

# Case Study

## Innovative moisture monitoring

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### Forskningsparken Tromsø

### Tromsø Science Park

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#### 1. Introduction

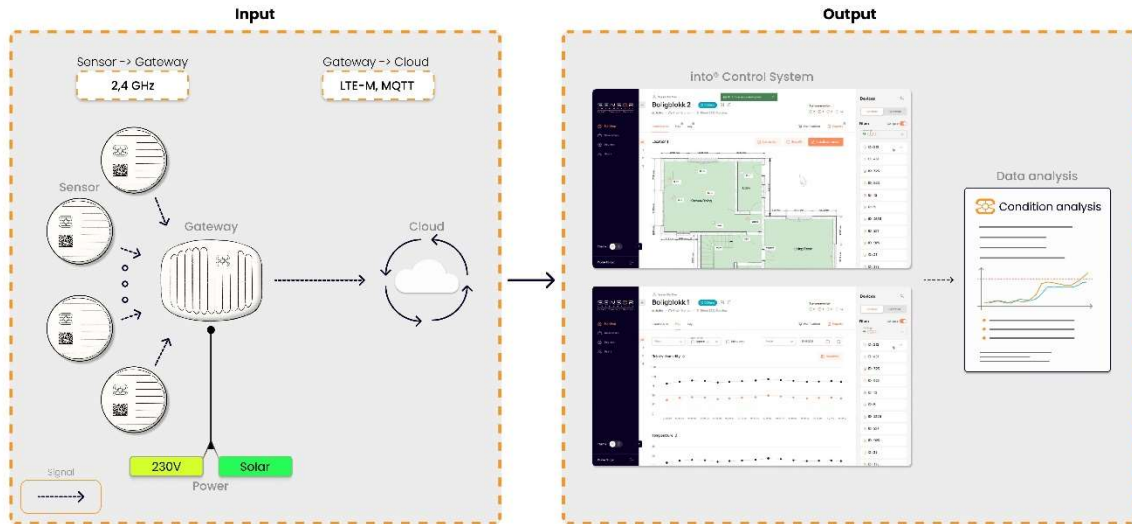
Tromsø Science Park Building 4 represents a groundbreaking project that emphasizes sustainability and technological innovation. The initiative involves close collaboration between key stakeholders, including owner Siva, contractor Consto, and Sensor Innovation, in the pursuit of innovation credits for what will become the world's northernmost BREEAM Outstanding project. Sensor Innovation's into-technology is integrated into all critical structural components to enhance the building's lifespan and mitigate the risk of water damage. This system is specifically designed to provide real-time data on moisture conditions, enabling early implementation of preventive measures.



## 2. Technical specification and data processing

### System Architecture

into® by Sensor Innovation



To monitor critical structural components for moisture and temperature deviations over extended periods, robust and intelligent technology with adaptive design is required, enabling the system to be updated and developed over time. The technical architecture of into is based on input from wireless components designed for harsh environments that can be seamlessly updated, paired with output grounded in real-world data and continuously evolving established technologies.

The sensors are certified to IP67 standards, ensuring their ability to withstand challenging moisture conditions and fluctuating temperatures for extended periods within a building's structure. The system's battery life is documented to exceed 30 years, aligning with the maintenance intervals of wall and roof materials.

Moisture levels in buildings are highly variable and depend on multiple factors. External climate parameters, such as temperature, solar exposure, and seasonality, influence the development and movement of moisture within structures. Additionally, construction parameters, including insulation type, insulation thickness, roofing material, and residual construction moisture, also play a role. To provide accurate alerts that distinguish between actual leaks and natural moisture variations, complex data analysis is required. The cloud solution utilizes a hybrid AI model that combines physics-based modeling with data-driven machine learning. The sensors measure relative humidity (RH), temperature ( $^{\circ}\text{C}$ ), and liquid presence ( $\Omega$ ).

### 3. Number and type of sensors installed

Tromsø Science Park Building 4 primarily consists of two main structures (Building A and Building B) connected by an intermediate structure. Sensor Innovation provides sensors for various applications associated with each building, maintaining a consistent structural configuration regardless of the building's specific function.

#### Roof monitoring

- a) Insulation inside roof (152 units – into Sensor Plus (Mode 1: Normal))  
Sensors are installed in a grid above the vapor barrier in the roof structure to monitor the ventilation of construction moisture and detect any potential leaks. This is one of the most high-risk structural components, with the greatest likelihood of damage, and often provides limited visibility into the exact location of a potential leak.
- b) Water level on roof (12 units) – into Bracket Sensors I are elevated approximately 40 mm above the roof surface to monitor and alert in cases of excessive stormwater, indicating an increased likelihood of clogged drains.

#### Wall monitoring

- a) Wood moisture in exterior walls (108 units) – into Sensor Wood. By installing sensors during the manufacturing of wall elements in the factory, the sensors have been monitoring the development of wood moisture levels to ensure insulation performance and structural integrity.

#### Monitoring of internal structures

Monitoring of internal structures primarily focuses on critical areas within the building that are at risk of operational disruptions or similar issues. The sensors used are into Sensor (Mode 2: Instant) and into Sensor Plus (Mode 2: Instant). These sensors provide real-time data to identify and address potential issues promptly in concealed or high-risk areas. These areas are often not subject to daily oversight and are inaccessible to visual inspection. For Tromsø Science Park, this includes:

- a) Pipe shafts
- b) Technical rooms
- c) Kitchens with automatic water stoppers integrated with the sensors.

