Action Plan for **Neuromorphic Computing**

1. The Opportunity of Neuromorphic Computing

The implementation of systems that combine sensors, intelligence and automation is one of the most significant business opportunities across industries in the next decade. However, capitalising on this opportunity requires **radical innovation** beyond scaling existing computing systems. The growing demand for computation is coupled with a massive increase in demand for AI capacity, data volume, hardware investments, and energy consumption, that hinder a pathway to profitability. For example, capital expenditures and operational costs of computation, especially AI, are getting out of hand, with an estimated 375 billion invested in data centres just in 2025 and AI labs still losing money per paying user.[1] It necessitates new approaches in computing to do things faster, more efficiently and more local.

Neuromorphic computing is computation inspired by the human brain: by mimicking the brain's efficiency, neuromorphic computers can process high volumes of data incredibly fast and handle complex tasks like image recognition with ease while using far less energy than traditional systems (see box 1). Neuromorphic computing provides a crucial business case for all industries facing this AI cost overshoot, as it promises an orders of magnitude lower energy footprint and the capability of dealing with large amounts of complex data. Neuromorphic computing is expected to be a >$20B market by 2030, driven by accelerated demand for AI and increased adoption of edge computing across industries.[2] As we explain in paragraph 2, **the Netherlands has the potential to take a leading position in this technology**.

> **Box 1: What is Neuromorphic computing?**
> Just like the brain processes and stores information together, computers that combine data storage and processing can be more effective and efficient. This requires simultaneous innovation in both hard- and software. We can use new materials, devices, and algorithms to make processors more "brain-like". For more information, read the recent white paper.

Adoption of neuromorphic computing can make essential contributions to major societal challenges. Without it, it is likely that society will hit bottlenecks in energy consumption for computing, digital sovereignty, and industrial transformation.

I. **Energy:** between 2017 and 2023, data centres doubled their energy footprint, fuelled by the growth in demand for AI.[3] The integration of neuromorphic processors in data centres (instead of expanding GPU capacity) has the potential to reduce the amount of energy required for some AI processing tasks by a multiple of between 10 and 1.000.[4] Implementing neuromorphic processors on the edge will enable energy-efficient AI solutions to locally deal with high volumes of data.
II. **Sovereignty:** the current European cloud and high-performance computing infrastructure is largely dependent on US companies and technology, manufactured in Asia, and owned by enterprises outside Europe.[5] This makes us vulnerable to geopolitical manipulation. However, the race for leadership in next-generation computing systems is still ongoing. Targeted investments and effective European collaboration can help secure a technological lead in neuromorphic computing, reinforcing European digital infrastructure, including our AI capabilities and our position in chip manufacturing.
III. **Industrial transformation:** long term transformative goals come within reach by applying neuromorphic computing. Neuromorphic architectures are ideal for self-driving cars, which require low power sensors and computation to operate under adverse conditions. Neuromorphic electronics can be deployed in medical wearables to ensure their reliability and privacy.

For these reasons, others are investing in neuromorphic computing. The technology is part of the US CHIPS and Science Act,[6] the German innovation agency SPRIN-D invests in multiple neuromorphic projects[7] and researchers in China unveiled a new neuromorphic supercomputer this year.[8] The EU has named neuromorphic chips as a candidate "breakthrough" technology for the pilot lines in the chips act.[9] The time to invest is now and the Netherlands can play an important role in this ecosystem.

[1] The New York Times (2025). The A.I. Spending Frenzy Is Propping Up the Real Economy, Too. Lydia DePillis, 27-08-2025. & Futurism (2025). OpenAI May Be in Major Trouble Financially. EDT Joe Wilkins, 08-07-2025.
[2] Precedence Research (2025). Neuromorphic Computing Market Size, Share and Trends 2025 to 2034.
[3] Berkeley Lab (2024). 2024 United States Data Center Energy Usage Report. Energy Analysis & Environmental Impacts Division.
[4] See Yang et al. (2023). High performance mechano-optoelectronic molecular switch. Nature communications, 14-1. and Kösters et al. (2023). Benchmarking energy consumption and latency for neuromorphic computing in condensed matter and particle physics, APL ML 1, pp. 16-101
[5] European Commission (2024). The future of European competitiveness - Part B | In-depth analysis and recommendations.
[6] 117th Congress (2022). H.R.4346 - CHIPS and Science Act.,
[7] SPRIND (2025). https://sprind.org/. See projects "Resistors With Brains", Artificial intelligence, inspired by nature" & "A square millimeter of future".
[8] Tech in Asia (2025). China debuts brain-like computer with 2 billion artificial neurons. August 4 2025.
[9] European Parliament (2022). The EU chips act – Securing Europe's supply of semiconductors. November 2022.

