SUSTaiN

AI-enhanced Vocational Education for a Sustainable Future

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Case Study Compendium

Co-funded by the European Union

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Introduction

The following case studies have been developed as part of the SUSTaiN project's WP2 objective to illustrate how Artificial Intelligence (AI) can be practically and sustainably applied **across key vocational sectors - agriculture, water management, energy, and transport.**

These examples showcase real-world innovations where AI has been used to address sector-specific challenges while advancing environmental and operational sustainability. By focusing on problem-solving, technological intervention, and measurable outcomes, the case studies aim to inspire and equip VET educators with sector-relevant insights that can be brought into the classroom. Each case follows a structured format - Problem, Intervention, and Outcome—making them accessible, adaptable, and ready to support AI literacy and sustainability integration in vocational education and training.

The selection of the four thematic areas—agriculture, water management, energy, and transport—was guided by the professional backgrounds, expertise, and sectoral focus of the SUSTaiN project partners. Each partner brought in-depth knowledge and existing networks within one or more of these fields, enabling the consortium to identify relevant, high-impact use cases that reflect both current industry needs and educational priorities. This alignment ensures that the case studies are not only representative of emerging AI trends but are also grounded in the real-world contexts familiar to VET institutions across Europe. By leveraging the consortium's sectoral diversity, the case studies provide a rich, cross-disciplinary resource that bridges innovation with vocational relevance.

Case Study Compendium

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AGRICULTURE

MooMonitor+:

AI-Driven Dairy Cow Monitoring by Dairymaster

Country: Ireland

Problem

Dairy farming requires continuous monitoring of cow health and reproductive status to maintain productivity and animal welfare. Traditionally, farmers relied on visual observation and manual tracking, which were time-consuming, labour-intensive, and often inaccurate in detecting early signs of oestrus (heat) or illness. Missing these indicators resulted in reduced fertility rates, longer calving intervals, lower milk production, and increased veterinary costs due to delayed treatment of health issues. Additionally, optimising feed intake and rumination was difficult without a precise method of tracking individual cow behaviour.

To address these challenges, there was a need for a technology-driven solution that could provide real-time, automated monitoring of cow behaviour and health, allowing farmers to make informed decisions that improve herd performance, reduce labour costs, and enhance overall farm sustainability.

Dairymaster, an Irish dairy technology company, recognised this need and developed MooMonitor+, an AI-powered system designed to track cow behaviour in real time and provide actionable insights for farmers.

Intervention

MooMonitor+ is a wearable AI-driven sensor that is attached to a cow's neck, designed to analyse various behavioural patterns such as feeding, resting, rumination, activity levels, and overall health indicators. Unlike traditional pedometer-based heat detection systems, MooMonitor+ utilises advanced AI algorithms to process real-time data and detect subtle behavioural changes that may indicate oestrus, stress, illness, or discomfort. The device continuously transmits data to a cloud-based platform, where machine learning models analyse trends and patterns. Farmers can access these insights through a mobile app or desktop interface, receiving instant alerts when a cow requires attention.

The AI system helps detect optimal insemination times, ensuring better reproductive success rates and reducing the need for hormone-based fertility treatments. It also identifies early signs of illness, allowing farmers to intervene before symptoms become severe, ultimately lowering veterinary costs and reducing cow mortality. Additionally, the integration of MooMonitor+ with farm management software enables automation of key processes, such as milk yield analysis, breeding decisions, and feed adjustments, making herd management more efficient. The platform also offers historical tracking and data visualisation, helping farmers recognise long-term trends and optimise herd performance. By providing real-time, AI-driven insights, MooMonitor+ significantly enhances decision-making in dairy farming while reducing reliance on manual monitoring.

Outcome

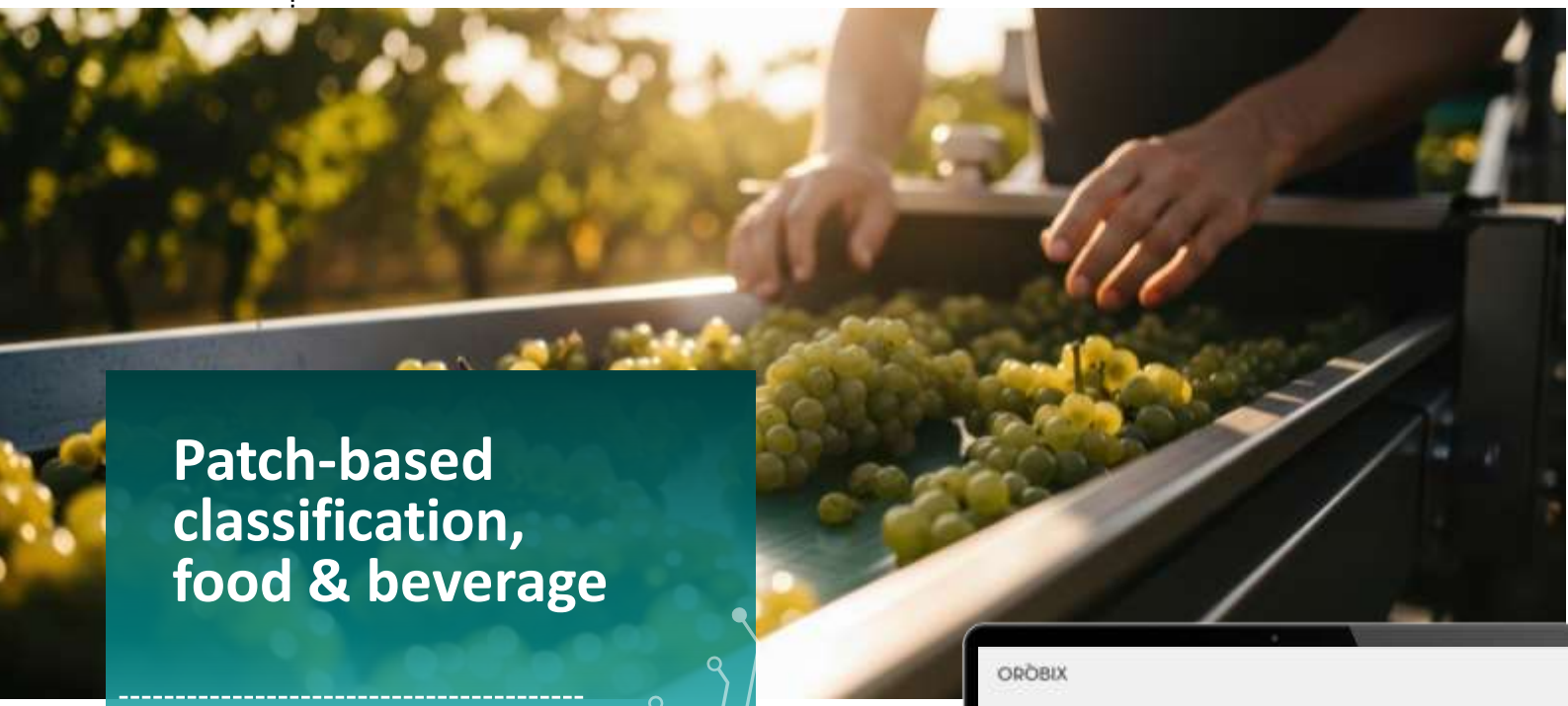
The deployment of MooMonitor+ has led to significant improvements in herd management, productivity, and sustainability. One of the most notable benefits is the increase in reproductive efficiency, with farms reporting a 30% rise in insemination success rates. The system's accurate heat detection has allowed farmers to reduce calving intervals, leading to higher milk production per lactation cycle and more efficient use of resources. Farmers using MooMonitor+ have also been able to reduce reliance on hormone-based treatments, aligning with sustainable dairy farming practices and improving consumer confidence in milk production.

