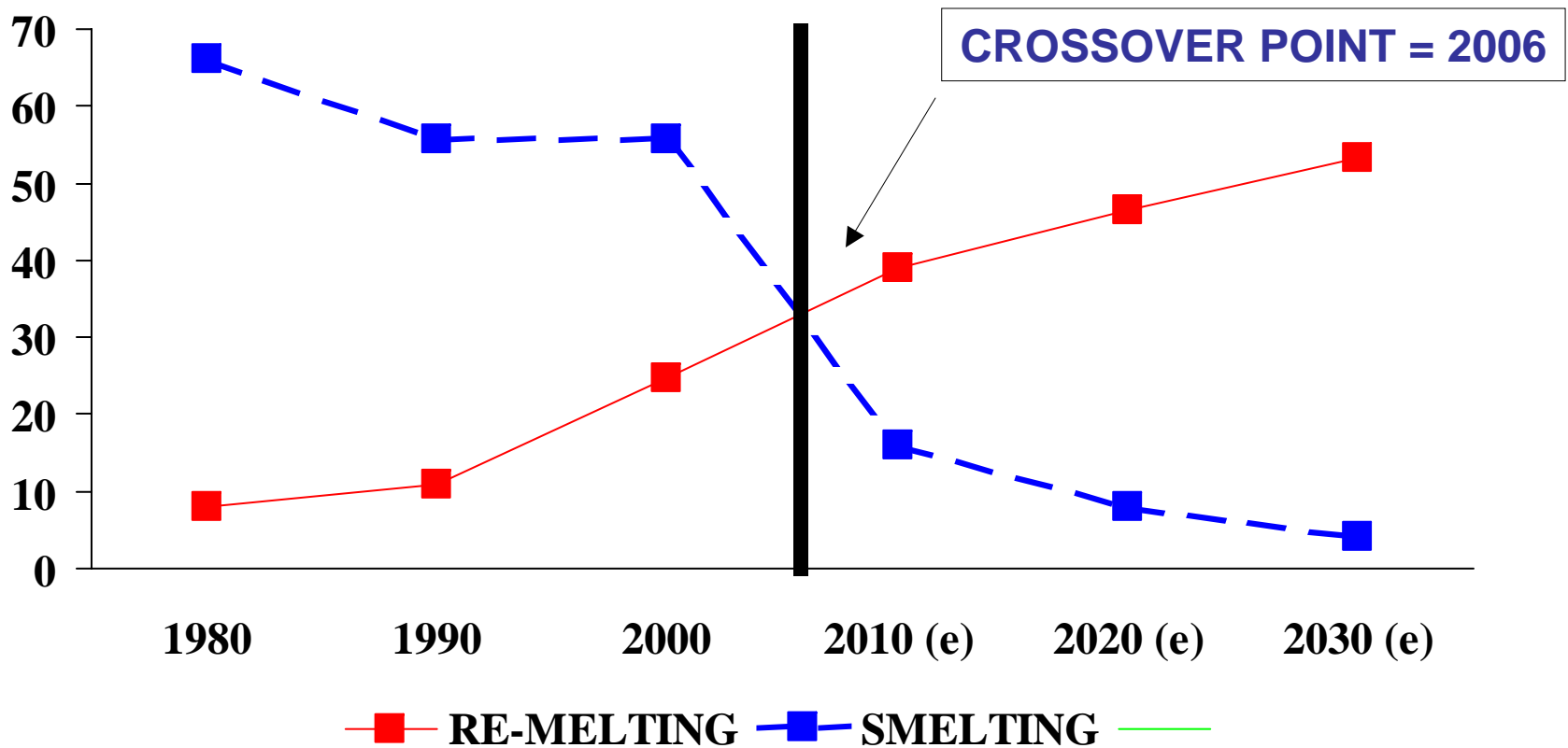


# ENERGY REQUIRED SMELTING VS. RE-MELTING

	<u>SMELTING</u>	<u>RE-MELTING</u>
	(BTU PER POUND)	(BTU PER POUND)
<b>THEORETICAL MINIMUM</b>	<b>10,200</b>	<b>510</b>
<b>CURRENT AVERAGE</b>	<b>26,000</b>	<b>2,200</b>
