Opportunities for International Cooperation in the Emerging Technologies Landscape of Advanced Compute

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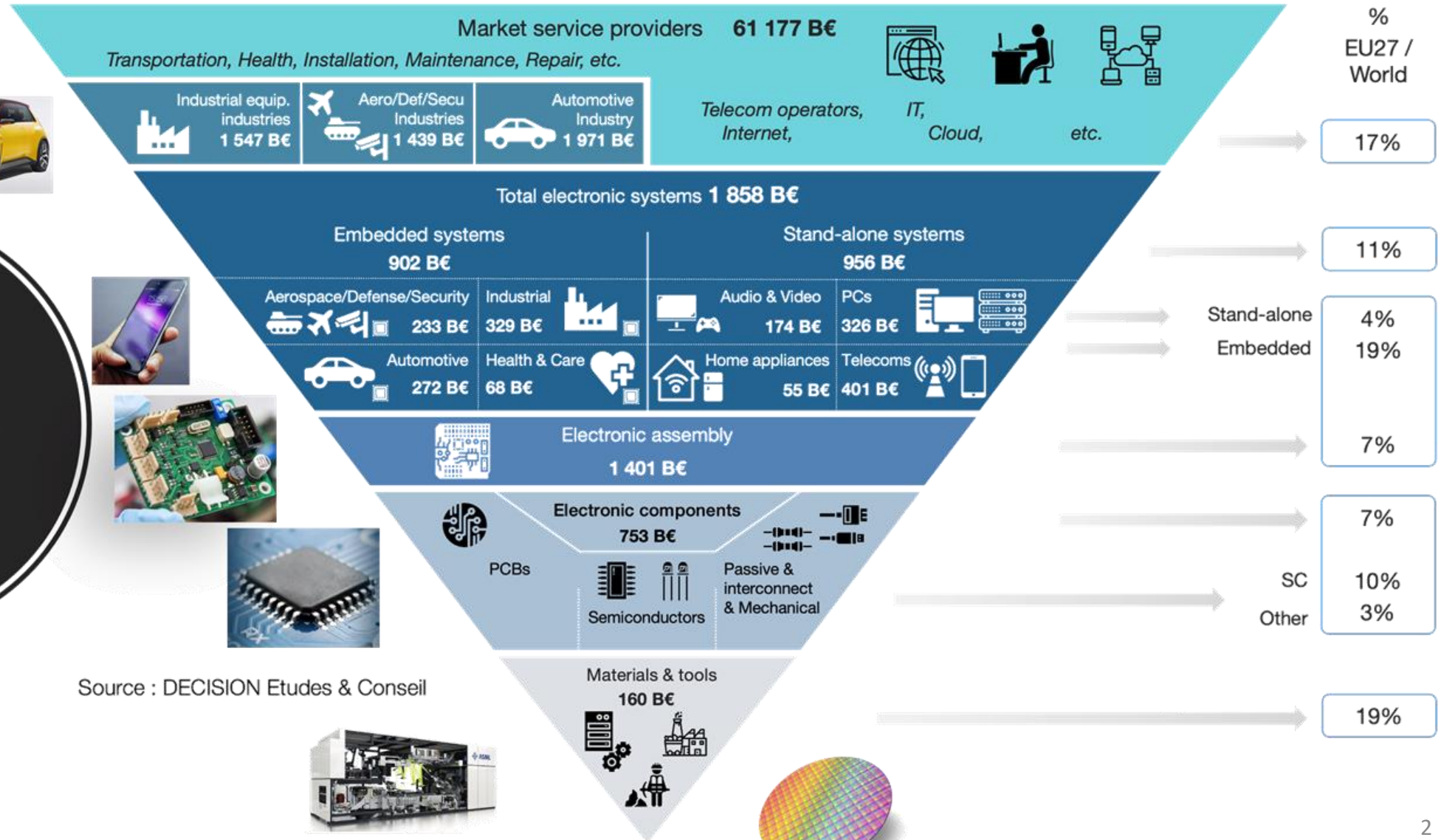**Director of Strategic Development, Tyndall National Institute, Ireland**

