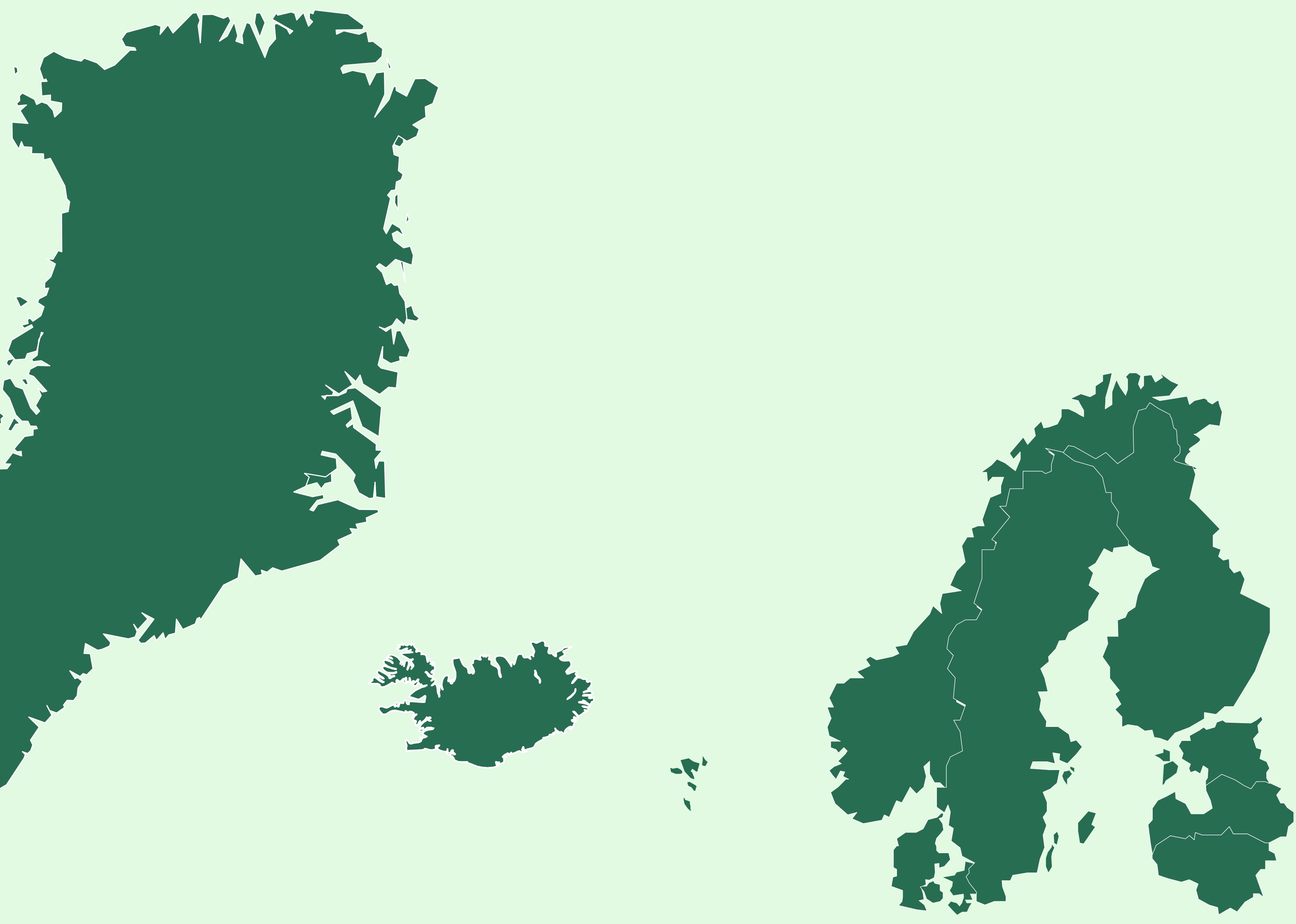
NordForsk

Nordic Quantum Technology Research Co-operation



Acknowledgements

I would like to express my sincere gratitude to my colleagues at Nordic Innovation — Stian Bergeland, Ville Mäkinen, and Olivia Rekman — for their invaluable support and useful discussions throughout this study.

I am deeply thankful to all the interviewees who generously shared their time, insights, and expertise, which formed the basis for my analysis.

I also extend my appreciation to NordForsk for providing the opportunity to conduct this study and for their continued commitment to advancing Nordic collaboration.

Special thanks go to the readers of early drafts for their thoughtful feedback and constructive suggestions, which helped improve the clarity and quality of this work.

Gudmund Høst, Special Adviser
22 October 2025

Disclaimer: This report is based on qualitative analysis of anonymized interviews conducted with stakeholders across the Nordic quantum technology ecosystem. While care has been taken to ensure a balanced and accurate representation of perspectives, the findings may reflect inherent limitations of qualitative research, including potential representation bias due to the selection and availability of interviewees.

The views and interpretations expressed in this report are solely those of the author and do not necessarily reflect the official positions or policies of NordForsk or any affiliated institutions.

Furthermore, both the policy and technological landscapes in quantum science are evolving rapidly. As such, some information presented in this report may have changed since the time of writing.

Executive summary

This report assesses Nordic quantum collaboration across research, infrastructure, and innovation, outlining joint steps for funders and performers. Coordinated efforts can accelerate progress and strengthen the Nordics' international position in quantum technologies.

Quantum computing, communication, and sensing are advancing rapidly, with transformative potential in cybersecurity, healthcare, energy, and finance. The Nordic countries offer complementary strengths—world-class research institutions, advanced infrastructure, and a tradition of collaboration.

Key findings:

- Strategic national investments have created a foundation for regional synergy.
- Stakeholders value pooling resources, aligning strategies, and joint innovation.
- Fragmented funding, limited infrastructure sharing, and administrative hurdles constrain collaboration.
- Existing initiatives (e.g., Nordic Quantum network, NordIQuEst, Nordic Quantum Life Science Roundtable) provide platforms for shared access and scale-up.
- Researchers and infrastructure providers strongly support joint funding, shared infrastructure, and inclusive governance.

To address these challenges and capitalise on opportunities, the report recommends:

- Launching a sustainable, region-wide funding program for research, infrastructure, and commercialization – drawing inspiration from the Nordic Top-level Research Initiative (TRI, 2009–2016).
- Building a Nordic framework for cross-border collaboration through a coordination forum to align strategies and streamline governance.
- Creating a federated infrastructure network with shared access to cleanrooms, testbeds, and laboratories.
- Strengthening industry–academia partnerships via innovation clusters, co-funded placements, and joint public-private R&D.
- Supporting a Nordic quantum startup ecosystem with incubators, accelerators, harmonized IP policies, and early-stage funding.
- Advancing talent and mobility through joint PhD programs, fellowships, and coordinated quantum literacy initiatives.
- Focusing on joint use-case development by identifying shared priorities, launching cross-border pilot projects, and promoting interdisciplinary collaboration.

These recommendations are actionable and scalable, offering clear entry points for sponsors. By investing in shared Nordic initiatives, stakeholders can amplify impact, reduce duplication, and help shape a globally competitive quantum ecosystem rooted in Nordic values and excellence.

Table of contents

Introduction

This report is designed to support strategic decision-making. For a concise overview of the study's purpose and scope, please refer to Objectives and Scope of the Report. For insight into the methodological approach, including stakeholder interviews and supporting analysis, see Methods and Material. These sections provide essential context for interpreting the findings and recommendations that follow.

Background

Quantum technologies (computing, communication and sensing) are advancing fast and moving from lab to deployment. The study explores where Nordic research strengths, infrastructure and policy instruments can deliver near term collaboration wins and build credible, longer term capability. I concentrate on actions that enable shared access to facilities, align funding mechanisms, strengthen talent mobility, and turn use case pilots into scalable results across the region.

At a glance

What we mean by "quantum technologies": computing (algorithms + hardware), communication (quantum key distribution/quantum-secure links), and sensing (precision measurement).

Why it matters now: near-term impact in security, health, energy, and advanced manufacturing; growing EU momentum and funding instruments.

What the Nordics already have: strong research groups, national facilities, and active cross-border networks.

What's missing: friction in cross-border access/funding; fragmented governance; talent mobility constraints.

This report does: prioritises joint actions where coordination changes outcomes (infrastructure access, funding mechanisms, talent, pilots).

Importance of Nordic Co-operation in Quantum Technology Research

Nordic cooperation in quantum technology is crucial for several reasons (1), (2):

Pooling Expertise and Resources: The Nordic countries each have strong research institutions and technological capabilities. By collaborating, they can pool their expertise and resources to tackle complex quantum challenges more effectively.

Global Competitiveness: The combined efforts of Nordic countries can position them as a leading global player in quantum technology. This cooperation enhances their visibility and attractiveness as partners for international academic and business collaborations.

Innovation and Standardization: Joint efforts in research and development can lead to innovative breakthroughs and the establishment of common standards in quantum technologies. This is essential for creating interoperable systems and fostering a robust quantum ecosystem.

Strategic Autonomy: By working together, Nordic countries can ensure their strategic autonomy in quantum technology, reducing dependence on non-European entities. This is vital for maintaining control over critical technologies and safeguarding national interests.

Economic Growth: Quantum technology has the potential to revolutionize various industries, from healthcare to cybersecurity. Nordic cooperation can accelerate the commercialization of quantum innovations, drive economic growth and create new business opportunities.

Educational and Research Excellence: Collaborative initiatives can enhance educational programs and research opportunities, thereby attracting top talent and fostering a new generation of quantum scientists and engineers.

Objectives and Scope of the Report

The study on Nordic collaboration opportunities within quantum technology was initiated by NordForsk based on discussions with national research funding organisations. The mandate was approved through the Director´s Decision No 289 on December 13, 2024.

The study aims to evaluate the potential for enhanced research and innovation cooperation on quantum technology among Nordic countries. This includes mapping current initiatives, analysing the funding landscape, and examining the roles of key institutions to find opportunities for improved coordination and address gaps. The study intends to help position the Nordic region in the global quantum technology landscape.

A status report was presented to NORDHORCS and the NordForsk board in Stockholm on March 18, 2025. The following day, the NordForsk board decided to request a draft proposal for a decade-long strategy for Nordic collaboration in quantum technology research and innovation. This strategy will involve national research and innovation funders, Nordic Innovation, and the Nordic Council of Ministers Secretariat.

Like NordForsk, Nordic Innovation operates under the auspices of the Nordic Council of Ministers. While NordForsk focuses on advancing research collaboration within the Nordic countries, Nordic Innovation's objective is to foster sustainable growth and boost competitiveness in the region. Nordic Innovation has been promoting quantum technology through various initiatives and collaborations. A noteworthy example is the report Nordic-Baltic Quantum Ecosystem from a project carried out by VTT Technical Research Centre of Finland as part of Nordic Innovation's program "Nordic Forward: Resilience and competitiveness for 2050". That report, which provides a detailed overview of the Nordic-Baltic quantum business ecosystem, complements and informs my study.

Through 2024-25, NordForsk and Nordic Innovation have increasingly interacted on quantum technology, beginning with information sharing and progressing to regular coordination meetings. This collaboration has resulted in several changes and adaptations to my study, aimed at promoting efficiency and ensuring unique contributions. The resulting focus is now on adopting a more integrated view of the research and innovation ecosystem, aiming to foster greater collaboration and synergy between funding organizations and within the community of research and innovation performers. This approach seeks to enhance coordination, maximize resource utilization, and ensure that all stakeholders contribute uniquely and effectively to the advancement of quantum technology.

This report's findings and recommendations have been validated in focus groups with both national infrastructure providers and leading Nordic quantum researchers. Their feedback has ensured that the analysis is not only comprehensive and up-to-date, but also reflects the practical realities, priorities, and challenges faced by the Nordic quantum community.

Methods and material

Data and Qualitative Analysis

Initially, I asked national funding agencies for a 30-minute conversation to gather insights and identify key institutions and contacts within quantum technology in each country. Additional contacts were gathered from discussions with Nordic Innovation colleagues and interviews with experts. In total, I interviewed more than 30 persons from six countries. These were mainly researchers and research leaders, but also public and private funding agency representatives.

Candidates were contacted by email with requests for 60-minute interviews. The interviews were subjected to qualitative analysis following a multi-step procedure. Initially, the interviews were transcribed, converting the audio recordings into written text. Subsequently, the transcripts were examined to identify recurring themes, patterns, and categories within the interview responses. Following this identification process, the material was analysed further to extract key themes and insights, which were then utilized to inform lessons, recommendations, and conclusions.

Interview Blueprint

The interview sessions started with me outlining the purpose of the study. The aim of the interviews was to gather valuable insights from key stakeholders in quantum technology to enhance collaboration and drive innovation across the Nordic region.

The approach involved conducting semi-structured interviews, allowing for flexible yet focused conversations. Each interview was recorded, transcribed, reviewed, and analysed. Participants remained anonymous, and their consent for recording was requested. There were specific questions for different groups like funding agencies, researchers, innovators, industry reps, private foundations, and national providers of digital infrastructure. The general questions focus on various aspects of quantum technology, including roles, funding situations, strategic priorities, current research projects, challenges in bringing innovations to market, company involvement, foundation priorities, and the state of high-performance computing (HPC) and quantum technology infrastructure. These questions aim to gather comprehensive insights into the development, implementation, and support of quantum technology in different contexts.

The National-Level Questions aim to understand how the transition from basic research to applied research and commercialization is supported, as well as the development and maintenance of quantum technology infrastructure in the country. They seek insights into collaboration with private foundations in funding quantum technology projects and the support provided for the commercialization and industrial adoption of quantum technologies. Additionally, the questions address the management of risks associated with funding high-risk, high-reward quantum technology projects and the strategies to tackle the shortage of skilled labour in the quantum computing sector.

The Nordic-Level Questions focus on exploring the potential for increased cooperation among Nordic countries in funding quantum technology initiatives. They seek to understand how funding agencies can better support cross-border sharing of resources like infrastructure and testbeds, and how Nordic institutions can enhance research efforts. Additionally, the questions aim to identify ways to create a more favourable environment for industry investment in quantum technology and how private foundations can contribute to enhancing Nordic cooperation in this field.

The EU-Level Questions focus on understanding how national strategies align with EU initiatives and how collaboration with EU initiatives on quantum technology is currently being managed. They also seek to identify the benefits of enhancing cooperation with EU researchers and innovators in quantum technology. Additionally, the questions aim to explore ways to better align Nordic and EU research efforts to support the development of quantum technology.

The interviews were concluded by asking for any additional thoughts or key contacts that the interviewees might want to add.

Input from Focus Groups and National Reviewers

To validate the findings, two focus group sessions were held in August and September 2025: one with quantum and e-infrastructure providers from Denmark, Finland, and Norway, and one with 16 leading Nordic quantum researchers, facilitated by the Nordic Quantum network. Providers stressed prioritization, federated access, and leveraging existing initiatives such as NordIQuEst. Researchers emphasized inclusive governance, long-term funding, talent mobility, and balanced national representation. Together, their input grounded the report in both strategic vision and practical feasibility (see Appendix III).

In parallel, a draft of the report was circulated to national experts across the Nordic and Baltic countries with a request for feedback. Experts were invited to review the sections describing their respective national quantum landscapes and, where possible, to share and coordinate input from other stakeholders. These contributions aimed to help reflect each country's perspective as accurately and thoughtfully as possible in the final version.

Desk Study

I have reviewed the available national strategy and position papers on quantum technology from various Nordic countries, as well as documents from outside the Nordics. Additionally, I have examined European strategies to gain an understanding of the current landscape and collaborative efforts in quantum technology development.

Interactions with Nordic Innovation

During my work, I benefitted greatly from interaction with colleagues in Nordic Innovation. In particular, the Mapping of Nordic-Baltic Quantum Ecosystem project, aimed to provide a comprehensive overview of the quantum technology landscape across the Nordic and Baltic region. The project, in collaboration with VTT Technical Research Centre of Finland, focused on identifying and analysing key players, initiatives, best practices, strategies, and opportunities within the quantum sector. It also assessed the maturity levels of quantum research and development, highlighted potential areas for collaboration and growth, and informed policy and investment decisions with data-driven insights. The project sought to catalyse collaboration among academia, industry, and government stakeholders, strengthen the region's competitive edge, drive economic growth through quantum advancements, and support informed decision-making for long-term technology roadmaps. VTT collected data through surveys, interviews, and stakeholder workshops, and produced a comprehensive report and visualization of the ecosystem, which was published in June 2025 (3).

Stakeholder Engagement and Strategic Events

In addition to the structured interactions outlined in the Focus Groups section, I also had the opportunity to engage with stakeholders and subject-matter experts throughout the through the following meetings and networking activities:

- Joint meeting of NORDHORCs and NordForsk Board, Stockholm, 18. March. Following the Stockholm meeting, the NordForsk Board decided to draft a proposal for a 10-year strategy for Nordic collaboration in research and innovation on quantum technology, involving the national funders of research and innovation, Nordic Innovation, and the Nordic Council of Ministers Secretariat.

- On April 3, 2025, I presented preliminary findings to the Nordic e-Infrastructure Collaboration (NeIC) in Oslo and discussed infrastructure-related aspects of Nordic quantum cooperation.

- I was invited to give a presentation at the QIT Norway 2025 Workshop; a two-day event hosted by Simula Research Laboratory, Oslo Metropolitan University, and Sigma2, which took place on May 12-13, 2025. The workshop brought together quantum experts and enthusiasts for inspiring presentations and gave me the opportunity to engage in discussions on various topics in quantum technology, including quantum computing, quantum sensing, quantum-secure communication, and quantum AI.

- I participated in The IQT Nordics 2025 event, which took place in Gothenburg, Sweden, from May 20-22, 2025, focusing on real-world applications and progress enabled by quantum technology. In additions to very interesting discussions and contacts this also gave me the opportunity to visit Chalmers Next Labs at Chalmers University of Technology.

- I was invited to participate in a panel discussion during the Finnish Quantum Days 2025 event, hosted by InstituteQ and the Finnish Quantum Flagship. The event took place on September 3-4, 2025. It celebrated 60 years of low-temperature quantum science and technology in Finland, marked the official co-launch of the Finnish Quantum Strategy with the Finnish government, and honoured UNESCO's International Year of Quantum.

Current Landscape of National Strategies

This chapter offers a comparative overview of national quantum technology strategies across the Nordic region, highlighting each country's ambitions, investments, and timelines. For a country-specific analysis of research strengths, weaknesses, opportunities, and threats, see the SWOT analyses in the Research Landscape Section. To understand how these national efforts connect through regional collaboration, refer to Joint Nordic Initiatives, which highlights ongoing cross-border projects and shared infrastructure.

Globally, there is a clear and accelerating trend toward comprehensive national quantum strategies, momentum that the Nordic countries are increasingly aligning with. Major non-Nordic nations have taken decisive steps in recent years: the United States enacted its National Quantum Initiative Act in 2018; China and Germany significantly increased funding around 2020; France launched its Plan Quantique in 2021; and Canada introduced its National Quantum Strategy in 2023. In parallel, the European Union has advanced several large-scale initiatives, including the €1 billion Quantum Flagship (launched in 2018), the European Quantum Communication Infrastructure (EuroQCI) program for secure quantum communication, and the EuroHPC Joint Undertaking, which began integrating quantum computers into European supercomputing infrastructure in the early 2020s.