<b>PRACTICALLY ACHIEVABLE</b>	<b><u>20,000</u></b>	<b><u>925</u></b>
<b>ENERGY EFFICIENCY SAVINGS OPPORTUNITY (BTUs / LB.)</b>	<b>6,000</b>	<b>1,275</b>



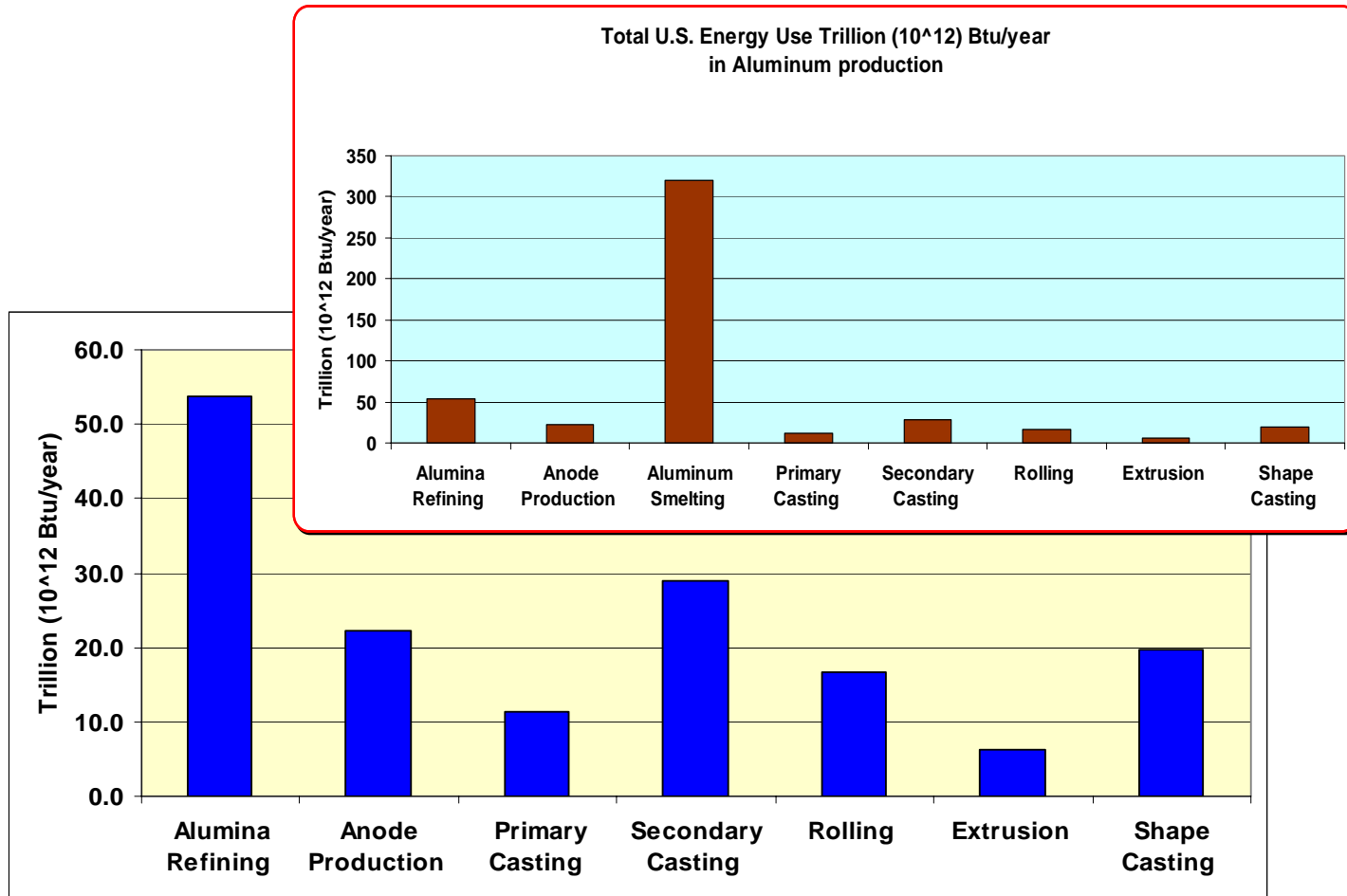
# U.S. ENERGY EFFICIENCY SAVINGS OPPORTUNITIES RE-MELTING VS. SMELTING (U.S. - TRILLIONS BTUs PER YEAR)



