

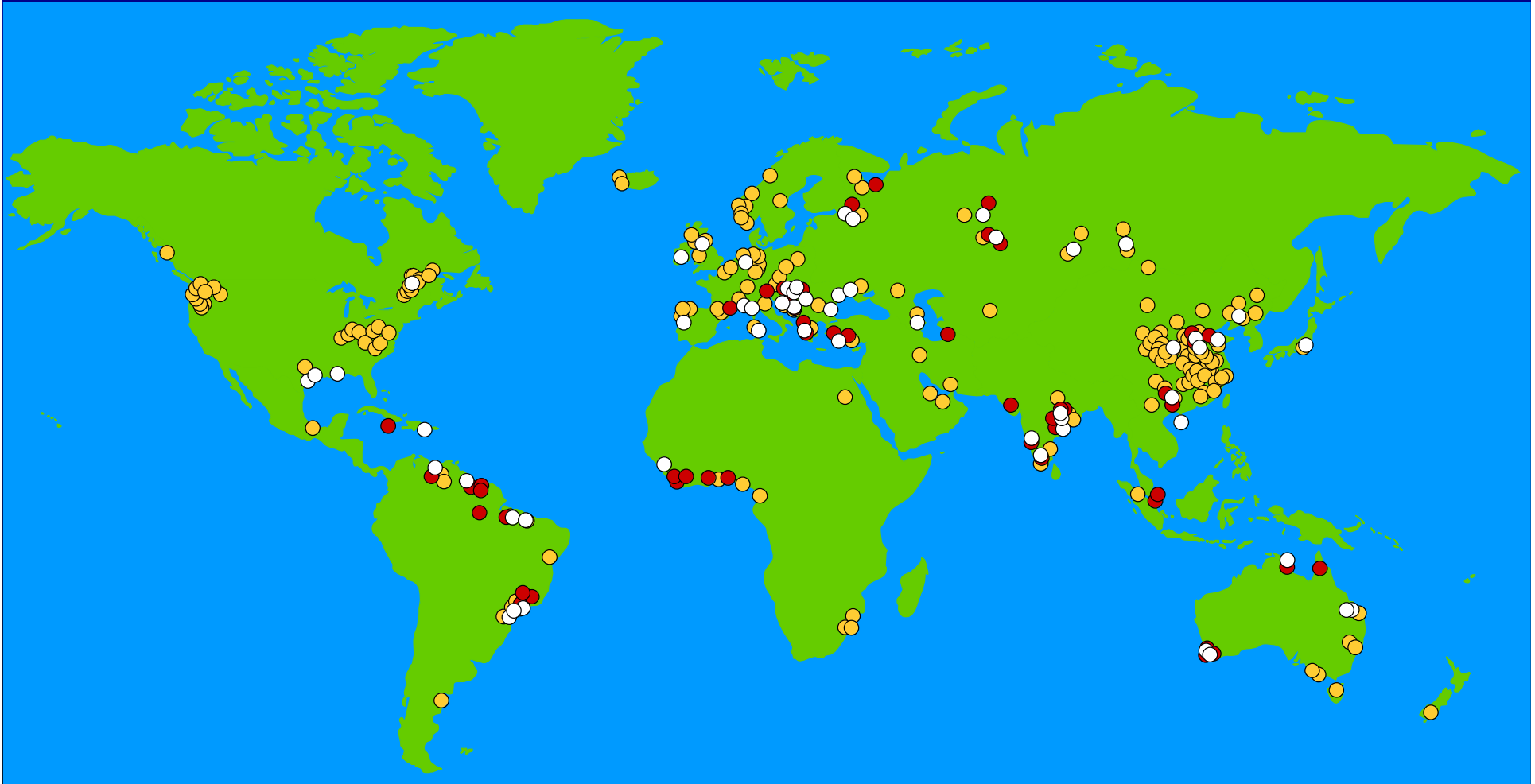
The background of the slide is a long-exposure photograph of a city street at night. The street is filled with light trails from cars and buses, creating streaks of red, white, and blue. Buildings are illuminated, and a street sign with the letters 'CV' is visible. A black bollard is in the foreground on the left.

