ICOS International Cooperation On Semiconductors

WORKSHOP – May 12-13, 2025 - Warsaw

International Cooperation on Semiconductors

:

EU and Non-EU Strengths, Weaknesses, Dependencies, Opportunities for International Collaboration

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INPACE

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INTRODUCTION

- ICOS Project starts in January 2023 for three years, it is funded by the Horizon Europe research program.

Coordinator

Technical co-Coordinator

- An ambitious project in the framework of the European strategy for semiconductors

PARTNERS & ADVISORY BOARDS

Motivation & Objectives

- **Semiconductors & Semiconductor-based photonics** are pivotal technologies for almost all existing industrial sectors, as demonstrated by the recent chips shortages
- **International cooperation** is key for **speeding up** technological innovation (e.g. ITRS/IRDS, IPSR-I, ECS-SRIA, NEREID), reducing **cost** by avoiding duplicated research, strengthening complex supply and value chains, and is encouraged by the new **strategies** of leading semiconductor countries

=> To build **balanced semiconductor partnerships** with like-minded countries

=> To set out cooperative framework on *initiatives of mutual interest*

=> To identify and support the establishment of the **most promising scientific international collaborations**

=> To support the growth of the European Semiconductor industry through **focused research alliances** based on awareness of advanced research activities

=> To strengthen **Europe's and partner Country's positions** in global value chains in this area and to contribute to the **EU Chips Act, Green deal and Digital Agenda**