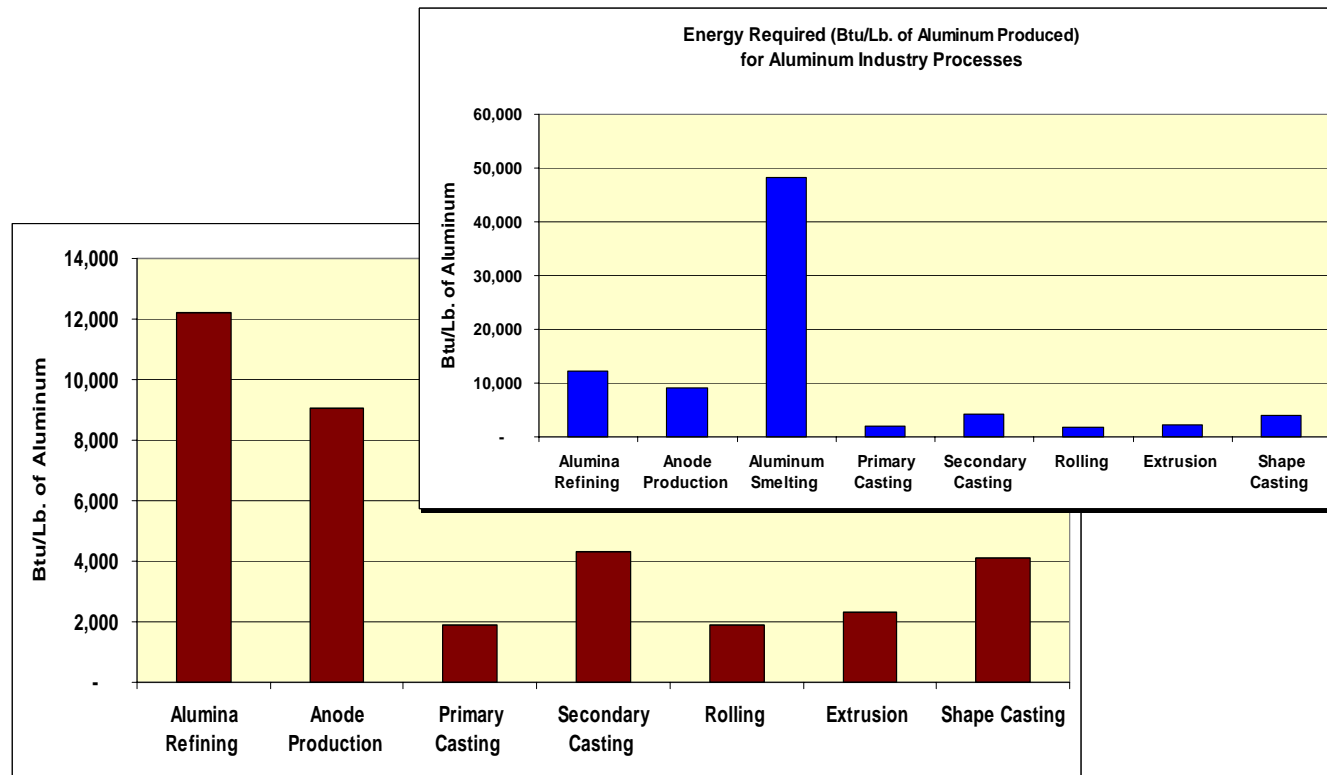
# CONCLUSION

**Going forward from 2004, the best opportunity for improving energy efficiency and lowering energy consumption in the U.S. Aluminum Industry is by focusing research upon re-melting.**