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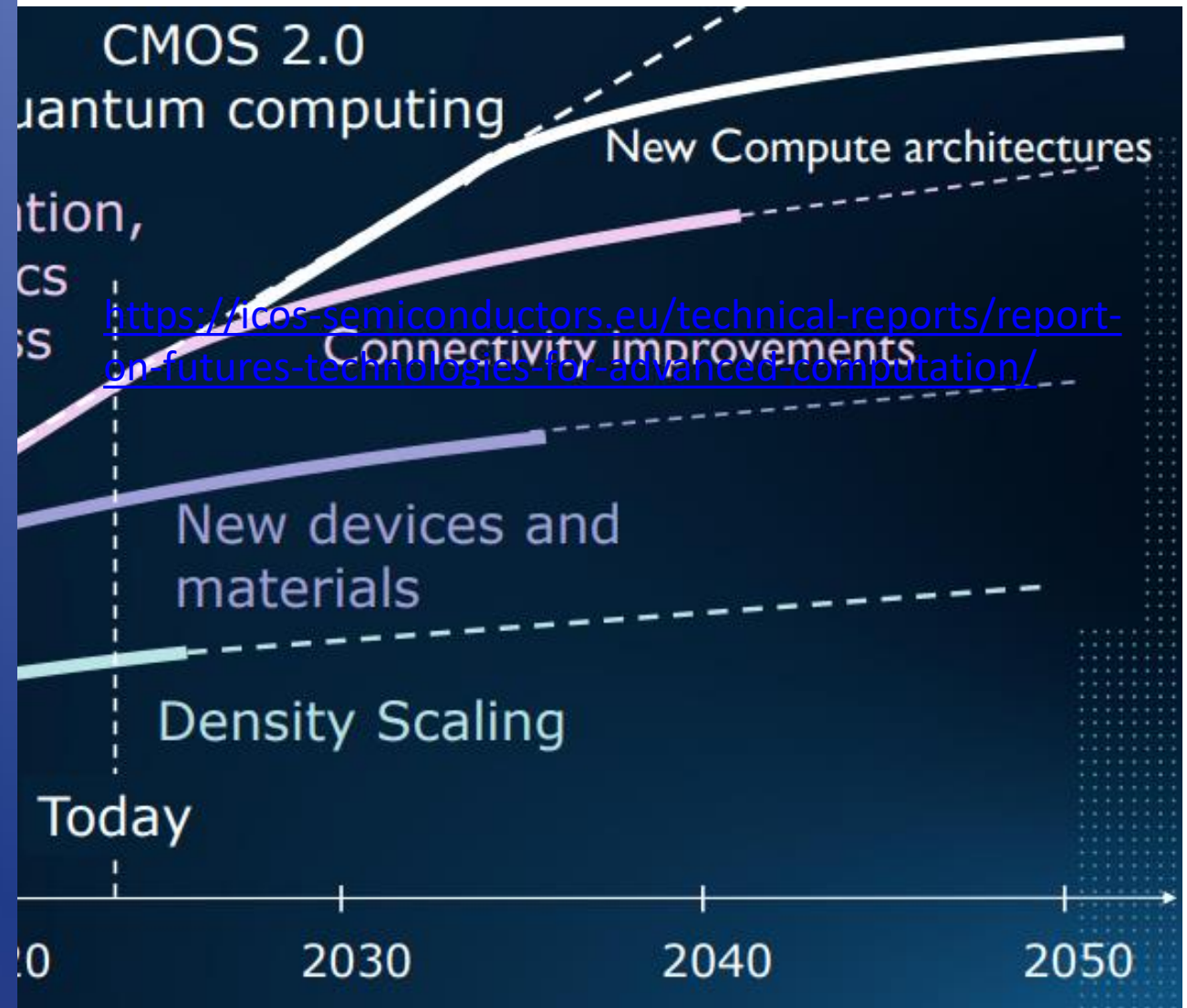
World Electronic manufacturing value chain in 2023

