

**9th PROMETIA Scientific Seminar
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Education and training for sustaining minerals and metallurgical industry in Europe

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What do we need for metals industry in the future?

Overview

- Circular economy and future needs
- Historical change and current status
- Innovation and sustainability driving force
- Challenges and opportunities

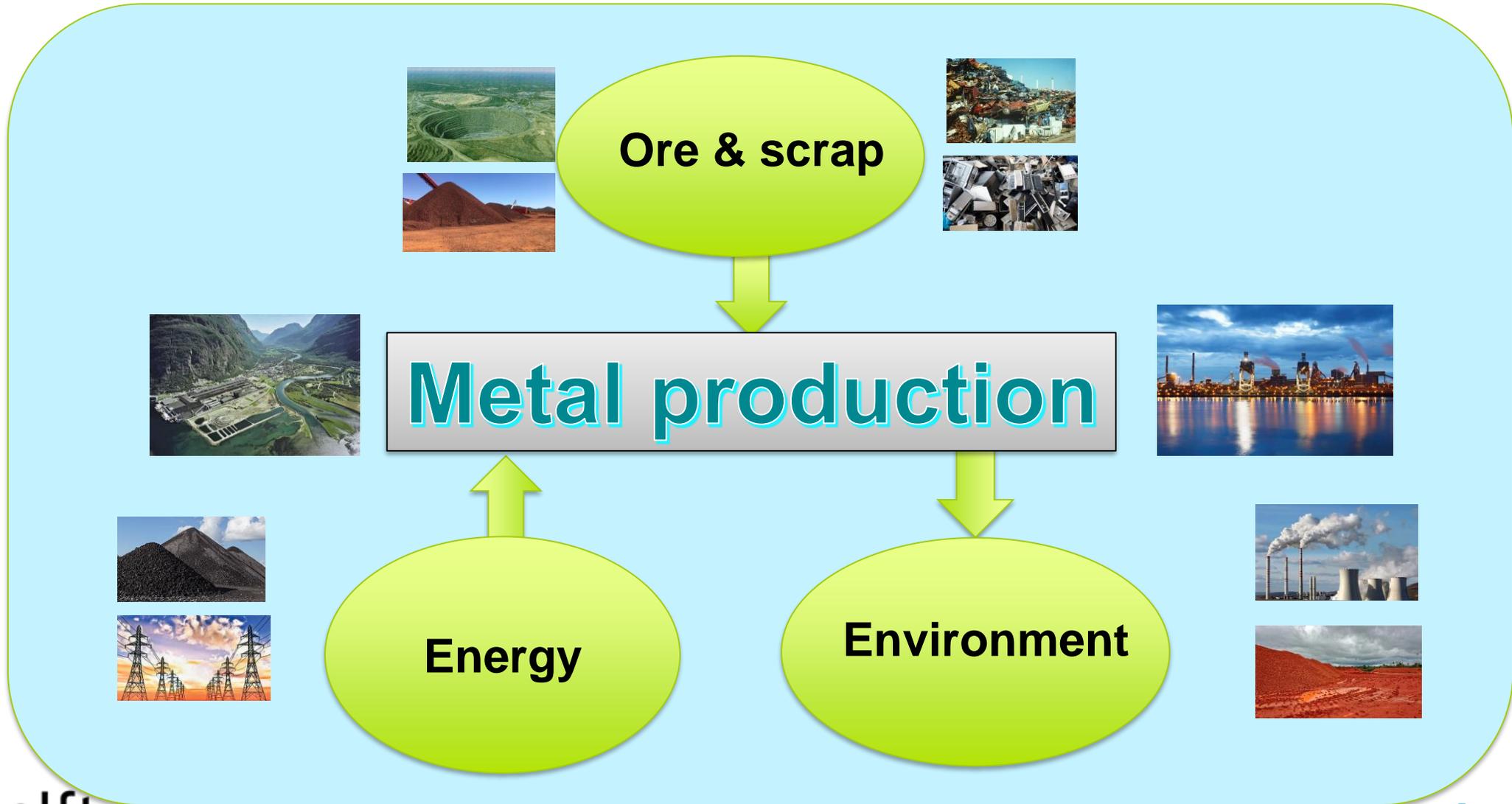
Circular economy and resource sustainability

- Raw materials are essential component of circular economy.
- Sustainable production, consumption and recycling are key to circular economy.
- Strong needs for metals and critical raw materials



EU definition of "Circular Economy"

