International Cooperation On Semiconductors

WORKSHOP

Key Emerging Technologies for future Industrial Applications

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# International cooperation for a resilient Europe: priorities and challenges


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# WP4 Objectives

- identify generic needs and challenges in the semiconductor field for which international cooperation driven by public authorities is critically important
- identify potential cases of complementary cooperation with other regions that address needs and challenges, for Advanced Computation and Advanced Functionality
- prioritize these concrete cases by applying societal, environmental, economic, scientific and policy-driven filters

# WP4 Objectives

- **identify generic needs and challenges in the semiconductor field for which international cooperation driven by public authorities is critically important**

# Fifteen Challenges

1. **Manufacturing Fabs**
   Chip manufacturing infrastructure in the EU is missing or is outdated
2. **Process Flow**
   Chip manufacturing infrastructure is available in EU but process flow is missing or is outdated/uncompetitive
3. **Foundry Access**
   Foundry access and associated PDK are missing: a. globally; b. in EU
4. **Second Source**
   Critical dependence on one chip manufacturer (no second sourcing)
5. **Disruption**
   Critical dependence on non-EU chip manufacturer(s) which are subject to substantial risks of disruption (commercial, environmental calamity, political, military, cyber risk…)

# Fifteen Challenges

6. **Competition**
   Competition from non-EU chip manufacturers is very strong
7. **Workforce**
   Human resource challenges: insufficient skilled workforce, insufficient ability to attract talent, insufficient training and reskilling programs, poor gender balance
8. **R&D Capability**
   Insufficient availability of R&D capability in the EU or insufficient access to R&D infrastructure for technological POC and feasibility
9. **IP-core**
   Missing access to IP-core or other blocking IP issues
10. **Supply Chain: Goods**
    Critical risks or bottlenecks in the supply chain of goods for EU-companies (materials, energy, gas, tools, other goods)

# Fifteen Challenges

**11. Supply Chain: Services**

Critical risks or bottlenecks in the supply chain of services for EU-companies (services for EDA, assembly and package, test, other)

**12. Investment**

Insufficient investment capability (corporate and VC) across the supply chain, in particular for startups and SMEs

