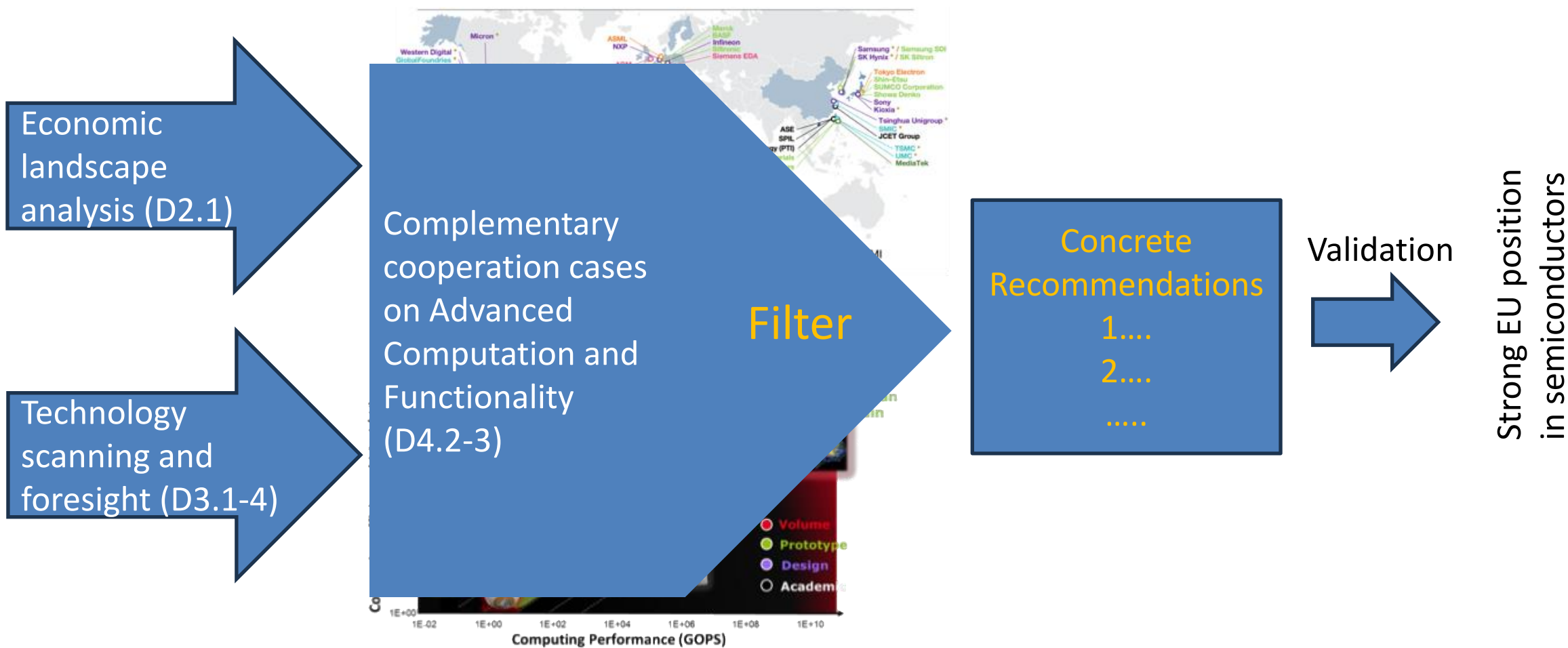


From the technology landscape to cooperation: How to apply filters for priorities?

