

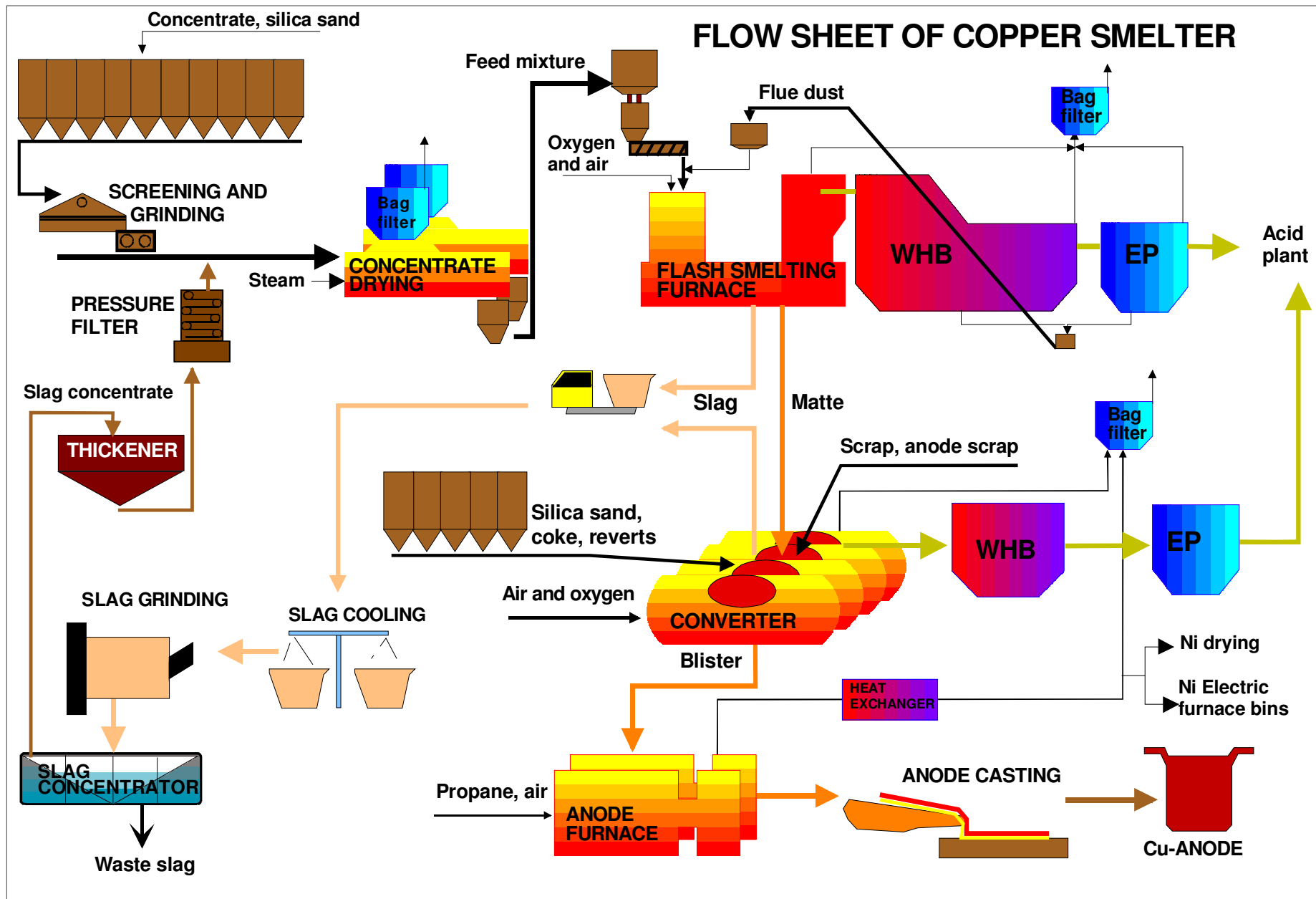


# ***Teollisen ekologian soveltaminen Perämeren- kaaren metallurgiseen teollisuuteen – Haasteet ja mahdollisuudet***

*Jyrki Heino OY ja prof. Olli Dahl TKK*

- 1. Harjavallan tehdasalueen kehitys menestykselliseksi teolliseksi ekosysteemiksi 1944 – 2008***
- 2. ProDOE tiimin esittely***
- 3. Perämerenkaareen metallurgisen teollisuuden haasteet ja mahdollisuudet pohjautuen Harjavallan kokemuksiin***
- 4. Mahdollisuudet ja edut EU:n mittakaavassa***
- 5. Mahdollisuudet globaalissa mittakaavassa***

# 1949 Ensimmäinen liekkisulatto Harjavaltaan



*Kuparin liekkisulatusprosessin SO<sub>2</sub> –ominaispäästöjen  
(kg SO<sub>2</sub>/ 1 t Cu) kehitys Harjavallassa*