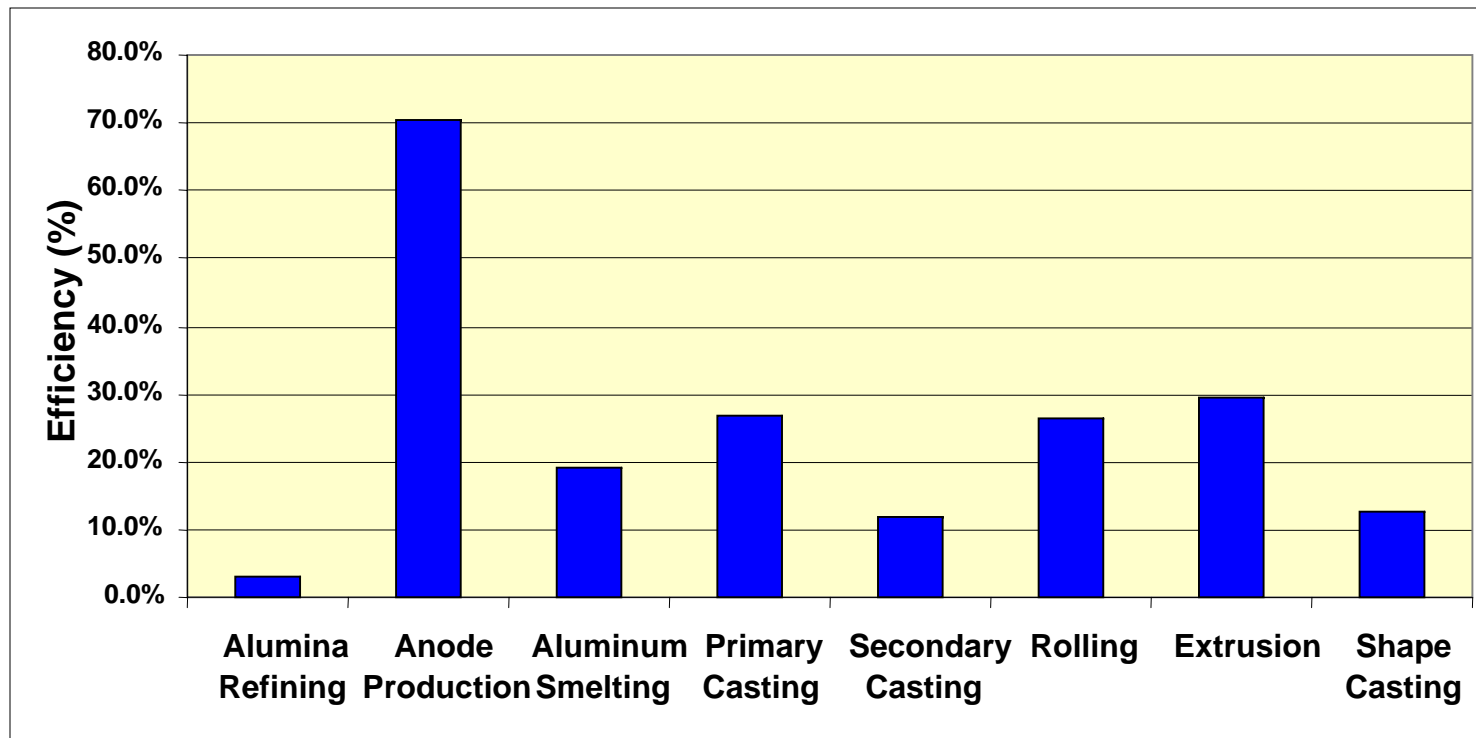
# Energy Use by the U.S. Aluminum Industry



