



## POLICY BRIEF 2024:9

Perspectives into topical issues in society and ways to support political decision-making.

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# From technology neutrality to diverse and impactful technology development

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Technology neutrality is a key principle guiding regulation at both the national and EU level, according to which no particular technology should be favoured, leaving technological choices to the markets. However, there is little research on the relevance of this principle for strategic choices in research and innovation policy, such as investments into quantum, hydrogen, or other emerging technologies. This project deepened the understanding of the importance of technology neutrality and developed a national approach to impactfully orient research and innovation policy towards societal goals, enabling diverse technological development.

# Research and innovation policy at a turning point

Technological breakthroughs and the innovations that emerge from them are critical to addressing the societal challenges of our time and building a just, green and digital transition. Through research and innovation policies, public governance has an important role in supporting the development of new technologies (e.g. artificial intelligence, quantum, hydrogen and biotechnology) towards specific societal objectives. Many of the most important technologies of our time have emerged as a result of early-stage public investments. Competitiveness and the development of international centres of excellence also require Finland to make choices between different areas of technological research, given limited resources.

At the same time, Finnish research and innovation policy has undergone considerable changes in recent years. The R&D Funding Act<sup>1</sup>, which entered into force in 2023, was enacted on the proposal of the Parliamentary RDI Working Group and will increase government R&D funding to 1.2% of GDP by 2030, or 4% in total when taking into account private sector contributions. The Ministry of Education and Culture and the Ministry of Economic Affairs and Employment are currently preparing a multiannual plan for R&D funding in line with the government programme. In Autumn 2023, the role of the Research and Innovation Council (TIN) in leading and coordinating national strategic choices in research and innovation policy was also reinforced<sup>2</sup>.

## TYSTI -research project

The Technological Neutrality and the Promotion of Society's Strategic Objectives - Emerging Technologies in Research and Innovation Policy (TYSTI) project examined ways to promote the strategic objectives of Finnish society by addressing emerging technologies and better understanding the meaning and significance of technology neutrality. The project explored the different definitions and practical interpretations of

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<sup>1</sup> Finlex 20.12.2022/1092. Laki valtion tutkimus- ja kehittämistoiminnan rahoituksesta vuosina 2024–2030. <https://www.finlex.fi/fi/laki/ajantasa/2022/20221092>

<sup>2</sup> Government Decree VNK/2023/125. <https://valtioneuvosto.fi/paatokset/paatos?decisionId=0900908f8084d1ee>

the principle of technology neutrality, in particular with a view to strengthening its desired implications for research and innovation policy. The first work package of the project focused on ways to identify emerging technologies and criteria for assessing their future impact and potential. The chosen weighting between different technology options is a key strategic decision for organisations, but barely covered as a research topic. The topic was assessed in terms of the relevance and implementation of the principle of technological neutrality. In the second work package, an analysis of the current state of regulation and funding for emerging technologies in Finland was carried out. In particular, it examined how technology neutrality is reflected in regulation and public funding. The study assessed, among other things, how funding instruments balance between technology push and market pull.

The third work package analysed the results of the previous work packages to identify the general principles that should guide societally impactful research and innovation, while considering technology neutrality. Finally, the fourth work package drew on the key findings of the project to formulate a model for impactful research and innovation policy, and recommendations to put it into practice. In this context, impactful research and innovation policy means:

1. The strategic deployment of research and innovation policy to create shared direction and foreseeability between RDI actors to achieve strategic objectives.
2. Supporting openness and diversity of technologies and markets
3. Strengthening the ability to grasp opportunities presented by technologies and anticipating and avoiding undesirable outcomes<sup>3</sup>.

## Technology neutrality as a regulatory principle

The concept of technology neutrality first came to the fore in the early 2000s in the context of EU's regulatory framework for electronic communications. Since then, and in particular since 2016, references to technological neutrality in EU regulatory documents have become far more frequent. Developments in EU regulation are also reflected in Finland. The first reference to technology neutrality in Finnish legislative drafting coincided with the aforementioned EU regulation of telecommunications.

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<sup>3</sup> One example of preventing undesirable outcomes is the regulation of high-risk technologies defined in the AI Act.