**kg SO<sub>2</sub>/produced metal tonne**

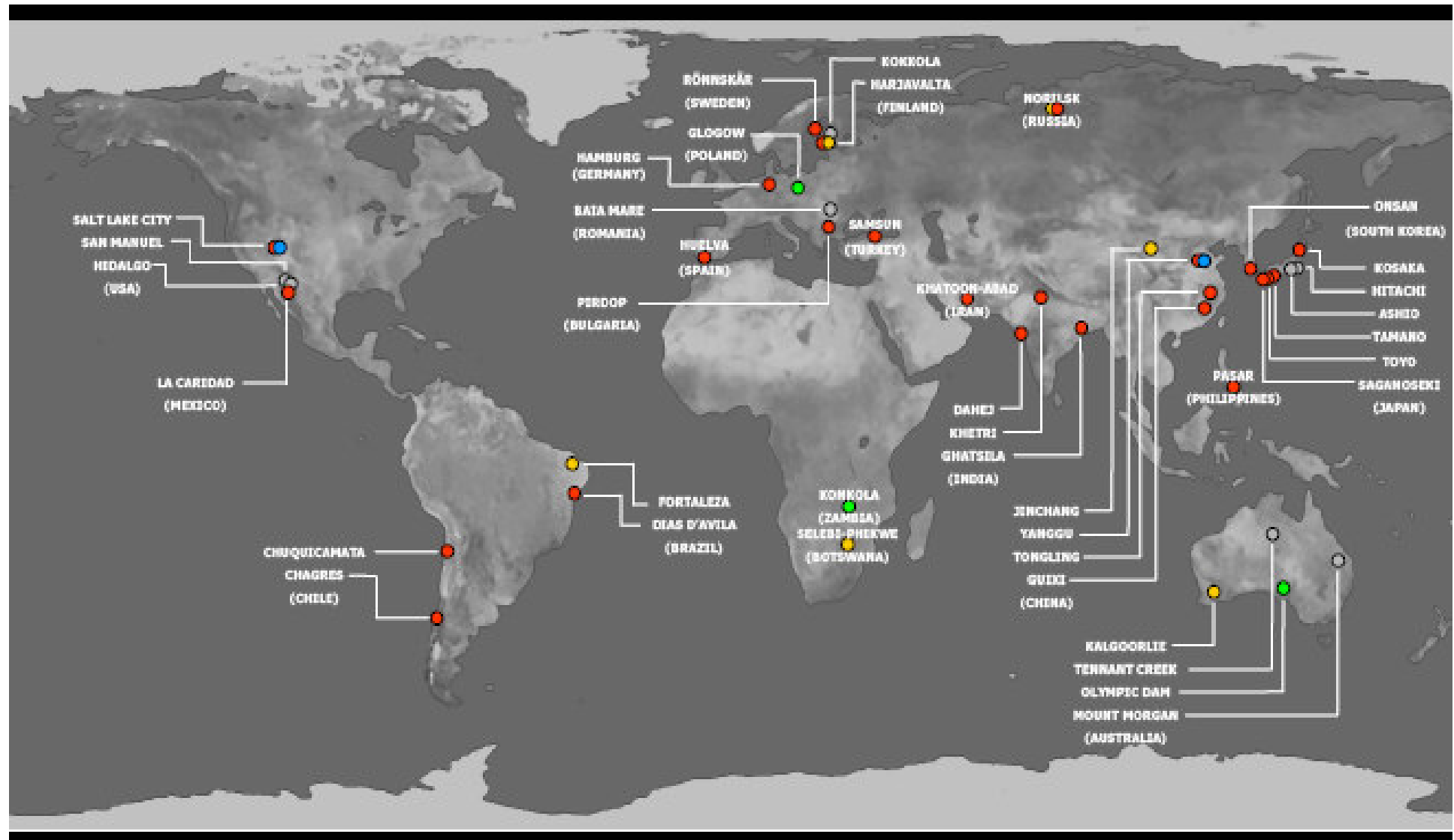
1000  
900  
800  
700  
600  
500  
400  
300  
200  
100  
0