In July 2025, the European Commission adopted the Quantum Europe Strategy (4), aiming to make Europe a global leader in quantum technologies by 2030. The strategy focuses on five key areas: advancing research and innovation, building scalable quantum infrastructure, supporting startups and industrialization, integrating quantum into space and security applications, and developing a skilled workforce. It seeks to overcome fragmentation across Member States and foster a coordinated, competitive European quantum ecosystem.

These developments have helped shape a continental framework that some Nordic countries are beginning to engage with more actively. As emphasized by the Nordic Prime Ministers in May 2025, there is a significant opportunity to foster a more coordinated and unified Nordic approach: one that fully leverages the growing European momentum, collaborative partnerships, and funding mechanisms in quantum technologies.

Denmark has adopted a dual-track approach that combines foundational research with commercialization. Finland is pursuing a long-term vision of quantum-driven economic growth. Sweden is considering the development of a national strategy for quantum technology, where the Wallenberg Centre for Quantum Technology serves as an important forerunner. Together, the Nordic countries are positioning themselves as global contributors in the quantum landscape. Norway and Iceland are also advancing their national capabilities, with Norway initiating a strategic framework and Iceland progressing from fundamental research to quantum applications, and integrating quantum into its digital infrastructure. No government-level quantum strategies were identified for the Baltic states; while Estonia, Latvia, and Lithuania have launched initiatives and roadmaps, none constitute formal national strategies dedicated solely to quantum technology.

For a visual summary of the timelines and durations of these initiatives, see Figure 1.

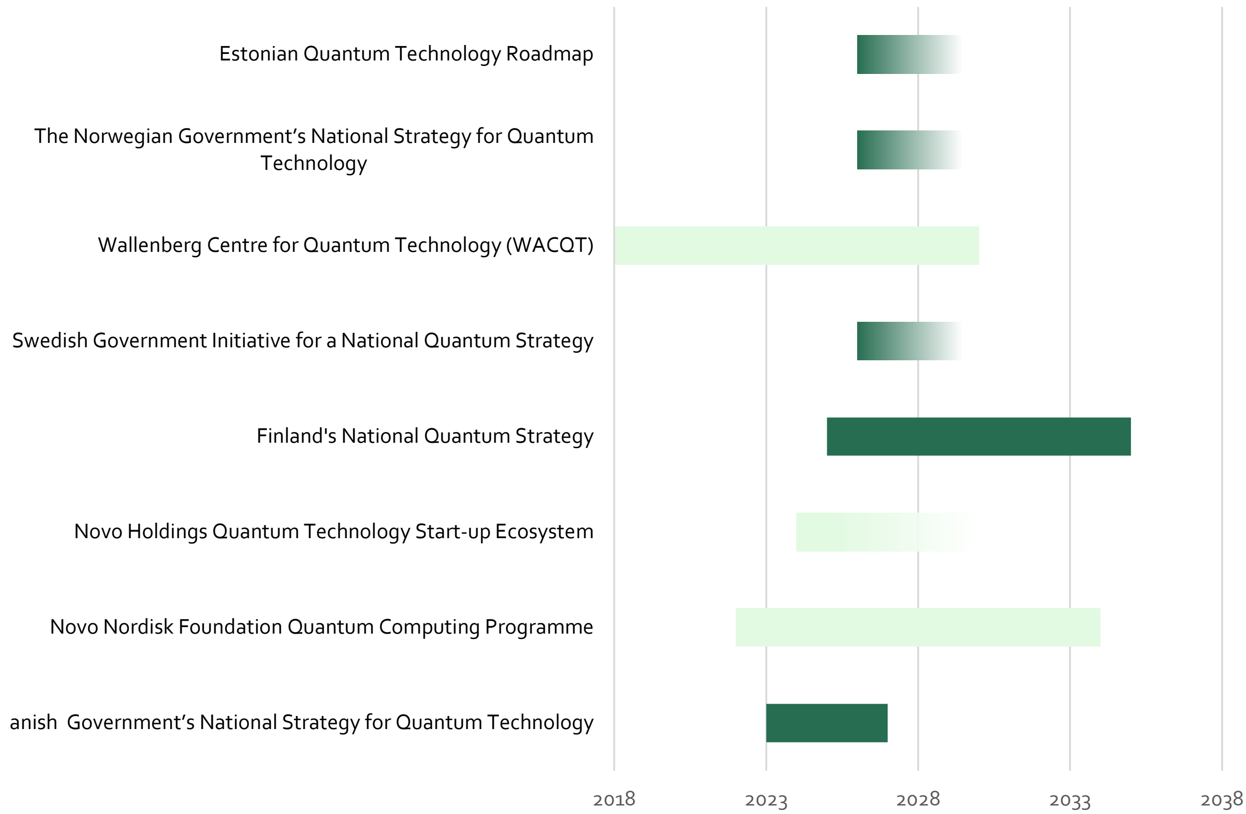


Figure 1: Durations of national strategies (dark) and long-term private programs (light).

Denmark

The Danish Government's National Strategy for Quantum Technology

Duration: The strategy spans from 2023 to 2027.

Investment: Denmark has allocated 1 billion DKK public funding into quantum research and innovation over this five-year period.

Denmark's National Strategy for Quantum Technology, outlined in two parts, aims to position the country as a global leader in quantum research and innovation while ensuring the secure and responsible development of quantum technologies. Part 1 (5) focuses on foundational investments in research, talent development, and infrastructure. It introduces a strategic program to support both basic and applied research, encourages interdisciplinary collaboration, and promotes access to quantum computing platforms and test facilities. The strategy also emphasizes the importance of translating scientific breakthroughs into practical applications, particularly in sectors like healthcare, cybersecurity, and climate modelling.

Part 2 (6) builds on this foundation by targeting commercialization, security, and international cooperation. It proposes initiatives such as the establishment of Quantum House Denmark, a national test centre, and a European quantum fund to support startups and scale-ups.

Public-private partnerships are central to this effort: the strategy highlights collaboration between universities, startups, and established companies to develop use-cases and demonstration projects in areas such as drug discovery, logistics optimization, and secure communications. The government aims to support such partnerships through targeted funding, shared infrastructure, and talent development programs. These efforts are designed to accelerate the commercialization of quantum technologies and ensure that Denmark's strong research base translates into economic and societal benefits.

Security is a central concern, with measures to protect critical infrastructure and prevent misuse of quantum technologies. The strategy also includes efforts to enhance talent pipelines and regulatory frameworks, ensuring that Denmark remains competitive and resilient in the face of rapid technological change.

Innovation Fund Denmark is a key implementing body for the Danish national quantum strategy. It channels a significant portion of the strategy's funding through its "Grand Solutions" program, which supports large, ambitious quantum technology projects involving both research institutions and companies. Innovation Fund Denmark has also initiated and driven a market oriented international program for applied quantum technologies in the EUREKA network. The fund's calls and priorities are directly shaped by the national strategy, and its programs are designed to bridge research and innovation, in line with Denmark's strategic goals for quantum technology.

Nordic and International Collaboration

Denmark's strategy places strong emphasis on international partnerships, particularly within the EU and among like-minded nations. It supports active participation in EU programs like Horizon Europe and EuroQCI and seeks to strengthen ties with Nordic neighbours and global allies through bilateral agreements and multilateral initiatives. The creation of an international quantum hub is intended to promote Danish leadership in global standardization efforts and facilitate strategic partnerships. These collaborations are seen as essential for scaling innovation, securing supply chains, and ensuring that quantum technologies are developed in alignment with democratic values and security interests.

Novo Nordisk Foundation Quantum Computing Programme

Duration: The programme spans 12 years from 2022 to 2034.

Investment: Novo Nordisk Foundation has committed 2.0 billion DKK to develop a fully functional quantum computer.

Anchored at the Niels Bohr Institute at the University of Copenhagen, the programme is mission-driven and focused on developing a fault tolerant quantum computer, a so-called Level 3 quantum computer, with the long-term goal of solving complex problems in the life sciences, such as drug discovery, genomics, neuroscience, and epidemiology. Quantum computing is seen as uniquely suited to these challenges due to its ability to model quantum mechanical systems that are currently beyond the reach of classical computers (7), (8).

Of the total investment, approximately DKK 1.1 billion is allocated directly to Novo Nordisk Foundation Quantum Computing Programme (NQCP), which is structured around interdisciplinary collaboration across quantum hardware, software, and algorithm development. The first seven years focus on materials research and platform selection, comparing four quantum modalities within a structured framework. The final five years are dedicated to scaling the chosen technology toward practical applications.

An additional DKK 900 million supports the Quantum Foundry, a specialized fabrication facility that develops advanced quantum materials and chip technologies to underpin NQCP's hardware ambitions. The programme also emphasizes international collaboration, engaging research groups from Denmark, the United States, Canada, and the Netherlands to build a globally integrated quantum ecosystem (7), (8).

Complementing NQCP, the Magne initiative represents a major step forward in Nordic quantum infrastructure. Funded by the Novo Nordisk Foundation and the Export and Investment Fund of Denmark, Magne is a Level 2 quantum computer built on logical qubits, offering significantly improved stability and error correction over earlier systems. Construction of Magne begins in autumn 2025, with operational readiness expected around the turn of 2026/27 (9). The initiative is housed within the newly established company QuNorth, based in Copenhagen, and aims to provide Nordic researchers and industries with access to cutting-edge quantum capabilities. Magne will be delivered through a partnership between Atom Computing and Microsoft, integrating advanced neutral atom hardware with full-stack quantum software. The project is designed to bridge the gap until Level 3 fault-tolerant quantum computers, such as those being developed under NQCP, are ready after 2030 (9).

Novo Holdings Quantum Technology Start-up Ecosystem

Duration: The investment period began in 2024.

Investment: Novo Holdings has committed 1.4 billion DKK to build a quantum technology start-up ecosystem.

Novo Holdings aims to establish a quantum technology start-up ecosystem, with Denmark as its central hub (10). The initiative aims to invest in and support some of the world's most promising quantum technology companies, particularly those with applications in the life sciences. This strategic move builds on Denmark's strong momentum in quantum research and its historical legacy in the field, dating back to Niels Bohr.

The investment will be anchored within Novo Holdings' Seed Investments division, where a dedicated Quantum Investments team will focus on quantum computing, sensing, and algorithms – areas with high relevance to healthcare and broader life sciences. While Denmark will serve as the primary base, the investment mandate is global, allowing for opportunities beyond the Nordics. The strategy complements the Novo Nordisk Foundation's broader efforts, including the NQCP and The Quantum Foundry, by ensuring that sufficient venture capital is available to commercialize emerging quantum technologies. The initiative also aligns with national and regional efforts, including support from the Danish government and the BioInnovation Institute's Deep Tech Lab – Quantum (10).

Finland

Finland's National Quantum Strategy

Duration: 2025-2035. The strategy aims to make quantum technology a core driver of economic growth and sustainability by 2035.

Investment: The strategy emphasizes targeted investment in education, infrastructure, and industry access to quantum systems, although specific monetary amounts are not detailed.

Finland's Quantum Technology Strategy 2025–2035 outlines a national vision to become a global leader in quantum technologies by fostering a competitive, skilled, and reliable ecosystem (11). The strategy emphasizes the development of quantum computing, sensing, and communication, aiming to integrate these technologies into Finnish industry and society. It sets ambitious targets, including growing the sector's turnover to €3 billion and creating 10,000 jobs by 2035. The strategy builds on Finland's long-standing strengths in superconductivity, cryogenics, and photonics, and leverages its robust research infrastructure and collaborative ecosystem involving universities, research institutes, and companies.

To achieve these goals, the strategy proposes a comprehensive set of measures, including the establishment of a Quantum Competence Centre, the development of a 1,000 logical-qubit quantum computer, and the deployment of quantum-secure encryption. It also calls for long-term research, development and innovation funding, international cooperation, and targeted support for start-ups and scale-ups. Finland aims to position itself as a trusted international partner, actively participating in EU and global standardization efforts while ensuring national security through quantum-resilient infrastructure. The strategy reflects Finland's commitment to responsible innovation and its ambition to turn quantum technology into a new engine of sustainable economic growth.

Finland's quantum strategy emphasizes the importance of Nordic and international collaboration as a key pillar for achieving its long-term goals. The strategy recognizes that as a small country, Finland must leverage partnerships with like-minded nations to amplify its impact and access complementary expertise, infrastructure, and markets. Nordic cooperation is seen as a natural and strategic extension of Finland's efforts, given shared values, geographic proximity, and existing scientific and industrial ties. The strategy encourages deeper collaboration with Nordic countries in areas such as joint research, infrastructure sharing, standardization, and the development of secure and interoperable quantum technologies.

Sweden

Swedish Government Initiative for a National Quantum Strategy

Duration: Potentially from 2026.

Investment: For 2027, SEK 50 million is reserved for a strategic initiative in quantum technology and SEK 100 million is projected for 2028.

As of mid-2025, Sweden is in the process of developing a national quantum strategy for the period 2025–2030. The Swedish Research Council has been tasked by the government to prepare the foundation for this strategy. The goal is to strengthen Sweden's position in quantum technology through enhanced research, education, innovation, and international collaboration. The strategy will also address the security and defence implications of quantum technologies, including the need for protective measures, global standards, and secure international partnerships.

Sweden has already developed a Quantum Agenda in 2023, which outlines nine priority areas to guide national efforts. These include fostering public-private collaboration, accelerating commercialization, and ensuring Sweden remains competitive in the rapidly evolving global quantum landscape. The agenda and upcoming strategy reflect Sweden's recognition of quantum technology as a strategic research area, as highlighted in the 2024 national research bill (12).

As part of this effort, quantum technologies have been designated a strategic research area. An initiative with deadline 4. November 2025 aims to reinforce Sweden's capabilities and global standing in quantum science, while also making Swedish research environments more attractive for international collaboration. Funding has been earmarked specifically for this purpose: SEK 50 million in 2027, rising to SEK 100 million in 2028.

Wallenberg Centre for Quantum Technology (WACQT)

Duration: The programme spans from 2018 to 2029.

Investment: The Knut and Alice Wallenberg Foundation has committed SEK 1.4 billion to the WACQT programme, with a target of developing a 100-qubit quantum computer by 2029.

The Wallenberg Centre for Quantum Technology (13) (WACQT) is a national research initiative aimed at positioning Sweden at the forefront of quantum technology. Directed from Chalmers University of Technology and involving several Swedish universities, WACQT focuses on developing Swedish expertise in quantum computing and simulation, quantum communication, and quantum sensing. Its flagship project is the development of a high-end quantum computer with a target of 100 qubits by 2029. A copy of this quantum computer is made available as a testbed to help researchers and industry translate real-world problems into executable quantum algorithms.

WACQT's strategy emphasizes openness, collaboration, and knowledge exchange. It includes a national graduate school in quantum technology, a guest researcher program, and strong industrial partnerships to bridge academia and industry. A recent agreement with IBM, supported by a SEK 50 million grant from the Knut and Alice Wallenberg Foundation, allows Swedish organizations to test algorithms on Chalmers' quantum testbed and scale up on IBM's more powerful quantum systems via the cloud (14). This dual-access model is designed to lower the barrier for Swedish academia and industry to engage with quantum computing, while fostering innovation and practical application of quantum technologies.

Norway

Duration: Potentially from 2026.

Investment: The government has allocated NOK 70 million annually from 2025 to strengthen national research in quantum technology.

In the national budget for 2026, the government proposes that additional NOK 150 million be allocated annually for five years to a new initiative aimed at promoting quantum technology in industry. The goal is to build selected technology communities to develop new business opportunities within quantum technology. In addition to this, the Government proposes expanding educational capacity in quantum technology by creating 100 new student places to ensure future expertise for Norwegian research and technology-based industry.

In May 2025, the Norwegian government officially launched the process of developing a national strategy for quantum technology, aiming to follow in the footsteps of countries like Denmark and Finland. The strategy will be built on a knowledge base prepared by the Research Council of Norway, Innovation Norway, and the Norwegian National Security Authority. The goal is to build internationally competitive research environments across all three core areas of quantum technology.

Iceland

Iceland's quantum landscape is advancing through active research, infrastructure development, and national coordination. The University of Iceland leads several projects in spintronics, magnetic metamaterials, and quantum sensing, including a Nordic collaboration with NTNU and KTH on Quantum LIDAR. It hosts Iceland's only cleanroom facility and is part of the Nordic Nanolab Network, with strong capabilities in quantum and nano-materials research. Reykjavik University contributes through its Nanophysics Center, focusing on quantum transport and silicon nanowire-based sensors. National efforts are further supported by IHPC Iceland, which integrates quantum expertise into the country's digital infrastructure.

The Baltics

Estonia

Estonia is currently developing its first national quantum technology roadmap, with a tentative timeline of 2026 and a 5–10 year perspective.
The work is coordinated by Metrosert, the national metrology and applied research institute, on assignment from the Ministry of Economic Affairs.

Duration: Potentially from 2026.

Investment: Not known.

The anticipated content of the Estonia quantum roadmap includes a focus on quantum sensing, metrology, and communication, as well as quantum software applications leveraging Estonia's strong IT sector.

The Estonian National Digital Decade Strategic Roadmap 2023 (15) references emerging technologies broadly, including artificial intelligence, 5G/6G, and new computing technologies such as quantum. Quantum technology is mentioned as part of a list of transformative technologies, but no specific initiatives, investments, or strategic actions related to quantum computing, communication, or sensing are outlined in the roadmap. The focus remains on enhancing digital infrastructure, public services, and innovation capacity across sectors, with quantum technology positioned as a future-facing area to monitor rather than a current strategic priority.

Latvia

Latvian Quantum Initiative (16) brings together Latvia's leading scientists and teaching staff in the field of quantum technologies with the aim of supporting knowledge, skills, technologies and ideas related to practical applications of quantum physics.

Duration: The initiative is ongoing.

Investment: Specific investment figures are not known.

In 2023, Latvia's Ministry of Foreign Affairs joined a Memorandum of Understanding (MoU) on the Development of Quantum Technologies in Latvia (17). This MoU aims to unify national efforts and foster sustainable cooperation among academic, governmental, and industrial stakeholders. The strategy emphasizes Latvia's ambition to become a testbed and development environment for emerging quantum technologies. It highlights the importance of international cooperation, particularly within EU and NATO frameworks, to align with allied standards and advance quantum research and applications. A key focus area is the security sector, where Latvia is preparing for the "quantum era" by developing quantum communication infrastructure and exploring new encryption methods to counter the risks posed by quantum computing to current cryptographic systems. The initiative also seeks to promote Latvia's achievements in quantum technologies globally and attract international partners by leveraging its diplomatic network and scientific expertise.

Lithuania

The Lithuanian Quantum Technologies Association (Quantum Lithuania) was established in 2023 and brings together scientific and business organizations with the common goal of developing Lithuania's quantum technologies ecosystem and enhancing its international competitiveness. The association was founded by Vilnius University, the Centre for Physical Sciences and Technology, and the information technology company Novian Technologies. In 2025, Quantum Lithuania put forth the Lithuanian Quantum Technologies Agenda (18).

Duration: The initiative spans from 2025 to 2035, representing a community-driven proposal rather than an officially approved government strategy.

Investment: A projected €65 million in national funding is required through 2035 to support research, infrastructure, commercialization, and talent development in the quantum sector, underlining Lithuania's ambition to become a regional leader.

The agenda provides a detailed roadmap, positioning Lithuania as a regional leader in quantum technologies. It focuses on four core pillars: quantum computing, quantum simulation, quantum communication, and quantum sensing and metrology. Critical sectors such as healthcare, national security, biotechnology, energy, and advanced materials are highlighted for their potential applications through quantum technologies, rather than as officially designated national priority areas. This aligns with Lithuania's vision of evolving into a high-value, innovation-driven economy.