2. The Position of The Netherlands

Crucially, computing using neuromorphic principles is already being applied to large-scale use cases. Apple, Samsung and Google have all deployed AI accelerators with neuromorphic design elements in their hardware. Memory manufacturers such as Samsung, Micron and SK Hynix have all announced moves towards in-memory computing, which is considered a first step towards neuromorphic architectures. The Netherlands is well positioned for this first wave of innovation, with several startups that are **commercialising** brain-inspired chip technology. These companies are gaining momentum:

- Axelera AI speeds up AI inference with in-memory computing. Its AI accelerators are now commercially available, and the company has raised ~€200m so far.
- Innatera has designed the world's first commercial neuromorphic microcontroller to bring brain-like intelligence to sensors and has raised more than €30m.
- Hoursec develops brain inspired software and chips that train AI more efficiently. [10]

And the next wave of neuromorphic innovation is coming. More than 100 researchers in the Netherlands study and develop new materials, devices, circuits, hardware architectures, and algorithms, ultimately aimed at making computing as efficient and functional as the human brain.[11] New neuromorphic systems are rapidly moving **from laboratory experiments to pilot devices** that deliver a competitive advantage. For instance, Dutch researchers have built the TEXEL processor, which advances neuromorphic hardware and provides a platform for testing algorithms and integrating new materials.[12] This type of multi-disciplinary research will provide many opportunities for scientific discovery, technology transfer and entrepreneurship in the Netherlands.

Neuromorphic computing is complementary to the technologies in the Dutch National Technology Strategy[13] and can play a role in innovation in these fields:

- **AI & data**: neuromorphic systems are specifically designed to run AI algorithms faster and more efficiently, making AI more sustainable. It supports continuous learning 'at the edge' (local, with less reliance on hyperscale data centres) and new AI methods beyond deep learning.
- **Cybersecurity technologies**: the enhanced efficiency of neuromorphic devices means that computing tasks can be performed locally instead of in the cloud, reducing the volume of sensitive data that needs to be transferred. Neuromorphic computing also has uses in cybersecurity. For instance, the combination of low power sensors and advanced edge processing is ideal for securing critical infrastructure.[14]
- **Semiconductors**: the development of new in-memory processors is leading to new opportunities in chip fabrication, diversifying the Dutch Semicon industry.[15] In addition, semiconductor fabrication equipment will play a key role in producing neuromorphic hardware architectures by Dutch scale-ups.
- There is an opportunity for crossovers with both **integrated photonics** and **quantum technologies** for "future of compute" breakthroughs. Leveraging these emerging compute technologies together requires a hybrid computation "orchestration layer". This layer distributes computing problems to harness the strengths of different hardware.[16] For instance, the AI power of neuromorphic computers will work complementary with the simulation power of quantum computers.[11]

Thus, neuromorphic computing can be an important building block in increasing **competitiveness** and **strategic autonomy** through advanced technological capabilities. It fits both the national strategy and the European competitiveness agenda.

3. What The Netherlands Needs

On the one hand, there is already opportunity for commercialising neuromorphic computing, based on existing hardware. On the other hand, there is the potential to build new chips from scratch, based on new materials, circuits and devices. The Netherlands has the **proven expertise** to do both. We can leverage this position with better coordination of the Dutch neuromorphic field and by strategically investing in the ecosystem's structural improvement. Doing so will attract investment, talent and entrepreneurship,

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[10] Other examples include OPT/NET (anomaly detection), GrAI Matter Labs (augmented reality processing, now part of Snap Inc), IMChip (HPC in-memory chips) and Cimplic (tools for novel chip design, Cognigron spin-off).
[11] Topsector ICT (2024). Neuromorphic Computing in the Netherlands – White Paper.
[12] Greatorex et al. (2025). A neuromorphic processor with on-chip learning for beyond-CMOS device integration. Nature Communications 16.
[13] Ministerie van Economische Zaken en Klimaat (2024). De Nationale Technologiestrategie - Bouwstenen voor strategisch technologiebeleid.
[14] See for instance Firoozi et al. (2024). Advancing civil engineering: The transformative impact of neuromorphic computing on infrastructure resilience and sustainability. Results in Engineering - 24.
[15] For instance, ASML has funded NL-ECO to research the impact of neuromorphic computing on fabrication technologies.
[16] This idea is already in development, see Faro et al. (2023). Middleware for Quantum: An orchestration of hybrid quantum-classical systems. 2023 IEEE International Conference on Quantum Software.

strengthening the Dutch economy in key industries such as energy, medical technology and defence,[17] and reinforcing European technological leadership in the future of computing.

Right now, three concurrent actions are needed:

I. **Ecosystem development (currently in progress).** The creation of a "Dutch Neuromorphic Computing Alliance" that brings together scientific and commercial expertise in a common vision. This alliance will be responsible for involving domestic and international stakeholders, drafting a technological roadmap, developing joint programmes, and taking the lead in attracting public and private investment. Governance can be modelled after initiatives like QDNL (using sociocratic principles to manage a diverse ecosystem) and act as a next step for the current coalitions: NL-ECO and Mission 10^X.

II. **Market driven application lab.** Use case exploration and validation for more mature systems to demonstrate the competitive advantage of neuromorphic computing. This application lab will allow scientists and hardware/software developers to make their technology accessible to industrial end users and explore the integration of neuromorphic computing into their computational workflows, through the development of concrete demonstrators and tools that help with implementation.