Ryoichi Ishihara, PhD
Delft University of Technology

Prioritise the cooperation cases by filters



<https://icos-semiconductors.eu/public-deliverables/>

- Needs/challenges in EU
 - Society, environment, economy, science and policy
 - Merged 15 into 3
- Urgency
 - ICOS stakeholder survey, April 2024, 103 respondents
 - Prioritize the technologies in the cooperation cases
- Update the needs/challenges
 - Added 5 more, based on the survey

White Paper 2024



<https://icos-semiconductors.eu/public-deliverables/>

- EU needs to mitigate risk of severe bottlenecks, due to external disruptive effects in the supply chains of
 - Advanced Packaging (2.5D, 3D, enabling technologies)
 - 10-65nm chips
 - Heterogeneous int. (Chiplet, system-on-chip)
 - Front-end-fab access
 - Raw materials/wafers
 - <10nm chips

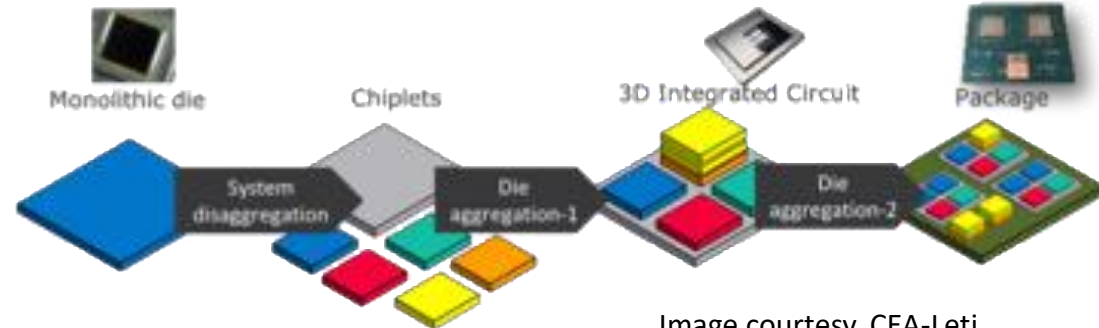


Image courtesy, CEA-Leti

EU needs to

- improve talent and gender balance, increase amounts of skilled workforce
- reduce the environmental impact (energy, water, chemical waste, or greenhouse gases)
- support **SME** more
- lead **advanced patterning** technology
- increase semiconductor products for **defense**
- increase **speed** of whole cycle
- lead **emerging technologies** (e.g., Quantum, Photonics)

Impact
Sovereignty
Openness

[illegible]

Recommendation 1

EU will mitigate the risk in

supply chain	collaboration with	in
Advanced Packaging	Taiwan, Korea	advanced packaging technology
	Singapore	equipment
	China	co-development in packaging
10-65nm chips	Taiwan, Japan	foundry
Heterogeneous int.	USA, Japan	heterogenous integration technology
Front-end-fab access	USA, Korea	ML architecture/chip
Raw materials/wafers	Japan	wafer and chemicals
	China, Brazil	rare earth materials
<10nm chips	USA, Korea	FE equipment (except litho.) and ML architecture/chip
	Taiwan, Korea, Japan	foundry

Recommendation 2

EU will attract talent, increase amounts of skilled workforce and improve gender balance

in area of	collaboration with	in
IC designers	India	IC design
Process engineers	Taiwan	BEOL and Foundry
	India	advanced patterning and power devices
	USA	FE equipment (except litho.)
Fab equipment and technician	Taiwan, Korea	BEOL
	USA	FE equipment (except litho.)
	India	advanced patterning and power devices

Recommendation 3

EU will prioritize reducing the environmental impact of the semiconductor industry

in improving	collaboration with	in
power consumption	USA	2D materials, memory and ML
	Korea and USA	ML architecture/chip
	Japan	GaN, energy harvester
recyclability, life cycle of electronics products	Japan	recycling electronics
less energy / CO ₂ emission in fab	USA and Taiwan	fab. design / process flow
less hazard chemicals	Japan	alternative chemical

EU will

	collaboration with	in
support SME more	USA	IC design
lead Advanced Patterning technology	Taiwan	foundry
	Japan	material
increase semiconductor products for defense	Canada	RF and telecommunication
increase speed of whole cycle from design to production	India	IC design
	China	system
lead emerging technologies (e.g., Quantum, Photonics)	Japan	material
	Taiwan	foundry

- Filters are applied to the cooperation cases on semiconductors.
- Short list of concrete recommendations (preliminary) are created to meet need and challenges in EU
 - For advanced technology supply chain (e.g., heterogeneous int.), US, Korea, Japan, Taiwan are often listed.
 - For attracting talents, India is often listed.
 - For EU leading technologies (e.g., EUV, Quantum), balance between closeness and cooperation is important
 - The recommendations to be validated by interviews
- Clear and agile geopolitical policy is important.