**13. Export Limitations**

Commercial restrictions in the context of dual-use export control

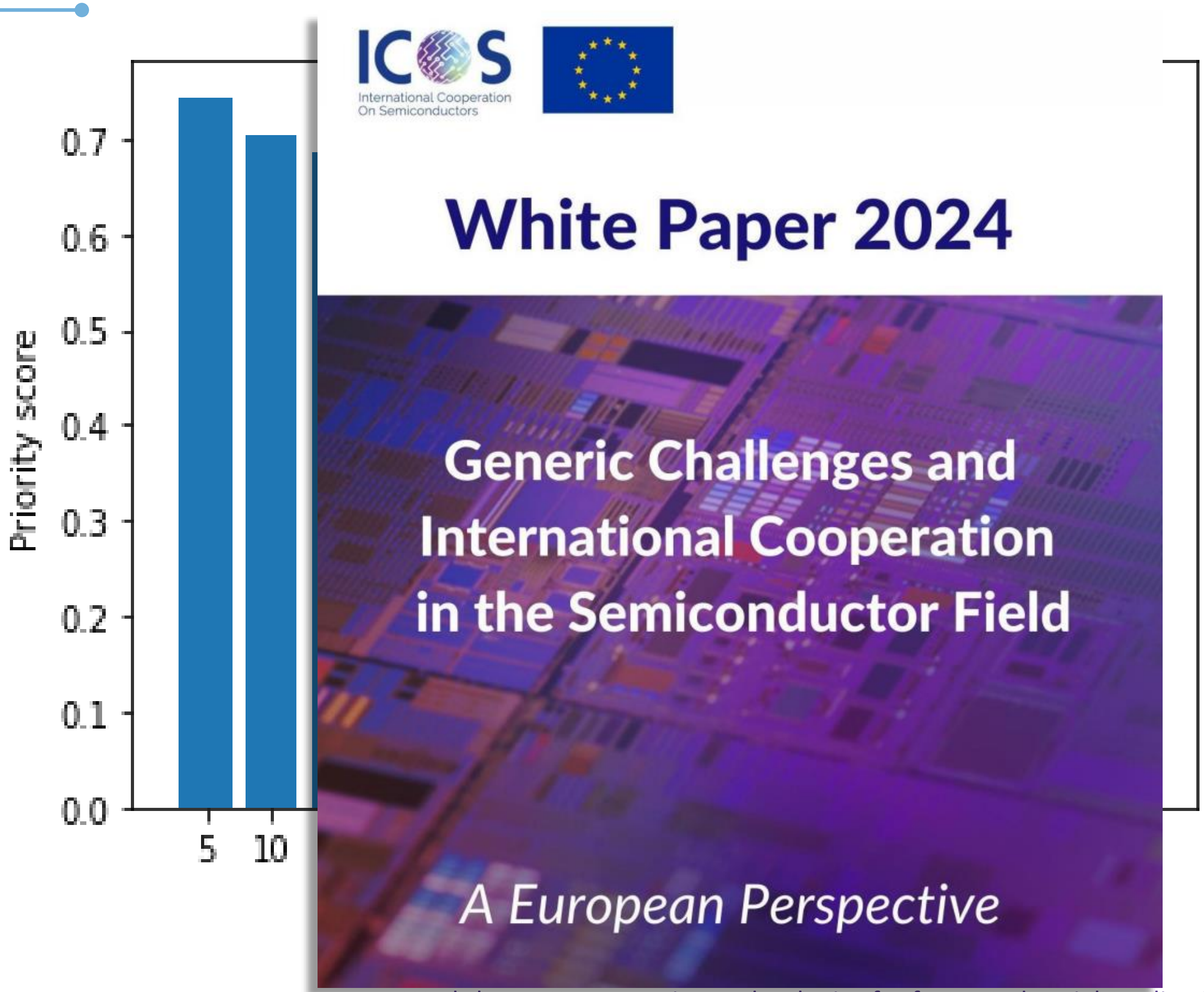
**14. Environmental Impact**

Challenges with respect to the environmental impact of the semiconductor industry

**15. Social & Governance**

Challenges to meet social and governance goals, in particular social/political acceptance of major new initiatives.

# Prioritization




1: Manufacturing Fabs
2: Process Flows
3: Foundry Access
4: Second Source
5: Disruption
6: Competition
7: Workforce
8: R&D Capability
9: IP-Core
10: Supply Chain: Goods
11: Supply Chain: Services
12: Investment
13: Export Restrictions
14: Environmental Impact
15: Social & Governance

# 4 main challenges

1. Critical dependence on non-EU chip manufacturer(s) which are subject to substantial **risks of disruption** (commercial, environmental calamity, political, military, cyber risk…)
2. Critical **risks or bottlenecks in the supply chain** of goods for EU-companies (materials, energy, gas, tools, other goods)
3. Critical dependence on one chip manufacturer (**no second sourcing**)
