# Chips from the North

*Semiconductor Strategy for Finland*

Summary

# 2024 Chips from the North: Semiconductor Strategy for Finland 2035

**€1,6B** industry revenue

**90 companies** across value chain

**7,000 direct employees**

**€5B to €6B** in industry revenue

**€90B to €180B** indirect value

**20,000 direct employees**

## Competitive advantages

Societal predictability and infrastructure

Mobile network expertise

System chip design

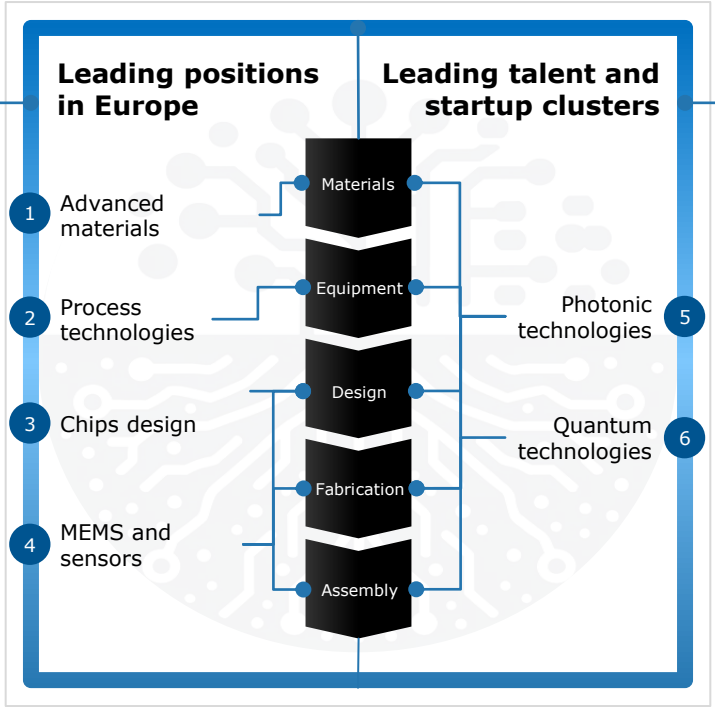
Sensors and MEMS

Process and material technologies

Photonic technologies

Quantum technologies

## Finland's six growth opportunities




## Enabling outcomes

Industry-academia-public collaboration
Effective collaboration structures and resources

Competitive R&D ecosystem
Joint R&D funding of €5B over ten years

Over 15,000 new employees
Elevated education output and talent attraction

New established R&D and design centers
Promotion of talent, startup and technology clusters

Over €1B manufacturing site investments
Public-private collaboration and public instruments

# Chips from the North – Semiconductor Strategy for Finland report is an industry-led effort to commit to identified growth opportunities and actions

## Why was the growth strategy developed?

**Objectives of the strategy work:**

- Commit semiconductor industry and stakeholders to common goals
- Create a strong and sustainable network for industry and stakeholder collaboration in implementing the strategy
- Convince international investors and experts of the opportunities and ambition within the Finnish semiconductor industry and ecosystem
- Persuade national decision-makers of the sector's opportunities and ambitions and provide goals and measures to key parties.

Semiconductors are the basis of society's essential devices, from smartphones to computers, and from health technology to energy systems. Without innovations in semiconductors, many societal goals (such as those related to the environment, artificial intelligence, and automation) cannot be achieved

The significance of the sector to the economy and national security is substantial, which is why many countries (and regions) have sought to strengthen their semiconductor sectors by creating national strategies and supporting measures

Finland can be a significant player in the semiconductor industry by leveraging its strong expertise and increasing collaboration within Europe. This requires Finland to invest in education, collaboration, attractiveness, and innovation infrastructure

## How was the strategy developed?

**The strategy was industry-led** – over 200 industry experts had the opportunity to influence the strategy through various methods:

**Survey** (~100 responses): A survey focusing on Finland's strengths, opportunities, and support pillars, covering representatives from companies, academics, organizations, public institutions, and investors

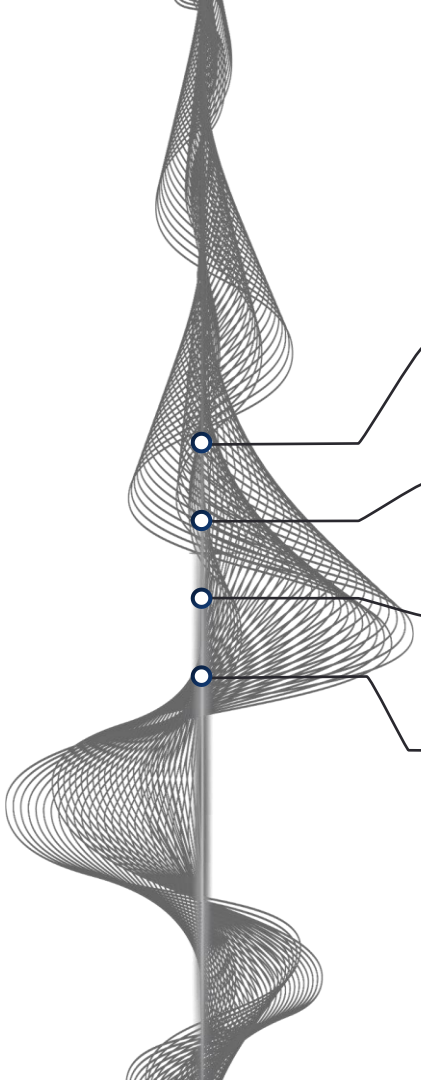
**Interviews** (20-30 interviews): Selected interviews to map out Finland's strengths and growth opportunities

**Focus group discussions** (+25 participants in four discussions): Discussions on Finland's growth opportunities and actions related to the workforce and educations, geopolitics, and collaboration

**Strategy and industry group meetings** (11-30 participants): Alignment of growth opportunities and actions

Additionally, the report utilized numerous different sources, including the "Microelectronics in Finland" report by academics and the results of TIF's APR workshop in 2022

