RECIPE BOOK

Real cases adapted to real life needs

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Introduction

This recipe book serves as a practical and user-friendly guide for Vocational Education and Training (VET) schools and companies, offering a structured approach to applied research through practical and adaptable methods. The content is based on real-life examples and experiences drawn from the BARCOVE project, which involved multiple countries working together to enhance research capabilities in the VET sector.

The book is divided into several key sections, each aimed at equipping educators, students, and company representatives with the tools necessary to carry out applied research projects. The first section introduces the Whole CoVE[1] Approach (WCA), a framework which provides a structured way for schools and companies to integrate research and sustainability goals into their organization. The second section explains how to design and implement a hackathon, where participants engage in rapid, intensive problem-solving. The third section explores design thinking, a problem-solving approach that encourages user-centric innovation.

Finally, the recipes, core of this book, provide concrete examples of how applied research can be implemented by VET Schools and companies. These case studies, from Denmark, Spain, and the Netherlands, highlight unique challenges and solutions, offering inspiration and guidance for future projects.

Reflections

Our goal with this recipe book is to create a resource that is both practical and transferable. We aim to deliver applied research methods that can be easily adapted and used in various educational and business contexts. By providing clear guidance on how to implement the WCA, hackathons, and design thinking, we hope to inspire VET schools and companies to take a more innovative approach to research and learning. Ultimately, this book is a tool for fostering creativity, encouraging entrepreneurship, and developing research skills that will benefit both students and industry professionals alike.

[1] Centre of Vocational Excellence

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What the Recipe Book Includes

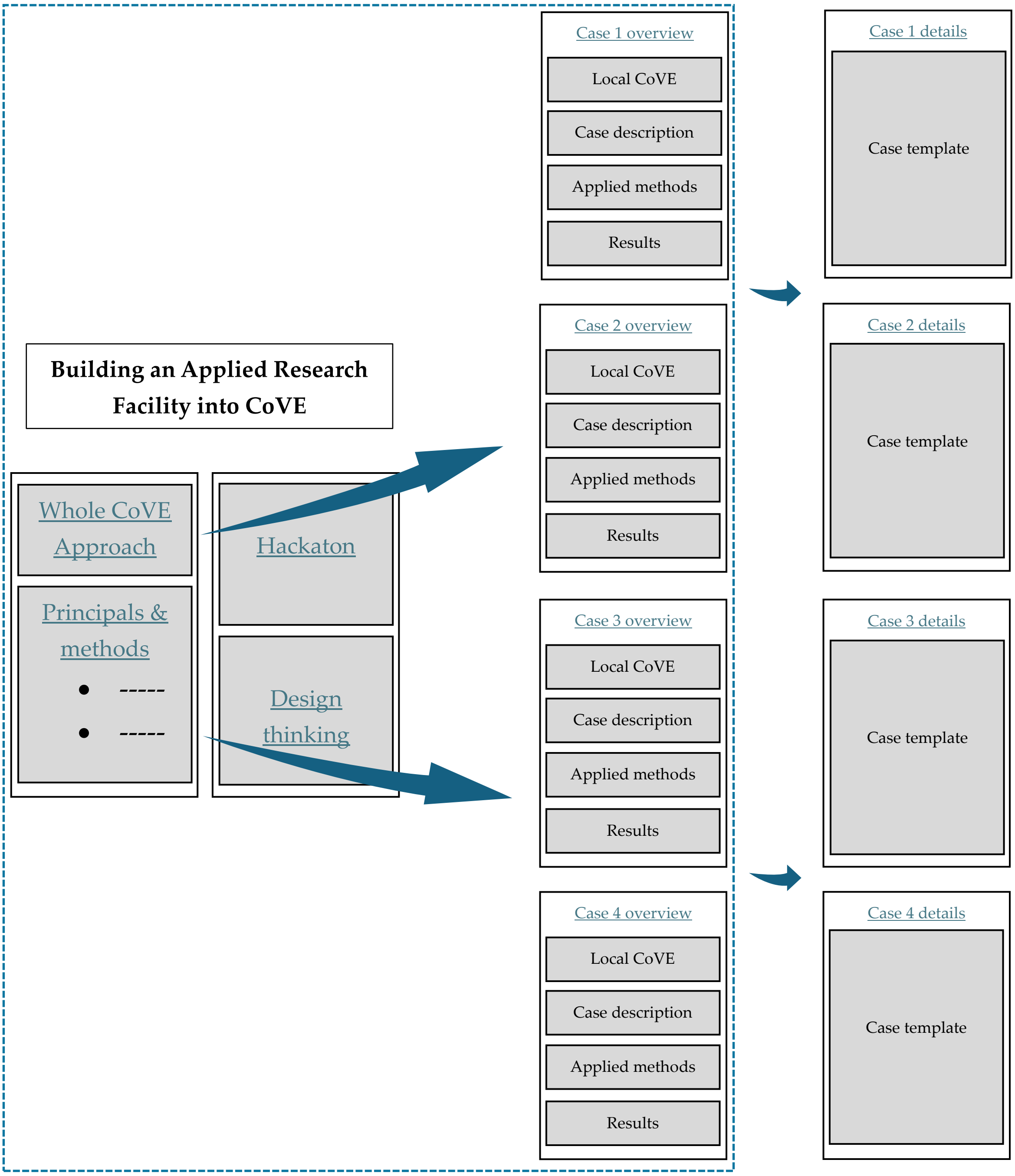

Figure 1. Diagram with the content

How to Use This Recipe Book

This recipe book is designed to be used flexibly, depending on your context. Each recipe provides an easy-to-follow overview of the case, giving you a clear starting point. If you need more in-depth information, you can explore the detailed case descriptions later in the book. The diagram above helps you navigate the recipe book content.

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Whole CoVE Approach, principals and methods

The Whole CoVE Approach is derived from the Whole School Approach (WSA). The Whole School Approach is a framework that supports schools in giving shape to education for a sustainable future, in consultation with all stakeholders and interested parties in and around the school. The WSA helps to integrate sustainability issues structurally and coherently into the school organization.

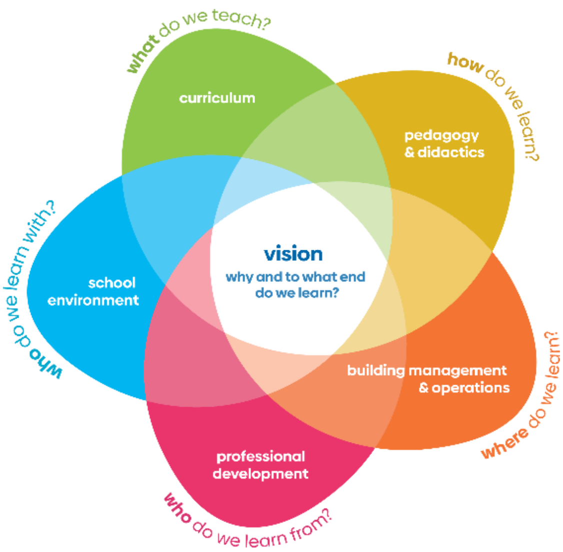

Figure 2. Model Whole School/CoVE

We used this model, which we renamed the Whole CoVE Approach **(WCA),** to describe the different situations in the different countries who participated in the BARCOVE project (see overview of the cases). Also, we give guidance on how to fill in the various parts to promote the development of research skills. This is set out below when explaining the different parts of the WCA.

Each school (including companies) can shape the WCA in its own way. The framework provides questions to start thinking and acting according to the school's ambition. In the case of the BARCOVE project, the ambition is to develop applied research skills for VET students: to stimulate the creativity, entrepreneurship and talents of young people. The WCA provides space to work on each part without losing sight of the whole.

The Whole CoVE Approach (WCA)

The heart of the Whole CoVE approach centers on vision, focusing on what we aim to achieve with this project: integrating applied science through collaboration between VET, business, higher education, and government. It also emphasizes the school's vision of teaching research skills to VET students.

In terms of vision, the following recommendations emerged from the desk research:

- School/company vision: It is important for sustainable implementation.
- Leadership engagement: Ensure that school leaders and policy makers are actively involved in defining and supporting the program, emphasising its value.

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- Leadership and vision: Develop a shared vision that emphasises the integration of business collaboration and research skills as a critical part of education.
- Alignment in the organisation: from director to manager to teacher or supervisor to student or employee.

Curriculum (What do we teach?): This section addresses how the projects are integrated in the curriculum. For example, it is a core component, a separate element, or an optional addition.

Pedagogy & didactics (How do we learn?): From all the good practices gathered from each country and the results of the desk research, we've learnt that didactics are important to implement applied research in VET schools:

- Teaching skills that make students curious and willing to experiment.
- Teachers as coaches, not teachers with the attitude of being owners of knowledge.

Appropriate didactics: Design thinking, problem-based learning, ADDIE model[2], investigative learning.

Building management & operations (Where do we learn?): Having a physical inspiring space within or outside the school that can provide the necessary room for students/teachers/companies to apply research. Examples from desk research include field labs or living labs, and knowledge circles.

Professional development (Who do we learn from?): We learn from each other, from experts and in collaboration with companies. To use different teaching methods, it is important to provide training for teachers and space to experiment. A change of the definition and system of education. It is no longer about right or wrong.

School environment (Who do we learn with?): The learning is in a network of people, organizations and companies with passion and expertise in the field of sustainability (green/blue). Successful implementation of business-school cooperation requires a cooperative and proactive approach, focusing on building strong partnerships between VET schools and businesses. The will to work together as schools and businesses. You need sustainable partnerships, developed over years of interaction.

For more information you can visit the following websites: https://www.wur.nl/en/education-programmes/wageningen-pre-university/whole-school-approach.htm; https://wholeschoolapproach.lerenvoormorgen.org/en/

[2] Analysis, Design, Development, Implementation, and Evaluation

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Hackathon

A hackathon is an intensive and collaborative event where participants work together to develop innovative solutions to specific challenges. The purpose of a hackathon is to promote creativity, innovation, and problem-solving by bringing together various stakeholders such as startups, experts, and students.

Overview of the Hackathon

To successfully organize a hackathon, several key details must be addressed:

- **What?** The first step is to brainstorm and choose a name for the hackathon that aligns with its goals and theme.
- **When?** Determine the dates for the arrival, hackathon event (usually two days), and departure.
- **Where?** Select a location (city and country) for the event.
- **Who participates?** Create a list of participants, including the number of startups, experts, and students involved. Categorize participants based on their roles or expertise.
- **Why it takes place?** The purpose of this hackathon is to focus on documenting climate solutions. Benefits include:
  - Addressing the global climate crisis by developing innovative solutions.
  - Networking opportunities for startups to meet new partners and potential collaborators.
  - Skill development in areas such as innovation, research, and business development.
  - Increased brand exposure for participants, showing their commitment to sustainability.

Participant Criteria and Selection Process

- **For Whom?** The hackathon targets companies, startups, and educational institutions engaged in fields like climate change, urban greening, and sustainability.
- **How to Participate?** The application process includes submitting forms for students and companies. The selection process involves reviewing the challenges each company presents, ensuring there are at least two companies per frame. Challenges will be organized into different frames (urban greening, climate solutions), with each company presenting specific issues. Selected participants will work collaboratively to address these challenges using the latest technologies, such as sensors or IoT solutions.

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- **Email Confirmation for Selected Participants:** An email will be sent to participants with event details, outlining the online session for orientation and providing an opportunity to clarify any questions.

Hackathon Structure and Benefits

Why Join a Hackathon?

Joining a hackathon offers participants a unique opportunity to dive into the forefront of innovation, networking, and skill-building. Participants have the opportunity to network, develop new skills, and contribute to sustainable solutions, which in this case focus on climate challenges and urban greening.

A Hackathon for Urban Greening and Climate Adaptation

This hackathon is particularly focused on urban greening and climate adaptation, crucial topics in today's rapidly changing environment. Companies, startups, and institutions involved in urban development and green solutions will greatly benefit from this event. Through practical research and collaboration, participants will address key questions such as how technological advancements in urban greening can be adapted across different contexts.

Participants will have the chance to:

- Work with Europe's top companies and startups in urban greening.
- Develop applied research and data collection skills.
- Receive brand exposure and meet potential investors and partners.

How Does the Hackathon Work?

Participants will go through a structured process:

- Pre-Hackathon: Participants will register and work with the hackathon organizers to formulate a challenge. Startups will present their innovations, which the hackathon will leverage to find solutions.
- During the Hackathon: The event will be divided into two days, with team-building exercises, keynote presentations, and innovation case studies. On the second day, teams will pitch their solutions to a panel.
- Post-Hackathon: After the event, companies will receive a calculated business case for bringing their solutions to market. Educational institutions may also continue working on the challenges in collaboration with the companies.

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Frames and Participants

The hackathon will be divided into thematic frames, each addressing a different aspect of urban greening and sustainability. Participants will be grouped into these frames, working alongside companies, experts, and coaches. Startups will bring their innovations, while companies will present specific challenges related to real-world problems.

Expectations and Requirements

Participants must be willing to collaborate under Creative Commons rules, meaning all outcomes will be shared. They must also agree to cover their own travel expenses and attend the event in person. Additionally, startups should bring innovations that help with data collection or processing.

Design thinking

Didactics are important to implement applied research in VET Schools. An important overall didactical method is design thinking. The design thinking method has several variants, implementations and interventions: we will explain here the hackathon and inquiry based learning method. First, we describe the design thinking method itself.

The basis and process of design thinking

Design thinking is a non-linear, iterative process that learners or teams use to understand users, challenge assumptions, redefine problems and create innovative solutions to prototype and test. It is most useful to tackle ill-defined or unknown problems and involves five phases: Empathize, Define, Ideate, Prototype and Test.