Market service providers 61 177 B€

Transportation, Health, Installation, Maintenance, Repair, etc.

| Industrial equip. industries 1 547 B€ | Aero/Def/Secu Industries 1 439 B€ | Automotive Industry 1 971 B€ | *Telecom operators, Internet,* | *IT, Cloud,* | *etc.* |

Total electronic systems 1 858 B€

| Embedded systems 902 B€ | | Stand-alone systems 956 B€ | |

| Aerospace/Defense/Security 233 B€ | Industrial 329 B€ | Audio & Video 174 B€ | PCs 326 B€ |
| Automotive 272 B€ | Health & Care 68 B€ | Home appliances 55 B€ | Telecoms 401 B€ |

Electronic assembly 1 401 B€

Electronic components 753 B€

PCBs — Semiconductors — Passive & interconnect & Mechanical

Materials & tools 160 B€

Source : DECISION Etudes & Conseil

% EU27 / World

	% EU27 / World
	17%
	11%
Stand-alone	4%
Embedded	19%
	7%
	7%
SC	10%
Other	3%
	19%

From components to systems
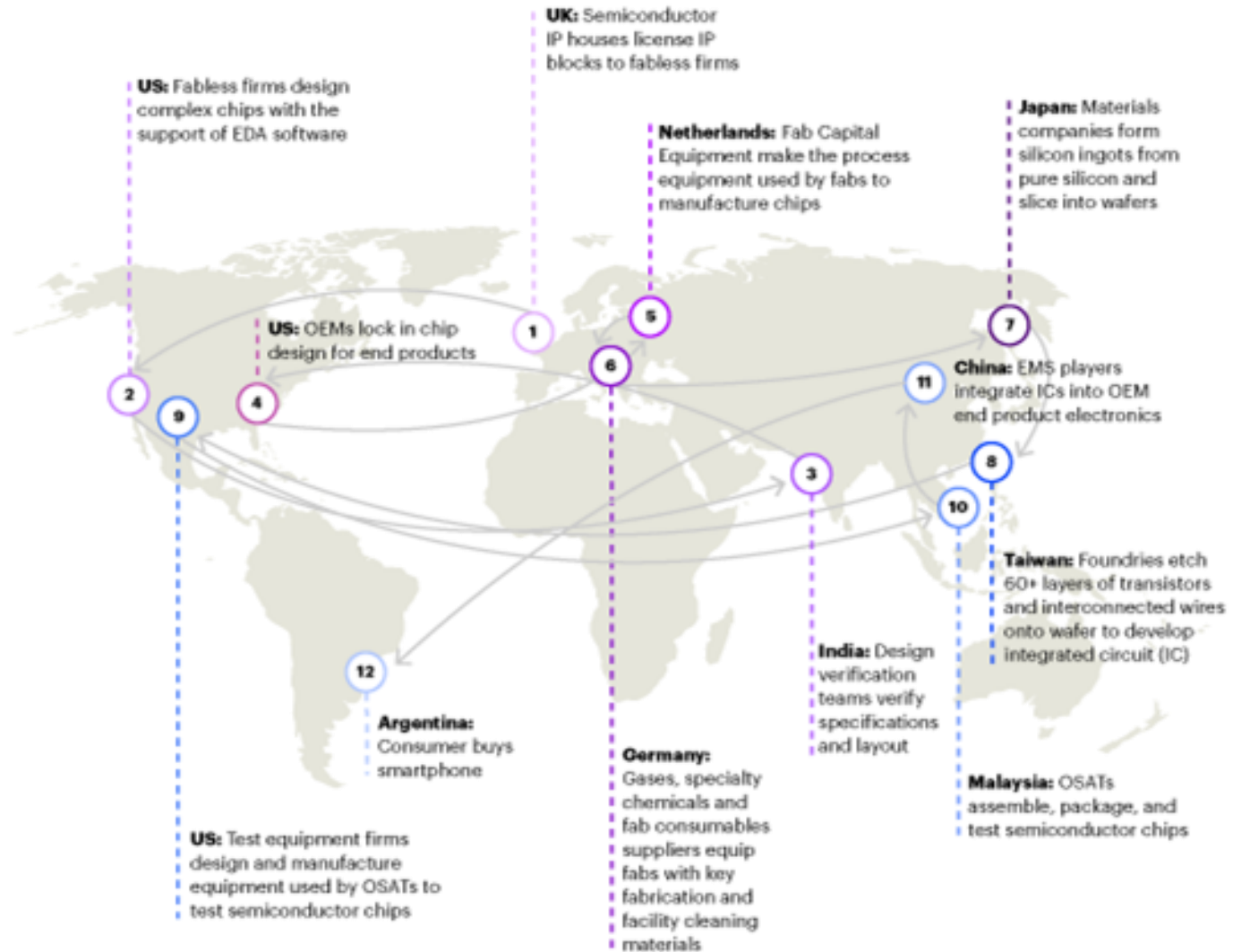
https://icos-semiconductors.eu/technical-reports/report-on-futures-technologies-for-advanced-computation/