Of the government's proposals, technology neutrality is by far the most referred to in the Ministry of Transport and Communications' proposals, accounting for 43% of all proposals in which the principle is mentioned. The term is therefore clearly well established in the legislative drafting of the Ministry of Transport and Communications. Technology neutrality is occasionally referred to in the drafts of the other ministries. It is used in different ways and in different contexts in the various administrative sectors, and there is no clear uniform method or definition.

In recent years, technology neutrality has been more prominent both in the EU and in Finland as part of the wider debate on pro-innovation regulation.<sup>4</sup> This is partly due to the EU's Better Regulation agenda<sup>5</sup> and the related innovation principle<sup>6</sup>.

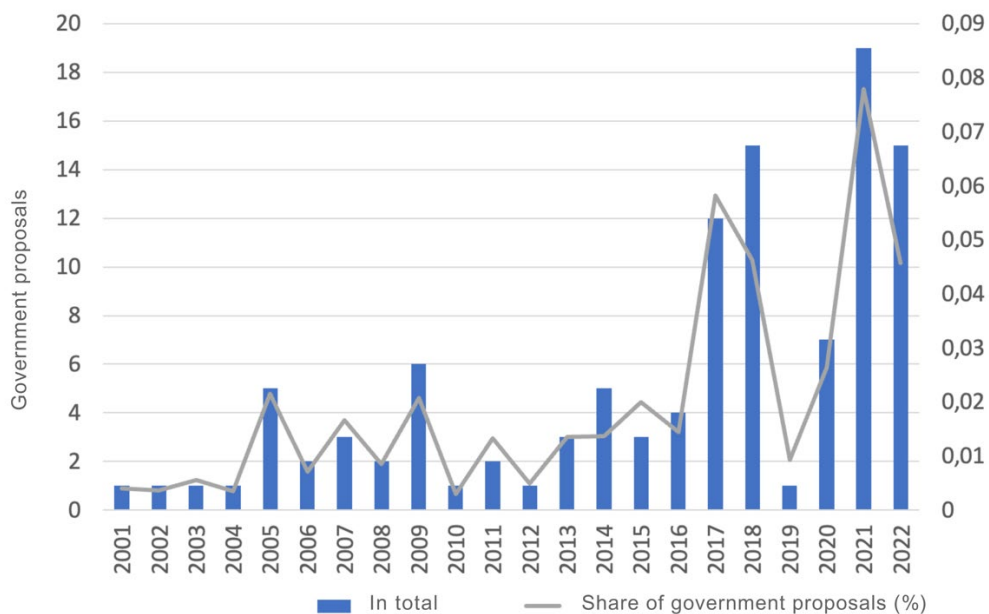


FIGURE 1. Presence of the term "technology neutrality" in government proposals.

Public research and innovation funding in Finland is generally not directly targeted at specific technologies, and the strategies of the main funders (Business Finland and the Research Council of Finland) do not define or limit technologies. However, some funding is channelled through different programmes which may have a broad thematic

<sup>4</sup> Salminen, V. ym. (2020) Innovaatiomyönteinen sääntely: Nykytila ja hyvät käytännöt. Valtioneuvoston selvitys- ja tutkimustoiminnan julkaisusarja 2020:27.

<sup>5</sup> European Commission. Better Regulation: why and how. [https://commission.europa.eu/law/law-making-process/planning-and-proposing-law/better-regulation\\_en](https://commission.europa.eu/law/law-making-process/planning-and-proposing-law/better-regulation_en)

<sup>6</sup> European Commission. Ensuring EU legislation supports innovation. [https://research-and-innovation.ec.europa.eu/law-and-regulations/ensuring-eu-legislation-supports-innovation\\_en](https://research-and-innovation.ec.europa.eu/law-and-regulations/ensuring-eu-legislation-supports-innovation_en)

focus or a defined societal challenge that research or innovation should address. Nevertheless, the choices made in funding and programmes are typically left broad, in line with the principle of technology neutrality.

## The principle of technology neutrality in research and innovation policy

Despite its significance, there is no single universally agreed or shared definition of technology neutrality. The research presented three perspectives on technology neutrality as a concept: 1. as an enabler of technological openness; 2. as a contributor to the benefits of market dynamics; and 3. as a promoter of technological diversity in society. The impact of technology neutrality is often context-specific and difficult to assess clearly. What matters is how technology neutrality is treated - as a regulatory tool (i.e. neutrality as a value in itself), as a market condition (openness, diversity), or as a societal objective that reflects both (e.g. resilience, innovation). The overall analysis carried out suggests that technology neutrality is a principle that does not in itself guarantee market openness or technological diversity.