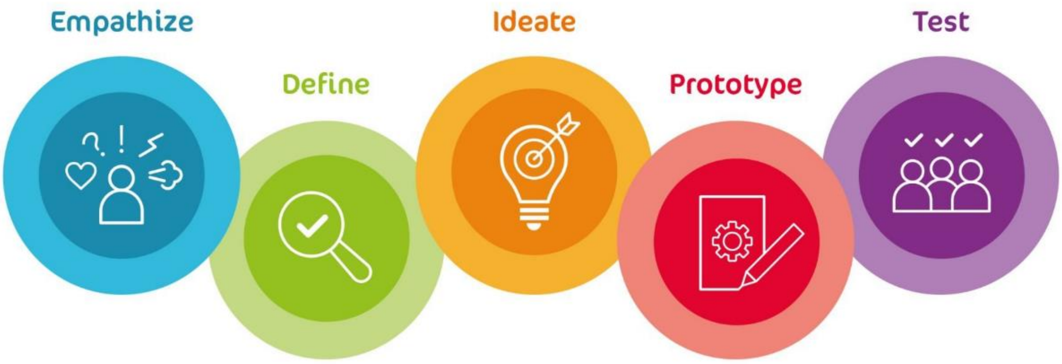

Figure 3. Process of design thinking

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Stage 1: Empathize—Research Users' Needs

The team aims to understand the problem. Empathy is crucial to design thinking because it allows designers to set aside your assumptions about the world and gain insight into users and their needs.

Stage 2: Define—State Users' Needs and Problems

Once the team accumulates the information, they analyze the observations and synthesize them to define the core problems. These definitions are called problem statements. The team may create personas to help keep efforts human-centered.

Stage 3: Ideate—Challenge Assumptions and Create Ideas

With the foundation ready, teams gear up to "think outside the box". They brainstorm alternative ways to view the problem and identify innovative solutions to the problem statement.

Stage 4: Prototype—Start to Create Solutions

This is an experimental phase. The aim is to identify the best possible solution for each problem. The team produces inexpensive, scaled-down versions of the product (or specific features found within the product) to investigate the ideas. This may be as simple as paper prototypes.

Stage 5: Test—Try the Solutions Out

The team tests these prototypes with real users to evaluate if they solve the problem. The test might throw up new insights, based on which the team might refine the prototype or even go back to the Define stage to revisit the problem.

These stages are different modes that contribute to the entire design project rather than sequential steps. The goal is to gain a deep understanding of the challenge and the ideal solution.

Hackathon: A competitive, challenge-based design thinking method

Hackathons can last between a few hours and one week. Events often have a specific focus but are generally used for innovation, education or social purposes, and there is often a goal to create usable technological improvements or innovations. This didactics is challenge based and works like a 'pressure cooking' for learning and innovating.

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These are the stages: Start (explanation of the challenge), explore, define, invent, select, build, test and share (the solution). It is an iterative process based on different insights, expertise and characters of people/students. You need well mixed groups!

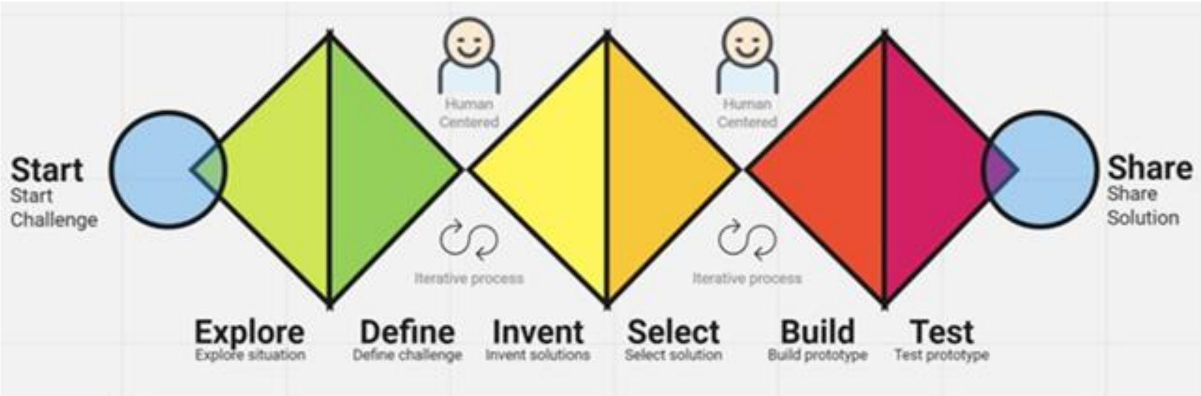

Figure 4. Stages of a design thinking project

For a hackathon it is important to put the competition element in the challenge, that improves motivation and the "pressure cooking" element.

Inquiry-based learning

Inquiry-based learning is a variant of design thinking. In order to implement applied research in education, the inquiry-learning cycle could work as a guidance.

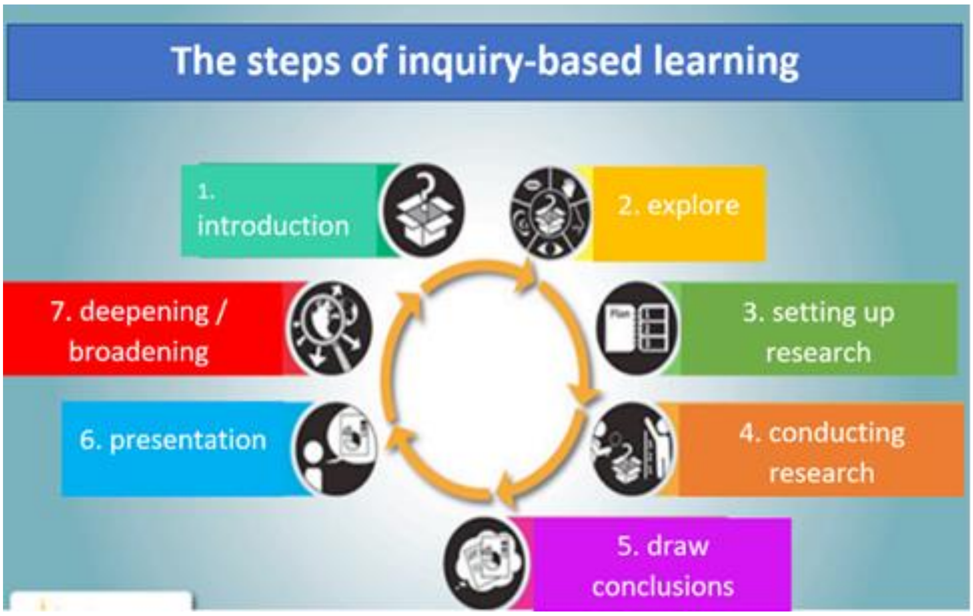

Figure 5. Steps of inquiry-based learning

1. Introduction & confrontation: Introduction or confrontation with a problem, phenomenon or object that is new, but connects to the student's world. The

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wonder and curiosity of the students are stimulated by offering objects and phenomena that are just above their level of knowledge (zone of close development) and who thereby challenge them and motivate to explore.

2. Explore: To explore the phenomenon or problem as widely as possible, preferably allowing the students to guide themselves. In this exploratory phase, students draw on prior knowledge and exchange experiences related to the material or phenomenon presented. This creative phase raises questions, ideas, and predictions, which is important for learning about each other's preconceptions and concepts.
3. Setting up research: The students transform the research questions into a feasible study. They decide on the research design they will use and make a plan outlining what they will observe or measure, the materials and measuring instruments needed, and who will do what and when. This is also the phase to formulate a hypothesis.
4. Conducting research: The students carry out the research according to their plan. They record their observations and data in a logbook and discuss their findings within their group (possibly with the teacher). The observations and data lead to results, which can be organized and analyzed using digital tools.
5. Draw conclusions: Based on the results, the students draw conclusions that may lead to solutions and potentially new follow-up questions, prompting a repetition of steps 1 to 4.
6. Presenting results: The students, together with their group, organize the setup, results, and conclusions into a presentation that includes drawings, photos, text, and tables or graphs. They present the outcome of the investigation, providing an answer to the question posed, to both the client and the rest of the group. Sharing experiences with peers is essential for the development of their own knowledge as well as that of other students and employees in the companies.
7. Deepening & broadening: Through conversations and presentations, the teacher gains insight into the students' level of comprehension. In this phase, the teacher builds on this understanding by further conceptualizing the key ideas. This involves expanding and applying these concepts in different contexts, as well as creating connections with other concepts or research to enhance coherence and depth.

This type of research is possible for inquiry-based learning:

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- **Experiments,** simply observe what happens when you test things. Conducting experiments is a good example of this approach. You might remember the classic primary school experiment with cress, where the research question was: "What grows better, cotton wool or potting soil?" That is an experiment, where you observe the outcome.
- **Monitoring research**, this involves collecting data in the field, conducting an analysis, and providing recommendations. A data analysis system is essential, which could be an existing digital platform.
- **Action research**, in action research, you make a change in the usual course of events at the request of individuals, then observe how this change is experienced. It focuses on the feelings and behaviors of people in their daily lives or within organizations. Importantly, the individuals being studied actively participate in the research. This type of research often begins with conversations or interviews.

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THE BEST RECIPES

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Overview Case 1 – Denmark: Pressurized rainwater systems

Local CoVE

Country: Denmark
School: Jordbrugets UddannelsesCenter Århus (Green Academy)
https://ju.dk/international-green-academy/
Company: OKNygaard
https://oknygaard.dk/nyhederne/
Challenge: In urban development, the implementation of Sustainable Drainage Systems (SuDS) can be complicated by factors such as lack of space, high groundwater levels, etc. Pressurized rainwater systems are a sustainable method that utilizes potential energy to move rainwater from surfaces to areas where the water can be used as a resource or evaporated. The challenge is to design a system in which water can be moved without electrical pumps. The system must include a pressurized well equipped with a sensor monitoring the waterflow.

<table>
<tr><td colspan="3">Vision School/company:
By working together, companies and the school aims to elevate the entire field, ensuring that both current and future professionals are equipped with the latest skills and knowledge.</td></tr>
<tr><td>Leaf</td><td>Question</td><td>How filled in the 1-to-1 case</td></tr>
<tr><td>Curriculum</td><td>What do we teach?</td><td>The one-to-one case in Denmark consists of several parts:
Workshops for teachers and students at the Green Academy on climate adaptation, rainwater systems, and pressurized rainwater systems, held in collaboration with the University of Copenhagen, the Danish Technological Institute, and the companies.
One-week innovation camp for basic course students and teachers at the Green Academy with the participation of 8 companies, each presenting real-life challenges.
Two-day workshop at OKNygaard, where students were taught theoretical elements and worked on practical problems at various workstations, in dialogue with experts from the companies. During the workshop the</td></tr>
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		pressurized rainwater systems were built and the sensor was integrated in the system.
Pedagogy & Didactics	**How** do we learn?	Hackathons with real-life challenges. Design thinking Method, Problem-based learning. Coaching. All teaching situations link theory with practical application.
Building management & Operations	**Where** do we learn?	The learning environments are characterized by practical facilities and high professional knowledge. Students work in the companies' facilities or in the school's workshops and practice areas, all equipped with modern and professional equipment and technology. Students collaborate with the company's employees and experts as well as teachers.
Professional development	**Who** do we learn **from**?	The key partners in this project include OKNygaard, Green Academy, Smart Brønd, and Wavin, with additional involvement from the Danish Technological Institute and the University of Copenhagen.
(School)environment	**Who** do we learn **with**?	Students are integrated into a learning community alongside teachers, industry experts, and other knowledge institutions. They test and evaluate products, providing valuable feedback to companies on user-friendliness and necessary information for product implementation. This collaborative environment promotes the development of innovative solutions by involving students in design processes and reflective practice. At the same time, students' innovation skills and research abilities are trained.

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Case description

The topic for the case was SuDS and how they can be implemented in urban design and development despite challenges factors such as lack of space, high groundwater levels, and risk of pollution. The challenge from the hackathon was to design a SuDS system capable of moving water without the use of electrical pumps. The system also required a pressurized well equipped with a sensor to monitor water flow.

Applied Methods

Working on the case started at the Hackathon in Aarhus with the following challenges:

- How can the Smart well (from SmartBrønd) be implemented in the most sustainable way and how can we convince users of its superior sustainability in comparison to other (rain) water solutions?
- How can we develop a pit for cleaning of the pressurized system as well as infiltration in the winter season.
- How can we develop a fitting/coupling between downpipes to pressurize so the system can actually be used in daily practice.

During the 2-day event a group of students from different countries worked together with experts on an initial solution. By the end of the hackathon, they had set the groundwork for our project. The working method was an intensive iterative process in accordance with the design thinking method.

Prototype Development

To move forward, we established a consortium of collaborating partners to continue developing the solution.

Primary Collaboration Partners:

The key partners in this project include OKNygaard, Green Academy, Smart Brønd and Wavin, with additional involvement from the Danish Technological Institute (TI) and the University of Copenhagen (KU). These institutions brought a blend of practical and theoretical expertise facilitating a robust learning and development environment.

Contributions from Each Partner:

- **OKNygaard**: Provides a development manager, employees, and location for the 1-to-1 case study, demonstrating real-world applications outside a school setting.
- **Green Academy**: Contributes teachers, facilitators, a Living Lab area for ongoing operational aspects, and students at various levels.
- **SmartBrønd**: Offers expertise on their product, including sensors and dashboards.
- **Wavin**: Supplies materials and makes their production facilities available for product refinement and learning through the project.

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The first step in the prototype development was a two-day practical workshop with all the collaborating partners serving the following purposes for the partners:

Green Academy: New knowledge for students. Strengthening innovation skills

OK Nygaard: Maturing of solutions they can later offer. Demonstration of solution at own headquarters.

Wavin: Participation in front solutions. Potential new product.

TI and KU: Development and documentation of new solutions in urban drainage. Specific contribution to another project regarding pressurized rainwater systems.

In the workshops, students were integrated into a learning community alongside teachers, industry experts, and other knowledge institutions. School facilities were used to build physical models of pressurized water systems, enabling students to experiment with products and materials. The workshop led to the upscaling phase.