Supply Chain Resilience

- Semiconductor manufacturing relies on a complex, geographically dispersed supply chain—no single country controls all stages (design, materials, fabrication, packaging)

- Bottlenecks or export restrictions in one country can disrupt the entire global tech ecosystem

UK: Semiconductor IP houses license IP blocks to fabless firms

US: Fabless firms design complex chips with the support of EDA software

Netherlands: Fab Capital Equipment make the process equipment used by fabs to manufacture chips

Japan: Materials companies form silicon ingots from pure silicon and slice into wafers

US: OEMs lock in chip design for end products

China: EMS players integrate ICs into OEM end product electronics

Taiwan: Foundries etch 60+ layers of transistors and interconnected wires onto wafer to develop integrated circuit (IC)

India: Design verification teams verify specifications and layout

Argentina: Consumer buys smartphone

Germany: Gases, specialty chemicals and fab consumables suppliers equip fabs with key fabrication and facility cleaning materials

Malaysia: OSATs assemble, package, and test semiconductor chips

US: Test equipment firms design and manufacture equipment used by OSATs to test semiconductor chips

Source: Accenture Report 2022

Safeguard Innovation

- High R&D costs and innovation complexity requiring billions of euros in R&D and infrastructure

- No single country can afford to go it alone indefinitely

- Shared research efforts and international talent exchange accelerate breakthroughs and reduce redundancy