Lithuania's strong scientific foundation in lasers, photonics, and materials science supports the agenda, with over ten active research groups already contributing across all quantum technology areas. Key proposals include the establishment of a national quantum technologies program, a dedicated Quantum Hub, and the integration of quantum content into higher education curricula. Additionally, there is a call for the enhancement of high-performance computing (HPC) infrastructure to support hybrid quantum-classical computing, increased involvement in EU and NATO quantum initiatives, and investment in secure quantum communication infrastructure.

Lithuania is strategically positioned to act as a Nordic–Baltic bridge by facilitating federated access to testbeds and cleanrooms, co-funding joint postdoc and industry placements with countries like Finland, Sweden, and Denmark, and positioning Lithuanian pilots as cross-border use cases in secure communication and sensing. This role is presented as a strategic opportunity rather than a formalized position in the Agenda.

Commercialization is a key focus, with recommendations to capitalize on Lithuania's strengths in enabling technologies and enhance collaboration between academia and industry. At the same time, the Agenda underlines current gaps: Lithuania lacks dedicated quantum technology startups, and talent shortages remain a key challenge. Addressing these weaknesses is essential alongside fostering commercialization opportunities.

Additionally, the strategy addresses national security risks posed by quantum technologies by advocating for post-quantum cryptography adoption and secure communication systems development. Participation in international quantum technology projects and networks is considered crucial to achieving a globally competitive ecosystem.

Overall, the Agenda offers a community-driven framework to leverage quantum technologies for economic growth, technological sovereignty, and societal benefits.

Current Landscape of Quantum Technology Research in the Nordic Region

In this chapter, an overview of quantum technology research in each country will be provided before examining the Nordic region as a whole. The overarching view is that quantum technology research within the Nordic region represents a dynamic and rapidly advancing field, characterized by robust academic foundations, national initiatives, and increasing industry involvement. Each Nordic country contributes distinct strengths to the quantum ecosystem.

Geopolitical tensions are increasingly influencing national strategies for quantum technology. While some respondents view these developments as a strategic or political threat – raising concerns about technological dependence and security – others see them as a catalyst for progress. The heightened urgency for investment and innovation across Europe can create favourable conditions for individual countries to strengthen domestic capabilities, attract funding, and position themselves as key contributors to technological sovereignty.

A summary of observations is given in Table 1, details from each country follow below.

Country	Strengths	Weaknesses	Opportunities	Threats
Denmark	Strong public-private funding (e.g., Novo Nordisk Foundation), leading institutions like Niels Bohr Institute	Fragmented coordination	Nordic/EU collaboration, commercialization	Dependency on private funding, geopolitical risks
Finland	Superconducting hardware, InstituteQ, strong infrastructure	Limited private investment, software lag	Kvanttinova cleanroom, EU alignment	Brain drain, global competition
Sweden	WACQT, Wallenberg funding, strong research base	Fragmented coordination, reliance on private funds	National strategy in development, Nordic synergy	Talent drain, infrastructure sustainability
Norway	Quantum software, sensor tech, interdisciplinary research	Fragmented research, limited infrastructure	Strategy in development, Nordic partnerships	Lagging behind peers, funding gaps
Iceland	Quantum annealing expertise, theoretical and experimental research on nanowires, international collaborations	Small ecosystem, limited infrastructure	Nordic integration, sensing applications	EU access limitations, faculty shortages, funding challenges

Table 1. Comparative SWOT matrix based on interviews.

Denmark

Overview

Denmark is making strides in quantum technology with investments from the Novo Nordisk Foundation and public funding. The nation focuses on superconducting qubits, spin qubits, neutral atoms, ion traps and photonic-based qubits. Denmark has built a strong ecosystem for quantum startups, aided by the Danish Quantum Community, Deep Tech Lab Quantum, and Quantum Denmark. It also participates in the European Quantum Communication Infrastructure (EuroQCI) and has started a national quantum communication project.

Based on the Nordic Quantum White Paper (3), the key actors involved in quantum technology research include institutions, networks and programs such as:

- **Niels Bohr Institute, University of Copenhagen**: A central hub for quantum research, particularly in quantum computing, sensing, algorithms, and communication.
- **Technical University of Denmark (DTU)**: Strong in quantum photonics, sensing, engineering and nanotechnology.
- **Aarhus University, University of Southern Denmark (SDU), and Aalborg University**: Strong in quantum mathematics, physics and chemistry and education.
- **Danish Quantum Community (DQC), Quantum Denmark and Deep Tech Lab - Quantum**: Spur and support quantum innovation and have coordinating roles.
- **Novo Nordisk Foundation Quantum Computing Programme (NQCP)**: A major initiative focused on building quantum computing capabilities. Quantum Foundry Copenhagen is a part of NQCP and focuses on producing quantum chips.

The impression from the interviews is that the interviewees believe that the strengths and opportunities collectively position Denmark as a leading player in the field of quantum technology, with a well-rounded ecosystem that supports research, innovation, and international collaboration. Furthermore, the impression is that addressing these weaknesses and threats will require a more coordinated national approach, increased investment in infrastructure and talent, and stronger collaboration both within Denmark and with other Nordic countries. More details are given below.

Strengths, Weaknesses, Opportunities and Threats

The Strengths, Weaknesses, Opportunities, Threats (SWOT) analysis is based on interviews with Danish stakeholders.

Strengths

Strong Public and Private Investment: Denmark benefits from a robust mix of public and private investments in quantum technology, underpinned by a clear national strategy and significant infrastructure development. A key public instrument is the Grand Solutions program administered by Innovation Fund Denmark, which supports ambitious, high-risk collaborations between academia and industry. Complementing these efforts, Denmark has developed state-of-the-art facilities such as Quantum Foundry Copenhagen, a privately owned company focused on producing high-quality quantum chips. A major milestone in Denmark's strategic investment landscape is the launch of 55 North in October 2025 – a dedicated quantum technology fund co-anchored by the Export and Investment Fund of Denmark (EIFO) and Novo Holdings. With a target size of €300 million, it stands as the world's largest venture capital fund focused exclusively on quantum technologies. The fund aims to accelerate breakthroughs by bridging cutting-edge research with commercialization. Together, these initiatives provide a strong foundation for Denmark's international leadership in quantum innovation.

Comprehensive Ecosystem and Collaboration: Denmark has established a comprehensive ecosystem for quantum technology that includes various initiatives and organizations. The Danish Quantum Community, Deep Tech Lab Quantum, and Quantum Denmark are key players in fostering collaboration and supporting startups. The Novo Nordisk Foundation Quantum Computing Program (NQCP) and Quantum Foundry Copenhagen are notable examples of large-scale initiatives aimed at developing quantum computing technologies. This ecosystem provides ample opportunities for collaboration and innovation across different sectors and disciplines.

Leading Research Institutions: Denmark is home to several leading research institutions that contribute significantly to quantum technology. The University of Copenhagen (especially the Niels Bohr Institute), Technical University of Denmark (DTU), University of South Denmark, Aarhus University, and Aalborg University are all involved in various aspects of quantum research. These institutions have strong research groups and infrastructure that support both fundamental and applied research in quantum technology. This concentration of expertise and resources presents opportunities for groundbreaking research and development.

International Collaboration and Talent Attraction: Denmark actively engages in international collaboration, attracting top talent and fostering partnerships with leading global institutions. The country has successfully recruited prominent researchers like Charles Marcus, who has played a pivotal role in re-establishing Copenhagen on the international quantum research map. Additionally, Denmark's national strategy and initiatives like the NQCP emphasize the importance of international collaboration and talent recruitment. This focus on attracting and retaining top talent enhances Denmark's renowned international presence in quantum technology.

Strategic Focus and Infrastructure Development: Denmark's strategic focus on quantum technology is evident through its national quantum strategy and significant investments in research and infrastructure. The country has developed state-of-the-art facilities and infrastructure to support quantum research and innovation. The establishment of Quantum Foundry Copenhagen, a private-owned company, which focuses on producing high-quality quantum chips, is a testament to Denmark's commitment to advancing quantum technology. This strategic focus and infrastructure development provide a strong foundation for future growth and innovation, and is also an opportunity.

Support for Innovation and Startups: Denmark has a strong tradition of supporting innovation and startups in the quantum technology sector. Initiatives like Deep Tech Lab Quantum at the BioInnovation Institute, and Quantum Denmark provide support and resources for startups, helping them to develop and commercialize their technologies. The Novo Nordisk Foundation also plays a crucial role in funding early-stage innovation and supporting the growth of quantum technology companies. This support for innovation and startups creates opportunities for new businesses and technological advancements.

Opportunities

Nordic and European Collaboration: Denmark is actively involved in Nordic and European collaboration, leveraging regional strengths and resources to advance quantum technology. The country participates in initiatives like the Nordic Quantum Life Science Roundtable and collaborates with other Nordic countries on various quantum research projects. Denmark's involvement in European initiatives and its complementary approach to EU-funded projects further enhance its position in the global quantum technology landscape. This collaboration provides opportunities for shared resources, expertise, and infrastructure, driving further advancements in quantum technology. However, Denmark could enhance its influence in EU-level quantum funding programs.

Potential for Increased Nordic Cooperation: There is significant potential for increased Nordic cooperation in quantum technology. Denmark's strong infrastructure and expertise can be complemented by the strengths of other Nordic countries, creating a more robust and competitive regional ecosystem. This cooperation can lead to shared infrastructure, joint research projects, and a stronger collective presence in the global quantum technology market.

Denmark’s launch of the world’s largest quantum technology fund (55 North) further strengthens its position as a global leader and offers new opportunities for international collaboration and commercialization.

Weaknesses

Coordination Challenges: There are multiple overlapping initiatives such as the Danish Quantum Community, Deep Tech Lab Quantum, Quantum Denmark, and the Chip Competence Center. This fragmentation can lead to inefficiencies and a lack of cohesive strategy, making it challenging to coordinate efforts and resources effectively.

Recruitment and Talent Retention: Denmark struggles with recruiting and retaining talent in the quantum technology sector. The recruitment process often attracts candidates primarily from outside Europe, making it difficult to build a strong local talent pool. This issue is compounded by the high demand for skilled researchers and the competitive nature of the global quantum technology market.

Infrastructure and Funding Limitations: Despite substantial investments in quantum technology infrastructure, there are still gaps that need to be addressed. The need for state-of-the-art equipment and facilities is critical for advancing research, but securing funding for such infrastructure remains a challenge. Additionally, the sustainability of these investments is a concern, as maintaining and upgrading infrastructure over time requires continuous funding.

Geopolitical and Security Concerns: The geopolitical landscape poses challenges for Denmark's quantum technology initiatives. The need to protect intellectual property and manage geopolitical interests can complicate collaborations and limit the openness of research. This is particularly relevant in the context of trade secrets and the protection of sensitive information from unwanted geopolitical attention. This is also a threat.

Limited Nordic Collaboration: While there are some collaborations with other Nordic countries, such as with Norway and Sweden, these partnerships are not as extensive or well-developed as they could be. Strengthening Nordic collaboration could help address some of the challenges related to infrastructure, talent, and funding, but this requires more coordinated efforts and strategic planning. This may also be regarded as a threat.

Threats

High Risk and Uncertainty in Investments: Investing in quantum technology is inherently risky due to the high level of uncertainty and the nascent stage of the technology. Evaluating the potential market, competition, and the viability of quantum technology companies is challenging. This high-risk environment can deter investments and slow down the commercialization of quantum technologies.

Limited Depth and Sustainable Scale: Denmark has invested in multiple quantum areas. This broad approach risks diluting impact, as spreading resources too thin may prevent any one effort from succeeding. Additionally, launching startups in application areas without a domestic supply chain, or a clear path to one, poses long-term sustainability challenges.

Dependency on Private Funding: Denmark's quantum technology sector relies heavily on private funding from foundations like the Novo Nordisk Foundation, Carlberg Foundation and the Villum Foundation. While this funding is substantial, it may not be sufficient to cover all the needs of the sector, especially as the technology matures and requires larger-scale investments. The dependency on private funding also means that public funding mechanisms need to be more robust and complementary to ensure sustainable growth.

Slow Administrative Processes: Administrative processes related to funding and access to resources can be slow and cumbersome. For example, the access procedure for certain resources like the LUMI supercomputer has been criticized for being too administrative-heavy and slow, hindering the progress of research. Streamlining these processes could help accelerate research and innovation in the quantum technology sector.

Finland

Overview

Finland excels in quantum technology, particularly low-temperature physics and superconducting circuits. Leading companies like Bluefors and IQM are advancing superconducting quantum computers. InstituteQ coordinates national research, education, and innovation efforts with support from universities, VTT, and CSC. Finland is part of the European quantum communication infrastructure and has a national quantum strategy.

The key institutions involved in quantum technology research are as follows (1):

- **Aalto University**: A leader in superconducting qubits and quantum hardware.
- **University of Helsinki, Tampere University, University of Oulu, University of Turku, University of Jyväskylä and University of Eastern Finland**: Active in various quantum research areas.

- **VTT Technical Research Centre of Finland**: Develops quantum technologies and infrastructure.
- **InstituteQ**: A national quantum initiative coordinating research, education, and innovation.
- **CSC – IT Center for Science**: Provides computational infrastructure.

The respondents find Finland's strengths in quantum technology to lie in its strong research tradition, advanced infrastructure, and collaborative ecosystem. Opportunities include developing autonomous quantum processors, expanding quantum software, and attracting global talent. However, the country faces threats from geopolitical tensions, global competition, and talent drain, while weaknesses include limited private investment and gaps in software and infrastructure.

Strengths, Weaknesses, Opportunities and Threats

The Strengths, Weaknesses, Opportunities, Threats (SWOT) analysis is based on interviews with Finnish stakeholders.

Strengths of Finland in Quantum Technology

Strong Research Tradition and Expertise: Finland has a long-standing tradition in quantum research, particularly in low-temperature physics and superconducting circuits. This has led to the establishment of companies like Bluefors and IQM. The country boasts high-level expertise in superconducting circuits, quantum thermodynamics, and quantum sensors.

Advanced Research Infrastructure: Finland is home to advanced research infrastructures such as Otanano, a national facility focusing on nanoscience, technology, and quantum technologies. This infrastructure supports both basic research and the scaling up of business innovations. VTT (Technical Research Centre of Finland) has specialized facilities for fabricating superconducting qubits and other quantum components.

Collaborative Ecosystem: The Finnish quantum ecosystem includes strong collaboration between universities, research institutions, and companies. For instance, Aalto University and VTT work closely together on quantum technology projects. The establishment of InstituteQ, a national quantum institute, facilitates collaboration across research, education, and innovation.

Successful Spin-offs and Industry Engagement: Finland has successfully spun off several companies from academic research, such as IQM, which is a leader in delivering quantum computers. Other notable companies include Algorithmiq, Arctic Instruments, Bluefors, QuantScient, Qmill and SemiQon.

High-Quality Education and Talent Development: Finnish universities offer specialized programs in quantum technology, attracting and nurturing talent in this field. The country also has initiatives to increase the intake of students in quantum technology programs.

Opportunities for Finland in Quantum Technology

Development of Autonomous Quantum Processors: There is a significant opportunity to develop autonomous quantum processors, which could revolutionize the scalability and efficiency of quantum computers. This involves creating components that can operate independently, reducing the need for external control.

Expansion of Quantum Software and Algorithms: While Finland excels in hardware, there is an opportunity to strengthen its capabilities in quantum software and algorithms. This includes developing new quantum algorithms and enhancing the integration of quantum computing with classical computing systems.

Increased International Collaboration: Finland can benefit from increased collaboration with other Nordic countries and international partners. This includes leveraging diverse approaches to quantum technology and sharing expertise and resources.

Attracting Global Talent: There is an opportunity to make Finland more attractive to international researchers and students in quantum technology. This could involve creating joint programs and initiatives to draw talent from outside Europe.

Enhanced Funding and Support for Applied Research: Business Finland is poised to increase its funding for applied quantum research, which can drive innovation and commercialization in this field. This shift towards more technology-oriented funding can help translate basic research into practical applications that boost the economy.

Leveraging New Clean Room Facilities: The upcoming Kvanttinova clean room facility, dedicated to quantum technology, presents an opportunity to advance research and development in this area. This facility can support the fabrication of high-quality quantum components and foster innovation.

Strategic Autonomy and Technological Sovereignty: Geopolitical tensions have heightened the urgency for countries to secure strategic autonomy in key technology areas. For Finland, this presents a clear opportunity to leverage its strong positioning in quantum technology to develop and maintain critical capabilities independently. The national emphasis on technological sovereignty aligns well with Finland's existing strengths, offering a pathway to reinforce resilience, reduce external dependencies, and lead in the development of secure, homegrown quantum solutions.

Threats to Finland in Quantum Technology

Geopolitical Tensions: The current geopolitical climate, including tensions with Russia and uncertainties in the US, poses a threat to Finland's quantum technology sector. These tensions could disrupt international collaborations and access to critical resources.

Dependence on Public Funding: Finland's quantum technology sector heavily relies on public funding, with limited private investment compared to countries like Sweden and Denmark. This dependence makes the sector vulnerable to changes in government policy and budget allocations.

Global Competition: The global race in quantum technology is intense, with significant investments from countries like the US and China. Finland faces the threat of being outpaced by these larger economies with more substantial resources.

Talent Drain: There is a risk of losing top talent to countries with more attractive funding and research opportunities. This brain drain could weaken Finland's position in the global quantum technology landscape.

Weaknesses of Finland in Quantum Technology

Limited Private Sector Involvement: Finland is often perceived as having limited private sector involvement in quantum technology compared to Denmark and Sweden. While this view holds true across much of the ecosystem, it does not reflect the full picture. Notably, IQM has attracted over €500 million in private equity investment, demonstrating strong commercial interest and scalability potential. However, outside of IQM, broader private sector investment remains modest, which may constrain the overall pace of commercialisation and ecosystem-wide innovation.

Fragmented Research Efforts: While Finland has strong research institutions, there is a need for better coordination and integration of efforts across different organizations. This fragmentation can lead to inefficiencies and duplicated efforts.

Lagging in Quantum Software: Finland's expertise is primarily in hardware, with less emphasis on quantum software and algorithms. This imbalance could hinder the development of comprehensive quantum solutions.

Funding Constraints: The overall funding for quantum technology in Finland, while significant, is still limited compared to the needs of the sector. This constraint affects the ability to undertake large-scale, long-term projects.

Norway

Overview

Norway is becoming an active participant in quantum technology, with recent investments in quantum research and innovation. The country has world-class groups working on quantum materials and device physics, quantum computing theory and algorithms, and quantum sensing. Norway is also engaged in the European quantum communication infrastructure and shows growing interest in quantum sensing and quantum computing. The Q-NRI project aims to establish the technical and organizational foundations for Norwegian access to the European LUMI-Q quantum computer. The Norwegian Quantum Cluster, launched in August 2025 and led by UiO, NTNU, SINTEF, and Kongsberg Group, supports research collaboration, education, and international positioning of Norwegian quantum science, with a focus on EU and Nordic engagement.

The key institutions involved in quantum technology research are as follows (1):

- **University of Oslo and Norwegian University of Science and Technology (NTNU):** Key players in quantum materials and device physics, quantum software, algorithms, and sensing.

- **OsloMet, University of Bergen, and University of South-Eastern Norway**: Contribute to education and research in quantum technologies including computing, cryptography, sensing, algorithms and software.