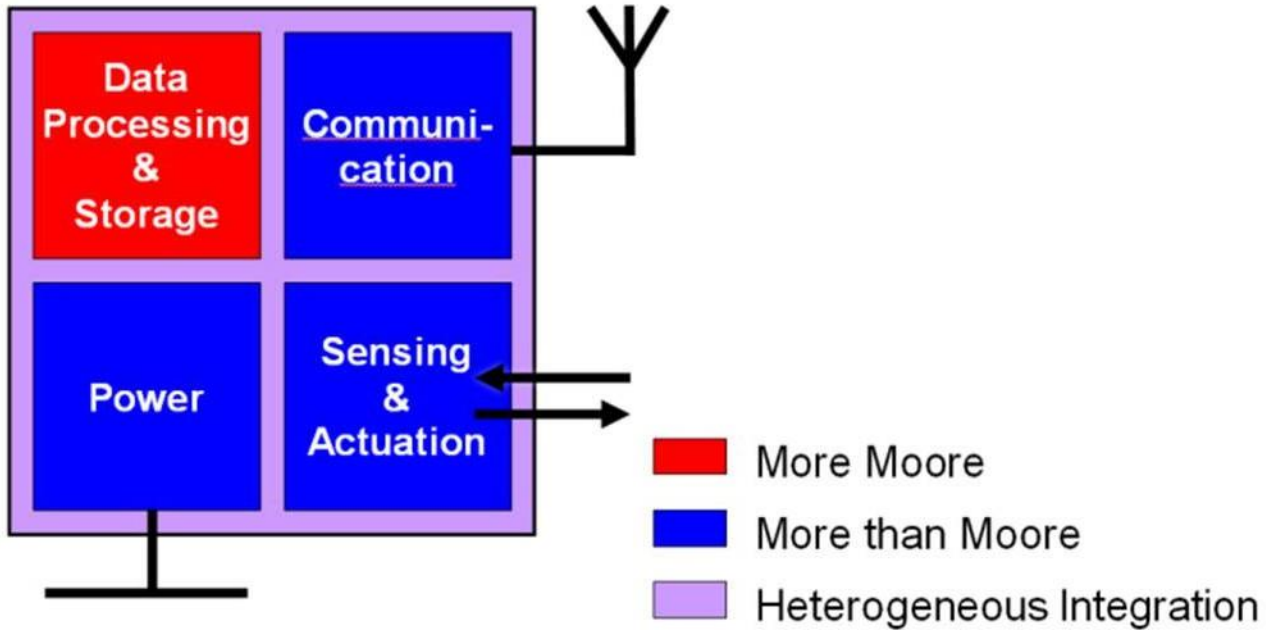
Objectives of ICOS

- **Investigated countries:**

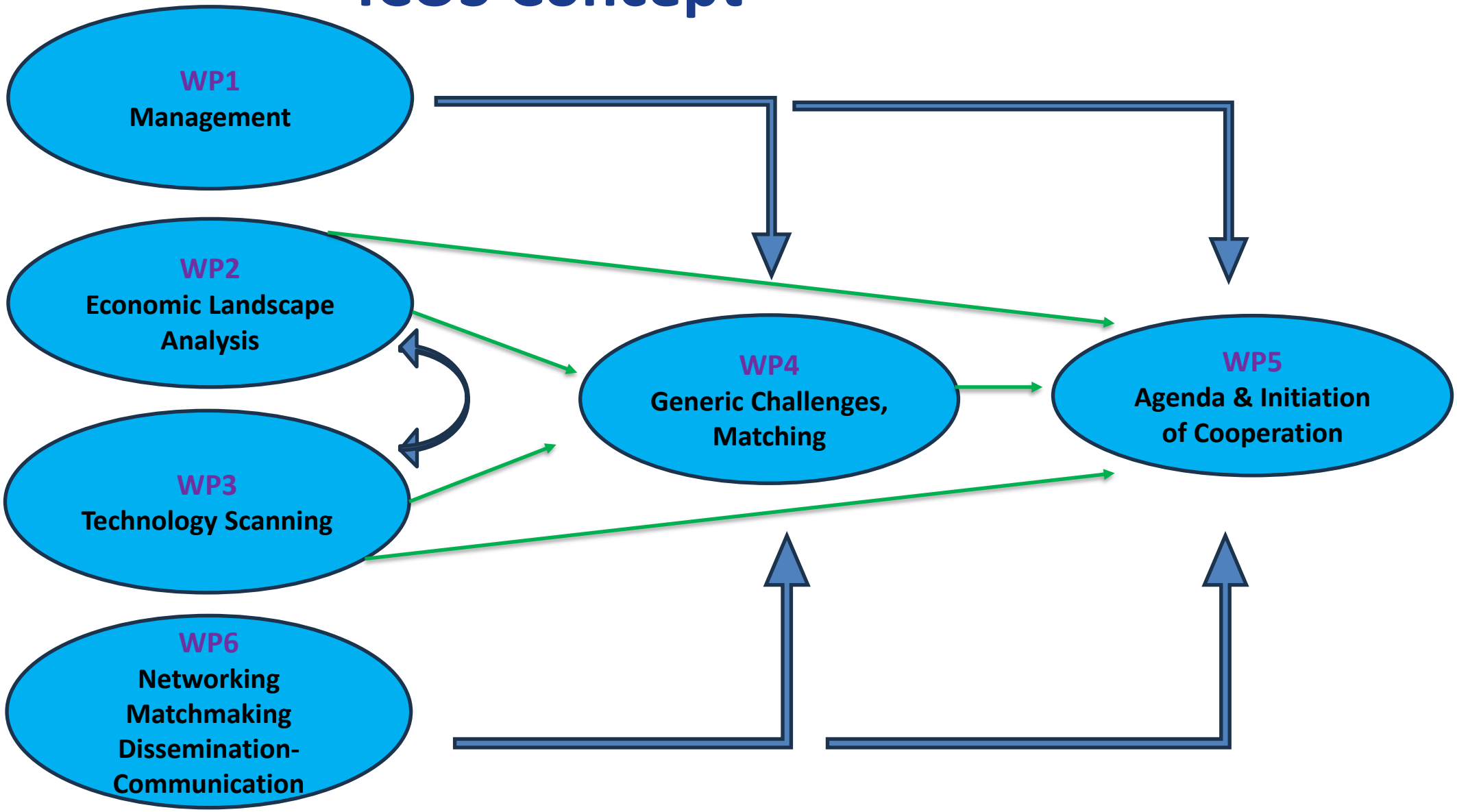
  - Japan
  - The United States of America
  - India
  - The Republic of Korea
  - Taiwan
  - Singapore
  - China
  - Canada, Malaysia (for some analysis)