III. **Prototyping facility for emerging technologies.** Investment in shared facilities to bring a new wave of neuromorphic computing technology out of the laboratory and towards fabrication. This infrastructure will allow the Netherlands to build new prototypes and will ultimately lead to a pilot line. Typically, no single university or company can shoulder these investments. Considering the strategic importance, it is an opportunity for a partnership with the existing technology transfer infrastructure of the semiconductor industry.

4. An Action Plan to Secure the Dutch Position

Figure 1 provides an overview, with a first operationalisation given below. The action plan prioritises investments at higher technological readiness first, with successfully developed use cases delivering an increased interest for stimulating research and development for the next generation of neuromorphic systems.

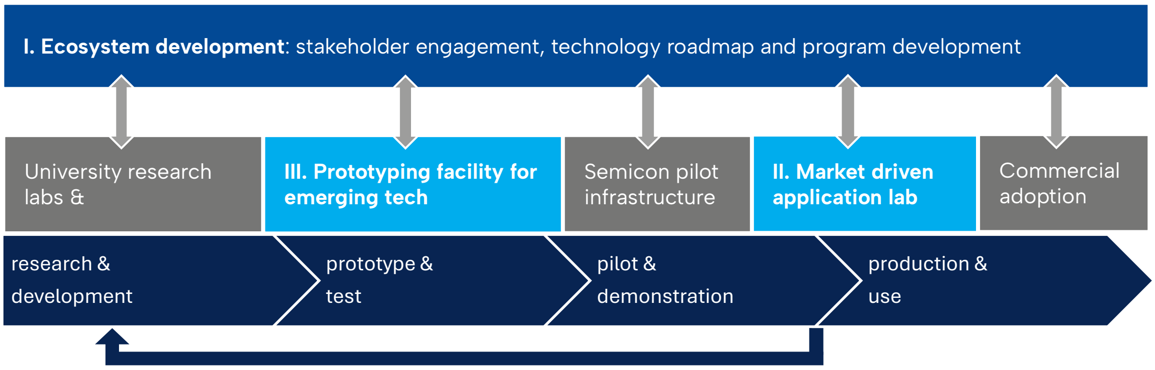

Figure 1: action plan for structural improvement of the Dutch ecosystem

I. Ecosystem development

Organising the Dutch neuromorphic field will increase the reach of the ecosystem and stimulate contributions to a shared agenda and technological roadmap. This will require some structural governance and management with representation from companies, research institutes and government. The organisation will need a small but dedicated core team and a steering committee, elected by the stakeholders. This team will organise working groups (e.g. for the technology roadmap), develop strategies to attract (competitive) funding, and provide support for developing project proposals and for executing projects across the technology stack.

Estimated cost €5M: ~€350k for the initial setup (9-12 months) and ~€1M per year running costs. This includes costs for management assistance, writing support, reports and website design, and organising workshops.

[17] Birch (2024). Neuromorphic technologies - Perspectief op nieuwe sleuteltechnologie

II. Market driven application lab

Key sectors of the Dutch economy and society (semiconductors, logistics, telecom, energy, science and education) rely on large-scale computing. Direct exploration of existing computational workflows on neuromorphic computers is challenging and relies on significant human effort and expertise. Consequently, revealing the advantage in performance of the current generation of neuromorphic computing technology, compared to classical methods, requires new testing and benchmarking infrastructure. The **application lab lowers the bar for users** to discover where neuromorphic computing creates value. It will provide:

- Concrete practical benchmark methodologies for end users to compare computational workflow results on key performance indicators like speed, energy efficiency, accuracy and reliability.
- Direct access to available neuromorphic hardware and help with installation, workshops, skills building, computational expertise and automated testing and deployment.
- Compelling demonstrators in relevant application domains to validate the commercial and societal value and to investigate opportunities for standardisation.
- The creation and integration of neuromorphic application developer toolsets such as open SDKs and reference designs to lower barriers for adoption.

Estimated cost €15M: ~€5M as an initial investment and a ~€10M operating budget for a 5-year term. Costs involve neuromorphic hardware, installation costs, workshops, software engineers, and generating visibility. The SURF Emerging Technology Platform can act as a model for this lab. These costs should increasingly be borne by private stakeholders and end users.

III. Prototyping facility for emerging technologies

Many discoveries from academic groups remain at university. Because the universities lack the facilities to further **convert their discoveries into production-ready systems**. The prototype facility aims to fill part of this gap by lowering the bar to prototype new materials, circuits, devices, and architectures in a production-like environment. It provides space for public-private research projects that aim to increase technology readiness.

This initiative can plug into existing and forthcoming semiconductor development facilities (such as imec) but will also require neuromorphic specific hardware, software and expertise. It can also enable building experiments with hybrid computation, by connecting neuromorphic computing to other emerging computing technologies such as quantum and photonic through a new orchestration layer.

Estimated cost €30M: ~€10M as an initial investment granting access to machinery for production and metrology and a ~€20M operating budget for a 5-year term.

Budget estimate

Total investment is ~€50M for a five-year programme. This programme functions as a flagship to draw out additional investments from other public and private stakeholders.

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