- **SINTEF, Simula Research Laboratory:** SINTEF is strong in applied quantum research, quantum software, and algorithms. Simula demonstrates particularly strong contributions in quantum software development, simulation, and post-quantum cryptography. Interviewees highlight Norway's strengths in quantum technology, including strong research institutions, expertise across quantum algorithms, sensors, device physics, and simulation, as well as solid government and defence support. Opportunities lie in developing a national strategy, expanding international collaboration, increasing funding, and enhancing education and commercialization. However, the sector faces challenges such as fragmented research, limited infrastructure and private investment, and dependence on external expertise. Threats include international competition, security concerns, political instability, technological lag, and potential talent drain.

Strengths, Weaknesses, Opportunities and Threats

The Strengths, Weaknesses, Opportunities, Threats (SWOT) analysis is based on interviews with Norwegian stakeholders.

Strengths of Norway in Quantum Technology

Strong Research Institutions and Collaborations: Norway boasts several key research institutions and collaborative networks that are pivotal in quantum technology. Institutions like the University of Oslo (UiO), Norwegian University of Science and Technology (NTNU), and SINTEF are heavily involved in quantum research. The Gemini Center for Quantum Science and Technology, for instance, is a significant network-building centre.

Expertise in Quantum Algorithms and Software: Norwegian researchers have a strong background in quantum algorithms and software development. This includes work on quantum computing and quantum information theory, with notable contributions from institutions like SINTEF and UiO.

Expertise in Quantum Device and Quantum Materials Physics: Norway has world-class expertise in the physics of quantum materials and devices, including the physics of state-of-the-art solid-state qubits and sensors as well as the complex physics of the underlying quantum materials that enable the device functionalities. Important contributions come from NTNU and UiO.

Advanced Sensor Technology: Norway's strong tradition in sensor technology is now advancing into quantum sensing – one of the country's most promising areas, especially for defence and maritime applications. Institutions like MiNaLab and SINTEF are active in this field, and Kongsberg Gruppen ASA has launched a disruptive technology unit focused on quantum sensing. This opens opportunities for Nordic collaboration and positions Norway to develop a centre of excellence with real industrial engagement, targeting applications such as high-precision navigation, underwater detection, and secure communications.

Interdisciplinary Approach: The country benefits from an interdisciplinary approach to quantum technology, involving departments of physics, mathematics, and computer science. This is evident in the collaborative projects and the integration of various scientific disciplines.

Government and Defence Support: There is significant support from the Norwegian government and defence sectors, including funding from the Ministry of Defence and the Norwegian Research Council. The involvement of the Norwegian Defence Research

Establishment in quantum research further strengthens this support.

Opportunities for Norway in Quantum Technology

National Strategy Development: There is a clear opportunity to develop a comprehensive national strategy for quantum technology. This would help coordinate efforts across various institutions and ensure focused investment in key areas.

International Collaboration: Norway can leverage international collaborations, particularly with leading institutions like the Niels Bohr Institute in Denmark and through initiatives like the Nordic Quantum network. This can help Norway access cutting-edge research and infrastructure.

Funding and Investment: Increased funding and investment, both from national sources and international partners like Novo Nordisk Foundation, can significantly boost Norway's quantum technology capabilities.

Educational Programs: Developing specialized educational programs in quantum technology at the bachelor, master, and PhD levels can help build a skilled workforce. This includes potential collaborations with Nordic countries to create joint educational initiatives.

Commercialization and Industry Partnerships: There is a significant opportunity to commercialize quantum technologies and foster industry partnerships. This includes potential applications in sectors like defence, energy, and telecommunications.

Infrastructure Development: Investing in and modernizing research infrastructure, such as the facilities at MiNaLab and NorFab, can provide the necessary tools for advanced quantum research and development.

Weaknesses of Norway in Quantum Technology

Fragmented Research Environment: The quantum research environment in Norway is highly fragmented, with many small and dispersed research groups across various institutions. This fragmentation makes it challenging to coordinate efforts and build a cohesive national strategy.

Limited Funding and Resources: There is a significant lack of private funding for quantum research in Norway, with most funding coming from public sources like the Norwegian Research Council. This limits the ability to scale up research activities and invest in necessary infrastructure.

Insufficient Infrastructure: Existing research infrastructure, such as NorFab1, is aging and in need of modernization. The lack of updated facilities hampers the ability to conduct cutting-edge research and develop new technologies.

Lack of Critical Mass: Many research groups in Norway lack the critical mass needed to sustain long-term projects and attract top talent. This is particularly evident in areas like quantum computing and quantum algorithms, where larger, more established groups in other countries have a competitive edge.

Dependence on External Expertise: Norway often relies on international collaborations to access advanced research facilities and expertise. While beneficial, this dependence can limit the development of homegrown capabilities and reduce the country's ability to lead in certain areas of quantum technology.

Threats to Norway in Quantum Technology

International Competition: Norway faces stiff competition from countries like Denmark, Sweden, and Finland, which have more established and better-funded quantum research programs. These countries are already making significant strides in building quantum computers and developing quantum technologies, potentially leaving Norway behind.

Security Concerns: The strategic importance of quantum technology for national security means that Norway must be cautious about sharing sensitive research and collaborating with international partners. There is a risk that critical technologies could be compromised or that Norway could become overly dependent on foreign expertise.

Economic and Political Instability: Fluctuations in public funding and political support for quantum research can pose a threat to the stability and continuity of research programs. Changes in government priorities or economic downturns could lead to reduced funding and support for quantum initiatives.

Technological Lag: Norway's late start in certain areas of quantum technology, such as quantum computing, means that it may struggle to catch up with more advanced countries. This lag could result in missed opportunities for innovation and commercialization.

Talent Drain: The limited availability of advanced research facilities and funding in Norway could lead to a brain drain, with top researchers and students seeking opportunities in countries with more robust quantum research environments. This would further weaken Norway's position in the global quantum technology landscape.

Sweden

Overview

Sweden has made significant investments in quantum technology through the Wallenberg Foundation, particularly via the Wallenberg Center for Quantum Technology (WACQT). The country prioritizes the development of superconducting quantum computers and quantum communication infrastructure. Sweden boasts robust research groups specializing in quantum sensing, quantum communication, and quantum computing, with collaborations across various universities and institutions.

The National Quantum Communication Infrastructure in Sweden (NQCIS) is an operational facility for building and testing quantum key distribution systems, creating a national testbed, and fostering collaboration among Swedish research institutions, industry, and startups to advance secure quantum communications. Additionally, Sweden is involved in the European quantum communication infrastructure (EuroQCI).

The key institutions involved in quantum technology research are as follows (1):

- **Chalmers University of Technology**: Home to the Wallenberg Centre for Quantum

Technology (WACQT), a flagship initiative in quantum computing.

- **KTH Royal Institute of Technology, Lund University, Gothenburg University, Stockholm University, Linköping University, and Karolinska Institute**: All contribute to quantum research and interdisciplinary applications.
- **Nordita**: A Nordic institute for theoretical physics, supporting collaboration and advanced research. Coordinator of the Nordic Quantum network.
- **RISE (Research Institutes of Sweden)**: Supports industrial applications and innovation.
- **Quantum Life Science Centre**: A hub for national and Nordic collaboration within development and use of quantum life science applications.

Respondents see Sweden as having strong research institutions and a collaborative culture supported by significant private funding, particularly from the Wallenberg Foundation. It is active in quantum communication and life sciences and has opportunities to expand public funding, Nordic collaboration, and industry partnerships. While the Wallenberg Centre for Quantum Technology (WACQT) is seen as essential in coordinating quantum technology efforts in Sweden, national coordinated is perceived as fragmented. Other challenges include limited public investment and infrastructure issues.

Sweden also faces threats from global competition, economic uncertainty, and potential talent drain.

Strengths, Weaknesses, Opportunities and Threats

The Strengths, Weaknesses, Opportunities, Threats (SWOT) analysis is based on interviews with Swedish stakeholders.

Strengths of Sweden in Quantum Technology

Strong Research Institutions: Sweden is home to several leading research institutions in quantum technology, including the Wallenberg Centre for Quantum Technology (WACQT) at Chalmers, KTH, Stockholm University, and Lund University.

Private Funding: The Knut and Alice Wallenberg Foundation provides significant private funding for quantum technology research, with a focus on building a superconducting quantum computer and developing quantum communication, sensing, and simulation technologies.

Collaborative Culture: Sweden has a collaborative culture that fosters partnerships between academia, industry, and government. This is evident in initiatives like the Quantum Sweden Innovation Platform (QSIP), which aims to build a Swedish quantum ecosystem.

Innovation in Quantum: Chalmers Next Labs exemplifies Sweden's push to bridge academic quantum research and industrial application. NQCIS is Sweden's facility for building and testing secure quantum communication systems, fostering collaboration among research, industry, and startups.

Quantum Life Science: Sweden has a strong focus on quantum life science, with initiatives like the Swedish Quantum Life Science Centre and collaborations with international partners like Cleveland Clinic.

Opportunities for Sweden in Quantum Technology

Increased Public Funding: There is an opportunity for Sweden to increase public funding for quantum technology through the development of a national quantum strategy. This would complement the existing private funding from the Wallenberg Foundation and help build a more robust quantum ecosystem.

Nordic Collaboration: Sweden can strengthen its position in quantum technology by collaborating with other Nordic countries. This includes sharing infrastructure, expertise, and resources to build a comprehensive Nordic quantum ecosystem.

Industry Partnerships: Sweden has the potential to form strategic partnerships with industries, especially in healthcare, defence, and logistics, to advance quantum technologies. Dedicated testbeds for startups and new initiatives are emerging, helping bridge research and industry.

Talent Development: By focusing on education and training in quantum technologies, Sweden can develop a skilled workforce that can drive innovation and research in this field.

Global Positioning: Sweden can position itself as a key player in the global quantum technology landscape by participating in international collaborations and contributing to major quantum research projects.

Weaknesses of Sweden in Quantum Technology

Fragmented Coordination: Sweden's national coordination in quantum technology is somewhat fragmented. While the Wallenberg Centre for Quantum Technology (WACQT) provides a central effort, local environments are spread and scattered, making it challenging to unify efforts across different nodes.

Limited Public Funding: Historically, there has been limited public funding for quantum technology in Sweden. Most of the funding has come from private sources like the Wallenberg Foundation, with minimal contributions from public agencies.

Infrastructure Challenges: Maintaining and developing state-of-the-art infrastructure for quantum technology is a significant challenge. There is a struggle to sustain technological work and retain technical personnel, which is crucial for long-term research and development.

Dependence on Private Funding: The heavy reliance on private funding from the Wallenberg Foundation can lead to a lack of diversification in funding sources, potentially limiting the scope and flexibility of research initiatives.

Innovation System Gaps: There are gaps in the innovation system, particularly in bridging the gap between academia and industry. This includes challenges in translating research into practical applications and commercializing quantum technologies.

Threats to Sweden in Quantum Technology

Global Competition: Sweden faces intense global competition in quantum technology, particularly from countries with more substantial public funding and coordinated national strategies. This competition could hinder Sweden's ability to attract top talent and secure international collaborations.

Technological Lag: There is a risk of technological lag if Sweden cannot keep pace with advancements in quantum technology infrastructure and research. This includes the potential for other countries to develop superior quantum computing, communication and sensing technologies.

Economic Uncertainty: Economic fluctuations and uncertainties could impact the availability of private funding from foundations like Wallenberg, which could, in turn, affect the sustainability of long-term quantum technology projects.

Policy and Regulatory Changes: Changes in national and international policies and regulations related to quantum technology could pose threats. This includes potential restrictions on international collaborations and funding, which are crucial for Sweden's quantum technology ecosystem.

Talent Drain: The inability to offer competitive funding and infrastructure could lead to a talent drain, where top researchers and innovators move to countries with better resources and opportunities.

Iceland

Overview

Iceland is steadily developing its capabilities in quantum technology, with a particular emphasis on quantum computing, quantum sensing, and quantum materials. The University of Iceland leads several active research projects, including magnetic metamaterials, spintronics, and quantum sensing. Notable efforts include a Grant of Excellence on magnetic nano-arrays and a Nordic collaboration with NTNU and KTH on Quantum LIDAR development. The university also hosts Iceland’s only cleanroom facility and participates in the Nordic Nanolab Network, supported by national infrastructure funding.

The Nanophysics Center at Reykjavik University complements this with theoretical and experimental research on quantum transport in nanostructures and silicon nanowire arrays for sensing applications. Industry interest is growing, with companies like Decode Genetics exploring quantum applications, and startups working on nanotechnology-related fabrication and characterization. Grein Research is also active in quantum sensing and superconducting materials, including participation in a Eurostars project to develop high efficiency quantum sensing for infrared radiation.

Support from RANNIS and government funding has played an important role in enabling student involvement and project development, although funding for quantum-related projects has declined in recent years. Iceland continues to face challenges such as limited domestic infrastructure, a shortage of faculty in quantum computing, and constrained funding. Addressing these will require sustained investment in infrastructure, recruitment, and training.

The Icelandic High-Performance Computing Centre (IHPC), based at Reykjavik University, contributes to the national quantum effort by integrating quantum expertise into Iceland's digital infrastructure. Its activities include exploring quantum annealing for optimization problems and supporting applications in remote sensing and AI.

Despite these promising developments, Iceland faces challenges such as limited domestic infrastructure, a shortage of faculty in quantum computing, and declining funding from RANNIS for quantum-related projects. Addressing these will require sustained investment in infrastructure, recruitment, and training to build a resilient national quantum ecosystem.

The key institutions involved in quantum technology research is **University of Iceland** and **Reykjavik University** (1). They are engaged in quantum information theory, quantum sensing, quantum transport, and education, with potential for deeper integration into the Nordic network.

Strengths, Weaknesses, Opportunities and Threats

The Strengths, Weaknesses, Opportunities, Threats (SWOT) analysis is based on an interview with one research group, additional input from two other groups, and the author's own assessment.

Strengths

International Collaborations: Iceland's quantum technology ecosystem benefits from active international collaborations with leading institutions such as KTH, NTNU, Uppsala University, Forschungszentrum Jülich in Germany and Peter Grünberg Institute. Through these partnerships, Icelandic researchers gain access to advanced quantum computing infrastructure, including the Jülich Supercomputing Center, and participate in joint research on spintronic materials, quantum devices, and quantum transport. Iceland has been actively involved in Nordita since its inception.

Expertise: Iceland has notable pockets of expertise in the theoretical and experimental physics of nanowires – including quantum transport, as well as in quantum annealing – including using the D-Wave quantum annealing system.

Interdisciplinary Research: There is a focus on interdisciplinary research involving quantum computing, high-performance computing, and machine learning.

Opportunities

Nordic Collaboration: Nordic collaboration could provide valuable resources and expertise, especially given current limitations in experimental equipment for nanowire fabrication and gas sensor research. Stronger connections with advanced Nordic laboratories would be particularly beneficial.

Expansion into Quantum Sensing and Communication: Iceland could explore and develop applications in quantum sensing and communication, particularly in Earth observation and secure communication, gas sensing, especially of gases related to magma activity precursor to volcanic eruptions.

Strategic Recruitment: There is an opportunity to strategically recruit faculty and researchers in quantum computing and related fields to strengthen the academic and research ecosystem.

Participation in International Projects: Iceland can benefit from strengthening participation in international projects and initiatives, such as those funded by the European Space Agency and Horizon Europe.

Weaknesses

Limited Infrastructure: Iceland lacks the infrastructure to host its own quantum computers and relies heavily on collaborations with institutions like Jülich for access to quantum technologies.

Small Ecosystem: The quantum technology ecosystem in Iceland is small, with limited players and resources.

Funding Constraints: There are constraints in sustained funding for quantum computing and related research, which limits the ability to expand and develop the field further.

Lack of Faculty Positions: There is a need for more faculty positions in quantum computing and related areas to support research and education.

Threats

Dependence on External Collaborations: The heavy reliance on external collaborations for access to quantum computing infrastructure poses a risk if these collaborations were to be disrupted.

Regulatory Limitations: Iceland's non-EU member status limits its ability to participate in certain EU-funded initiatives and procure quantum computing infrastructure through EuroHPC JU.

Competition for Talent: There is a risk of losing talented researchers and students to other countries or institutions with better funding and infrastructure.

Changing Government Priorities: Shifts in government priorities and funding allocations have already led to reduced support for some groups working in quantum technology research and development, and may continue to impact the field in the future.

The Baltic Countries

The analysis of the situation in the Baltics is based on a few interviews, information gathered in the Nordic Quantum Landscape report (3) and open sources.

Estonia

Estonia's quantum technology ecosystem is still in its formative stages but is gaining momentum through academic, governmental, and commercial engagement. While the country lacks a formal national quantum strategy, it benefits from a strong digital innovation culture, deep expertise in software engineering, and a growing interest in quantum-related applications such as sensing and cryptography. Institutions like the University of Tartu are actively involved in European research projects, and government-backed initiatives like EstQCI and the quantum coordination unit led by Metrosert are helping to coordinate national efforts. Estonia's participation in Nordic and EU collaborations further enhances its visibility and integration into the broader quantum landscape.

Strengths

Estonia's strengths and initial focus are in quantum sensing, metrology, and communication. Estonia excels in software engineering and digital innovation, making it well-positioned for quantum software, algorithms, and post-quantum cryptography. The University of Tartu has a long-standing academic foundation in quantum computing and is involved in major EU projects like OpenSuperQPlus. Estonia's reputation in secure e-government services and its agile startup culture support innovation and commercialization, particularly in software-led quantum applications.

Weaknesses

The national quantum community is small and fragmented, with limited experimental infrastructure and no dedicated national strategy. Public funding dominates, with minimal private investment, and there is a significant shortage of students and researchers. Even well-funded researchers struggle to recruit PhD candidates, and experimental physics groups face challenges in securing research funding.

Opportunities

Estonia is actively engaged in international initiatives such as EuroQCI, EstQCI, and NordIQuEst, which provide valuable exposure and collaboration opportunities. There is growing commercial interest in quantum-adjacent technologies like sensing and secure communications, and Estonia's strong software culture supports potential spin-offs. With the right policy support and investment, Estonia could establish a competitive niche in the quantum economy, especially in software, cryptography, and sensing.

Threats

Estonia faces strong global competition from countries with more mature and better-funded quantum programs. The absence of a national strategy and limited infrastructure could hinder progress. There is also a risk of brain drain, as researchers and students may seek better opportunities abroad. Continued reliance on external expertise and facilities for hardware development may limit Estonia's ability to lead independently in the field.

Latvia

Latvia is rapidly emerging as a proactive regional player in quantum technology, driven by strong academic foundations, increasing public investment, and growing industry engagement. The country is focusing on quantum computing, communication, and photonics, with the Latvian Quantum Initiative (2023–2026) serving as a central coordination platform to align research, policy, and commercialization efforts. Notable industry collaborations include Accenture Baltics' work on quantum algorithms for medical imaging and Tilde's involvement in quantum linguistics research. Latvia is also investing in secure quantum communication infrastructure, including a national Quantum Key Distribution (QKD) network and participation in the EuroQCI initiative. With substantial EU funding and a clear policy direction, Latvia aims to become a testbed for applied quantum innovation.

Here is a structured SWOT analysis summarizing Latvia's position:

Strengths

Latvia benefits from strong academic institutions and coordinated national efforts through the Latvian Quantum Initiative. Public investment is robust, with support from the EU Recovery and Resilience Facility and co-funded infrastructure projects like the QKD network. The country is also home to early industry engagement, with companies like Accenture Baltics and Tilde exploring quantum applications in healthcare and language technology.