Scaling up

Scaling up and building the set-up was carried out as a two-day practical course involving the startup company Smartbrønd, the supply company Wavin, OKNygaard, teachers and first-year VET students from Green Academy. The set-up was built at OKNygaard company site on Rosbjergvej in Brabrand. The main focus was that students, in collaboration with the companies and teachers, would learn about pressurized rainwater systems and then build a system in existing facilities. All construction work was performed under thorough instruction, and the students should also experience what it's like to be an employee and be part of a new project.

Integration in VET education

During this phase, it became clear that integrating didactic and pedagogical approaches to support students' development of innovation and research skills in VET education required a distinct focus. The teachers' competences were strengthened through a practical learning process consisting of a one-week innovation camp including two prior teachers workshop focusing on developing innovation- and research skills:

Teacher's workshop 1: 3,5 hours workshop regarding problem based learning held for all the teacher at the school and the pedagogical leaders.

Teacher's workshop 2: 4 hours workshop hosted by Katapult regarding teachers training in the design thinking method.

One-week Innovation camp: 150 ground course students, 8 companies, 3 experts and 20 teachers.

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Results

The pressurized rainwater system including the pressurized well and the sensor are functioning. The well thus serves several purposes; partly to ensure that the water is safely disconnected from the building and a possibility to maintain/clean the water system, as well as a solution to measure the waterflow and ensure the capacity of the system regarding the amount of rainwater. The students are doing real-time monitoring and learning about data reading, data management, and data visualization.

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Overview Case 2 – Spain: Vegetated roof garden

Local CoVE

Country: Spain

School: EFA La Malvesia

Company: PAIMED

Challenge: Monitoring biodiversity in a roof garden in Valencia, Spain. In the BARCOVE project, CoVE Spain aims to develop innovative solutions for tracking biodiversity in a rooftop garden in Valencia, Spain.

Vision School/Company: To integrate education, technology, and sustainability to create a replicable model for monitoring biodiversity in urban environments.		
Leaf	Question	How filled in the 1-to-1 case
Curriculum	**What** do we teach?	A real case to install a biodiverse vegetated roof garden at Paimed headquarters to monitor biodiversity and test the benefits of increasing biodiversity in urban areas. First year – urban greening students worked 1,5 days in the installation process and monitoring the sensors data and Faunaphotonics insect sensors. Specific applied research monitors newly planted vegetation, watering systems, installation process, substrates, biodiversity that visits/uses the roof garden.
Pedagogy & Didactics	**How** do we learn?	Our school used the challenge-based learning (CBL) method, centered on observation, reflection, and action. Teachers ask students questions without providing answers, giving them space to explore, make mistakes, and practice problem-solving. Also, we work with the company to tackle a real-world problem.
Building management & Operations	**Where** do we learn?	A real 1:1 case of a vegetated roof garden at Paimed headquarters to measure biodiversity, temperature, humidity sensors. Students from EFA La Malvesia

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		become acquainted with the company and get the experience of monitoring the whole process. Project managers and other professionals working at the headquarters provide students with a true day-to-day work experience.
Professional development	**Who** do we learn **from**?	Paimed: An opportunity to explore new content areas for potential services and products, fostering innovation through collaboration with the school. Initial funding is provided by a collaborative Erasmus project. EFA La Malvesia teachers and students: By addressing real challenges faced by companies, teachers and students engage in applied research and innovative learning methods, equipping students with new skills and competencies.
(School)environment	**Who** do we learn **with**?	• Paimed, professional experts in vegetated green roofs and biodiversity • EFA La Malvesia teachers • EFA La Malvesia students

Case Description

In the BARCOVE project, EFA La Malvesia in Spain partnered with PAIMED to develop innovative solutions for tracking biodiversity in a rooftop garden located at PAIMED's headquarters in Valencia. The goal, based on the company problem that needed to be solved, was to create a biodiverse rooftop garden, integrating advanced sensors to monitor temperature, humidity, and biodiversity. The challenge for the team was to demonstrate the benefits of increasing biodiversity in urban environments while involving first-year Urban Greening students in the installation and monitoring processes. Students participated in the construction and data collection using cutting-edge technology, including FaunaPhotonics biodiversity cameras.

Applied Methods

During the project, PAIMED technicians showed the students how to install the rooftop garden, which included several layers (waterproofing, drainage, and

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substrate) and an irrigation system. The garden was divided into two sections: one planted with a drought-resistant turf (*Zoysia Trinity*) and the other with a mix of shrubs, perennial grasses, and herbaceous plants. In addition, FaunaPhotonics biodiversity cameras and various environmental sensors were installed to collect real-time data on temperature, humidity, and biodiversity. Students also collaborated with professionals from PAIMED to understand how to monitor and interpret the collected data.

Results

The rooftop garden at PAIMED headquarters is now fully operational, equipped with sensors and monitoring tools that provide valuable data on temperature, humidity, and biodiversity. Monitoring and maintenance are ongoing, and the PAIMED workers are in charge. Students from EFA La Malvesia participated in some tasks for the construction, installation of sensors, and data monitoring phases, gaining hands-on experience in real-world urban greening projects. The rooftop garden will continue to serve as a learning space for future students, providing ongoing opportunities to engage in practical, applied research.

The use of FaunaPhotonics biodiversity cameras enabled the team to gather quantitative information about insect abundance and biomass. Additionally, the project offered PAIMED and FaunaPhotonics an opportunity to test new products and technologies in a real-world setting, providing feedback for future market implementations.

This project not only served as a learning experience for students and teachers but also contributed to sustainable urban development by promoting biodiversity in a built environment.

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Overview Case 3 – The Netherlands: Minibosk

Local CoVE

CIV Water/Centre of Vocational Excellence Water West-EU Leeuwarden

The Platform of Vocational Excellence (PoVE) Water aims to excel in vocational education within the water sector by developing regional and national Centers for Vocational Education and Skills (CoVE Water) and uniting these centers under the umbrella of the PoVE Water (https://www.civwater.nl/). In the BARCOVE project CIV water cooperated with students of Aeres MBO Leeuwarden and Firda Leeuwarden.

Country: The Netherlands

School: Aeres MBO Leeuwarden https://www.aeresmbo.nl/locaties/leeuwarden

Company: Municipality of Leeuwarden https://www.leeuwarden.nl/

Challenge: The inner city of Leeuwarden now has little green. The challenge is to design a movable container that is self-sufficient in terms of water and nutrients for greening the city centre.

Vision Aeres MBO: We teach people to be agile, to be resilient and inclusive. They receive guidance and personal development coaching, citizenship and craftsmanship. This means that we provide education based on career guidance. This includes the ownership of the student (what does he/she want to learn) is central. It also stimulates curiosity and research skills of students in search of new knowledge and abilities.		
Leaf	Question	How filled in the 1-to-1 case
Curriculum	**What** do we teach?	Students work for 1,5 days in the MAB on different projects with real assignments. The learn about the different subjects and the students work on improving competences. One of the groups (3 students) is working on the project of the municipality of Leeuwarden. The MBA (consultancy firm) is embedded in the curriculum. On the other days students learn about different subjects concerning the environment.
Pedagogy & Didactics	**How** do we learn?	• Didactics or, role of the teacher: teacher as coach to encourage inquiry-based learning. • Method: design thinking, inquiry-based learning (working in

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		MAB= environmental consultancy firm).
Building management & operations	**Where** do we learn?	• Inspiring learning environment: De Kanselarij. • In MAB 10 weeks, 1,5 days a week • Outside (doing research in the inner city of Leeuwarden).
Professional development	**Who** do we learn **from**?	• Professional development teachers (didactic coaching). • From experts (about the topic of the assignment). • By doing.
(School) environment	**Who** do we learn **with**?	• Community of learning and practice • A network of people, organizations and companies with passion and expertise in the field of sustainability (green/blue)

Case description

Bosk was held in Leeuwarden in 2022, where 1,200 trees 'walked' through the city center over 100 days. This art project aimed to demonstrate the positive impact trees have on urban life, highlighting the urgent need for trees and greenery in cities (https://arcadia.frl/projecten/bosk/).

The challenge

The inner city of Leeuwarden now has little green. In addition, there is also little space to plant greenery and cables in the ground make it difficult (for the plant roots). As a follow-up to Bosk, the municipality of Leeuwarden is now considering mobile greenery in the city centre (a kind of mini Bosk). Green in movable green containers that are self-sufficient in terms of water and nutrients. Further requirements for the bins:

- Containers must be movable by 1-2 people.
- They should have a consistent appearance.
- Green in the containers should contribute to biodiversity.
- Greenery should contribute to cooling the environment.
- Containers should be representative.
- Consideration of suitable plant species.
- Ideas for efficient movements of the containers.
- Ability to collect rainwater.

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The challenge: Design a movable container that is self-sufficient in terms of water and nutrients for greening the city centre. Client is Nico Kelderhuis of the municipality of Leeuwarden.

Applied Methods

Hackathon: Working on the case started at the Hackathon in Aarhus, Denmark. In two days, a group of students from different countries and courses worked together on an initial solution direction. This involved working primarily according to the principles of design thinking.

One-to-one case: The continuation of the challenge was undertaken by a group of three students from Aeres MBO Leeuwarden (VET school) in the environmental consultancy office. In this setting, students work 1,5 days per week on field-related assignments over approximately 10 weeks, with each group handling its own unique project. This consultancy office is integrated into the curriculum of the environmental researcher course, primarily using inquiry-based learning. The students are supervised by teachers and hold regular meetings with Nico Kelderhuis from the municipality of Leeuwarden to discuss progress and results.

Results

Hackathon: Presentation with an initial sketch of the container for trees and suggested plants that could be used in these containers. The presentation was presented to the municipality of Leeuwarden after the hackathon.

One-to-one case: An advisory report and presentation were prepared to explain the findings of the study. Included with the advisory was a recommendation for follow-up research, suggesting that students conduct experiments with the proposed bins and sensors to determine under what conditions the bins can be self-sufficient.

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Overview Case 4 – The Netherlands: Monitoring system

Local CoVE

Country: Netherlands

School: Yuverta mbo Houten

Company: Koninklijke Ginkel Groep

Challenge: Develop innovative solutions and a dashboard for sensor monitoring and data on roofs

<table>
<tr><td colspan="3">Vision: Integrate sensor monitoring and data technology into education in order monitoring green roofs in relationship to climate and also biodiversity.</td></tr>
<tr><td>Leaf</td><td>Question</td><td>How filled in the 1-to-1 case</td></tr>
<tr><td>Curriculum</td><td>What do we teach?</td><td>A real case involved installing several sensors on a vegetated experimental roof garden at Yuverta Houten. These sensors (for humidity, temperature, and CO_2) generate data, but data alone is not useful without meaningful conclusions. To address this, university students built a dashboard, which gardening and urban green students at Yuverta (EQF levels 3 and 4) are now testing and using. In this project they learned how to:
Make a plan for the several sensors.
Install these sensors.
Read the data in the dashboard.
Give feedback to the students at the university to improve the dashboard.
Draw conclusions from the data presented in the dashboard in relationship to maintenance and other actions.</td></tr>
<tr><td>Pedagogy & Didactics</td><td>How do we learn?</td><td>When conducting applied research with students on real-life challenges, we</td></tr>
</table>

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		primarily use design thinking methods to approach problem-solving. To achieve this, we incorporate hackathons and inquiry-based learning, both of which are variants of design thinking. The inquiry-learning cycle serves as a useful guide for implementing applied research in education. The steps include: 1. Introduction & confrontation 2. Explore 3. Setting up research 4. Conducting research 5. Draw conclusions 6.Presenting results 7. Deepening & broadening
Building management & Operations	**Where** do we learn?	At the Green Roof Experience Centre, located at Yuverta School Houten, where knowledge and innovations in roof and facade greenery come together. On one side of the roof, students learn how to create roof gardens, while on the other side, they learn about garden maintenance. The maintenance side includes the five most common types of gardens, each with different maintenance needs: a sloping sedum roof, an herb roof, a garden with perennials, a garden with raised containers and lighting, and a roof garden with vegetation that attracts bees and butterflies. This section is where we conducted sensor and dashboard research.
Professional development	**Who** do we learn **from**?	In this real-life case, we all learn from and with each other. Students from Yuverta and HAS University gain hands-on experience by working closely with the company,

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		monitoring the entire process, and experiencing day-to-day work life. Professionals from Koninklijke Ginkel Groep also benefit, learning from innovations in roof sensor technology and dashboards. This knowledge extends beyond the project leaders to the field workers as well. As this is an experimental roof, other companies have the opportunity to learn from it too.
(School) environment	**Who** do we learn **with**?	• Koninklijke Ginkel Groep. • Yuverta students and teachers. • HAS students. • Other companies such as Hemelwatertechniek.

Case Description

This project, titled 'Monitoring System for Data-Driven Green Management,' was carried out by students from HAS Green Academy in 's-Hertogenbosch, in collaboration with Practor Heidi Kamerling, urban greening teacher Willem Heuseveldt, and third-year students in gardening/landscape (EQF levels 3 and 4) from Yuverta Houten, under the commission of the Consortium Dashboarding Greenroofs. The primary goal was to design and implement a monitoring system to manage urban green areas, specifically green roofs, using real-time sensor data to promote sustainability. The team consisted of students Julian Sessink, Colin Zimmerman, and Imke Achten, led by project manager Maurits Dorlandt.

Questions:

- Main Question: How can a data-driven monitoring system improve sustainable management of green roofs?
- Sub-questions:
  1. What are the most critical environmental parameters to monitor on green roofs?
  2. How can sensors and IoT technologies be integrated into an effective data collection system?

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3. How can the data be processed, analyzed, and visualized for actionable insights?
4. What tools and software are necessary for building a reliable and scalable infrastructure?

Applied Methods

1. Exploration Phase

During the exploration phase, we brainstormed innovative ideas to pitch as part of a CoVE at the hackathon. This phase helped us identify the right partners to collaborate with during the event.

We decided on the need to remotely monitor the condition of rooftops, addressing the following key areas:

- Operational control: Enabling better management and oversight.
- Financial margin: Reducing the risk of failure and associated costs.
- Commercial opportunity: Providing a new service to customers.
- Quality improvement: Enhancing performance through continuous research.