In terms of health monitoring, MooMonitor+ has enabled early detection of illnesses such as ketosis, mastitis, and lameness, which can severely impact milk yield and overall herd productivity. The system's continuous tracking of rumination and feeding behaviour helps farmers identify digestion-related issues before they escalate, allowing for timely veterinary intervention and lower treatment costs. This proactive approach has resulted in lower mortality rates and improved cow longevity, reducing the need for premature culling. Additionally, labour efficiency has increased, as farmers can now save up to two hours per day by relying on AI-driven monitoring instead of manual herd observations.

The economic and environmental benefits of MooMonitor+ are also significant. Higher fertility rates, improved cow health, and optimised feeding routines have led to greater profitability for dairy farms. The system has also contributed to lower veterinary expenses by facilitating preventative care rather than reactive treatments. By reducing stress levels and ensuring low-intervention health management, MooMonitor+ promotes better animal welfare, allowing cows to live healthier, more productive lives.

As AI technology continues to evolve, Dairymaster is exploring further enhancements, such as predictive analytics, automated milking system integration, and real-time environmental monitoring, to create a fully AI-powered precision dairy farming ecosystem.

AGRICULTURE



Patch-based classification, food & beverage

Country: Italy

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Problem

In agriculture, changes in production and management are now essential due to the growing challenges posed by climate change, shrinking arable land, and increasing global water demand. Traditional farming practices are no longer sustainable, and companies in the grape-growing and wine production sector are under pressure to innovate by optimising resource use while maintaining quality and safety throughout the supply chain, from vineyard to consumer.

One of the key challenges in wine production is grape selection. Quality control of incoming grapes is typically performed manually by skilled operators, a process that is time-consuming and prone to errors due to the subjectivity of human judgement. To address this, there was a need to develop a system that could objectively assess the quality of grapes in storage boxes, serving as both an entry control checkpoint and a management tool for the raw material supply chain. Such a system would play a crucial role in product tracking, ensuring transparency and traceability from the vineyard to the final bottle.

By improving production efficiency and maintaining high-quality standards, it would offer significant benefits to producers. For wineries, this system represents a fundamental step towards enhancing traceability and optimising resource management, ultimately delivering a more consistent and high-quality product to consumers.

Intervention

Oròbix, a Bergamo-based company in Italy's Lombardy region, specialises in AI-driven solutions for the manufacturing sector. Leveraging its expertise, the company has adapted a deep learning system originally developed for manufacturing to enhance quality control in the wine supply chain. The AI model is trained to classify grapes by quality, becoming operational in just 30 minutes, after which it continuously refines its accuracy through learning.

The Lunelli Group, renowned for its Cantine Ferrari winery, was the first to implement this system, specifically for the production of Ferrari Trentodoc sparkling wine. Following its success, two other major wine producers have also adopted the technology, further integrating AI into the industry's quality assurance processes. The system employs Deep Learning techniques to conduct an initial assessment of grape quality, using automated image processing of top-down photographs of the grape boxes. The classification model works by dividing images into smaller 'patches', assigning each patch to a specific quality category, and then classifying the entire image accordingly.

Beyond classification, the system also identifies and highlights problem areas within the images, detecting issues such as foliage, downy mildew, rot, foreign material, or other forms of damage. This process generates a detailed quality map, indicating which sections of the grape boxes meet higher or lower quality standards.

A camera captures the images, which are then uploaded to AI-go Studio, a platform developed by Oròbix, where the deep learning process takes place. Within AI-go Studio, the images are used to train the classification model, allowing it to recognise and categorise grapes based on predefined quality classes set by the user. Using a set of customisable rules aligned with user-defined quality parameters, AI-go generates an overall classification for the grapes within each box. Once the model has been trained and validated, it is deployed in a production environment via AI-go Runtime, which enables real-time monitoring of model performance and accuracy. The system is also integrated with the customer's data collection platform, ensuring continuous optimisation and long-term reliability in grape quality assessment.

Outcome

Unlike many artificial intelligence systems that operate as black boxes, making it difficult to trace the decision-making process, Oròbix's system offers full transparency. Users can reconstruct the classification path, understand how the final result was obtained, and compare different classifications, ensuring a clear and interpretable process. According to Oròbix, the system introduces objectivity and efficiency into the evaluation of grape quality, aligning with the industry's need for end-to-end product control, from the vineyard to the bottle. Additionally, the system is designed to maintain and enhance quality standards, even in unpredictable conditions such as those caused by climate change and other external risk factors.