**Aluminium Mass Flow Modeling  
and Emissions Projections**

**Kenneth Martchek**

**Alcoa Inc.**

**Global distribution of bauxite mines (●)  
alumina refineries (●) and aluminium  
smelters (●)**



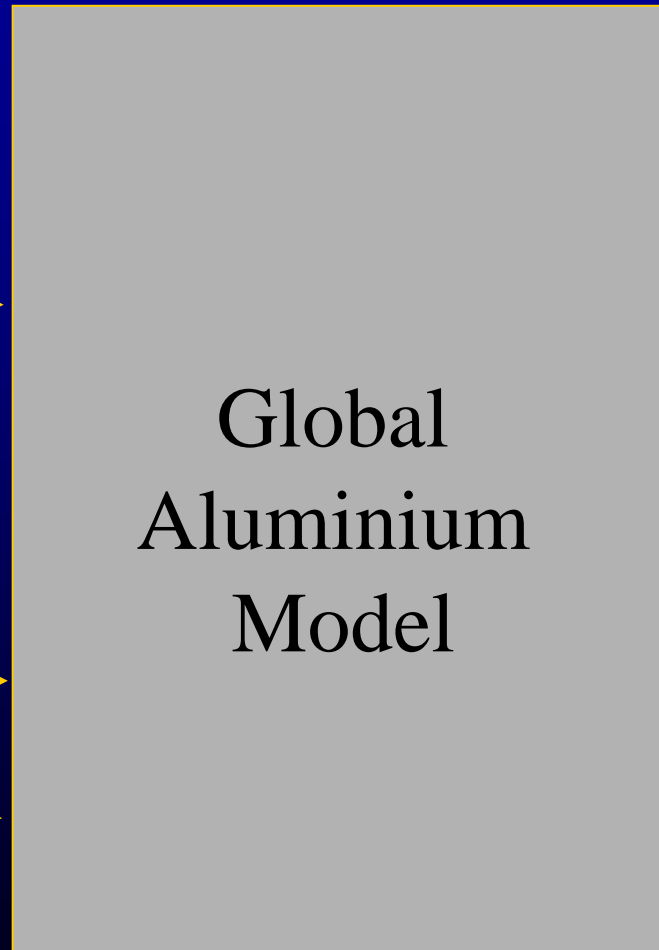
# Key Modeling Considerations

- *Objectives*
  1. Quantitative understanding of past and current global aluminium metal flows and subsequent GHG (Greenhouse Gas) emissions
  2. Develop future scenarios of metal flows, GHG emissions, and industry improvements.
- *Methodology:*
  1. Utilize regional association statistics (1950-present)
  2. Quantify annual flows and emissions based on:
    - a) product shipments by market sectors,
    - b) estimated product lifetimes,
    - c) end-of-life recovery rates by market sector,
    - d) current and projected emissions intensities.

# Global Mass Flow Model

## Annual Inputs

- Product Shipments by Market
- Primary Produced
- Anticipated Product Lifetimes
- Recycling Rates
- Market Growth Projections