We then reached out to partners within our network to participate in the hackathon:

- Optigrün, an international market leader in rooftop systems, confirmed their participation.
- Hemelwatertechniek (HWT), a company specializing in irrigation techniques, also joined us.

2. Hackathon Execution

A hackathon is an intensive event, typically lasting from one to several days, where participants collaborate on software projects to prototype solutions quickly. Our hackathon focused on the following challenges:

- Dashboard Planning: Creating a plan to measure various Key performance Indicators (KPIs) to optimize the functionality of green roofs, transforming them into smart roofs.
- Dashboard Development: Building a user-friendly dashboard for smart roofs and decks, incorporating features for measurement, monitoring, analysis, and programming to meet our operational goals.

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3. Prototype Development

By the end of the hackathon, we had laid the foundations for our project. To move forward, we established a consortium to continue developing and maintaining the dashboard. The consortium members included:

- De Enk Groen & Golf (a landscaping company with similar needs for a dashboard).
- Optigrün.
- Hemelwatertechniek (HWT).
- HAS Green Academy (students contributed to the prototype development).
- Koninklijke Ginkel Groep.

The students from the HAS Green Academy took the lead in building the initial prototype, while the other consortium members acted as stakeholders and clients. Between February and June 2024, the students delivered both their research and a functional prototype of the dashboard.

4. Scaling Up

After June 2024, the consortium began scaling up the solution. One of the students was hired by the Koninklijke Ginkel Groep to further develop the dashboard. The dashboard has since been implemented in a real-world setting at the newly constructed Yuverta Rooftop Garden. To provide additional support and expertise, Terralytics, a specialized company, partnered with Julian, one of the project leads.

This collaborative effort has enabled us to refine and expand the dashboard, ensuring its practical use and long-term success.

5. Integration in VET education

To ensure the project's long-term impact and continuity, we are integrating the dashboard development into Vocational Education and Training (VET) programs. The collaboration with HAS Green Academy made this possible, as students were not only involved in the prototype development but also in applying their technical skills in a real-world project.

This integration should help students gain hands-on experience and offered an innovative learning opportunity, linking education with industry needs. The Rooftop Garden at Yuverta provides an excellent real-life training location. It also should provide a model for incorporating sustainability and smart technologies into VET curriculums, ensuring that future professionals are equipped to work with advanced

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systems like the smart roof dashboard. This initiative bridges the gap between education and practical application, promoting a closer partnership between academic institutions and industry.

Results

1. Sensor Data Collection: The system successfully collected data on soil moisture, temperature, humidity, CO_2 levels, and other environmental factors critical for green roof management.
2. System Scalability: The infrastructure is scalable, allowing for future expansion to other green roofs or urban green projects.
3. Real-time Monitoring: The system allows for real-time data visualization, making it easier to manage green spaces based on current environmental conditions.
4. Data Insights: Insights gained from this system enable efficient water management, optimization of plant health, and overall improvement of urban sustainability goals.
5. Tool Integration: The project demonstrated effective use of open-source tools such as Node-RED, PostgreSQL, and Grafana, showing how affordable and scalable IoT solutions can be developed for urban green management.
6. A framework for new VET curricula.

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Case 1 Details – Denmark: Pressurized rainwater systems

Welcome to this comprehensive guide on the installation and replacement of pressurized manhole covers, the establishment of outlets for pressurized systems, and the replacement of downspout pipes with tight joints. This guide is designed for professionals and VET school students who are keen to master these essential techniques.

This guide is a product of applied research and represents a collaborative effort between industry and educational institutions. By working together, companies and schools are able to elevate the entire field, ensuring that both current and future professionals are equipped with the latest skills and knowledge. This collaboration not only enhances the quality of workmanship but also contributes to a safer and more sustainable world.

In the following sections, you will find step-by-step instructions that are broadly applicable to various technical installations and products. Written in clear and precise language, these instructions ensure you can follow along with confidence. Whether you are working on replacing a manhole cover, establishing a reliable outlet system, upgrading downspout pipes, or applying similar methods to other technical projects, this guide provides you with the essential knowledge and skills.

These methodologies exemplify how applied research and the partnership between industry and educational institutions can significantly raise the level and speed of development in joint projects. By embracing these collaborative approaches, we can collectively advance our field, drive innovation, and secure a better future for our world. Dive in and explore these methods to equip yourself with the expertise to execute critical tasks with professionalism and precision. Through the synergy of industry and education, we can collectively advance our field and secure a better future for our world.

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Recipe name: **Pressurized rainwater systems**

<table>
<tr><td rowspan="5">Organization</td><td>School:</td><td>Green Acade my</td><td>Company/ Partner:</td><td>OK Nygaard</td><td>Start-up:</td><td>SmartBrønd</td></tr>
<tr><td>Other partners involved:</td><td colspan="5">Wavin
University of Copenhagen
Danish Technological Institute</td></tr>
<tr><td>Financial budget:</td><td colspan="5">Not applicable</td></tr>
<tr><td>Human resources</td><td colspan="5">Building the set-up: Startup, supply-company, company and school involved
Participants:
Green Academy: 15 first year landscaping students.
Teachers: Boncho Kostadinov, Martin Duus, Anne-Marie Thomassen.
OK Nygaard: Kristoffer Sindby, Lone Feldballe, 1 maintenance staff.
Wavin, 1 professional and Smartbrønd, 1 professional
Continuous cooperation and data exchange between school, startup and company with experts, teachers and students.

Implementation of the applied research case in the school curricula:
Besides the one-to-one case, the school has been working with different approaches to implement the didactics and pedagogical approached needed to support the development of research and innovation skills for students:
Teacher’s workshop (8 h) about the development and upscaling of pressurized rainwater systems (by the University of Copenhagen)
Workshop (8 h) for students about design, building and upscaling of pressurized rainwater systems (by the University of Copenhagen)
Implementing didactics and pedagogical approach in the school:
Teacher’s workshop 1: 3,5 hours workshop regarding problem-based learning held for alle the teacher at the school and the pedagogical leaders.
Teacher’s workshop 2: 4 hours workshop hosted by Katapult regarding teachers training in the design thinking method.
A one-week innovation camp: Participants such as 8 companies, 20 teachers, 150 ground course students.</td></tr>
<tr><td>Materials and equipment</td><td colspan="5">Materials and equipment include 1 pressurized well developed in the project, 5 new pressurized roof downspouts of 8 meters length using known components, and a constructed well with</td></tr>
</table>

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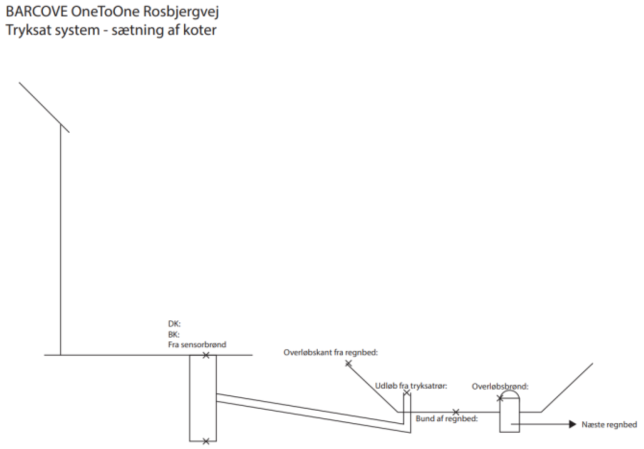
		known materials, which has been equipped with 1 pressure and 1 flowmeter, both developed and tested within the project.
Location	Location:	The pressurized rainwater system including the well with the sensor is located at the company site: OK Nygaard, Rosbjergvej 5, 8220 Brabrand Denmark.
	Climate zone & conditions:	Denmark is located in the temperate climate zone and has a coastal climate. The system is placed outside the building and is exposed to changing weather conditions. Weather and climate do not influence the system.
Technical information	Technical / IT pre-skills needed	Pre-skills needed for students: The students have basic IT skills and are familiar with Microsoft Office 365. They can search for information on the internet and critically evaluate sources. They have basic technical skills and are familiar with the most common tools used by landscapers. The students did not have any prior skills regarding sensor installation or monitoring. Pre-skills needed for the expert or teacher: It is necessary to be able to secure the equipment in a road well. During operation, one must be able to remove the cover and replace the battery on the equipment.
	Technical solution:	The drainage of rainwater from the roof of the company is conducted through a pressurized rainwater system. The rainwater is directed into a pressurized well where the sensor from SmartBrønd is installed. From the well, the water is led to an outlet-well where it passes through an evaporation element built with boulders to a rain basin.  SmartBrønd's equipment is securely installed in the well, Br1, and connected to dashboards from which the water balance of the well and the location of the equipment can be monitored.

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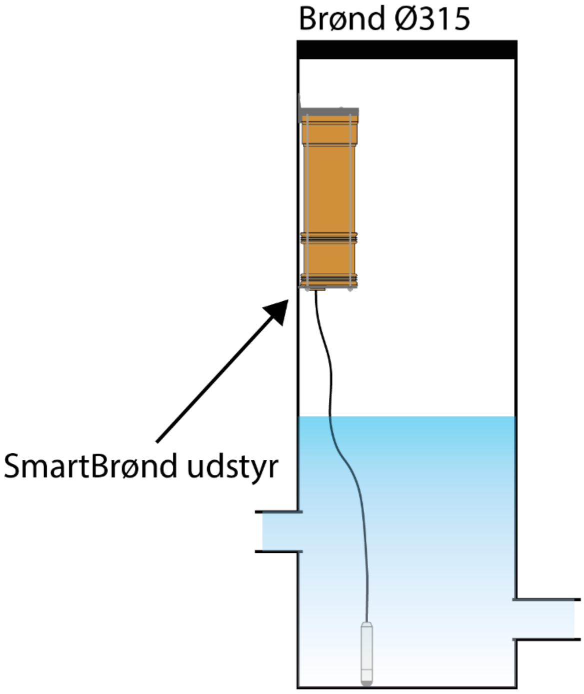
<table>
<tr><td></td><td></td><td>
</td></tr>
<tr><td></td><td>Description technical solution:</td><td>Description of Pressure set solution

Building the set-up with students at company site.
Installation of secure cover on existing 315 well.
A hole is drilled in the cover frame and well and bolted through this is sealed with " foam" from the outside. Pressure cover is bolted to frame.
315 PVC well is dug to install the smart well sensor system. The well must be connected to the existing sewer system.


Work in progress

Final result of the installation of the sensor and installation of the secure cover.</td></tr>
</table>

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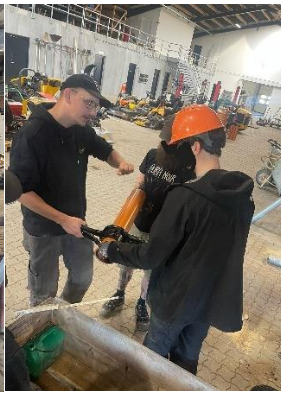
		 Down pipe in the machine-hall is made with tight joints from the ground up to 2,5 m. Transitions can be established as socket joints.   Outlet from a secure system, carried out with a 110 mm PVC pipe up through the stone pile. Before 90 g foot bend, a branch pipe must be made which is connected to a 32 mm drain which must lie at the bottom of the wadi.   Outlet well, raised to a level that is 5 cm below the lowest point in the rain bed. A boulder "structure" is built around the well. Possibly build into a wall across the rain garden.  

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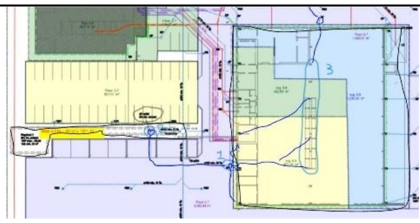
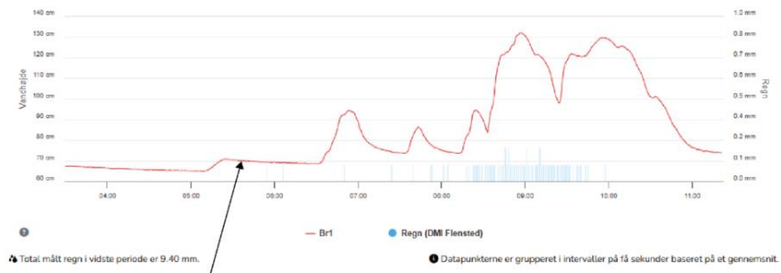
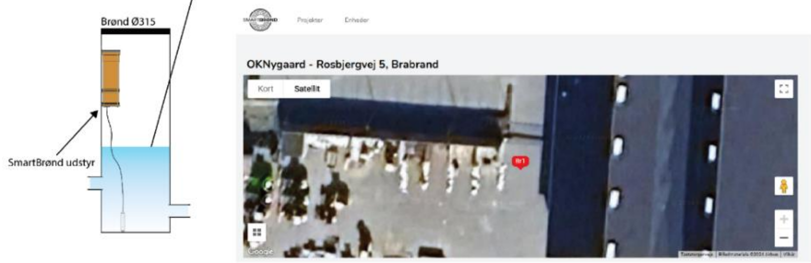
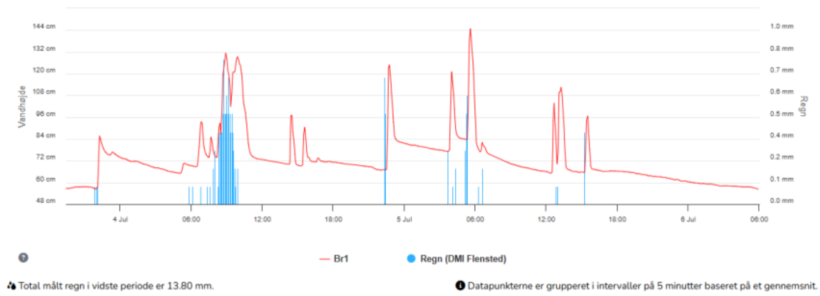
		
	Measurement tools used	SmartBrønd's measuring equipment monitors water levels, and their dashboard provides access to rainfall data.
	Monitoring results:	
Process	Ingredients:	Materials and equipment include 1 pressurized well developed in the project, 5 new pressurized roof downspouts of 8 meters length using known components, and a constructed well with known materials, which has been equipped with 1 pressure and 1 flowmeter, both developed and tested within the project.
	Step by step instructions:	Building the pressurized rainwater system and implementing the sensor **Video explaining pressurized gutters:** **https://www.youtube.com/watch?v=Sv8FgzIbiAc** **Installation and Replacement of a Pressurized Manhole Cover** Start by gathering all necessary materials: the new cover frame, bolts, manhole foam, and tools including a drill and wrench.