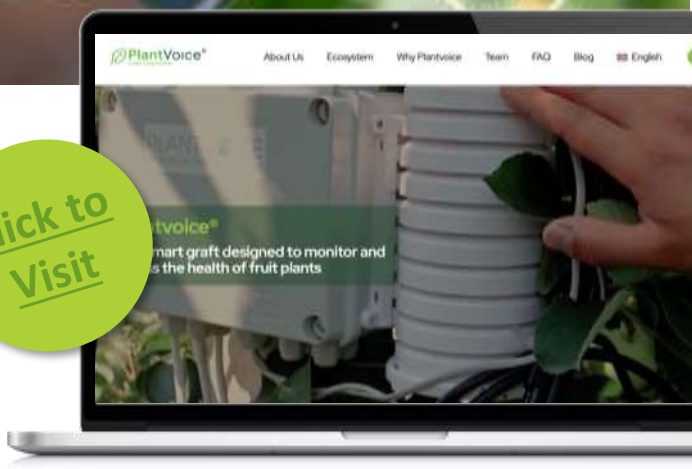
In an increasingly competitive and demanding market, this level of adaptability is essential for ensuring consistent product excellence.

Beyond its immediate benefits in quality control, the system also delivers cultural and technical advantages. By enhancing product knowledge and traceability, it fosters a continuous improvement mindset, drives cost reductions, and supports more sustainable production practices, contributing to the long-term resilience and innovation of the wine industry.

AGRICULTURE

Plantvoice

Country: Italy



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Problem

Across Italy, the declining health of fruit, olive, and wine-producing plants has become a significant concern. Many fruit trees suffer from disease and environmental stress, driven by multiple factors, including climatic changes, increased pest aggressiveness, the emergence of new pests linked to climate change, and improper agricultural practices. These challenges have had severe consequences on plant health, leading to reduced yields, lower product quality, and diminished sustainability in the agricultural sector.

One of the most well-known cases, recognised even at the European level, is the Xylella fastidiosa outbreak in Apulia, which has devastated olive groves, highlighting the urgency for innovative solutions in plant health monitoring and management. PLANTVOICE was developed as a concrete response to these challenges. Founded in Bolzano, Italy, by brothers Matteo and Tommaso Beccateli, PLANTVOICE is a startup dedicated to plant health monitoring.

With roots in Parma, Emilia-Romagna, a region renowned for its food and wine excellence, the founders chose to establish their company in Bolzano's tech hub, leveraging collaborations with industry leaders and university research centres to develop cutting-edge solutions for plant health management.

Intervention

PLANTVOICE is a revolutionary AI-powered solution that transforms how farmers monitor and manage plant health. Designed to be simple, affordable, and accessible, it ensures that even older and less tech-savvy farmers can easily adopt and benefit from its technology.

Acting as a virtual companion, it provides farmers with continuous support, helping them understand what is happening within their plants and enabling them to make informed decisions. Unlike many agricultural technologies that focus on broader environmental factors, PLANTVOICE is uniquely tailored to the direct needs of farmers by offering real-time insights into plant health.

PLANTVOICE enables continuous, real-time monitoring of a plant's health and stress levels. The system collects data through a biocompatible sensor, approximately the size of a toothpick, which is inserted directly into the stem of the plant. This sensor measures the flow and composition of sap in real-time, providing critical insights into plant physiology. The data is then transmitted to a cloud-based platform, where it is processed using artificial intelligence to assess the plant's overall condition.

Unlike traditional monitoring systems that rely on external environmental factors, PLANTVOICE focuses on internal plant stress indicators, providing direct and highly accurate measurements.

By utilising artificial intelligence, PLANTVOICE can detect the earliest signs of plant distress, allowing farmers and agronomists to identify problems and intervene in real-time. This proactive approach significantly improves crop health, optimises resource use, and enhances overall agricultural sustainability.

The AI analyses the collected data to identify specific stress factors, which may include:

- Insufficient water or nutrient levels
- Incorrect fertiliser application
- Improper irrigation
- Early-stage plant disease detection (even during the incubation phase)

Outcome

PLANTVOICE is currently in use across twenty farms, monitoring approximately 150 hectares of agricultural land. The data collected from farmers using the system has demonstrated significant improvements in resource efficiency and productivity.

Key benefits include:

- 40% reduction in water usage, optimising irrigation practices.
- 13% average reduction in fertiliser consumption, contributing to more sustainable farming.
- Lower production costs, as a result of optimised resource management.
- Increased yield and improved product quality, ensuring greater profitability for farmers.

A key advantage of PLANTVOICE is that farmers can directly monitor plant health using either a PC or a mobile app. The app is designed to be intuitive and user-friendly, operating on a traffic light system for quick interpretation of plant conditions:

Traffic Light System:

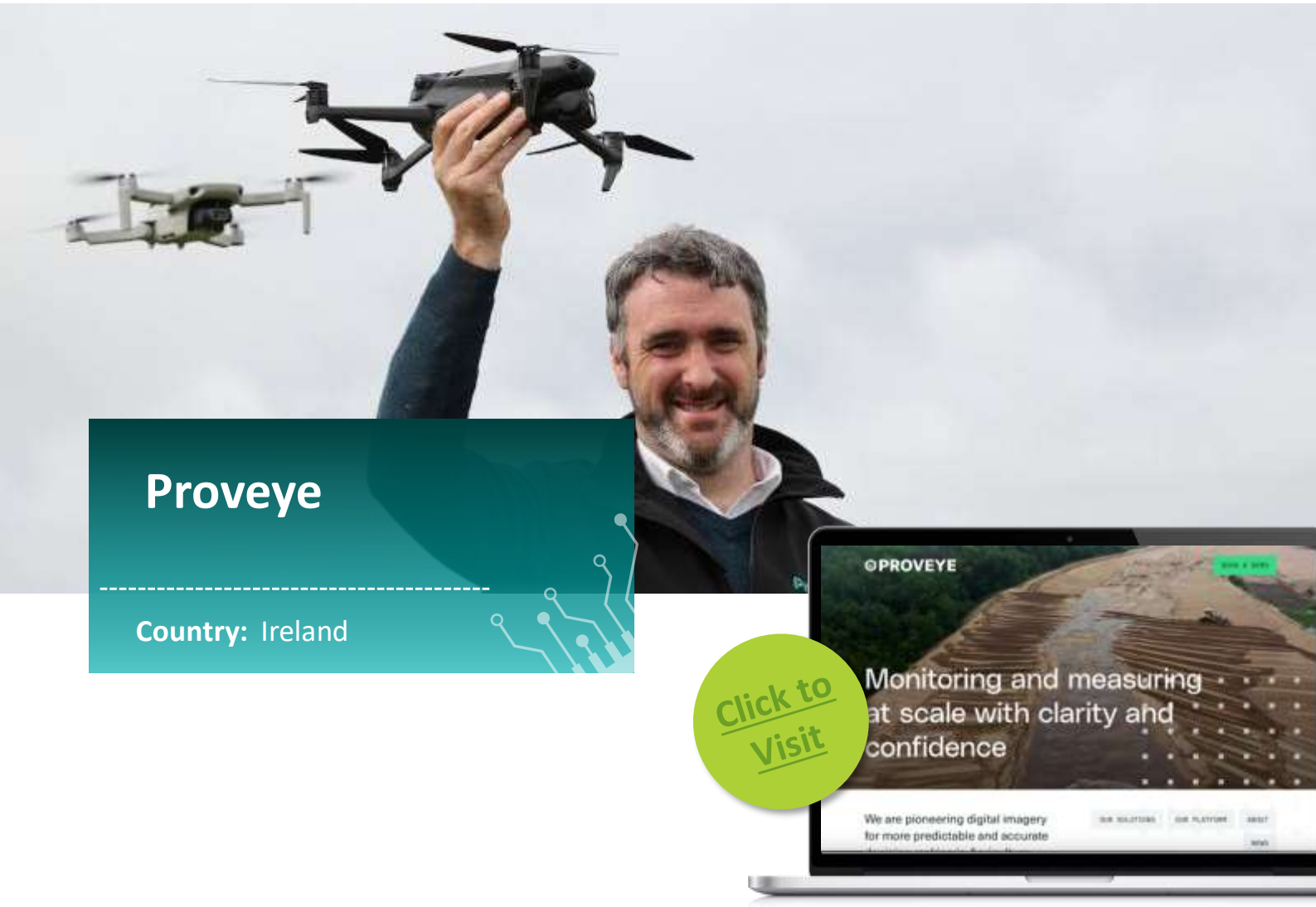
- **Green** Optimal health status, no action required.
- **Yellow** A potential issue has been detected in the incubation stage, allowing early intervention.
- **Red** A serious issue has been identified, requiring immediate action.

The system provides a detailed heat map, offering farmers clear, precise, and actionable insights by identifying:

- The exact nature and location of a problem within the field.
- The severity of the issue, enabling prioritisation of interventions.
- Who should take action, whether it be the farmer or an agronomist.
- Early-stage hazard detection, allowing for timely, cost-effective, and sustainable solutions.

PLANTVOICE helps farmers manage immediate plant health concerns and delivers long-term sustainability benefits. The system allows farmers to track production trends over time, ensuring better yield predictions and long-term crop health management. By integrating AI-driven monitoring with predictive insights, PLANTVOICE empowers farmers to preserve plant health, reduce costs, and optimise resources, creating a more sustainable and resilient agricultural sector.

AGRICULTURE



Proveye

Country: Ireland

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Problem

There has been a problem in the field of agriculture within Ireland, where it was difficult to access the quality of the land. It would take many man hours to physically explore the land, excavate and see what the soil was like and what the best use of each area would be. Image data has been available, but it was of very poor quality that did not help farmers in the long tun.

If there was an option to merge all of the relevant farming data together to develop a comprehensive report, it would enable the landowners to make decisions that would save them money and produce better results in the long term.

Proveye was the answer to this problem. It is a spin-off company from the University of Dublin School of Biosystems and Food Engineering. The software uses AI to achieve pioneering digital imagery for more predictable and accurate decision making in Agriculture, Nature and Industry.

Intervention

The company founders, Dr Jerome O'Connell, Professor Nick Holden, are from University College Dublin and have 30+ years of experience in the delivery of novel software solutions for the agriculture and natural resources sectors. ProvEye uses first-to-market intellectual property to process and analyse UAV and satellite imagery to obtain insights into the efficiency and sustainability of the agricultural industry. The software gives unprecedented accuracy in the measurement of crop yield, disease detection, productivity, and environmental impact from leaf to field to farm to the national scale.

Proveye provides a solution for improving productivity and sustainability in agricultural land management. It addresses key challenges such as:

01 Grassland Management:

By offering the world's most accurate remote grassland management platform, Proveye helps farmers manage grass-based food production more effectively. This includes optimizing productivity and ensuring sustainability through better monitoring.

02 Data Integration:

Proveye aggregates data from various sources like drones, satellites, and sensors, enabling comprehensive analysis and unique perspectives on agricultural land. This helps farmers make more informed decisions.

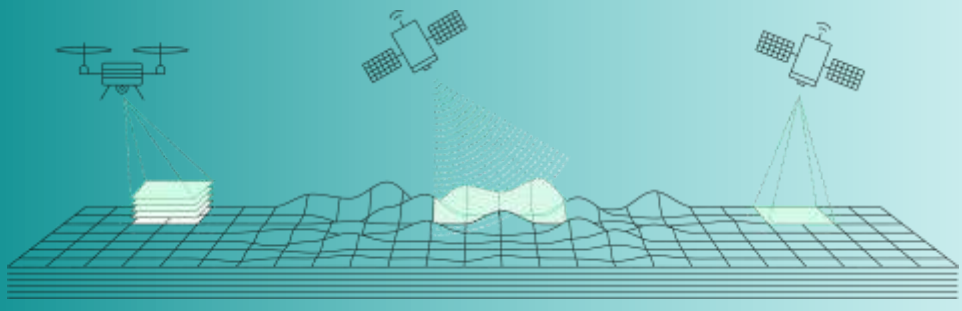
03 Sustainability Verification:

It helps verify the sustainability of agricultural practices, ensuring compliance with environmental standards and promoting long-term farming health.

