Ga production potential in Greece

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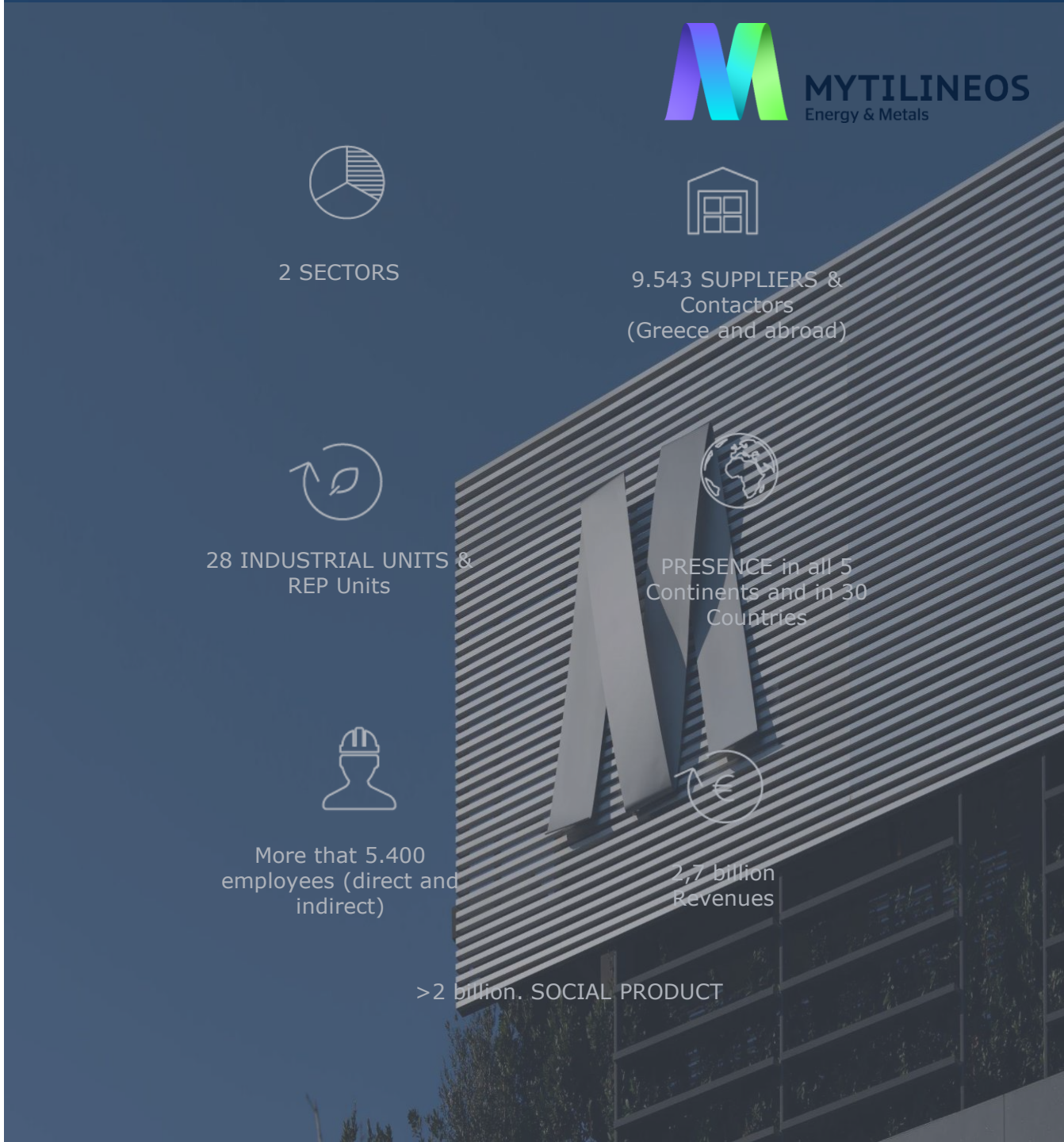
8th Greek Raw Materials Community Dialogue

MYTILINEOS
Energy & Metals

Contents

MYTILINEOS at a glance

- Founded in **1908**
- Listed in ASE since 1995
- A leading company in critical sectors of the Greek Economy
- With a contribution that reaches **1,21%** of the Gross Domestic Product
- Exports that exceed **2% of national exports**
- **Environmental investments €83 mil.**



A leading industrial company in Energy & Metals

Metallurgy Sector

- Aluminium of Greece
- Delphi Distomon
- EP.AL.ME.