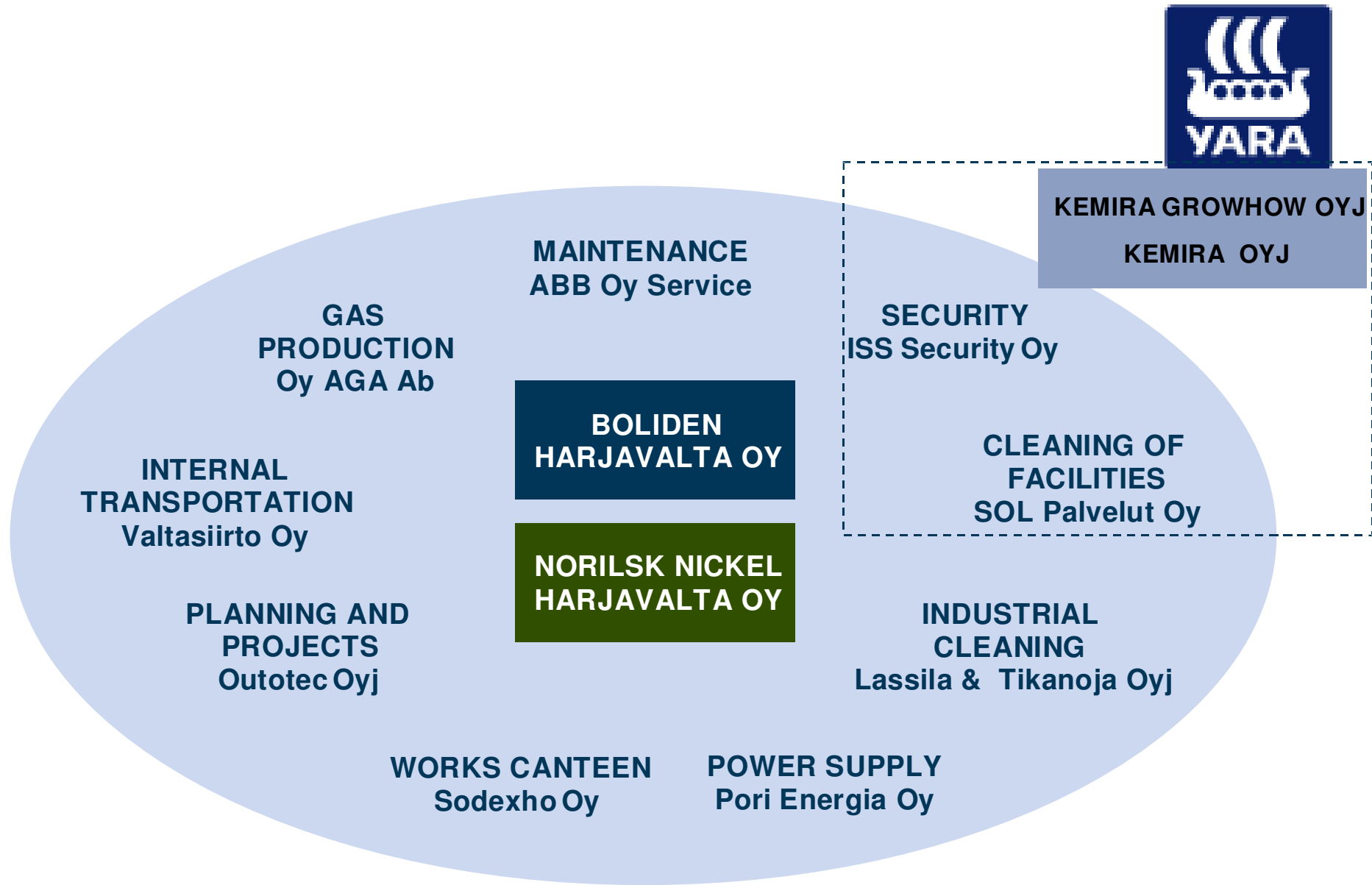
50 60 70 80 90 91 92 93 94 95 96 97 98

# Flash Smelters around the world

- Cu SMELTING
- Cu CONVERTING
- DIRECT TO BLISTER
- Ni SMELTING
- NOT IN OPERATION



# Harjavalta Suurteollisuuspuisto 2008



Ahola 2005, Leinonen 2007 ja Sydän-Satakunta 2008

## ***Yritys- ja tuotemoninaisuuden kehitys 1945 - 2008***

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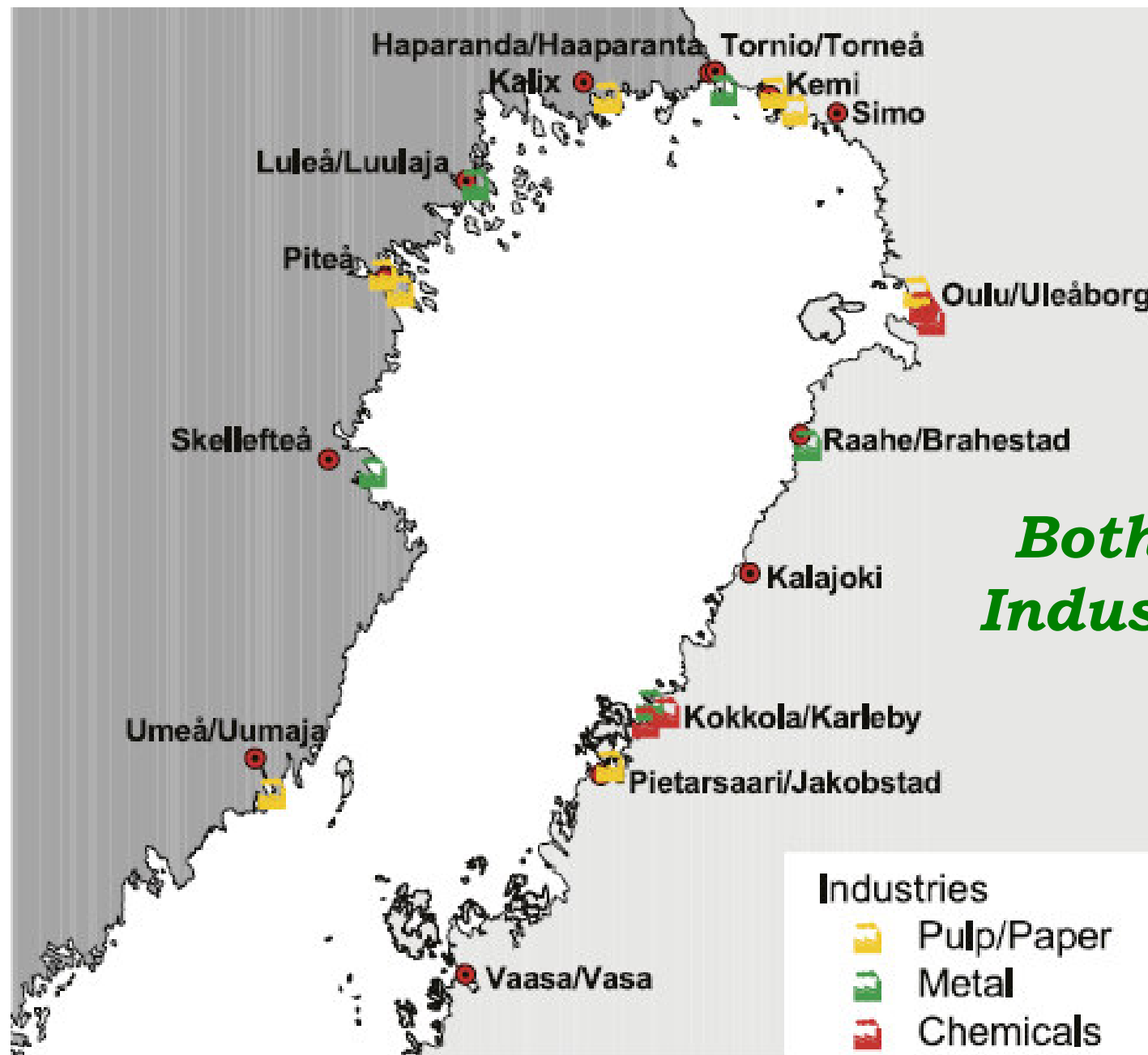
<b>Vuosi</b>	<b>Yritys</b>	<b>Tuotteet</b>
<b>1945</b>	<b>Outokumpu</b>	Anodikupari
<b>2008</b>	<b>Boliden</b>	Anodikupari, nikkelikivi, rikkihappo, rikkidioksidi, oleum, nikkeliraekuona, pesuhappo, Hg-rikaste
	<b>Norilsk Nickel</b>	Nikkelikatodit, nikkelibrikitit, nikkelipulverit, nikkelihienopulveri, nikkeliliuos, nikkelikemikaalit, ammoniumsulfaatti, kobolttisulfaattiliuos
	<b>Kemira Oyj</b>	Alumiinisulfaatti
	<b>YARA</b>	Ureafosfaatti, metyleeniurea, rakeistetut lannoitteet, vesiliukoiset kasvihuonelannoitteet
	<b>AGA</b>	Kaasumainen happi, typpi ja vety, nestemäinen happi, typpi ja argon
	<b>Porin Lämpövoima</b>	Prosessihöyry, korkeapainehöyry, prosessilämpö, kaukolämpö, raakavesi, suolaton ja saostettu vesi, sähkö ja paineilma