04 Performance & Risk Monitoring:

Proveye continuously measures and monitors the performance and risks of large-scale, nature-based solutions, such as those involved in environmental and biodiversity conservation.

In essence, Proveye offers advanced technology and integrated data to improve the efficiency, profitability, and sustainability of farming operations, particularly in grass-based food production.



Outcome

Proveye can be used by agricultural advisors, fertilizer and pesticide suppliers, and food processors to deliver insights on productivity and sustainability in agricultural lands. It captures images through drones and satellites, integrating multiple image sources and AI models simultaneously. By combining data from various systems and sensor types, Proveye offers unique viewpoints at different scales, providing the most comprehensive overview possible.

Proveye addresses various challenges, including verifying sustainability and enhancing productivity in grass-based food production, as well as continuously monitoring the performance and risks of large-scale nature-based solutions.

Proveye can take the uncertainty out of agriculture and can save hours of manpower. The concept has already won numerous awards, including the 2022 Ornua Most Innovative AgTech Start-up. In 2023 Proveye won the Start-Up Innovator of the Year Award and the Ace Agritech Centre of Excellence Award at the Enterprise Ireland Innovation Arena awards.

Proveye for Grass is the flagship product designed for companies in the dairy and beef industry. It is the world's most precise and comprehensive remote grassland management platform.

The platform provides the first complete grass system analysis on the market by integrating three critical data streams: precision yield measurement, sward composition mapping, and biodiversity analysis.

This marks a significant advancement in data-driven grassland management, enabling more profitable farming.

WATER MANAGEMENT

AI analytics transforms water management in municipality of Lillestrøm

Country: Norway

Problem

Lillestrøm, a municipality in southeast Norway with 87,500 residents, is situated at the confluence of three major rivers - Glomma, Nitelva, and Leira - forming the largest inland delta in Northern Europe. While this location offers recreational opportunities, it also presents significant challenges in managing waterways, wastewater, and flood risks.

The municipality's water department already had systems in place to oversee potable water and wastewater flows. However, decision-making relied on weather forecasts and environmental data that were often fragmented, reactive, and imprecise. Manual processes meant that critical information often arrived too late to be useful, limiting the ability to take proactive measures.

Lillestrøm's challenge was not just effective water management but the lack of readily available, real-time data. Third-party organisations provided environmental insights, but these were costly, temporary, and had limited applications. Civil engineer Asgeir Hagen and enterprise architect Erlend Berg recognised the need for a continuous stream of live data to improve decision-making and resource allocation.

Intervention

In 2018, Lillestrøm adopted InfoTiles, an AI-powered analytics platform built on Microsoft Azure. This centralised solution aggregates real-time data from Internet of Things (IoT) sensors, SCADA systems, and environmental platforms, making previously siloed data accessible and actionable.

Key Features of the AI-Powered System;

01

Network Mapping:

Engineers mapped critical features in the water network, including temperature, flow rates, and pipeline conditions across three million metres of infrastructure

02

Predictive Maintenance:

Remote monitoring helps prioritise repairs by identifying pipes and pumps at risk of failure.

03

Automated Data Processing:

InfoTiles integrates multiple data sources, reducing reliance on costly, short-term data collection efforts

04

Traffic and Flooding Predictions:

The system incorporates traffic sensor data to assess the impact of floods on roadways, enabling proactive rerouting.

With these enhancements, Lillestrøm's water teams now receive continuous real-time updates, allowing them to anticipate issues, respond faster, and improve overall efficiency.

Outcome

By leveraging AI and real-time analytics, Lillestrøm has not only enhanced local water management but also contributed to global sustainability efforts. The municipality now feeds live data into the United for Smart Sustainable Cities (U4SSC) initiative, allowing it to benchmark its progress against international standards.

Lillestrøm's adoption of AI-driven water management sets a precedent for other municipalities, demonstrating how data intelligence, predictive analytics, and cloud-based solutions can drive smarter, more sustainable urban water systems.

The implementation of AI-driven water analytics has significantly improved efficiency, sustainability, and public safety in Lillestrøm.

01 Cost and Resource Efficiency

- Engineers can now detect leaks before they escalate, reducing financial losses. Fixing a single leaking pipe (500ml/second) prevents a monthly water loss of approximately €2,600.
- Norway's average water loss is 30-40%, making predictive analytics crucial for reducing unnecessary wastage.

02 Improved Public Safety and Flood Prevention

- Early flood warnings allow teams to take preventive action, minimising risks to people and property.
- Traffic rerouting based on predictive models prevents congestion and ensures emergency services can navigate affected areas.

03 Citizen Engagement and Accessibility

- Real-time water quality and bathing temperature updates are now available to residents via the municipality's website.
- Data-sharing capabilities have improved transparency and decision-making for both local authorities and the community.

WATER MANAGEMENT

Sustainable Water in Bengaluru

Country: India

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Problem

Bengaluru, a rapidly expanding city with an estimated 13 million residents by 2020, faces significant challenges in managing its water supply efficiently. The Bengaluru Water Supply and Sewerage Board (BWSSB) oversees nearly one million connections, catering to a diverse customer base across different neighbourhoods. Most of these connections rely on manually-read water meters of varying types and brands, making accurate billing and revenue recovery a persistent issue.

Like many large cities worldwide, Bengaluru grapples with water distribution inefficiencies. However, its challenges are further compounded by an intermittent supply system. Water losses fall into two broad categories:

Real losses, caused by physical leaks, overflows, and network inefficiencies. Apparent (commercial) losses, stemming from inaccuracies in meter readings, unregistered customers, incorrect billing, and properties misclassified in the tariff system.

