

**ESTEP 2025 Annual Event**

28-30 October 2025  
Udine (ITALY)

How decarbonisation, digitisation  
and circular solutions forge the  
sustainable European steel future?

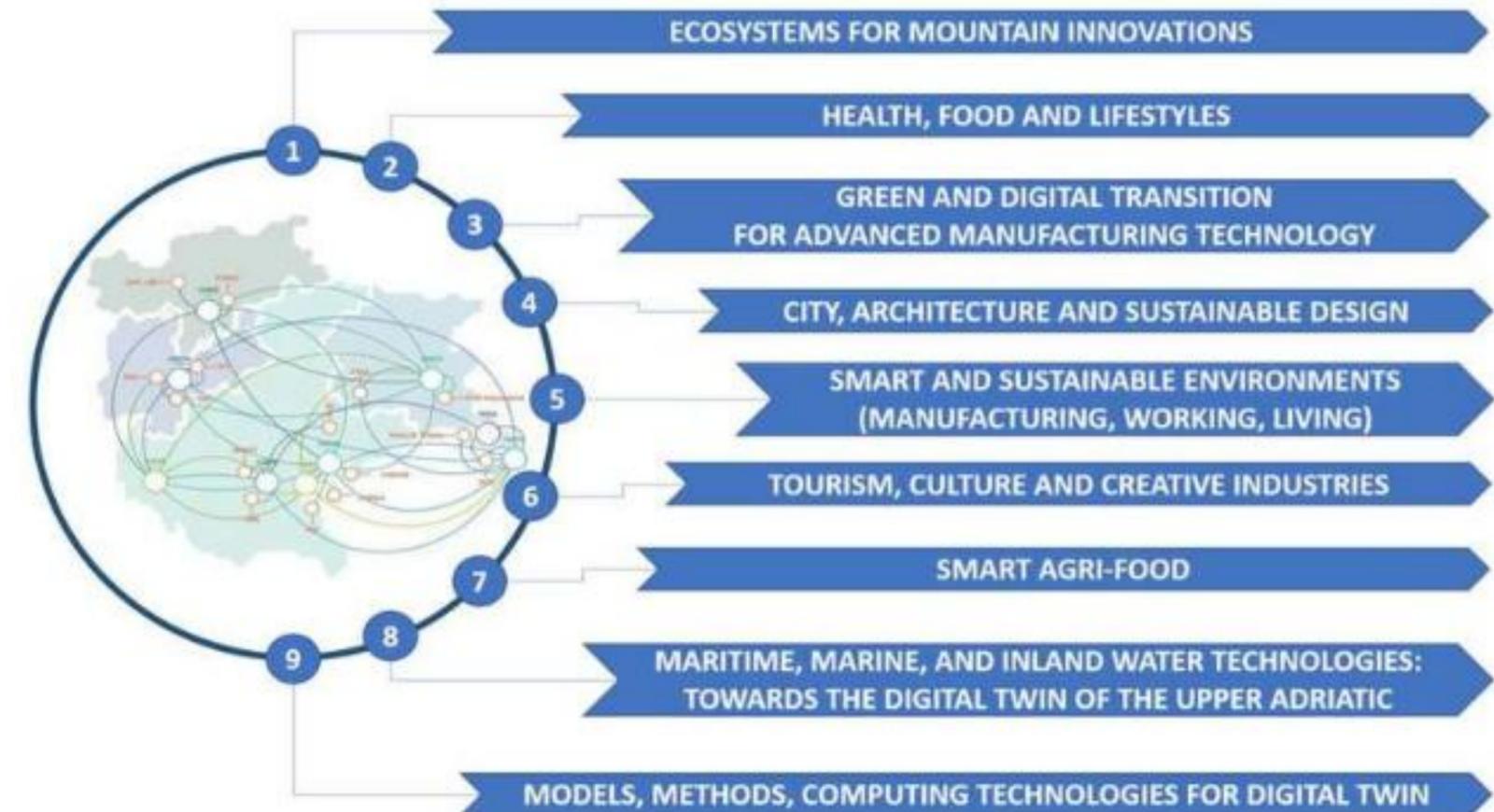
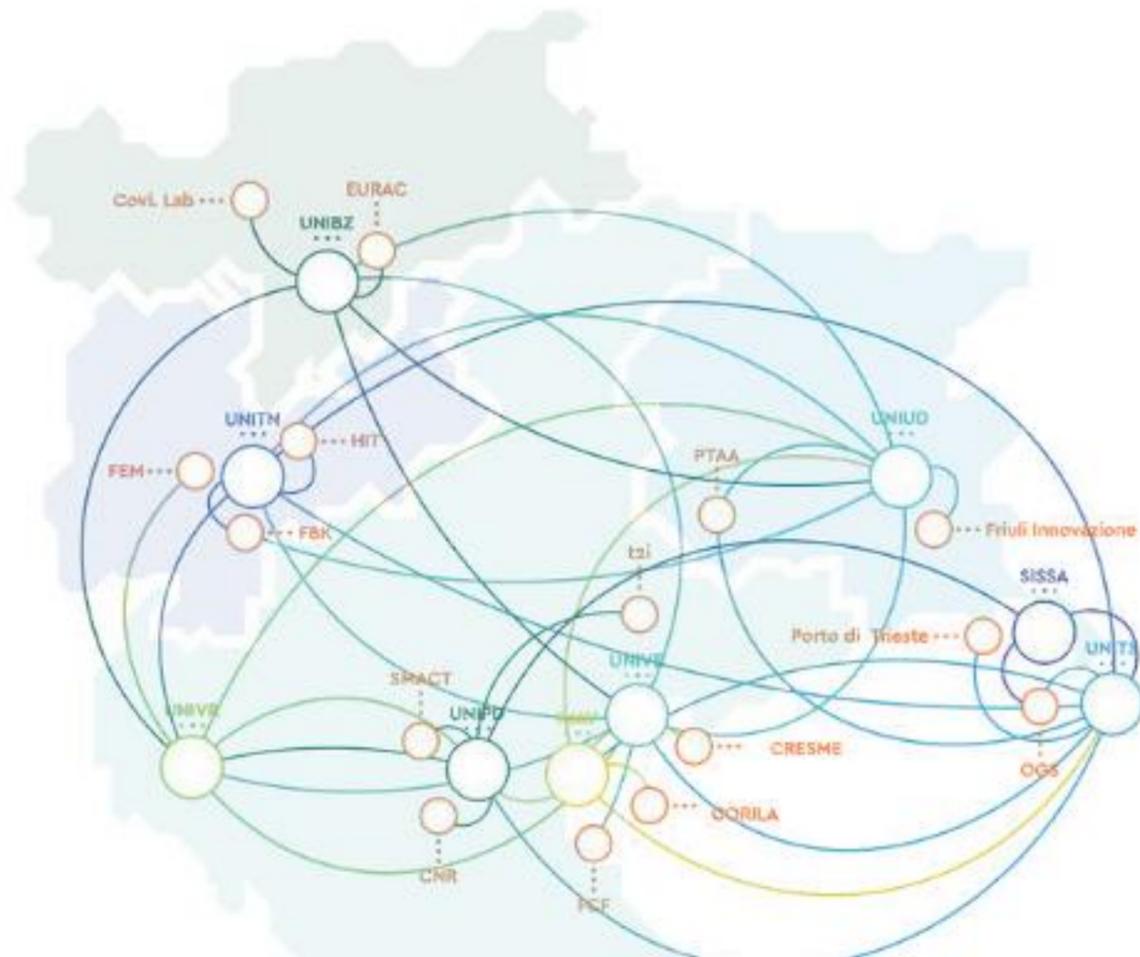
**Alex Lanzutti**  
**University of Udine**  
Ass. Professor