Main scientific topics

- Advanced computing & Advanced functionalities: sensing, RF & optical communications, optical devices, energy harvesting, power devices, …



ICOS Concept



ICOS
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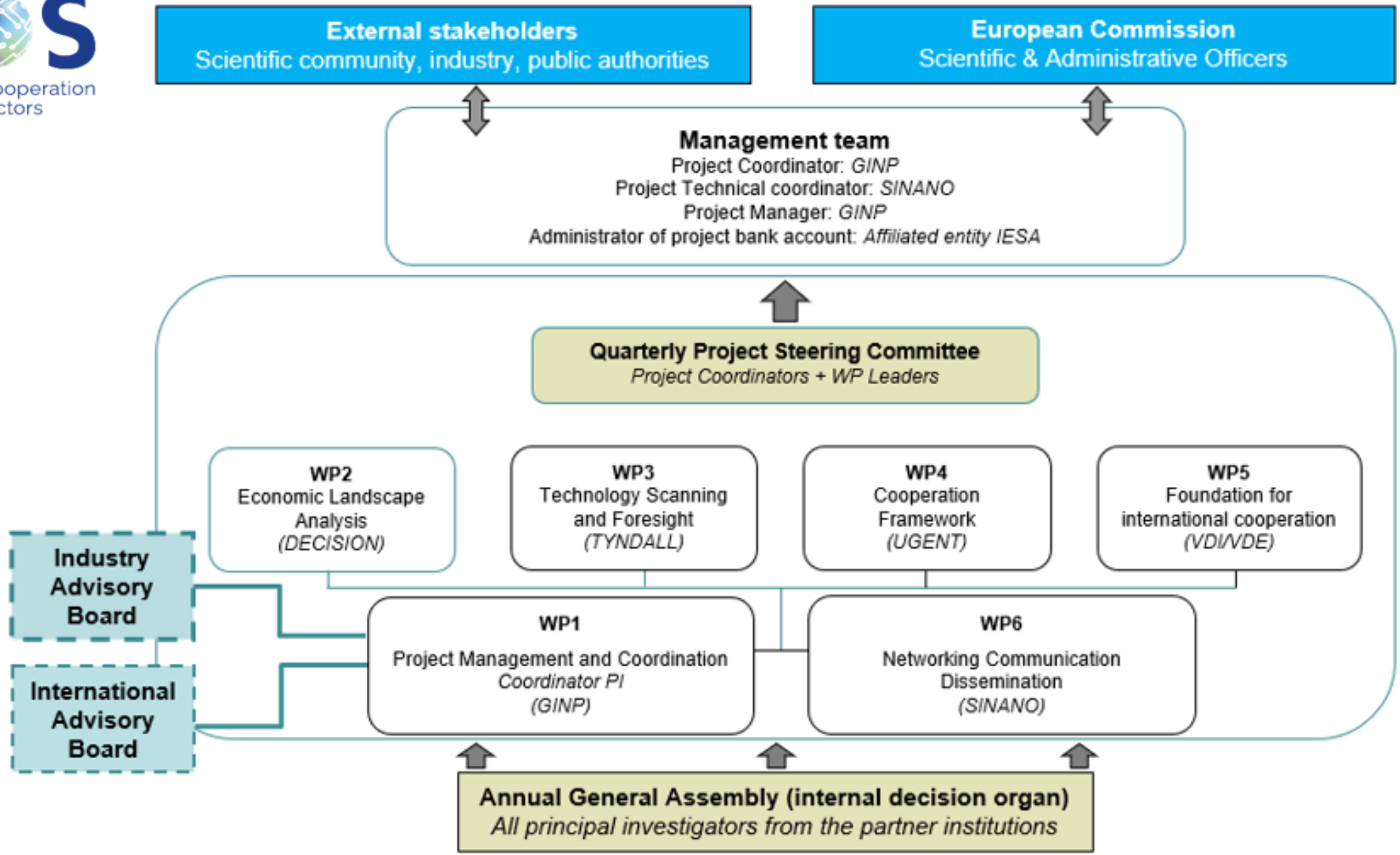