# Agenda



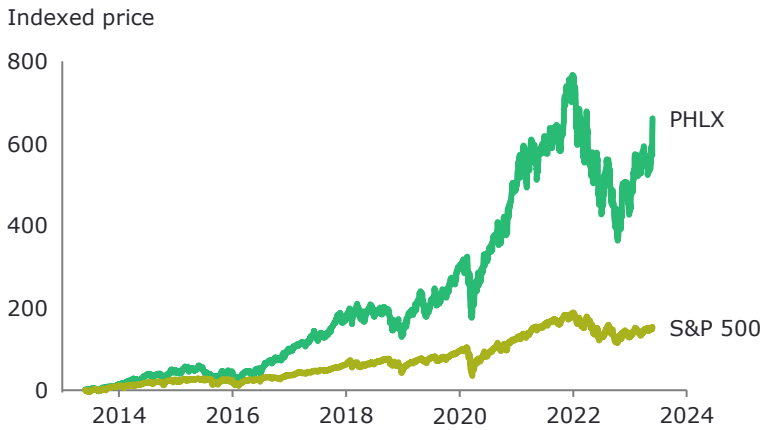
- Global opportunities in semiconductors
- Finland as part of the global industry
- Finland’s six growth opportunities
- What can government and industry do

# Growth opportunities in semiconductors

# The semiconductor industry has outperformed the general economy over the past 10 years, with interest and importance set to increase

## The PHLX Semiconductor Index[1] has grown ~6x, compared to the S&P 500's 2x, since 2013

**Daily prices indexed,** between 2013 and 2023 (2013 = 100)




## Interest in semiconductors continues to increase, with significant attention from governments and businesses

Sam Altman Seeks Trillions of Dollars to Reshape Business of Chips and AI

OpenAI chief pursues investors including the U.A.E. for a project possibly requiring up to $7 trillion

China is quietly reducing its reliance on foreign chip technology

Firms such as Huawei are cultivating local suppliers

**Nvidia passes Alphabet in market cap and is now the third most valuable U.S. company**

**Germany, Intel Agree €10 Billion Subsidy Package for Chip Plant**

**Inside Apple's chip lab, home to the most 'profound change' at the company in decades**

**UK and Japan to boost defense and chips ties ahead of G7**

A $35bn mega-merger strengthens a quiet chip duopoly

The purchase of Ansys by Synopsys is a bet on the ubiquity of semiconductors

'Just-in-time to just-in-case': EU's $49bn chip plan shows tectonic shift in global economy

**Tim Cook and President Joe Biden came to Arizona to announce plans for American-made chips**



1. Tracks largest 30 companies involved in semiconductor production and equipment
Source: NYSE and NASDAQ price data, Capital IQ, BCG

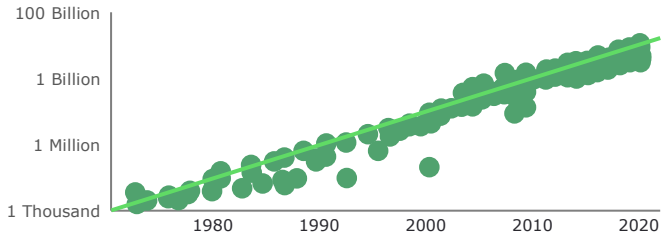
# The semiconductor industry offers numerous growth opportunities: Slowing Moore's Law spurs innovation and demand increases across sectors

## Continuous demand for improved performance drives need for continuous semiconductor innovations

Maintaining **Moore's Law**[1] is becoming increasingly difficult and costly due to physical and size limitations. The importance of alternative performance improvements is being highlighted by the limitations of Moore's Law:

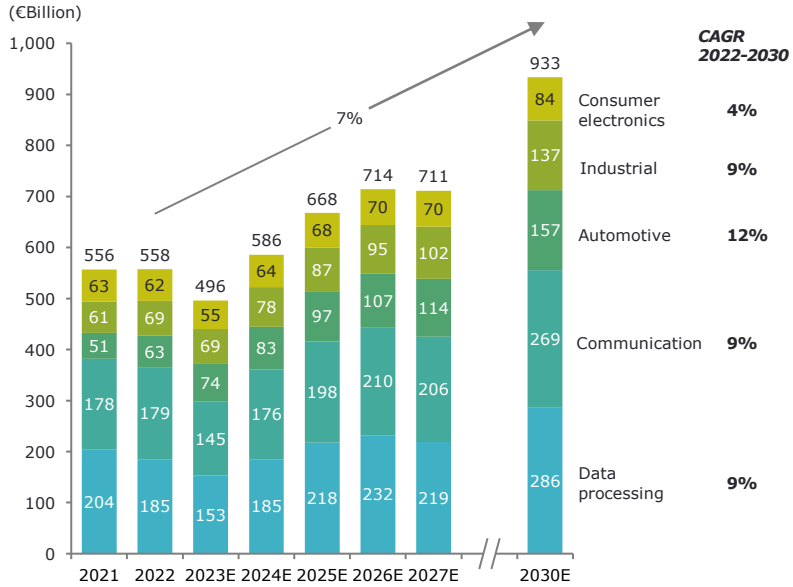
- **"Beyond Moore"** refers to technologies that are not related to the scaling of transistors but rather develop computing power through innovations such as quantum technology or neuromorphic computing
- **"More Than Moore"** (MtM) refers to the diversification of the functionality of integrated circuits, for example, through new materials and components (such as MEMS, photonics). MtM devices are designed for various industries, including automotive, telecommunications, entertainment, and energy

**Moore's Law: Number of transistors in chips has doubled every two years**




## The demand for semiconductors is growing across end-users

**Semiconductor demand by end-use sector**






1. Prediction made by Gordon Moore in the 70s that the number of transistors in consumer-priced processors would double approximately every two years, leading to exponential growth in computing power
Source: Gartner, BCG

# Increasing demand visible in the semiconductor industry market (€560 billion in 2022) growth projections across different device/end-use segments