# **A multidisciplinary discussion on the future of steelmaking in the Triveneto region by 2050: the think tank experience.**



## INTRODUCTION

*iNEST (Interconnected Nord-Est Innovation Ecosystem), financially supported in the frame of PNRR Program, is aimed at extending the beneficial effects of digitalization to the key specialization areas of “Nord-Est” (Friuli-Venezia Giulia, Veneto and Province Autonome di Trento e Bolzano): industrial and manufacturing, agriculture, marine and mountain environment, architecture and construction, tourism, culture, wellness and food are the fields addressed.*



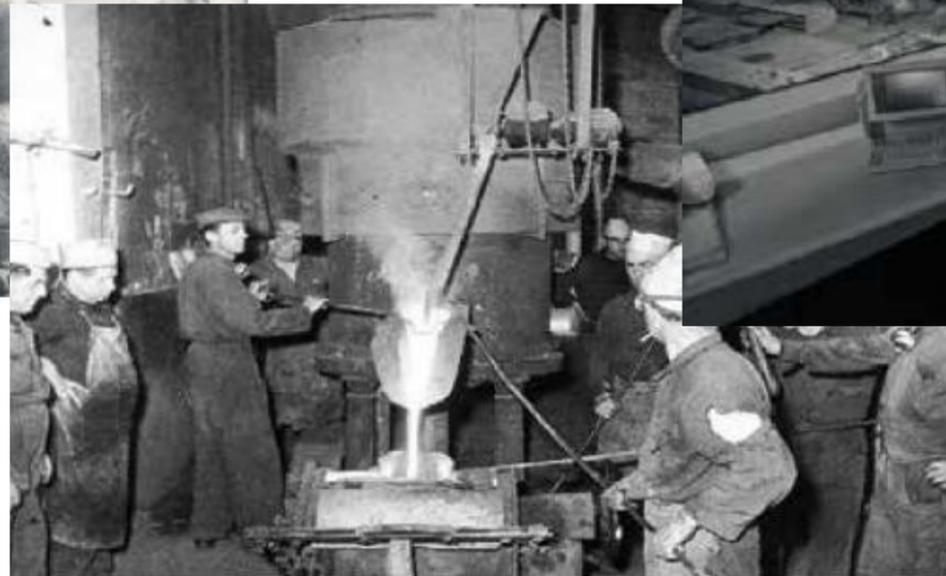
## The round tables:

- Multidisciplinary specialists from academia, industry, and institutions in the Triveneto region;
- 4 round table discussions
- Theme: steel industry, time horizon 2050
- Dozen of personalities involved
- Many hours of discussion
- Interview with industry specialists

**THINK**  
**METALLURGIA 2050**  
**TANK**



# Introduction: steelmaking evolution in Friuli territory



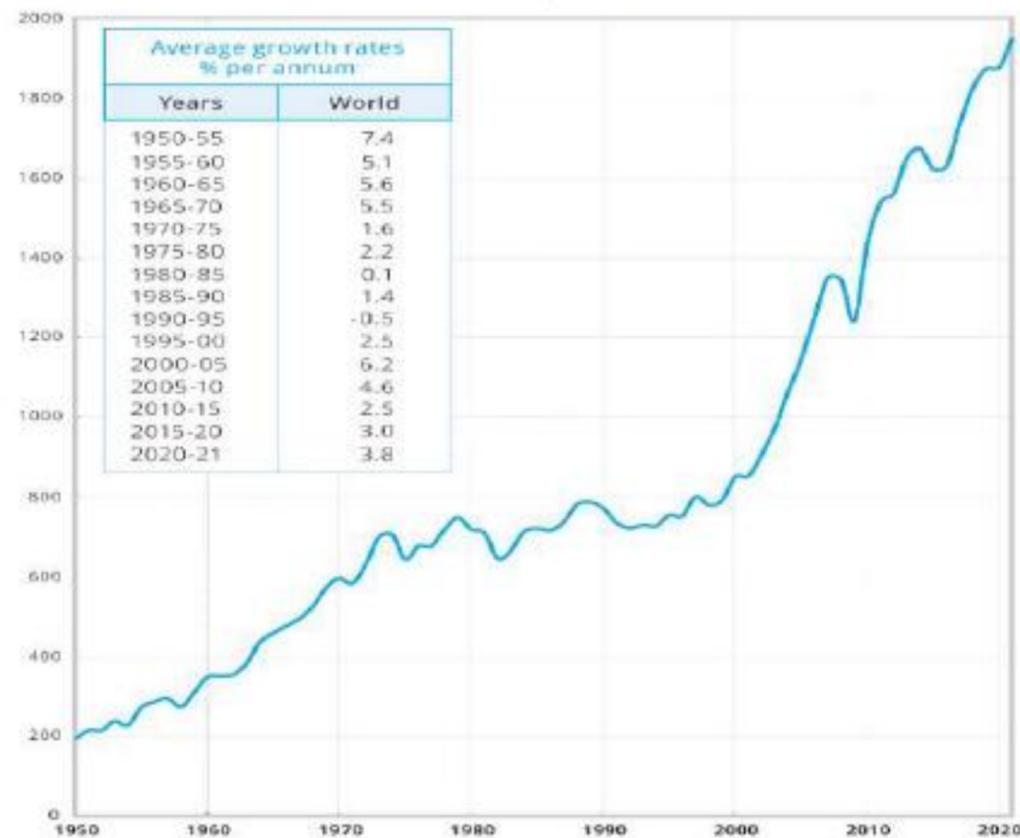
# Introduction: economic context

## World steel production

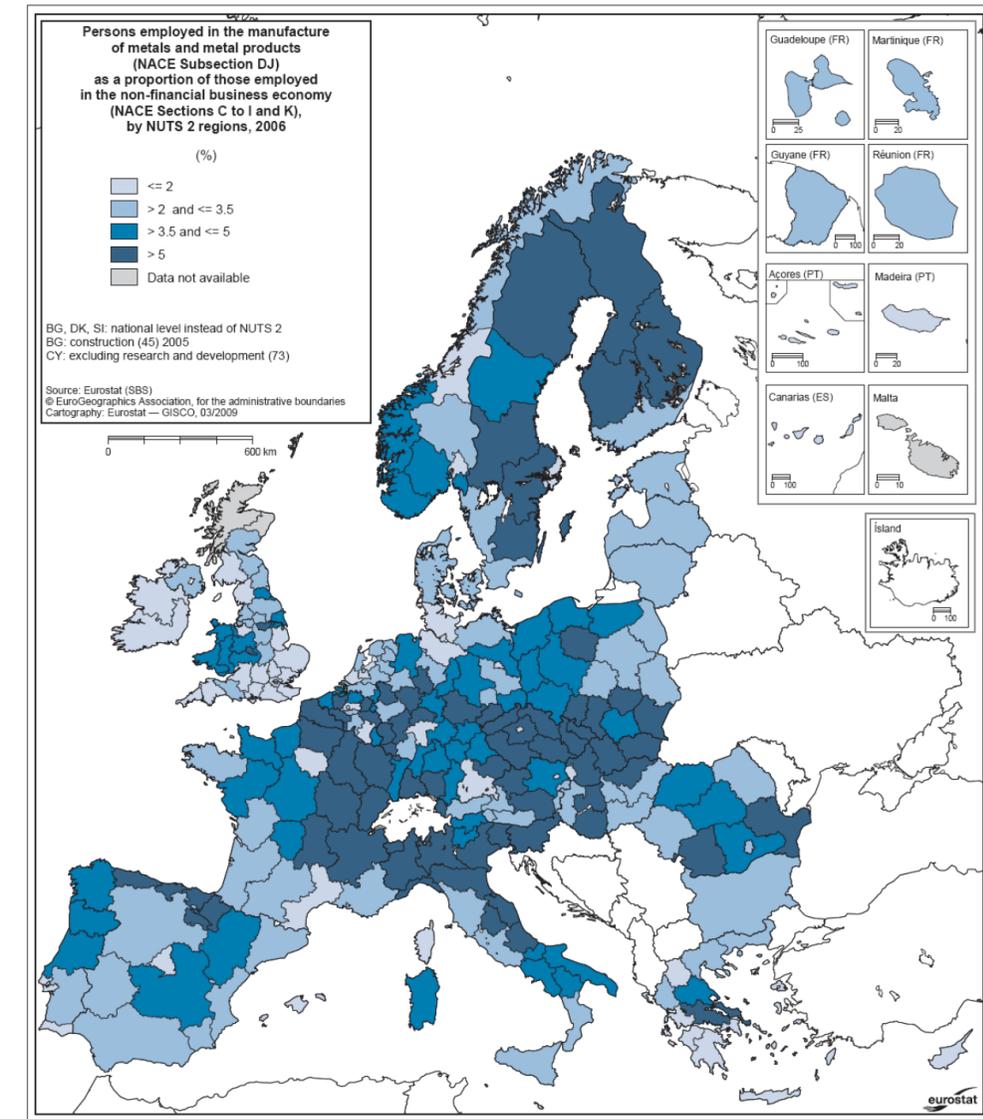
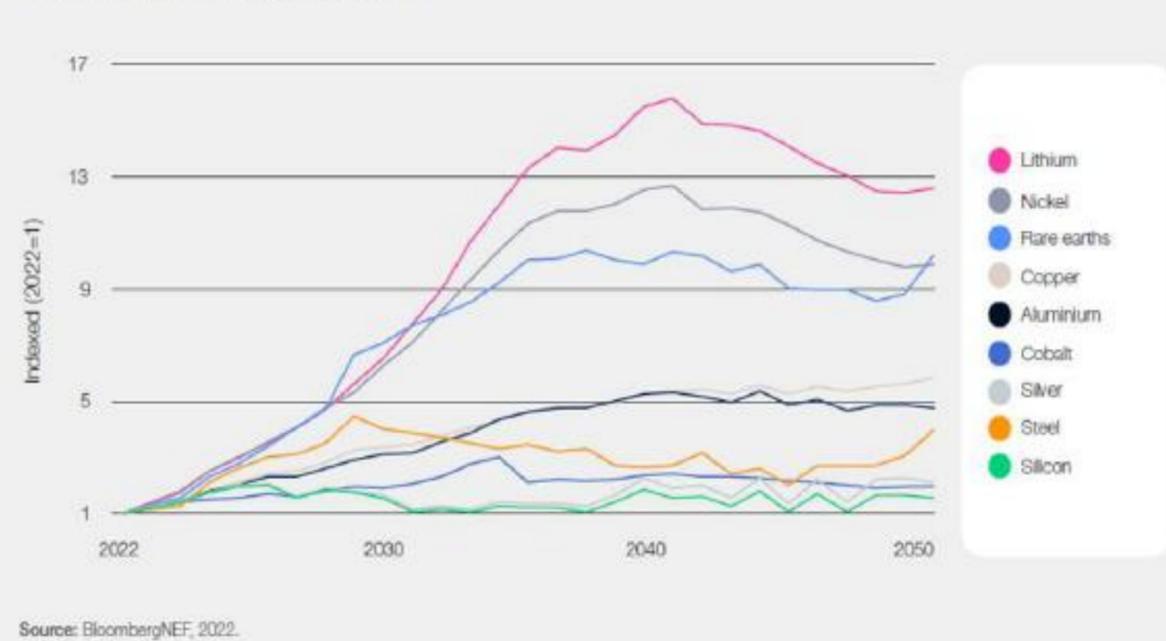
## Critical materials for energy transition