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## ***INDUSTRIAL ECOLOGY APPLIED TO METALLURGICAL INDUSTRY AROUND BOTHNIAN ARC***

***The main target is to improve material and energy efficiency through both intra and inter company development in the metallurgical industries around the Bothnian Arc region.***

***The ideas found at the Harjavalta industrial ecosystem can be applied to carbon steelmaking and other related industry sectors, to increase production efficiency, improve energy utilization and start new local business, where different firms concentrate on their own areas of core know-how.***



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Nordenbasen ärende 106-2004/188 BD

Dahl, Fabritius & Virtanen 2007



# ***EU waste strategy 2005***

- ***Simplification and modernisation of existing legislation***
- ***Introduction of life-cycle thinking into waste policy.***
- ***Promotion of more ambitious waste prevention policies***
- ***Better knowledge and information which will underpin the continued development of waste prevention policy.***
- ***Development of common reference standards for recycling.***
- ***Further elaboration of the EU's recycling policy***

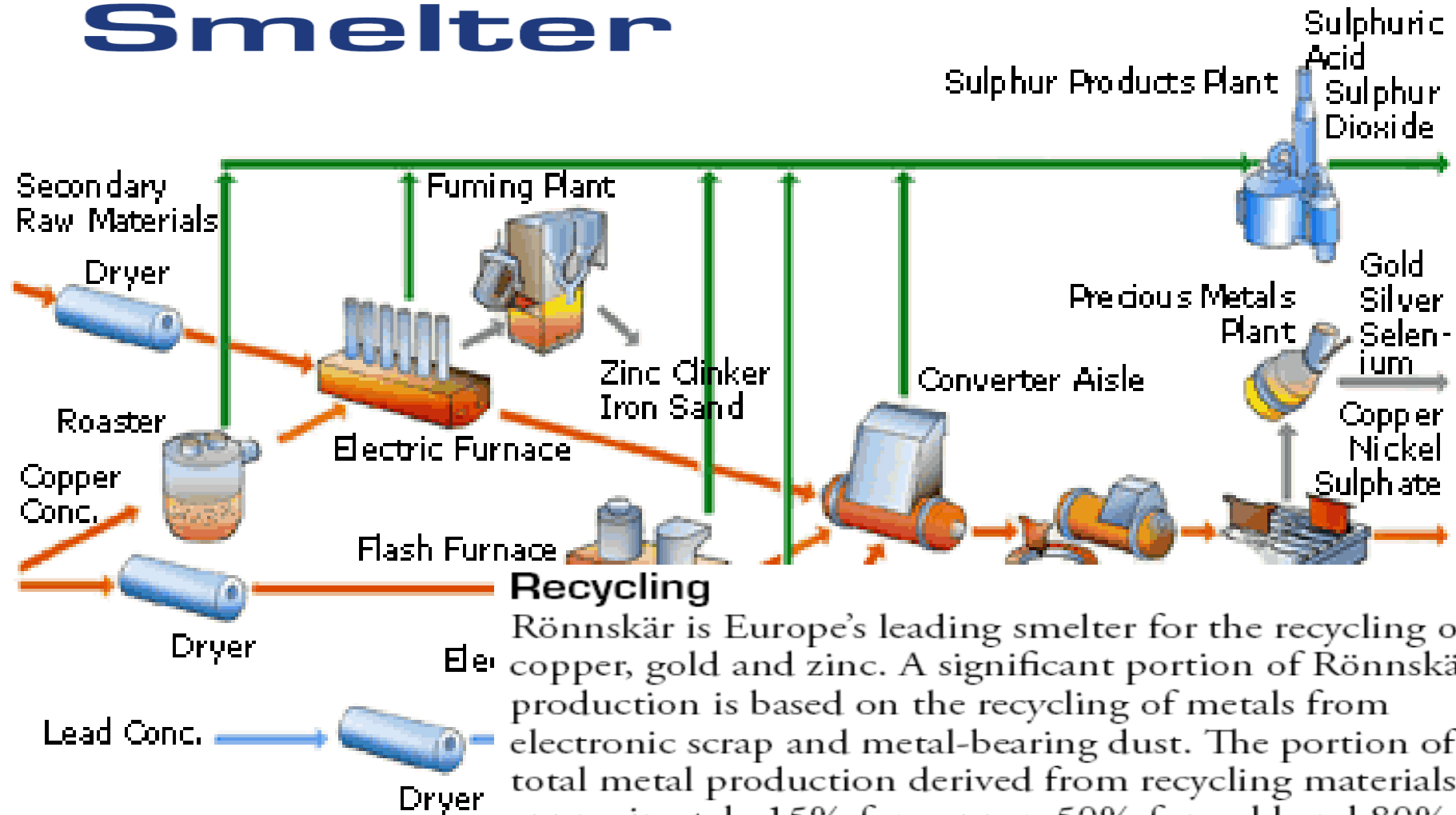
*The core idea of the **Bothnian Arc Industrial Ecology Enterprise** is to utilize the research results of the Finnish Academy funded **ProDOE team** (Prof. Heiskanen) and especially its **Innovative Use of Material Streams sub-project (IMS)** (Prof. Dahl)*

- *Laboratory of Mechanical Process Technology and Recycling, Helsinki University of Technology, HUT (Prof. Heiskanen)*
- *CleanTech Team, Department of Forest Products Technology, HUT (Prof. Dahl)*
- *Laboratory of Energy Engineering and Environmental protection, HUT (Prof. Fogelholm)*
- *Laboratory of Environmental Protection, HUT (Prof. Hukkinen)*
- *Institute of Law, HUT (Prof. Ekroos)*
- *Lahti Centre, HUT*
- *Laboratory of Process metallurgy, University of Oulu (Prof. Härkki)*

# Bothnian Arc metal industry

- Boliden Rönnskär nonferrous gold, silver, copper and lead plant in Skellefteå, Sweden.
- A strong steel cluster make the Bothnian arc area a very significant steel region in Europe:
  - Mefos research centre, University and SSAB Tunnpålt ore based carbon steel plant in Luleå, Sweden,
  - Outokumpu stainless steel plant in Tornio, Finland,
  - University in Oulu, Finland and
  - Rautaruukki ore based carbon steel plant in Raahel, Finland.
- Kokkola Industrial Park including Boliden zinc plant and OMG cobalt plant in Kokkola, Finland.