**Circle size** = 2022 revenue

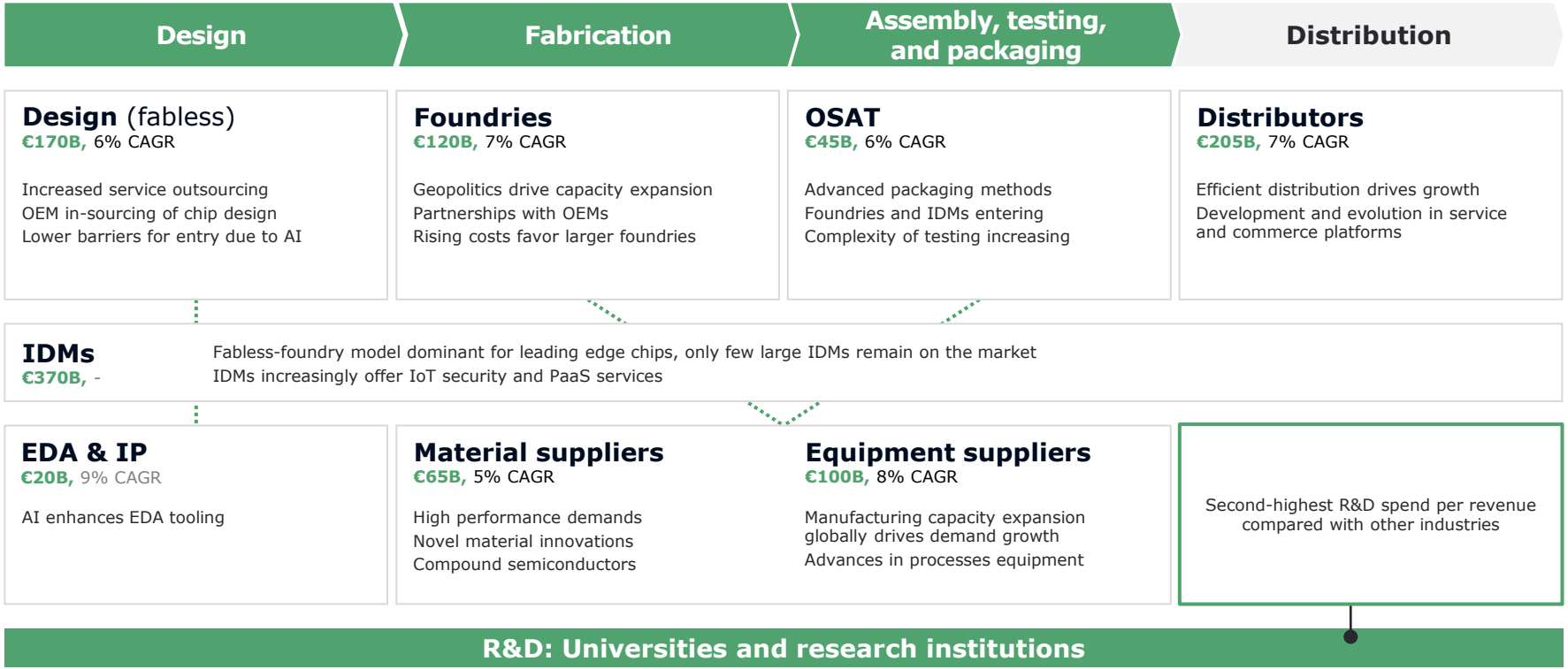
**CAGR, 2022-30**
- 1-5%
- 5-10%
- +10%

DEVICES

USERS

| | Logic<br>€210B<br>*6% CAGR*<br>**Moderately**[1] concentrated market (HHI Index 1000-1800) | Memory<br>€135B<br>*7% CAGR*<br>**Highly**[1] concentrated market (HHI Index 2300) | Discrete, Analog, Other<br>€215B<br>*7% CAGR*<br>**Unconcentrated**[1] market (HHI Index <1000) |
|---|---|---|---|
| **Data processing**<br>(compute, storage)<br>€185B<br>*6% CAGR* | €90B<br>**Use case drivers**: Datacenters, edge computing<br>**Technological drivers:** AI chips, SoCs, advanced packaging, quantum and photonic technologies | €65B<br>Big data analytics, high performance computing<br>Energy efficient, fast and scalable new memory technologies, advanced packaging (e.g., 3D stacking) | €30B<br>Power management for data centers, environmental monitoring sensors, discrete components<br>High-efficiency power components, specialized sensors (e.g., MEMS) |
| **Communications**<br>Incl. smartphones<br>€180B<br>*4% CAGR* | €50B<br>Smartphones, 5G/6G infrastructure (base stations, network processors), satellite communication<br>SoCs, low-power chips, photonics, high-speed signal processing | €45B<br>Smartphones, high-speed networks, 5G<br>Advanced materials, energy efficiency | €85B<br>IoT, enhanced wireless comms bandwidth, signal processing, communication infrastructure<br>RF components, analog, power amplifiers |
| **Automotive**<br>€65B<br>*12% CAGR* | €20B<br>Autonomous vehicles (e.g., ADAS, LiDAR systems), electric vehicles (e.g., battery management systems)<br>Automotive SoCs, chiplets, AI chips, low-latency, photonic interconnections | €5B<br>Infotainment systems, control units, storage for AI and sensor data<br>High-performance reliable memory | €35B<br>Autonomous and electric vehicles<br>Imaging, power mgmt., compound materials, analog ICs, photonics |
| **Industrial**<br>Incl. healthcare, military<br>€70B<br>*9% CAGR* | €20B<br>Robotics, automation, surveillance systems, secure communications<br>Low-energy SoCs, chiplets, AI chips, advanced packaging | €5B<br>Control systems, military computing, solutions for harsh conditions.<br>High-endurance storage | €45B<br>Automation, robotics, military, security, healthcare equipment<br>High-precision analog devices, discrete components, power semiconductors, MEMS sensors, optoelectronics |
| **Consumer**<br>€60B<br>*4% CAGR* | €25B<br>Smart home devices, wearables, personal electronics, extended reality (XR, VR, AR)<br>Low-power SoCs, advanced packaging, integrated connectivity, user interfaces | €15B<br>Media storage, consumer devices, gaming<br>Non-volatile memory, fast and high-capacity memory, multi-tasking | €25B<br>Home entertainment, personal electronics, XR, VR and AR<br>Low-cost sensors, advanced photonics, optoelectronics for displays and interfaces |

# Changing demand drives evolutions across the highly fragmented semiconductor value chain create additional opportunities for plays






1. Outsourced assembly and testing 2. Integrated device manufacturer 3. Electronic design automation and intellectual property
Source: Gartner, BCG

# Governments globally are focusing on strategic technology autonomy in semiconductors due to security concerns and economic growth potential

## EU Chips Act aims to increase self-reliance on chips by mobilizing €43 billion in investments

The main goal of the EU Chips Act is to improve the EU's self-reliance by increasing the union's global semiconductor market share from 9% to 20% by 2030. The Act is based on three pillars: the Chips for Europe Initiative, a framework for supply security, and a mechanism for crisis management. The EU aims to mobilize €43 billion in public and private investments through the regulation.

1. **Chips for Europe Initiative:** Aims to facilitate and accelerate the industrial utilization of R&D activities in the sector by increasing pilot lines and design platforms, and by supporting startups and SMEs, among other measures
2. **Supply Security:** Attracts manufacturing investments and capacity increases by using subsidies and simplifying licensing processes
3. **Crisis Management:** Strengthens cooperation in monitoring and managing crises in the semiconductor sector through early warning indicators and crisis measures.