## Steel production in EU

million tonnes, crude steel production



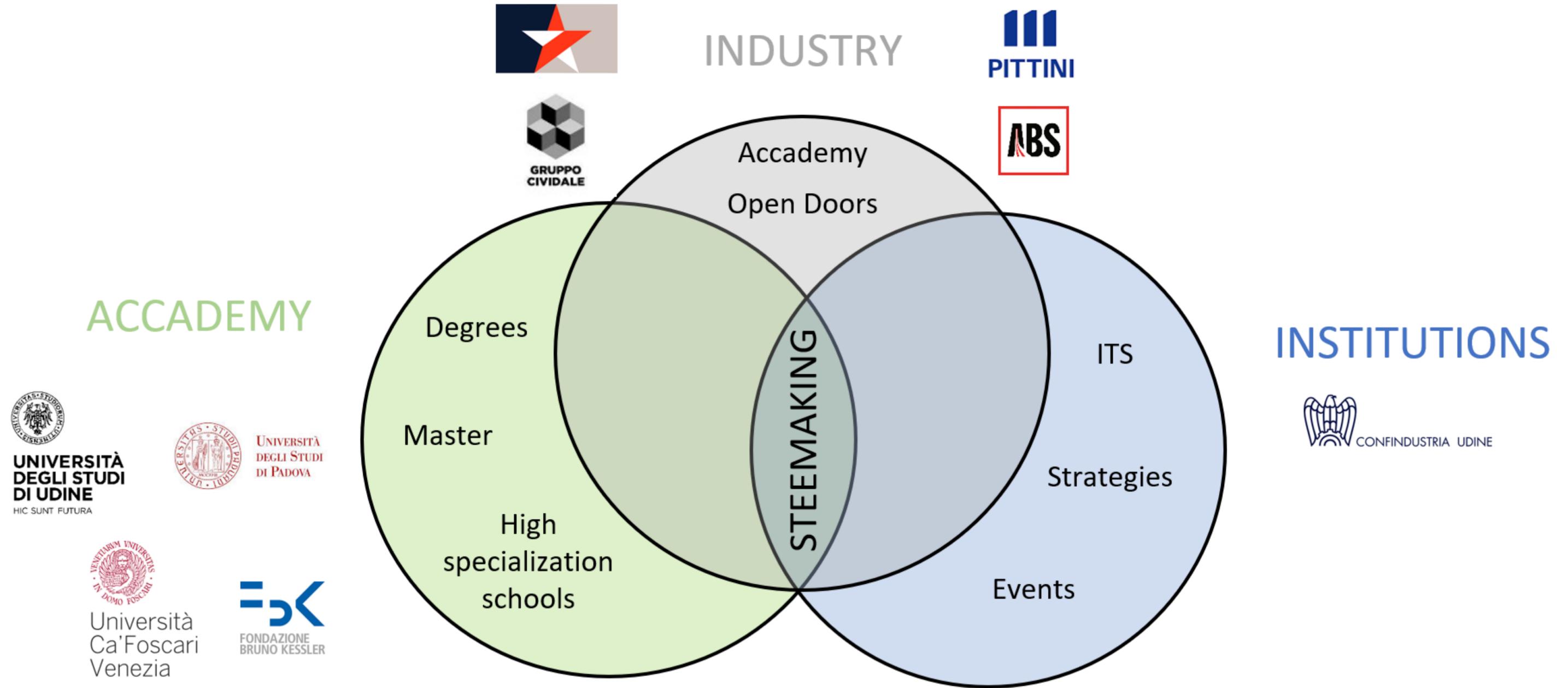
Growth in demand for metals used for clean energy transition under BloombergNEF's Net Zero Scenario



Source: Eurostat (SBS)

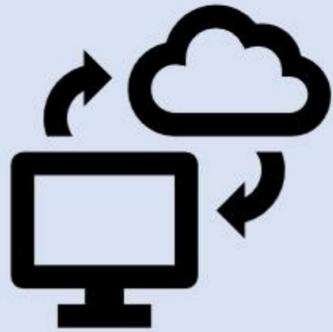


# Introduction: educational context



# Introduction: challenges

Digitalizing



New energies



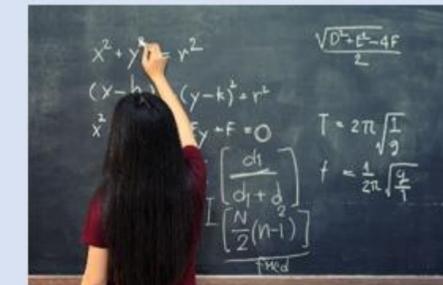
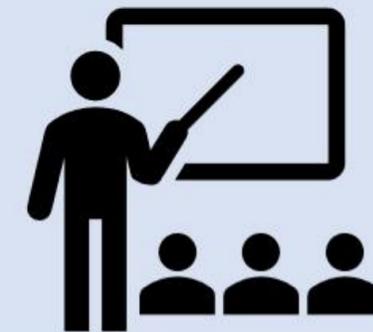
Decarbonization