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		Remove the old manhole cover and identify any parts that need to be reused or disposed of properly. Prepare the new cover by drilling holes in the cover frame and the manhole itself. Apply manhole foam around the bolts to ensure a tight seal. Next, position the new cover and bolt it securely to the frame, ensuring all bolts are tightened properly and the cover is correctly positioned. For the installation of the Smart Well sensor system, dig and prepare the site for the 315 PVC well. Connect the Smart Well sensor system to the existing sewer system and ensure the backfilling is packed tightly to prevent future settling. Finally, review the completed installation with the students, test the system to ensure proper functionality, and upload all quality assurance documentation to the inspection system. **Video explaining installation and replacement of a pressurized manhole cover and the installation of the Smart well sensor:** https://www.youtube.com/watch?v=TFEdWzHs7gY **Establishing an Outlet for a Pressurized System** Begin by gathering the required materials: 110 mm PVC pipe, a 90° foot bend, 32 mm drainage pipe, connectors, and stones. Measure and cut the 110 mm PVC pipe to the required length. Connect the branch pipe to the existing sewer pipe and attach the 32 mm drainage pipe, laying it along the bottom of the wadi. Install the 90° foot bend after the branch pipe, directing it approximately 90 degrees up the wadi, and ensure the seal and correct angle. Build the stone pile around the outlet pipe to distribute water and prevent erosion, making sure the stones are interlocked for stability. Review the installed system and test the water flow to ensure proper distribution. **Video explaining how to build an outlet for pressurized rainwater systems:** https://www.youtube.com/watch?v=NcDlqmjFx-8 **Replacing Downspout Pipes with Tight Joints** First, gather all safety gear including helmets, harnesses, and gloves. Ensure all safety gear is worn before ascending the scaffolding or lift. Set up the scaffolding and adjust the lift properly and ascend safely by holding onto the railing and moving methodically. Remove the old downspout pipes, handling tools safely at height. Install the new pipes with tight muff joints, ensuring each joint is sealed properly. Finally, review the completed work and conduct a water test to check for leaks.

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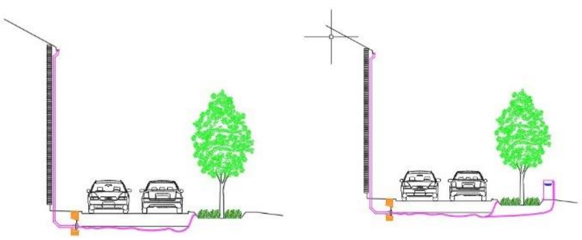
		Building an Outlet Well with Boulder Structure Gather the necessary materials: the outlet well, boulders, soil, plants, tools, and safety equipment. Elevate the well to the desired level and secure its position. Place the boulders around the well to build the structure, ensuring stability and leaving space for soil between the boulders. Add soil between the boulders and plant vegetation with robust root systems. Finally, review the completed work, test drainage efficiency, and assess the stability of the structure. **Video explaining how to build an outlet well with boulder structure:** https://www.youtube.com/watch?v=DKiZdZjZGug
Learning outcomes	Learning outcomes	• Be able to identify and analyze complex problems and develop innovative ideas and solutions. • Be able to work effectively in teams, share responsibilities and to contribute to common goals through collaboration and communication. • Identify and understand the basic principles of the design and function of pressurized LAR systems. • Understanding methods to accurately measure and record data from pressurized LAR systems. • Analyze and interpret collected data to assess the system's efficiency and identify potential areas for improvement. • Design and propose optimizations for pressurized LAR systems based on analyzed data and applied research. • Collaborate in teams to install pressurized LAR systems. • Students will be able to use SmartBrønd's measuring equipment to monitor water levels and utilize the dashboard to access and interpret rainfall data.
	Comments, lessons learned, Other info	The learning outcomes supports the development of technical skills as well as personal skills, which are essential for landscapers working with modern climate adaptations and environmental technologies.
	Further photos	The initial solutions from the Hackathon:  Students, teachers and experts working and learning together:

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Beneficial opportunities for company/start-up: SmartBrønd		Participation has increased SmartBrønd’s visibility and created positive attention in the industry. We have contributed to the development of new, sustainable technologies that enhance our competitiveness. The project has developed our skills and provided us with access to new knowledge. We have strengthened our network and opened up new collaboration and business opportunities
Potential implementation in the market		Participation has strengthened SmartBrønd’s product and competitiveness in the market. Through dialogue with educational institutions, for example, we have communicated our message to future landscape gardeners who will carry out climate adaptation projects. This has ensured that our innovative solutions and technologies are widely implemented. We have gained greater visibility and positive attention, which can attract new customers and partners. Our engagement in the project has also improved our reputation as a responsible and sustainable company.

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Case 2 Details – Spain: Vegetated roof garden

Recipe name: Monitoring biodiversity in a roof garden in Valencia, Spain

Organization	School:	EFA La Malvesia	Company/Partner:	PAIMED	Start-up: FaunaPhotonics	March 13th - October, 2024
	Other partners involved:	Not applicable				
	Financial budget:	Materials and equipment - 100 sqm roof garden				

Hand Labour	Hour	Gardener manager	20.58 €
Hand Labour	H	Gardener	10.22 €
Materials	m²	Root resistant layer QRF-500	7.37 €
Materials	m²	Protection geotextile GTW-300	3.56 €
Materials	m²	Drainage layer PR-DRAIN-25	16.81€
Materials	m²	Filter geotextile GTF-150	2.87 €
Materials	m²	Substrate	12.1€
Materials	m²	Irrigation system	11.3 €
Materials	m²	Plants	44.3 €
Subtotal			*129,11€/sqm*

Sensors	Unit number	Cost
LR-MB-10 ESTACION BASE WIFI SOLEM INT.	1	238.78 €/ud
LR-IP-2 MODULO LORA 2 ESTACIONES+CAUDAL	1	239.75 €/ud
LR-MS4 MODULO SENSORES 4 IMPUTS-	2	271.36 €/ud (2ud)
-SOND-PLUVIO-01 PLUVIOMETRO SOLEM	1	69.33 €/ud (1ud)
NCFCR-10-CONTADOR 1" C/SENSOR IMPULSO	2	07.51 €/ud (2ud)
1-SOND-TEMP SENSOR TEMPERATURA PT100 SOLEM-	1	71.73 €/ud (1ud)
SOND-HUMD SENSOR HUMEDA VH400 SOLEM	2	203.20 €/ud (2ud)

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<table>
<tr>
<td rowspan="3"></td>
<td></td>
<td>
<table>
<tr><td>SENSOR PHAUNA PHOTONICS-</td><td>2</td><td>2.200 €/ud (2ud)</td></tr>
</table>
<table>
<tr><th>Items</th><th>Unit costs</th><th>Subtotal</th></tr>
<tr><td colspan="3">Green roof</td></tr>
<tr><td>Layers, substrate</td><td>129.11€/sqm</td><td>12,911.00 €</td></tr>
<tr><td colspan="3">Sensors</td></tr>
<tr><td>Temperature, humidity,</td><td></td><td>1,583.73 €</td></tr>
<tr><td colspan="3">Biodiversity cameras</td></tr>
<tr><td>FaunaPhotonics</td><td>2,200 €/unit</td><td>4,400 €</td></tr>
</table>
</td>
</tr>
<tr>
<td>Human resources</td>
<td>Time period devoted to their tasks
Installation
3 students, approximately, 20 hours in 3 visits to the company.
1 Paimed technical worker, 20 hours.
1 professional to supervise work, 3 hours.
Monitoring - Design thinking
Work at school with landscape design teacher in 2 sessions, 4 hours
Work at school with Paimed technician to understand sensors and data through monitoring, 2 hours
Work at roof garden - 2 days (4 hours each) with students to monitor vegetation, temperature and humidity sensors. Also, students filled out plant templates. 8 hours.
Work at roof garden - teacher and technical staff - 2 days, 3 people for 2 hours, in total 12 hours.</td>
</tr>
<tr>
<td>Materials and equipment</td>
<td>Listed in the financial budget</td>
</tr>
<tr>
<td rowspan="2">Location</td>
<td>Location:</td>
<td>PAIMED, 46240 Carlet, Valencia,
https://maps.app.goo.gl/GMSPnMtPJLzq7Z2Z6</td>
</tr>
<tr>
<td>Climate zone & conditions:</td>
<td>Zona B3
https://visor.gva.es/visor/?capas=spa_icv_viv_z_climaticas
https://productos.five.es/producto/zonificacion-climatica</td>
</tr>
<tr>
<td>Technical information</td>
<td>Technical / IT pre-</td>
<td>Students needed to get acquainted with the humidity and temperature sensors before the FaunaPhotonics sensors arrived.</td>
</tr>
</table>

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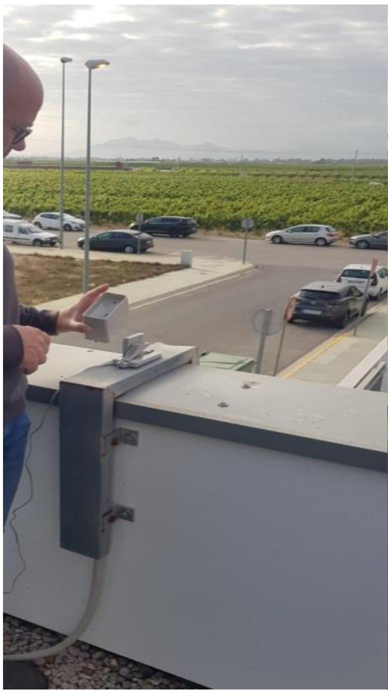
	skills needed	
	Technical solution:	Monitoring biodiversity through FaunaPhotonics sensors provides valuable data on various rooftop garden vegetation, benefiting both the company and students by enhancing their understanding of biodiversity's advantages.
	Description technical solution:	 *Photo 1*  *Photo 2* Sensors have been installed to measure temperature, humidity on both sides of the vegetated roof. One part of the roof was planted with turf and another part with herbaceous plants, perennial shrubs and ornamental grasses. Two very simple biodiversity cameras were installed until the FaunaPhotonics biodiversity cameras arrived in Valencia.
	Measurement tools used:	Sensor's characteristics:

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	SOLEM LR-IP
Referencia	LR-IP
Estaciones	1 / 2 / 4 / 6
Alimentación	Batería 9 V (6AM6 ó 6LR61)*
Compatibilidad	Con electroválvulas de 9 V
Estanqueidad	100 % estanco (IP68)
Control	A través de la plataforma Mysolem o de MySOLEM App
Comunicación	Bluetooth® Smart 4.0 Low Energy Radio LoRa™
Conexiones	A sensor de lluvia A válvula maestra A solenoide Latch 9 V
Distancia máxima del solenoide	30 m
Longitud	14 cm
Altura	9 cm
Profundidad	5,5 cm
Temperaturas de trabajo	De -20 °C a 60 °C
Memoria	No volátil (Copia de seguridad en caso de corte de energía < 30 s)
Precio	A consultar (precio sin IVA)

*No incluida

	SENSOR TEMPERATURA
Referencia	SOND-TEMP
Tipo	PT100 3 cables Clase B
Cubierta de portección	INOX 316 L
Comunicación	Cableado PVC
Longitud del cable	3 m
Colores del cableado	Naranja 1 con rojo LR-MS Naranja 2 con blanco LR-MS
Estanqueidad	100 % estanco
Longitud	10 cm
Diámetro	0,6 cm
Temperaturas de trabajo	De -40 °C a 105 °C
Precio	A consultar (precio sin IVA)

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PLUVIÓMETRO	
Referencia	SOND-PLUVIO-01
Señal de salida	Contacto seco
Estanqueidad	100 % estanco
Comunicación	Cableado
Longitud del cable	80 cm
Colores del cableado	Rojo: conectado al cable amarillo de LR-MS Verde: conectado al cable negro de LR-MS
Longitud	13,5 cm
Altura	8 cm
Profundidad	6 cm
Precio	A consultar (precio sin IVA)

SOLEM LR-MS	
Referencia	LR-MS
Estaciones	1 / 4
Alimentación	Batería 9 V (6AM6 ó 6LR61)*
Compatibilidad	Con sensor de caudal de impulsos
Estanqueidad	100 % estanco (IP68)
Control	A través de la plataforma Mysolem o de MySOLEM App
Comunicación	Bluetooth® Smart 4.0 Low Energy Radio LoRa™
Rango LoRa	800 m**
Conexiones	3 entradas de adquisición configurables: Contacto seco (sensor de lluvia, anemómet-ro,...) Impulso (caudalímetro, anemómetro,...) Analógico (0 - 3,5 V) (sensor de humedad, sensor de radiación solar, ...) 1 entrada de temperatura PT100 (excepto en el LR-MS1)
Distancia máxima al sensor	30 m
Longitud	14 cm
Altura	9 cm
Profundidad	5,5 cm
Temperaturas de trabajo	De -20 °C a 60 °C
Memoria	No volátil (Copia de seguridad en caso de corte de energía < 30 s)
Precio	A consultar (precio sin IVA)