Energy Sector

- M Renewables
- M Energy Generation & Management
- M Energy Customer Solutions
- M Integrated Supply & Trading
- M Power Projects

METALLURGY SECTOR

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DELPHI - DISTOMON

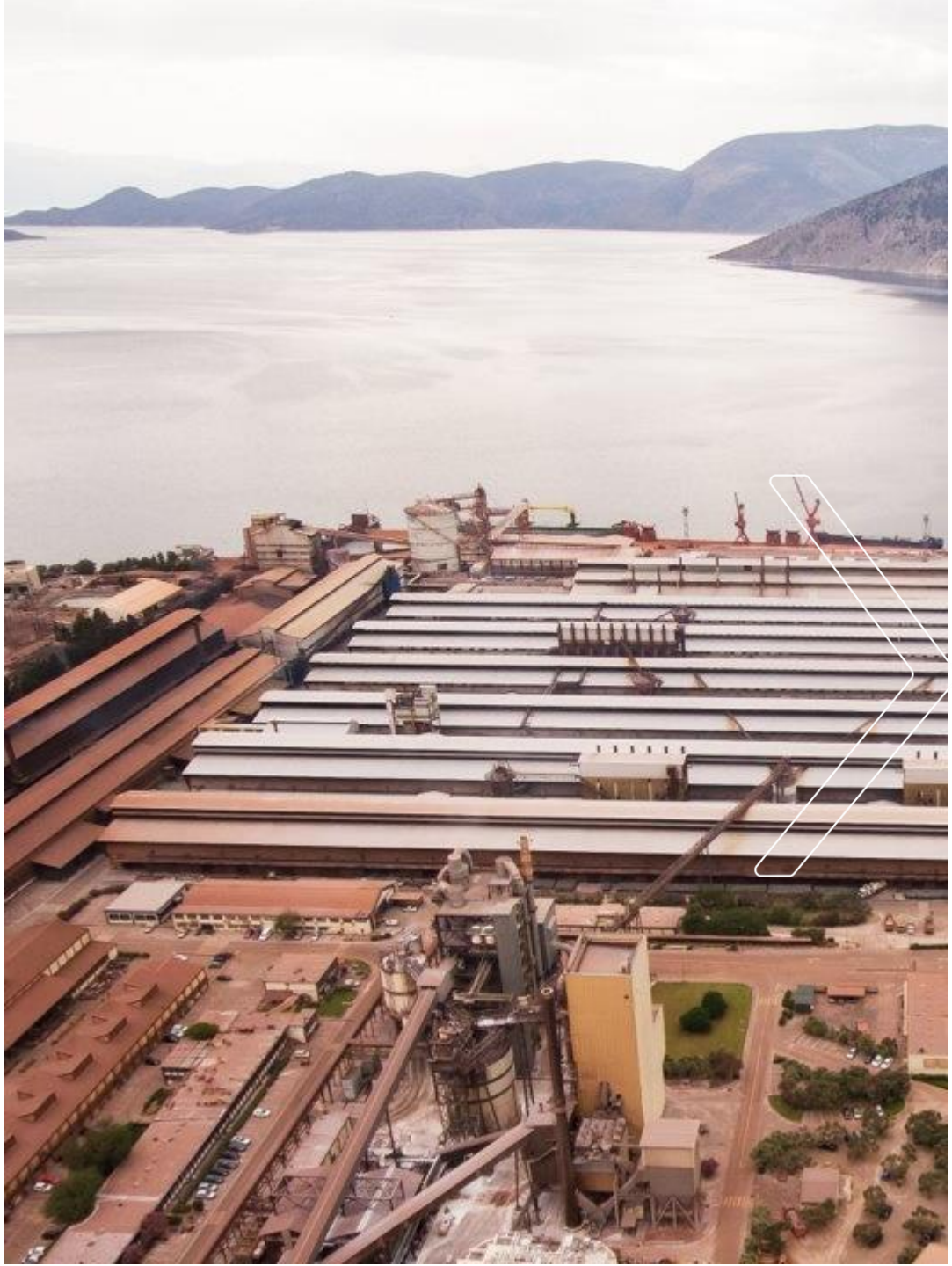
- The 2nd largest producer of diasporic type bauxite in Greece and Europe
- Mines located in the Mt Parnassus – Mt Giona zone
- >550,000 tones/year bauxite from underground construction sites only
- > 230 employees (direct & indirect)