Weaknesses

The commercial quantum sector in Latvia is still in its infancy, with limited industrial capacity and few mature quantum startups. The ecosystem's long-term sustainability will depend on continued investment, talent development, and the ability to scale research into viable commercial products.

Opportunities

Latvia is well-positioned to become a regional testbed for applied quantum technologies, particularly in secure communications, quantum software, and small-scale component manufacturing. Its participation in EuroQCI and strong public-private collaboration offer pathways to expand its role in Europe's quantum infrastructure and innovation landscape.

Threats

Latvia faces stiff competition from more advanced quantum ecosystems in Europe and globally. Delays in commercialization, overreliance on EU funding, and potential misalignment between research and industry needs could hinder progress. Ensuring cohesive strategy execution and talent retention will be critical to maintaining momentum.

Lithuania

Lithuania is steadily developing a comprehensive quantum technology (QT) ecosystem through a community-driven approach, leveraging its well-established academic excellence in photonics, quantum optics, and theoretical physics. The country benefits from a robust foundation in enabling technologies such as lasers, semiconductors, and advanced materials, which are crucial for advancements in quantum computing, sensing, and communication. Research groups across major universities and national labs are active across all four QT pillars, with a particular focus on enabling technologies like optics, semiconductors, and precision metrology, all of which are critical to quantum computing, communication, and sensing.

National high-performance computing (HPC) resources and an established research network provide a foundation for early experiments in hybrid QC–HPC. Although the commercial sector is still developing, Lithuania has made notable progress in research, infrastructure, and international collaboration. The creation of the Lithuanian Quantum Technologies Association (Quantum Lithuania) and active participation in EU initiatives demonstrate the country's growing ambition to emerge as a regional leader in quantum technology.

Lithuania's lab infrastructure, which includes capabilities adjacent to cleanrooms, precision laser systems, and cryogenic and measurement stacks, supports component-level experimentation and initial system integration. The country is increasingly engaging with EU programs and Nordic networks, positioning itself to take advantage of federated access to testbeds and joint training initiatives. This aligns with the national agenda's objectives of adapting HPC for hybrid workflows and increasing participation in European and NATO quantum actions.

Lithuania’s industrial base, though small, has experience in exporting enabling technologies such as lasers, optics, control electronics, and materials. This creates natural pathways for developing quantum sensing instruments, secure communication hardware, and specialized components. However, Lithuania currently lacks QT-specific startups and faces shortages in trained specialists, meaning early-stage growth will require not only targeted seed funding, flexible IP models, and access to Nordic testbeds, but also long-term investment in talent pipelines and entrepreneurship.

Strengths

Lithuania hosts over ten active research groups with expertise across all four QT pillars: computing, communication, sensing, and simulation. The strong foundation in lasers, photonics, and materials science is complemented by advanced HPC infrastructure and international collaborations. Vilnius University and the Centre for Physical Sciences and Technology are pivotal within this ecosystem. Additionally, Kaunas University of Technology provides substantial expertise in post-quantum cryptography and cyber-threat analysis, collaborating with the Ministry of National Defence and the National Cyber Security Centre to co-develop the national post-quantum cryptography migration plan and risk-assessment methodologies for critical infrastructure. The formation of Quantum Lithuania has effectively unified efforts across academia, industry, and government.

Weaknesses

Despite its scientific strengths, Lithuania lacks a formal national strategy and dedicated QT study programs. Funding remains limited and fragmented, and participation in EU-funded projects and international networks is still relatively low. The commercial ecosystem is underdeveloped, with no dedicated QT startups and limited private investment, and there is a shortage of specialists and practical training opportunities, which hinders talent development and retention.

Opportunities

Lithuania has the potential to become a significant regional player in QT by formalizing a national strategy, establishing a quantum competence centre, and integrating QT into key industries such as lasers, life sciences, and space. Early commercialization opportunities exist in quantum sensing and communication, and Lithuania’s participation in EU initiatives like EuroQCI and Horizon Europe could enhance its global positioning. Establishing dedicated study programs and fostering international collaboration would further strengthen the local ecosystem.

Threats

Lithuania faces national and economic security risks if it fails to develop secure quantum communication infrastructure and post-quantum cryptography capabilities. The absence of coordinated investment and strategy could result in a loss of competitiveness in science and technology sectors. Persistent talent drain, limited ability to attract foreign investment, and weak startup activity pose significant threats. Without timely action, Lithuania risks being outpaced by its neighbours and missing opportunities in the global quantum transition.

Nordic Region – joint Nordic

Overview

From a regional perspective, quantum technology research in the Nordic region is a vibrant and rapidly evolving field characterized by strong academic foundations, national initiatives, and growing industry engagement. An overview is given in the Nordic Quantum White Paper (1).

The region is recognized for its collaborative spirit and high-quality research across the full spectrum of quantum technologies. Denmark, Finland, Norway, and Sweden each contribute unique strengths to the quantum ecosystem. Denmark and Finland are particularly strong in quantum hardware and superconducting qubits, with institutions like the University of Copenhagen, DTU, and Aalto University leading in quantum computing platforms. Sweden, through Chalmers University and the Wallenberg Centre for Quantum Technology (WACQT), is advancing scalable quantum processors based on superconducting qubits, quantum communication and sensing. Within quantum computing, Sweden work on hardware, software and theory. Norway is developing expertise in quantum software, algorithms, and sensing, while Iceland is emerging as a contributor in quantum information theory and education.

Nordita plays a key role in supporting Nordic quantum collaboration. It hosts the Wallenberg Initiative on Networks and Quantum Information and it is the institutional home of the Nordic Quantum coordinator. Nordita has also initiated work to coordinate MSc- and PhD-level education within quantum science across the Nordic countries.

Research in the region spans several key areas: quantum computing, quantum communication, quantum sensing, quantum simulation, and quantum materials. These efforts are supported by national strategies and funding programs, such as Finland's InstituteQ, Sweden's WACQT, and Denmark's NQCP. The Nordic countries also benefit from infrastructure that is shared at the national level, including cleanrooms, cryogenic facilities, and high-performance computing resources.

Major Ongoing Collaboration Projects and Initiatives

Nordic Quantum Network

The Nordic Quantum network (1) was established to unify and elevate the region's role in quantum science and technology. Originating from meetings and roundtables held between 2021 and 2024, the network brings together researchers to assess strengths and foster collaboration. Its purpose is to position the Nordic countries as a global hub for quantum research, innovation, and education by strengthening scientific excellence, developing a quantum-literate workforce, fostering industry-academia partnerships, and coordinating shared infrastructure and resources.

In August 2025, a Nordic Quantum coordinator was appointed. The coordinator is hosted by Nordita an funded through partner contributions. The coordinator's main role is to facilitate and strengthen quantum science and technology activities across the region, support collaboration and educational initiatives, and maintain communication within the network. The coordinator also helps ensure the Nordic region's continued leadership in quantum research and innovation.

The network includes a broad coalition of leading academic and research institutions from across the Nordic region.

Nordic-Estonian Quantum Computing e-Infrastructure Quest

The NordIQuEst initiative (19) is a pioneering, three-year NeIC-funded effort to establish a cross-border quantum computing ecosystem tailored to the Nordic region. By uniting seven partners from five countries (Denmark, Estonia, Finland, Norway, and Sweden) the project successfully laid the groundwork for a federated infrastructure that integrates quantum computing and high-performance computing (HPC) resources. Key achievements include the creation of a publicly accessible application library, extensive training programs, and the first academic demonstration of an HPC-to-quantum computer connection across borders. Despite challenges in granting open access to the platform due to resource ownership constraints, NordIQuEst significantly advanced regional quantum capabilities. Importantly, the initiative is ongoing, with a second phase planned to address access limitations, expand training, and secure new funding to fully realize the vision of a unified Nordic quantum ecosystem.

Nordic Quantum Life Science Round Table

The Nordic Quantum Life Science initiative aims to unite leading scientists, healthcare professionals, and industry partners across the Nordic region to explore and advance the intersection of quantum technologies and life sciences. Sparked by growing interest in the field, the initiative began with a round table in Sweden in 2021 and has since evolved into a collaborative, rotating forum hosted annually by different Nordic countries.

Nordita

Nordita, the Nordic Institute for Theoretical Physics, plays an important role in the Nordic quantum landscape. While it does not lead large-scale hardware projects or national initiatives, it contributes in a more foundational way by nurturing the theoretical understanding that underpins quantum science. Through its workshops, research programs, and collaborative environment, Nordita brings together scientists from across the region to explore the fundamental principles of quantum mechanics and related fields. Its strength lies in fostering dialogue, encouraging cross-border collaboration, and supporting the kind of deep, conceptual work that often precedes technological breakthroughs. In this way, Nordita helps ensure that the Nordic quantum effort remains grounded in strong scientific foundations, even as the region continues to grow its presence in this rapidly evolving field. Since August 2025 Nordita hosts a Nordic Quantum coordinator.

Nordic Quantum Technology Pre-Incubation Program

Funded by Nordic Innovation and led by the BioInnovation Institute in Denmark, this initiative aims to design a Nordic pre-incubation program that bridges the gap between quantum research and entrepreneurship, fostering early-stage innovation across the region.

Resilient Critical Infrastructures for the Nordics

Also funded by Nordic Innovation, this project – coordinated by the Danish Quantum Community – explores quantum technology-based applications to enhance the resilience of critical Nordic infrastructures, including energy, water, and communication systems.

Examples of bilateral collaborations

Swedish-Finnish postdoc programme

The Swedish-Finnish postdoc program is a targeted initiative within the Wallenberg Centre for Quantum Technology (WACQT) aimed at fostering cross-border collaboration in quantum research between Sweden and Finland. The program supports postdoctoral researchers who are formally employed at Swedish universities but spend approximately half of their research time in Finland. This arrangement allows for deep scientific exchange and integration between the two countries' research environments.

The program, which ends in 2025, is fully funded by WACQT and adheres to the statutes of the Knut and Alice Wallenberg Foundation, which stipulate that funding must be used within Swedish institutions. However, the structure of the program allows for flexible implementation, enabling Swedish researchers to collaborate internationally while maintaining compliance with funding rules.

This initiative has supported eight such postdoctoral positions and is considered a successful model for Nordic cooperation. It not only strengthens scientific ties between Sweden and Finland but also contributes to building a shared talent pool and advancing quantum technology research across the region.

University of Oslo and the Niels Bohr Institute

The Faculty of Mathematics and Natural Sciences, University of Oslo and the Niels Bohr Institute, University of Copenhagen have entered a strategic partnership to strengthen research and education in quantum science and technology. The collaboration focuses on sharing infrastructure, facilitating researcher exchanges, education and advancing quantum computing, sensing, and communication. It was formalized during a royal visit and builds on Denmark's strong national investment in quantum research and Norway's academic strengths. A key enabler is the Novo Nordisk Foundation, which has invested heavily in Danish quantum research, such as the Novo Nordisk Quantum Computing Programme hosted at Niels Bohr Institute.

Strengths, Weaknesses, Opportunities, and Threats

The Strengths, Weaknesses, Opportunities, Threats (SWOT) analysis is based on interviews with national stakeholders. A summary is given in Table 2.

Strengths	Weaknesses
• The Nordic tradition of trust and openness fosters effective cross-border collaboration. • Strong research infrastructure and innovation capabilities across the Nordic region. • Competitive edge in quantum life sciences, especially in healthcare applications. • Unique infrastructure and high-quality equipment. • Complementary national strengths (e.g., Norway in sensors, Denmark/Sweden in quantum computing).	• Lack of dedicated funding specifically for quantum technologies. • Coordination challenges due to absence of cross-border funding mechanisms. • Further development of technical staff and infrastructure is needed to fully support experimental research and technology development across the region. • Difficulty attracting and retaining skilled quantum researchers. • Lack of mechanisms for cross-border funding limits joint initiatives.
Opportunities	**Threats**
• Nordic countries can focus on complementary quantum technologies to maximize impact. • Shared security interests enabling joint efforts in quantum cryptography and sensing. • Expansion into new sectors like quantum finance and defence. • Potential for structured funding via NordForsk and Nordic Innovation. • High-level education and research collaboration through the Nordic Quantum network. • International partnerships. • Strategic alliances with private foundations (e.g., Novo Nordisk Foundation). • Building a unified Nordic quantum community leveraging cultural and logistical proximity.	• Geopolitical shifts requiring stronger regional unity. • Sustainability of collaboration threatened by unstable funding. • Heavy private funding, especially in Sweden and Denmark, can limit openness and collaboration – highlighting the need for stronger cross-network interaction.

Table 2: Summary of joint Nordic SWOT.

Strengths

Shared Values and Collaboration: The Nordic region benefits from a strong tradition of trust, openness, and collaboration. These shared values foster seamless cross-border partnerships and underpin the region's ability to coordinate efforts, pool resources, and advance quantum research as a unified community.

Strong Research Infrastructure and Innovation Capabilities: The Nordic region is recognized for its well-funded research infrastructure and strong innovation capabilities.

Competitive Advantages in Quantum Life Sciences: The Nordic countries have strong research capabilities and innovation in quantum technologies, particularly in healthcare and life sciences. Collaborative projects include quantum computing for protein folding, radiotherapy optimization, and quantum sensing for higher resolution imaging in healthcare.

Unique Infrastructure and High-Quality Equipment: The region boasts unique infrastructure and high-quality equipment that enhance research capabilities. Examples include Myfab (Sweden), OtaNano, FiQCI and Kvanttinova (Finland), Norfab (Norway), Nanolab (Denmark).

Complementary Strengths Across Countries: Different Nordic countries have complementary strengths. For example, Norway has strong traditions in sensor technology and theoretical research, while Denmark and Sweden have advancements in quantum computing.

Opportunities

Building Complementary Strengths: By coordinating efforts and sharing expertise, Nordic countries can focus on developing complementary quantum technologies—maximizing impact and innovation instead of duplicating similar projects across the region.

Leveraging Shared Security Interests: Shared security interests among Nordic countries, particularly in areas like quantum cryptography and quantum sensors, present opportunities for collaboration in both civilian and potential defence applications.

Expanding Collaboration to Other Sectors: There is potential for expanding Nordic collaboration to other sectors, such as quantum finance and quantum defence. This could involve joint initiatives between NordForsk and Nordic Innovation to support both research and innovation in quantum technologies.

Structured and Stable Funding Mechanisms: There is a strong need for structured, long-term funding; especially joint Nordic programs that support both research and innovation, leverage complementary strengths, and fill gaps in the value chain. NordForsk and Nordic Innovation could play key roles in enabling this.

Promoting High-Level Education and Research Collaboration: The Nordic Quantum network aims to promote high-level education, research collaboration, and infrastructure sharing among Nordic countries. This includes creating complementary courses and schools for PhD and postdoctoral education to avoid unnecessary overlaps.

Collaboration with International Partners: There are opportunities for collaboration with international partners, such as the Cleveland Clinic, to further enhance research and development efforts. Additionally, collaboration with the EU could support Nordic collaboration.

Collaboration with Private Foundations: Partnering with private foundations such as the Novo Nordisk Foundation can provide significant funding and strategic support. Such collaboration can advance quantum technology initiatives, promote regional cooperation, and enhance the global competitiveness of the Nordic quantum technology ecosystem.

Creating a Unified Nordic Quantum Community: By pooling efforts and resources, the Nordic region could create a strong, unified community that is more competitive globally. This includes leveraging cultural similarities and ease of travel within the region to facilitate collaboration.

Weaknesses

Lack of Dedicated Funding: One of the significant weaknesses is the lack of dedicated funding for quantum technology within the Nordic countries. Funding is often provided through bottom-up calls that cover all fields, making it challenging to secure specific funding for quantum technology.

Coordination Challenges: There are difficulties in coordinating funding and infrastructure across different Nordic countries. The lack of common funds as well as administrative and legal mechanisms that allow money to cross national borders hinders joint initiatives.

Infrastructure and Technical Staff: There is a need for further development of infrastructure and technical staff to support experimental research and technology development. The interviewees highlight the importance of securing national infrastructures which are crucial for advancing quantum technology research.

Recruitment and Skilled Workforce: There are challenges of recruitment and a need for more state-of-the-art infrastructure to support research. Attracting young researchers to the region is a global challenge, and the Nordic countries need to address the skilled workforce shortage in quantum technology.

Cross-Border Funding Mechanisms: The lack of mechanisms that allow money to cross national borders to support joint initiatives is a significant weakness. This issue makes it difficult to coordinate funding and infrastructure across different Nordic countries.

Threats

Geopolitical Considerations: The changing global landscape makes it crucial for the Nordic countries to become a stronger unit. The geopolitical importance of Nordic collaboration is highlighted, noting that the region needs to pool efforts and resources to remain competitive globally.

Sustainability of Collaborative Efforts: There is a need for more structured and long-term funding mechanisms to support networking and collaborative efforts. The sustainability of these collaborative efforts is threatened by the lack of long-term funding.

Private Funding Impact: Significant private funding – especially in Sweden and Denmark – can shift research from open to more closed environments, creating challenges for information sharing and collaboration. Strengthening networks and interaction across research environments is needed to balance these effects and maintain openness.

A SWOT analysis was also conducted as part of the Nordic Quantum White Paper (1), and it aligns closely with the present analysis. Notably, the white paper highlights several unique strengths and risks. Among the key strengths is the Nordic region's consistently high performance on the European Innovation Scoreboard (20), where countries like Sweden, Finland, and Denmark rank among the top in areas such as patent applications, scientific publications, and venture capital investment. This innovation leadership provides a strong foundation for quantum technology development. Additionally, the white paper emphasizes the robust open-access infrastructure (e.g., Myfab, OtaNano, Nanolab), a well-established quantum science and technology (QST) community, and strong industry-academia networks as critical assets.

On the risk side, the white paper uniquely identifies the potential for a "quantum winter", a downturn in hype and investment in quantum technologies, as a significant threat. This could lead to reduced funding, talent attrition, and slower progress if expectations are not met in the near term. The analysis also notes limited long-term funding sources, low awareness among potential industry end-users, and a lack of national coordination strategies as current weaknesses that could hinder the region's ability to capitalize on its strengths.

What They Shared: Suggestions from Interviews

This chapter presents a synthesis of key recommendations gathered through interviews with stakeholders across the Nordic quantum ecosystem. These perspectives are further examined in the Policy Alignment section, which compares stakeholder input with formal Nordic and European quantum strategies. The insights from interviews reflect a shared ambition to strengthen Nordic collaboration in quantum technologies through practical, forward-looking measures. The suggestions span critical areas such as policy and governance, funding, infrastructure, education, and international cooperation. Interviewees emphasized the need for long-term, sustainable funding models, streamlined cross-border collaboration, and coordinated governance structures to ensure strategic alignment and impact.

These perspectives are shaped not only by regional dynamics but also by the broader international context previously outlined in this report, where major global actors have launched ambitious national quantum strategies and large-scale initiatives. Against this backdrop, the Nordic region must consider how to position itself strategically and collaboratively in a rapidly evolving global quantum landscape.

Preconditions – Policy and Governance

Level of Funding and Investment

Increase public and private investment in quantum technology.

