TECHNICAL UNIVERSITY OF CRETE

HIAS2026 Symposium

indigo

industrial and digital innovations research group

Green and Resilient Energy-Flexible Production Processes

Engineering the Next Generation of Intelligent Industrial Infrastructure

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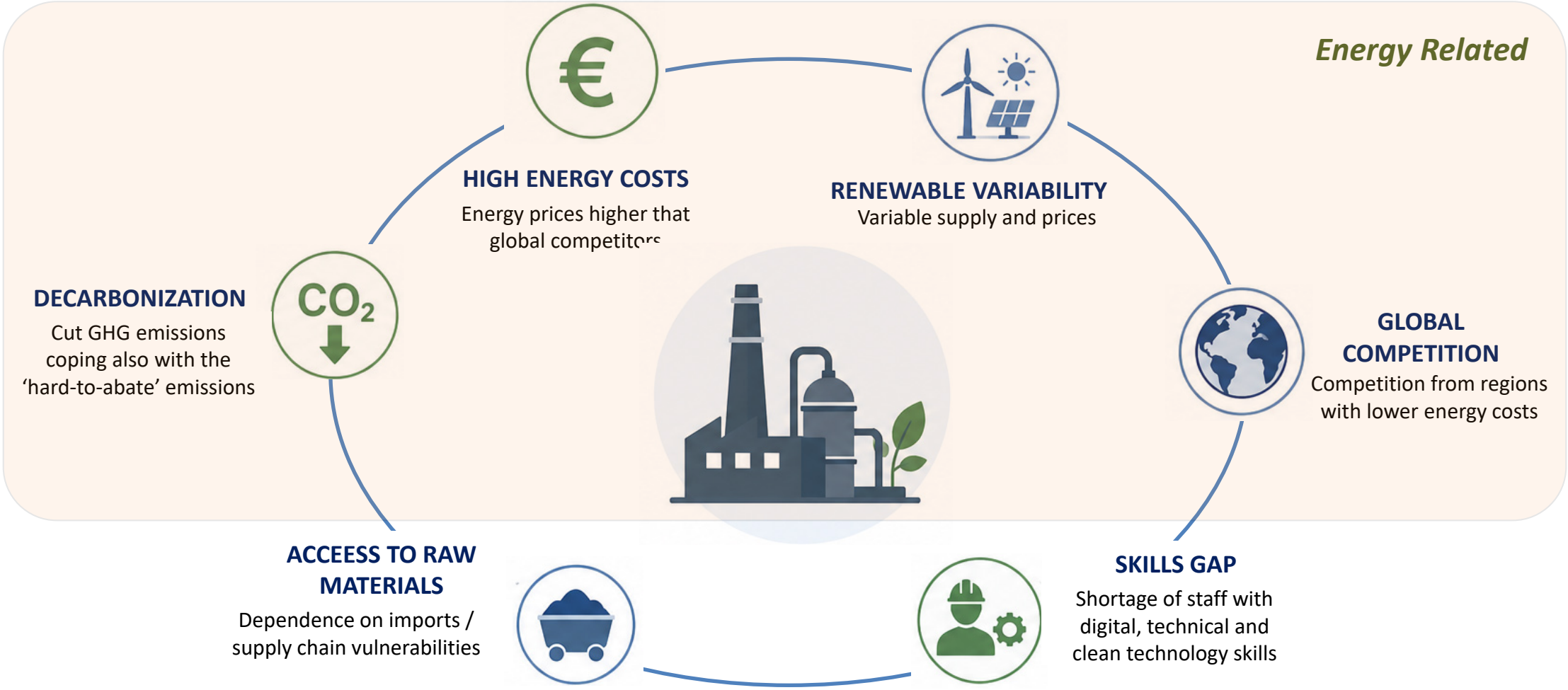
Challenges Facing European Industry

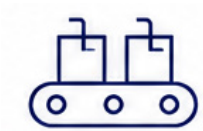


Industry must operate as part of the energy ecosystem

From Stability to Adaptability and Flexibility

Traditionally, industries have been designed around:

stable energy supply



continuous production

predictable demand

Today, industries must operate under:

renewable variability

volatile electricity prices

uncertain supply chains

climate risks

Intelligent and flexible infrastructure is the foundation of the industrial future