ALUMINIUM OF GREECE

- Alumina Refinery and Aluminium Smelter
- Agios Nikolaos, Korinthos Gulf, Voiotia, Greece
- >195,000 t/y Aluminium and 860,000 t/y Alumina
- With on site-port facilities
- > 1,500 employees

EP.AL.ME

- The largest independent producer of recycled aluminum
- Facilities located in Oinofyta, Viotia
- 45,000 tones of secondary aluminium
- 77 employees



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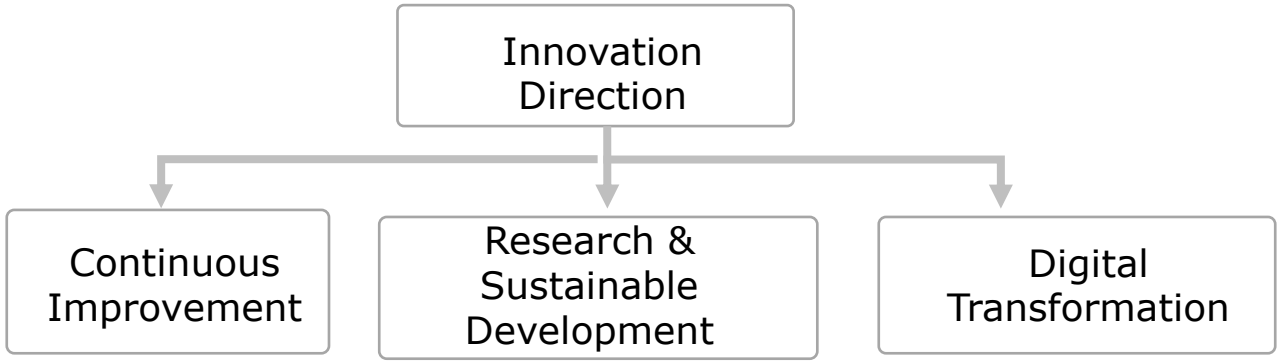
Innovation Direction



OUR PURPOSE:

Increase plant's competitiveness

Tackle the sustainability challenges

Creating value for all

Research & Sustainable Development

"Funded by Major European Actions"

"Partners to major Aluminium industry clusters"

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RnD activities for:

- Waste valorization **(Bauxite residue)**
- Added value products (**Sc, Ga, V, Al2O3 4N**)
- CO_2 Emissions reduction (**CCUS**, **H_2 burners, electrification**)

R&D into new products from the alumina refinery

[2022-2024] EIT Upscaling project to optimize the Sc extraction flowsheet; Pilot has already leached 10t BR and showcased potential for ~25% reduction in acid consumption

[2022-2024] EIT Upscaling project to extract Ga and V from Bayer liquor with innovative extractants. Currently in lab scale stage; pilot in 2023-2024.

[2021-2023] EIT Upscaling project to produce 4N alumina from Si production slags. 50 kg of HPA to be produced in 2023.