For the application of technology neutrality, it is important to consider whether a clear commercial interest towards the societal objectives of research and innovation policy can be identified and whether these objectives can be achieved in a market-driven way without government incentives. In situations where there is a commercial interest, the public government must play a steering role to ensure fair competition. On the other hand, in situations where there is no commercial incentive, the government must make concrete investments into certain emerging technologies. The relevance of technological neutrality depends on the prospects for socially important emerging technology to gain a foothold in the market.

### **Balancing open technology development with the achievement of societal objectives is not an either-or issue.**

An important difference in the application of the technology neutrality in relation to strategic choices in research and innovation policy arises from the intersection of its regulatory and funding context. In simple terms, technology neutrality is often a sound and justified regulatory principle, regardless of whether strategic choices are made, as it can contribute to future-proofing, predictability and impartiality of regulation. In turn, funding can be directed towards highly specific technological choices and

programmes where appropriate for achieving societal objectives such as the green transition or data economy. The results of the project indicate that this may be appropriate, especially in the Finnish context, where resources are limited.

### Three perspectives on technology neutrality



FIGURE 2. Three perspectives on technology neutrality, its meaning and implications.

The key finding of the research is that the principle of technology neutrality should be seen as an instrument, not as an end in itself. Viewing technology neutrality as a means to many different ends also helps to clarify the role and objectives of regulation. Technology neutrality or technology specificity can be applied as tools to steer the market in a desirable direction, such as favouring more environmentally friendly technologies. Even then, focus on particular technology should be based on market competition. Rather than emphasising technology neutrality, it would be more relevant to consider the impact of regulation on the sustainability and resilience of the innovation system as a whole.

## National framework for steering research and innovation policy towards societal objectives

The national framework for research and innovation policy created in the project supports the process of making strategic choices and strengthens Finland's ability to steer innovation policy impactfully, taking into account the principle of technology neutrality. Its six functions emphasise cooperation between RDI actors, foresight, and monitoring the societal impact of technological development.