Why Existing Industrial Plants Cannot Cope

Rigid Equipment

Equipment and processes designed for rigid operation

Steady-State Operation

Optimized for continuous and constant conditions

Limiting Ramping Capacity

Slow response to energy and demand variations

Loss of Competitiveness

Higher costs, missed opportunities, higher emissions

INDUSTRIAL RIGIDITY

The main barrier to flexibility and resilience

Engineering Principles

Foundation for Green and Resilient Energy-Flexible Production

1 FLEXIBILITY BY DESIGN

Build to adapt

Processes & industrial units that can adapt from the start

2 ENERGY-AWARE PROCESSES

Operate Intelligently

Design & operate processes with energy efficiency & renewables in mind

3 HUMAN-CENTRIC INTELLIGENCE

People at the center

Empower people with clear insights & intuitive tools

4 RESILIENCE BY DEFAULT

Be ready for change

Anticipate risks, withstand disruptions &and recover quickly

5 AI-ASSISTED DECISION MAKING

Decide with confidence

Use data & AI to support fast, informed & optimal decisions

6 SYSTEM-WIDE OPTIMIZATION

Think systemically

Optimize across the whole plant & the energy ecosystem

The New Industrial Paradigm

Industry as a Cyber-Physical Ecosystem

PHYSICAL LAYER
The Real World

- Industrial Plants
- Automation & Control
- Energy Systems
- Logistics & Supply Chains

CYBER LAYER
The Digital World

- Cognitive Digital Twins
- Data & Connectivity
- AI & Analytics
- Decision Support

HUMAN LAYER
People at the Center

- Expertise
- Collaboration
- Values &Goals

A new paradigm for a competitive, resilient and climate-neutral industry

Artificial Intelligence as an Enabler

AI ANALYZES

- Forecasts
- Simulates
- Optimizes
- Recommends
- Detects & Alerts

AI

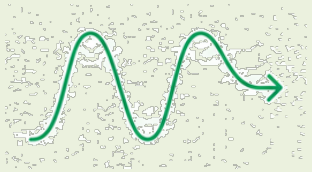
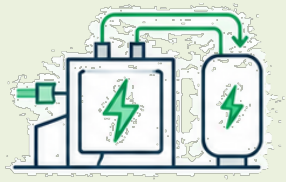
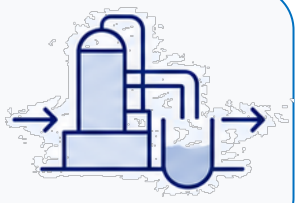
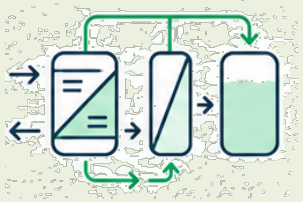
Extracts insights from data and models

HUMAN DECIDES

Engineers and operators make informed, responsible decisions

AI supports, human decide. Together we achieve the best outcomes

Process Redesign for Flexibility – Examples from ACT2Flex project

	Legacy Baseload Paradigm	Adaptive Flexibility Solution
Process Operation	Constant flat-load processing 	**Buffered batch** operations(silos) 
Thermal Energy	Fossil-fired melters and heaters 	**Fast ramping** high voltage electrode boilers & flash accumulators 
Utilities	Constant load water treatment 	**Variable load** RO-CEDI with demin water buffers 

The ACT2Flex Demo Cases

Energy Flexibility in Chemical Industry

Industry: KRONOS EUROPE NV (Titanium Dioxide Manufacturer)
Location: Gent, Belgium

Flexibility Innovations

1. Process Redesign with Material Buffering
2. Hybrid and Flexible Steam Generation
3. Integrated Energy Storage
4. Flexible Water Treatment
5. Advanced Digital Orchestration

Energy Flexibility in Metallurgical Industry

Industry: ElvalHalcor S.A. (Copper Manufacturer)
Location: Oinofyta, Greece

Flexibility Innovations

1. Intelligent, Grade-Aware Scrap Management
2. Hybrid Heating System
3. Electrification
4. Efficiency Boost – Electromagnetic Stirring
5. Intelligent Digital Control

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Thank you!

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