4. Human resource challenges: insufficient **skilled workforce**, insufficient ability to attract talent, insufficient training and reskilling programs, poor gender balance
5. Chip manufacturing **infrastructure in EU is missing** or is outdated
6. Challenges with respect to the **environmental impact** of the semiconductor industry
7. **Foundry access** and associated PDK is missing

# WP4 Objectives

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# Cooperation cases on Advanced Functionality and Computing

- Assess the need for international cooperation on the previously identified challenges
  - For different steps in the value chain
  - For different technologies
- Assess EU strengths and gaps with other countries on different technologies
- Identify potential cases of complementary research

# Cooperation cases on Advanced Functionality and Computing

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ICOS

International Cooperation On Semiconductors

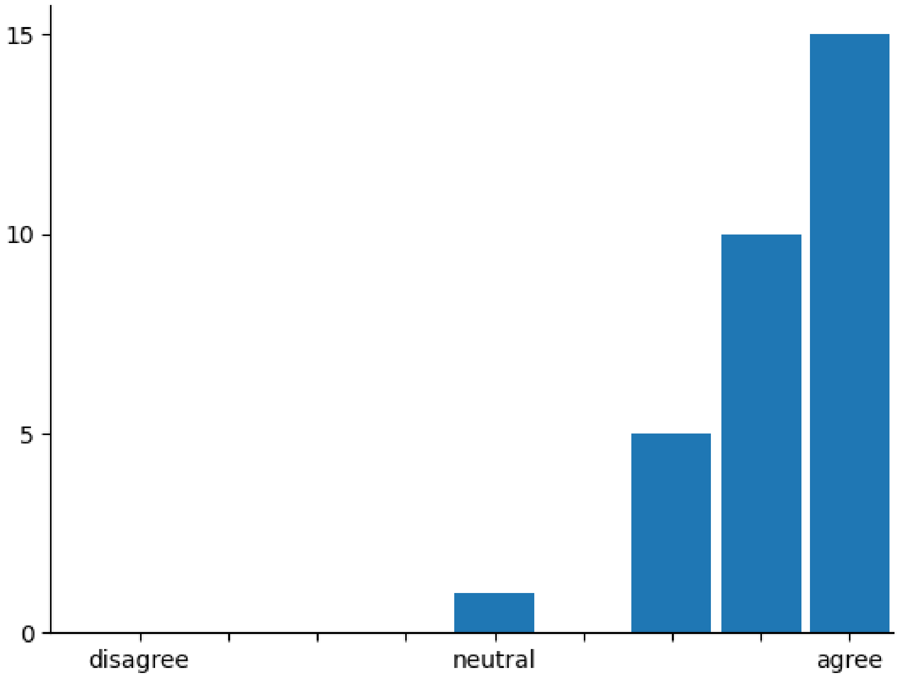
# Survey on international cooperation opportunities for the semiconductor industry in Europe