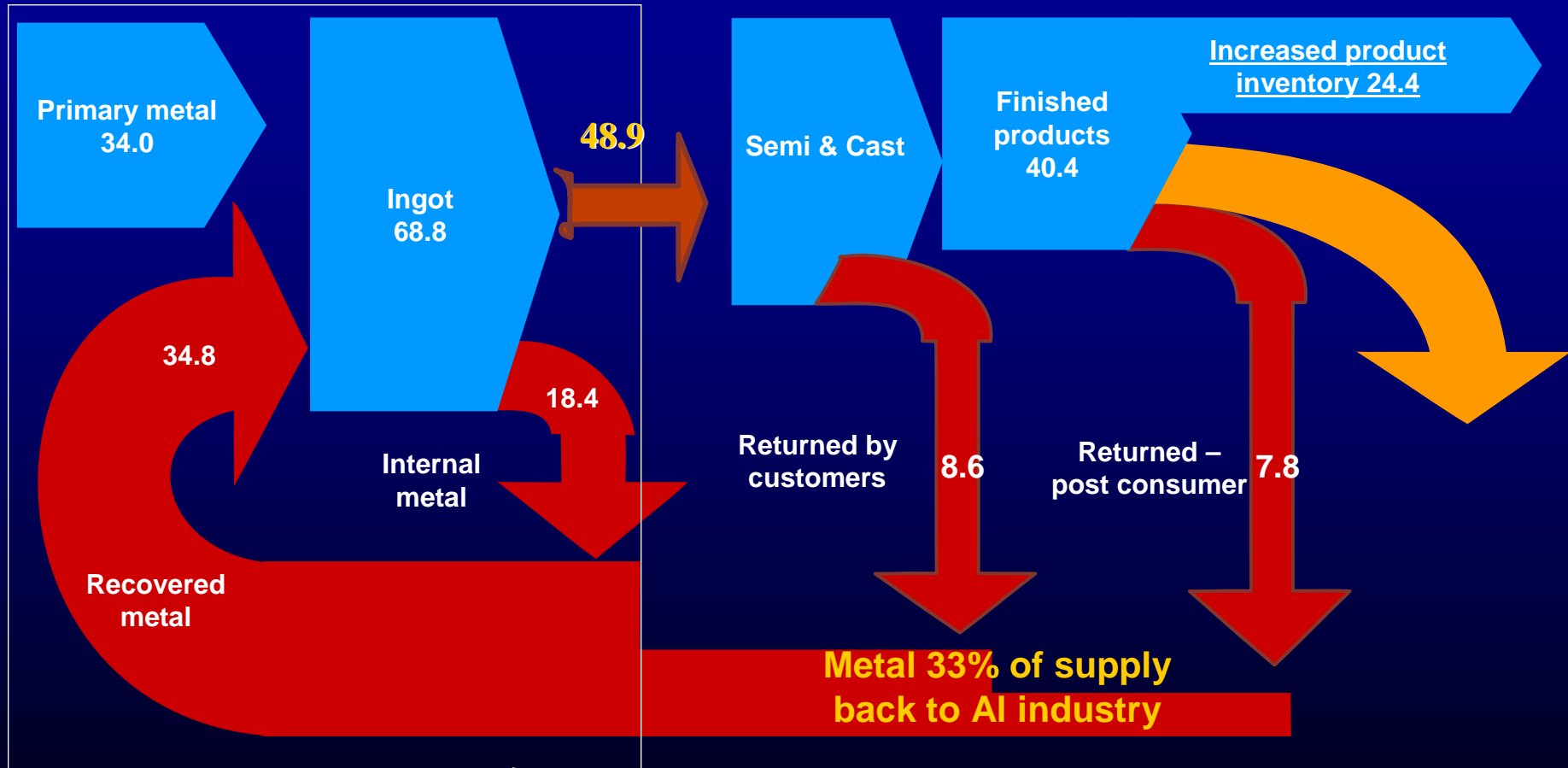


## Annual Outputs

- **Post-Consumer Recycle**
- **Customer Recycle**
- Internal Runaround
- Un-recovered Aluminium
- **Emissions**  
– CO<sub>2</sub> eq

# 2006 Global Aluminium Mass Flows

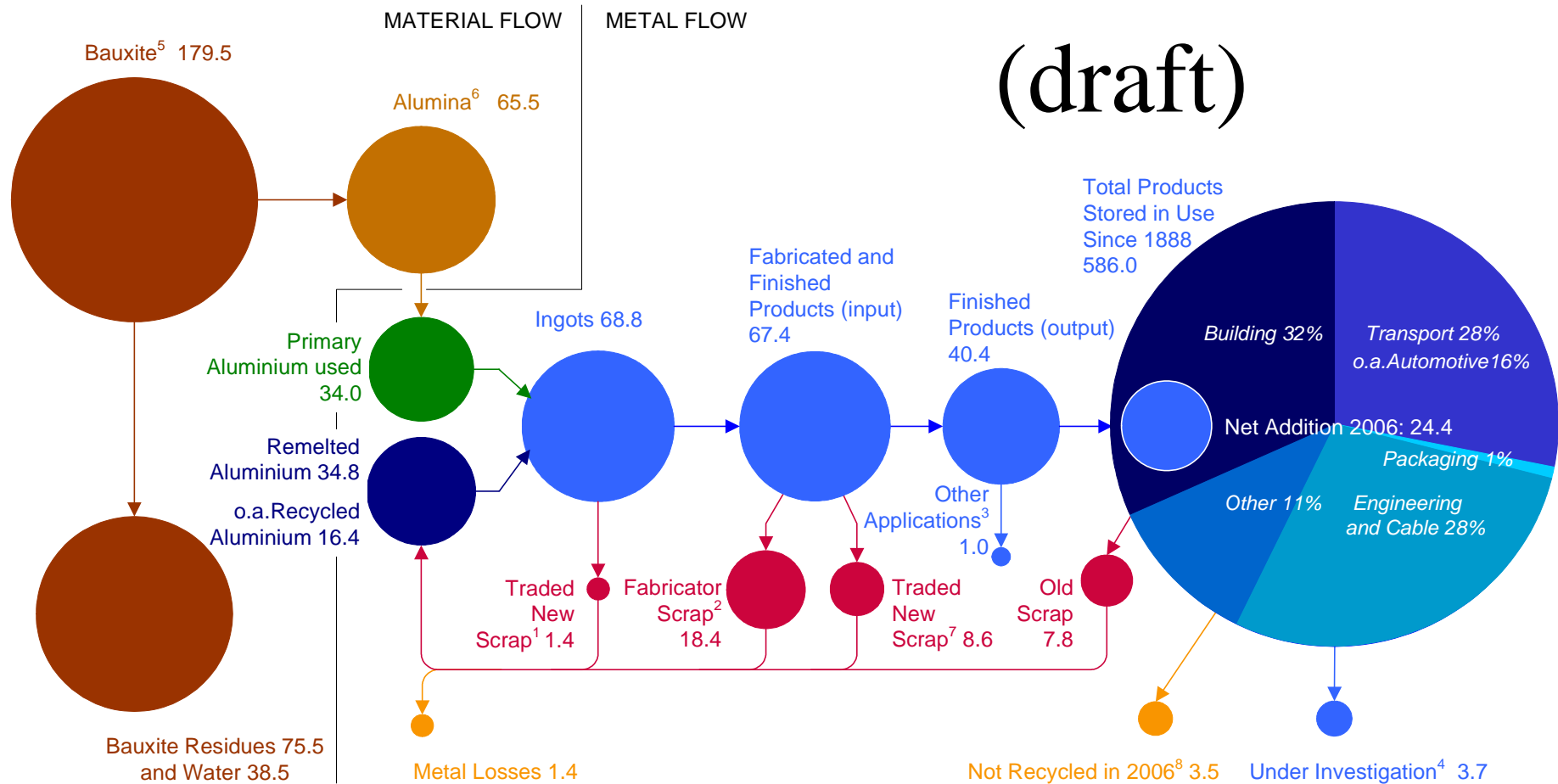
Million metric tonnes



Aluminium Industry

# Global aluminium flow 2006

(draft)