Problem

Apparent losses also impact sewerage fees, which are linked to metered water consumption but are further influenced by factors such as borewell usage, property classification, and domestic or commercial status. Without addressing both real and apparent losses, long-term sustainability and financial viability remain at risk.

BWSSB faces a major challenge in detecting these losses. Manual meter readings introduce uncertainties—reduced consumption could be due to seasonal changes, reduced supply hours, faulty meters, or even fraud. Additionally, rapid urbanisation makes it difficult to track properties that have shifted from lower to higher tariff categories, such as single-family homes replaced by multi-unit apartment complexes.

To ensure fair and equitable water distribution while accurately recovering revenue, BWSSB urgently needs a solution that can identify and address apparent losses.

Intervention

In 2019, SUEZ India launched the DATACITY programme—the first of its kind in Asia—working alongside the Government of Karnataka, BWSSB, and innovation partner NUMA Bengaluru. DATACITY is an international open innovation initiative that develops data-driven solutions to tackle urban challenges.

Through co-creation workshops, BWSSB and SUEZ identified a key problem: *"How can BWSSB detect revenue losses, highlight opportunities to improve revenue generation, and maximise return on investment (ROI)?"*

Following a rigorous selection process, SmartTerra, a startup specialising in urban water management, was chosen to lead the pilot project. SmartTerra is developing an AI-powered operational intelligence platform to help water utilities transition from reactive to predictive, data-driven operations.

The startup has previously won a deployment grant from the Urban Drinking Water Challenge 2018 by ImagineH2O and is incubated at T-HUB in Hyderabad

SmartTerra's platform is designed to address key challenges at the intersection of water utilities and city infrastructure, focusing on:

- Identifying and reducing water distribution losses.
- Improving network health and efficiency.
- Enhancing data-driven decision-making for utilities.

Outcome

The pilot project was rolled out in D1A Zone, SUEZ's Operations & Maintenance (O&M) concession in central Bengaluru.

This zone is divided into 43 District Metered Areas (DMAs), covering approximately 90,000 connections.

These connections span nearly 40 classifications, including Domestic, Multi-House, and Non-Domestic.

To build an AI-powered detection system, the team analysed:

- Two years of monthly meter readings (Oct 2017 – Sept 2019) from BWSSB's Revenue, Billing & IT (RBIT) department.
- Connection attributes, including location, borewell presence, and meter type.
- Daily water supply data from SUEZ's SCADA department.
- Network maps and DMA boundaries to assess spatial trends.
- By leveraging AI and data analytics, the project aims to enhance BWSSB's ability to detect revenue losses, improve billing accuracy, and ensure a fair water distribution system for Bengaluru's residents.

TRANSPORT AND LOGISTICS

Automated racking systems - the future of logistics companies

Country: Bulgaria

Click to Visit

Problem

Efficient warehouse and logistics management is essential for modern supply chains, where businesses must handle high order volumes, fast deliveries, and real-time inventory tracking. Traditional warehouse management methods are labour-intensive, error-prone, and inefficient, leading to delays, stock losses, and increased operational costs. Automated warehouse solutions provide fast, accurate, and secure handling of goods while minimising human error and enhancing efficiency. These systems free operators from monotonous and physically demanding tasks, allowing them to focus on higher-value operations. Equipped with sophisticated management software, automated warehouses optimise material flow and streamline storage, retrieval, and distribution processes, making logistics more agile and sustainable.

With over 20 years of experience in the supply, installation, and maintenance of automated warehouse systems, Proinstall Ltd. firmly believes that automation is the key to successful logistics in the future.

Modern automated systems not only optimise warehouse processes but also improve efficiency, reliability, and flexibility across logistics operations. By reducing reliance on manual labour, enhancing inventory accuracy, and streamlining workflows, these solutions allow businesses to scale effectively, reduce costs, and operate more sustainably.

Intervention

To address these challenges, Proinstall Ltd. has implemented cutting-edge automated storage and retrieval systems (ASRS), integrated with advanced software and IoT (Internet of Things) connectivity to enhance warehouse efficiency. These systems use energy-efficient automation technologies to reduce power consumption and operational costs, contributing to more sustainable logistics operations. Automation has also improved staff safety, minimising direct human interaction with heavy goods, reducing workplace accidents, and creating a safer working environment. Warehouse management software (WMS) ensures real-time tracking of goods movement, allowing businesses to maintain high levels of accuracy, accountability, and compliance in stock management. By reducing product damage, misplacement, and storage errors, these systems significantly lower financial losses due to inventory mismanagement.

Faster and more precise order fulfilment leads to shorter delivery times, higher reliability, and improved customer service levels. Proinstall Ltd.'s automation systems are fully compatible with IoT devices, ERP platforms, and AI-driven analytics, allowing for seamless integration with digital supply chain management solutions. Automation not only reduces the need for manual labour but also minimises errors and optimises space usage, resulting in significant cost savings for businesses.

These warehouse automation solutions optimise both small and large-scale storage operations by leveraging robotics, AI-driven inventory management, and real-time monitoring, ensuring businesses achieve higher efficiency with lower environmental impact.

Outcome

The implementation of Proinstall Ltd.'s automated warehouse systems has led to substantial improvements in logistics efficiency, sustainability, and operational flexibility. Automated vertical storage systems maximise warehouse space by utilising building height, making them ideal for facilities with limited floor space while ensuring easy and fast access to stored goods. For warehouses handling small and medium-sized items, robotic mechanisms and conveyor systems provide fast, accurate access to inventory, reducing delays and optimising stock rotation. In large-scale storage facilities, palletised goods are managed efficiently through robotic storage and retrieval systems, allowing for better inventory turnover and improved order fulfilment rates.

With AI-powered tracking and automated retrieval, businesses have seen reduced incidents of misplaced, damaged, or lost inventory, leading to higher stock accuracy and lower financial risks. The use of energy-efficient automation has also helped businesses lower their carbon footprint, reduce waste, and transition towards greener supply chain practices. By combining automation, AI, and advanced storage solutions, Proinstall Ltd. is helping businesses modernise logistics operations, increase efficiency, and move towards a more sustainable and technologically advanced future for warehousing and supply chain management.

