Let water and data flow

The Danish water sector has a large potential for growth and improved community solutions. Digitalization is a key factor in realizing this potential. But the transformation requires a stronger ecosystem for research and innovation in the water sector.

Water is as important as ever, because it supports nearly all economic growth across sectors, and because water-related issues – such as extreme weather, natural disasters, drought, and the failure of climate change adaptation – are considered among the greatest risks to the well-being and prosperity of mankind. There is also huge potential in creating sustainable solutions and business models that promote growth and employment. The water sector is old, but it is young as an industry.

Over the past 40 years, a highly professional effort was made to streamline and further develop the water sector to provide environmental benefit and become an export success. However, there are still big challenges both in Denmark and internationally which research, innovation, education, and entrepreneurship in water technology can help meet.

To meet these challenges, it is conceivable that the 2020s will see the development of systems of water technologies based on product-service systems and service-based business models, collaborative autonomous systems of water technology components, multi-utility systems across the water, energy and waste sectors, as well as the implementation of anti-terror protection of water supply, including by means of cybersecurity. The keyword for these initiatives is digitalization.

It is also likely that environmentally hazardous substances will receive special focus when the targets of the EU Water Framework Directive are to be met. And environmental problems which are today unknown may suddenly come up, as we have seen from time to time in the past decades.

In 2030, we therefore envisage a digitalized water sector in which large efficiency gains have been attained, while it has also become possible to cut across specialist, organizational and regulatory silos and thus achieve a more holistic and value-creating water sector management. This is necessary to achieve the UN Sustainable Development Goals.

However, the project that forms the basis of this report points to a number of threats to the possibilities of the water sector to exploit the new opportunities offered by digitalization.

The risk willingness of utility companies and their possibilities for exploring new opportunities have declined in recent years. One consequence of this is reduced participation of the utility companies in research and innovation projects. The project also shows that water technology manufacturers, consulting engineers, utility companies, municipalities, and universities – to some extent – specialize in different directions. The consequence is that the water sector ecosystem appears fragmented and without common goals.

In the Danish water sector, there is consequently a broadly shared demand for a common vision and overlapping incentive structures that can support the ambition to make Denmark an international leader in this field, with resulting increased exports and employment. An obvious possible joint vision for the water sector is to take the next technology leap into digitalization and Industry 4.0 – as a driver of a transformation that can make the sector more efficient and innovative, less fragmented, and more sustainable.

The report is based on a range of interviews and workshops with stakeholders and actors from the Danish water sector. It begins with a brief review of the importance and growth potential of the water sector globally (Chapter 1), and a short outline of the development of the Danish water sector since the 1970s, when the Danish Ministry of the Environment was set up as the first of its kind in the world (Chapter 2). Then follows an account of trends in the water sector within three selected themes: Climate change adaptation, Urban water management, and Water resources management (Chapter 3), an outline of a digitalization model for the water sector (Chapter 4), and a number of project ideas from DTU within the above themes (Chapter 5). Finally, a synthesis is formulated as five summarizing recommendations (Chapter 6). The recommendations are as follows:

Recommendation 1:
Strengthened ecosystem

It is well known from other sectors (e.g. the hearing aid industry) that large-scale strategic initiatives can create coherence in a technological ecosystem. Large-scale strategic initiatives may therefore be necessary to reverse the trend in the water sector. At the same time, framework conditions and incentive structures must be established in order to support the development and implementation of new solutions and radically strengthen the interaction between university research and water sector needs. Finally, there is a need for the actors in the water sector to collaborate on a joint vision for the next big technology development, which seems to be linked to digitalization and Industry 4.0.