*"Chips are essential for our green and digital transitions, and for our economies. Our economy would not function without chips ... **We need to promote the design, testing and production here in Europe**. For that, the Chips Act is a game changer."*

- Ursula von der Leyen, President of the European Commission

## Countries around the world support their domestic semiconductor industry through varying strategies

**Examples of economies' actions**

- PERTE Chip strategy allocates €12 billion by 2027 into the industry, focusing on chip design, quantum chips, and photonics
- Electronique 2030 strategy allocates approximately €5 billion into the industry, focusing on production, R&D activities, and education
- No national strategy, but have supported an Intel factory with €10 billion and other factories and design centers with over €6 billion
- National strategy allocates £1 billion by 2034 int to the industry focusing on chip design and materials (especially compound semiconductors).
- Released the CHIPS Act (€52 billion) and the Inflation Reduction Act (€71 billion), focusing on supporting advanced semiconductor manufacturing capacity
- Approximately €75 billion 'Electronics Fund,' of which about 70% is focused on supporting semiconductor manufacturing facilities. However, it is uncertain how much money is actually invested

# Finland as part of the global industry

# Finnish semiconductor industry in numbers

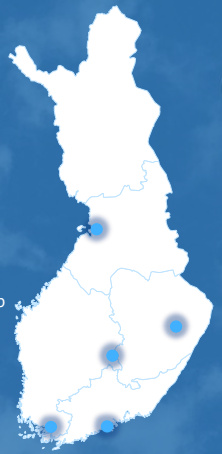
*excl. Nokia and Microsoft*

**€1.6B revenues**
Finnish semiconductor industry total revenue in 2022

**90 companies**
The industry is comprised of roughly 90 companies of which ~60% are SMEs[2]

**7,000 employees**
The industry directly employs almost 7,000 professionals

**Finnish semiconductor industry is spread out over regions**



**The Helsinki region** is strong in ALD, quantum, sensors, RF, materials, in addition to significant research infrastructure (1,100M€ in revenues, ~4,500 employees)

**The Oulu region's** expertise is focused on communications technologies, driven by the historical position of Nokia (250M€ in revenues, ~1,500 employees)

**The Tampere region** has strong presence of chip design and photonics expertise (150M€ in revenues, ~500 employees)

**The Turku region** hosts a medical technology cluster, and accompanying imaging expertise (50M€ in revenues, ~200 employees)

**The Joensuu region** is home to a photonics hub (10M€ in revenues, ~100 employees)

# Finland is strong in specific semiconductor segments, supported by research, education, and infrastructure

## Finnish semiconductor industry companies, products and employees

- Companies in the industry are mostly IDMs[1], Fabless, Equipment, and Material suppliers
- Approx. 45% (€700M) of revenue comes from ASICs, ~30% (€500M) of revenue from MEMS and sensors, and ~25% (€400M) of revenue comes from optoelectronics and photonics
- Companies in the industry primarily supply to end-users in telecommunications, industrial automation, healthcare, and automotive sectors
- Foreign companies have targeted Finnish expertise and technologies, either through acquisitions (e.g., Picosun by Applied Materials, Minima by Bosch) or by establishing offices in Finland (e.g., Huawei, MediaTek)

**Example of companies operating in semiconductor industry in Finland**

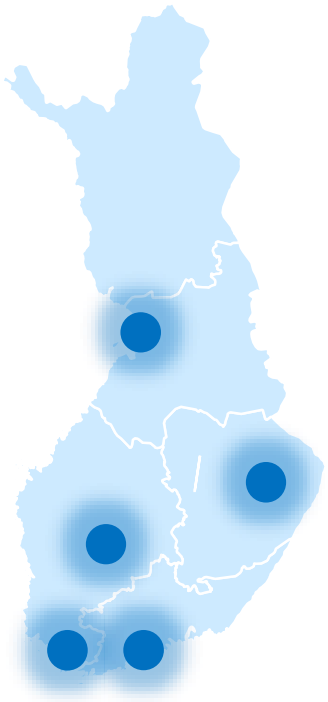
## Research institutions support world-class semiconductor innovation

- Finland is home to multiple renowned research institutions (universities, research centers) dedicated to advancing semiconductor technology
- Universities offer specialized semiconductor programs directly aligned with the needs of the industry, ensuring a supply of skilled professionals (though the quantity should be increased)
- Driven by high-quality research and education, Finland is a pioneer in many critical innovations, such as mobile networks and ALD

**Example of research institutions (universities, research centers) in semiconductor field in Finland**

1. IDM = Integrated Design Manufacturer 2. SME = Defined as companies that employ less than 250 persons and has annual revenues below 50M€. Companies which fulfill the criteria in Finland, but are subsidiaries of larger companies which don't full the criteria are not counted (e.g., Nvidia, ASM Microchemistry, etc.)
Source: Statistics Finland, BCG

# Finland's semiconductor industry is spread over regions, with clusters situated around universities



**Companies' turnover:** Number of companies and employees (2022)
*Excl. Nokia and Microsoft revenue and employee figures*

## Oulu region
**€260M**
14 companies
1,400 employees

**Wireless and sensor cluster**

## Joensuu region
**€10M**
5 companies
90 employees

**Photonics cluster**

## Tampere region
**€130M**
17 companies
550 employees

**Chip R&D and design hub**

## Capital region
**(Helsinki, Espoo, Vantaa)**
**€1,130M**
43 companies
4,400 employees

**Broad research and expertise cluster**

## Turku region
**€45M**
9 companies
200 employees

**Medical cluster**

## Example companies in Finland

| | | | |
|---|---|---|---|
| NOKIA | Networks | BOSCH | Sensors |
| Microsoft | R&D and design | intel | SW, RF circuits |
| VAISALA | Sensors and MEMS | SemiQon | Quantum processors |
| muRata | MEMS | SILICON LABS | Wireless connectivity |
| HUAWEI | Networks | NVIDIA | SoC software |
| BLUEFORS | Cryogenic equipment | modulight | Lasers and optics |
| OKMETIC | Silicon wafers | Danfoss | Power, climate and drives |
| Detection Technology | X-ray detectors | dispelix | XR waveguides |
| BENEQ | ALD | ASPOCOMP | PCBs |
| NORDIC | Wireless connectivity | ASM | ALD |
| OPTOFIDELITY | Testing equipment | Texas Instruments | Analog, power and wireless |
| APPLIED MATERIALS | ALD | IQM | Quantum computers |
| SENOP | Optronic solutions | CANATU | Nanomaterials |
| CoreHW | IC design | PiBond | Nanomaterials |



1. Covers North Ostrobothnia and Kainuu regions 2. Covers North Karelia and North Savo regions 3. Covers Pirkanmaa and Kanta-Häme region 4. Covers Uusimaa region 5. Covers Southwest Finland region
Source: Company financials, literature research, expert interviews, European Patent Office, BCG

