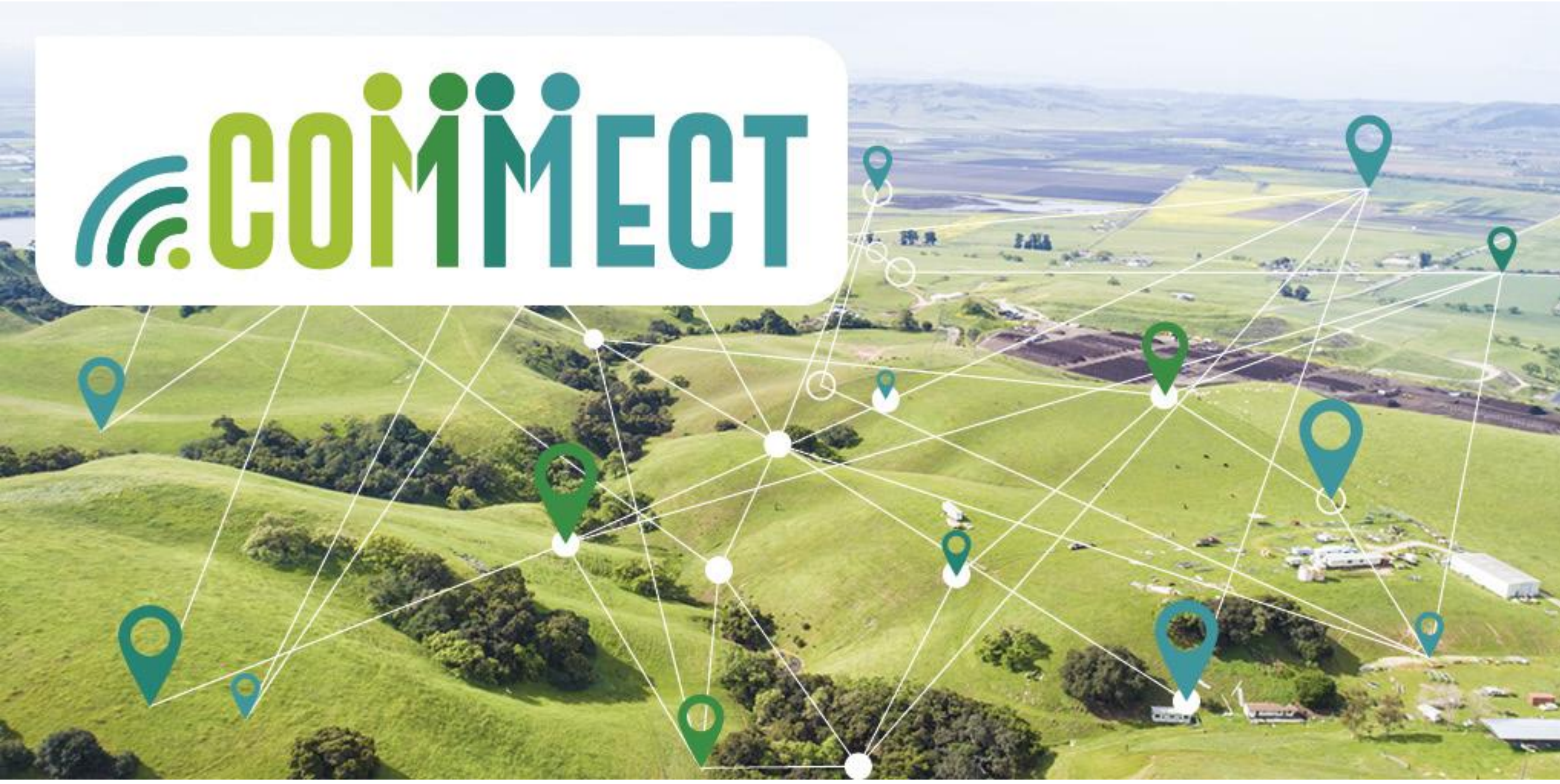
**Bridging the digital divide and addressing the need of Rural Communities with Cost-effective and Environmental-Friendly Connectivity Solutions**




# Deliverable 7.3

# Report on Strategic and Innovation Management version 1

**29.02.2024**

**PUBLIC**

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# COMMECT

## Bridging the digital divide and addressing the need of Rural Communities with Cost-effective and Environmental-Friendly Connectivity Solutions