# Assess the need for international cooperation for the challenges

The European semiconductor industry is at risk of **severe bottlenecks** in at least one step of the supply chain due to **external disruptive effects** (pandemics, natural disasters, military conflicts etc.) or due to the **lack of second sourcing**

# Disruptions to the supply chain

The European semiconductor industry is at **risk of severe bottlenecks** in at least one step of the supply chain due to **external disruptive effects** (pandemics, natural disasters, military conflicts etc.) or due to the **lack of second sourcing**



# Disruptions to the supply chain

For the following steps in the value chain, how urgent is the need to mitigate this risk?

# Disruptions to

For the following semiconductor technologies, how urgent is the need to mitigate this risk?

# Assess the need for international cooperation for the challenges

Europe **lacks large amounts of skilled workforce** in semiconductors and features **insufficient ability to attract talent**, poor gender balance performance and lacks specialization in training and reskilling programs.

# The hunt for talent

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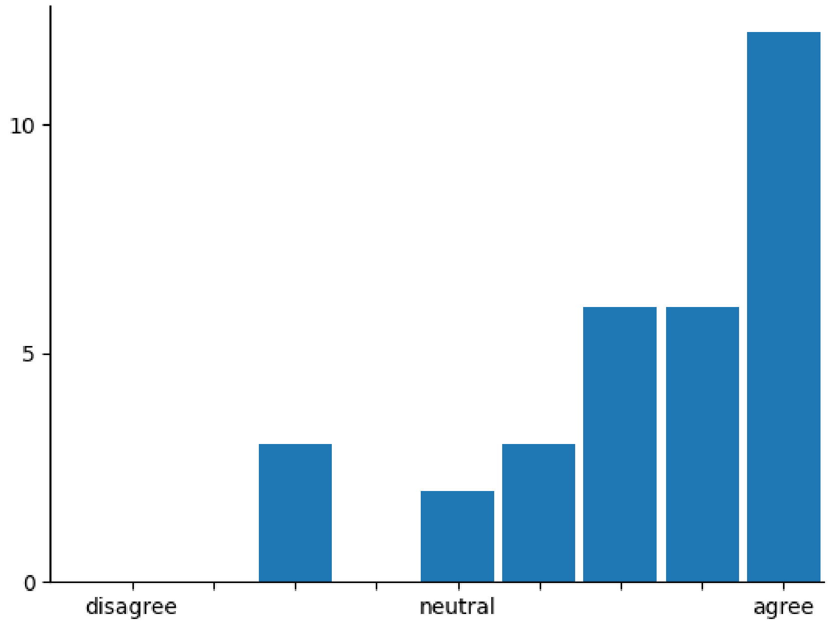
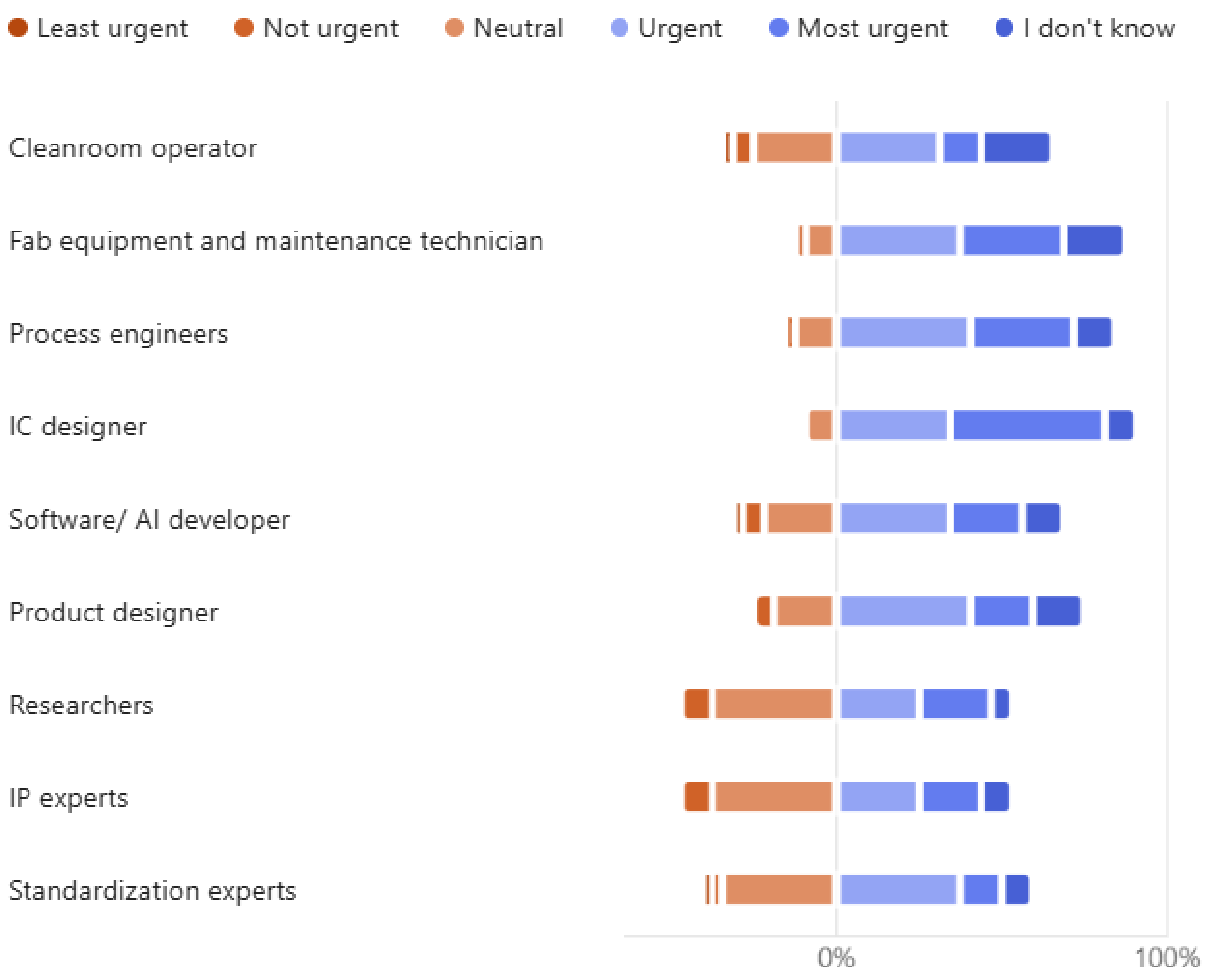