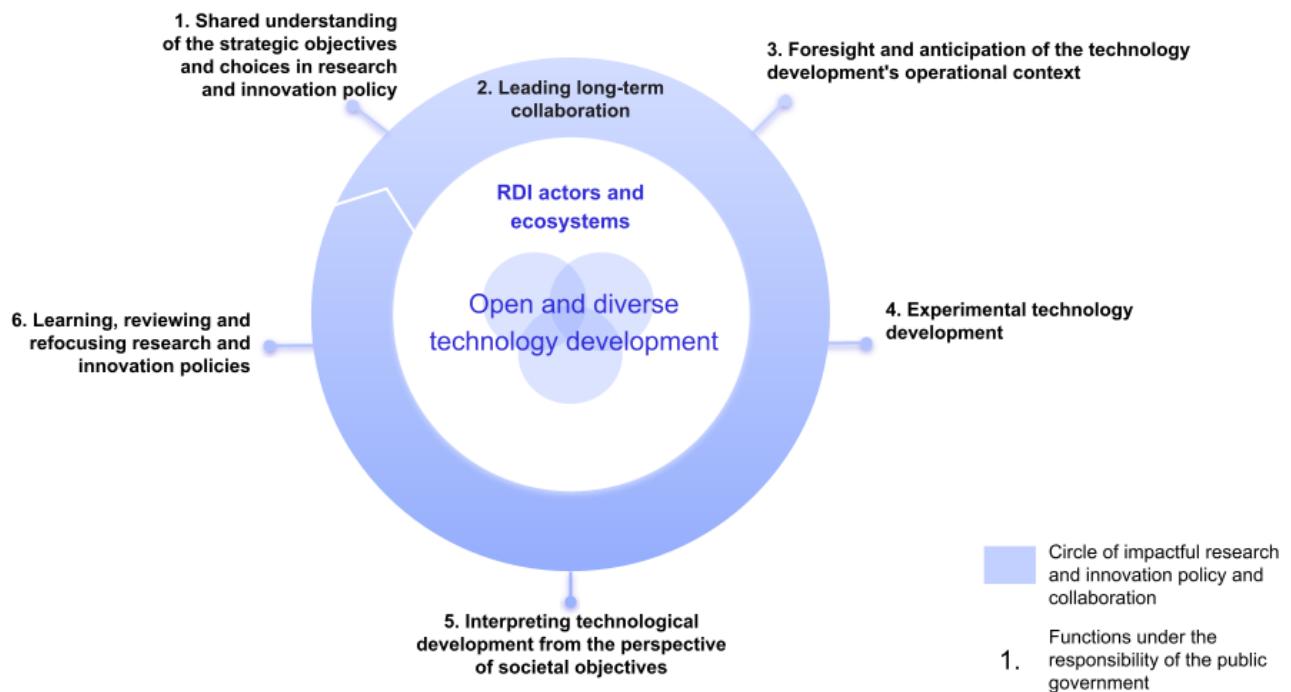


FIGURE 3. Framework for impactful research and innovation policy.

### 1. Shared understanding of the strategic objectives and choices in research and innovation policy

The primary focus of research and innovation policy should be on societally desirable ends, not on precise means or technologies. However, in situations where there is insufficient commercial interest in technology areas that are important for societal objectives and where there is a need to accelerate development, targeted support and steering of technology development may be needed. The key is to ensure that such choices in technologies, as well as broader national strategic choices in growth areas, are widely perceived as legitimate by RDI actors. This requires a sufficient level of consensus among Finnish RDI actors: not merely listening, but active places to

participate in the debate and preparation of these choices. A shared national direction towards commonly understood desirable goals supports preparation of choices in research and innovation policy and targeting of private and public investments. Notably, a shared direction does not imply a completely unified vision, but rather the reconciliation of several different perspectives.

**Link to technology neutrality:** Strategic choices must take into account societal goals, the most promising technologies, and Finland's sustainable competitive advantages. The primary focus must be on the ends rather than the means, in line with the basic principles of technology neutral regulation. The government steers research and innovation policy, but its choices should be jointly defined because shared understanding underpins the legitimacy of technological choices and influences the long-term planning of individual RDI actors.

**Analysis of the present context:** In recent years, Finland has lacked a clear longer-term vision for research and innovation policy and a shared understanding of strategic objectives and choices. However, the work of the Parliamentary RDI Working Group, the multi-annual plan on research and development funding, and the role of Research and Innovation Council will considerably strengthen conditions for this in the future.

## 2. Leading long-term collaboration

Public governance has an essential role to play in enabling and sustaining cross-sectoral collaboration towards societally desirable outcomes. Technological development and application happen in a decentralised environment but always in relation to society and existing knowledge. Research and innovation policies with international impact beyond Finland can be achieved by encouraging RDI actors to collaborate around commonly agreed goals, enabling more effective sharing and deployment of knowledge, skills, resources and innovations. By creating shared platforms and supporting the emergence of ecosystems and clusters, different RDI actors such as universities, businesses, research institutes, funders and the public sector will be better able to find and interact with one another.

**Link to technology neutrality:** The role of the state is to support open and diverse technology development as well as to enable and promote long-term collaboration between RDI actors. Monitoring the knowledge that emerges from collaboration is essential as the state alone cannot achieve sufficient awareness and understanding of the RDI actors' operating environment. Maintaining technological neutrality is likely to preserve market diversity. However, targeted choices, cross-sectoral collaboration and its long-term leadership are required if collective benefits are to be achieved around a particular knowledge or thematic area, for example in relation to the green transition.



**Analysis of the present context:** Finland has a strong tradition of closely-knit and effective RDI collaboration. However, in recent years there has been no clear forum for the governance of research and innovation policy as a whole. The Research and Innovation Council will provide a natural forum for collaboration at the strategic level in the future.

### **3. Foresight and anticipation of the technology development's operational context**

An up-to-date, knowledge-based situational picture and foresight provide the basis for future-oriented research and innovation policy and positive risk-taking. The key here is not only the availability of knowledge, but also its strategic interpretation and linkage to the preparation of research and innovation policies. Strategic choices in the most promising technology areas should not be locked into already established technologies and acknowledged national strengths; it is essential to anticipate future developments in both the societal and technological environment. Every technological investment involves uncertainties over the benefits it will generate, but foresight can help to dispel these. Strengthening the role of technology foresight in research and innovation policy is one key element in keeping Finland ahead of global developments.