**Grant agreement No. 101060881**

# Report on Strategic and Innovation Management version 1

WP7 Project Management

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## COMMECT Project Abstract

Over the last years, the importance and need for broadband and high-speed connectivity has constantly increased. The Covid-19 pandemic has even accelerated this process towards a more connected society. But this holds mainly true for urban communities. In Europe a 13% lack access persists, and mainly concerns the most rural and remote areas. Those are the most challenging to address since they are the least commercially attractive. COMMECT aims at **bridging the digital divide**, by providing quality, reliable, and secure access for all in rural and remote areas. The **goal of extending broadband connectivity in rural and remote areas** will be achieved by *integrating Non-Terrestrial Networks with terrestrial cellular XG networks, and low-cost Internet of Things (IoT). Artificial Intelligence, Edge and Network Automation will reduce energy consumption both at connectivity and computing level.*

**Participatory approach** with end-users and ICT experts working together on development challenges will be the key **for the digitalization of the sector**. To ensure the rich exchange of best-practice and technical knowledge among the actors of the agro-forest value chain, COMMECT will set up **five Living Labs across and outside Europe**, *where end-users "pain" and (connectivity) "gains" will be largely discussed, from different perspectives.*

COMMECT aims at contributing to a balanced territorial development of the EU's rural areas and their communities by making smart agriculture and forest service's accessible to all. COMMECT will facilitate that, by developing a **decision-making support tool** able to advise on the best connectivity solution, according to technical, socio-economic, and environmental considerations. This tool, incorporating collaborative business models, will be a *key enabler for jobs, business, and investment in rural areas, as well as for improving the quality of life in areas such as healthcare, education, e-government, among others.*

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## Executive Summary

The Report on Strategic and Innovation Management introduces background information on types of innovation. The report outlines some key components of the ecosystems for innovation in the Living Labs (LLs), such as the close collaboration between ICT experts, end-users and different stakeholders.  The report also summarizes the expectations from the European Commission (EC) in terms of securing impact during the project period and afterwards. COMMECT will follow the EC guidelines, toward maximizing the impact of the project results.

The deliverable leverages on the data collected in Work Package 1 (WP1), about end-users' needs, and describe how the proposed solutions in COMMECT relate to or improve current state-of-the-art solutions for end-users and use cases in the five LLs. The deployment plans for the solutions identified in deliverable D1.1 are described in deliverable D4.1. In this report we developed a scoring system for evaluating the level of innovation for the solutions proposed for the different use cases in the five LLs the scoring system takes into account the market and technology and scores it based on a combination of these. We also asked the LLs to evaluate each use case solution on the regular technological readiness level (TRL) scale. Most use cases are evaluated to be 4, meaning at a small-scale prototype level, or above indicating a good level of technological readiness for the solutions.

The report provides practical information on how to deal with Intellectual Property Rights (IPR) and what help can be obtained through the EU system such as Horizon IP Scan as well as how to deal with the strategic management of the project. Particular attention is given to the Decision-making Support Tool (DST), considered a key innovation of the project. Its goal is to help farmers and other stakeholders related to rural areas get answers and to assist them in their decision making within the industry they work in. The DST will provide information on connectivity solutions, business models and other insights from the COMMECT project.

This document, in combination with the deliverables on communication and dissemination (D6.3) and on standardization and exploitation (D6.4), constitutes the description of how the COMMECT project will valorize and secure impact of project results.

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## Glossary of Terms

| | |
|---|---|
| **AI** | Artificial Intelligence |
| **DST** | Decision Support Tool |
| **ETSI** | European Telecommunication Standards Institute |
| **eMTC** | Enhanced Machine Type Communication |
| **IP(R)** | Intelligent Property Rights |
| **LoRaWAN** | Long Range Wide Area Network |
| **LPWAN** | Low Power Wide Area Networks |
| **LLM** | Large Language Models |
| **LL** | Living Lab |
| **NB-IoT** | Narrow Broadband Internet of Things |
| **NTN** | Non-Terrestrial Networks |
| **ML** | Machine Learning |
| **MVP** | Minimum Viable Product |
| **PEFC** | Program for Endorsement of Forest Certification |
| **PoC** | Proof of Concept |
| **PN** | Private Networks |
| **SME** | Small Medium Sized Enterprises |
| **TTO** | Technology Transfer Office |
| **TRL** | Technology Readiness Level |
| **UAV** | Unmanned Aerial Vehicle |
| **WiFi** | Wireless Fidelity |
| **XG** | Next Generation |
| | |

# 1. Introduction

The objective of this deliverable is to describe the process of strategic and innovation management, adopted in the COMMECT project. This deliverable mainly focuses on describing the systems for which innovative ideas may be realized through the project or in the time after, based on the activities carried within the LLs. In this first version of the report, we present the end-user needs, proof of concepts and combine it with information of state-of-the-art.