Structure of ICOS project & stakeholders

Funded by the European Union

IMPLEMENTATION

IMPLEMENTATION

EXHAUSTIVE ANALYSIS OF SEMICONDUCTORS' VALUE CHAINS, FOR ELECTRONICS & PHOTONICS

Identification of :

- EU's economic and industrial strengths & weaknesses
- Strategic dependencies
- Market and cooperation opportunities

IDENTIFICATION OF RESEARCH AREAS FOR INTERNATIONAL COOPERATION

Identification of next generation & emerging technologies, especially in advanced computation and functionalities.

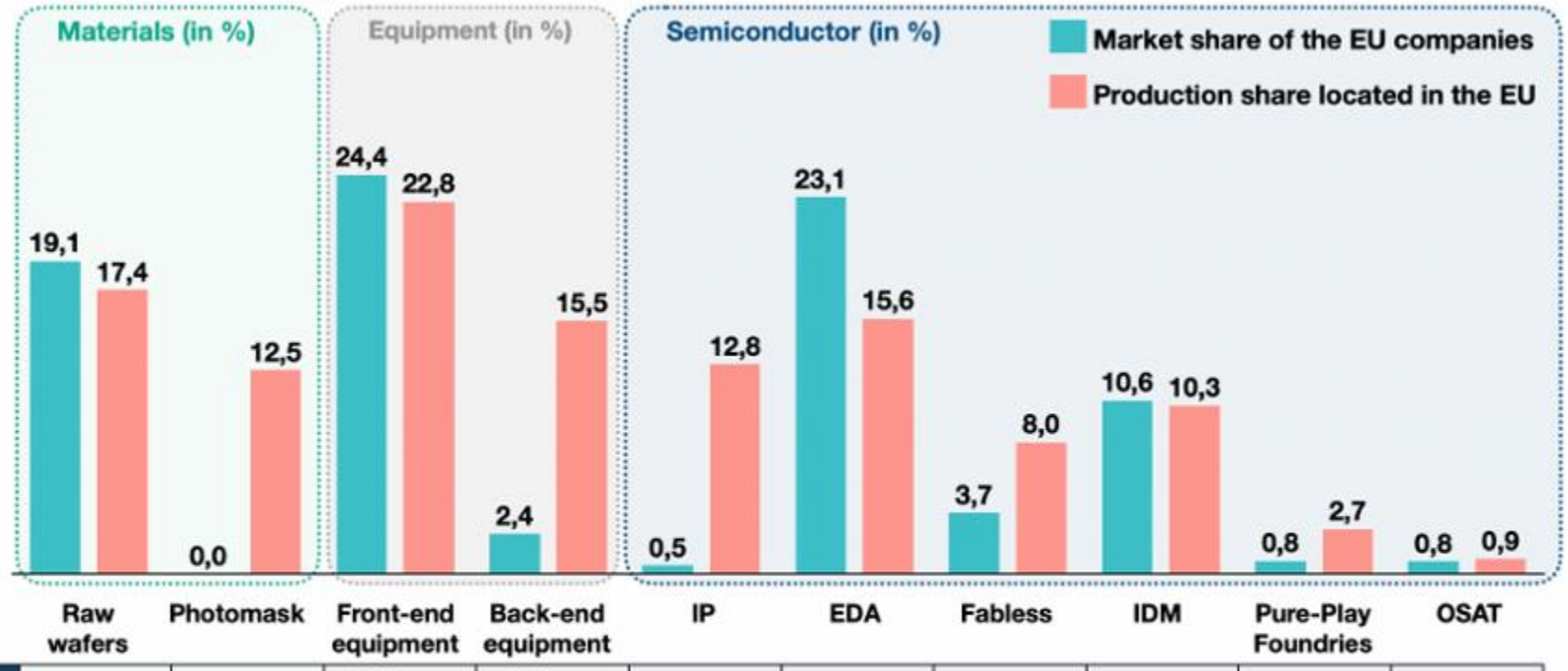
DETERMINATION OF MOST INTERESTING COUNTRIES FOR INTERNATIONAL COOPERATION

Identification of challenges for which international cooperation is critically important.