# Finnish semiconductor industry generates €1.6B in annual revenues with revenue coming mainly from MEMS and sensors, optoelectronics and wireless

**Companies' turnover in Finland 2022**, *Global market size and growth 2022-2030*

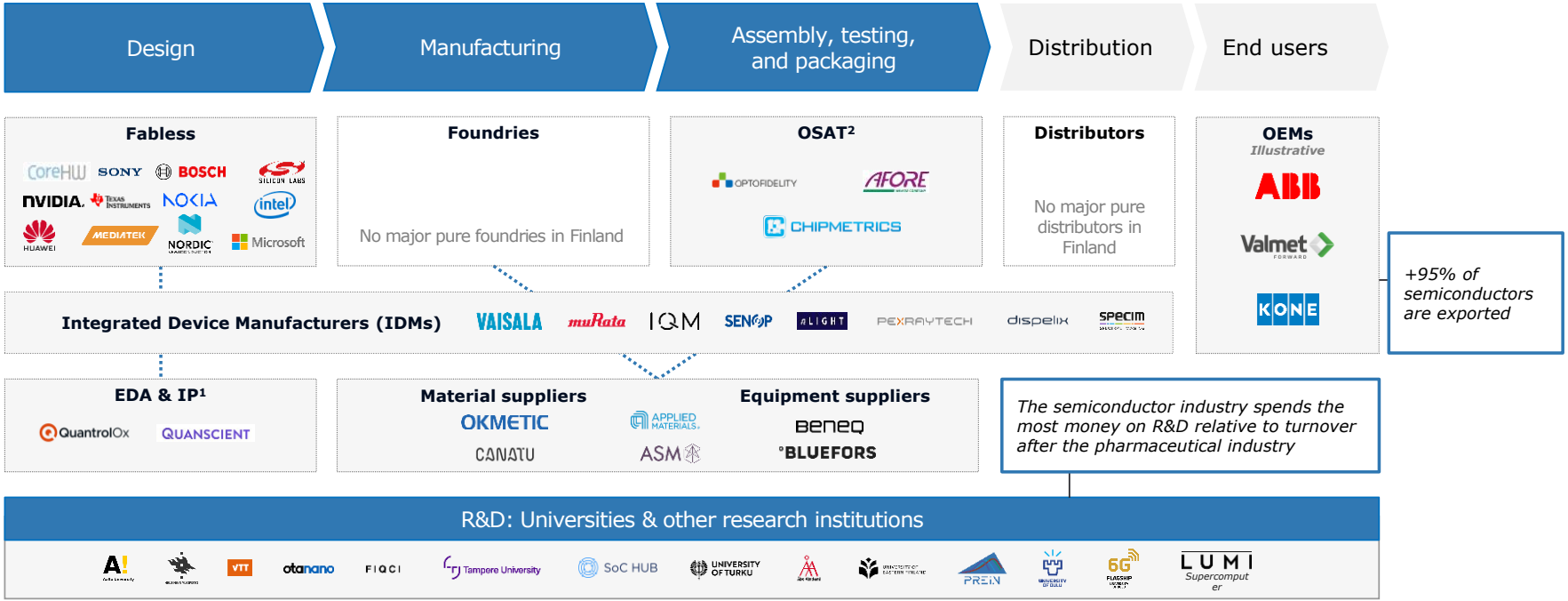
| DEVICES / VALUE CHAIN | Logic<br>€85M<br>*€210B, 6% CAGR* | MEMS & Sensors<br>€515M<br>*MEMS: €12B, 8% CAGR* | Optoelectronics<br>€365M<br>*€34B, 8% CAGR* | RF and baseband<br>€425M<br>*€19B, 7% CAGR* | Other<br>€180M<br>*€170B, 5% CAGR* | Opportunities |
|---|---|---|---|---|---|---|
| **Fabless**<br>€360M<br>*€170B, 6% CAGR* | €15M<br>**Key competences:** SoC design | | | €325M<br>Wireless communications, chips, modems | €20M<br>Analog devices, power management | • Mobile SoC design<br>• Edge AI chip design<br>• Ultra-low power design<br>• Power management<br>• RF MEMS components |
| **IDMs**<br>€670M<br>*€370B* | | €410M<br>MEMS and sensors | €240M<br>Imaging, optics, detectors | €5M | €10M<br>Quantum technologies | |
| **OSAT**<br>€50M<br>*€45B, 6% CAGR* | | €5M | €45M<br>Testing equipment | | | |
| **Equipment**<br>€310M<br>*€100B, 8% CAGR* | €55M<br>ALD processes and equipment | €20M<br>ALD processes and equipment | €70M<br>ALD processes, equipment, lasers | €20M | €150M<br>Cooling for quantum technologies | • Atomic layer deposition<br>• Flexible microelectronics<br>• Sustainable process technologies |
| **Materials**<br>€180M<br>*€65B, 5% CAGR* | €15M<br>Photonic materials, nanomaterials | €80M<br>Silicon wafers | €10M<br>Photonic materials | €75M<br>Silicon wafers | | • Specialized wafer production<br>• Next generation advanced materials |
| **Opportunities** | | • Communication, healthcare, automotive<br>• RF MEMS components<br>• Multifunctional sensors<br>• Quantum sensors | • Photonic solutions and photonic chips<br>• SiP design<br>• Photonic-quantum technologies | | Quantum technology research, design, and fabrication | |



Source: Company financials, literature research, expert interviews, BCG

# Semiconductor companies in Finland are mostly IDMs, fabless, and equipment players supported by advanced R&D expertise

*! Based on company's operational focus in Finland.*






Source: Press releases, literature research, expert interviews, BCG

# The Finnish semiconductor industry has numerous societal and technological competitive advantages supporting long-term growth in semiconductors