Raw materials



Education/territory intercation



2050

# The digitalization

## State of the art:

- increasing automation and use of digital tools
- remote monitoring of plants
- use of robots for repetitive tasks
- acquisition of operational monitoring data

## Advantages:

- increased workplace safety thanks to technological advances
- increasing job satisfaction
- help in optimizing resources with a view to sustainability and energy savings



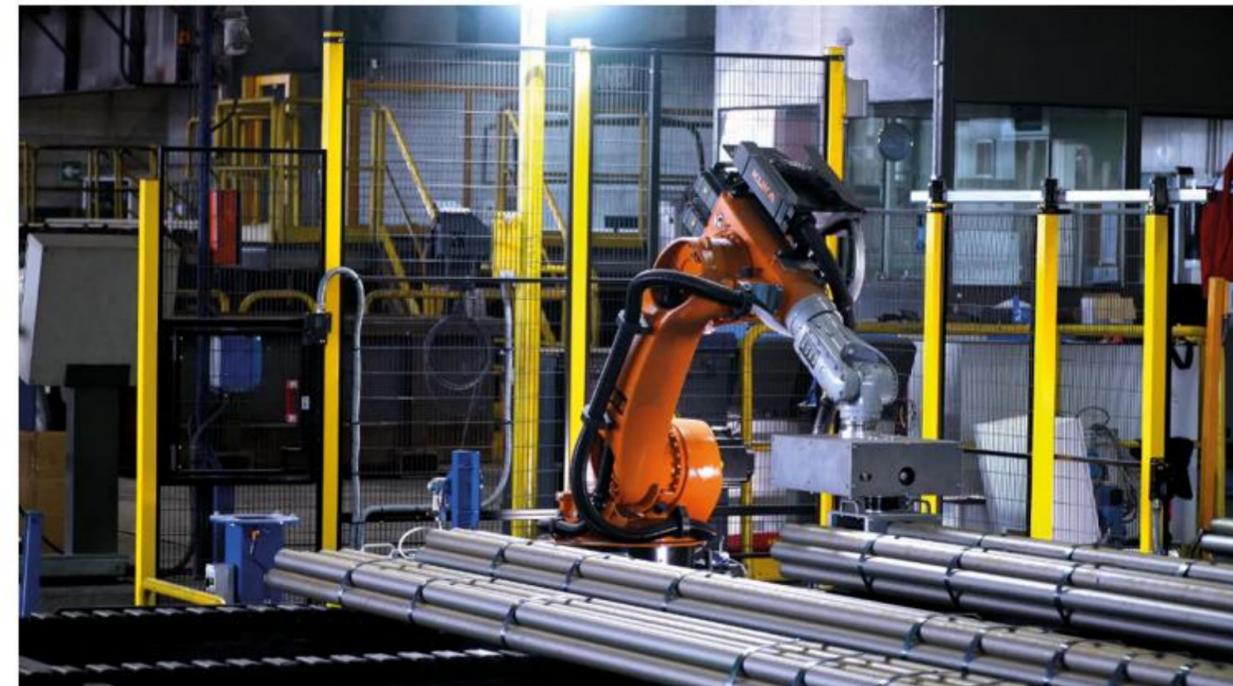
## Current issues:

- heterogeneity of acquired data
- difficulty in processing multidimensional data
- technological demonization
- poor digitization in traditional foundry environments

# The digitalization

## The vision on enabling technologies :

- use of AI based on both data and models
- collaborative robotics interacting with AI
- use of augmented reality
- use of the cloud for storing large amounts of data
- big data and data analytics
- Cybersecurity
- multi-level communication integration
- use of the internet for external communication
- use of quantum computers



# Energy and Environment

## State of the art:

- highly energy-intensive processes
- mainly C-based energy sources
- heat recovery from hot sources
- attempts at partial use of green sources
- steelworks mistakenly associated with pollution

## Advantages:

- Energy recover for energy production → cogeneration
- Energy recover for nearby towns → district heating