THANK YOU



This project has received funding from the European Union's Horizon Europe research and innovation programme under GA N° 101092562

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And is a side event of the

**ECS BROKERAGE
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ICoS Final Event – Results & Recommendations on
International Cooperation on Semiconductors for
European Economic Resilience

Feedback Loop with Community: Recommendation for International Cooperation in R&D

**Peter Ramm
Fraunhofer EMFT**



Peter Ramm
Head of Strategic Projects
IEEE TC Chair 3D/TSV
Fraunhofer Institute for Electronic Microsystems and Solid
State Technologies EMFT

Feedback from Events

- Contributions to Global Business Council (Scottsdale) and ECS Meeting (Gothenborg)
- Organized Panels at ICOS Workshops Athens and Warsaw

Results from Surveys

- “International R&D collaboration in semiconductor technologies”
- “To what extent should the European Union support establishing or maintaining the following technologies as a key competence”

Interviews with European Experts

- Large Enterprises
- SMEs
- RTOs

Feedback from ICOS Events

ICOS Workshop Glyfada/Athens, May 2024: Panel on International Cooperation:

Moderated Panel on “**Opportunities for International Cooperation**” at the ICOS Workshop in Glyfada/Athens with the following international high level expertise panelists:

- Paolo Gargini, IRDS, USA
- Shankar Kumar Selvaraja, AGNIT and Indian Institute of Science (IISc), India
- Sridhar Srinivasan, GEECI and IISc, India
- Mitsumasa Koyanagi, Tohoku University, Japan
- Ken Uchida, Tokyo University, Japan
- James Sexton, IBM, USA

Feedback from ICOS Events

Panel Session at ICOS Workshop Warsaw, May 2025:

Organization and Moderation of the panel on “**Potential international collaborations on emerging semiconductor technologies**” at the ICOS Workshop in Warsaw on key technological challenges with international experts in **dedicated Chips Act relevant fields** of

More Moore: Mustafa Badaroglo, Qualcomm USA

Beyond CMOS: Giorgos Fagas, Tyndall Ireland

More than Moore: Hiroyuki Akinaga, AIST Japan

FDSOI: Dominique Noguét, CEA France

Power Devices: Mikael Ostling, KTH Sweden

MEMS / IC Design, Modelling and Simulation: Grzegorz Janczyk, Lukasiewicz (IMiF) Poland

Interviews with European Experts

List of companies or organisations taking part in the personal interviews, categorized with respect to their role in European semiconductor community.
(The company names of Small and Medium Sized Enterprises (SME) were anonymized)

Participating stakeholders in the communication channel “Personal interviews”

Category / role	Company or organisation
Large Industry, LE	LE1 (DE; <50.000 employees), LE2 (DE, AT; <50.000), LE3 (NL; <50.000), LE4 (FR; <2.000), LE5 (IT, FR; <50.000)
SME	SME1 (SE), SME2 (FR), SME3 (SE), Association4 (NL)*
RTO	RTO1 (BE), RTO2 (PT), RTO3 (FR), RTO4 (DE), RTO5 (IE), RTO6 (FI)
	AT: Austria, BE: Belgium, DE: Germany, IT: Italy, FI: Finland, FR: France, IE: Ireland, NL: Netherlands, PT: Portugal, SE: Sweden *Association4 is not a typical SME. As foundation with around 30 employees, it is supporting the entire European integrated photonics industry. While its activities foster many SMEs in the sector, we treated Association4 in this report as SME.