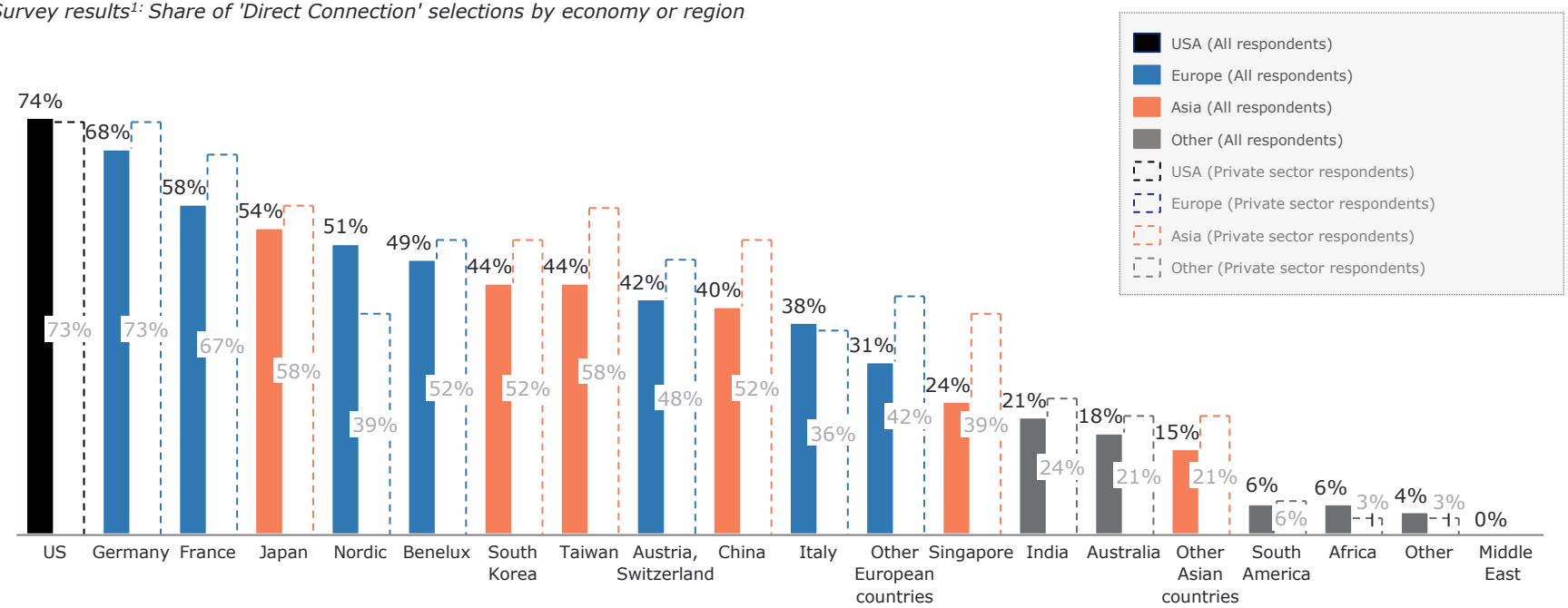
| | | |
|---|---|---|
| Societal | **Low cost of innovation:** Finland has a strong education system, low white-collar labor costs, company-academic collaborations support low cost to innovate | • Survey: White-collar labor costs mentioned as the top one strength in Finland, followed closely by education system and workforce expertise<br>• Engineers in Finland earn 20-30% less than the average in benchmark countries |
| | **Societal stability and predictability:** Finland is the most stable country and business environment globally with predictable public policy and services | • Ranked as the world's most stable country and most stable business environment by the Global Innovation Index |
| | **Well-functioning infrastructure:** Relatively low risk from natural disasters and moderate climate supports stable electricity production | • Finland's electricity production is stable and less impacted by extreme weather<br>• 90% of electricity generation is carbon neutral, with about 50% coming from renewables |
| | **Natural resources:** Water richness combined with abundance of land and affordable energy makes an attractive destination for semiconductor fabrication | • Finland is ranked as the world's water-richest country.<br>• Natural resources cited as strengths by the surveyed industry stakeholders. |
| Technological | **Mobile network expertise**: Finland has leading expertise in 5G/6G system circuit design and research, attracting global companies. | • Survey: 5G/6G mentioned as #1 technological strength in Finland, vast majority of respondents said industry is best positioned to serve telecommunications sector<br>• Nokia is the leading provider of network infra and mobile networks in the world |
| | **System chip design:** Strong competences in SoCs due to Nokia and Tampere ecosystems for 5G and research for 6G, ultra-low power SoC design and AI chips | • Survey: a high share of respondents commented Finland has strong competences in SoCs due to Nokia and the unique SOC hub in Tampere<br>• Per capita, Finland is 2nd in SoC patents per capita in Europe |
| | **Sensors:** Finland holds strong EMEA market share in inertial/environmental sensors and specialized wafers for automotive and industrial end uses | • Sensors/MEMS received 2nd most mentions on strengths in the industry survey<br>• Large leading players, such as Vaisala and Murata, present in country, supported by MEMS and sensing specific research and education programs |
| | **Photonics and optoelectronics:** Finland has one of Europe's most concentrated knowledge base of photonics expertise attracting global companies | • Dense research and company clusters in optical sensing, detectors, imaging, and XR.<br>• Photonic firms are expected to grow 30% in turnover and 18% in workforce YoY |
| | **Process, material technologies:** Finland stands out on advanced material and process technology expertise with decades expertise | • Survey: Highlighted that Finland has decades research and business experience in ALD, and additional clear competitive advantages in material niches<br>• Per capita, top 5 for patents and citations for advanced materials in Europe |
| | **Quantum technologies**: One of Europe's densest expertise clusters formed by leading companies, Aalto University, VTT, and other institutions | • Survey: 2nd most mentions in survey question about industry product strengths<br>• Per capita, 1st in quantum computing related patents and 2nd in citations in Europe |


Source: Survey results, WIPO, OECD, SCIMago, European Patent Office, Keel University, BCG

# The Finnish industry is export-heavy, internationally connected but susceptible to geopolitical tensions with considerable exposure to mainland China

## The Finnish industry's direct geographical connections

*Survey results[1]: Share of 'Direct Connection' selections by economy or region*






1. Q: Which geographies is your organization directly connected to? (Customers, Supply chain or R&D cooperation related between companies related to semiconductors) (Cooperation partners in research both academy and industry)
Source: National Microelectronics & Semiconductor Strategy survey 2023, BCG

# Finland’s six growth opportunities

# Finland to surpass global market growth, yielding significant job creation and indirect economic impact over the next decade

## +10% annual revenue growth[1]

The Finnish semiconductor industry projects to outpace the global average growth of 7-8% over the next 10 years, tripling Finnish revenue to €5-6B by 2035

Most Finnish semiconductor companies and research are focused on above-market growth segments, such as wireless connectivity, SoC chip design, quantum technologies – and serve customers in growing end use segments

Finnish semiconductor industry emphasizes that growth cannot be sustained without skilled resources, long-term investments and collaboration in R&D

## 15,000 new jobs

The number of employees needs to increase from 7,000 to 20,000 by 2035

Over 50% of new jobs require an MSc degree, 20% a BSc and 10% a PhD or DSc.