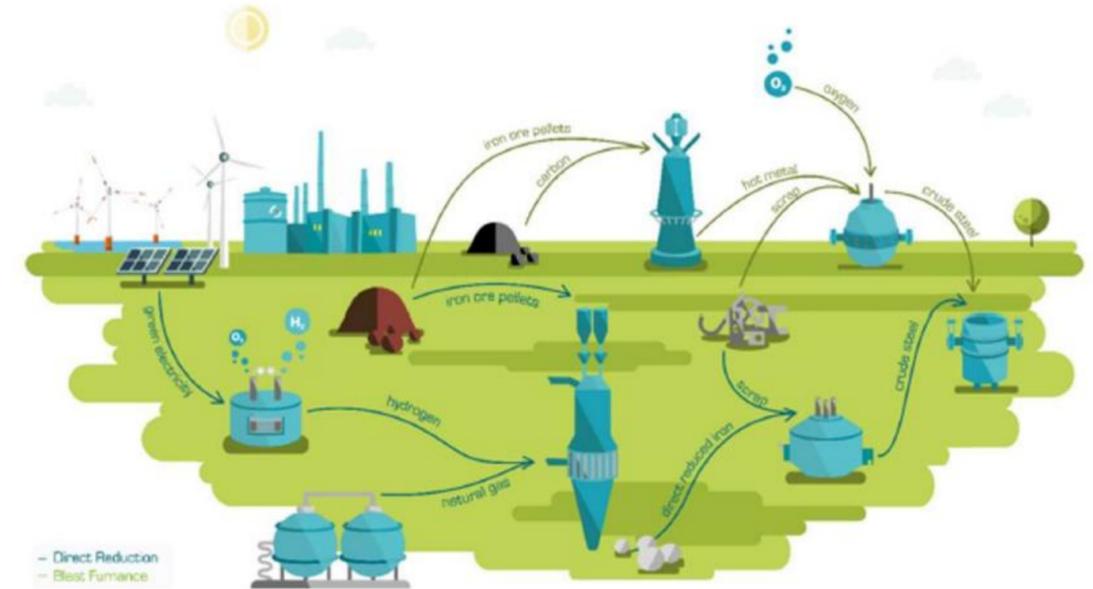
## Current issues:

- green and innovative technologies that are not yet mature
- legislative restrictions (e.g., nuclear power)
- technological measures that are not easily understood by external users
- technological inequality between foundries and modern steel mills

# Energy and Environment

## Future perspectives:

- use of traditional hybrid technologies in order to keep pace with technological developments in green technologies
- redesign of production layouts to make basis for innovative technologies
- use of small nuclear reactors on a local scale with energy sharing (energy communities)
- partial use of biomass where possible
- greater energy recovery from any heat source
- creation of dedicated areas within the steelworks for energy production
- redeeming the image of the steelworks with neighboring communities



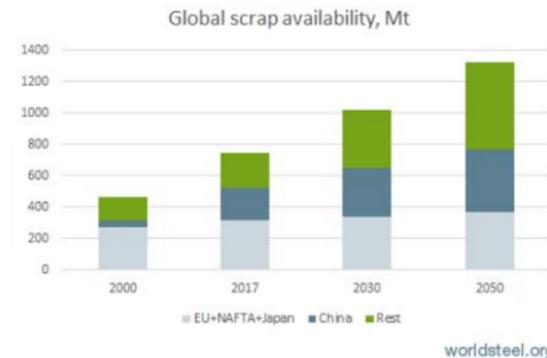
# The Raw Materials

## State of the Art:

- Use of Fe ore with low amount of Fe;
- Use of scrap (85% of Italian production)
- Use of C base fuels;
- Use of alloying raw materials produced with not green processes;
- Use of refiners coming from C based materials;

## Advantages:

- Use of materials easily implemented to current technologies;
- Intensive use of circular economy



|                              | Produzione in miniera<br>(migliaia di tonnellate) |                  |                    |                  | Riserve<br>(milioni di tonnellate) |                    |
|------------------------------|---|------------------|--------------------|------------------|------------------------------------|--------------------|
|                              | Minerale utilizzabile                             |                  | Contenuto di ferro |                  | Minerale grezzo                    | Contenuto di ferro |
|                              | 2022  | 2023             | 2022               | 2023             |                                    |                    |
| United States                | 39,000  | 44,000           | 24,700             | 28,000           | 3,100                              | 1,300              |
| Australia                    | 944,000   | 960,000          | 584,000            | 590,000          | 58,000                             | 27,000             |
| Brazil                       | 435,000   | 440,000          | 276,000            | 280,000          | 34,000                             | 15,000             |
| Canada                       | 69,000  | 70,000           | 41,400             | 42,000           | 6,000                              | 2,300              |
| Chile                        | 17,700  | 18,000           | 11,100             | 11,000           | NA                                 | NA                 |
| China                        | 272,000   | 280,000          | 170,000            | 170,000          | 20,000                             | 6,900              |
| India                        | 251,000   | 270,000          | 156,000            | 170,000          | 5,500                              | 3,400              |
| Iran                         | 78,300  | 77,000           | 51,300             | 50,000           | 3,300                              | 1,500              |
| Kazakhstan                   | 53,600  | 53,000           | 8,890              | 8,800            | 2,500                              | 900                |
| Mauritania                   | 12,700  | 13,000           | 7,950              | 8,100            | NA                                 | NA                 |
| Mexico                       | 10,800  | 12,000           | 6,800              | 7,600            | NA                                 | NA                 |
| Peru                         | 19,300  | 19,000           | 12,900             | 13,000           | 2,600                              | 1,200              |
| Russia                       | 84,200  | 88,000           | 55,800             | 58,000           | 29,000                             | 14,000             |
| South Africa                 | 63,700  | 61,000           | 40,500             | 39,000           | 990                                | 620                |
| Sweden                       | 38,900  | 38,000           | 27,700             | 27,000           | 1,300                              | 600                |
| Turkey                       | 17,700  | 17,000           | 10,700             | 10,000           | 152                                | 99                 |
| Ukraine                      | 34,100  | 36,000           | 21,300             | 22,000           | 6,500                              | 2,300              |
| Other countries              | 57,200  | 48,000           | 32,200             | 27,000           | 18,000                             | 9,500              |
| <b>World total (rounded)</b> | <b>2,500,000</b>                                  | <b>2,500,000</b> | <b>1,540,000</b>   | <b>1,500,000</b> | <b>190,000</b>                     | <b>87,000</b>      |