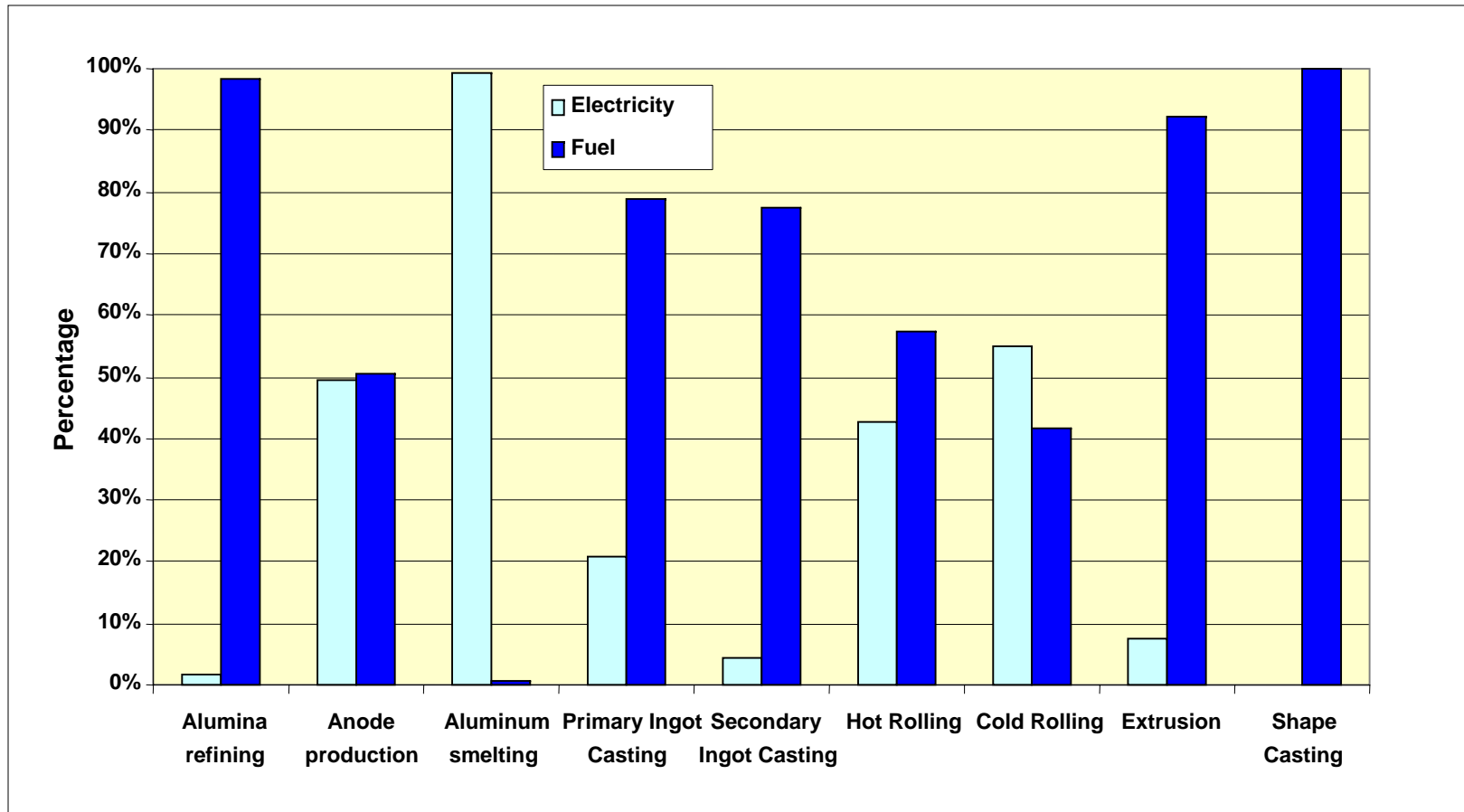
# Energy Use per Lb. of Aluminum Production for the U.S. Aluminum Industry