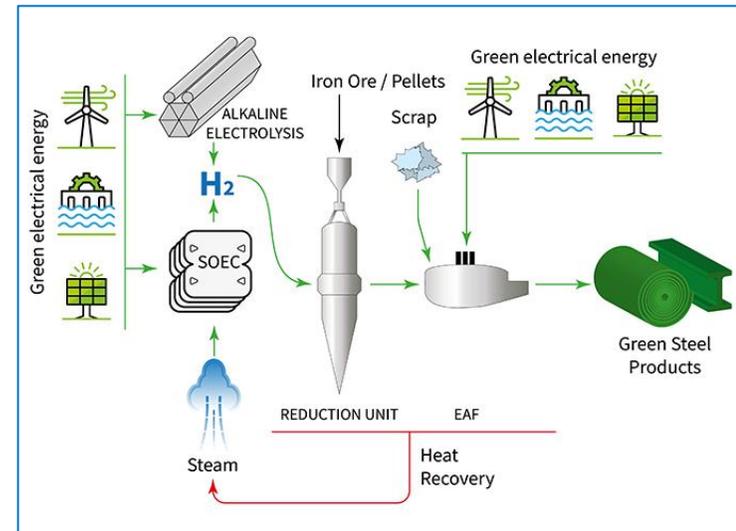
Metals production: energy and emission intensive



Clean transition: metals & energy – grand challenge

Inter-dependence

- Transition to clean energy: requiring large amount of construction materials and critical metals
- De-carbonization of metals production: demanding huge amount of clean and green energy



Great demand for innovation

- Increased consumption in metals and materials
- Depleting natural resources of minerals and metals
- Requiring more efficient extraction and refining technologies
- Demanding expertise and new knowledge
- Education and training: the key to sustain the future



Education and training: backbone of innovation in raw materials sustainability

- **4 levels of education and training**
 - Bachelor and Master: university education → engineers or researchers
 - PhD or postdoctoral program: researchers and scientists
 - Life-long learning: for all ages
 - Professional on-post training in industry: young engineers



Current European perspectives

- **Advanced mining and metal production industry**
 - **Mining**
 - Iron ore mines (LKAB in Sweden)
 - Chromite ore mine (Outokumpu in Finland)
 - Copper mines (Rio-Tinto in Spain, Boliden in Sweden, KGHM Rudna mine in Poland)
 - ...
 - **Metals production**
 - Steelmaking (170 mt/y)
 - Non-ferrous metals production (Al, Cu, Zn, precious metals, technology metals)
 - Metal recycling: multi-metals processing and recovery
 - **Great challenges**
 - Opening new mines - restricted
 - Circularity and import - dependence of ore and energy
 - De-carbonization: EU “Green Deal” - 2030 & 2050 targets
 - Shortage in talented younger generation (engineers, researchers)



Education and training in process metallurgy

University metallurgical curriculum: facts and phenomena

- Diminishing since 1980s and merged/dissolved in materials science/chemical engineering, but re-establishing & strengthening from middle of the 1st decade in the new millennium
- A new (slow) boom from the 2nd decade in the 21st century
- Distributed in Scandinavia (Sweden, Finland, Norway), Western Europe (Germany, Belgium, Austria, Netherlands), Eastern Europe (Poland, Czech Republic, Slovakia, Serbia), Southern Europe (Greece, and others?)
- Process metallurgy is still limited (groups) and hardly at Department level
- Clustering joint efforts have been attempted (FEMP, EMC, EMEC...)
- New opportunities emerging: supported by EIT RawMaterials, and green steel initiatives, ...



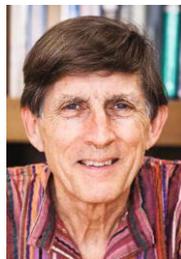
Stronger physical metallurgy, weaker process metallurgy

Education and training in process metallurgy

- **University metallurgical curriculum: more facts**
 - Small classes, more international students and (PhD, postdoc) researchers (Asia: India – Iran - China; S. America, Africa)
 - Difficult to recruit researchers and scientists within Europe
 - Few updated text-books and monographs incorporating new technologies and developments
- **New trend**
 - Broader scoping curriculum & teaching
 - Covering also resource, energy, environment – sustainability
 - Recycling metallurgy with strong emphasis

Academic – industry partnership: crucial

- Industry needs and support: the key
- Industry - government joint structural funding program: essential
 - Common working style in most European countries, but
 - Vulnerable for maintaining a sufficient magnitude & stability
 - Short-term vision and strategy: risk to continuity
 - Career and employment opportunities: still limited
- Prof. (emeritus) Peter Hayes: call for actions!

