Interreg CENTRAL EUROPE
Co-funded by the European Union
MISSION CE CLIMATE

CITIZEN SCIENCE AND PARTICIPATION

CITIZEN TOOLKIT FOR ENVIRONMENTAL MONITORING.

INNOVATIVENESS

The solution presents high integration of digital technologies. Its innovativeness lies in combining:

- open data principles,
- participatory and data-driven education,
- a functional link between technical monitoring and community engagement.

OBJECTIVE

Develop and implement a Citizen Toolkit focused on environmental monitoring and engagement within the Pforzheim area. This toolkit aims to empower citizens to contribute data and insights using IoT sensors, thereby fostering community participation in smart city initiatives and promoting environmental stewardship.

GEOGRAPHICAL COVERAGE:

THE PILOT PROJECT WAS IMPLEMENTED IN THE CITY OF PFORZHEIM. UPTAKES ARE PLANNED IN FURTHER AREAS OF THE NORTH AND BLACK FOREST REGION.

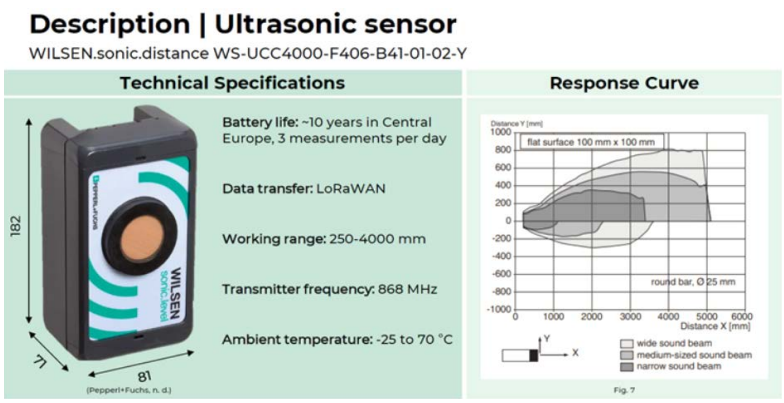
CLIMATE RESILIENCE SOLUTION IN MUNICIPALITY OF PFORZHEIM

The pilot delivered a working end-to-end civic-sensing stack–LoRaWAN devices feeding an enerchart dashboard–validated in real conditions across multiple use cases (water level, air quality, noise, soil humidity, and indoor/urban microclimate, etc. Most sensors have been running continuously; only early water-level units were lost to theft, prompting plans for secured replacements.

A "v1 Citizen Toolkit" with step-by-step guides was produced, with updates queued from subsequent field learnings. The approach for a wider citizen-science rollout was set with local partners, and a public presentation on 6 May 2025 drew roughly 250 attendees, surpassing awareness goals and generating demand for a follow-up. Data is already informing practical decisions–such as road-salt silo logistics, flood preparedness, green-space care, urban climate tracking, and mobility flows.

Key lessons include the robustness and scalability of LoRaWAN and the need for stronger device security. Interim KPIs indicate strong relevance and smooth technical operation, with user satisfaction to be quantified as the rollout expands.

Overall, the pilot progressed from feasibility to stable, real-world sensing with a documented, citizen-ready toolkit and clear momentum for regional scaling.



Description of ultrasonic sensor

IMPLEMENTATION STEPS

The development of the digital solution within the City of Pforzheim took place according to the following steps:

1) PROTOTYPE DEVELOPMENT
2) PILOT TESTING
3) DATA COLLECTION AND ANALYSIS
4) ITERATIVE IMPROVEMENTS

STEP 1 – PROTOTYPE DEVELOPMENT

Based on the identified objectives, stakeholders collaborate to develop prototypes of the IoT sensor technology and the Citizen Toolkit. This involves designing and testing sensor configurations, as well as drafting instructional materials for the Citizen Toolkit.

STEP 2 – PILOT TESTING

Once prototypes are developed, pilot testing is conducted in the designated pilot area within the Pforzheim community. This involves deploying IoT sensors in real-world environmental monitoring scenarios and assessing their functionality, usability, and effectiveness. Citizens are actively involved in the testing process, providing feedback on the usability and utility of the Citizen Toolkit.

STEP 3 – DATA COLLECTION AND ANALYSIS

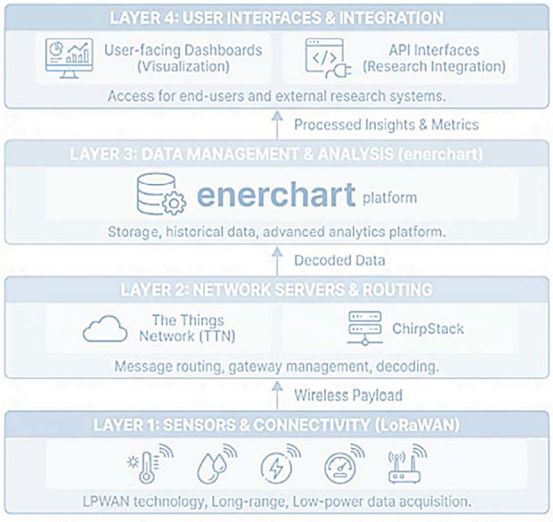
Throughout the pilot testing phase, data is collected from the deployed IoT sensors to monitor environmental parameters such as air quality, temperature, and humidity. This data is then analyzed to evaluate the performance of the sensors and assess their impact on environmental monitoring efforts.

STEP 4 – ITERATIVE IMPROVEMENT

Based on the findings from pilot testing and data analysis, stakeholders iterate on the design of the IoT sensors and the Citizen Toolkit to address any identified issues or areas for improvement. This iterative process ensures that the final products meet the needs and expectations of end-users.