# Rönnskär Smelter



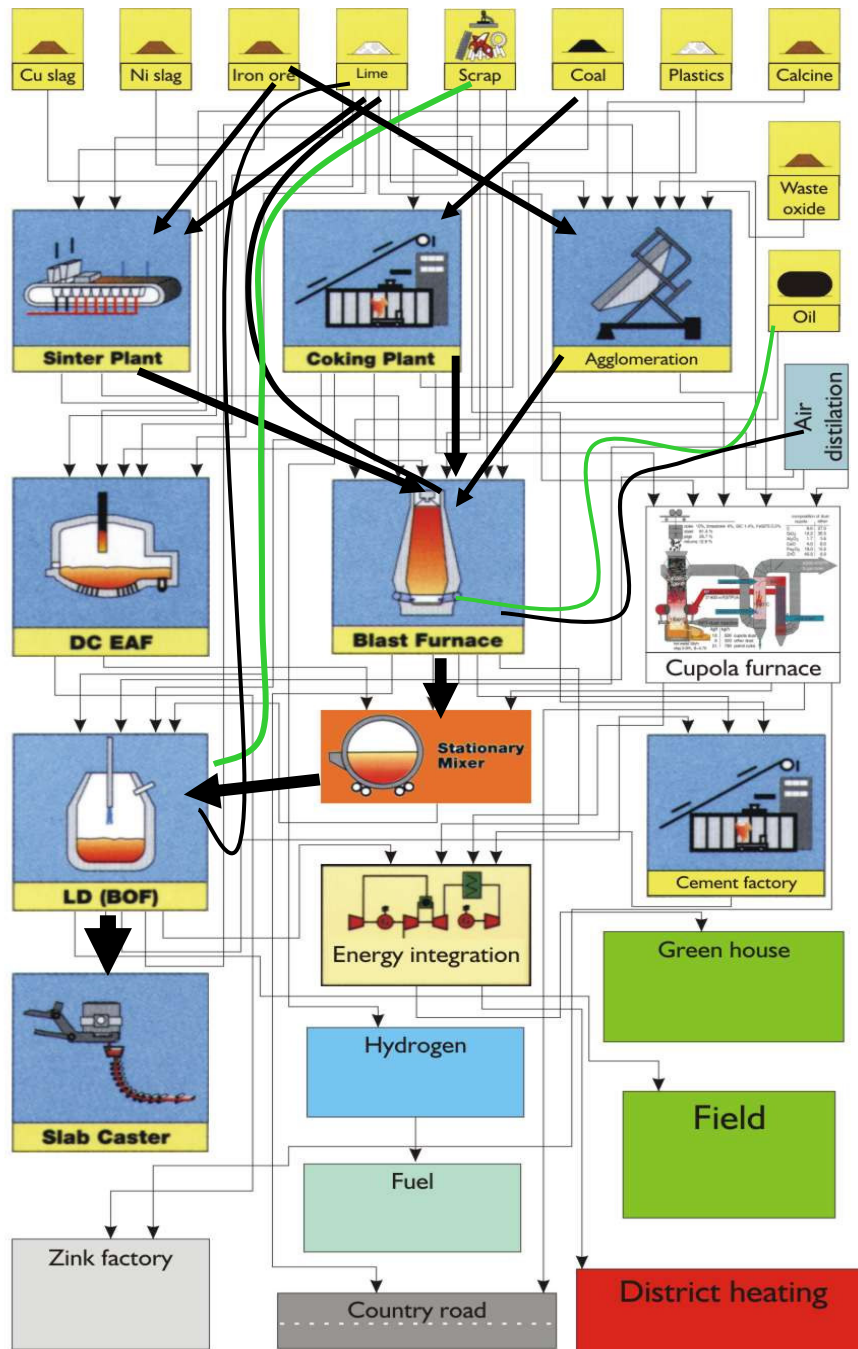
- Gas Flow
- Copper Flow
- Lead Flow

**Recycling**  
Rönnskär is Europe's leading smelter for the recycling of copper, gold and zinc. A significant portion of Rönnskär's production is based on the recycling of metals from electronic scrap and metal-bearing dust. The portion of total metal production derived from recycling materials is approximately 15% for copper, 50% for gold and 80% for zinc.

Granulated slag which is produced by the zinc fuming plant, is used as filler in road construction and building foundations, for example, thereby conserving natural gravel resources.

## ***Major environmental problem and challenges of carbon steel industry***

- ❖ Steel industry is very important emitter of CO<sub>2</sub>. With each ton of steel based on iron ore approximately 2 tons of CO<sub>2</sub> are generated and each ton of steel based on scrap equals between 0.4 and 0.8 tons. (Christmas 2000)***
- ❖ There is ahead a mega jump in technological and economic efficiency by totally eliminating waste streams and fully exploiting synergies with other related industrial technologies. (Szekely 1995)***



*The idea of Industrial ecology applied to ore based carbon steel making (Heino & Virtanen 2005)*