Quantum technology represents one of the most promising yet challenging frontiers in science and innovation, requiring substantial and sustained investment to realize its potential. As emphasized in the Danish context, the development of a full-stack quantum computer and the supporting ecosystem, ranging from advanced materials and chip fabrication to algorithms and applications, demands resources far beyond what individual institutions or countries can provide alone. Public investment is essential to support foundational research, infrastructure, and education, while private investment plays a critical role in accelerating innovation, scaling technologies, and bridging the gap to commercialization. The success of initiatives like the Novo Nordisk Foundation's Quantum Computing Program and Quantum Foundry Copenhagen illustrates how strategic private funding can complement public efforts to build world-class capabilities. To remain competitive globally and ensure that the Nordic region contributes meaningfully to the quantum revolution, it is vital to expand both public and private investment across the entire quantum value chain.

Policy Support for Basic Research

Support basic research in quantum technology, as it forms the foundation for future innovations.

Basic research is the cornerstone of progress in quantum technology, particularly because the field remains in an early, exploratory phase where many of the foundational principles and components are still under development. As emphasized in the Norwegian context, quantum technologies such as sensing and communication are not yet mature enough for widespread industrial application, meaning that the bulk of innovation still depends on academic research. Institutions like MiNaLab, in collaboration with SINTEF, are conducting essential experimental work on quantum materials and sensors, but these efforts are still relatively small and fragmented. Without sustained investment in fundamental research, there is a risk that the Nordic region will fall behind in developing the scientific knowledge and technical capabilities needed to participate in future breakthroughs. Supporting basic research not only builds the intellectual infrastructure for innovation but also helps identify and nurture the next generation of scientific leaders who will drive the field forward.

Long-Term, Sustainable Funding

Establish long-term, sustainable funding to support quantum technology research and education, ensuring initiatives are not short-term projects but have continuous and stable funding.

Several stakeholders across the Nordic quantum ecosystem emphasize the critical need for long-term, stable funding to ensure the success and continuity of quantum technology initiatives. As noted by multiple interviewees, quantum research is inherently long-term and resource-intensive, requiring sustained investment to build infrastructure, attract and retain talent, and develop viable technologies. For instance, both the Wallenberg Foundation's strategic program WACQT and Novo Nordisk Foundation's Quantum Computing Program are designed to run over more than a decade, recognizing that breakthroughs in quantum computing and sensing demand continuity beyond typical short-term project cycles. Similarly, in Finland and Norway, researchers highlighted the challenges of maintaining momentum and building critical mass without predictable funding streams. Without long-term support, promising initiatives risk fragmentation, loss of expertise, and missed opportunities for global competitiveness. Therefore, establishing sustainable funding mechanisms is essential to foster innovation, build robust educational pipelines, and ensure that Nordic countries remain at the forefront of quantum technology development.

Collaborative Funding Programs

Create joint funding programs involving contributions from multiple Nordic countries to overcome cross-border funding challenges and support research and innovation in quantum technology.

Cross-border collaboration in quantum technology across the Nordic region is often hindered by fragmented national funding structures and the absence of mechanisms for shared investment. Several Nordic researchers and stakeholders have pointed out that while there is strong scientific interest in working together, the lack of coordinated funding makes it difficult to launch and sustain joint projects. For example, efforts to establish shared infrastructure, organize joint doctoral schools, or support mobility between institutions are frequently constrained by administrative and financial barriers. In some cases, promising bilateral or multilateral initiatives have struggled to move forward due to the absence of matching funds or compatible funding timelines across countries. A joint Nordic funding program would help overcome these challenges by aligning national priorities, pooling resources, and enabling more ambitious and integrated research and innovation efforts. Such a program could also strengthen the region's global competitiveness by fostering a more cohesive and collaborative quantum ecosystem.

Coordination and Governance

Establish a coordinating body to oversee and facilitate Nordic collaboration in quantum technology, managing joint initiatives and coordinating funding.

Establishing a coordinating body to oversee and facilitate Nordic collaboration in quantum technology is essential for building a cohesive and effective regional ecosystem. As highlighted in the summary of Nordita's strategic vision, the absence of a centralized framework has made it difficult to align efforts, share resources, and maintain momentum across national boundaries. Nordita has already taken steps toward establishing a Nordic Quantum Platform, recognizing the need for a dedicated coordinator to manage joint scientific programs, workshops, and educational initiatives. The coordinator was officially hired in August 2025 to manage these efforts. However, progress remains constrained without stable and structured support. A formal coordinating body would provide the necessary infrastructure to streamline collaboration, reduce duplication, and ensure that Nordic countries can leverage their complementary strengths in a strategic and unified manner.

Such a body could also play a critical role in coordinating funding efforts, addressing the challenge of fragmented national funding systems that often hinder cross-border projects. By managing joint initiatives and facilitating communication among stakeholders, the coordinating body would help optimize resource distribution, promote mobility, and align Nordic efforts with broader European and global quantum strategies. This would not only enhance the region's competitiveness but also ensure that investments in quantum technology yield long-term, collective benefits. Such activities could shown significant benefit by directly highlighting to the EU the advantages for investment into the Nordics.

A model worth considering is the EuroQCI program, part of the Connecting Europe Facility, which is designed to link national quantum communication infrastructures across borders. However, its success depends on strong governmental co-funding.

Focus on Strengths

Concentrate on areas where Nordic countries have existing strengths rather than competing directly with larger countries in all areas of quantum technology.

Given the scale of global investments in quantum technology by countries like the United States and China, it is neither strategic nor feasible for smaller Nordic countries to compete across the entire spectrum of quantum research. Instead, focusing on areas of established strength offers a more effective path to impact and leadership. As highlighted in the Norwegian context, quantum sensing has emerged as a particularly promising niche, with strong experimental capabilities centred around facilities like MiNaLab and partnerships with institutions such as SINTEF. Danish collaborators have also recognized this as one of the most compelling aspects of Norwegian quantum research. By concentrating efforts and resources on such areas where Nordic countries already possess infrastructure, expertise, and industrial relevance the region can build globally competitive capabilities without diluting impact across too many fronts. This targeted approach also aligns well with the broader Nordic strategy of fostering complementary strengths and avoiding unnecessary duplication in a rapidly evolving technological landscape.

Enablers – Infrastructure and Resources

Infrastructure Sharing and Access to Research Facilities

Share and develop advanced quantum infrastructure across the Nordic region to enable effective collaboration, maximize investment impact, and accelerate regional leadership in quantum science and technology.

Effective collaboration in quantum technology across the Nordic region would benefit greatly from more seamless sharing of infrastructure and resources. By concentrating efforts and resources in areas where Nordic countries already have infrastructure, expertise, and industrial relevance, the region can build globally competitive capabilities. This focus helps avoid spreading resources too thin across multiple fronts.

As highlighted in the Swedish-Finnish collaboration on photonic quantum technologies, researchers often face significant administrative and legal hurdles when attempting to work across borders, even on small-scale projects. For instance, efforts to integrate Swedish cryogenic quantum technology with Finnish silicon photonics platforms encountered delays due to institutional bureaucracy, including negotiating non-disclosure agreements and navigating differing legal frameworks. These barriers can be especially discouraging when the scientific and technological synergies are clear, and the geographical distance is minimal.

Given the high cost and complexity of quantum facilities, there is a strong emphasis on creating shared resources that can be accessed by multiple institutions and researchers. For example, the collaboration between Chalmers University and Aalto University on single quantum detection leverages Chalmers' cleanroom capabilities, demonstrating how shared infrastructure can support cutting-edge research without duplicating effort.

Promoting cross-border access to unique facilities and specialized equipment is essential for maximizing the value of existing investments. Initiatives like Otanano in Finland, a national infrastructure for nanoscience and quantum technologies, exemplify how centralized platforms can serve both academic and industrial users.

To fully realize the potential of Nordic collaboration, future efforts should focus on:

- *Reducing bureaucratic friction to accelerate joint research*
- *Expanding access to physical quantum infrastructure*
- *Coordinating investments to ensure equitable access across institutions and countries*

This collaborative and streamlined approach will not only enhance the region's capacity for innovation but also help build a resilient and self-sufficient quantum technology supply chain, establishing the Nordics as a global reference point in quantum science and technology.

Access to Quantum Computing Resources and Hybrid Infrastructure

Ensure broad, hands-on access to quantum computing infrastructure and invest in hybrid systems to empower research, accelerate innovation, and strengthen Nordic competitiveness.

Expanding access to quantum computing resources and facilities is critical for advancing cutting-edge research, driving innovation, and maintaining the Nordic region's competitiveness in the global quantum arena. High-quality infrastructure, such as quantum processors, fabrication facilities, and testbeds, plays a pivotal role in enabling both academic and industrial progress. Initiatives like the Quantum Foundry Copenhagen and Sweden's WACQT testbed highlight the value of providing researchers and companies with direct access to quantum hardware and simulation platforms. These facilities not only support experimentation and development but also serve as essential training environments for future quantum scientists and engineers.

Complementing these efforts, the NordIQuest project, under the Nordic e-Infrastructure Collaboration (NeIC), has established a robust foundation for shared access to high-performance computing and quantum-related infrastructure. This initiative exemplifies how coordinated regional efforts can enhance collaboration, reduce duplication, and improve the overall efficiency of resource utilization across national boundaries.

Looking ahead, researchers and developers in quantum computing increasingly emphasize that quantum computing will inherently rely on hybrid models that combine quantum and classical systems. This reflects the complementary strengths of each architecture and underscores the strategic importance of integrating quantum computing with high-performance computing (QC-HPC) systems. Although these technologies are at different stages of maturity, their convergence is seen as essential for unlocking new capabilities and accelerating innovation.

Realizing the full potential of QC-HPC integration will require sustained investment in shared infrastructure, the development of hybrid algorithms, and the coordination of research programs across the region. These initiatives will help place the Nordics among the internationally recognized contributors to next-generation computing and ensure a durable presence in the evolving global quantum ecosystem.

Mechanisms for Action – Collaboration in Practice

Education and Training

Develop coordinated education and training programs to build a strong talent pool in quantum technology, including joint PhD and postdoctoral programs.

Building a robust talent pipeline is essential for the Nordic region to remain competitive in the rapidly evolving field of quantum technology. Stakeholders across the region emphasized that education and training are foundational to sustaining long-term leadership in quantum research and innovation. In Sweden, the WACQT initiative has placed a strong emphasis on education, leading to the recruitment of assistant professors, the establishment of a national graduate school, and the training of over a hundred PhD students. These efforts ensure that the next generation of researchers is well-equipped with both theoretical knowledge and practical skills in quantum computing, sensing, and communication. Such national efforts provide a strong foundation for broader regional coordination.

As highlighted in the Danish context, there is already recognition of the importance of workforce development. One cross-border initiative is the Niels Bohr Institute's collaboration with the University of Oslo on a jointly funded postdoctoral project.

Initiatives such as the Finnish-Swedish postdoctoral program further demonstrate the value of structured mobility and shared research efforts. These examples demonstrate the feasibility and value of cross-border training programs that leverage complementary expertise and infrastructure.

Moreover, institutions like Nordita are well-positioned to coordinate educational efforts, particularly in theoretical physics, and could play a central role in facilitating student exchanges and shared curricula. Coordinated Nordic PhD and postdoctoral programs would not only enhance the quality of training but also foster a sense of regional identity and collaboration among emerging researchers. By pooling resources and aligning educational strategies, Nordic countries can cultivate a highly skilled workforce capable of driving innovation and sustaining long-term leadership in quantum technologies.

Furthermore, coordinated efforts like the Nordic Quantum network and Nordita's role in organizing joint summer schools and doctoral courses show that cross-border collaboration can address challenges such as limited student numbers in specialized fields. By harmonizing educational and research strategies, Nordic countries can create a more integrated and dynamic research environment. This approach not only enhances scientific excellence but also strengthens the region's position in the global quantum landscape. To fully realize these benefits, sustained investment and strategic coordination are needed to support long-term, impactful partnerships.

International Collaboration

Complement Nordic collaboration with strong international partnerships, building connections with leading researchers and institutions globally.

While strengthening Nordic collaboration is essential, it must be complemented by robust international partnerships to ensure global competitiveness in quantum technology. As emphasized by leaders in the Danish quantum ecosystem, building connections with top institutions worldwide, such as MIT, Berkeley, TU Delft, and Toronto, has been instrumental in advancing cutting-edge research and infrastructure. These collaborations provide access to specialized capabilities, such as ion implantation and advanced fabrication techniques, that may not be available within the Nordic region. Moreover, engaging globally allows Nordic researchers to benchmark their progress, attract top talent, and stay at the forefront of technological innovation. By combining regional strengths with global excellence, the Nordics can position themselves as a key player in the international quantum landscape.

Networks

Strengthening existing networks

Leverage and expand existing networks to strengthen Nordic and international collaboration in quantum technology.

Leveraging and expanding existing networks is a powerful strategy for strengthening both Nordic and international collaboration in quantum technology. The Nordic Quantum network, coordinated by Nordita, plays a key role in facilitating collaboration among researchers, promoting the sharing of resources, and supporting joint educational initiatives. This network is particularly valuable for organizing summer schools and joint courses, which are essential for gathering a critical mass of students in highly specialized areas of quantum science, something that individual institutions often struggle to achieve alone.

In parallel, the Nordic Quantum Life Science Roundtable exemplifies a successful bottom-up initiative. It brings together stakeholders from across the Nordic countries to discuss key topics such as research support, innovation, and ecosystem development at the intersection of quantum technology and life sciences. These kinds of networks not only foster scientific exchange but also help align strategic priorities and build a more cohesive and competitive Nordic presence in the global quantum landscape. Strengthening and expanding such platforms will be crucial for sustaining momentum and ensuring long-term impact.

Establishing New Collaborative Platforms

Establish new, agile Nordic platforms that unite researchers, industry, and funders to co-develop roadmaps, share infrastructure, and coordinate investments in quantum technology.

Establishing new collaborative platforms is essential to strengthen and scale Nordic efforts in quantum technology. While existing networks like the Nordic Quantum network and the Nordic Quantum Life Science Roundtable have laid important groundwork, there is a clear opportunity to build more structured, agile, and goal-oriented platforms that can drive both scientific and technological progress. As highlighted in discussions around strategic initiatives, certain challenges, such as building a full-stack quantum computer or developing advanced quantum sensing applications, require coordination beyond what open competition alone can achieve. New platforms could bring together researchers, industry, and funders across the Nordic region to co-develop focused roadmaps, share infrastructure, and align investments. These platforms should be designed to be flexible, responsive to emerging needs, and capable of integrating both bottom-up scientific input and top-down strategic direction. By doing so, they can help the Nordic region maintain a competitive edge and foster innovation across the entire quantum value chain.

Research and Development

Facilitating Knowledge Exchange and Researcher Mobility

Promote researcher mobility and exchange to strengthen collaboration and build a skilled Nordic quantum workforce.

Researcher mobility is a cornerstone of a vibrant quantum ecosystem. Programs like the Swedish-Finnish postdoctoral exchange have proven effective in fostering collaboration and aligning research agendas across borders. These exchanges enhance mutual understanding, promote shared use of infrastructure, and build networks of complementary expertise.

Initiatives such as the Nordic Quantum network, supported by institutions like Nordita, are laying the foundation for joint summer schools and specialized doctoral courses. These programs are especially valuable in niche areas where individual institutions may lack critical mass. By promoting structured mobility and knowledge exchange, the Nordic region can cultivate a new generation of quantum scientists equipped with diverse perspectives and collaborative experience.

Advancing Collaborative Research and Joint R&D in Quantum Technology

Foster structured, cross-border research and development collaborations to align Nordic strengths, share infrastructure, and accelerate scalable quantum innovation.

Collaborative research and joint R&D initiatives are essential for advancing quantum technology in the Nordic region, where expertise and infrastructure are distributed across multiple countries and institutions. Large-scale efforts such as Sweden's WACQT and Denmark's NQCP demonstrate the value of structured partnerships, both within and across borders. These initiatives have enabled researchers to co-develop technologies, share infrastructure, and build complementary expertise in areas like superconducting qubits, quantum sensing, and chip fabrication.

Cross-border collaborations also foster a more integrated ecosystem by connecting academia, industry, and government stakeholders. For example, partnerships with companies in sectors such as defence, pharmaceuticals, and semiconductors have helped align academic research with real-world applications. Joint projects like the Aarhus–Oslo postdoctoral collaboration and partnerships with Finnish firms such as SemiQon illustrate how pooling Nordic strengths can address complex challenges more effectively.

To maximize impact, these collaborations should be supported by:

- *Flexible funding mechanisms*
- *Streamlined administrative processes*
- *Long-term commitments*
- *Shared roadmaps and infrastructure*

By coordinating strategic goals and reducing duplication, the Nordic region can accelerate the development of scalable quantum technologies and enhance its global competitiveness.

Industry and Innovation

Strengthening industry-academia partnerships

Establish structured industry-academia partnerships to align research with industrial needs, accelerate commercialization, and strengthen the Nordic quantum innovation ecosystem.

Strengthening industry-academia partnerships is essential for accelerating the development and commercialization of quantum technologies. The NQCP and its associated Quantum Foundry Copenhagen exemplify how close collaboration between academic institutions and industry can create a robust innovation ecosystem. These partnerships enable the translation of cutting-edge research into scalable technologies by aligning academic exploration with industrial needs, such as the fabrication of ultra-pure quantum chips and the development of full-stack quantum computing platforms.

Moreover, industry-academia collaboration fosters mutual benefits: companies gain access to world-class research and talent, while academic institutions benefit from real-world challenges, funding opportunities, and pathways to impact. NQCP's model of engaging with global and Nordic industrial partners, such as SemiQon in Finland, demonstrates how shared goals and complementary capabilities can drive progress. To fully leverage this potential, structured programs that support joint R&D, shared infrastructure, and co-funded positions are needed. These partnerships not only enhance technological competitiveness but also help build a resilient and dynamic quantum innovation landscape in the Nordic region. Raising quantum awareness across the broader industry sector will be key to unlocking new applications and accelerating adoption.

Supporting quantum technology startups and spin-offs

Support quantum startups and spin-offs through targeted funding, incubators, and academic entrepreneurship to accelerate commercialization and grow a competitive Nordic quantum industry.

Supporting quantum technology startups and spin-offs is critical for translating scientific breakthroughs into real-world applications and building a competitive innovation ecosystem. Denmark has taken a proactive approach by establishing initiatives like the Deep Tech Lab Quantum and Quantum Denmark, which provide startups with access to advanced infrastructure, packaging capabilities, and proximity to leading research environments such as the Niels Bohr Institute. These initiatives not only lower the barrier to entry for new ventures but also foster a dynamic interface between academia and industry, where ideas can rapidly evolve into scalable technologies.

Startups play a vital role in driving innovation, agility, and commercialization in the quantum sector. They often explore niche applications, develop specialized components, and attract private investment that complements public research funding. By supporting these ventures through targeted funding, incubator programs, and access to shared facilities, Nordic countries can accelerate the development of a robust quantum industry. Moreover, fostering a culture of entrepreneurship within academic institutions, through spin-off support, IP flexibility, and mentorship, ensures that groundbreaking research does not remain confined to the lab but contributes to economic growth and technological leadership.

Joint use cases research to innovation

Support joint use case research that links fundamental science with real-world applications to accelerate impactful quantum innovation across sectors.

Supporting joint use case research that bridges the gap between fundamental science and real-world innovation is essential for unlocking the full potential of quantum technologies. The Danish ecosystem, particularly through the NQCP, has adopted a layered approach that integrates applications and algorithms research with hardware development. This structure enables researchers to explore concrete use cases, such as quantum-enhanced simulations or materials discovery, while simultaneously advancing the underlying technologies needed to realize them. By aligning research with practical challenges, joint use case initiatives help ensure that quantum innovations are not only scientifically significant but also societally and economically relevant.