USE CASE REPORTS

Visualisation of short use case reports in the enerchart dashboard can be found here: **enerchart**



Infrastructure layers visualization of digital solution

Over the course of this project, numerous lessons have emerged, encompassing both the technological aspects of IoT deployment and the broader impacts of engaging citizens in data-driven urban and environmental sustainability.

TECHNOLOGY APPROACH

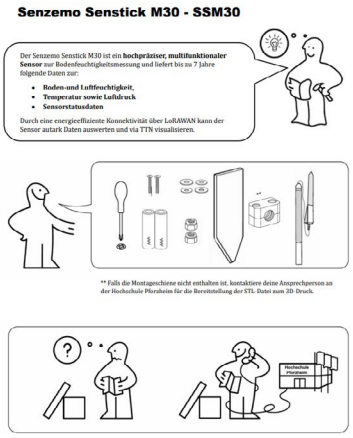
From a technological perspective, the adoption of LORAWAN technology has proven highly advantageous for connecting a diverse array of sensors to a robust, Internet-based dashboard. The long-range, low-power capabilities of LORAWAN enabled the installation of sensors in locations that are traditionally challenging for wired solutions or short-range wireless alternatives. The flexibility and scalability of the network have allowed stakeholders to continuously expand sensor coverage and experiment with new use cases with minimal incremental investment. Notably, LORAWAN's energy efficiency and reliable connectivity have facilitated real-time data collection for applications such as road salt silo management, flood level detection, soil condition monitoring, environmental sensing, and even dynamic crowd and traffic analysis.

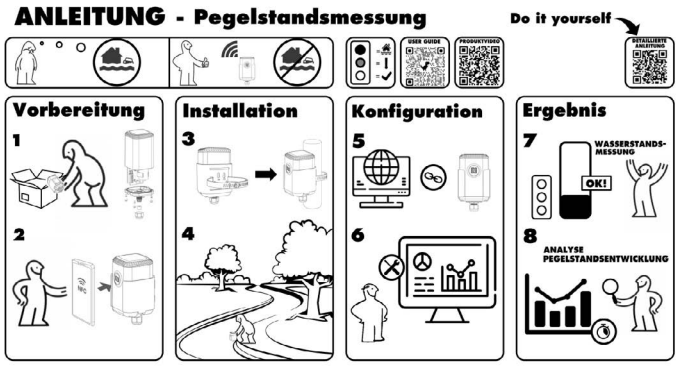
Utilizing **The Things Network** (TTN), an open, global platform, has further accelerated both technology adoption and knowledge sharing. With its suite of accessible tools and strong security features, TTN allowed project teams and citizen collaborators alike to rapidly prototype, test, and scale their IoT applications. The thriving TTN community proved instrumental not only in technical troubleshooting but also in fostering a sense of shared purpose. Local communities across Europe participated in parallel efforts, exchanging expertise and even integrating data streams, which laid a foundation for future cross-regional collaborations.

CITIZEN SCIENCE APPROACH

Beyond the technical realm, the integration of citizen science emerged as a crucial ingredient for project success and for realizing a deeper dimension of sustainability. Engaging citizens–both as data collectors and informed users–transformed the project from a purely technological exercise into a participatory movement. Citizens actively contributed by installing sensors in their homes, gardens, and workplaces, as well as by responding to emergent insights from the dashboard data. For instance, real-time alerts regarding flood risks or road salt depletion empowered local communities to take preemptive, sustainable actions. The Do It Yourself instructions, which were initially devised during the first campaign, enabled broader public participation and enhanced the project's reach and impact.

The citizen science approach also enriched the educational process, as students and non-experts gained hands-on experience in sensor deployment, data analysis, and digital literacy. This democratization of technology resulted in increased public awareness of sustainability challenges and the value of open data. Participants developed a sense of ownership and agency, recognizing that environmental impact is not solely the domain of experts but something shaped by everyday actions and informed decisions.





Examples of DYI manuals for sensors installation

COLLABORATION APPROACH

On the operational side, several valuable lessons surfaced. The effectiveness of collaboration between krumedia and Hochschule Pforzheim was amplified by clear communication and well-defined roles. Ongoing, routine data collection worked best when both technological and human factors were given equal attention. Challenges–such as the theft of water level sensors–underscored the need for robust security measures and contingency planning. In response, future deployments will emphasize sensor protection and rapid replacement strategies.

Perhaps one of the most significant lessons is the symbiotic relationship between technological advancement and societal involvement. Technology alone cannot drive meaningful or lasting change in urban sustainability. It is the convergence of innovative tools with motivated, informed citizens that has brought about palpable results–from optimized salt logistics and more resilient flood prevention to improved public resource management and greener mobility.

The ongoing analysis and visualization of sensor data through user-centric dashboards proved essential for turning raw numbers into actionable intelligence. For example, continuous records of air quality, soil moisture, traffic density, and public-space occupancy allowed both municipal authorities and everyday citizens to track trends, benchmark progress, and intervene with timely, sustainability-minded actions.

Demonstration of pilot approach at SMART CITY DAYS 2025, Pforzheim

PILOT SUMMARY

The pilot in Pforzheim contributes a practical, scalable pathway for tackling climate challenges by turning citizen participation into continuous environmental intelligence and actionable local decisions. It delivers a low-cost LoRaWAN sensing network, using The Things Network and an enerchart dashboard, that citizens and students help install and operate, shifting monitoring from occasional expert surveys to always-on, community data streams.

The project couples technology with a DIY Citizen Toolkit and campaigns that grow digital literacy and ownership. By blending open IoT, user-centric dashboards, and structured citizen science, the pilot accelerates how communities monitor and adapt to climate change while building the social capital needed for long-term resilience.