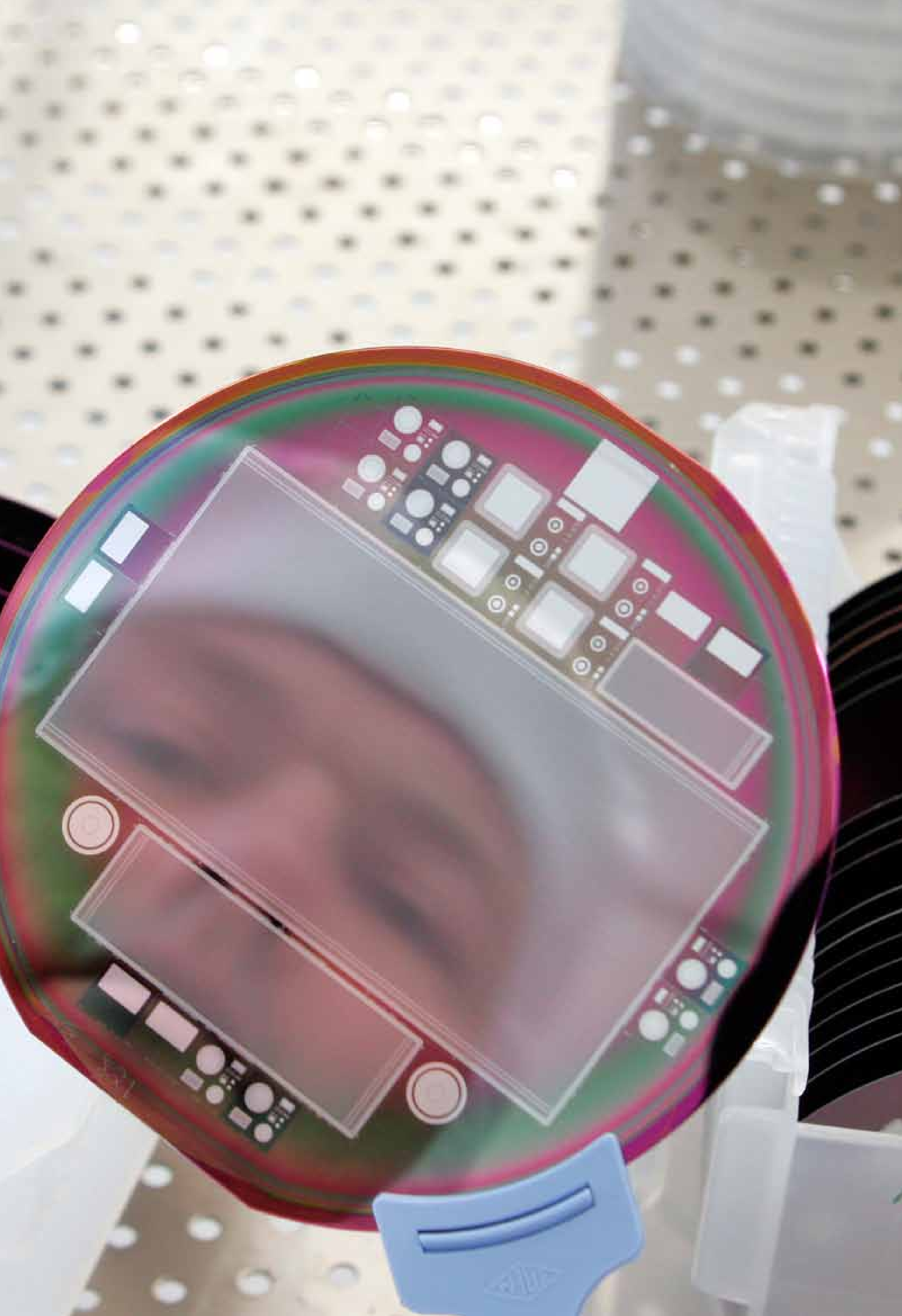

Photo: SINTEF / Thor Nielsen

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Enabling technologies

The international community faces a number of major challenges in such fields as energy and the environment, health and welfare, and transport. Overcoming these will to a large extent depend on our ability to develop and exploit new knowledge. Some technological fields will be of particular importance and will demand special strategic attention.

An enabling technology is a generic technology which represents a major leap in technology development, which has reached a level of maturity making it available for widespread use, forming a basis for major advances in important areas in society. Enabling technologies contribute to the development of society in a long-term perspective and are developed continuously by linking basic and needs-driven research and development.

Different enabling technologies are often interlinked and contribute to each other's development. They combine different areas of expertise and depend on strong interdisciplinary interaction. The development of enabling technologies often calls for significant investment in laboratory facilities. The social return is often significantly greater than the yield in terms of commercial profitability. Hence, significant publicly funded R&D effort is required in order to realise the potential ofof enabling technologies.

High-priority enabling technologies

In the 2005 Parliamentary White Paper *"Vilje til forskning"*[1] the Norwegian government prioritised three technological fields of particularly high social significance:

- Information and communication technology (ICT)
- Biotechnology
- New materials and nanotechnology

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The latest White Paper on research, *"Klima for forskning"*[2] – reiterates these priorities.