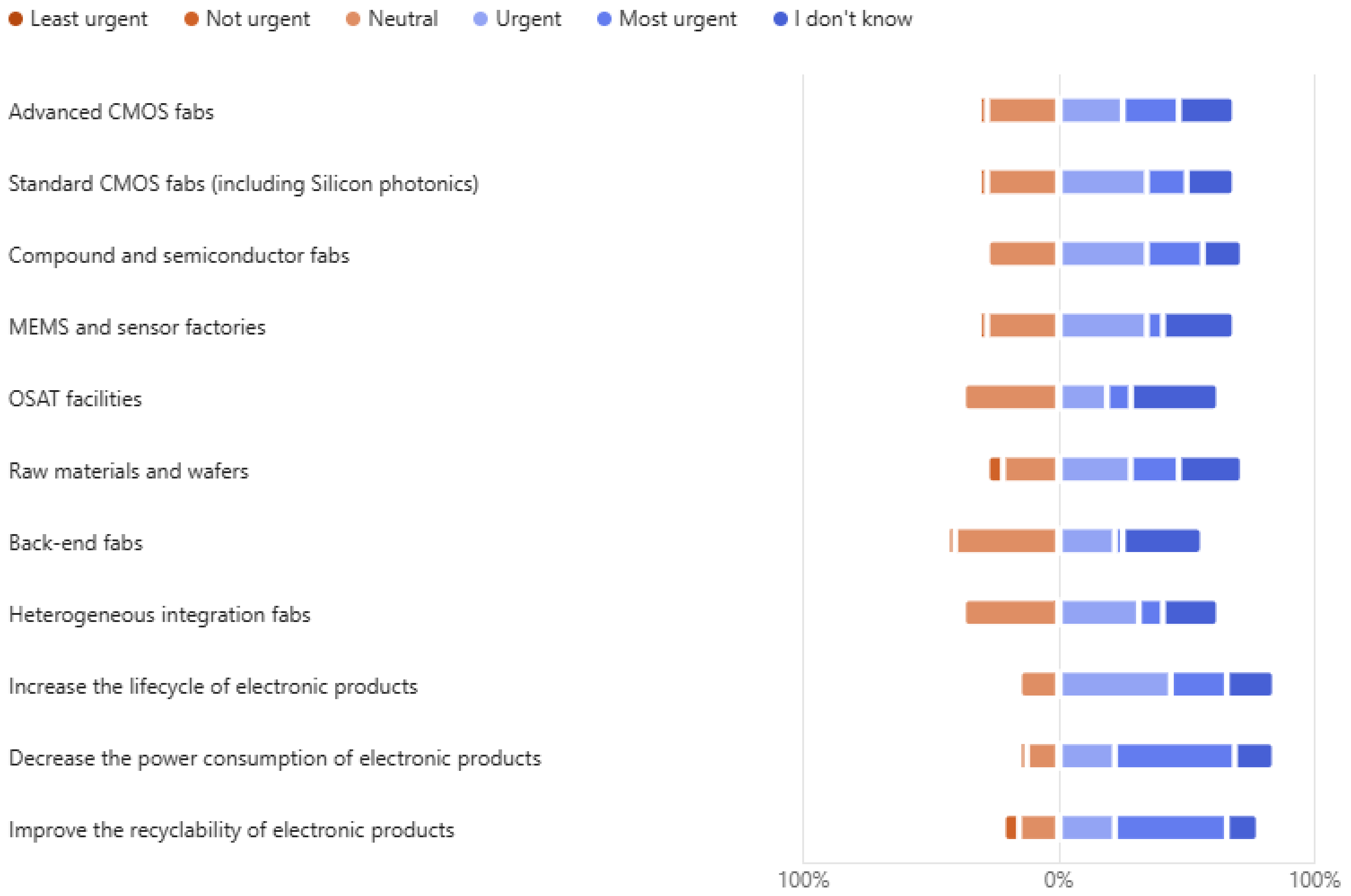
# The hunt for talent

Tackling the lack of the following skilled labor is particularly urgent:



# Ecology

Europe needs to pı
impact of the semi
chemical waste, or



# Cooperation cases on Advanced Functionality and Computing

- Assess the need for international cooperation on the previously identified challenges
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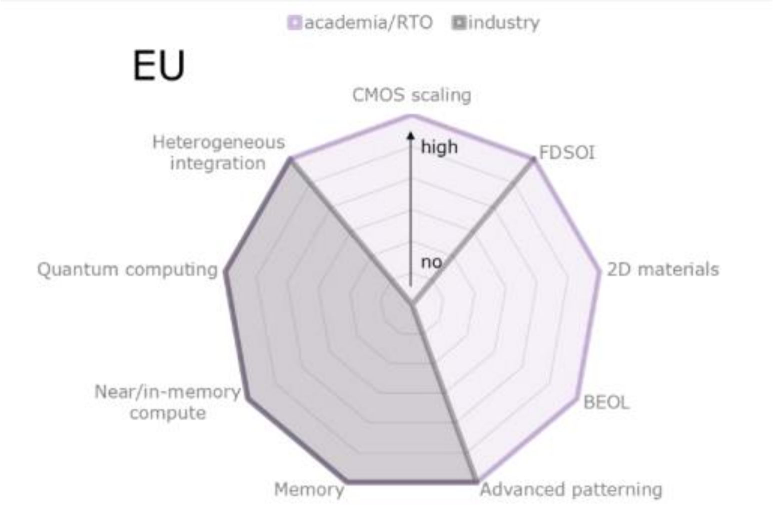
  - For different technologies
- **Assess EU strengths and gaps with other countries on different technologies**
- Identify potential cases of complementary research

# Assess EU strengths and gaps with other countries on different technologies




ICOS –Report on Future Technologies for Advanced Computation – Olivier Faynot et al.