## Significant indirect economic impacts

R&D investments into semiconductors are expected to create €90B to €180B indirect value to other sectors – and each euro invested in the sector's R&D is estimated to increase the gross domestic product of Finland by €16,5[2]

1. Average and median responses from a Finnish semiconductor industry survey: 'What is your estimate for an annual growth rate of Finland Microelectronics & Semiconductor industry until 2035?' (Global market expected to grow ~7-8% YoY, Gartner) 2. Based on the SIA report 'How Federal Investment in Semiconductor R&D Spurs U.S. Economic Growth and Job Creation

# Finland has six growth opportunities, which are based on its competitive strengths and increasing demand

**Leading positions in Europe** | **Leading talent and startup clusters**







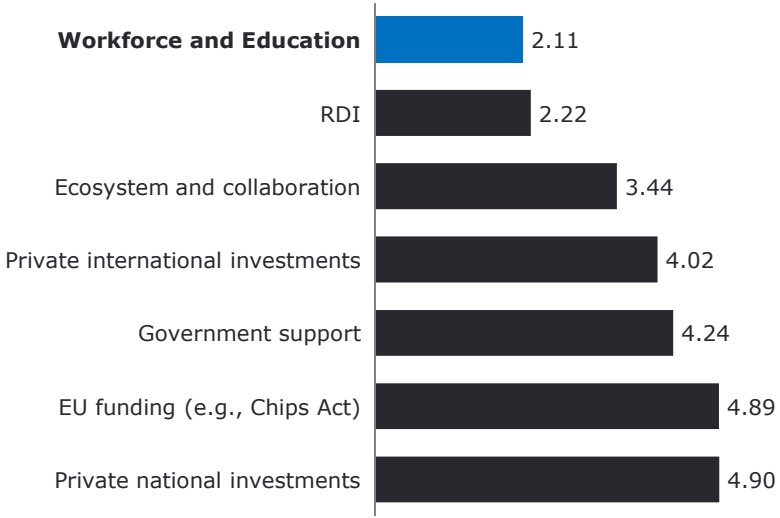
| | Advanced materials | Process technologies | Chip design | MEMS and sensors | Photonics | Quantum tech |
|---|---|---|---|---|---|---|
| Vision | Finland has reinforced specialized wafer production capabilities and manufactures world-leading specialized wafer<br><br>Finland leads design and manufacturing of novel high-performance semiconductor materials | Finland leads in research, development and productization of thin films for novel applications<br><br>Finland develops leading flexible and biodegradable process and manufacturing technologies | Finland designs leading next-generation mobile network chips<br><br>Finland is integrated deeply with Europe's industrial demand for automation, AI, and robotics<br><br>Finland breaks new grounds with energy-efficient, ultra-low power chips | Finland leads in design and manufacturing of MEMS solutions for communications, industrial, automotive, and healthcare sectors<br><br>Finland leads in innovations for next generation advanced sensor solutions | Finland has a reinforced domestic photonics end-to-end value chain to design and manufacture world-leading photonic solutions<br><br>Finland leads globally in photonics-microelectronic SiP design capabilities<br><br>Finland breaks new grounds in healthcare, silicon-photonics, and quantum integration | Finland has technological and export superiority in Europe in designing and manufacturing quantum technologies<br><br>Finland has an end-to-end value chain with state-of-the-art quantum infrastructure<br><br>Finland is Europe's leading quantum ecosystem for academia-industry collaboration |

Note: SoC = System-on-Chip; SiP = System-in-Package; MEMS = Microelectromechanical systems; HF/HV = High-frequency/High-voltage; ALD = Atomic layer deposition
Source: BCG

# The success in growing Finnish semiconductor industry is highly dependent on the supply of workforce and research from higher education institutions

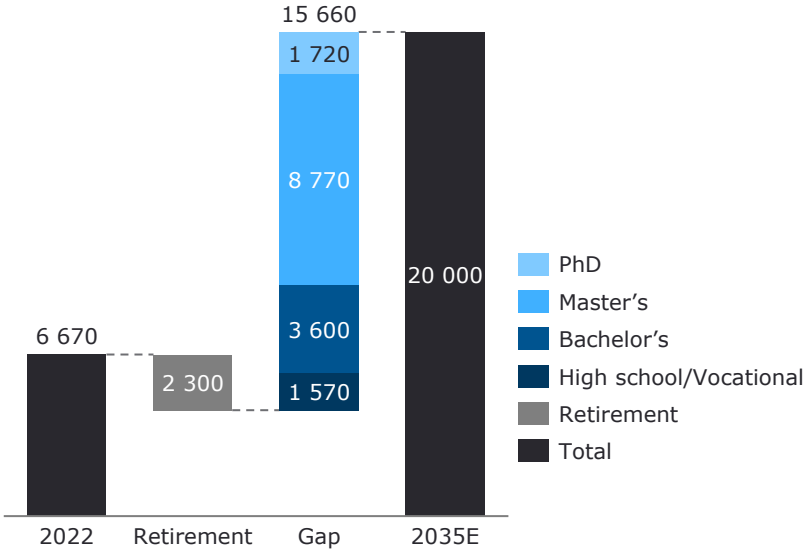
## The industry perceives that workforce and education are the most critical enablers for industry growth

*Survey results[1]: The lower the average rank, the more critical the enabler is*




## Industry is estimated to need over 15,000 mostly highly educated professionals

*Total number of employees, by education level, in 2022-2035*




1. Q: Rank the following enablers from most critical to least critical for the success of the Finnish Microelectronics and Semiconductor industry 2. Based on estimates without productivity growth assumptions, i.e., static revenue per employee. Education data based on estimates from Norwegian semiconductor industry report. Retirement estimates based on EU figures
Source: Orbis, Company reports, Industry reports, Gartner, Industry survey, BCG

# Finland should aim for five outcomes across the six growth opportunities and set up efficient public-private collaboration to coordinate supporting actions

## 1 Competitive R&D ecosystem

Increase R&D investments, international collaborations and R&D infrastructure

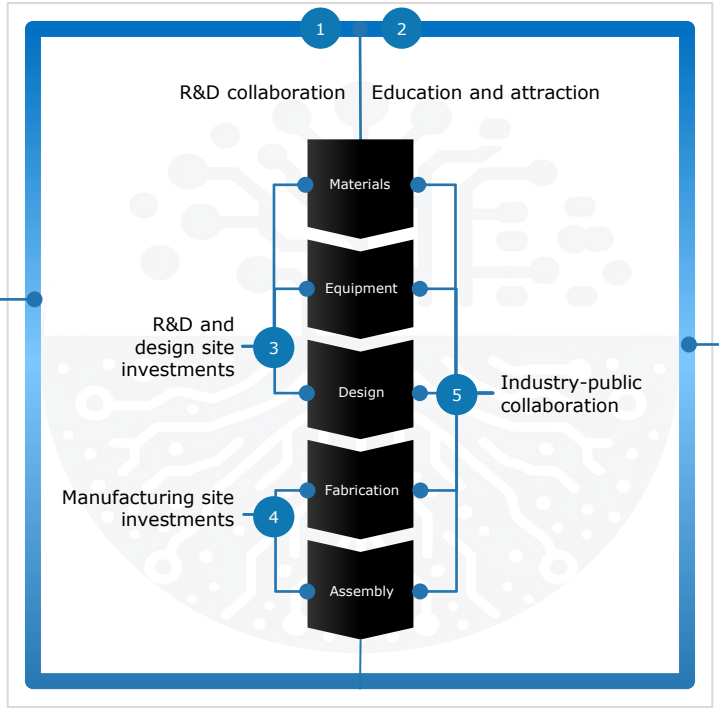
- Pilot lines operating model
- Joint R&D funding of €5B over ten years
- Coordinated EU funding tracking
- Multi-year flagship research program
- Closer non-EU bilateral relationships