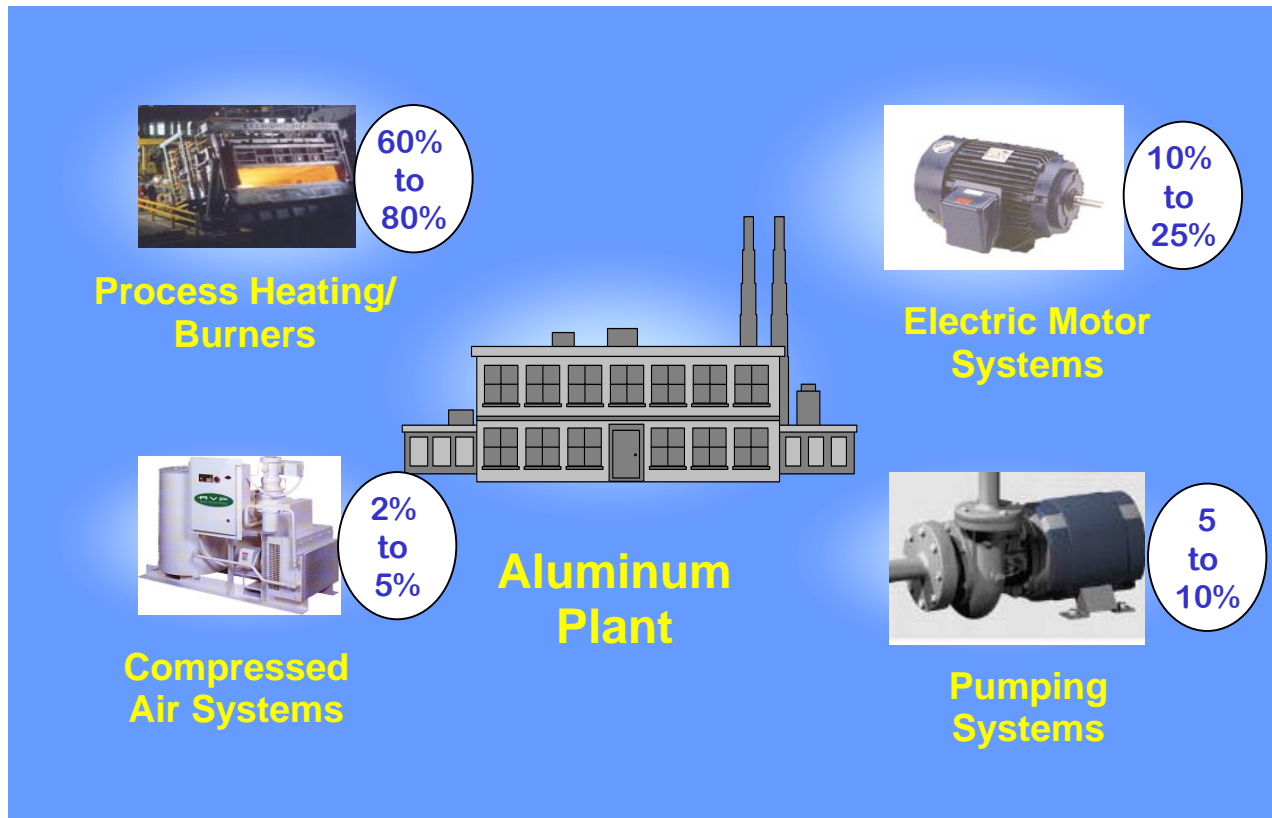
# Overall (Gross) Energy Efficiency for Aluminum Industry Processes