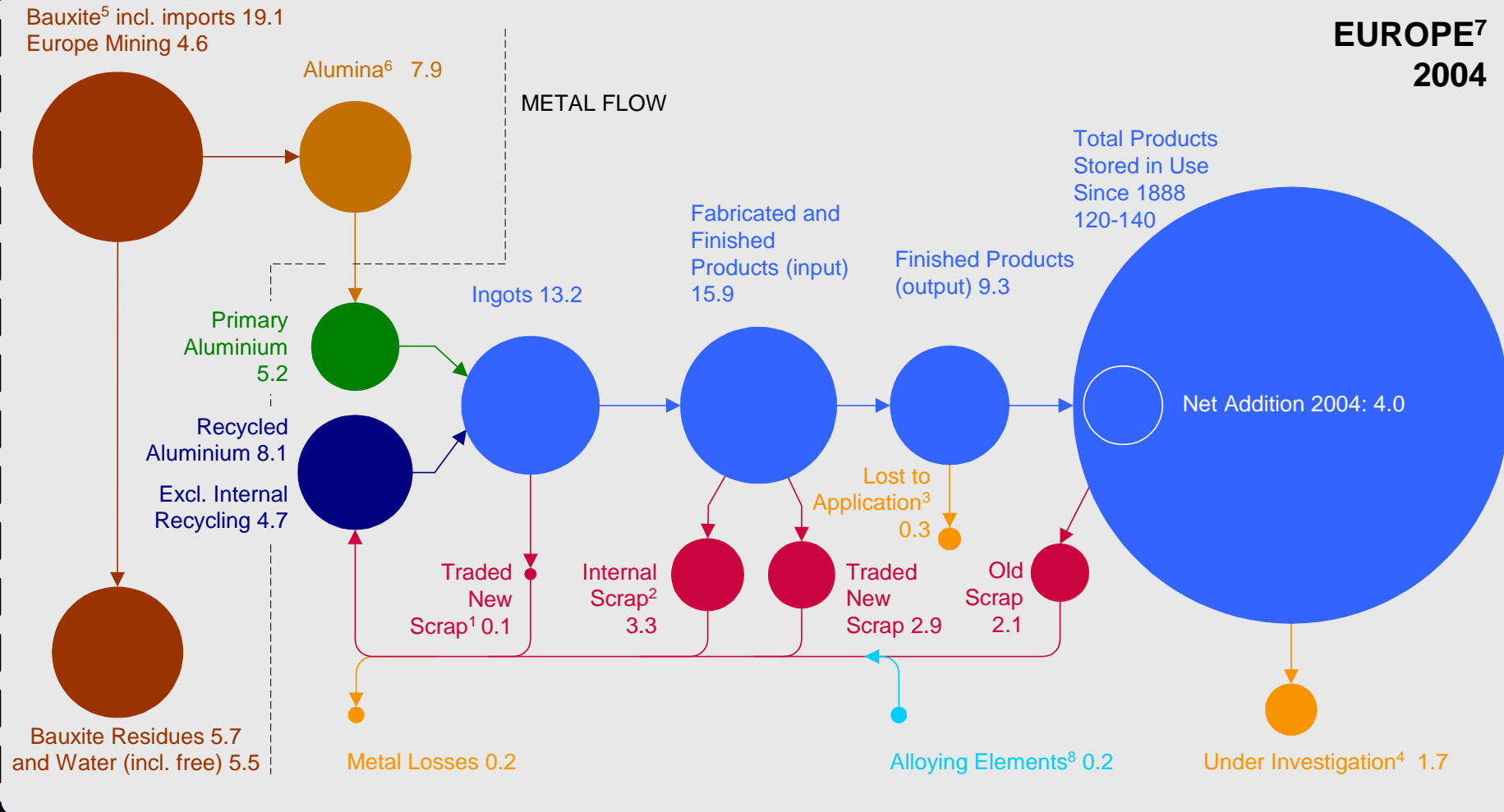


Values in millions of metric tonnes. Values might not add up due to rounding. Production stocks not shown

1 Aluminium in skimmings; 2 Scrap generated by foundries, rolling mills and extruders. Most is internal scrap and not taken into account in statistics; 3 Such as powder, paste and deoxidation aluminium (metal property is lost) 4 Area of current research to identify final aluminium destination (reuse, recycling or landfilling); 5 Calculated based on IAI LCI report - update 2005. Includes, depending on the ore, between 30% and 50% alumina; 6 Calculated. Includes on a global average 52% aluminium; 7 Scrap generated during the production of finished products from semis; 8 Landfilled, dissipated into other recycling streams, incinerated, incinerated with energy recovery.