## 3/4 Investment attraction

Attract significant R&D, design and manufacturing site investments

- Promotion of talent and startup clusters
- 6G EU Design Center of Excellence
- Broad range of public instruments
- Public-private collaboration

## Five enabling outcomes




## Workforce growth 2

Alleviate industry talent gap by educating and attracting 15,000 new employees

- Investments in education quantity and quality
- Funding mechanisms and tenure tracks
- Scalable programs for upskilling and reskilling
- Campaigns to promote industry attractiveness
- Coordinated international talent pipelines

## Industry-public collaboration 5

Enable long-term collaboration among industry, academia, and government

- Effective industry collaboration structure
- Geopolitical monitoring and coordinated response
- EU policy and funding influence

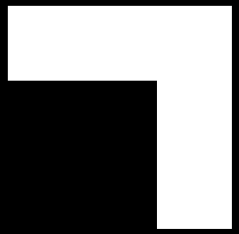
# What can government and industry do?

# What government and industry can do (1/2)

| Outcome | | Action | Responsible |
|---|---|---|---|
| 1 | Finland should increase R&D investments, secure international R&D collaborations and build infrastructure to rapidly commercialize innovations. | 1.1 **Finland needs a total funding of €5B for semiconductor R&D over the next ten years**, **focused on the six opportunity areas**. The majority of this will be carried out by the industry, with the government providing significant leverage through increased funding. | Industry, Government |
| | | 1.2 **Finland needs to create an operating model for pilot lines that builds and operates them, funds necessary equipment, attracts customers, and interacts with leading European research and technology organizations**. The government should also pledge matching funds for these pilot lines and associated projects under the EU Chips Act and similar initiatives. | Government, Industry, Academia |
| | | 1.3 **Finland should establish and track a plan to gain the most benefit from semiconductor-related EU funding programs**. The plan should include building networks to European research and technology organizations and global companies, enabling participation in multi-party funding calls and helping to attract international customers. | Industry, Government |
| | | 1.4 **Finland should establish closer bilateral relationships on semiconductor technologies and related trade and R&D initiatives** with partners beyond the EU: in particular the US, the UK, Canada, Japan, South Korea, India, and Taiwan. | Government |
| 2 | Finland should aim to alleviate the talent gap to support growth and industry competitiveness. | 2.1 **Finland should commit to raising the quality and quantity of microelectronics higher education**. This means significantly increased student intake and adequate output of MSc and DSc graduates. Industry and academia should co-create degree programs that funnel new talent into the field. | Government, Academia, Industry |
| | | 2.2 **Postdocs and professors should be attracted through innovative research funding mechanisms and world-class tenure tracks and campaigns**. Additionally, research and industry should collaborate on further developing leading semiconductor publications, aiming to gain international visibility and attract top talent. | Academia, Industry, Government |
| | | 2.3 **Finland should foster vocational education and training in microelectronics** through degree programs and short courses with appropriate use of on-the-job learning and apprenticeships to meet the growing demand for manufacturing staff. | Government, Industry |
| | | 2.4 **Scalable programs for upskilling and reskilling the current workforce should be put in place**, enabling smooth career transitions within the semiconductor industry and building a talent pipeline from declining industries. | Government, Industry, Academia |
| | | 2.5 **Finland should launch campaigns to promote the attractiveness of semiconductor-related studies and careers among students**. There should be internships and other efforts to provide practical work-related engagements during studies and communicate clear paths towards industry employment. | Industry, Academia |
| | | 2.6 **Finland should establish coordinated international talent pipelines to Finland from abroad**, ease immigration policies with targeted measures for critical talent, support pathways to industry jobs, and define joint actions to retain foreign students and talent in Finland. | Government, Industry, Academia |

# What government and industry can do (2/2)

| Outcome | | Action | Responsible |
|---|---|---|---|
| 3 | Finland should aim to attract significant semiconductor R&D and design sites from foreign companies. | 3.1 **Finland must prioritize long-term initiatives to promote its design-related talent, startup, and technology clusters**. This involves enhancing research-industry collaboration through forums, showcasing innovations at international trade shows, executing targeted marketing campaigns, and leveraging diplomatic channels to bolster visibility among large design companies. | Government, Industry, Academia |
| | | 3.2 **A comprehensive set of public instruments should be developed and put forth**, tailored to attracting specific design sites. | Government |
| | | 3.3 **Finland should establish an EU-labeled 6G and Edge AI Design Center of Excellence** under the EU Chips Act. | Industry, Government, Academia |
| 4 | Finland should aim to attract significant (>€1B) semiconductor manufacturing site investments from foreign companies. | 4.1 **Public-private partnerships should be established to jointly attract manufacturing site investments**. These partnerships should consistently promote Finland's manufacturing capabilities at research-industry forums, international trade shows, and through diplomatic channels. | Government, Industry |
| | | 4.2 **Finland should establish and employ a comprehensive set of public instruments** specifically designed to appeal to and secure specific manufacturing sites. | Government |
| 5 | Finland should enable long-term collaboration among industry, academia, and government to support the execution of the strategy, and to maintain situational awareness on geopolitical, technological, and economic developments that affect the execution. | 5.1 **Finland should establish an effective collaboration structure** for the implementation of the national semiconductor strategy that enables tracking of key outcomes and actions. | Government, Industry, Academia |
| | | 5.2 **There should be an active process for sharing key developments in geopolitics and industrial and trade policies**. The industry and government should define and support proactive industry activities that would address key challenges in the operating environment. | Industry, Government |
| | | 5.3 **Finland should bolster the cooperation and resources needed to influence EU semiconductor-related policies**, objectives, and funding instruments. | Industry, Government |



Technology Industries
of Finland