#### 4. Advantages compared to typical industry practices

The *into* system solution offers measurable added value in terms of environmental sustainability over the lifespan of a building, both during the construction and operational phases. It aims to set a new standard for moisture control from a life cycle perspective for buildings (LCC).

##### Construction phase

- State-of-the-art: Manual moisture measurements are performed before wall closures, visual inspection of building moisture in materials, and roof pressure testing. Experience shows that manual measurements are often not planned around critical areas, and the causes of moisture issues are often not identified, leading to a linear increase of damage occurring in the first 10 years after construction.
- The innovation provides comprehensive control of building moisture and leak points. Findings from R&D projects carried out in collaboration between Sensor Innovation and SINTEF indicate that rapid identification of leak points, as well as measuring the effects of leak mitigation measures and additional ventilation measures (e.g., ventilation hoods), provides building owners with quicker control over the building and prevents material damage.
- Measurable impact in the construction phase: The *into* system solution will document measurable benefits by detecting leak points and/or the need for ventilation points in structures where precise monitoring solutions are currently unavailable. This can be compared to experiences from other buildings, demonstrating CO2 savings in the form of reduced material damage and improved insulation.

##### Operational phase

- State-of-the-art: There are suppliers of sensors for measuring wood moisture and sensors (either active or passive) that can be placed at risk points to alert leaks (humidity or water). However, they lack a method for comprehensive building monitoring and intelligent alerts that distinguish between actual leaks and natural moisture variations. Furthermore, their battery life does not match the entire lifespan of a roof or wall.
- *Into* system solution: The system will provide building managers and users with full control over the building's moisture levels. By offering monitoring of roofs, exterior walls, and pipe shafts, the system ensures comprehensive moisture control throughout the building's lifespan, in line with the construction's lifespan. Inside the structure, the added value includes extensive control, the ability to detect leaks in the early stages, and active moisture monitoring throughout the building's life. Additionally, the solution enables a transition from cyclical to condition-based maintenance, ensuring efficient

resource utilization.

- Measurable impact in the operation phase: *into* will provide real-time alerts and moisture condition reports for the building. By receiving real-time leak notifications and taking corrective actions, the building owner can document that the building remains dry and retains its insulation properties. Through condition-based maintenance, the building manager can document actions taken, leading to potential environmental benefits. The primary goal of the innovation is environmental impact, while also documenting economic gains through efficient resource utilization in the operational phase and societal benefits in the form of a good indoor climate.

## 5. Successes, challenges and lessons learned

### Successes

The contractor and building owner report that the experience with the use of innovative moisture sensors from Sensor Innovation has been a positive contribution during the construction phase. Data from the sensors is presented in a user-friendly interface, and notifications of potential leaks function as intended. Sensor Innovation has been on-site multiple times to participate in project planning, installation, training, and testing of the sensors.

The sensors were installed in wall elements at the element manufacturer's facility, while those for the roof and shafts were mounted on-site, allowing the project to continuously monitor moisture levels throughout the construction period. A key point highlighted is that the use of technology to monitor workmanship encourages greater attention to detail in the execution of tasks, as any deviations or installation errors are identified early on.

### Challenges and lessons learned

- a) Planning and engineering: The *into* solution is a new technology that requires interface clarifications and planning for all related trades, as well as the selection of components that interface with the *into* technology. It is important to confirm early on that this technology will be used.
- b) Construction phase: One of the challenges during the construction phase is the need for a temporary power source for the *into* Gateway to operate the system before a permanent power supply is installed in the completed building. A key takeaway is to start planning for the necessary extension of construction power early, ensuring that the coverage area is large enough to support the sensors during the construction period. As a result of these experiences, Sensor Innovation has developed a solar solution for both the construction and operational phases.
- c) Further Development of Products and Services in the *into* Technology: The project is an innovation, providing a foundation for the development of both the products and services.
  - ✓ Customization of Alert Algorithms for Sensors with Activated Measures: Towards the end of the construction phase, several sensors triggered alerts for water presence, but the cause was identified as increased building moisture from the closure phase of the building, not actual leaks. When the sun became stronger with high temperatures and increased vapor pressure, the system detected elevated values. The system triggered alarms daily, but the alerts had already been identified, and corrective actions were implemented. Through close communication between the construction management and Sensor Innovation, the issue was identified and resolved. Based on this, Sensor Innovation fine-tuned the threshold values in its models to avoid similar false positive alerts in the future.

- ✓ Digital interface in BIM models: When a leak alert occurs, it is crucial to quickly locate the correct sensor. The sensors are embedded in the building envelope and are not physically visible, so the digital cloud solution must easily guide operational personnel to the correct location. Updates will be made in the cloud solution to better visualize sensor locations relative to the building's axes. A suggested improvement from the contractor and building owner is to digitize sensor locations within the building's BIM model. This would simplify interface management with other trades during design and execution, and it would make it easier for Siva's operational staff to locate sensors in the event of a leak. Sensor Innovation states that methods for better visualization and linking actual and projected sensor locations are under development.
- ✓ Further Development of the iCS Platform: Experiences from larger and more complex buildings indicate that the current platform has areas for improvement in scaling for larger building owners and the global market through distributors. The experiences from this project, with interfaces between multiple trades and subcontractors, have identified the need to adapt the value chain in iCS. This is in the early stages of a dedicated development project. This will improve the user experience and the value of the platform for the end customer, who could be the contractor (during construction or warranty periods) or the building owner, by enabling planned and condition-based operations before damage occurs.
- ✓ Service Development in iCS: As part of this project, Sensor Innovation has developed a hybrid-AI solution with significant development potential for early prediction of mold/decay issues before damage occurs.

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