Moreover, joint use case research fosters collaboration across disciplines and sectors, bringing together academia, startups, and industry to co-develop solutions. This approach accelerates the translation of quantum capabilities into applications in fields like pharmaceuticals, logistics, and cybersecurity. It also provides a framework for iterative feedback between users and developers, which is crucial for refining both hardware and software. To maximize impact, Nordic countries should invest in coordinated programs that support cross-border, cross-sector use case development; leveraging shared infrastructure, complementary expertise, and a common vision for innovation.

The key themes and priorities identified here directly inform the Recommendations for Nordic Policymakers, ensuring that proposed actions are grounded in stakeholder experience.

Nordic Approaches Today: Policies and Proposals

Joint statement by the Nordic Prime Ministers and Heads of Government

The joint statement "Laying the foundation for future Nordic advancements" issued on 25 May 2025 by the Nordic Prime Ministers and Heads of Government outlines a strategic and forward-looking commitment to advancing quantum technologies across the region. Recognizing the transformative potential of quantum computing, communication, sensing, and cryptography, the statement emphasizes the importance of deepening Nordic cooperation to remain at the forefront of global advancements in this field. Key policy objectives include fostering scientific and educational partnerships, aligning national funding programs, promoting ethical regulatory frameworks, and accelerating commercialization efforts. The statement also highlights the need for secure, interoperable supply chains and enhanced international collaboration. Crucially, stakeholders such as NordForsk are identified as instrumental in facilitating this agenda, particularly through their role in coordinating research and innovation efforts under the Nordic Council of Ministers. NordForsk's involvement underscores the importance of structured, cross-border collaboration in achieving the region's quantum ambitions.

Nordic Innovation: The Nordic-Baltic Quantum Ecosystem Report

Building on the strategic vision laid out in the 25 May 2025 joint statement by the Nordic Prime Ministers and Heads of Government (21), this report provides a comprehensive, data-driven analysis of the Nordic-Baltic quantum landscape (3). It supports the statement's call for deeper regional cooperation by mapping commercial activity, identifying technological strongholds, and offering targeted policy recommendations. These include measures to accelerate market formation, attract investment, and enhance cross-border collaboration, key priorities echoed in the Prime Ministers' declaration. The report further emphasizes the value of shared strategies, joint pilot initiatives, and a unified voice in international forums, reinforcing the Nordic commitment to shaping a responsible and competitive quantum future.

The analysis of the Nordic-Baltic quantum landscape highlights three high-impact policy recommendations designed to address key gaps and accelerate regional progress. First, it proposes the creation of a Quantum Coordination Forum to align strategies, coordinate cross-border efforts, and support joint initiatives, ensuring political ambitions translate into effective collaboration. Second, it calls for a thought leadership initiative to position the Nordic-Baltic region as a global influencer in quantum policy, standardization, and strategic foresight by uniting voices from research, industry, and the public sector. Third, it recommends launching ambitious cross-country pilot projects that bring together researchers, technology providers, and end-users to fast-track innovation and elevate the region's profile in the global quantum arena. These targeted actions are supported by a broader "policy toolbox" to complement national strategies and drive long-term development.

A further discussion of this report is given in a later chapter.

Nordic Quantum White Paper

The Nordic Quantum White Paper (1) outlines a bold vision to establish the Nordic region as the world's most attractive and collaborative ecosystem for quantum technologies, underpinned by the most quantum-literate workforce globally. It proposes a coordinated strategy across Denmark, Finland, Norway, and Sweden (with potential inclusion of Iceland) to strengthen scientific excellence, foster innovation, and enhance educational frameworks in quantum science and technology (QST). The strategy emphasizes joint actions in research, education, infrastructure investment, and international engagement. Key initiatives include Nordic doctoral networks, shared infrastructure, coordinated EU-level advocacy, and a dedicated Nordic Quantum coordinator. The White Paper also highlights the importance of industry-academia collaboration, public outreach to boost quantum literacy, and strategic visibility to attract talent and investment. By pooling resources and aligning national efforts, the Nordic Quantum network aims to amplify the region's global influence and competitiveness in the rapidly evolving quantum landscape. The white paper is endorsed by more than 30 scientists across the Nordic countries.

From Insight to Action: Aligning Stakeholder Recommendations with Strategic Nordic Quantum Policy

This chapter builds on the insights gathered from stakeholders (see What They Shared: Suggestions from Interviews), presenting key recommendations that reflect the practical needs and strategic aspirations of actors across the Nordic-Baltic quantum landscape. To contextualize and deepen these findings, I compare them with two foundational policy documents: the Nordic-Baltic Quantum Ecosystem report (3) and the Nordic Quantum White Paper (1), as well as the Joint Statement by the Nordic Prime Ministers and Heads of Government on Quantum Technologies (21) issued on 25 May 2025. Together, these sources offer a multi-layered view of the region's quantum ambitions, from grassroots innovation to high-level policy coordination. By synthesizing these perspectives, this chapter identifies areas of convergence, highlights actionable gaps, and explores how stakeholder-driven insights can inform and enhance the implementation of regional strategies. The goal is to bridge the dialogue between policy and practice, ensuring that the Nordic quantum agenda is both visionary and grounded.

Strategic Alignment with the Nordic-Baltic Quantum Ecosystem Report

Converging Priorities: Alignment Between Stakeholder Recommendations and the Nordic-Baltic Quantum Ecosystem Report

A comparative analysis of this report's insights from interview respondents and the "Nordic-Baltic Quantum Ecosystem" report (3) reveals a strong convergence around strategic priorities for advancing quantum technology across the Nordic and Baltic region. Note that the sources for the present report and the groundwork of the ecosystem report also involves interviews and that there may be some overlap in interview subjects. However, despite their differing formats, one grounded in practitioner interviews and the other in policy analysis and ecosystem mapping, both sources highlight foundational needs that reinforce the case for coordinated regional action.

A central theme is the call for long-term, sustainable funding. Stakeholders emphasized the importance of predictable investment to support infrastructure, talent development, and continuity in research. The ecosystem report echoes this concern, identifying insufficient long-term funding as a major policy gap and recommending mechanisms to support sustained R&D and commercialization. Both perspectives stress that without stable financial support, the region risks fragmentation and missed opportunities for global impact.

Closely related is the shared emphasis on joint funding mechanisms and cross-border collaboration. Interview respondents advocated for Nordic-wide funding programs to overcome fragmented national systems and support shared infrastructure and researcher mobility. The ecosystem report reinforces this by proposing a Quantum Coordination Forum and cross-country pilot projects to align strategies and pool resources. Both sources recognize that coordinated governance and funding are essential to enable impactful, region-wide initiatives.

Infrastructure sharing is another area of strong alignment. Stakeholders called for streamlined access to shared facilities such as cleanrooms and testbeds, citing bureaucratic barriers as a major obstacle. The ecosystem report responds with a proposal for a Nordic-Baltic infrastructure access program, designed to provide federated access to quantum resources and maximize the value of existing investments.

The importance of industry-academia collaboration is also a recurring theme. Stakeholders highlighted the need for structured partnerships to translate research into scalable technologies. The ecosystem report supports this by recommending startup and scale-up support programs, as well as public-private pilot projects. Both documents view such collaboration as essential for fostering innovation, developing talent, and ensuring market readiness.

Support for startups and spin-offs is another shared priority. Interviewees stressed the need for incubators, flexible intellectual property frameworks, and access to infrastructure to help early-stage ventures grow. The ecosystem report aligns with this by proposing targeted support programs and early-stage funding to build a robust quantum business ecosystem.

Education, talent development, and researcher mobility are also emphasized in both documents. Stakeholders recommended joint PhD and postdoctoral programs, as well as coordinated training initiatives to build a strong talent pipeline. The ecosystem report complements this with proposals for joint education programs, mobility fellowships, and workforce retraining initiatives. Both sources agree that cross-border education and mobility are critical to developing a skilled and adaptable quantum workforce.

Finally, both documents prioritize joint use case development as a strategy to bridge fundamental research and real-world innovation. Stakeholders advocated for collaborative research focused on practical applications, while the ecosystem report recommends launching cross-country pilot projects involving end-users to accelerate technology readiness. This shared focus on use-case-driven R&D reflects a commitment to demonstrating the societal and economic value of quantum technologies.

Additional Insights from Stakeholders

While the ecosystem report provides a comprehensive strategic overview, the stakeholder interviews offer additional operational insights that enrich the policy narrative. One such area is the challenge of administrative and legal barriers to cross-border collaboration. Interviewees described delays caused by institutional bureaucracy, such as negotiating non-disclosure agreements and navigating incompatible legal frameworks. These practical issues are largely absent from the policy report but critical to the success of joint initiatives.

Stakeholders also offered a more detailed vision for governance. While the report proposes a Quantum Coordination Forum, interviewees elaborated on the specific functions such a body should perform, including aligning funding mechanisms, managing shared infrastructure, and facilitating communication among stakeholders. This more granular perspective reflects the lived experience of those navigating fragmented governance structures.

Another valuable contribution from the interviews is the emphasis on focusing regional efforts on areas of existing strength, such as quantum sensing. While the report identifies strongholds, stakeholders provided a strategic rationale for concentrating resources where the Nordics already have a competitive edge, rather than spreading efforts too thinly across all quantum domains.

Finally, the interviews highlighted the importance of international collaboration beyond Europe. While the report focuses primarily on EU-level coordination, stakeholders emphasized the value of existing partnerships with leading global institutions such as MIT, Berkeley, and TU Delft—many of which could be deepened. They also highlighted opportunities to establish new collaborations that would further strengthen the Nordic quantum ecosystem. These relationships are seen as essential for benchmarking progress and accessing specialized capabilities.

Comparison with the Nordic Quantum White Paper

Aligning Vision and Practice: Comparing the Nordic Quantum White Paper with Stakeholder Perspectives

Note that the sources for the present report and the Nordic Quantum White Paper (1) may partially overlap. The Nordic Quantum White Paper and the insights from interview respondents both articulate a shared ambition to position the Nordic region as a prominent global contributor in quantum science and technology. While they align on several strategic goals; particularly around collaboration, education, and infrastructure, the White Paper introduces a more formalized policy roadmap. At the same time, stakeholder interviews offer grounded, operational insights that could enhance the White Paper's proposals, especially in areas such as education and skills development, regulatory frameworks, and international positioning.

Shared Vision and Strategic Goals

Both documents emphasize the importance of cross-border collaboration, shared infrastructure, and workforce development. The White Paper proposes Nordic doctoral networks, visiting researcher schemes, and shared recruitment of postdocs. These align closely with stakeholder calls for joint PhD and postdoctoral programs, mobility schemes, and co-funded industry-academia partnerships. Both sources also highlight the need to build a robust talent pipeline and increase quantum literacy across sectors.

In terms of infrastructure, both documents stress the value of open-access facilities and coordinated investment. The White Paper references specific platforms such as Myfab, OtaNano, and DTU Nanolab, while stakeholders emphasize the need to reduce bureaucratic barriers to accessing these resources.

Education and Skills: From Vision to Implementation

The White Paper outlines a strong vision for education, including doctoral training networks and summer schools. Stakeholders reinforce this vision but add practical suggestions for implementation. These include co-funded, cross-border PhD programs embedded in industry, flexible IP arrangements to support spin-offs, and targeted training for professionals in sectors like cybersecurity and logistics. These insights could help operationalize the White Paper's broader goal of building the world's most quantum-literate workforce.

Regulatory Frameworks: A Missing Piece

One area where the White Paper is notably silent, but stakeholders are vocal, is the need for harmonized regulatory frameworks. Interviewees highlighted administrative and legal barriers to collaboration, such as delays in negotiating NDAs and navigating institutional policies. These practical challenges can significantly hinder joint projects. Including model agreements or a call for regulatory alignment in the White Paper would strengthen its coordination agenda and make its proposals more actionable.

International Positioning: From Participation to Influence

The White Paper emphasizes visibility and participation in international dialogues, including EU initiatives and global standardization efforts. Stakeholders, however, push for a more strategic approach: one that includes building alliances with leading global institutions (e.g., MIT, TU Delft, Berkeley), benchmarking against international best practices, and actively shaping global standards in areas like quantum security and ethical AI. These contributions suggest that the Nordic region should not only participate in global forums but also lead in setting the agenda.

Additional Contributions from the White Paper

The White Paper introduces several structural and strategic elements not emphasized in the interviews. These include:

- A full-time Nordic Quantum coordinator.
- A roadmap for engaging with EU-level initiatives like the European Quantum Pact and Chips Act.
- A dedicated communication strategy to raise awareness and attract talent.
- A call for seed funding to support coordination and outreach activities.

These additions provide a more comprehensive policy framework and reflect a top-down perspective that complements the bottom-up insights from stakeholders.

Policy Convergence: Reflections on the Prime Ministers' Joint Statement

Bridging Vision and Practice: How Political Commitments Support Grassroots Recommendations

The Joint Statement by the Nordic Prime Ministers and Heads of Government (21) represents a significant political endorsement of regional cooperation in quantum innovation. When compared with the grassroots insights captured in the "Insights from Interview Respondents," it becomes clear that the high-level commitments not only echo but also reinforce many of the practical recommendations voiced by researchers, innovators, and institutional leaders across the Nordic quantum ecosystem.

Shared Commitment to Ethical Governance

Both the Joint Statement and the stakeholder interviews recognize the importance of ethical and responsible development of quantum technologies. The Prime Ministers commit to “monitoring regulatory development while promoting a technology-enabling, ethical regulatory framework.” This aligns with stakeholder concerns about the need for governance structures that support innovation while addressing legal, ethical, and security implications. Interviewees focused more on operational barriers, such as administrative delays and legal inconsistencies. In contrast, the political statement provides a broader mandate for harmonizing regulation and embedding ethical considerations into policy frameworks.

Advancing Commercialization and Innovation

Commercialization is a central theme in both documents. The Joint Statement calls for “strengthening commercialisation efforts to accelerate the market-maturing of Nordic quantum solutions,” which directly supports stakeholder calls for increased support to startups, spin-offs, and industry-academia partnerships. Interview respondents emphasized the need for targeted funding, incubator programs, and infrastructure access to help early-stage ventures scale. The political commitment to leveraging EU and private funding, and to profiling the Nordics as a destination for quantum investment, provides a strategic platform to realize these grassroots ambitions.

Regional Coordination and Shared Infrastructure

The Joint Statement’s emphasis on “strengthening collaboration between national funding programmes” and exploring “common funding initiatives” reflects a clear alignment with stakeholder recommendations for joint Nordic funding mechanisms and shared infrastructure. Interviewees repeatedly stressed the need for a coordinating body to manage cross-border initiatives, reduce duplication, and streamline access to facilities. The political call to “utilise relevant frameworks such as the Nordic Council of Ministers, not least NordForsk” reinforces the potential for institutional mechanisms to bridge policy and practice.

The Role of NordForsk and Supporting Institutions

NordForsk is explicitly mentioned in the Joint Statement as a key actor in supporting collaboration on quantum technologies. This reflects its growing role as a facilitator of cross-border research funding and coordination. Stakeholders also recognized the importance of such institutions, though often implicitly, by calling for more structured and sustained support for joint initiatives. The alignment between political intent and grassroots needs suggests that NordForsk and similar bodies are well-positioned to serve as intermediaries that can translate high-level strategy into operational programs that support researchers, educators, and innovators on the ground.

Recommendations for Nordic Policymakers

Building on the strong alignment between stakeholder insights and regional policy frameworks, this chapter outlines key recommendations to guide the Nordic-Baltic quantum agenda. These recommendations build on existing regional efforts such as those described in Joint Nordic Initiatives, aiming to scale and structure collaboration across the Nordic quantum ecosystem. The priorities reflect both strategic consensus and practical needs, offering a roadmap for coordinated action that bridges vision and implementation. The recommendations are grounded in insights from stakeholder interviews, the Nordic-Baltic Quantum Ecosystem Report (3), and the Nordic Quantum White Paper (1), and are further reinforced by the high-level political commitment expressed in the Joint Statement by the Nordic Prime Ministers and Heads of Government on Quantum Technologies (21).

This chapter reaffirms the value of aligning bottom-up insights from practitioners and innovators with top-down strategies and policy frameworks. Such alignment ensures that the Nordic quantum agenda remains both visionary and grounded, enabling policies that are not only ambitious but also responsive to the operational realities of the ecosystem. Together, these sources highlight a shared ambition to position the Nordic region as a prominent global contributor in quantum innovation through cross-border collaboration, ethical governance, and strategic investment.

1. Establish Sustainable, Region-Wide Funding Mechanisms

To ensure long-term impact, the Nordic-Baltic region must move beyond fragmented national funding and commit to:

- Multi-year, cross-border funding programs that support research, infrastructure, and commercialization.
- Joint investment platforms coordinated by institutions like NordForsk to pool national resources.
- Equitable access to funding across all countries to foster inclusive growth and avoid regional disparities.

2. Build a Nordic Framework for Cross-Border Collaboration

Effective collaboration requires more than goodwill—it needs structure. The region should:

- Create a Nordic Quantum Coordination Forum to align national strategies and streamline governance.
- Support multi-country research consortia and joint pilot projects that span institutions and borders.

- Harmonize legal, administrative, and IP frameworks to reduce friction in cross-border cooperation.
- Leverage and strengthen existing networks, such as Nordic Quantum network, NordIQuest, and Nordic Quantum Life Science Roundtable, to facilitate collaboration, knowledge exchange, and community-building across the region.

(This recommendation reflects feedback from both researchers and infrastructure providers, who emphasized the importance of inclusive governance and practical mechanisms for collaboration.)

3. Create a Federated Nordic Infrastructure Network

Quantum research depends on access to specialized facilities. Aligning with stakeholder calls for improved access and coordination of infrastructure (see Infrastructure Sharing in Stakeholder Insights), a federated approach would:

- Develop a Nordic infrastructure access portal to coordinate use of cleanrooms, testbeds, and labs.
- Implement standardized access protocols and reduce bureaucratic barriers for cross-border users.
- Encourage co-investment in shared infrastructure to maximize efficiency and regional value.

4. Strengthen Nordic Industry-Academia Partnerships

To accelerate innovation and commercialization, the region should:

- Launch Nordic innovation clusters that connect universities, startups, and industry across borders.
- Co-fund cross-border PhD and postdoc placements embedded in companies.
- Support joint public-private R&D projects that address shared regional challenges and market opportunities.

5. Support a Nordic Quantum Startup Ecosystem

Entrepreneurship must be nurtured at the regional level. Key actions include:

- Establish Nordic-wide incubators and accelerators with access to shared infrastructure and mentorship.
- Harmonize IP and licensing policies to enable easier cross-border spin-off creation.
- Provide early-stage funding pools accessible to startups from all Nordic-Baltic countries.

6. Launch a Nordic Talent and Mobility Strategy

A mobile, skilled workforce is essential for regional competitiveness. This responds directly to the needs identified in Education and Training by stakeholders across the region. It involves:

- Creating joint Nordic PhD programs with co-supervision and mobility components.

- Offering Nordic mobility fellowships for researchers, educators, and professionals.
- Coordinating quantum literacy and upskilling programs across sectors and borders.

7. Focus on Joint Use-Case Development

To demonstrate real-world value, the region should:

- Identify shared Nordic priorities (e.g., climate technology, secure communication) for quantum applications.
- Launch cross-border pilot projects involving end-users from multiple countries and sectors.
- Promote interdisciplinary collaboration to ensure solutions are both technically robust and societally relevant.