Mytilineos' Pilot Units

- Pyro Pilot [Indirect Rotary Kiln, 1MVA EAF]
- Hydro Pilot [Leaching, Precipitation, filterpress, Ion-exchange]

About Gallium in general

- Gallium is a relatively soft, silvery metal
- Has a melting point at a big range (29 – 2043 oC)
- Has exceptional electrical conductivity
- Gallium does not occur as a free element in nature and the few high-content minerals, such as gallite (CuGaS2), are too rare to serve as a primary source.
- As gallium compounds can be found in trace amounts in zinc ores (such as sphalerite) and in bauxite (including Greek).
- **Today Gallium is extracted as a by-product from the Bayer process in alumina refineries.**

Gallium applications

- In recent years, the enormous growth of electronic applications has made Gallium to be a high-tech metal.

- Gallium in electronics is used in the form of:

  Gallium Arsenide (GaAs)

  LED, Computers, Semiconductors

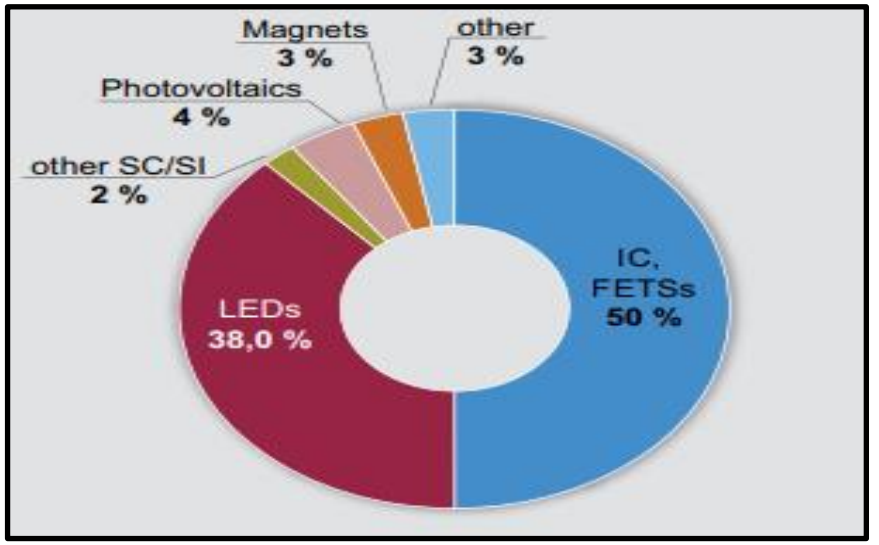
  Gallium Nitride (GaN)

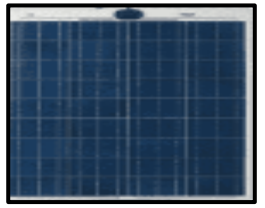
  Fiberoptics, Laser diodes, Telecommunications (4G/5G)

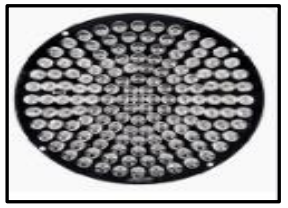
  Gallium Antimonide (GaSb)

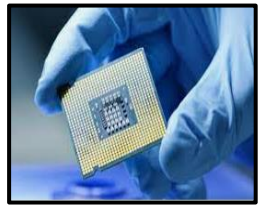
  Photovoltaic systems

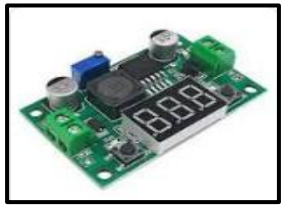
- GaAs and GaN account for the 94% of the total consumption