The interview questions were grouped into 5 thematic blocks:

- a) Importance, Opportunities, and Risks of International Cooperation
- b) International Cooperation Needs
- c) Standardisation
- d) Strategic Actions and Measures
- e) Sum-up questions

Key results:

- International R&D cooperation should not be treated as an add-on, but as a central instrument to implement a focused **sovereignty strategy**.
- **Cooperation should be intensified with like-minded countries, explicitly Japan, South Korea, Taiwan, and – for specific domains – Canada, Singapore and India.**

Survey 1 on “International R&D collaboration in semiconductor technologies”

-> Key Results:

- **European stakeholders are strongly in favor of deepening international collaboration in a selective and risk-aware way.**
- Organizations across industry, academia and RTOs see the **greatest cooperative value** in advanced technologies **where Europe is active but not self-sufficient.**
- **USA, Japan, Taiwan and South Korea** are rated as **highly important** in the domains **leading-edge manufacturing, packaging, memory and system integration.**
- **Canada and Singapore** emerge as **attractive in photonics, packaging and future compute**, while **India** is seen as promising mainly for **design and talent.**

Survey 2 on “To what extent should the European Union support establishing or maintaining the following technologies as a key competence”

The ranking of the **five most cited technologies** regarding *key or important priority* for support or maintaining by EU is listed below:

1. **Advanced packaging**
2. **Heterogeneous integration**
3. **Power devices**
4. **10-65 nm CMOS**
5. **Sensing/MEMS**

THANK YOU



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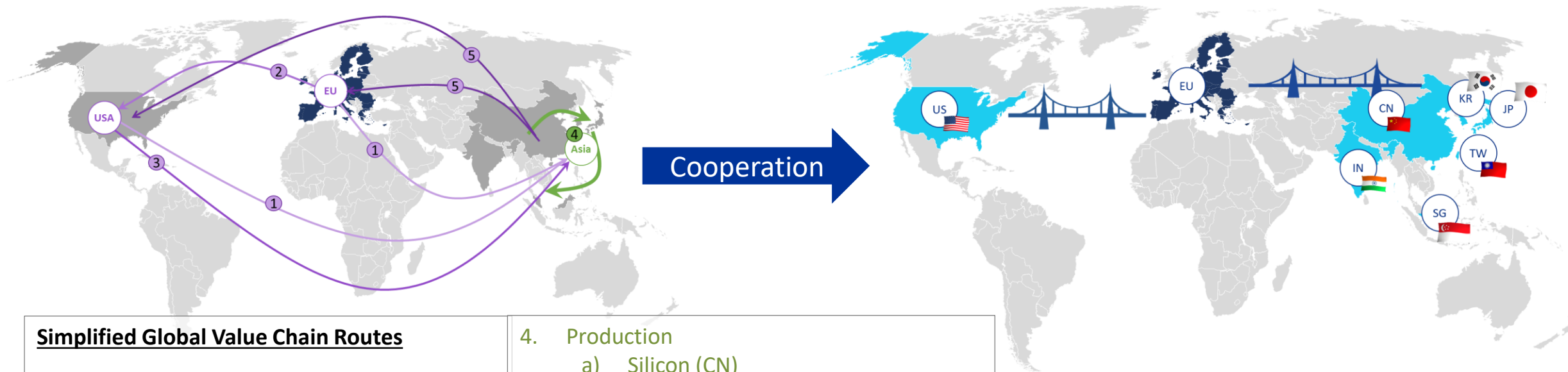
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ICoS Final Event – Results & Recommendations on
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European Economic Resilience

International Cooperation: Which paths are most promising?

Dr. Melanie Hentsche
VDI/VDE – IT GmbH

Why do we need international cooperation?