TRANSPORT AND LOGISTICS

New Generation Cargo Drones

Country: Bulgaria

Companies involved:

1. **The Institute of Mechanics at BAS**
2. **The Lifting Equipment Cluster**

Problem

The Institute of Mechanics at the Bulgarian Academy of Sciences (IMech-BAS) is leading a project to develop innovative, environmentally friendly materials for next-generation unmanned aerial systems (UAS), specifically cargo drones used in transport and logistics. Traditional cargo transport methods often rely on fossil fuel-powered vehicles, contributing to carbon emissions, high operational costs, and logistical inefficiencies.

The increasing demand for faster, more sustainable delivery solutions has created a need for lightweight, high-capacity drones capable of transporting goods with minimal environmental impact. However, existing drone technology faces limitations in lifting capacity, battery efficiency, and material durability.

This project, funded by the European Union's Next Generation EU instrument under the FPAP, aims to address these challenges by developing innovative materials and engineering solutions to improve cargo drone performance while promoting sustainability.

Intervention

The project's core objective is to develop next-generation cargo drones by incorporating lightweight, environmentally friendly composite materials and an advanced cargo lifting system. This includes:

- Establishing R&D facilities to conduct testing in a controlled demonstration environment, ensuring real-world applicability.
- Developing a new composite material tailored for drone-based logistics to enhance durability, weight efficiency, and environmental sustainability.
- Designing an innovative cargo lifting system, integrating a cargo bay and electric lifting mechanism into drone architecture for improved payload management.

A significant aspect of the project is the introduction of new composite materials specifically designed to increase drone lifting capacity while reducing energy consumption. The project prioritises lightweight construction to extend battery life, reduce energy use, and enhance operational efficiency.

Mathematical and software modelling play a key role in optimising material properties, aerodynamic performance, and energy efficiency. The research team is applying advanced simulations and AI-driven modelling to refine materials and structures before full-scale testing.

The project is also closely aligned with sustainability goals, ensuring that the materials and manufacturing processes used contribute to a circular economy, reducing waste and reliance on non-renewable resources.

Outcome

The development of next-generation cargo drones is set to revolutionise the transport and logistics sector by providing more efficient, sustainable, and cost-effective delivery solutions. The project has led to several key advancements:

01

Enhanced sustainability

The integration of eco-friendly composite materials significantly reduces the environmental impact of drone production and operation, supporting the transition to greener logistics.

02

Improved energy efficiency

The use of lightweight materials and optimised aerodynamics results in lower energy consumption, extended flight times, and reduced reliance on fossil fuels.

03

Increased payload capacity

The introduction of a new cargo lifting system enhances the lifting capabilities of drones, making them more viable for commercial and industrial applications.

04

Advancements in AI-driven modelling

The project demonstrates the potential of mathematical and software simulations in optimising material properties, aerodynamics, and structural performance, leading to more resilient and efficient drones.

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ENERGY

Predictive Maintenance in Wind Farms

Country: Norway

Companies involved:

1. **Nordex**

   A prominent wind turbine manufacturer that has integrated AI-driven predictive maintenance systems to optimize the performance and maintenance of their turbines.

2. **The Lifting Equipment Cluster**

   A prominent wind turbine manufacturer that has integrated AI-driven predictive maintenance systems to optimize the performance and maintenance of their turbines.

Problem

Wind energy plays a critical role in Norway's renewable energy strategy, contributing significantly to reducing carbon emissions and increasing energy independence. However, maintaining wind turbines presents a major challenge, as unexpected failures, harsh weather conditions, and high maintenance costs can lead to prolonged downtimes and reduced energy output. Traditional maintenance methods often rely on scheduled inspections or reactive repairs, which can result in inefficient resource allocation and higher operational costs. Given the growing importance of sustainability in the energy sector, there was a need for a more proactive and intelligent approach to turbine maintenance. Artificial intelligence (AI) offered a promising solution by enabling real-time monitoring and predictive analytics to anticipate potential issues before they escalate, ultimately improving the efficiency, reliability, and sustainability of wind energy production.

Intervention

To address these challenges, an AI-driven predictive maintenance system was developed and implemented by Nordex and Equinor. The system leverages data collected from advanced sensors installed on wind turbines, continuously monitoring key performance indicators such as vibration levels, temperature fluctuations, wind speed, blade movement, and component wear and tear.

Using machine learning algorithms, the system analyses historical and real-time data to detect patterns, anomalies, and early warning signs of potential failures. Instead of relying on fixed maintenance schedules, AI-driven insights allow operators to perform maintenance only when needed, preventing breakdowns while minimising unnecessary servicing.

The AI-powered system provides several key functionalities, including:

01 Early Fault Detection

Identifying minor issues before they develop into major failures.

02 Real-Time Monitoring

Continuously tracking turbine performance, even in remote offshore wind farms.

03 Automated Alerts

Notifying maintenance teams when anomalies or potential faults are detected.

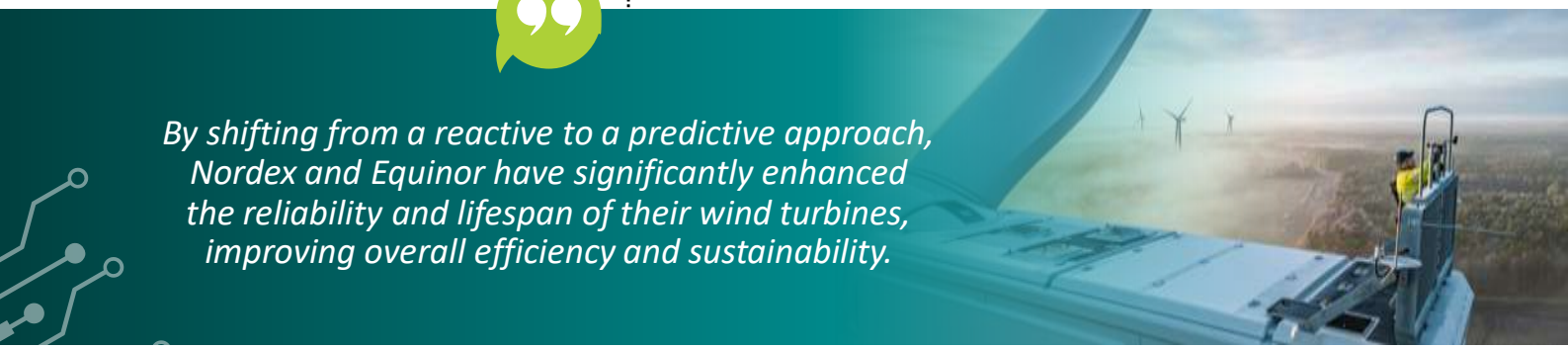
04 Optimised Resource Allocation

Ensuring maintenance efforts focus on turbines most at risk, reducing operational disruptions.