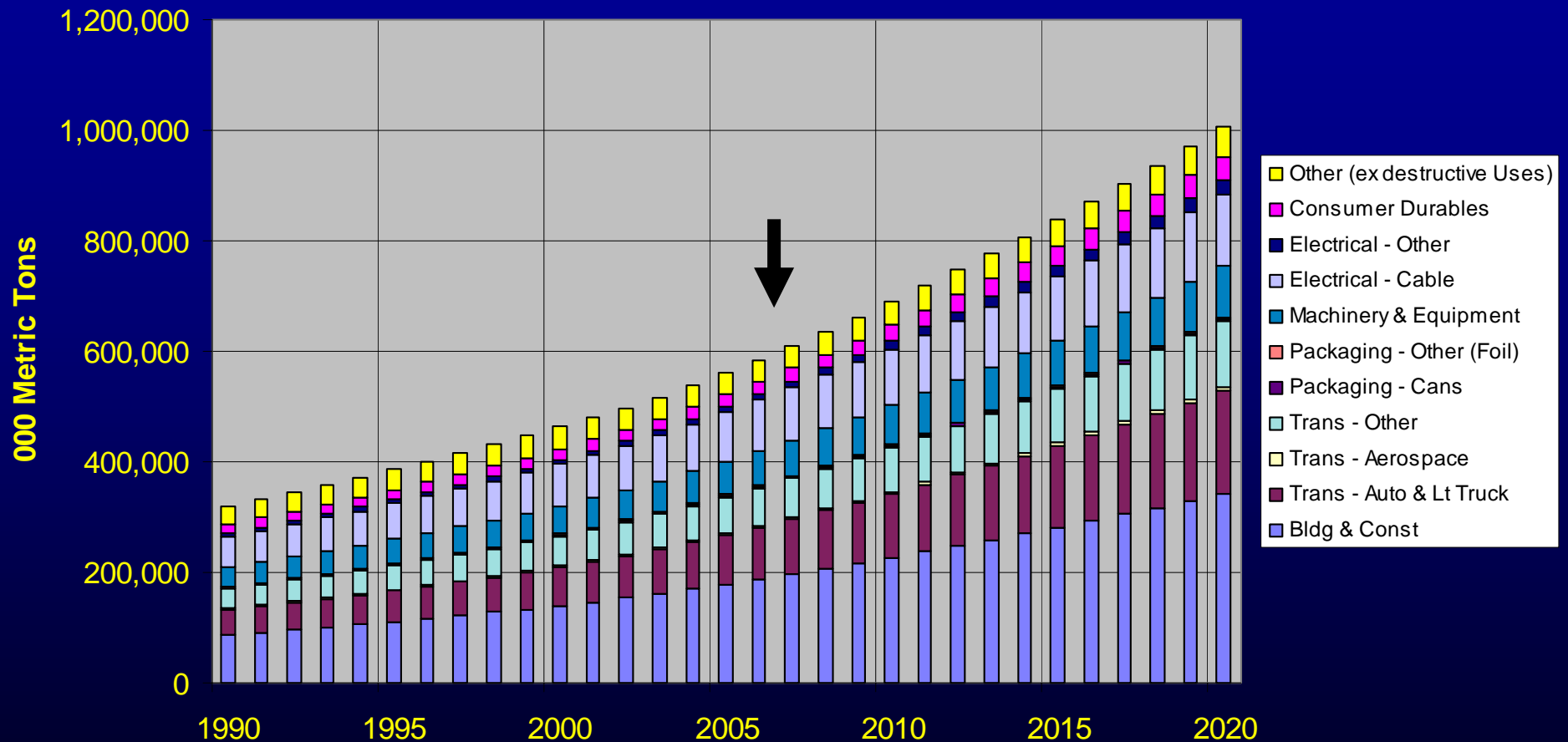
# Example of Emerging “Regional Models”

**EUROPE<sup>7</sup>  
2004**



Bauxite 14.5	Alumina +3	Ingots +2.8	Fabricated Products -0.4	Finished Products -0.7	End-of-life Products -0.5	Scrap -0.4	<b>NET IMPORT</b>
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# Global Product Inventory by Market



About 600 million tons today

# Aluminium Product Sustainability



Source: Günther Kirchner, 'Substitution of Primary Aluminium by Recycled Aluminium - Wishful Thinking or Reality?'

**Since 1888, 806 million metric tons of aluminium produced**

**About  $\frac{3}{4}$  of The Aluminium Ever Made Is Still in Productive Use**

# **Modeling to Study Aluminium Production Greenhouse Emissions**

*Based on Current and Projected Metal Flows*

All industry “direct” emissions (within our factories) caused by:

- Mining bauxite and Refining to  $\text{Al}_2\text{O}_3$ ,
- Smelting of primary aluminium (electrolysis),
- Rolling, extrusion and casting of “semi fab products,”
- Melting and casting of recycled and primary metal

All industry “indirect” emissions associated with purchased electricity, steam, caustic soda, petroleum coke, etc.