**Link to technology neutrality:** The market may produce lock-in situations favouring established technologies and players. The government needs to pre-emptively target its support to (digital) infrastructures and the most promising future technology areas before global market demand becomes established. On the other hand, where there is greater uncertainty surrounding the landscape, there is a case for increasing technological openness and market diversity.

**Analysis of the present context:** Foresight is already an advanced practice in the Finnish public sector by international standards, but its link to decision-making has been relatively weak<sup>7</sup>. Moreover, it has focused on general scanning of the policy environment rather than on more specific technology foresight. Closer collaboration with research institutes, universities and businesses could complement the technology focus in foresight.

### **4. Experimental technology development**

Technological breakthroughs usually happen through sustained experimentation. Promoting experimentation is essential for technology development and innovation so

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<sup>7</sup> OECD (2022) Anticipatory Innovation Governance Model in Finland Towards a New Way of Governing <https://doi.org/10.1787/22190414>

that the most viable solutions are discovered. The government can foster more strategic, experimental technology development, for example by setting frameworks for experimentation (e.g. challenge and objective-based experiments, testing for adverse effects, assessing regulatory needs) and by resourcing open and shared experimentation environments and infrastructures. This allows for learning based on continuous experimentation. At the same time, the funding base for basic research must be safeguarded. Technological progress is not linear: even investments that appear unsuccessful at first may lead to significant innovations. Therefore, research and innovation policies must encourage risk-taking. This requires long-term and flexible funding for basic research and experimentation.

**Link to technology neutrality:** Framing experiments around the desired outcomes allows for autonomous development of technologies to address societal challenges without over-constraining means. Experimentation platforms and regulatory sandboxes can support technological diversity, emerging solutions and proactive regulation.

**Analysis of the present context:** In Finland and the EU, there is a reasonable amount of experimentation funding available through various programmes for promising technology areas, with funding conditions that generally allow the development of different technologies in a technology-neutral way. There is scope for a significantly greater use of experimentation, testing platforms and regulatory sandboxes in Finland.

## 5. Interpreting technological development from the perspective of societal objectives

Technological development and research and innovation policies need to be assessed in light of their societal impact via various indicators. Better knowledge production and monitoring of technological developments and their impact are also required to interpret and assess the alignment of innovations with societal objectives. This will allow support and funding to be targeted at the most promising technologies in terms of societal needs, taking into account both Finland's competitiveness and responsible technological development.

**Link to technology neutrality:** Targeting RDI support to specific technology areas can sometimes be in conflict with technology neutrality, but more precise indicators and targets, such as the framework by the Finnish Technology Advisory Board<sup>8</sup>, can be set to justify deviations. The impact of technology neutrality should also be

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<sup>8</sup> Ministry of Finance (2021). Suomen teknologiapolitiikka 2020-luvulla – Teknologialla ja tiedolla maailman kärkeen. Teknologianeuvottelukunta. Valtiovarainministeriön julkaisuja – 2021:30. ISBN: 978-952-367-692-3.

assessed in a broader context, for example to avoid technological lock-in. It is important that strategic technology choices are made in a transparent and consistent manner.

**Analysis of the present context:** The evaluation of research and innovation policy in Finland has focused on quantitative measures of publications, exports or productivity, rather than on, for example, environmental or societal sustainability. There is a need for a broader shift in perspective and the development of new mechanisms to assess technological development from the perspective of societal objectives.

## 6. Learning, reviewing and refocusing research and innovation policies

Governments must provide justification for the strategic choices they make in research and innovation policy, on the basis of the latest available knowledge. Key to this is a commitment by the government to review the direction of research and innovation policy and to refocus actions in the light of new knowledge and experiences. Central to this process of building a situational picture and developing learnings are the evaluation of the impact of previous activities, scanning of the Finnish and global RDI landscape, technology foresight and facilitated interaction with stakeholders.