Source: Accenture Report 2022
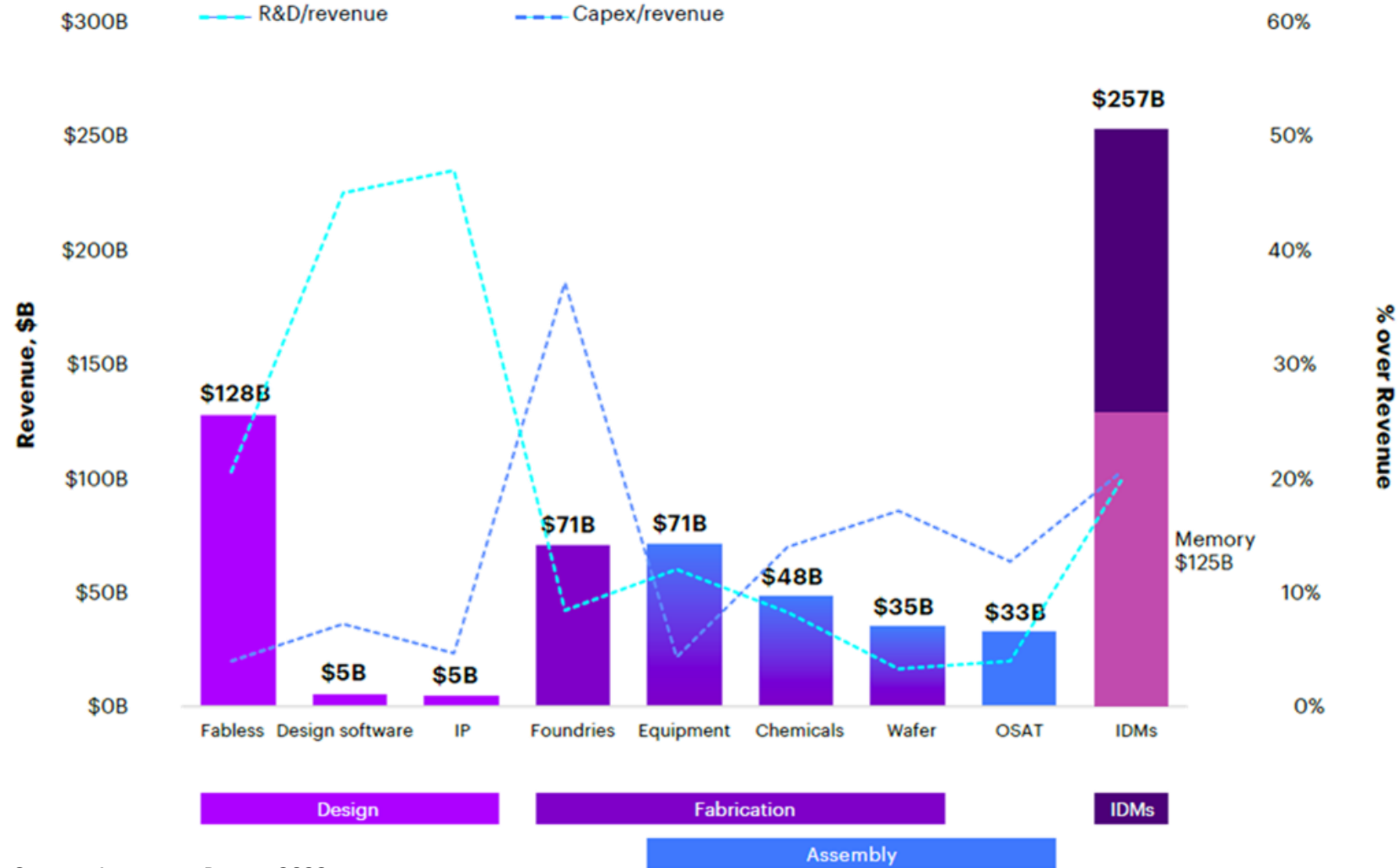
Talent Development

- Chronic global shortage of semiconductor engineers, technicians, and researchers

- Cooperation through education, training programmes, and skilled worker mobility is essential to develop a future-ready workforce