# Use of Electricity and Fuel for Aluminum Production Processes



# Four Systems offer major energy saving opportunities in Secondary Aluminum Industry Plants



The numbers show the percentage of total energy used for the specific system

## Process Heating in Aluminum Production

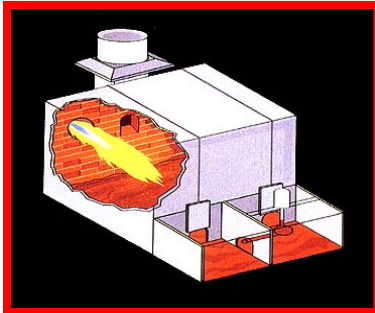
# Types of Processes where Heat is Used

- **Primary Aluminum Production**
  - Drying
  - Calcining
  - Heating - Anode baking
- **Secondary Aluminum Production**
  - Metal Melting
  - Metal Heating
  - Metal Heat Treating
- **Fabrication and Finishing**
  - Metal Heating
  - Fluid Heating
  - Heat Treating
  - Drying
  - Curing and Forming



# Process Heating

**Process heating consumes more than 70 % to 85% of the total energy used for the secondary aluminum industry**



- Process heating systems are used for melting, heating, heat treatment, drying, smelting, roasting, fluid heating etc.
- Process heating equipment include furnaces, melters, ovens, heaters, dryers etc.
- These equipment use fuel (natural gas, oil etc.) and electricity as source of energy
- Process heating offers significant (usually more than 50%) energy savings through application of new developments through R&D for heating equipment

# Process Heating Energy Issues

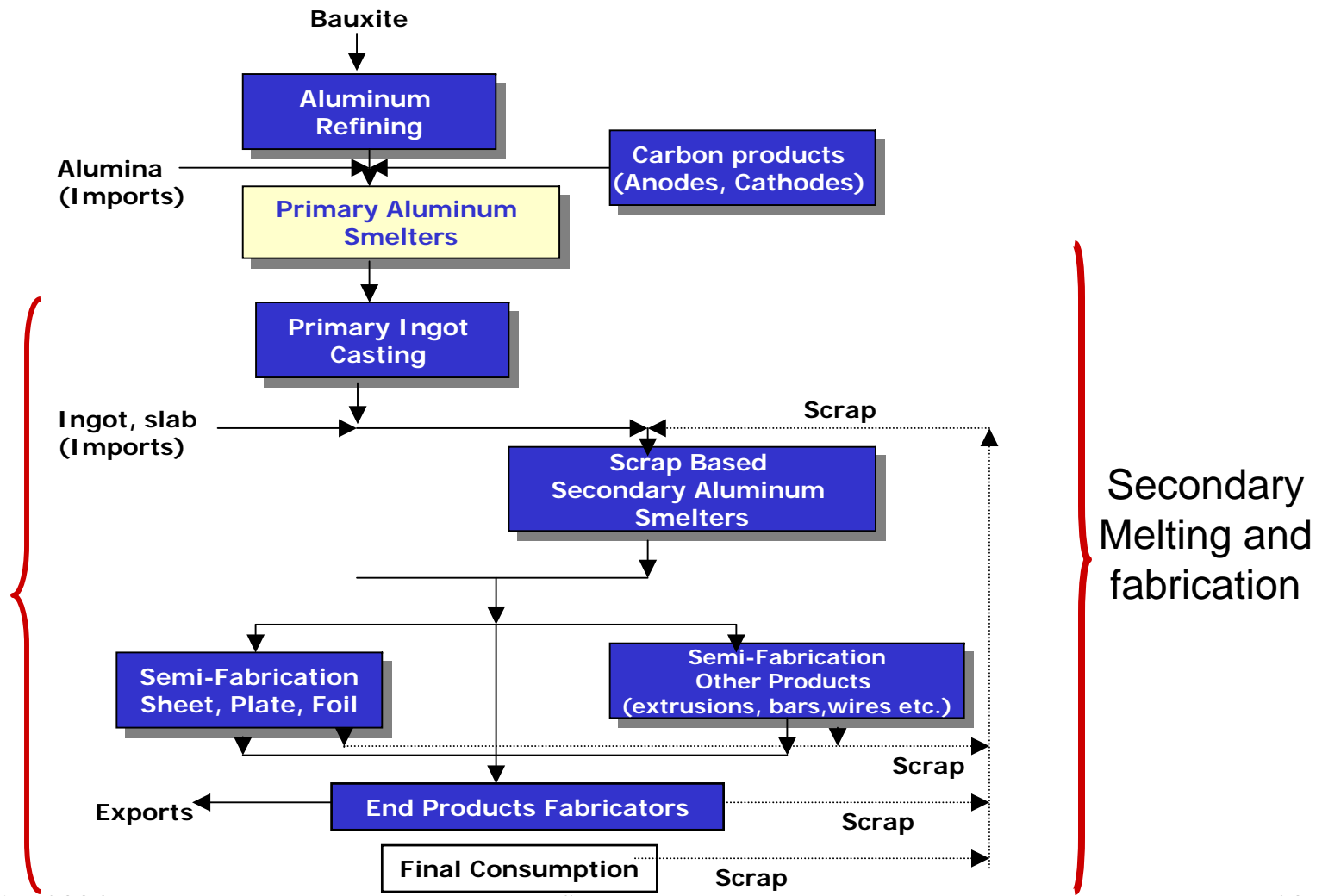
- Low efficacy of furnaces
- Excessive maintenance of furnace parts (refractories, burners, radiant tubes, recuperators etc.)
- Availability of simple and reliable sensors and controls for flue gas composition (NO<sub>x</sub>, O<sub>2</sub> etc.)
- High turn-down, low NO<sub>x</sub> burners
- Models and tools to predict heating and soak time for a variety of sizes and shapes in heating/heat-treating furnaces
- Life of recuperators for air heating