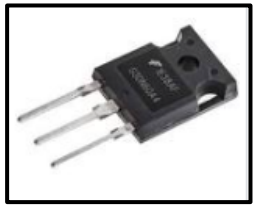












Global Ga Production Capacity

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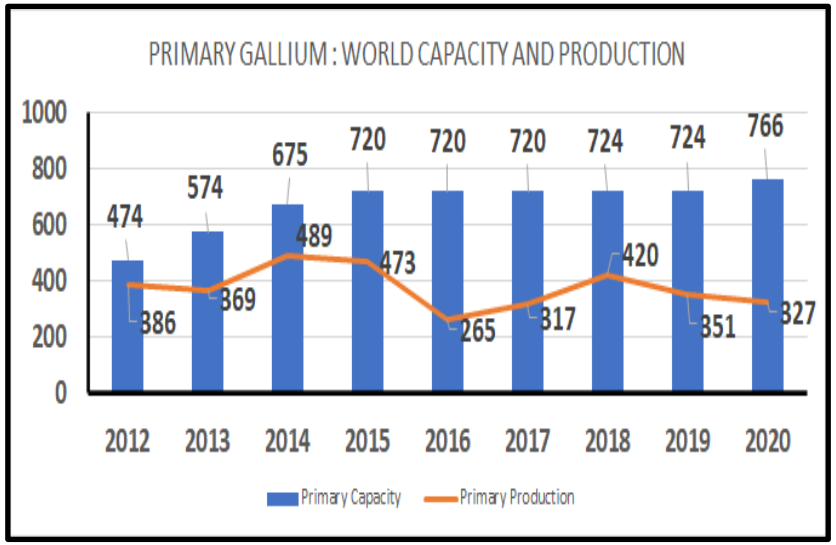
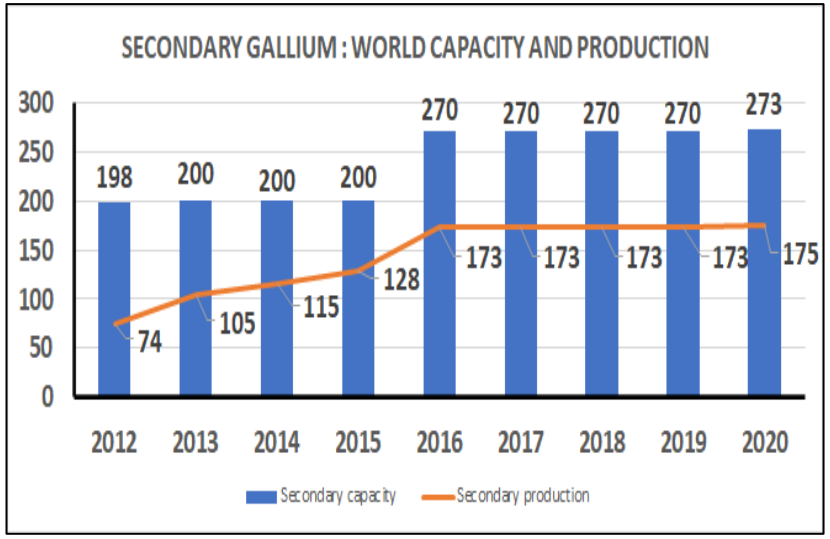
Primary Ga production

- Last years world production capacity is stable at **750 – 770 t/y**
- Production fluctuates **40 – 60%** of the annual capacity.
- China dominates the primary Ga production and capacity.
- In Europe (Germany) primary Ga production was shut down in 2016.



Secondary Ga production

- Main source is post-production scrap from semiconductors industry.
- Production from post-consumer scrap is not possible