AGENDA FOR AND INITIATION OF INTERNATIONAL COOPERATIONS

- Dialogue with actors of existing cooperation
- International collaboration with non-EU national authorities
- Define standardisation needs and activities
- Support the European Commission

Market & Production shares EU & non-EU / EU

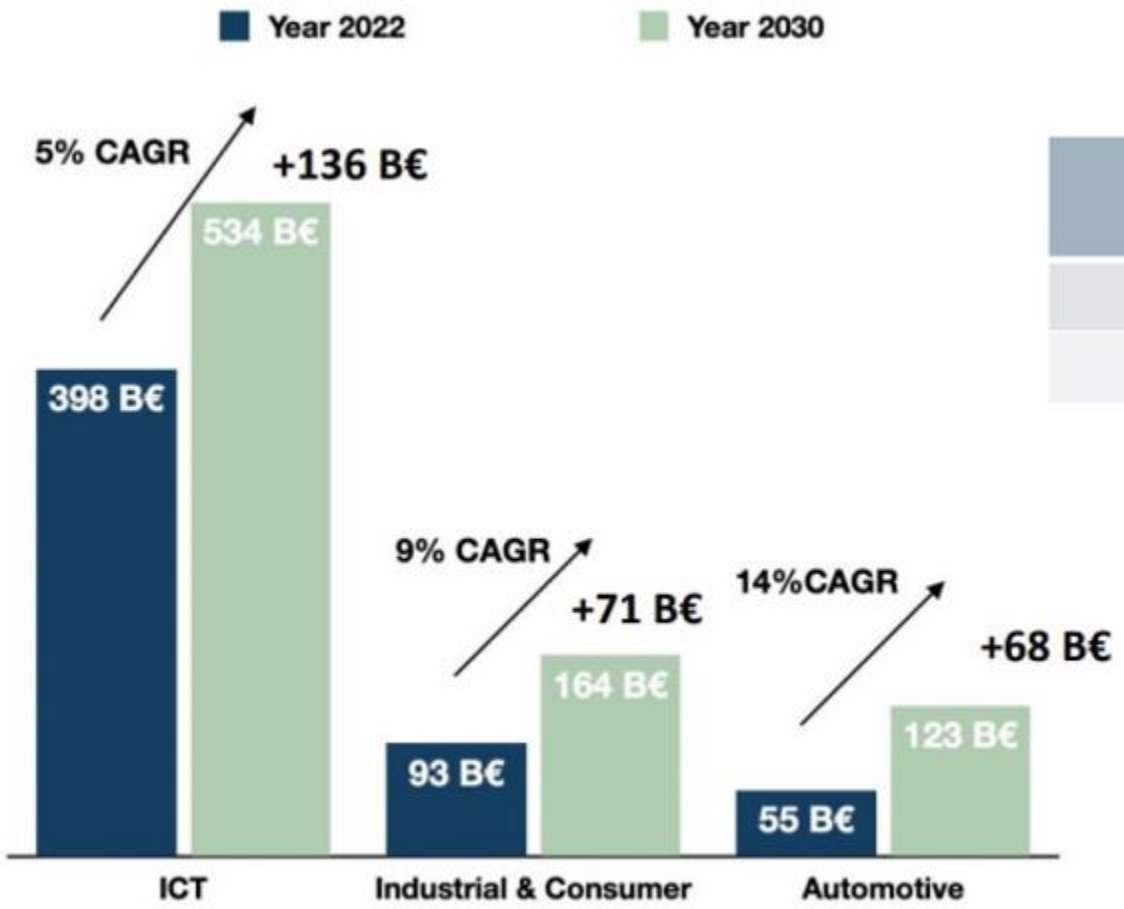


Global market size	16 B€	2.5 B€	96 B€	12 B€	6 B€	8 B€	168 B€	377 B€	127 B€	44 B€

In comparison, the EU account for 17% of the global GDP in 2022[29].