**Basic principle: The primary production chain of the ore based steel making is not disturbed (OPTIDUST 2002).**



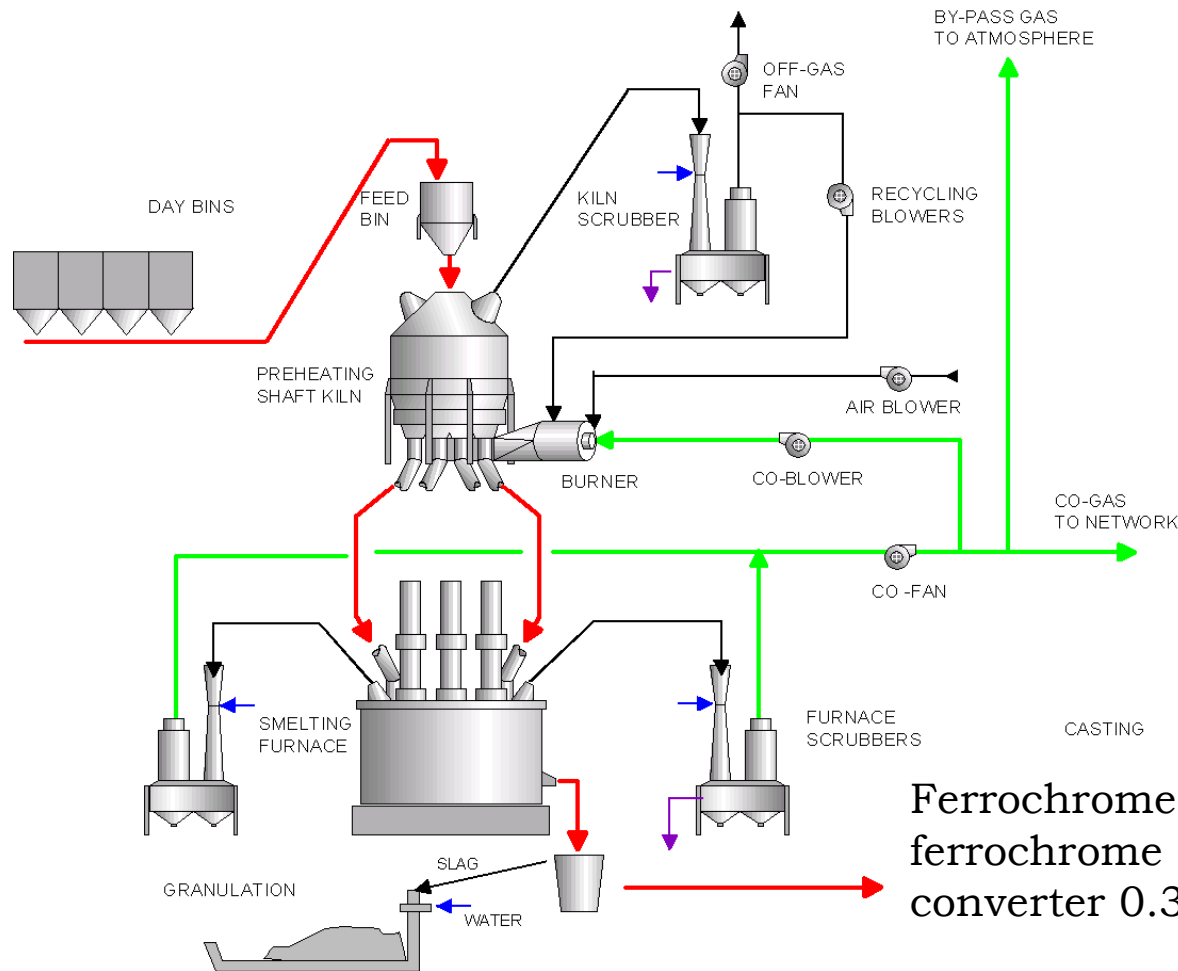
*Use of secondary raw materials from other industries (Scrap, slags, roasting residues, plastics and heavy oil, etc.)*

*Low heat energy utilization in district heating, in greenhouses or somewhere else in the surrounding community.*

*Better energy efficiency with the aid of energy integration included pinch technology, etc.*



# Outokumpu ferrochrome smelting process in Tornio



## **BAT technology developed in Tornio:**

- Furnace charge is pre-heated in stationary shaft kiln.
- Smelting furnace is closed and sealed.
- CO-gas is cleaned and utilized in the plant and outside.

Ferrochrome smelt to ferrochrome converter 0.3 Mt

Ferrochrome slag products 0.4 Mt



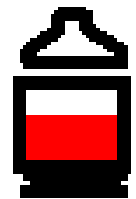
0.4 Mt other raw  
and alloy materials

## *Outokumpu stainless steel plant in Tornio*

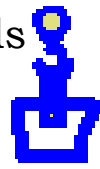
0.3 Mt **LIQUID  
FERRO CHROMIUM**  
+  
**SCRAP**



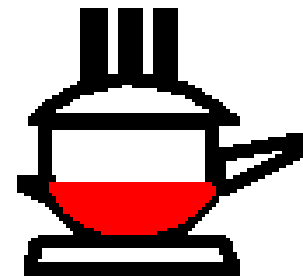
1.2 Mt scrap



**SCRAP  
DRYING**



**FERRO CHROMIUM  
CONVERTER**



**ELECTRIC ARC  
FURNACE**



**AOD-CONVERTER**

Steel slag products 0.4 Mt



**LADLE  
FURNACE**

Steel plant internal  
circulation 0.3 Mt



**TO HOT ROLLING  
MILL**



**SLAB  
GRINDING**



**SLAB  
CUTTING**

1.7 Mt steel products

**CONTINUOUS  
CASTING MACHINE**

An aerial photograph of the Kokkola Industrial Park, showing a large industrial facility with various buildings, storage tanks, and infrastructure situated along a body of water. The title 'Kokkola Industrial Park' is overlaid in white text at the top center.