To correctly understand how the strategic and innovation management in the project is being analysed there is a need to understand what is meant by innovation and how it will be interpreted in the context of this deliverable. In this deliverable we are providing an overview of the Technological Readiness Level (TRL) of each defined use case in the COMMECT project as well as highlighting the Decision-making Support Tool (DST) developed uniquely in this project for the selected stakeholders and end users.

## 1.1 Types of innovation

There are various types of innovation. In COMMECT and in particular in the Living Labs we use fast prototyping-testing-iteration approach: this means creating a prototype by updating it several times, consistently taking into consideration feedback from stakeholders and users. Based on this methodology we can view innovation from three perspectives [1]:

1. *Incremental innovation* refers to a gradual, continuous improvement on products or services that already exist. Hence the impact to the market would be considered low
2. *Radical innovation* is more along the lines of a breakthrough in an industry, and it will often lead to the establishment of a new market.
3. *Disruptive innovation* is when a market is disrupted from technology or a new business model [2]

There are different drivers and promoters for innovation, including:

1. Increased profit
2. Improved efficiency
3. Following rules and regulations
4. Competition [3]

When it comes to drivers and promoters in the Living Labs the various stakeholders will differ in terms of their drivers, regarding the innovation. As an example, the Norwegian Living Lab N. 2 – Connected forestry has multiple stakeholders but many of them especially the major stakeholders such as the Forest owner's association and the companies who employ the operators work within relatively small profit margins. There is very little room for delays or errors without it having a substantial impact. So, for these stakeholders the investment into innovation is driving strongly by not losing money and trying to generate more profit.

## 1.2 Ecosystem for Innovation in Living Labs

The idea of an innovation ecosystem is to bring together people or organisations whose goal is to innovate and:

- Include the links between resources, organisations, investors and policymakers.
- The actions supported by the European Innovation Ecosystems complement the actions carried out by the European Innovation Council (EIC) and the European Institute of Innovation and Technology (EIT), activities across Horizon Europe, initiatives at national, regional and local levels as well as private and third sector initiatives.

**Ecosystems for innovation in the Living Labs in general**

Although the ecosystems for innovation will vary to some degree in the five LLs considering that they all are taking place in different countries there are some innovation ecosystems that can be found in all of them:

- *Research institutions:*
  Research institutions play a pivotal role in innovation. Given the correct approach performing research is innovation. Through various initiatives in the differing countries researchers are being encouraged to work and collaborate with the business sector to boost innovation in society overall [4]

- *Industry clusters:*
  Harvard business review describes clusters as "*geographic concentrations of interconnected institutions in a particular field. Clusters encompass an array of linked industries and other entities important to competition"* [5]

- *Project funding (Domestic/international such as Horizon Europe):*
  Government/public or private sector funding contributes towards innovation through allowing SME's and research institutions to move forward with innovation projects that they otherwise would not be able to. Through having targeted funds, they also contribute towards innovation in areas deemed crucial on a national and global level.

- *Venture capital:*
  Private equity is one of the most expansive forms of investment in start-ups and early-stage emerging companies, as such it in large contributes towards innovative services/products being able to access the market.

**Ecosystems for innovations that are explicit to some Living Lab countries:**

- Incubators (helping startup companies and/or individual entrepreneurs to develop their businesses), which in some countries are called hubs (the meaning behind the terminology can vary depending on the country).

- There are also "technology transfer offices" (TTOs), providing companies and other organisations with up-to-date information, management and advice related to the areas of research and transference of knowledge to help the companies with optimising their resources and increasing their competitiveness.

The relevance of these ecosystems comes into play in relation to the further exploitation and development of the defined use cases. The various innovation ecosystems can be useful partners or sources of funding to be able to pursue and further develop the use cases.

### 1.3 Expectations from the European Commission

As according to the Grant agreement, it is expected that the results from the project are exploited even beyond the timeline of the project itself. It is expected that the beneficiaries of the project continue up to four years after end of the action and attempt their best to either directly or indirectly exploit the results of the project.

## 2. Innovation Management

### 2.1 End-User needs and use cases.

Each Living Lab identified a set of user-needs and then developed use cases to best meet as many users' needs as possible. While detailed information is documented in deliverable D1.1

Report on end user's needs and relevant use cases hereafter we summarise the main concepts, relevant for identifying potential innovation [6].