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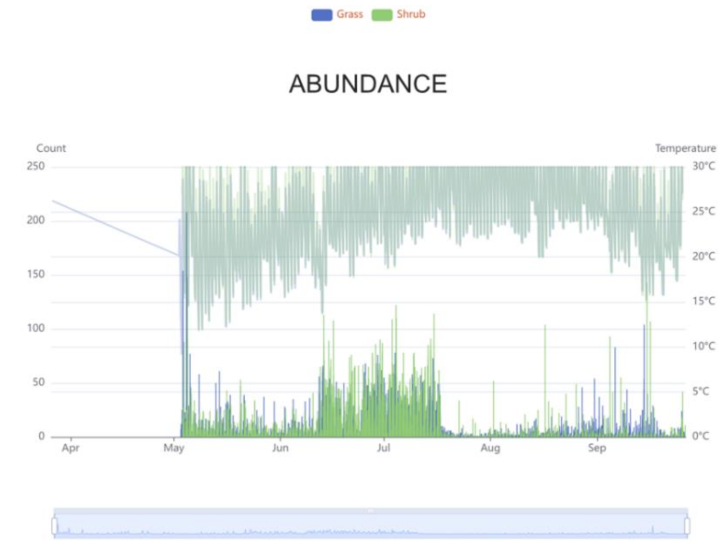
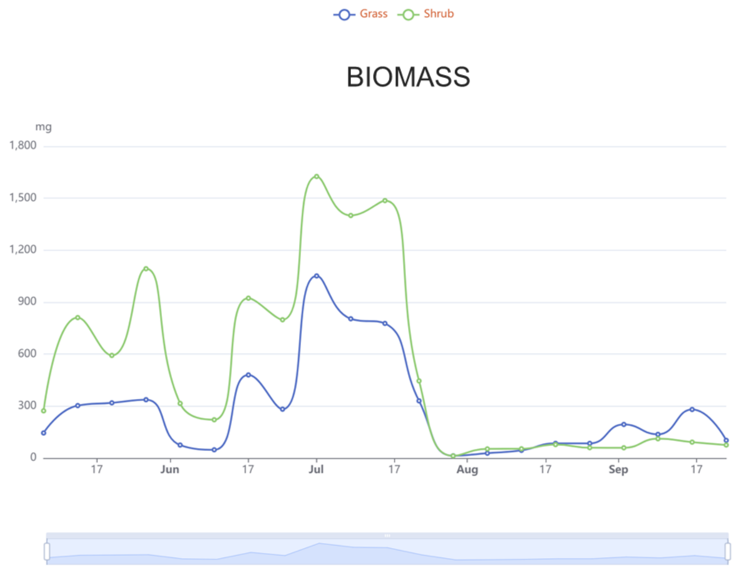
Monitoring results:





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		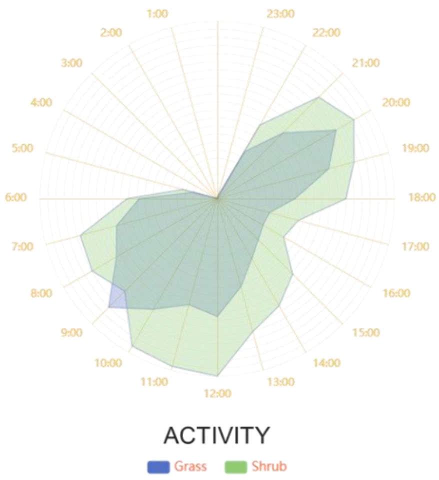
Process	Ingredients:	Roof garden Construction: Waterproofing layer: Waterproofing covers up the entire surface of the roof, taking special care of those singular points where manholes or any other structure is. This waterproof layer should have a special protection against roots. Drainage layer: Proper drainage is crucial for preventing water buildup and protecting your roof from potential damage. It helps to avoid structural issues, such as leaks and rot, and ensures that your roof garden remains in excellent condition. Together with the drainage layer it needs to be installed a geotextile that protects the waterproof layer and another one that separates the drainage layer from the substrate. Roof garden substrate: In the case of a roof garden, it is key to use a very light substrate to avoid increasing the weight of a building. The materials used include coco fiber, peat, volcanic gravel, silica sand and compost. Irrigation system: Installation of irrigation system together with flow meter and sensors. The drip lines have been installed 30 cm spaced with integrated drippers 2,2 l/h spaced 30 cm. In this pilot case 10 cm of substrate have been installed. Planting: The pilot case has two different sections. The first one will be planted with a mix of shrubs to promote biodiversity. The other half of the roof garden will be planted with a high drought resistant turf, *Zoysia trinity*. Here is the selected plant list:

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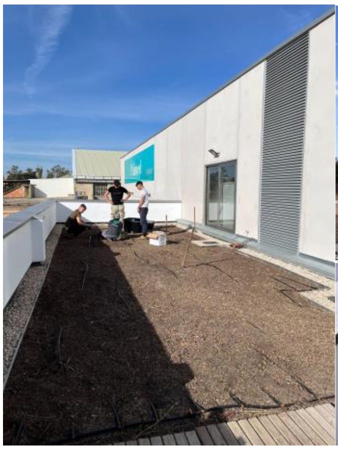
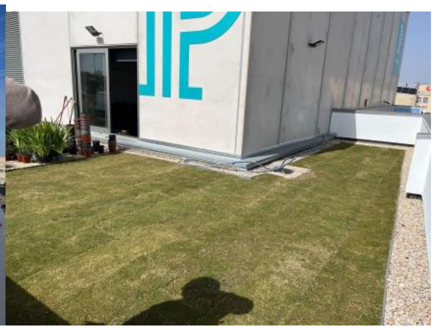
ESPECIE	SUPERFICIE TOTAL	PORCENTAJE	SUPERFICIE ESPECIE	DENSIDAD	UNIDADES
tagetes lemonii	50	12,00%	6	11	66
myrtus communis var tarentina		8,00%	4	11	44
salvia chamaedryoides		9,00%	4,5	11	50
achillea millefolium "Cerise Queen"		16,00%	8	11	88
Festuca mairei		3,00%	1,5	11	17
Carex Testacea		5,00%	2,5	11	28
allium sphaerocephalon		9,00%	4,5	11	50
aristea ecklonii		11,00%	5,5	11	61
kniphofia caulescensm		7,00%	3,5	11	39
verbena rigida		11,00%	5,5	11	61
achillea tomentosa		3,00%	1,5	11	17
crocus sativus		5,00%	2,5	11	28

Step by step instructions




Step 1 - Brief Description – different protection and drainage layers are installed, as well as Substrate medium for the selected plants to generate biodiversity. The drip irrigation is also installed in both parts of the garden (March 2024)

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Here we can see the turf area before and after installation. Drip line irrigation is also installed, not sprinklers or diffusers (March 2024).

April 2024 – 2nd session – monitoring vegetation's growth and conditions

April 2024 – 2nd session – sensors installation

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		 *September 2024 – 3rd session – roof and sensors monitoring*
Learning outcomes	Learning outcomes	• To interpret gardening projects, analysing their parts to plan and organize the work to be done. • To characterize the material and human resources, assessing their suitability to plan and supervise activities related to landscaping and the production of plants and agricultural products. • To select and handle tools and machines, relating them to the operation that will be carried out, to supervise and carry out work at height in conditions of quality and safety. • To make decisions in a well-founded manner, analysing the variables involved, integrating knowledge from different areas and accepting the risks and the possibility of mistakes in these, to face and resolve different situations, problems or contingencies. • To develop leadership, motivation, supervision and communication techniques in group work contexts, to facilitate the organization and coordination of work teams.
	Comments, lessons learned, Other info	Coordination between school and a company is crucial for the implementation and monitoring of the pilot project. There are two entities with different goals, rhythms and internal structure. In terms of monitoring the water consumption, we learnt that we need to improve the water flow meter system. That was one of the amendments we already made. Implementation of new varieties takes more time and observation that a regular roof garden with the plants that usually are used.

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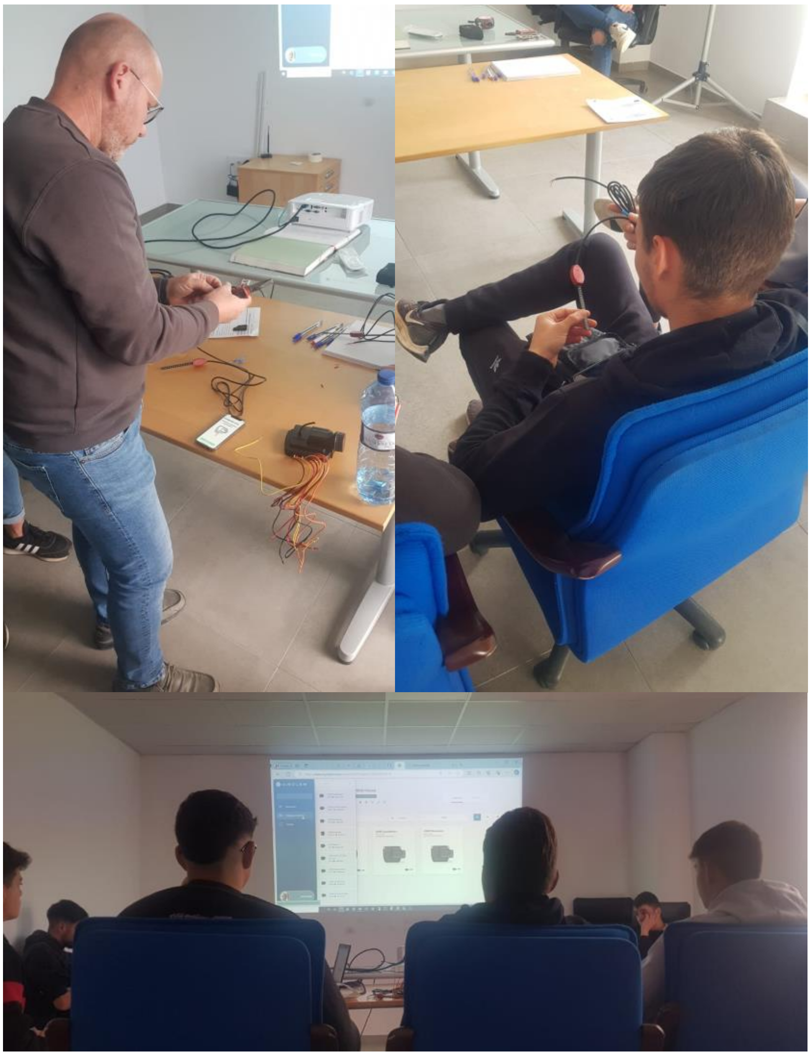
		It has been a very positive experience, from the company point of view, to be able to get measures and data about what exactly is happening in a roof garden.
	Further photos	 *April 2024 – 2nd session – sensors and dashboard workshop*
Beneficial opportunities for company/start-up		Opportunity to learn about contents we need to explore as new services and products, to innovate through a school.
Potential implementation in the market		The start-up FaunaPhotonics is already developing the biodiversity cameras to implement in the market

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Case 3 Details – The Netherlands: Minibosk

Recipe name: Minibosk

Organization	School:	Aeres Leeuwarden	Company/Partner:	Municipality of Leeuwarden	Start-up:	---
	Other partners involved:	CIV water				
	Financial budget:	Not applicable				
	Human resources:	• Professional worker (Municipality of Leeuwarden) total 6 hours • Teachers, 10 weeks, 1,5 day a week (total 8 hours) Students are largely working independently. Standard about 2 hours per week coach conversation with the group and on request from the group if they encounter problems. • Students (3) 10 weeks for 1,5 day a week. During this period, there were a number of cancellations due to other activities or days off. • Students visited the Drielanden Trees company in Nunspeet(NL) to get advice on caring for trees in containers. They had an interview with the owner (2 hours)				
	Materials and equipment	Not applicable				
Location	Location:	Leeuwarden				
	Climate zone & conditions:	Temperate maritime climate. The climate in Leeuwarden is warm but temperate. There is no dry season, and it is wet all year round in Leeuwarden. Even the driest month has a lot of rain. According to the Köppen-Geiger climate classification, this particular weather pattern is classified as belonging to the Cfb category. The average temperature in Leeuwarden is 10.3°C. The average annual rainfall amounts to 851 mm.				