05 Integration with Digital Twins

Simulating turbine performance to test and refine predictive models.

By shifting from a reactive to a predictive approach, Nordex and Equinor have significantly enhanced the reliability and lifespan of their wind turbines, improving overall efficiency and sustainability.



Outcome

The implementation of AI-driven predictive maintenance has resulted in significant improvements in operational efficiency and sustainability in wind energy production. Key outcomes include:

- 25% reduction in maintenance costs, achieved by reducing unnecessary inspections and interventions.
- 40% increase in turbine operational efficiency, as fewer breakdowns mean longer uptime and higher energy output.
- Extended turbine lifespan, as proactive maintenance reduces wear and tear, delaying the need for major replacements.
- Lower carbon footprint, as fewer service trips (especially to offshore wind farms) mean reduced emissions from maintenance operations.
- Improved safety for maintenance crews, as AI helps predict and prevent failures, reducing the risk of working in hazardous conditions.

Beyond operational improvements, the success of this AI-driven maintenance system has been incorporated into Vocational Education and Training (VET) programs. By studying real-world applications of AI in the renewable energy sector, students gain valuable insights into the role of technology in improving energy sustainability. The case study has been used to demonstrate how AI can optimise renewable energy infrastructure, reduce costs, and support the global transition to greener energy solutions.

Furthermore, the integration of predictive maintenance into wind energy operations serves as a model for other renewable energy sectors, including solar and hydroelectric power, showcasing how AI can be applied across various sustainable energy initiatives. As AI continues to evolve, further refinements in predictive analytics and automation are expected to enhance efficiency and reliability even further, reinforcing the long-term viability of wind power as a key renewable energy source.

ENERGY

Smart Grid Optimization

Country: Norway

Companies involved:

1. **Statkraft**

   A leading renewable energy company in Norway that has implemented smart grid technologies to optimize energy distribution and integrate renewable sources.

2. **Elvia**

   This Norwegian grid company has utilized AI for smart grid management to enhance operational efficiency and reduce energy losses.

Problem

Norway's energy sector faces increasing challenges in electricity distribution efficiency and the growing demand for renewable energy integration. Traditional grid management systems struggle to accommodate the fluctuating supply of renewable energy sources such as wind and solar power. This leads to electricity wastage, increased operational costs, and inefficiencies in energy distribution. With sustainability at the core of energy transition efforts, there was a need for an intelligent system that could optimise grid performance, minimise energy losses, and ensure the seamless integration of renewable energy into the national grid.

Intervention

To address these challenges, an AI-driven smart grid solution was developed and implemented by Statkraft and Elvia. The system utilises machine learning algorithms to analyse real-time data from various grid components. By processing this data, the AI is able to predict energy demand patterns, dynamically manage energy loads, and optimise the integration of renewable energy sources.

The AI continuously monitors and adjusts electricity flow, ensuring that energy from wind and solar sources is efficiently distributed across the grid. This reduces overloading, prevents wastage, and improves the reliability of renewable energy supply. The system also allows grid operators to respond proactively to fluctuations in energy production and demand, ensuring a stable, cost-effective, and sustainable electricity network.

A key feature of the AI-driven solution is its predictive capabilities. By analysing historical and real-time grid data, the system can anticipate peak demand periods and adjust distribution accordingly, ensuring that energy is stored and deployed where it is needed most. Additionally, the AI can identify and mitigate grid faults before they escalate, reducing downtime and maintenance costs.

The implementation process involved several key steps:

- Integration of smart sensors across the grid to collect detailed performance data.
- Development of AI models capable of processing large datasets in real time.
- Automation of energy balancing processes, reducing human intervention and response times.
- Collaboration between Statkraft, Elvia, and energy regulators to ensure compliance with national energy policies.

By integrating smart automation and AI-driven decision-making, the system boosts efficiency while strengthening the grid's ability to handle rising energy demands and climate-related disruptions, ensuring a more stable and adaptable energy infrastructure for Norway.

Outcome

The implementation of this AI-driven smart grid has led to significant improvements in energy efficiency, operational cost savings, and sustainability. The system has achieved a 20% reduction in energy losses during electricity distribution and improved renewable energy integration by 30%. By making the grid more efficient and adaptable, the solution has lowered operational costs and enhanced the reliability of renewable energy sources, ensuring a more stable power supply for consumers.

Furthermore, the AI system has helped prevent blackouts and grid failures by predicting demand surges and automatically reallocating energy where it is most needed. The ability to detect potential system failures in advance has also resulted in a reduction in grid maintenance costs and emergency repairs.

From an environmental perspective, the smart grid system contributes to Norway's sustainability goals by maximising the use of clean energy sources and reducing dependence on fossil fuel-based backup power, aligning with the country's commitment to carbon neutrality and green energy transition.

Additionally, energy companies and grid operators can use insights from the AI system to develop more effective energy policies and investment strategies, ensuring that infrastructure improvements align with future energy demand and sustainability objectives.

The successful deployment of AI in Norway's smart grid serves as a model for other countries looking to modernise their energy distribution systems. With continuous advancements in AI and smart grid technology, further improvements in energy efficiency, cost reduction, and renewable energy utilisation are expected in the coming years.

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