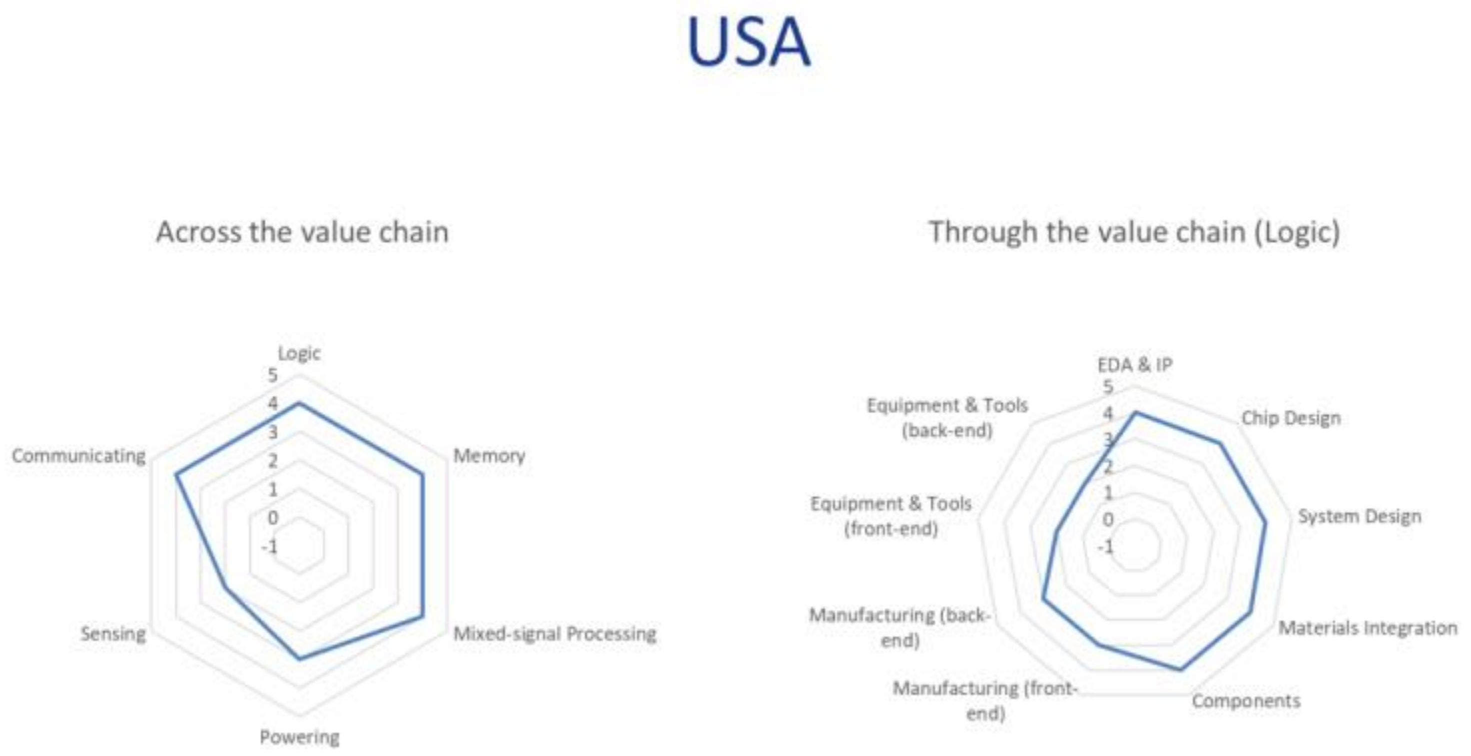



*Figure 3 USA strengths and weaknesses in the semiconductor industry — preliminary analysis.*

ICOS – Recommendations for International Research Cooperation, Paolo Motto Ros et al.