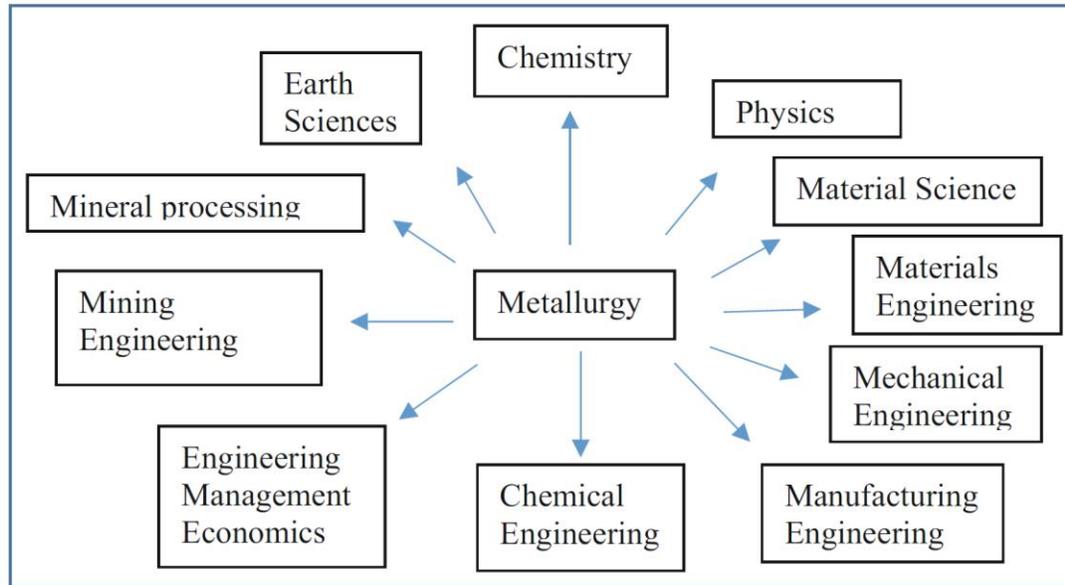


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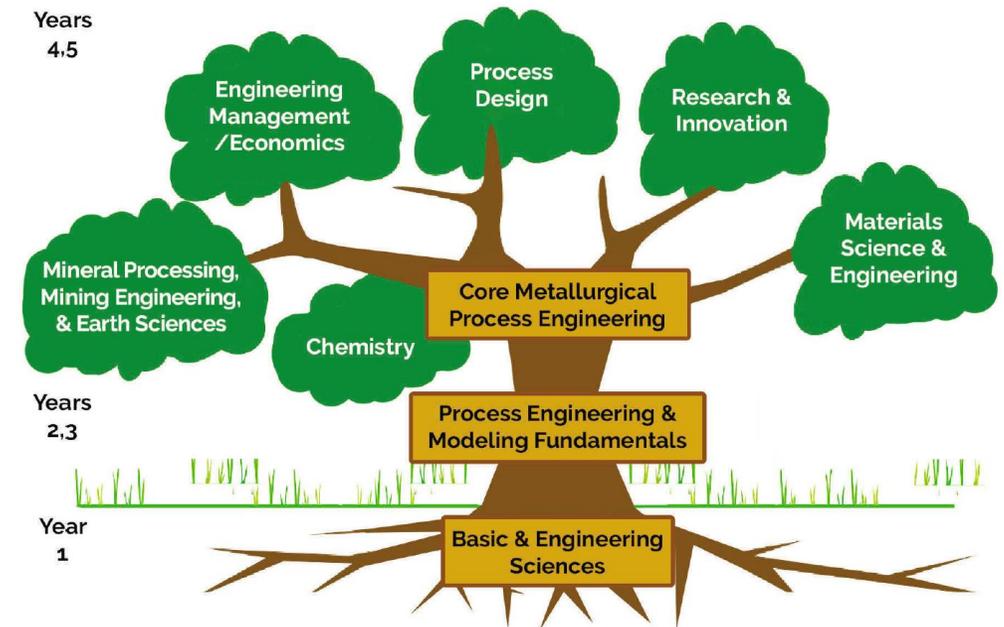


Future process metallurgical engineering curriculum

Example of prof. Peter Hayes (2018, 2019)



P.C. Hayes: "The Changing World of Metallurgical Education". In: Extraction 2018 (TMS). pp.57-67.



Prof. Hayes: proposed program structure for bachelor's of metallurgical process engineering programs: based on a strong process engineering core with flexibility to cover the many branches and specializations that embody the discipline.



Current status and trend:

After an initial decline there has been a recent renaissance in Europe with the impetus provided by the changes in industry profile, the need for resource security and sustained supply of new elements/materials, recycling, reprocessing and the implementation of new process technologies to address environmental issues.

By prof. Peter Hayes (Extraction 2018)

Important questions for industry and education providers:

- What specialist knowledge and skills, and attributes are we looking for in the metallurgists of the future?
- What level of qualification are we seeking? Graduate BE, or advanced standing Masters, PhD, and /or other?
- How can industry help to provide and sustain these educational opportunities?
- How to best attract these potential employees into the profession?

Green steel initiatives – decarbonisation of steelmaking industry

- Incentives for new (mid-long term) demand for metallurgical process engineers and scientists
- More open positions for researchers (PhD, postdoc, industry R&D) and academics
 - New academic position in primary steelmaking at Oulu University (2022)
 - New academic position in sustainable steelmaking at TU Delft (2023)



Role of EIT RawMaterials Academy



The RawMaterials Academy offers education programmes through four strands:

- [Master's Education](#)
- [PhD Education](#)
- [Lifelong Learning](#)
- [Wider Society Learning](#)

Promotions of PROMETIA association

- PROMETIA annual “Tech Tour”
 - Supporting practical learning and building professional network in mining and metallurgical engineering
 - For young researchers and engineers



December 2021 in Spain



June 2022 in Sweden

**Questions?
Suggestion?
New ideas?**

Thank you!



Contact information

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