Tabella 1 – Produzione di minerale di ferro per paese, il dato del 2023 è stimato.

## Current issues:

- Hard availability of Fe ores due to geopolitical situation;
- Saturation limit of scrap demand
- Presence of high level of scraps
- Gradual increase of deleterious elements in steel (Cu)

# The Raw Materials

## Future perspectives:

- Use of urban mines;
- Reduce the use of iron ore with green technologies (DRI instead of BF);
- Increase in scrap use;
- Upgrading of scrap materials (e.g. reuse of refractories);
- Reuse of process materials (e.g. foundry sands);
- Use of carbon-based materials obtained from waste;



# Education/Territory Interaction

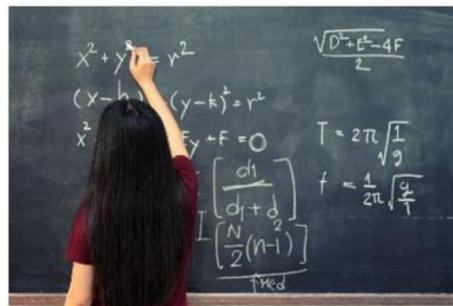
## State of the art:

- Teaching technical disciplines, mainly.
- Cross-disciplinary training
- Continuous education
- Discussions on the evolution of metallurgy education (Metallurgy 2040).
- Active learning approach.
- Contributing to education through company academies.
- Educational offers based on the current needs of companies, such as decarbonisation and green production (ITS, Master's, Bachelor's and PhD programmes).



## Current issues:

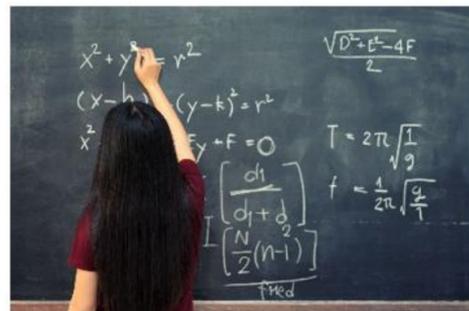
- image of the steelworks discourages students from choosing courses in line with the company's needs
- difficulty in implementing shared training courses
- low appeal of the disciplines (limited real knowledge of the sector)



# Education/Territory Interaction

## Future perspectives:

- initiatives to change the historical image of the steelworks
- extensive training, including for personnel outside the steelworks, by internal Academies
- increased continuing education offerings by higher education institutions and universities, with the involvement of companies
- increased multidisciplinary of educational offerings
- attractiveness for students already at low levels of education, with awareness-raising in the classroom;
- greater interaction between businesses and the local area, with training initiatives and sharing of choices (e.g., energy)



## Final thoughts

### **MATERIAL:**

- Steel is an essential material for everyday life that cannot be dispensed with.
- From a green perspective, prioritize the production of steel from scrap (Italy is already at the forefront).
- Use steel produced from Fe ore reduced by H (DRI) to compensate for the scarce supply of scrap.

### **PERSONS:**

- The steelmaking plants of the future will consist more of technicians than workers.
- Robotics will perform the most dangerous operations, separating the spaces between automated operations and humans.
- AI will lead to an increase in the degree of automation in production processes.

### **ENERGY:**

- The supply problem will be partially solved by the use of alternative sources or recovery.
- Nuclear energy (small-scale fission or fusion in the future) seems to be the only green candidate for energy-intensive companies.
- The problem is strongly dependent from political debate.

## Final thoughts

### GEOPOLITICAL FACTORS:

- systemic uncertainty structured within a global scenario
- economic instability caused by geopolitical tensions and protectionist measures
- economic uncertainty slowing down investment

### NIMBY SYNDROME:

- train and inform people about how modern factories have evolved compared to the past
- stimulate interaction between communities and businesses





**QUESTIONS**

**& ANSWERS**



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