# Assess EU strengths and gaps with other countries on different technologies

| Country | CMOS scaling | Memory | 2D materials | BEOL | Adv. patterning | NMC/IMC | Quantum | Heterogeneous integration | Packaging | Assembly |
|---|---|---|---|---|---|---|---|---|---|---|
| EU | 5 | 4 | 5 | 5 | 5 | 5 | 4 | 5 | 5 | 4 |
| USA | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| Taiwan | 5 | 4 | 4 | 5 | 5 | 4 | 3 | 5 | 5 | 4 |
| S. Korea | 5 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 |
| Japan | 5 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 |
| China | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 |
| Singapore | 4 | 3 | 4 | 3 | 3 | 4 | 3 | 3 | 3 | 3 |
| India | 3 | 2 | 4 | 2 | 2 | 4 | 4 | 2 | 2 | 2 |
| Canada | 2 | 2 | 3 | 2 | 2 | 3 | 4 | 2 | 2 | 2 |
| Australia | 2 | 2 | 3 | 2 | 2 | 3 | 4 | 2 | 2 | 2 |

Table 1: Strength matrix involving RTOs and academia.

# Assess EU strengths and gaps with other countries on different technologies

| Country | CMOS scaling | Memory | 2D materials | BEOL | Adv. patterning | NMC/IMC | Quantum | Heterogeneous integration | Packaging | Assembly |
|---|---|---|---|---|---|---|---|---|---|---|
| EU | 3 | 2 | 2 | 3 | 5 | 3 | 2 | 3 | 3 | 3 |
| USA | 4 | 5 | 3 | 4 | 4 | 5 | 5 | 5 | 4 | 4 |
| Taiwan | 5 | 3 | 2 | 5 | 4 | 3 | 2 | 5 | 5 | 5 |
| S. Korea | 5 | 5 | 2 | 5 | 4 | 2 | 2 | 5 | 5 | 5 |
| Japan | 4 | 3 | 3 | 4 | 4 | 3 | 3 | 4 | 4 | 4 |
| China | 4 | 3 | 3 | 4 | 3 | 3 | 3 | 4 | 5 | 4 |
| Singapore | 3 | 2 | 2 | 3 | 3 | 3 | 2 | 3 | 3 | 3 |
| India | 2 | 2 | 3 | 2 | 2 | 3 | 3 | 2 | 2 | 2 |
| Canada | 1 | 1 | 2 | 1 | 1 | 2 | 2 | 1 | 1 | 1 |
| Australia | 1 | 1 | 2 | 1 | 1 | 2 | 2 | 1 | 1 | 1 |

Table 2: Strength matrix involving industry.

# Cooperation cases on Advanced Functionality and Computing

- Assess the need for international cooperation on the previously identified challenges
  - For different steps in the value chain
  - For different technologies
- Assess EU strengths and gaps with other countries on different technologies
- **Identify potential cases of complementary research**