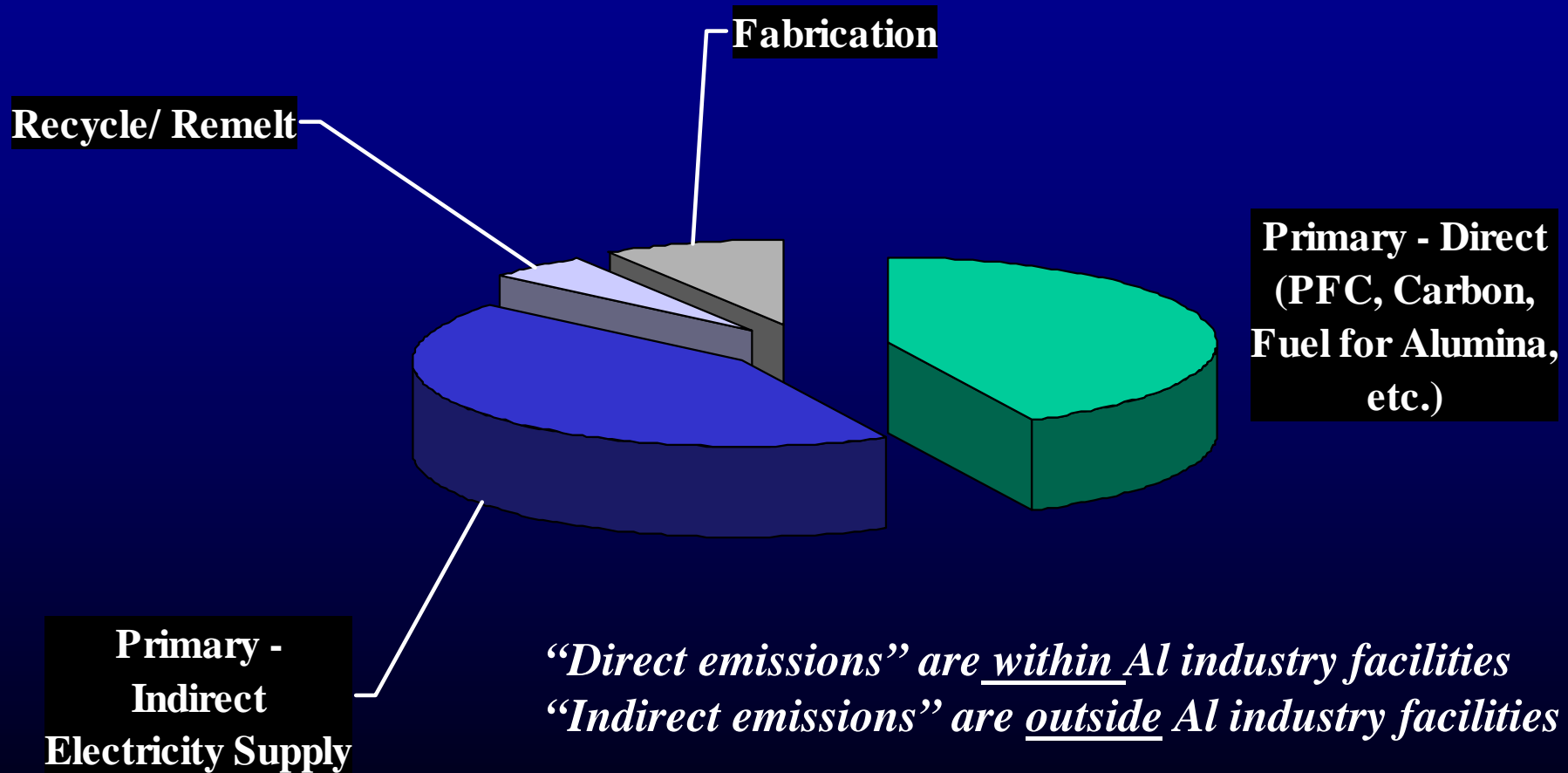
# GHG Emissions Intensity of Primary Aluminium Operations

Kg CO2e/ ton output	Mining	Refining	Anodes	Smelting	Casting	Per Ton of Ingot
Process	0	0	388	1,582	0	1,767
Fuels	16	754	135	133	155	1,882
PFCs				960		970
Purchased Electricity	0	58	63	5,147	77	5,414