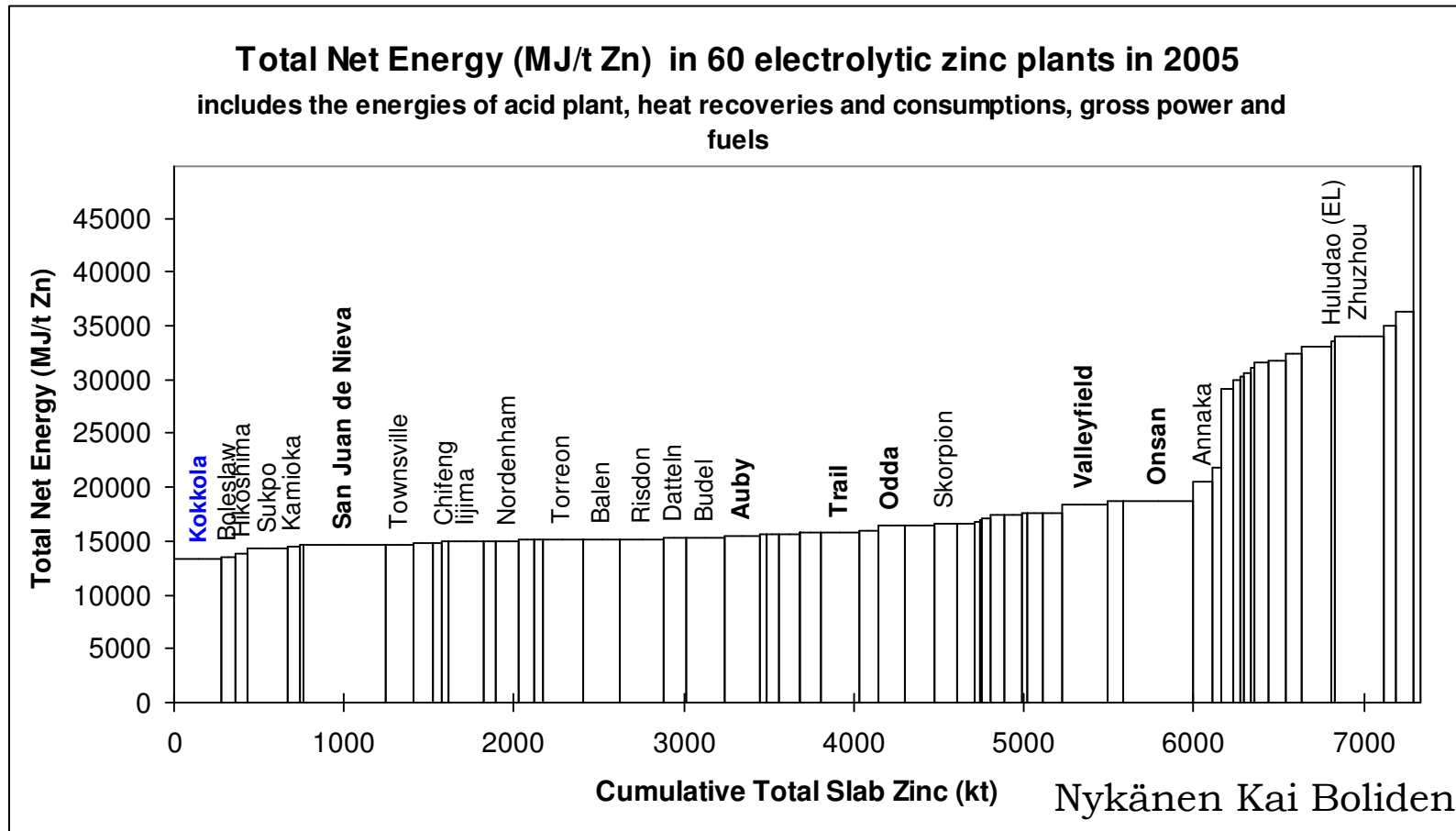
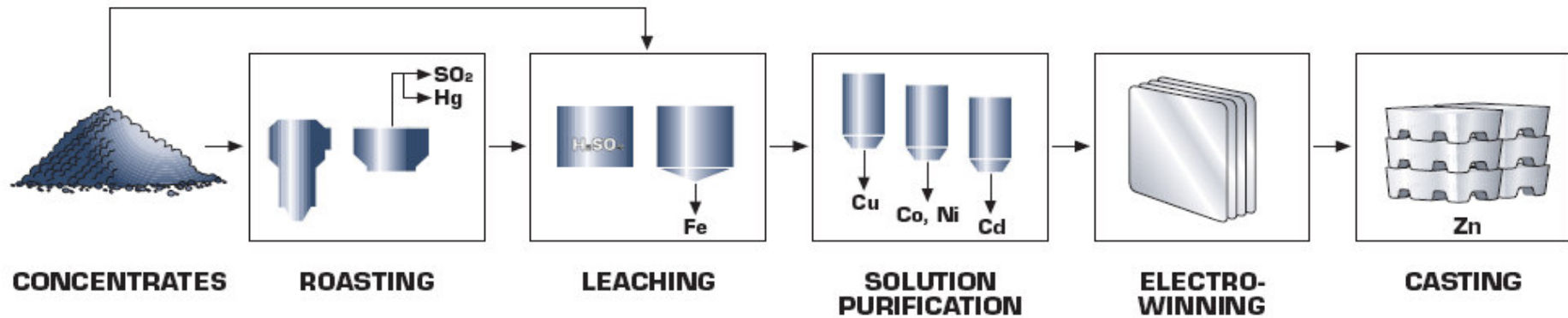
# Kokkola Industrial Park

**Companies:** Boliden Kokkola, Oy, Eurest Finlans Oy, Fortum Klan Powerstation, Kemfine Oy, Kemira GrowHow Oy, Kemira Oyj, Kokkola Harbour, Kokkolan Voima Oy, Maintpartner Oy, Neste Oil Oyj, Norkalk Oyj Abb, OMG Kokkola Chemicals Oy, OnePoint, Oy M. Rauanheimo Ab, Oy Polargas Ab, Oy Woikoski Ab, Sodexho Oy Kokkola, TETRA Chemicals Europe.