Workforce in the EU semiconductor industry
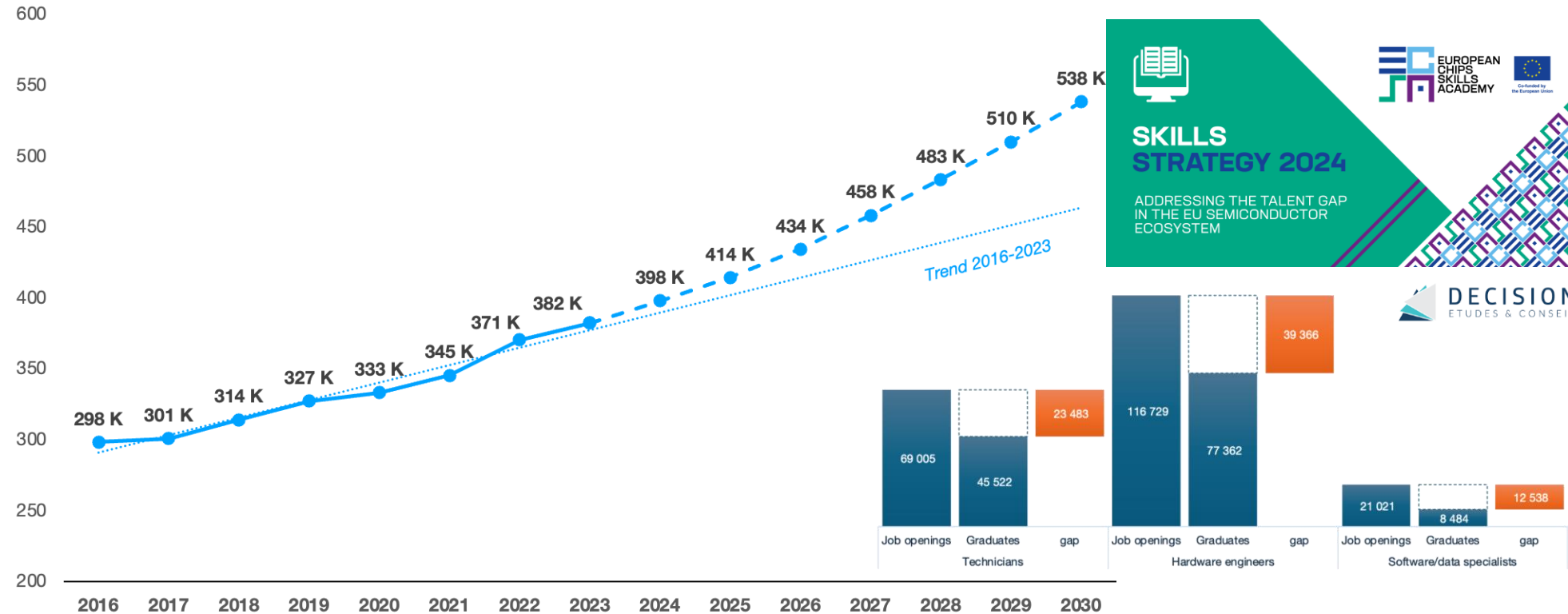
Long-term Sustainability

- International collaboration, including the definition of standards, ensures that innovations are interoperable and widely adoptable

- Shared sustainability goals and green manufacturing standards can reduce environmental impact—something no single country can solve in isolation.

Collaboration Opportunities

USA-EU

Ecosystem strengths:

- Dominant in semiconductor design, electronic design automation (EDA) tools, and intellectual property (IP)
- US industry maintains leadership in CMOS scaling, MRAM development, and NMC/IMC architectures
- Leading role in semiconductor manufacturing equipment
- Robust R&D and Innovation Capacity

Potential Partnerships:

- Access to advanced EDA tools, IP libraries, and on AI-enhanced design methodologies
- Advanced packaging, especially in heterogeneous integration, chiplet standards (e.g., UCIe), and high-density interposers
- Fabless design companies and semiconductor startups to accelerate innovation in AI, HPC, and heterogeneous integration

Key Benefits:

- Close critical technology gaps
- Strengthen innovation ecosystems for next-generation compute
- Reduce dependency on East Asia for advanced nodes and packaging technologies

Canada-EU

Ecosystem strengths:

- Emerging leadership in quantum and photonics (see D-Wave, Xanadu)

- Advanced packaging (3D stacking and heterogeneous integration and specialised manufacturing; see IBM Bromont plant and MiQro Innovation Collaborative Centre (C2MI)

- R&D and design hub in compound semiconductor fabrication, advanced packaging, and photonics

Potential Partnerships:

- Quantum hardware and algorithms

- Photonics and optical inteconnects

- Chiplet-based architectures and UCIe standards

- Integration of logic-memory for AI and HPC workloads

- Novel AI compute architectures

Key Benefits:

- Close gaps in quantum and AI compute technologies

- Accelerate innovation in HPC and photonics.

- Strengthen semiconductor integration and packaging capabilities.