### 2.1.1 Living Lab 1 Luxembourg

The Living Lab in Luxembourg that is focusing on the digitalisation of viticulture identified seven users' needs. They are as follows:

A. Downy mildew control
B. Management of drought stress
C. Site-specific fertilisation
D. Single plant inventory
E. Leaf level symptom mapping
F. Local pattern analysis
G. Regional spatial information

To address such needs, two use cases were identified:

- UC 1.1: In-field microclimate and crop monitoring in vineyards - aims to support user need 1A and 1B
- UC 1.2: Digital Twin for Digitalized Management of Vineyards: primarily supports user needs: 1B, 1C, 1D, 1E, 1F and 1G.

### 2.1.2 Living Lab 2 Norway

The second Living lab in Norway, focusing on connected forestry, identified six user needs.

A. Improved connectivity solutions for forestry operations
B. Digitalisation
C. Improving data flow between stakeholders and end-user
D. Need for digitalisation of the forest PEFC and $CO_2$ certification.
E. Operator safety
F. Documentation - Protected Areas

To address such needs, three use cases were identified:

- UC 2.1: Remote operational support from expert for forest machine operator: tailors to the user needs 2A, 2B and 2E.
- UC 2.2: Complex situational awareness services in the forest: emphasises user needs 2B, 2C and 2E.
- UC 2.3: Digital decision support for the forest machine operator: covers use case needs: 2A, 2B, 2D, and 2F.

### 2.1.3 Living Lab 3 Denmark

Connected livestock transfer is the focal point of the Living Lab in Denmark, more specifically looking at the export and transportation within the pig industry. LL Denmark identified seven user needs.

A. Guidance systems that can provide safe and reliable livestock transportation.
B. Safe livestock transport to non-EU countries
C. Frequent journey logs reporting
D. Data-driven solutions for livestock transportation
E. Automated counting of pigs during loading/reloading/unloading and authority inspection
F. Low-cost tool for high resolution coverage analysis
G. Automatic license plate recognition for allowing the transport vehicles access to the farm.

To address such needs, two use cases were identified:

- UC 3.1 Monitoring of livestock transport along rural routes.
  For this use case the user needs addressed are 3A, 3B and 3C.
- UC 3.2 License plate recognition and UC 3.3 Monitoring of livestock loading/Unloading process.
  User needs 3E and 3G are the main needs being addressed in this use case.

### 2.1.4 Living Lab 4 Türkiye

In Türkiye the Living Lab is looking into smart olive tree farming. They identified three user needs.

A. Agricultural control for the olive fly
B. Agricultural control for diseases
C. Providing education to rural communities and refugees

To address such needs, two use cases were identified:

- UC 4.1: Microclimate monitoring for early disease and pest detection: tailors to the user need 4A.
- UC 4.2: Monitoring of pest insect traps: tailors to the user need 4B.

### 2.1.5 Living Lab 5 Serbia

The Living Lab Serbia is focusing on the sustainable agriculture and preservation of natural environment. They identified six user needs:

A. Better network connectivity
B. Access to a sustainable source of energy
C. Ensure the insight into environmental parameters.
D. Digitalisation of agriculture activities
E. Rural community collaboration space
F. Ensuring the safety of crops and equipment

To address such needs, five use cases were identified:

- UC 5.1 Creation of a shared rural infrastructure: addresses user needs 5A and 5B.
- UC 5.2 Securing crops and equipment: addresses user needs 5F and 5D.
- UC 5.3 Shared environmental monitoring platform: addresses user needs 5C.
- UC 5.4 Shared digital agriculture platform: targets user needs 5C and 5D.
- UC 5.5 Shared community platform: addresses user needs 5E.

## 2.2 Proof of Concept and state of the art

This section describes the technology enablers and deployment plans for the proof-of-concept solutions aiming to meet the end-users demands and requirements for the single LLs use cases. The content is based on extracts from D4.1 Set-up and design of Living Labs [7].

### 2.2.1 Living Lab 1 Luxembourg

Here we describe the two use cases (UC 1.1 and UC 1.2) from LL Luxembourg.

*UC 1.1 In-Field Microclimate and Crop Monitoring in Vineyards*

This use case aims to support the winegrowers plant protection practices. More specifically targeted towards protecting against downy mildew infections and spread. The state-of-the-art today is that the winegrowers plan plant protection based on their experience, weather forecast and models as well as systematic interval spraying, but due to increasing locality of weather events and changing local risks for infections it is becoming more and more difficult.