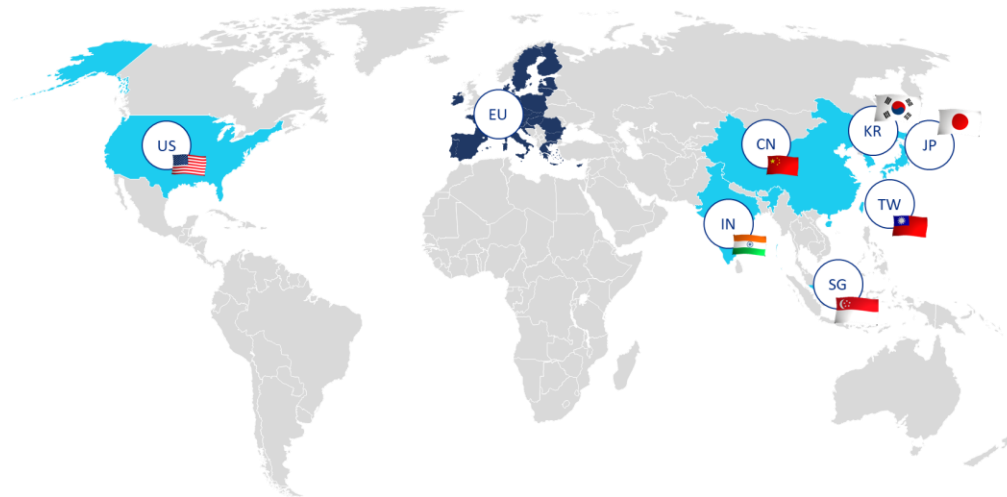
Simplified Global Value Chain Routes

1. Semiconductor Manufacturing Equipment
2. IP Development
3. Semiconductor Design

4. Production
 - a) Silicon (CN)
 - b) Silicon Wafers (JP)
 - c) Front End (TW)
 - d) Back End (MYS)
 - e) Smartphone Manufacturing (CN)
5. Shipping and Sale of the Smartphone

Key message:

In the semiconductor world of the 21st century, **no one** will be the sole leader.
For Europe, **global partnerships** are strategic and a **key to stability, resilience and innovation**.



Download

[https:// icos-semiconductors.eu/
other-outcomes/factsheets](https://icos-semiconductors.eu/other-outcomes/factsheets)

Key Message:

We created **7 factsheets** benchmarking non-EU cooperation countries, designed as a **door opener** for future engagement. Our goal is to establish cooperation frameworks that generate **shared benefits and long-term value** for all parties.



Semiconductor Ecosystem SOUTH KOREA

Main Stakeholders

POLICYMAKING

1. National Research Foundation of Korea
2. Ministry of Science, ICT
3. Ministry of Trade, Industry and Energy (MOTIE)
4. Korean Ministry of SME and Startups
5. Korea Chamber of Commerce and Industry

RESEARCH ORGANISATIONS

1. Korea Institute of Science and Technology (KIST)
2. Korean Electronics Technology Institute (KETI)
3. Electronics and Telecommunications Research Institute (ETRI)
4. Semiconductor Fabrication Supports
5. National NanoFab Center (NNFC)
6. Korea Advanced Nano Fab Center (KANFC)
7. Korea Institute of Machinery & Materials (KIMM)

INDUSTRY ASSOCIATIONS

1. Korea Semiconductor Industry Association (KSIA)
2. Korea Electronics Association (KEA)

INDUSTRY (NON-EXHAUSTIVE)

3. ADTechnology (Design Services for SoC solutions)
4. Anapass (Display driver ICs, High-Speed Interface solutions)
5. BOS Semiconductors (Fabless, Automotive chiplets for autonomous driving)
6. DB Hitek (Foundry services, specialized in automotive and power management ICs)
7. DI Corporation (Test systems for memory and logic devices)
8. DOOSAN Group (Electronic materials, CCL, OLEDs, semiconductor materials)
9. DONGJIN SEMICHEM (Photoresists, CMP slurries)
10. Hanwha Group (Semiconductor equipment, automation, defense)
11. Hana Micron (Assembly, packaging, testing services)
12. Hyundai Motor Group (Autonomous driving chips, partnerships with Samsung and KIA)
13. LG Corp. with LG Electronics and LG Innotek (Consumer electronics, IoT, semiconductors, robotics)
14. Magnachip Semiconductor (Analog and mixed-signal Semiconductors)
15. NEPES (Semiconductor packaging and testing services)