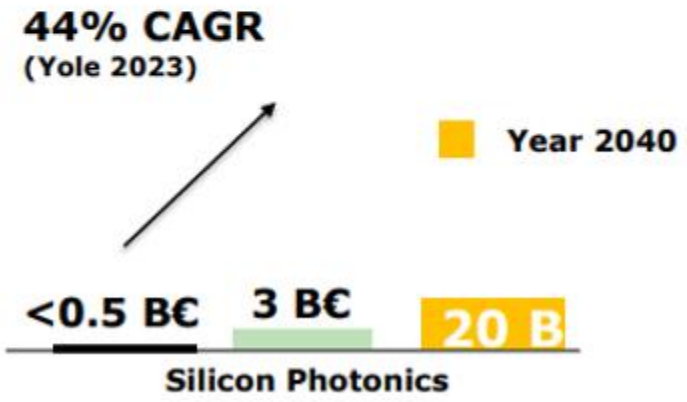
Source: DECISION Etudes & Conseil

Growth in Electronic and Photonic Chips



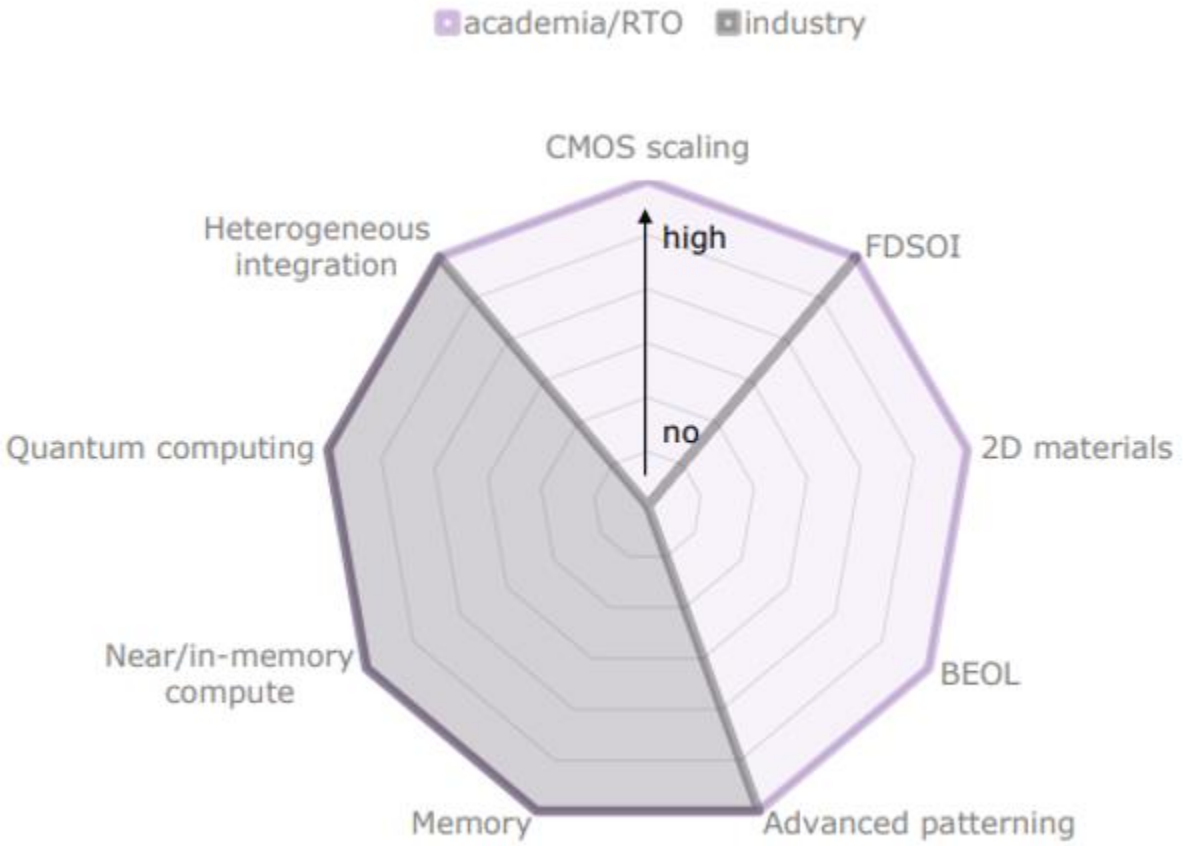
Source: DECISION Etudes & Conseil, Mc Kinsey, WSTS