Taiwan-EU

Ecosystem strengths:

- Global leadership in advanced semiconductor manufacturing
- Integrated and complete semiconductor value chain
- CoWoS (Chip-on-Wafer-on-Substrate) and 3D packaging technologies
- Strong industrial clusters and skilled workforce backed by Government (R&D) support

Potential Partnerships:

- Access to leading-Edge manufacturing and integration
- From materials and device innovation to
- Fabless design companies and semiconductor startups to accelerate innovation in AI, HPC, and heterogeneous integration

Key Benefits:

- Close critical technology gaps in HPC, AI, and quantum computing.
- Accelerate innovation in packaging, heterogeneous integration, and energy-efficient architectures.
- Reduce dependency for advanced nodes while building resilience in global supply chains.

Japan

Ecosystem strengths:

- Global leadership in semiconductor manufacturing equipment and materials
- Capabilities in chiplet technology, optical chiplets, and heterogeneous integration
- Lead in specialty chips (robotics, edge AI) and power semiconductors (SiC and GaN)
- Investments in advanced manufacturing including leading edge-nodes

Potential Partnerships:

- Materials science including photoresists, interconnects, 2D semiconductors, ferroelectrics
- Advanced memory and storage technologies (MRAM, PCM, DRAM/NAND, and memory-centric architectures)
- Heterogeneous integration and advanced packaging

Key Benefits:

- Accelerate system-level integration for AI and HPC
- Close gaps in quantum and memory technologies
- Access advanced materials and packaging expertise
- Strengthen digital sovereignty and supply chain resilience.

Republic of Korea-EU

Ecosystem strengths:

- Global leadership in memory chip manufacturing, advanced memory technologies (DRAM, NAND) and emerging memory (PCM, MRAM)

- Advanced manufacturing and foundry capabilities

- Leadership in heterogeneous integration, 3D architectures, and panel-level packaging for AI-driven chips

- Strong automotive semiconductor ecosystem

Potential Partnerships:

- Memory technologies, particularly for AI accelerators and near/in-memory computing

- Brain-inspired neuromorphic devices, AI-enhanced EDA tools, and energy-efficient architectures for edge computing

- Quantum hardware and algorithms

- Backend integration and panel-level packaging

Key Benefits:

- Address Europe's relative weakness in memory technologies

- Enhance Europe's packaging supply chain resilience and support logic-memory integration for AI and HPC workloads

India-EU

Ecosystem strengths:

- Leadership in semiconductor design; home to nearly 20% of the global semiconductor design workforce, with strong capabilities in chip design, verification, and embedded systems

- Growing manufacturing and packaging capabilities

- Expanding talent pool, academic-industry partnerships and indigenous innovation

Potential Partnerships:

- Semiconductor design and verification

- AI and machine learning for compute optimisation

- Compound semiconductors and power electronics

- Access to advanced packaging facilities

Key Benefits:

- Accelerate design cycles for AI accelerators, HPC chips, and edge computing devices

- Develop energy-efficient architectures for IoT systems

- Skills and workforce attraction

- Enhance supply-chain resilience

Singapore-EU

Ecosystem strengths:

- **Strategic global position and supply chain role**
- **Advanced manufacturing and packaging capabilities**
- **Diverse and mature industry cluster**
- **R&D and workforce excellence**

Potential Partnerships:

- **Advanced Packaging and Heterogeneous Integration**
- **Quantum technologies**
- **AI-driven compute and edge architectures**
- **Silicon photonics and optical interconnects**

Key Benefits:

- **Access cutting-edge packaging and photonics technologies**
- **Accelerate AI and quantum integration into advanced compute systems.**
- **Enhance energy efficiency and security in HPC and edge architectures.**

Concluding Remarks

- Ambitious roadmapping

- Co-funded joint R&D and Innovation

- Talent Development and Education

- Joint ventures including Public-Private partnerships

- Standardisation and Regulation

A more detailed perspective

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