16. PSK (Semiconductor processing equipment)
17. Samsung Corp. with Samsung Foundry (Semiconductor manufacturing, displays, 5G, consumer electronics, HPC Chips, automotive)
18. Silicon Works (LX Semicon) (Design, display driver ICs for TVs and mobile devices)
19. SK Group with SK Hynix and SK Siltron (DRAM, NAND flash memory, silicon wafers, AI and HPC memory solution, Packaging/Testing)
20. Telechips (System-on-a-chip, automotive)

Funding Instruments

- The K-Chips Act raises facility investment tax credits for semiconductor firms to 20% for large/medium and 30% for small enterprises. It also extends R&D tax credit eligibility by five years (to 2029) for key technologies, and by seven years (to 2031) for semiconductor R&D [12]
- Up to 50% in R&D Tax Credits
- Boosting prototype production, Korea aims to grow 10 fabless firms with KRW 1 trn. (\$730 million) in sales [13], [14]
- Investment Tax Credits for manufacturing investments [15]
- Provision for training high-tech professionals and potential discharge of mandatory military service for research personnel in the field [16]
- Support for start-ups of KRW 3.294 trn. (approx. \$2.23 bn.), by the government and local governments in 2025 [17], [18]

Chip Strategy

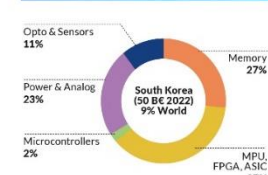
K-semiconductor belt with the K-Chips Act passed first on March 30, 2023 and renewed in Feb. 27, 2025

- Objective: approx. € 62 bn. (100 trn. Won) in semiconductor & AI supported by Korean Development Bank for 3 years [1], [2], [3]
- Doubling the Workforce [4]
- Attract a cumulative investments of 622 trn. Won (approx. €430 bn.) for a semiconductor megacenter by 2047, with Samsung and SK Hynix are the biggest investors [5]
- Self-Sufficiency: Goal to achieve 50% self-sufficiency in key materials, parts, and equipment by 2030 [6]
- Energy Laws: Focus on expanding the power grid, managing radioactive waste, and promoting offshore wind power to ensure stable energy for the semiconductor sector [7]
- Focus on Non-Memory: Expanding into logic semiconductors and Fabless firms, diversifying from flash memories.
- Fabs & Complexes: New fabs and national advanced industry complexes under development [8], [9]
- Semiconductor Capacity: Half of South Korea's capacity is focused on the 10-20nm range. Samsung is one of the few producing below 6nm.
- Samsung Foundry: Unveiled automotive process solutions under the Chips-Act, ranging from 2nm to advancements in the 8-inch wafer technology legacy.
- Special Act: Measures and regulations to protect and foster the national high-tech industry [10]
- Future Goals: 1.4nm technology by 2027 [11]

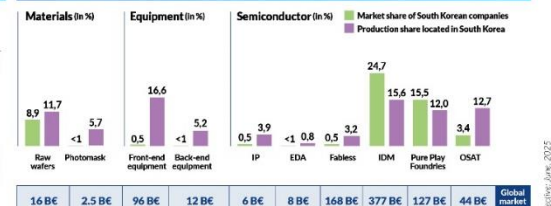
Relations with the EU

- The Republic of Korea - EU Digital Partnership was announced jointly by President von der Leyen and President Yoon on 28 November 2022 [19]
- Since 2025 South Korea is partner of the Horizon Europe programme [20]
- Strategic project funds with national EU partners [21]
- Republic of Korea-EU Joint Scientific and Technological Cooperation Committee meeting [22]
- Approx. €6 billion (approx. 9.8 bn. Won) from the Chips JU for collaborations and a similar amount from the National Research Foundation of Korea [23]

Demand by application



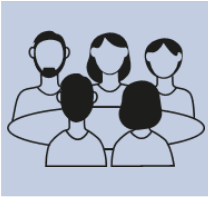
Market and Production Share



Source: DECISION Evides & Corell

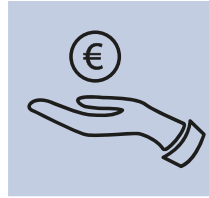
Source: DECISION Evides & Corell

Policy Advice - Introduction



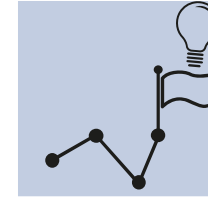
Coordinated action

What do we need to be agile in a rapidly evolving world?