Silicon Photonics Market ÷ Semiconductor Market	
2023	< 0.1%
2040	> 1%



Source: Yole market studies; Roel Baets

Main technologies: EU & non-EU / EU



- R&D very strong in all areas of compute
- Unique strong position in EUV lithography
- In general, industrial EU players lacking to take up R&D

Challenges, possibles solutions & Collaboration opportunities: “Advanced computing”

- Classical’ Logic Scaling Roadmap beyond FinFET technology that extends devices structures through **sub nm nodes** (e.g., **GAA and CFET architectures**)
- Exploration of ‘**Fully Depleted SOI**’ technology for Power Efficient Analog and RF applications
- Exploration of **alternative channel materials** (e.g., **2D** materials)
- Extension of the **scaling of BEOL technologies**, through the use of Ru, Airgap or Graphene-based metallization, by reducing the associated RC network
- **Added BEOL functionality** through the introduction of new materials such as 2D, oxide semiconductors and ferroics
- Exploration of the use of BEOL **Non-Volatile Memories** (using for example resistive RAM such as FeRAM, MRAM, PCRAM) to supplement/replace charge-based memories, for in-memory computing (eNVM), and for Power Efficient Neuromorphic-based architectures
- **Photonic chips for optical interconnects and quantum information processing**
- Demonstration of the capability of the ‘**Buried Power Rail delivery’** to decongest the interconnection density that is becoming the most limiting factor for the **scaling at 2nm and below**
- Enablement of the **High-NA EUV lithography** for the patterning of 2nm nodes and beyond
- **Usage of 3D integration** to desegregate the classical large area chips into **chiplets that will be much more power efficient** when reconstruct using 3D integration design flow and associated toolbox
- **Cryogenic electronics** for power saving and quantum computing

Challenges & possible solutions & collaborations opportunities: “Advanced functionalities”

- Innovation in **new, highly sensitive and more versatile sensors** requiring more advanced sustainable (bio)materials innovation and integration
- **For energy harvesters the improvement of the performance**/ efficiency is as important as the development of “**green” materials**
- **Wide band gap** (e.g. SiC, GaN) and **ultrawide band gap materials** (e.g. AlN, GaOx, diamond) for power
- **Flexible, Printable, Wearable Electronics**: Future Hybridization of Flexible & Si-based electronics
- **Heterogeneous integration** of best materials for target application
- **Advanced design tools**, including multi-physics simulation for first-time-right modelling capabilities
- **Rapid prototyping** to bypass long chip iteration cycles (e.g. PDK, ADK availability)
- **Packaging that meets multiple design requirements** such as optical, electrical, mechanical, thermal, RF, (bio-)fouling etc.

Possible joint activities

- Webinars
- Workshops
- Contribution to Regional & International Technology Roadmaps (IRDS)
- International R&D&I cooperation on topics of mutual interests
- Exchange of researchers
- Access to Research Infrastructures
- Standardisation needs for emerging technologies

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Thank you for your attention

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