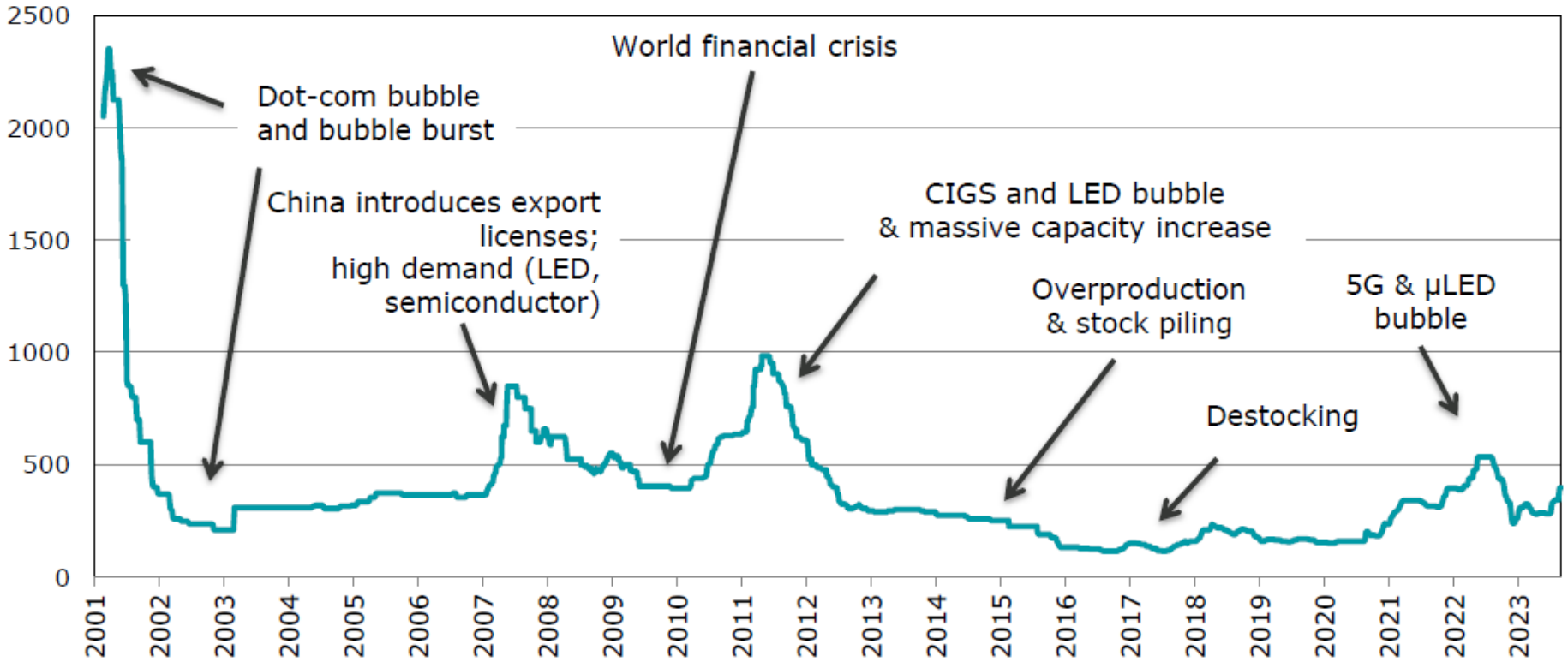
Gallium price and market

Demand

- Primary Ga 4N demand in Europe is currently **30-40 t/y** and is covered by China.
- World demand is expected to increase **6-10%** in the next years.
- Biggest markets are Japan and China