Recommendation 2:
Large-scale strategic initiatives and integration of academic competences

Strategic initiatives are proposed based on the themes dealt with in the report – Climate change adaptation, Urban water management, and Water resources management:

- System integration across data sources, physical plants and systems, digital water technology solutions and integrated water technology platforms – both during operations and in the planning of future investments – where new water technologies will come into play.
- New robust optical sensors that can measure multiple substances in low concentrations and which make it possible to act proactively to signals of changes in e.g. water volumes and water quality of significance to the state of the environment, the operation of water infrastructure, the service life of pipelines, etc.
- New methods for monitoring the water cycle in nature and the environment, as well as the technosphere, using satellites, drones, and autonomous vehicles, as well as passive samplers, and in situ sensors.
- New data-driven analysis and control algorithms based on deterministic model understanding, statistical descriptions of uncertain data sources and Big Data, machine learning, and artificial intelligence aimed at exploiting the growing volumes of data of varying type, quality, and frequency.
- New (collaborating autonomous) systems of water technologies based on intelligent components and integration across water technology solutions and associated utility sectors such as water and energy technology (initially) and water and food technology (subsequently).
- Digital tools combining integrated economic analyses with risk management, sustainability assessment, and scenario projections, and incorporating methods that can identify workflows, action-based needs, and openness towards new technology.

In connection with developing a digitalization model for water technology, there is a need for integrating both domain knowledge and academic competences. In specific terms, integration must be achieved between in-depth academic competency in science and technology related to water, in-depth academic competency related to digitalization, and more general skills in how systems are integrated. Here, there is a need for researchers who can navigate across various academic competences. The recommendation of the report is therefore that priority is given to bridging between academic competences with importance being attached to connecting technologies through system integration.

Recommendation 3:
A clear framework for sharing data on water

The report highlights large opportunities in exchanging data in the water sector. A secure, transparent and trusting framework for such data sharing is essential.

The report therefore recommends that the key stakeholders and actors jointly create clear agreements on exchange and use of data. Furthermore, it is recommended to create a technical platform and an organization that can function as a one-stop shop for researchers and companies that want to work and innovate with water data. Advisory services should be associated with this water database.

Recommendation 4:
Strengthened cross-disciplinary education effort in water technology

The dialogue with enterprises, industry associations, utility companies, public authorities, and institutions has revealed a need for a substantial strengthening of study programmes in water technology and methods. This applies in particular to graduates with in-depth academic competency in water science and technology, combined with knowledge of digitalization and with skills in interdisciplinary integration. In addition to graduates, there is demand for researchers who hold a PhD. Here, a widely rooted PhD programme anchored in the action-based interdisciplinary needs of the water sector will have a significant effect. The PhD graduates can either be part of corporate R&D departments or – as young university researchers – they can support collaboration with companies, utilities, consulting engineers and municipalities.

Recommendation 5:
Better conditions for entrepreneurship and the start-up growth layer

New technological breakthroughs are often created by high-tech start-ups in collaboration with universities. There is especially a need to expand the effort and create a better framework for entrepreneurship. This can – for example – be done in the form of (1) networks and co-working spaces where professionals are attached to start-up ideas and innovation projects at an early stage to ensure a faster track to market and growth, (2) targeted innovation programmes aimed at promoting SMEs' access to collaboration with water technology researchers, (3) committed long-term innovation partnerships between large private and public players, including universities, and (4) a legislative and managerial framework that enables entrepreneurs to develop and market services based on the rapidly growing data volumes in the water sector.

About DTU sector development projects

Sector development projects are one of the tools that DTU employs to cooperate with the business community and authorities to identify research and development needs in a sector or industry. A sector development project extends from an initial identification of ideas over the lobbyism in relation to private and public funding sources to specific collaborations with companies and authorities. The result is a report on a series of interdisciplinary methodological challenges and a number of research and commercially valuable project opportunities within a technology and recommendations for actions.

Interviewed companies/ authorities/research institutions and workshop participants

Miljø- og Fødevareministeriet, BIOFOS, Kalundborg Forsyning, DANVA, Aquaporin, Aarhus Vand, SWECO, KL, EnviDan, Arla, KMC, RealDania, COWI, Kamstrup, HOFOR, Grundfos, Krüger Veolia, NIRAS, Ramböll, Unisense, DHI, Naturens Rige, Danfoss, VandCenter Syd, Roskilde Kommune, AVK

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Summary

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