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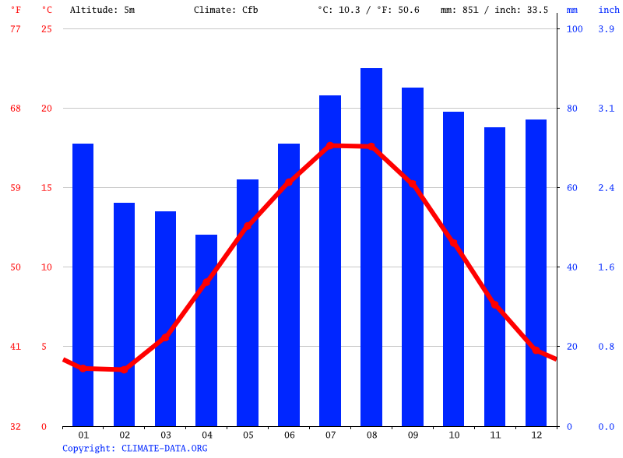
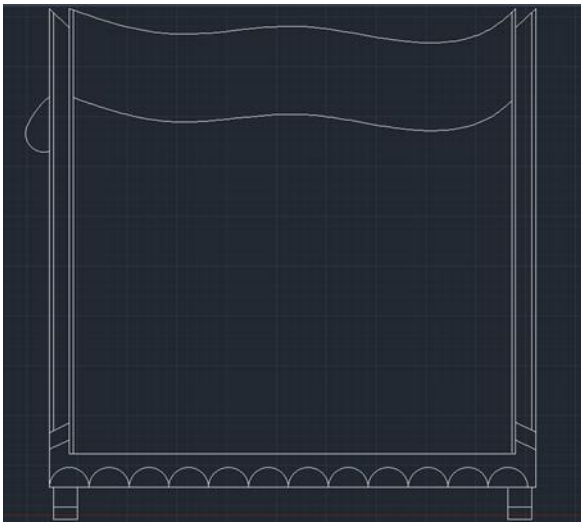
		 Source: https://nl.climate-data.org/europa/koninkrijk-der-nederlanden/friesland/leeuwarden-2100/#climate-graph
Technical information	Technical / IT pre-skills needed:	Working with Microsoft Office (Word, PowerPoint), searching information online. Need knowledge of operation and connecting sensors for follow-up research.
	Technical solution:	

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	Description technical solution:)	The students have come up with a concept for a tree bin that would be self-sustaining (with the help of local residents). The bins would have a preliminary size of 120x120x90 cm, which would give a capacity of 1,3 cubic meters. This is enough space for the trees we want to plant. On the sides of the trough, you will see openings leading to a reservoir below. This is connected to the soil above, and a layer of rock wool helps the water to reach the roots. The tubs are also connected to a system of residents' water fences around the tubs. A coupling connects these, and a small pump is used to pump the water to the tree in extreme drought conditions; the paragraph below provides an additional explanation of the involvement of local residents. The pumps and reservoirs may require maintenance after 5 to 10 years when the pumps are replaced or if the pumps fail. The tanks are designed to be easily moved with a forklift truck, allowing them to be moved to different neighborhoods and connected to different water networks. A sensor is placed in the root ball of the tree so that it can measure the moisture content of the tree. This allows you to see if the tree is dehydrated or not, and if it is, the water reservoir in the container has to be refilled. An average tree needs 10 liters of water per day, which is 70 liters of water per week. To properly monitor when a tree needs water, a sensor is placed in the tree's root ball. This sensor detects when the tree needs water and sends it to an app that local residents have on their phones. That app can be used to see exactly when the tree needs water and what can be done to best care for it. There will also be a QR code on the bins, with this code you can see what kind of tree it is,

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		for example. The residents will also get a water fence in their garden. The water fence will be used to provide extra water for the trees and will collect rainwater from the roofs to be used later on the trees. Residents can choose their own fences, and they are easy to install. You have to look at the area and the garden to see how many of these blocks can be placed. Residents can then connect these themselves when the tree needs water through a tap at the bottom of the fence. The fence is divided into blocks, each block holds 165 liters of water, so 8 of these blocks make 1320 liters of water. For plant nutrition, water gel pellets mixed with long-acting coated fertilizer pellets were chosen. These pellets are suitable can last a year and deliver nutrition to the tree for a year. To continue this research, the students recommend involving students of students from the green education program, as they know more about certain types of plants and trees that would go well with the bins. We would also recommend further research into the bins by making some prototypes and placing them in a street. To see what the residents think of the bins and to see if the plants and trees grow well in the tree boxes. Before the prototypes can be placed, the neighborhood needs to be consulted to see if any residents are willing to help look after the tree boxes and keep an eye on them. They will also need to be asked if they would like to have a water fence or water barrel in their garden to connect to the boxes.
	Measurement tools used:	Not applicable
	Monitoring results:	Not applicable
Process	Ingredients:	Not applicable
	Step by step instructions:	Way of working in the environmental consulting firm (See annex I)
Learning outcomes	Learning outcomes :	• Students come up with original ideas. • Students can do a lot themselves, but also need teachers in a coaching role to take steps again.
	Comments, lessons learned, Other info:	• Students come up with original ideas • With classes dropping out from time to time, it was difficult at times to keep students in the flow. • Working with a real client motivates students
	Further photos	---

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Beneficial opportunities for company/start-up	The municipality does not have to employ its own staff to water bins. The city can be greened without putting plants in the ground.
Potential implementation in the market	Before the idea can be implemented, further research must be carried out.

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Case 4 Details – The Netherlands: Monitoring system

Recipe name: Monitoring system for data-driven green management

Organization	School:	Yuverta Houten, HAS hogeschool Den Bosch	Company/ Partner:	Koninklijke Ginkel Groep	Start-up:	Consortium Dashboarding Greenroofs (HWT, Optigrun, De Enk)
	Other partners involved:	HAS Green Academy De Enk Groen & Golf HWT Hemelwatertechniek WaterPRO Optigrün Benelux Terralytics				
	Financial budget:	€27.500				
	Human resources (professional workers, students, teachers, etc.)	Students: 3 Project lead: 1 Workers: 3 Teachers: 2 Stakeholders/clients: 6 Technical expert: 1				
	Materials and equipment	Yuverta Houten: • 10x Dragino LSE01 LoRaWAN Soil Moisture & EC sensor €899,50 ex. • 1x Sencecap S2120 8-in-1 LoRaWAN Weather Sensor €299,00 ex. • 1x Sencecap S2103 LoraWAN CO2, Temp. & Humidity Sensor €129,00 ex. • 1x Dragino LPS8N LoRaWAN Gateway €139,95 ex. Testcase Koninklijke Ginkel Groep Veenendaal: • 1x Dragino LSE01 LoRaWAN Soil Moisture & EC sensor €89,95 ex. • 1x Sencecap S2120 8-in-1 LoRaWAN Weather Sensor €299,00 ex. • 1x Sencecap S2103 LoraWAN CO2, Temp. & Humidity Sensor €129,00 ex. • 1x Dragino LPS8N LoRaWAN Gateway €139,95 ex. • 1x LoRa Fiberglass Outdoor Antenna with RP-SMA cable €47,19 ex. Prototype: • 1x LCD screen • 1x PLC system				

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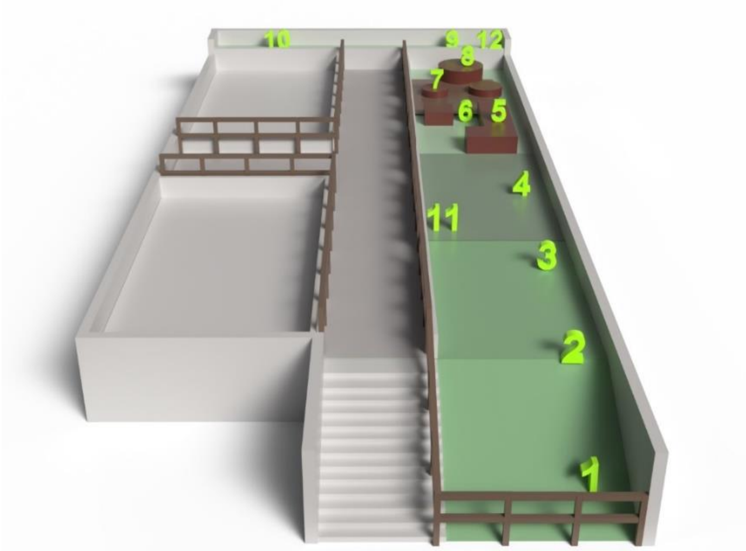
		• 1x Wenglor UMD402U035 Distance Sensor • 1x data transmission system • 1x steel frame • 2x substrate types • Different plant species
Location	Location:	Development dashboard: Koninklijke Ginkel Groep Veenendaal Research location: Training-roof at Yuverta Houten Picture 1: Yuverta Training-roof sensor locations 
	Climate zone & conditions:	Temperate maritime climate zone with mild summers (17-22°C) and cool winters (0-6°C), featuring year-round rainfall of about 700-900 mm and high humidity.
Technical information	Technical / IT pre-skills needed:	Knowledge of: • Data processing (ETL-proces, Node-RED, Dataflow) • Database (PostgreSQL) • Connectivity (LoRa, HTTP, MQTT, TCP/IP) • Programming (HTML, Json, Python, CSS) • Dashboard (Grafana)
	Technical solution:	The system integrates various sensors to monitor: • Soil moisture and conductivity (Dragino LSE01 LoRaWAN) • Weather conditions (Sencecap 8-in-1 LoRaWAN weather station) • CO_2, temperature, and humidity (Sencecap S2103 sensor) The students installed and configured these sensors in a test setup. The data was transmitted via LoRaWAN gateways and processed through The Things Network (TTN) using Node-RED for data flow management. PostgreSQL was used for database management, and the data was visualized using Grafana dashboards.

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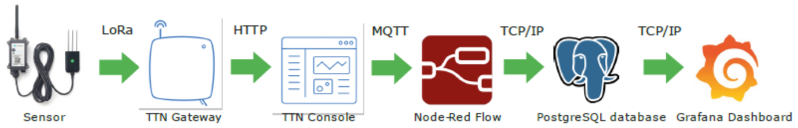
		1. Sensor Data Collection: The system gathers data on soil moisture, temperature, humidity, and CO_2 levels, crucial for managing green roofs. 2. System Scalability: The infrastructure can expand to other green roofs or urban green projects. 3. Real-time Monitoring: Provides real-time data visualization for effective green space management. 4. Data Insights: Enables efficient water management and plant health optimization, contributing to sustainability goals. 5. Tool Integration: Utilizes open-source tools like Node-RED, PostgreSQL, and Grafana for affordable and scalable IoT solutions.
	Description technical solution:	Picture 2: Dataflow from sensor to online visualization: 
	Measurement tools used:	No existed tool used, see technical solution for the specifically made data solution for Yuverta Houten.
	Monitoring results:	*Picture 3: Tem soil moisture sensors displaying the most recent soil moisture values divided over the Yuverta training roof.*  *Picture 4: Air temperature and light intensity compared to soil temperature.*

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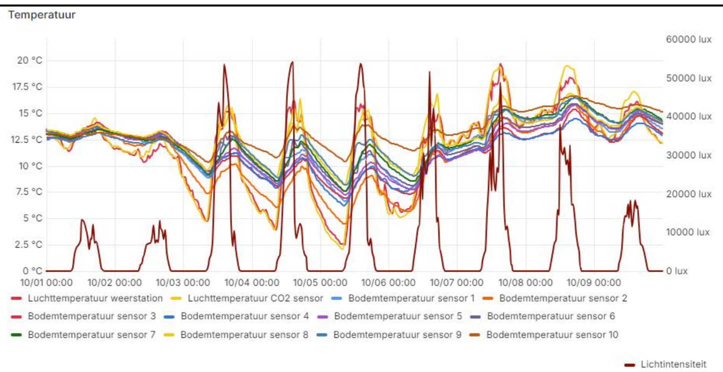
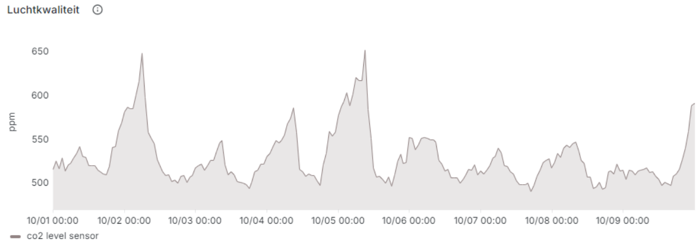
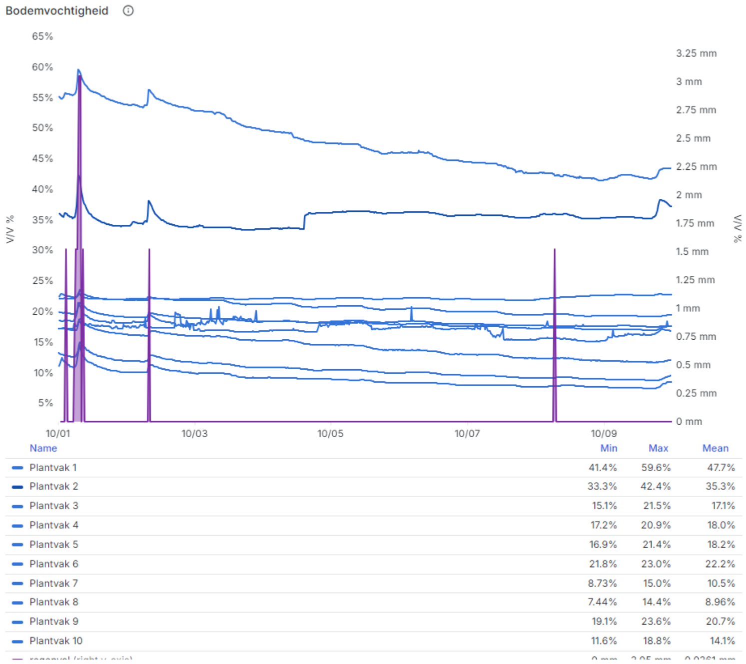


Picture 5: Outside air quality:



Picture 6: Ten soil moisture sensors in different soil types compared to rainfall



Process	Ingredients:	• 10x Dragino LSE01 LoRaWAN Soil Moisture & EC sensor (supplier Antratek) • 1x Sencecap S2120 8-in-1 LoRaWAN Weather Sensor (supplier Antratek) • 1x Sencecap S2103 LoraWAN CO2, Temp. & Humid Sensor (supplier Antratek)

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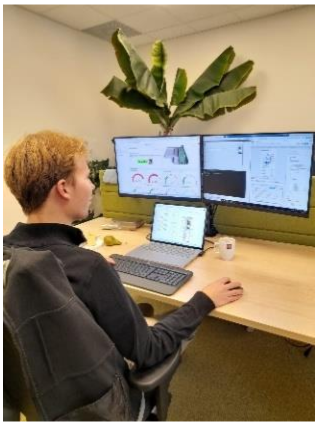
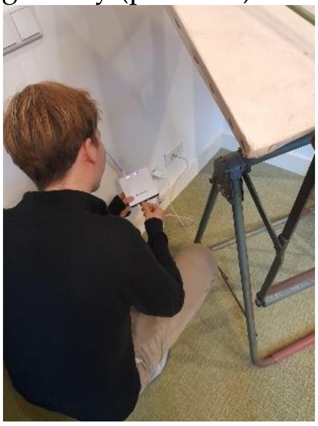
		• 1x Dragino LPS8N LoRaWAN Gateway (supplier Antratek) Prototype: • 1x LCD screen • 1x PLC system • 1x Wenglor UMD402U035 Distance Sensor • 1x data transmission system • 1x steel frame • 2x substrate types • Different plant species Terralytics (IT supplier) Database (postgresSQL) ETL tool (rednode) Cloud IOT (The Things Network) Dashboard tool (Grafana)
	Step by step instructions (photos, short videos and text explanation)	Step 1: Creating data collection and dashboarding (picture 7):  Step 2: installing the gateway (picture 8):  Step 3: installing sensors and the weatherstation (picture 9):