# Identify potential cases of complementary research

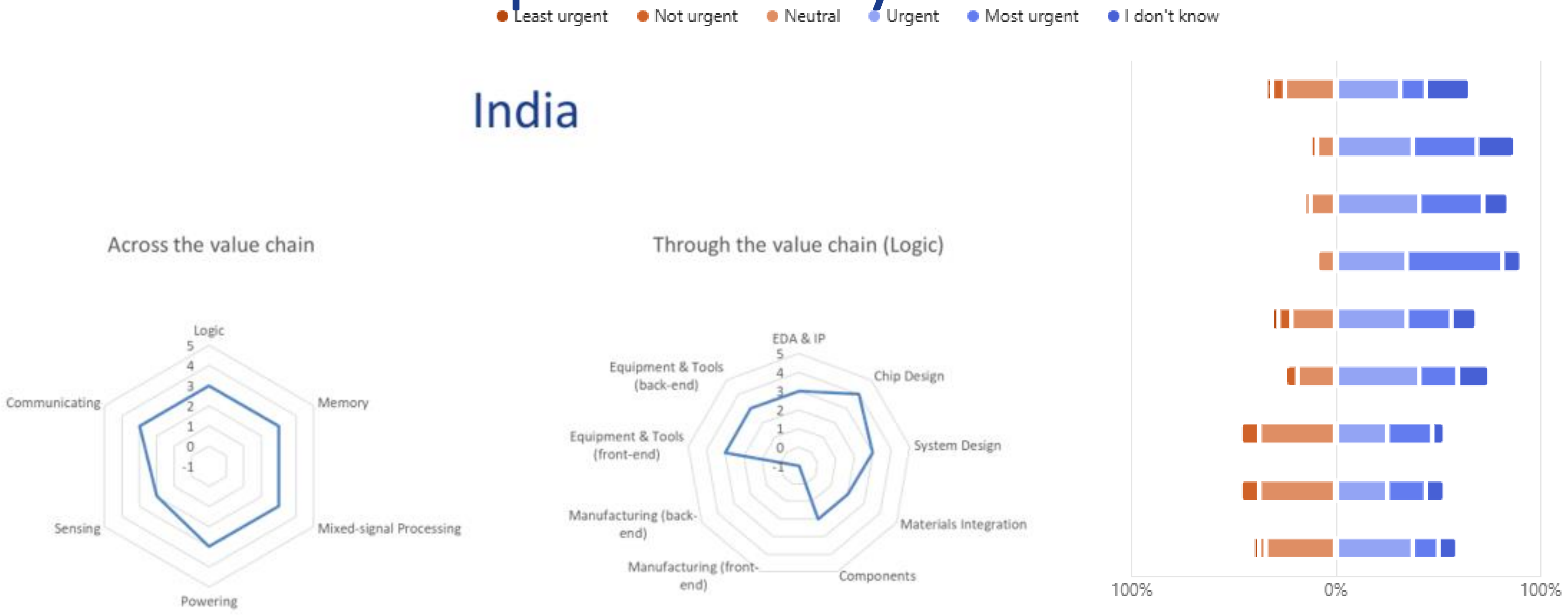



Fig. 9: India strengths and weaknesses in the semiconductor industry — preliminary analysis.

# Identify potential cases of complementary research

- List for each considered region the major RTOs, universities, and industrial players

- Summarize their commercial and research expertise and focus

- List the major ongoing collaborations

- List for each considered region the major RTOs, universities, and industrial players

3.1.6.2 *USA*

- **Institutes:**
  - **Industrial:** Memory Companies (Micron - exploring NVM-based IMC, potential DRAM-based approaches), Logic/AI Companies (Intel - Loihi neuromorphic chip (digital), ongoing IMC research; IBM - NVM-based IMC research, historical work; Nvidia, AMD - focus heavily on NMC via HBM integration on GPUs/APUs, exploring future IMC), Hyperscalers (Google - TPUs leverage HBM, internal research; Meta - AI hardware research). Numerous AI hardware startups e.g., Cerebras, SambaNova - large scale systems; Mythic, Syntiant, Cornami, Untether AI - NVM or analog IMC; EnCharge AI - spinout from SRC/DARPA research. Rain Neuromorphics focuses on NVM-based analog AI hardware. Tenstorrent is aggressively pursuing AI/NMC.
  - **Academic/Consortia:** Leading universities (Stanford, MIT, UC Berkeley, UCSB, UCSD, Purdue, Princeton, Georgia Tech, UCLA, Carnegie Mellon, etc.) are pioneers in NVM devices (RRAM, FeFETs), IMC circuits, neuromorphic architectures, algorithms. SRC (funds extensive university research in IMC/NMC via programs like JUMP 2.0).
  - **Government/RTO:** DARPA (major funding programs like Neuro-inspired Computational Elements (NICE) and OPTIMA focusing on compute-in-memory, leveraging prior investments like STARnet, JUMP; FRANC program). IARPA, NIST, National Labs. SRC programs like e.g., JUMP 2.0 themes (e.g., cognitive computing, COGNISAT).

- Summarize their commercial and research expertise and focus

- **Technology Focus:**
  - **NVM-based IMC:** Significant R&D by universities and startups using RRAM, MRAM, FeFETs for analog/mixed-signal IMC, focusing on AI inference acceleration, particularly at the edge.
  - **Neuromorphic Computing:** Intel's Loihi platform is a key industrial example. Strong academic research explores spiking neural networks (SNNs) and hardware implementations.
  - **SRAM/DRAM IMC/NMC:** Research into digital and mixed-signal IMC using modified SRAM/DRAM. Industry focus on high-bandwidth NMC using HBM integrated with processors via advanced packaging (2.5D/3D).
  - **Full Stack Development:** Research spanning devices (NVMs, transistors), circuits (analog/mixed-signal, ADC/DAC), architectures, compilers, algorithms, and AI applications. Addressing variability, noise, and scalability.

- List the major ongoing collaborations
- **Gather feedback from ICOS partners on different technologies and partners**

- **Collaborations:** DARPA programs (e.g., OPTIMA) foster collaboration between universities, industry (IBM, Infineon), and startups. SRC programs are crucial industry-academia links. Strong venture capital ecosystem funding AI hardware startups.

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# Prioritizing cooperation objectives

- Gather feedback on conclusions
- Filter based on technology trends
- Talk to players in academia, industry and politics to assess feasibility and effectiveness of cooperation cases

# THANK YOU

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