*Scope 1 = 4.6 tons CO2e per ton of metal*

*Scope 2 = +5.4 tons CO2e per ton of metal*

# GHG Emissions Intensity CO<sub>2</sub>e per ton of Aluminium



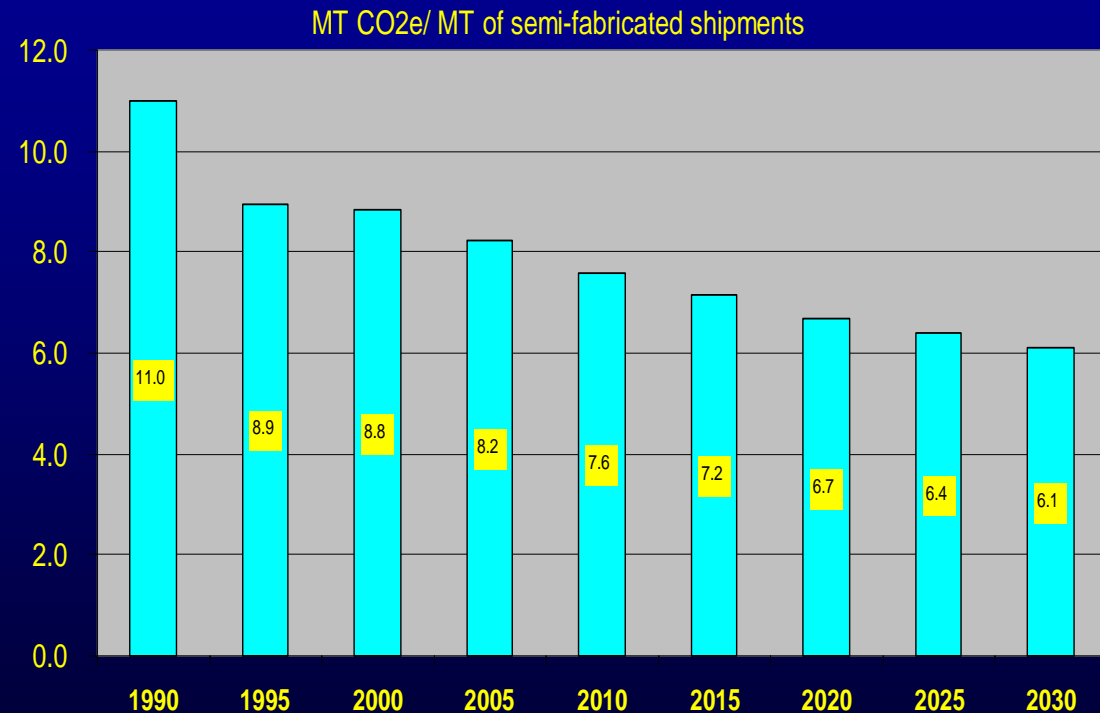
# Modeling Projections

Looking for Additional Opportunities  
for Substantial Improvement

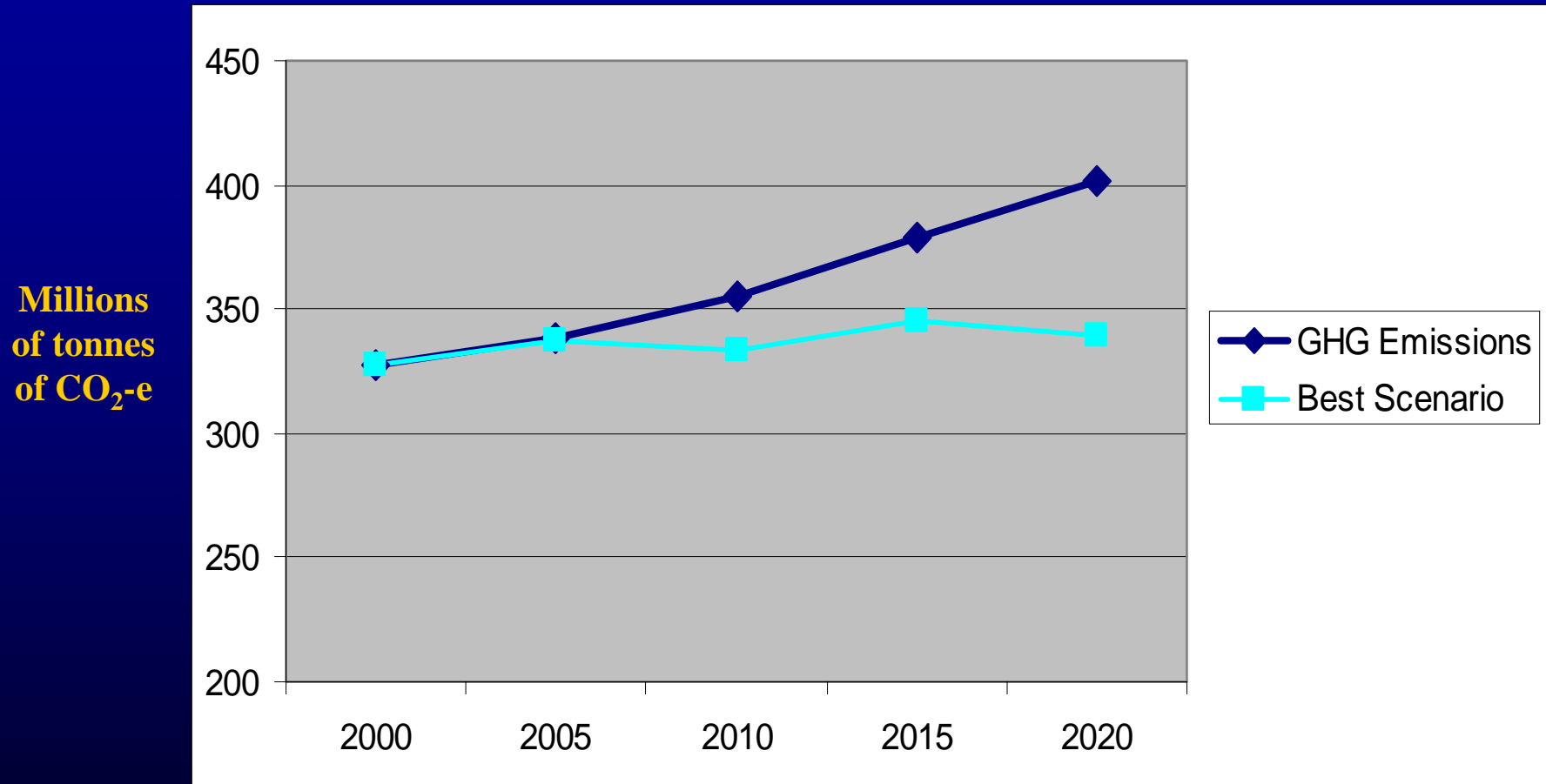
# Modeling: Lower GHG Intensity of Aluminum Product Shipments