In 2009 the European Commission identified five Key Enabling Technologies (KETs)[3]. These are of considerable strategic relevance for European industry and commerce by virtue of their economic potential, knowledge-intensiveness and expected contribution to solving the major challenges of the international community. The key technologies identified by the European Commission are as follows:

[1] Parliamentary White Paper No. 20 (2004-2005): "Vilje til forskning" (Commitment to Research), the Norwegian Ministry of Education and Research

[2] Parliamentary White Paper No. 30 (2008-2009), "Klima for forskning" (Climate for Research), the Norwegian Ministry of Education and Research

[3] "Preparing for our future: Developing a common strategy for key enabling technologies in the EU", (September 2009)

- Micro and nanoelectronics
- Biotechnology
- Advanced Materials
- Nanotechnology
- Photonics

In addition, advanced manufacturing technology is emphasised as an important interdisciplinary field. The European Commission states:

"Those nations and regions mastering these technologies will be at the forefront of managing the shift to a low carbon, knowledge-based economy, which is a precondition for ensuring welfare, prosperity and security for its citizens. Hence the deployment of KETs in the EU is not only of strategic importance but is indispensible (sic) for Europe."

The status of Norwegian efforts in the field of enabling technologies

The high-priority technological fields in Norway correspond to a large extent with those of Europe. Of these, ICT has reached the highest level of maturity, and has attained considerable significance for industry and society. Also biotechnology, new materials and nanotechnology have already made significant contributions to value creation and benefit to society.

The NIFU/STEP report *"Tematiske prioriteringer og teknologiområder i det norske forsknings- og innovasjonssytemet"*[4] describes Norwegian efforts in the prioritised technological fields. Total public and private R&D investment in these technological fields was NOK 10 billion in 2005. The dominant field was ICT, with NOK 6.5 billion, while investments in biotechnology and nanotechnology/new materials were significantly lower, at NOK 1.9 billion and NOK 1.6 billion, respectively.

About 80 per cent of the R&D investments within ICT and nanotechnology/new materials were made by the private sector, while its share was just above 50 per cent within biotechnology. Total public R&D investment in these technological fields in 2005 was NOK 2,5 billion. The NIFU/STEP report points at a strong interdisciplinary effort in the high-priority technological fields.

In the Parliamentary White Paper *"Et nyskapende og bærekraftig Norge"*[5], the Norwegian government points out that long-term involvement in enabling technologies contributes significantly to the continued development of high technology industry. In a Parliamentary White Paper about ICT[6], the government points out that research is crucial for continued development and for ensuring that technology is put to use.

In 2003, the Research Council of Norway established its "Major Programmes" division, which is intended to contribute to a concentrated and integrated research effort in high-priority fields. In 2009, a Scandinavian expert panel carried out a mid-term evaluation of this initiative.[7] The panel pointed out many positive results but underlined that the full potential has yet to be achieved.

It is difficult tto quantify the results of the focused efforts within enabling technologies because of their generic and long-term nature. The technologies may be exploited in a wide spectrum of applications over an extensive period of time.

Recommendations

SINTEF supports the Norwegian parliament's resolution to maintain the focus on three high-priority technological fields. We suggest a name change from "new materials and nanotechnology" to "functional materials and nanotechnology", in order to emphasise the fact that known materials with new functions are also part of the initiative. SINTEF's recommendations are as follows:

A more balanced effort

In the high-priority enabling technologies it is the private sector which is responsible for the majority of R&D investment. It is positive that industry makes such a strong contribution, but the weaker public R&D share makes that the potential of the technologies is by no means realised. A better balance is necessary between "technology push" and "market pull", and the research system must facilitate "cross-fertilisation" between these. It is especially important that Norway invests more in basic research and reinforces the support to development and commercialisation of technology from research institutions. Moreover, better co-ordination and interaction is necessary between different programme initiatives generated by the Research Council of Norway, in order to achieve a more blanced effort through the entire R&D value chain.

SINTEF particularly stresses the importance of the Research Council of Norway's User Driven Innovation Arena (BIA), and which needs larger and more predictable financial resources.

Improved long-term thinking

The development and exploitation of ICT technology over time demonstrates the importance of staying power. Enabling technologies demand long-term public investment in a continuous, parallel and interactive process of sowing and harvesting. The authorities must make adequate investments and maintain these over time.

The "Nanomat" research programme is a good example: The programme commenced with great ambition in 2002, but did neither succeed to realise the planned intensity nor maintain an adequate continuity. In reality the programme has been put on hold since 2008. The result is that established expertise erodes and that the developed competence is not being exploited to its full potential in the Norwegian Industry. In order to ensure continuity it is necessary to employ financial measures that reduce the dependency of uncertain annual funding through through the state budget.

Invest in laboratories

Top modern scientific equipment and laboratories are crucial in order to realise the inherent potential of enabling technologies. The

[4] "Tematiske prioriteringer og teknologiområder i det norske forsknings- og innovasjonssystemet" (Thematic prioritisations and technological fields in the Norwegian research and innovation system) [in Norwegian], NIFU/STEP Report No. 22/2007 (2007)

[5] Parliamentary White Paper No. 7, "Et nyskapende og bærekraftig Norge" (An innovative and sustainable Norway) the Norwegian Ministry of Trade and Industry (2008-2009)

[6] Parliamentary White Paper No. 17 (2006-2007), "Eit informasjonssamfunn for alle" (An Information Society for All), the Norwegian Ministry of Government Administration and Reform

[7] "Sats på forandring" (Concentrate on change) [in Norwegian], the Research Council of Norway (2009)

acquisition and operation of such equipment is often extremely expensive. The Norwegian authorities acknowledge that this area has been neglected, and have significantly increased the available funds for investment in important research infrastructure at Norwegian research institutions. Experience from the applications submitted to the infrastructure scheme indicate how critical the shortfall has become and in SINTEFs opinion it is necessary to increase funding of laboratories and scientific equipment further.