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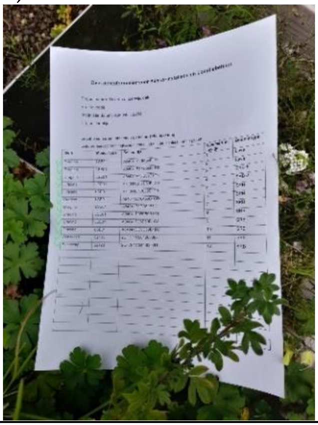
		 Step 4: connecting the sensors and the weather station to the dashboard (picture 10): 
Learning outcomes	Learning outcomes	Through the process of exploration, collaboration, and development during the hackathon and beyond, several key learning outcomes emerged: **1. The Importance of Cross-Disciplinary Collaboration** We learned that bringing together partners from different fields—technology, landscaping, water management, and education—enhances innovation. The collaboration between Optigrün, Hemelwatertechniek, and educational institutions like HAS Green Academy demonstrated that diverse expertise leads to more comprehensive and effective solutions. **2. Real-World Application of Vocational Education** By involving students in the actual development of the dashboard, we saw how Vocational Education and Training (VET) can be more deeply connected to real-world challenges. The students gained valuable hands-on experience, and we realized how integrating projects like this into education can strengthen the practical learning outcomes for future professionals. The project provided a practical learning environment where students applied theoretical knowledge to solve real industry problems. **3. The Power of Prototyping in Innovation**

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		The hackathon taught us the value of rapid prototyping. While the final product wasn't developed during the event, we established a strong foundation and clear direction. Prototyping allowed us to test ideas quickly, gather feedback, and iterate on the dashboard's design, showing us the importance of moving from concept to early-stage product as a way to drive innovation. **4. Scalability and Sustainability of Smart Technologies** The successful scaling of the smart roof dashboard beyond the hackathon to a real-life installation at the Yuverta Rooftop Garden underscored the value of building scalable solutions. We learned that sustainable technologies, when designed properly, can be adapted to larger, real-world contexts and offer long-term value. Furthermore, partnering with companies like Terralytics for continued support showed us the importance of collaboration for sustained growth. **5. The Role of Data and Monitoring in Operational Efficiency** We gained insights into the value of data collection, monitoring, and analysis in managing green infrastructure, such as smart roofs. The ability to track and manage KPIs through the dashboard showed us how technology can greatly improve operational efficiency, reduce costs, and enhance the quality and longevity of green roof systems. **6. Challenges of Building and Maintaining Consortia** Finally, we learned that building and maintaining a consortium of stakeholders requires clear communication, shared goals, and ongoing collaboration. Each member of the consortium had unique needs and expectations, and managing these relationships was crucial to the success of the project. This taught us the importance of fostering strong partnerships and ensuring each stakeholder's involvement is aligned with the overall project goals. These learning outcomes not only helped us improve the specific smart roof project but also provided broader lessons in innovation, teamwork, education, and sustainability that can be applied to future projects.
	Comments, lessons learned, Other info	The Pf curve of the different substrates is important to be able to set the range of when the moisture is good and when the soil is to wet or dry. Without the Pf curve you cannot read out the real value of the soil moisture. The gateway was placed in a room where we didn't have access to during the holiday period of the school. The power went off and we were not able to put it back on again. We learned from this that the location of the gateway should be always accessible to guarantee the data collection and not lose important data. We

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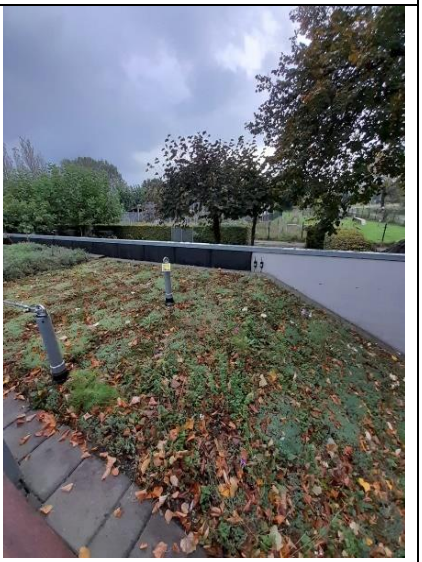
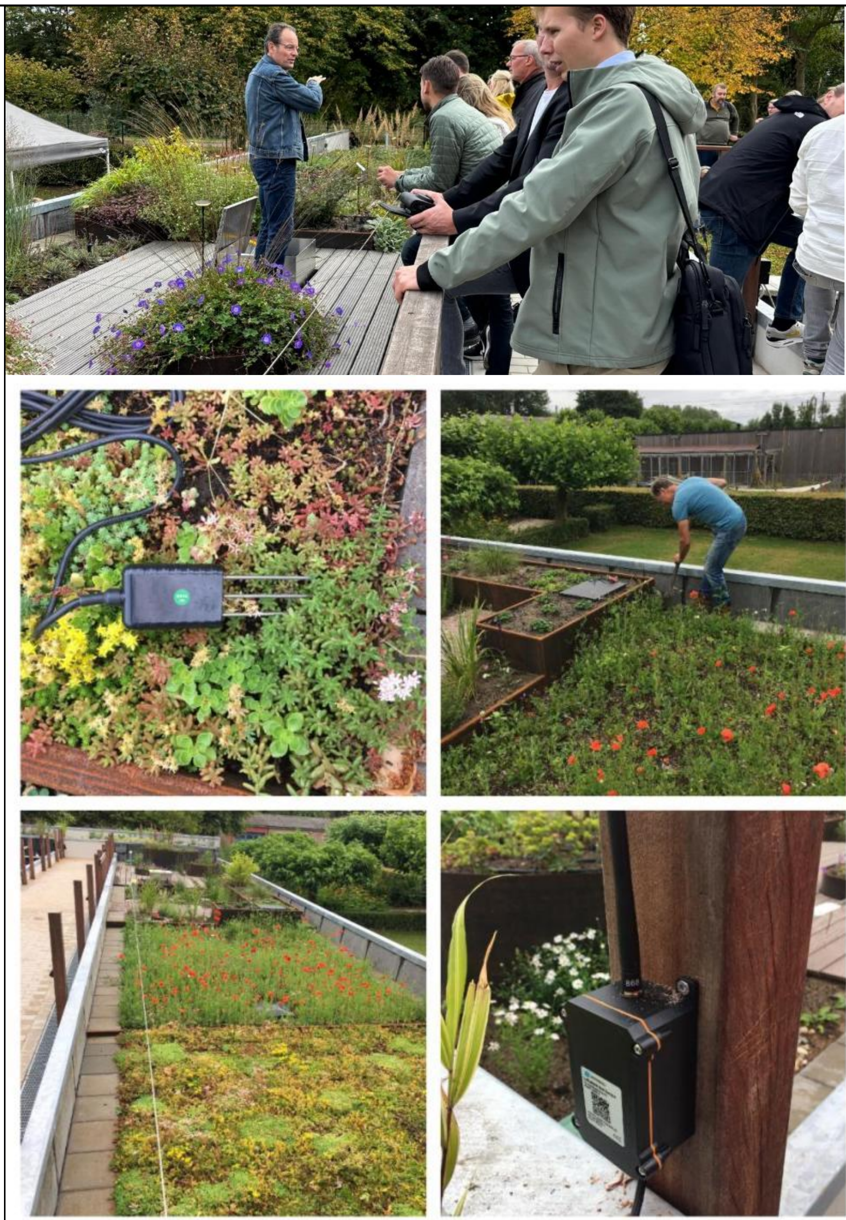
		also learned that during the power cut the other gateways in a range of 10km picked up the signals of the sensors and delivered the data to the dashboard.
	Further photos	 

		
Beneficial opportunities for company/start-up		**1. Operational Control on Rooftop Gardens** The smart roof dashboard allows the company to offer a service that improves operational control over rooftop gardens. This system provides real-time data on factors such as water levels, plant health, and weather conditions, enabling property owners and facility managers to optimize the maintenance and performance of green roofs. The company can offer the following revenue-generating services: **2. Reduced Risk of Failure Costs** One of the primary benefits of the dashboard is its ability to reduce the risk of failure, which can translate into a clear financial advantage for both the company and its clients. Proactive monitoring and early detection of issues, such as irrigation problems, pest infestations, or structural vulnerabilities, help prevent costly repairs or total system failures.

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	3. New Revenue Streams through Premium Services The dashboard allows the company to offer higher-tier services that can create new revenue opportunities: Predictive Maintenance: Using data analytics, the company can predict potential issues before they occur and offer predictive maintenance services. Clients would pay a premium to ensure problems are resolved before they lead to costly damage. Performance Optimization Consulting: The dashboard can highlight opportunities for optimizing rooftop garden performance, such as energy savings, water usage efficiency, and overall sustainability. Offering consulting services based on these insights could generate additional revenue from clients looking to maximize the environmental and financial return on their green roof investments.
Potential implementation in the market	The dashboard can be implemented at any rooftop garden, but potentially also in Green Facades or regular green on ground level. Any owner of soil and vegetation could be interested in the dashboard, and also any landscaper working professionally could benefit from it.

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Annexes

Annex I MiniBosk plan of action format

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AERES MBO

Milieu Adviesbureau (MAB)

Name of the project

Students' names

LOGO company

[Datum]

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Here comes information about the project's implementers, clients and supervisors

Executives
Name student 1 Email student 1
Name student 2 Email student 2
Name student 3 Email student 3
Name student 4 Email student 4

Principals
Name organization
Name client 1 Email client 1
Name client 2 Email client 2

Supervisors
Name supervisor 1 Email supervisor 1

Aeres MBO Leeuwarden
Water, Earth and Climate
Academic year

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Table of contents

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Introduction

In this section you briefly describe the background of the project and incorporate the information from the interview report. Who is the client, what does he do, what does he want done and why? Describe this in at least half an A4 sheet.

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Plan of Action

What follows is part of the plan of action (PoA). In the PoA you describe the following:

- Description of conversation with the client. (see next page)
- Description of the organization. (½ A4)
    - What do they do, when founded, how many people work there
- Description of research on topic. Show that you have studied in depth (minimum 2 A4, in consultation with supervisor)
- The project should be able to be divided into main and sub-questions. (in consultation with supervisor)
- Objective and final product
- Structure of research. What are you going to do? And in what way? (minimum 1 A4, in consultation with supervisor)
    - If you are going to take samples, do so according to a protocol. Describe this.
- (Preliminary) planning of the activities (see schedule, in consultation with supervisor)

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Interview report(s) with client

Shortly after you are assigned to a group, you will have a conversation with the client. In this conversation you will introduce yourself and find out exactly what it is the client wants from you.

In this box, describe the client's information. Who is he/she? On behalf of what company or organization? What does the company do? Contact information:

What should you start doing? What is the background of his problem? What needs to be delivered in the end?

What can you expect from each other? What agreements do you make ?

The client should expect you to: You should expect the client to

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What are the options for a field trip at the company/organization?

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Organisation

Describe here the organization behind the client.

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Background

In preparation for the pitch and the executive part, you will delve into the background of the project. The idea is that over the next 10 weeks you will become experts, so to speak, on the topic your project is about.

In this section, you will describe the background. Look for what is known about the problem, what possible solutions are there? What is out there? Remember to put your used sources in the bibliography according to APA!

TIPS:

- Ask (other) teachers if you can't figure it out

- Within the course there are also a lot of books on different topics

- Search on YouTube for videos

- Ask fellow students if you can't figure it out

In the final Pitch you give in week 3, summarize all the information you have and present it to the class. You can also use this pitch to solicit class input, who knows, there may be creative ideas from classmates!

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Objective and final product

What is the ultimate goal of the project and what final product will you deliver? What field trips are planned?

Main and sub-questions

Summarize the research into main and sub-questions.

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Activities and planning

For the projects you have the whole period. In the table below, make a schedule for each week. What will you do, when will you do it and how will you do it. Take into account travel times, already completed activities, days that are cancelled due to study days or holidays and describe the materials you will need.

wk	date	day	phase	Activities
1		MO		
		THU		
2		MO		
		THU		
3		MO		
		THU		
4		MO		
		THU		
5		MO		
		THU		
6		MO		
		THU		
7		MO		
		THU		
8		MO		
		THU		
9		MO		
		THU		
10		MO		
		THU		

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Method of operation

How did you guys end up working? What did you do and how?

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Results

Describe the results of your work here. Note! Only a factual account of the results belongs here, you should not draw any conclusions yet.

Example: You are doing research for a nature organization on the biodiversity of beetles in a certain area. You have found 3 very rare beetles that have not been observed in the Netherlands since 1876 and say something about major ecological changes in the area. Very special! But also, in such a case you only write down that you found those rare beetles and that they are rare. Only at the conclusion do you describe what all that says for this area.

In other words, no interpretation of what you found. Just a concise, clear representation of what you found. Possibly supported by graphs and tables.

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Conclusion (or advise)

What exactly do your results say? Link this to the main and sub-questions you created earlier and answer the questions with your found results.

Discussion

What have you done that could affect the results?

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Bibliography

The current paper has no sources.

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Assessment criteria

LAY-OUT		Present
1	Page Numbering	
2	Use of headings, paragraphs	
3	Providing images, graphs and tables with lower- or upper-case lettering	
4	APA citation of sources	
5	Calibri font, font size 12pt	
6	Spelling, capitalization, space usage	
7	Cover page with title, names, date, client and supervisor	

STRUCTURE REPORT		Present
8	Table of contents has correct reference to chapters and pages	
9	Introduction is present	
10	Methodology - - Clear description of protocols and materials	
11	Results - - What did the work produce? - - Clear presentation of results (graphs)	
12	Conclusion - - Main and sub-questions have been answered based on results	
13	Discussion	

All 13 items must be present

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The End

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