**Link to technology neutrality:** RDI actors can rely on research and innovation policies being updated against the best available situational and future knowledge. Rather than being locked into specific technologies, research and innovation policies follow technological developments and their projections on a regular basis. This will allow updating the direction based on strategic choices and reallocation of resources.

**Analysis of the present context:** Finland has conducted a wide range of RDI evaluations for decades, but there has been a lack of a holistic overview of the effectiveness<sup>9</sup> of Finnish research and innovation policy. Evaluation and learning has been fragmented, and has suffered from silos between governments and ministries. The reformed Research and Innovation Council could provide a platform for continuous and independent evaluation and learning to support strategic choices.

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<sup>9</sup> Alaja, A. & Lemola, T. (2022). TKI-arvioinnin vuosikymmenet – arvioiteja arviointien perään. Tieteessä tapahtuu 5/2022.

## Recommendations

### Core aim 1: Converting societal objectives into concrete strategic R&I choices

1. Strengthening the Research and Innovation Council's capacity to form a strategic overview of research and innovation policy drawing on the expertise of all sectors of government, promoting strategic foresight and ensuring the council's preparation is knowledge-based.
2. Defining Finland's strategic research and innovation policy choices based primarily on the demand created by global challenges and on national competitive advantages, taking into account e.g., strategies of digitalisation and the green transition.
3. Developing challenge and mission-oriented funding programmes for the advancement of strategic objectives and promoting the strengthening and emergence of clusters of competence and ecosystems.
4. Ensuring an independent evaluation process for research and innovation policy by developing new indicators for measuring progress towards societal objectives and committing to reviewing strategic choices on the basis of continuous evaluation.
5. Fostering early use of new knowledge at national level and influence on state aid and research and innovation policies at EU level, building on lessons learned.

### Core aim 2: Seamless flow of information and collaboration between research, industry and public bodies

6. Ensuring long-term, cross-administrative coordination of research and innovation policy across successive governments for instance, by strengthening the cooperation between the Research and Innovation Council and the Parliamentary R&D Monitoring Group.
7. Strengthening the collective ownership among Finnish R&D actors over long-term goals of research and innovation policy by facilitating actor-driven futures work.
8. Strengthening the integration of diverse stakeholder perspectives and experiences into research and innovation policy by establishing a stakeholder network within the Research and Innovation Council.
9. Strengthening the uptake of international RDI collaboration and funding, for example by expanding the national matching funding for EU-projects to cover more research and innovation actors.
10. Creating a new technology foresight forum with international expertise to bring together the best future knowledge to enable Finland to stay ahead of the global technology development.

### Core aim 3: Continuous foresight and assessment of emerging technologies

11. Strengthening technology foresight capacities of RDI actors and public administration experts through training programmes, to enable a more proactive response to technological development opportunities.
12. Defining coherent principles for targeting RDI funding to the most environmentally and societally promising technology areas.

13. Supporting the conditions for experimental technology development by establishing and strengthening experimentation and testing facilities in Finland.
14. Ensuring the conditions for strong basic research in higher education funding to promote technological diversity and seize future opportunities.
15. Investing in shared and joint-use research infrastructure, enabling streamlined research and innovation collaboration between universities and companies.
16. Placing technological diversity, rather than technology neutrality, at the centre of research and innovation policy at the national and EU level.

## Conclusions

Finland has the opportunity to orient its research and innovation policy towards strategic societal objectives while simultaneously increasing its competitiveness. This requires strong leadership from the government, a shared vision and continuous collaboration between RDI actors, and looking at technology neutrality as a means - not an end in itself. The significance of research and innovation policy has grown in recent years, with the introduction of the R&D funding law to increase R&D expenditure.

Foresight (both broader and specifically technology foresight), strategic synthesis of knowledge, cross-sectoral and cross-ministerial cooperation, continuous learning, and reassessment of choices made are important steps in strengthening the impact of research and innovation policies. Impactful research and innovation policy creates shared direction and predictability between RDI actors to achieve strategic objectives, promotes technological openness and diversity, and improves the societal acceptability of technological solutions. Emerging technologies are constantly opening up new opportunities to support societal development - impactful research and innovation policy is one way to ensure that these opportunities are seized.

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## Read more

The final report of the project and the policy brief in Finnish are available on the Institutional Repository for the Government: <https://urn.fi/URN:ISBN:978-952-383-332-6>

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