## **Top-class environmental technologies:**

- *Stable soil conditions - no threat of high cleaning expenses,*
- *World's most precise monitoring systems,*
- *Top-class water filtration and*
- *the companies are free to focus on their core operations.*

# Boliden Kokkola Oy



## ***The special acts of the PRODOE IMS sub-project in the Bothnian Arc area***

- To clarify the chemical, physical and mineralogical properties of waste streams to determine optimal further utilization stages without any extra energy consumption in drying, agglomeration, grinding, warming, etc.,
- Better utilization and cascading of the energy captured in metallurgy process sequences,
- Utilisation of low heat energy from industrial parks in communities and in greenhouse villages or other suitable places,
- The elimination of waste streams by fully exploiting synergies with other related industrial technologies, and
- Significant advances will be also achievable through the identification of specific minor residue material streams for further processing in specialized companies.

# BOTHNIAN ARC INDUSTRIAL ECOLOGY ENTERPRISE

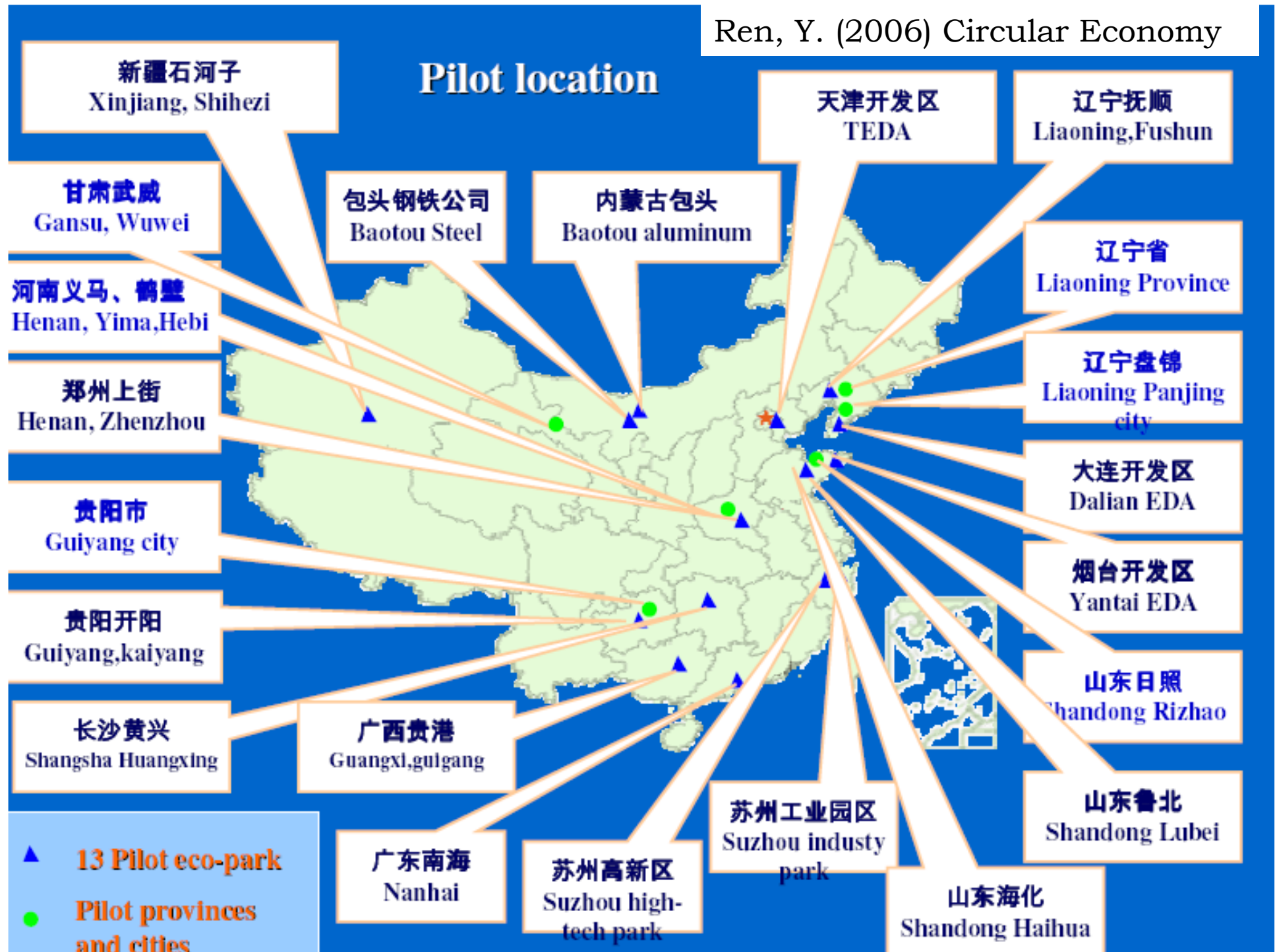
- *Bothnian Arc region survey is very fruitful application frame of reference of the ProDOE ideas and intellectual expertise.*
- *The Bothnian Arc region has a wealth of special knowledge available to help solve residue and also other by-product problems and there is a high level of interest in generating such mutual activities.*
- *The shipment of materials by sea favours the common treatment of bulk industrial residues and by-products because the costs are low compared with overland transport.*
- *In spite of tough competition in the main production fields amongst the target industries their environmental issues and solutions can be understood to be a common field.*

## ***ADVANTAGES IN REGIONAL AND EU LEVEL***

- ***The concept of seeking workable local Industrial Ecosystem and trans-national Industrial Ecology opportunities amongst Finnish and Swedish industries has great regional economic significance in the Bothnian Arc region and later in other similar parts of EU.***
- ***There is much public interest in opportunities for cooperation around the Baltic Sea as well as in ways to achieve greater harmonisation in the application of EU environmental law.***

## *GLOBAL POSSIBILITIES*

- *China and India are facing a series of resource and environment issues, which have excluded the economy's healthy development.*
- *In China the eco industrial park concept has begun to be serious in consideration by authorities and communities in some industrial regions in China.*
- *Several eco industrial park projects are initiated by local authorities, which are in co-operation with academic institutions*





An aerial photograph showing a large industrial complex, possibly a power plant or refinery, with several large buildings and a tall smokestack. The facility is surrounded by green fields and a body of water in the foreground. The text "Thank you" is overlaid in green in the bottom left corner.

*Thank you*