On average, worldwide aluminum products are becoming less GHG intense on a per ton shipped basis due to:

1. Increase in the % recycled metal relative to primary metal and
2. Lower emissions from primary aluminum facilities.

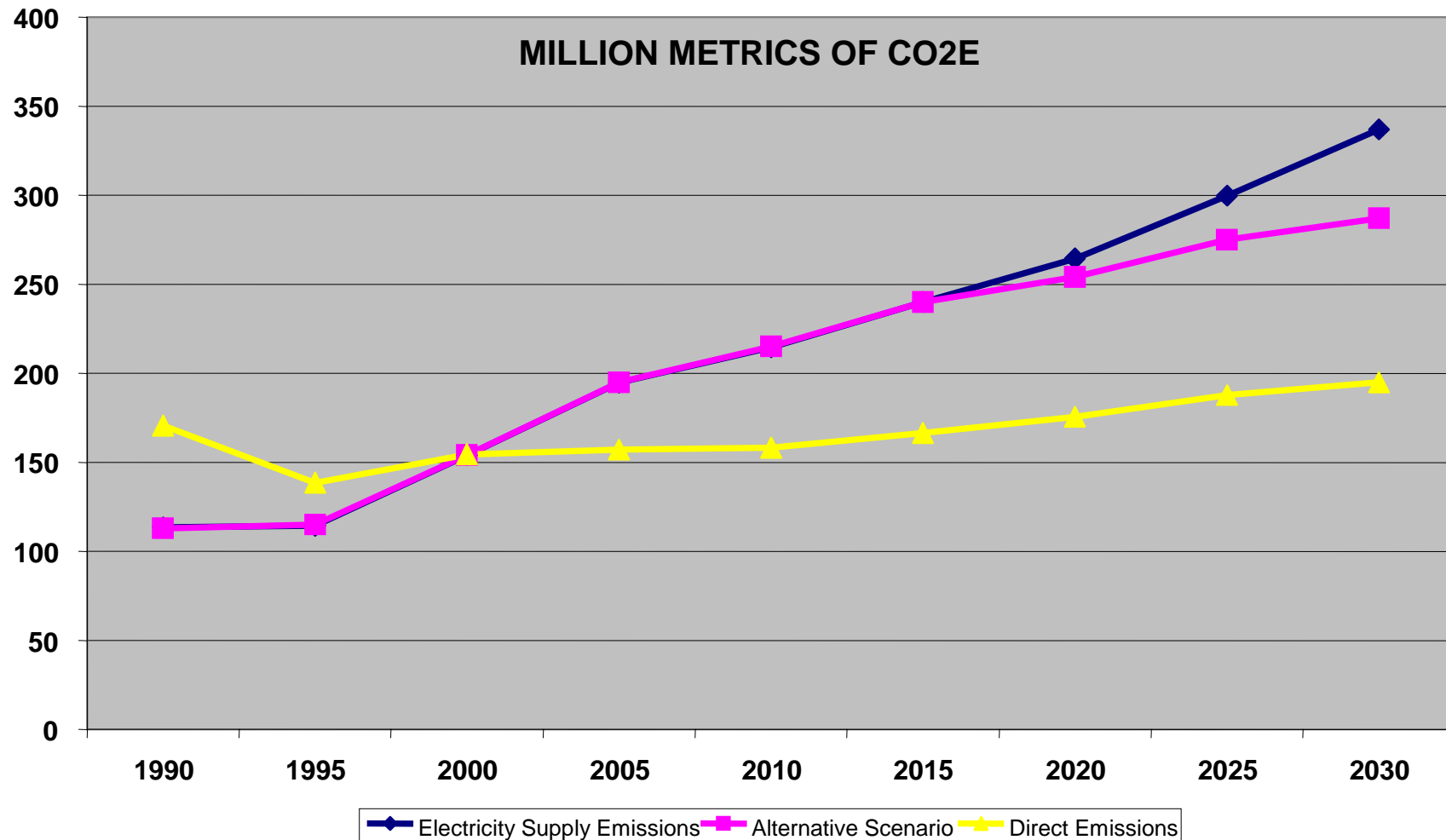


# Movement to “Today’s Best Practice”



**Full Industry Adoption of “Today’s Best Practice” Could Stabilize Growth of Global Production GHG Emissions**

# How to Stabilize Indirect Emissions As We Grow ?



# E27 Regional Model Results

## Components of Direct Emissions