Price

- Average Ga price 2006-2022: 264 USD/kg
- July price : 350 USD/kg



Primary Ga production technologies

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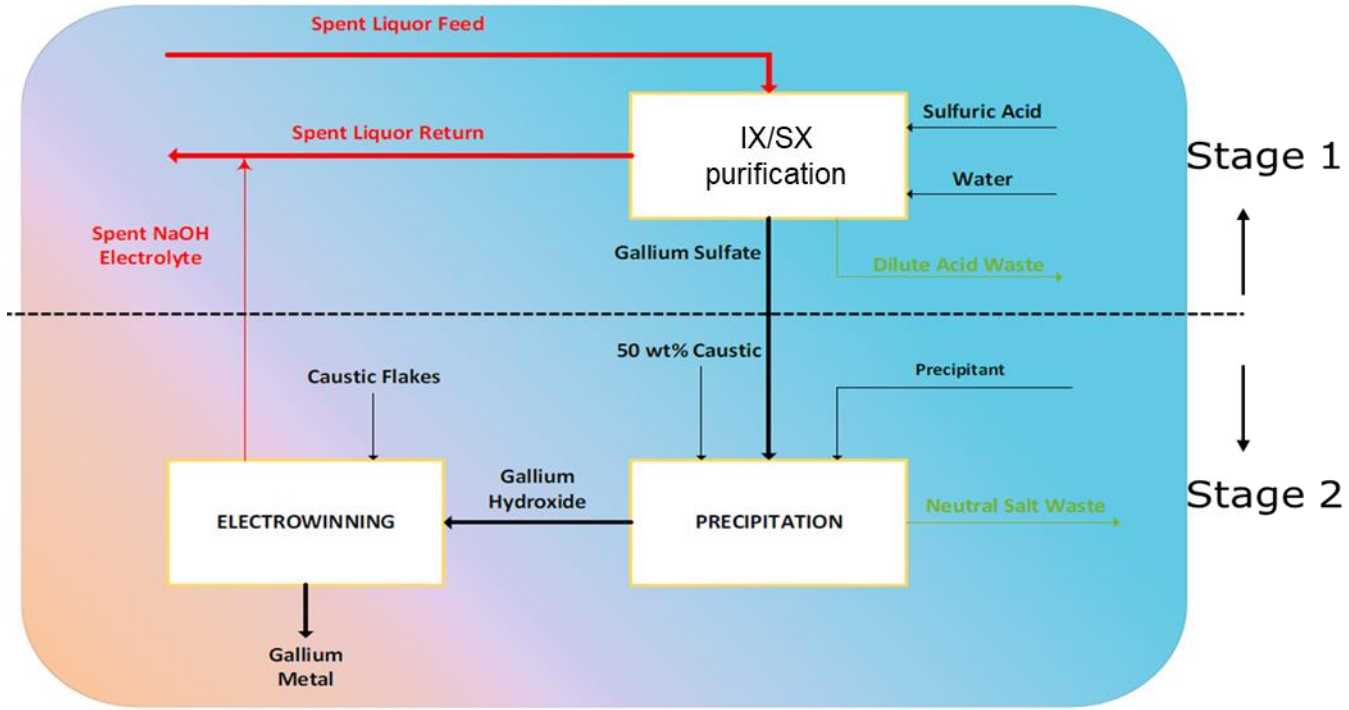
Main Ga production steps are:

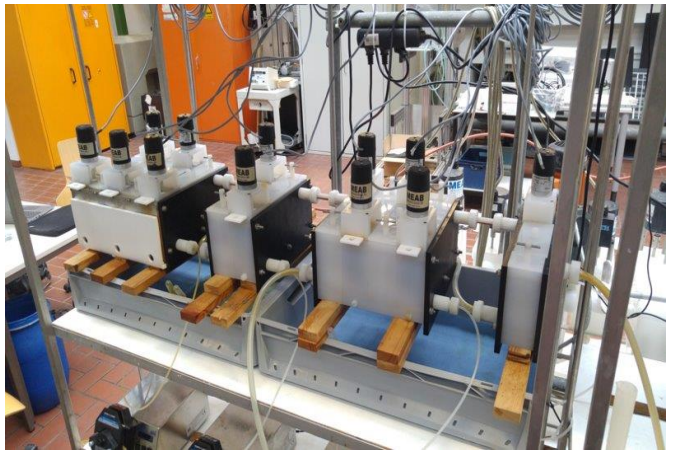
Ga extraction from spent Bayer liquor

There are 2 available technologies:
- ❑ Ion exchange (IX)
- ❑ Solvent extraction (SX)



Electrolysis to produce Ga 4N

- ❑ Collaboration with NTUA



Gallium production business plan at Mytilineos

Study for industrial production is developed in 4 pillars

i. Pilot testing of available technologies (IX – SX)

ii. Technologies assessment for OPEX estimation

iii. CAPEX estimation for a 40t/y production facility

iv. Contact with major Ga 4N potential customers

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Thank you