Strategic investment

What do we need to strengthen our strengths?



Innovation support

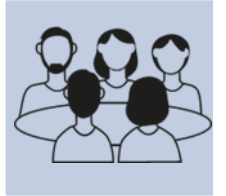
How can we build on and improve our strengths?



Key message:

Collection, analysis, filtering and prioritisation of data are key steps in identifying the **most promising path(s)** from research to policymakers.

Strengthen EU Capabilities for Win/Win Cooperation



Strengthen EU coordination and coherence

- Establish transparent **database** and coordinated **contact points**
- Better **align EU member states' strategies** on international collaboration
- Set **new impulses** under the umbrella of **existing formats**
- Use and extend **existing platforms, initiatives, clusters**

Strengthen EU steering capacity

- Set up a well-coordinated **European regulatory framework**
- **Improve the effectiveness** of regulatory
- **Accelerate decision making** of political bodies

Leverage RTOs and pilot lines

- Expand pilot lines and bridge the “**Lab-to-Industry**” **transition** for the industry in EU
- Expand activities of **Europractice** and increase Europractice funding
- Leverage EU RTOs by **facilitating access to int. collaboration** via dedicated funding



Foster strategic partnerships in technology and materials

- Define **strategic priorities** for **supply** (know-how, resources) and **leadership** (research, trade)
- Pursue collaboration with **multiple international partners** to **avoid dependency** and ensure negotiating leverage
- **Prioritise key partners** for specific fields in the international collaboration

Strengthen EU workforce development

- Expand **research collaborations** and **talent exchange in pre-competitive R&D** with Japan, Canada, Australia, Taiwan, South Korea
- Maintain and develop existing **politically organised collaboration frameworks** (JP, TW).
- Develop **workforce development agreement with India** for skilled workforce in software (AI) and communications.

Establish trust and secure IP Protection

- **Support industry stakeholders** with robust frameworks for intellectual property protection
- Support RTOs in **preventing leakage** of sensitive **research results**
- Foster **strong relationships with key stakeholders** to leverage the value of **trusted personal contacts**.

Innovation Support

Strategic Focus - Long Term Vision



Address critical vulnerabilities

- Secure access to **advanced technologies**
- Set up funding and secure access to **foundries for advanced chip design**
- Secure resilience of the supply chain through **multilateral agreements** and **friendshoring**
- Secure the access to **critical and/or raw materials**

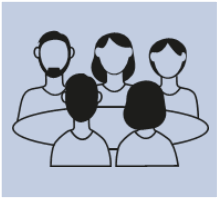
Reinforce EU strength and establish leading position

- Set framework to preserve **leading role in EUV equipment** (funding and geopolitical measures)
- Aspire a **leading role for setting standardisation** frameworks in the field of chiplet technologies, sensing and quantum

Strengthen future technologies and enablers

- Strengthen research collaboration in **photonics, new materials, quantum computing, neuromorphic, in/near-memory, power systems, mixed-signal, and communication electronics**
- Build capacities for **2.5-3D packaging and chiplets** as a strategic enabler
- Secure funding for development of **open-source IP and tools**

Policy advice - Conclusion



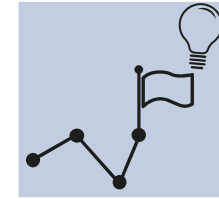
Coordinated action

- Agile acting
- Common database
- Harmonised processes
- Simplified approval procedures
- Reduced regulatory



Strategic investment

- Investment in existing strength
- Expansion into new markets
- Lab-to-Industry transitions
- Incubation infrastructure
- Increased tape-out capacity



Innovation support

- Partnerships offering complimentary skills and mutual benefits
- Relationships with multiple international partners
- Collaboration between R&D and industry

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