Final Remarks

Summary of Key Points

This report has explored the current landscape, strategic opportunities, and collaborative potential of quantum technology across the Nordic region. Key findings include:

- **Strong Regional Foundations**: The Nordic region has cultivated a diverse and complementary landscape in quantum technology, supported by robust ecosystems, specialized expertise, and collaborative innovation across multiple domains.

- **Shared Regional Vision:** Despite differences in scale and focus, there is a shared recognition of the importance of quantum technology for economic growth, national security, and scientific leadership. This is reflected in national strategies, institutional investments, and emerging cross-border initiatives.

- **Challenges to Address**: Fragmented funding mechanisms, limited infrastructure sharing, and administrative barriers continue to hinder deeper collaboration. Talent retention, infrastructure modernization, and sustainable funding remain critical needs.

- **Opportunities for Synergy**: The Nordic region is well-positioned to lead globally by leveraging complementary strengths, aligning national strategies, and investing in shared infrastructure and education. Initiatives like the Nordic Quantum network, NordIQuEst, and the Nordic Quantum Life Science Roundtable exemplify the potential of coordinated action.

- **Stakeholder Alignment**: Interviews and policy documents converge on the need for long-term funding, joint research programs, shared infrastructure, and a coordinated governance model to support a thriving Nordic quantum ecosystem.

Final Thoughts on the Importance of Nordic Cooperation in Advancing Quantum Technology

Nordic cooperation is not merely a strategic advantage—it is a necessity for global relevance in quantum technology. The complexity and resource intensity of quantum research demand a scale of collaboration that transcends national borders. By working together, the Nordic countries can:

- **Amplify Global Influence**: A unified Nordic voice in international forums enhances the region's ability to shape global standards, attract investment, and influence ethical and regulatory frameworks.

- **Accelerate Innovation**: Shared infrastructure, joint funding, and coordinated education programs reduce duplication, foster innovation, and enable faster translation of research into real-world applications.

- **Ensure Strategic Autonomy**: In a geopolitically sensitive domain like quantum technology, regional collaboration strengthens resilience, reduces dependency on external actors, and safeguards critical capabilities.

- **Build a Quantum-Literate Society**: Coordinated efforts in education and public engagement can cultivate a workforce and citizenry equipped to navigate and benefit from the quantum era.

To support this vision, it may be timely to consider a dedicated initiative, similar in structure to the Top Research Initiative (22) (TRI), but focused on quantum technology. Such a program could offer a coordinated and sustained framework for Nordic collaboration, helping to align research efforts, develop shared infrastructure, and nurture talent. While ambitious, a TRI-type effort for quantum could build on existing strengths and serve as a practical step toward deeper regional integration in this emerging field.

In conclusion, we have what it takes for the Nordic region to be a key actor in the global quantum ecosystem. Achieving this means committing to shared priorities, consistent funding, and open collaboration. It's time to start, with purpose and pace.

The Nordics are well placed to shape the future of quantum technology. Seizing this opportunity calls for shared priorities, sustained investment, and open collaboration. The time to act is now — with purpose and pace.

List of References and Further Reading

1. Nordic Quantum. White Paper: Nordic Quantum. Nordita. [Online] 2024. https://nordita.org/site/assets/docs/nordic_quantum_white_paper.pdf

2. Research Council of Finland. [Online] 2023. https://www.aka.fi/en/about-the-rcf/whats-new/press-releases/2023/finland-in-the-frontlines-of-the-quantum-revolution-in-the-eu/

3. Nordic Innovation. Nordic-Baltic Quantum Ecosystem. s.l. : Nordic Innovation, 2025.

4. European Commission. Quantum Europe Strategy. [Online] 2025. https://digital-strategy.ec.europa.eu/en/library/quantum-europe-strategy

5. Ministry of Higher Education and Science. Strategy for Quantum Technology: Part 1 – World-Class Research and Innovation. Ministry of Higher Education and Science. [Online] 2023. https://ufm.dk/en/publications/2023/strategy-for-quantum-technology-part-1-2013-world-class-research-and-innovation

6. Ministry of Industry, Business and Financial Affairs. National Strategy for Quantum Technology Part 2 – Commercialisation, Security and International Cooperation. [Online] 2023. https://www.eng.em.dk/publications/2023/national-strategy-for-quantum-technology

7. NQCP. [Online] https://nqcp.ku.dk/about-nqcp/

8. Novo Nordisk Foundation. [Online] https://novonordiskfonden.dk/en/projects/novo-nordisk-foundation-quantum-computing-programme/

9. Novo Nordisk Foundation. EIFO and the Novo Nordisk Foundation Acquire the World's Most Powerful Quantum Computer. [Online] 2025. https://novonordiskfonden.dk/en/news/new-quantum-computer-with-great-potential-to-boost-nordic-research-and-innovation/

10. Novo Holdings. [Online] https://novoholdings.dk/news/novo-holdings-commits-dkk-1-4-billion-euro188-million-to-build-a-quantum-technology-start-up-ecosystem

11. Ministry of Economic Affairs and Employment Enterprises. [Online] 2025. https://julkaisut.valtioneuvosto.fi/bitstream/handle/10024/166272/TEM_2025_18.pdf?sequence=1

12. Government of Sweden. Forskning och innovation för framtid, nyfikenhet och nytta. s.l. : Government of Sweden, 2024. Regeringens proposition 2024/25:60.

13. Chalmers. WAQT. [Online] https://www.chalmers.se/en/centres/wacqt/

14. Knut and Alice Wallenberg Foundation. Knut and Alice Wallenberg Foundation. [Online] 2024. https://kaw.wallenberg.org/en/press/new-agreement-gives-swedish-academia-and-industry-unique-access-even-larger-quantum-computers

15. Ministry of Economic Affairs and Communication. [Online] https://mkm.ee/sites/default/files/documents/2024-09/Estonian%20National%20Digital%20Decade%20Strategic%20Roadmap%202023.pdf

16. Latvian Quantum Inititative. Latvian Quantum Initiative. [Online] https://www.quantumlatvia.lu.lv/en/about/about-the-latvian-quantum-initiative/

17. Ministry of Foreign Affairs. Ministry of Foreign Affairs. [Online] 2023. https://www.mfa.gov.lv/en/article/foreign-ministry-join-memorandum-understanding-development-quantum-technologies-latvia

18. Lithuanian Quantum Technologies Initiative Group. Quantum Lithuania. [Online] 2025. https://publuu.com/flip-book/809898/1785033

19. Carugno, C., et al. NordIQuEst: The Nordic–Estonian Quantum Computing e–Infrastructure Quest. Communications in Computer and Information Science, vol 2398. Springer, Cham. 2025, pp. 113-127.

20. European Commission. European Innovation Scoreboard. [Online] https://projects.research-and-innovation.ec.europa.eu/en/statistics/performance-indicators/european-innovation-scoreboard/eis-2024#/

21. Nordic Prime Ministers and Heads of Government. Finnish Government. [Online] 26 May 2025. https://valtioneuvosto.fi/en/-/joint-statement-by-the-nordic-prime-ministers-and-heads-of-government-on-quantum-technologies-laying-the-foundation-for-future-nordic-advancements-1

22. Melin, Goran, et al. Evaluation of the Top-level Research Initiative - Final report. s.l. : Technopolis Group, 2018.

23. Polytechnique insights. [Online] 2023. https://www.polytechnique-insights.com/en/columns/science/quantum-physics-explained-by-one-of-its-nobel-prize-laureat/

24. Reykjavik University. Nanophysics Center of Reykjavik University. [Online] 2025. https://www.ru.is/en/research-center/nano

Appendices

Appendix I: Mandate for the Study

NordForsk

Director's Decision No 289
Date: 13 December 2024

Subject: Mandate for Study on Opportunities for Nordic Research and Innovation Cooperation on Quantum Technology

Background
Quantum technology, encompassing quantum computing, communication, and sensing, is advancing rapidly and has the potential to transform sectors such as cybersecurity, healthcare, energy, finance and defence. The Nordic region, with its robust research institutions, innovation ecosystems, and collaborative tradition, is well-positioned to lead in this field. Research in quantum technology drives innovation by uncovering new principles and techniques that pave the way for groundbreaking applications and advancements in in areas such as computing, communication, and materials science.

Action
Investigating the potential for stronger coordination and cooperation across the region Nordic countries on quantum technology could increase the potential impact and international competitiveness of Nordic quantum research and innovation. NordForsk therefore initiates a study to assess the potential for increased research and innovation cooperation on quantum technology among Nordic countries. It should map national, Nordic, and international initiatives in the field, analyse the funding landscape, and explore the role of key institutions. The study should also propose actions to enhance cooperation and address gaps, positioning the Nordic region as a major player in the global quantum landscape.

Decision:
The director commissions Special Adviser Gudmund Høst to carry out the study on Opportunities for Nordic Research and Innovation Cooperation on Quantum Technology in accordance with the mandate as outlined in Annex 1.

The decision was made in the presence of Siri Bjarnar, chief operating officer, who also acted as rapporteur.

Enclosed documents:
- Annex 1: Mandate for Study on Opportunities for Nordic Research and Innovation Cooperation on Quantum Technology

Oslo, 13.12.2024

Arne Flåøyen
Director

Stensberggata 25 – NO-0170 Oslo – +47 476 14 400 – www.nordforsk.org

Annex 1: Mandate for Study on Opportunities for Nordic Research and Innovation Cooperation on Quantum Technology

Background:
Quantum technology, encompassing quantum computing, communication, and sensing, is advancing rapidly and has the potential to transform sectors such as cybersecurity, healthcare, energy, finance and defence. The Nordic region, with its robust research institutions, innovation ecosystems, and collaborative tradition, is well-positioned to lead in this field. However, to maximize the impact and international competitiveness of Nordic quantum research and innovation, the potential for stronger coordination and cooperation across the region Nordic countries will be investigated.

Research in quantum technology drives innovation by uncovering new principles and techniques that pave the way for groundbreaking applications and advancements in areas such as computing, communication, and materials science. NordForsk is responsible for funding and supporting basic and applied research projects, fostering academic collaborations, and developing research infrastructure. Nordic Innovation promotes the commercialization of research outcomes and supports the development of innovative solutions that contribute to the high-level goals set out by the Nordic Council of Ministers.

Purpose of the Study:
This study aims to assess the potential for increased research and innovation cooperation on quantum technology among Nordic countries. It will map national, Nordic, and international initiatives in the field, analyze the funding landscape, and explore the role of key institutions. The study will also propose actions to enhance cooperation and address gaps, positioning the Nordic region as a major player in the global quantum landscape.

Scope:
The study will first map national quantum technology strategies and research initiatives in the Nordic countries, including ongoing or planned collaborations and institutional efforts. The study will also compare Nordic activities with international quantum initiatives, particularly in leading regions like the European Union and the US. An important component will be reviewing the current funding landscape, including public and private sector investments. The study will aim at identifying opportunities for joint Nordic funding actions and cross-border sharing of resources such as infrastructure and testbeds. The role of Nordic and national institutions will be explored, as they are critical in fostering collaboration and policy alignment. The opportunities for enhancing Nordic-Baltic cooperation in quantum technology will be considered. Lastly, the study will identify any gaps or needs at the national or regional level that could be addressed through coordinated Nordic action.

Approach:
The study will mainly use qualitative methods, including a review of national and international quantum technology strategies, stakeholder consultations, and a comparative analysis of national strategies and funding models.
Throughout the study communication with Nordic Innovation will be maintained to avoid duplication and ensure effective information sharing. The study will draw on Nordic Innovation's planned mapping of the Nordic quantum ecosystem. This mapping, along with proposed Nordic use cases, aims to demonstrate the applicability of quantum technology for Nordic businesses.
Based on the findings, the study will generate policy recommendations aimed at improving

the framework for Nordic cooperation and strengthening the region's role in quantum research and innovation.

Deliverables:
The study will produce a report that includes an analysis of Nordic and national initiatives, funding opportunities, gaps, and recommendations for improving Nordic collaboration in quantum technology. The report will also include specific proposals for joint actions to enhance research and innovation in the region.

Timeline and Deadlines:
The study will be carried out over 12 months, with the following key milestones and deadlines:

- **Phase 1 (Months 1-3):**
  Review existing national and Nordic quantum initiatives and gather initial data on the quantum technology landscape in the region.

- **Phase 2 (Months 4-6):**
  Conduct stakeholder consultations, including interviews with representatives from relevant government bodies, research institutions and private sector.
  Begin comparative analysis of national and international quantum initiatives.
  March 2025: Present status of work to NordForsk and NORDHORCs.

- **Phase 3 (Months 7-9):**
  Complete the analysis of collaboration opportunities, funding gaps, and institutional roles.
  Reflect on the report from Nordic Innovation's mapping of the Nordic quantum ecosystem alongside Nordic use cases to illustrate the applicability of the technology for Nordic businesses.
  Identify opportunities for joint Nordic actions and partnerships, considering different national contexts.

- **Phase 4 (Months 10-12):**
  Finalize the study report with recommendations for enhancing Nordic cooperation in quantum technology.
  October 2025: Present findings to key stakeholders, including NordForsk and NORDHORC, and prepare dissemination of report.

Appendix II: List of Acronyms

DQC – Danish Quantum Community

EuroQCI – European Quantum Communication Infrastructure

HPC – High-performance computing

IP – Intellectual Property

IQM – Industrial Quantum Machines

LUMI-Q – A European consortium contributing quantum computing environment as part of the EuroHPC Joint Undertaking

NORDHORC – Nordic Heads of Research Councils

NQCP – Novo Nordisk Foundation Quantum Computing Programme

QC – quantum computing

Q-NRI – A Norwegian project (2025-) for «Further Development of National Research Infrastructure for Quantum Technology Research»

QKD – quantum key distribution

QSIP – Quantum Sweden Innovation Platform

QST – quantum science and technology

QT – quantum technology

SWOT – strengths, weaknesses, opportunities and threats

TRI – The Top-level Research Initiative (TRI), launched by the Nordic Council of Ministers in 2008, was a major collaborative research and innovation program with a total budget of DKK 400 million (approximately €54 million at the time), jointly funded by the Nordic countries over the period 2009–2016. TRI supported large-scale Nordic research collaboration in climate, energy, and environmental technologies (22).

WACQT – Wallenberg Centre for Quantum Technology

Appendix III: Stakeholder Validation and Practical Insights

To ensure the relevance, accuracy, and practical value of this report's findings and recommendations, targeted focus group sessions were conducted with key stakeholder groups across the Nordic quantum ecosystem. These sessions included national infrastructure providers and leading quantum researchers, whose feedback helped validate the main themes, refine recommendations, and highlight practical considerations for collaboration, funding, governance, and talent development. Their insights ground the report's conclusions in the lived experience and current realities of the Nordic quantum community.

Key Insights from Nordic Quantum Researchers

Group Discussion, September 2025 – Facilitated by the Nordic Quantum Network

A focus group with 16 leading Nordic quantum researchers provided valuable validation and refinement of the report's findings. The discussion confirmed the overall SWOT analysis and surfaced several important nuances and actionable points for advancing Nordic quantum research collaboration:

- Validation of Main Themes: Broad agreement with the report's identification of strengths, weaknesses, opportunities, and threats for each country and the region. Strong support for Nordic cooperation, joint funding, infrastructure sharing, and talent mobility.

- Inclusivity and Representation: Emphasis on ensuring that any Nordic coordination forum includes both strategic and grassroots voices. The field's growing diversity requires multiple, interconnected networks rather than a single umbrella structure.

- Narrative Nuance: Caution against oversimplifying national strengths in summary tables or presentations. Recommendations to either provide fuller context or clarify that examples are illustrative.

- Long-Term Vision and Funding: Strong support for sustainable, region-wide, multi-year funding mechanisms to ensure continuity and long-term impact.

- Talent Recruitment, Retention, and Mobility: Concerns about geopolitical restrictions (e.g., NATO-only hiring), and the need to support international PhD students and postdocs to remain and contribute in the Nordics.

- Education and Workforce Development: Recognition of the scale and importance of doctoral and industry retraining programs. Recommendation to highlight this as a Nordic strength.

- Dual-Use and Defence Applications: Acknowledgement of the strategic importance of dual-use technologies and the need to address them in policy and collaboration frameworks.

- Nordic-Baltic Collaboration: Interest in including Baltic countries in future collaboration, while noting differences in funding and participation.

Key Insights from National e-Infrastructure providers

Group Discussion, August 2025

A focus group with e-infrastructure providers from Denmark, Finland, and Norway confirmed and refined the SWOT analysis and recommendations. Key actionable points included:

- The need to prioritize and assess the feasibility of recommendations.

- Recognition of diverse and fragmented funding mechanisms across the Nordics.

- Concrete models for collaboration, such as Denmark's Quantum Algorithm Academy.

- Strong support for federated infrastructure access and building on initiatives like NordIQuEst.

- Considerations for industry and public sector access, and the future of hybrid HPC-quantum systems.

- The most immediate step: enabling cross-border access to quantum infrastructures.

Appendix IV: Primer on Quantum Technology and Its Significance

Quantum physics is the broader field that encompasses all phenomena and theories related to the behaviour of matter and energy at the quantum level. The field began in the early 20th century with the pioneering work of Max Planck and Albert Einstein. Planck introduced the concept of quantized energy levels, while Einstein explained the photoelectric effect using quantum theory. This laid the foundation for the development of quantum mechanics, the theoretical framework within quantum physics that provides detailed mathematical descriptions of these phenomena.

Physicists like Werner Heisenberg, Erwin Schrödinger, and Paul Dirac and Niels Bohr made unique and foundational contributions that established the core principles and mathematical framework of quantum mechanics. Quantum physics has revolutionized our understanding of the fundamental principles of physics, such as the behaviour of matter, electric currents, and chemical bonds.

One of the key concepts in quantum physics is the dual nature of particles, which can exhibit both wave-like and particle-like properties. This duality is crucial for explaining phenomena like the stability of matter and chemical bonding.

In recent decades, we have witnessed the "second quantum revolution" powered by the discovery of principles like quantum entanglement and superposition. The second quantum revolution is the driving force behind the rapid advancements in quantum technology, enabling new applications and capabilities that were previously unimaginable. Quantum technology is commonly categorized into the areas quantum computing, quantum communication and quantum sensing (23).

1. **Quantum Computing**: This area focuses on developing computers that use quantum bits (qubits) to perform calculations much faster than classical computers. Quantum computing has the potential to revolutionize fields such as cryptography, optimization, and complex simulations. The area is rapidly advancing but still experimental. There is significant potential for future applications in fields like cryptography, drug discovery, and optimization.

2. **Quantum Communication**: This involves using quantum principles to create secure communication channels. Quantum communication techniques, such as quantum key distribution, ensure that data transmission is theoretically unbreakable, providing unparalleled security. The area is relatively mature with secure communication technologies already in use. Major challenges include maintaining entanglement over long distances and integrating quantum communication systems with existing infrastructure.

3. **Quantum Sensing:** Quantum sensors leverage quantum properties to measure physical quantities with extreme precision. These sensors can detect minute changes in various fields, such as magnetic and electric fields, and have applications in medical imaging, navigation, and environmental monitoring. This is the most mature area

of quantum technology. Some challenges include commercialization and adoption. Practical applications are already deployed within industries like healthcare, aerospace, manufacturing, environment.

NordForsk

Stenbergsgata 27
NO-0170 Oslo
nordforsk.org