# Environmental Issues

- NOx emissions from burners and furnaces
- Particulate emissions from furnaces
- Emission from recycled scrap processing (volatiles, inorganic etc.)
- Emissions from coating processes (volatiles, fumes etc.)
- Dross processing and residual disposal

# Major Sectors of Aluminum Industry

## Areas for Process Heating R&D Opportunities



# Research Priorities for the Aluminum Industry

- Most of the research should be done in recycling and remelting areas
- Develop and design aluminum remelting furnace for the future that minimizes melt loss, increase cost effectiveness, increase safety, improve fuel/energy efficiency, improve melt rates and reduce emissions
- Develop a low cost process for metal purification of primary alloys from recycled scrap. This includes methods to remove specific impurities such as Mg, Fe, Pb, Li, Si, and Ti to produce high-quality metal from mixed scrap.
- Develop new secondary alloys that better match scrap to specifications for increased utilization. Coupled with this is a goal to develop manufacturing processes for scrap-tolerant alloys, such as spray rolling and other rapid solidification processes
- Minimize the loss of aluminum to oxidation and dross formation during remelting. Priorities include developing a more complete understanding of oxidation mechanisms and developing processes that more effectively separate metal from dross or salt cakes.

# Research Priorities for the Process Heating in Aluminum Industry

- Efficient and long-life waste heat recovery systems for combustion air preheating
- High efficiency, low-emission heating systems
- Improved systems for molten-metal recirculation
- Sensors and control system for melting, heating and aluminum heat treating furnaces
- Emission control systems for furnaces
- Improved metallic and refractory materials for furnaces, burners, radiant tubes etc.
- Low cost oxygen supply
- Fuel or energy source flexibility for heating
- Low dross or near-zero melt loss heating system