In UC 1.1 multiple sensors installed in the vineyard will provide relevant in-situ data for underrepresented sites, related to leaves wetness, soil moisture, and air temperature. A connectivity platform is fundamental to ensure reliable data collection, and thus, continuous monitoring of meteorological and soil conditions. This data can feed models providing accurate prediction of disease severity, and thus offering winegrowers comprehensive information for their decision-making. Figure 1 below illustrates the communication technologies proposed by LL Luxembourg, relying om LoRaWAN or cellular XG for the access network, depending on the density and distance between sensors [7]. For the backhauling network, if a cellular network is available, it will be used, otherwise satellite backhauling can be also an option.

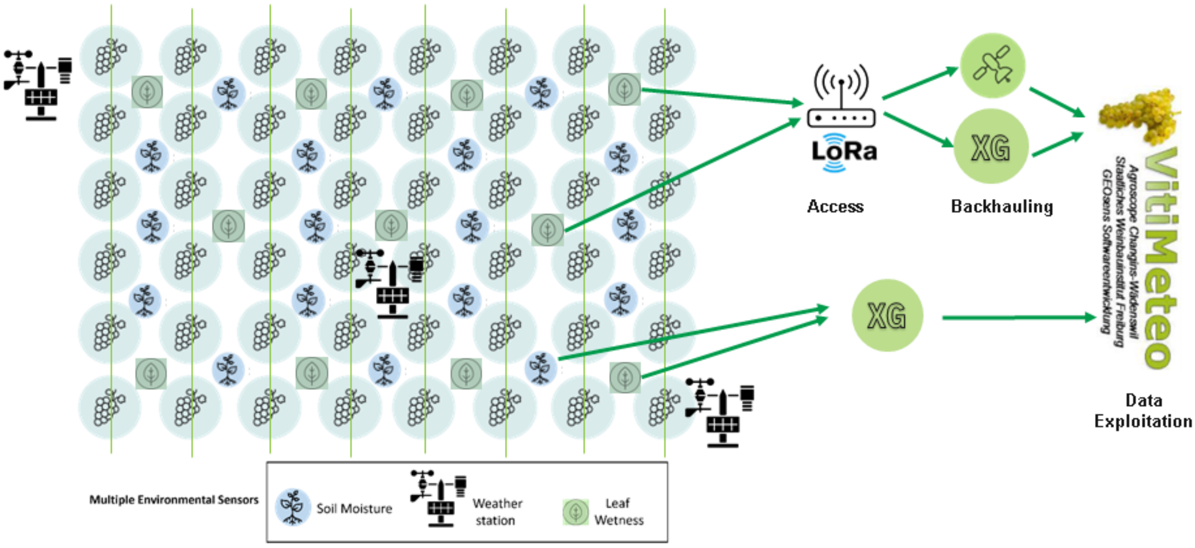


*Figure 1. Overview of enabling technologies for UC 1.1*

The multi-sensor weather station supports several connectivity solutions and monitors weather conditions in the vineyards. The RAK7249 outdoor gateway was selected to collect data from sensors in the field. The data backhauling with this gateway can be done using cellular networks (4G), Wi-Fi or Ethernet [7]. Five locations along the Moselle valley have been selected to install the new weather stations or the simplified installation of leaf wetness and temperature sensors. Due to distance between locations, one LoRaWAN gateway is not sufficient, and the devices are therefore equipped with SIM cards with a roaming option and optimised transmission algorithm, thus improving energy efficiency of the device.

*UC 1.2 Digital twin for digitalised management of vineyards*

Use case 1.2 aims to generate substantial parts of a digital twin (DT) to represent the vineyard. Visualisation through cameras mounted on Unmanned Aerial Vehicles (UAVs) or smartphones installed on the tractors, provides the winegrowers with the possibility to monitor growth and health status of the crop and map plants for replanting. Today this is done manually checking individual leaves for symptoms. Although there are several sensors available to provide data, the data transfer itself is limited due to large quantities of data needing transferred. Furthermore, satellite images provide free and objective information over several year and support documentation and the decision of planting new varieties under different weather conditions. Moreover, regional differences become visible. The transfer of high-quality videos and images from smartphones mounted on tractors relies on a broadband backhauling network to transfer payloads to servers where they will be processed. A simplified version of a digital twin of a vineyard for modelling and management is planned. This will allow for monitoring and analysis of the wine plants from diverse scales, hence providing timely recommendation to winegrowers to optimize interventions for protect against leaf diseases and other climate threats. The digital twin is based on three scales of remote sensing data collection form the single plant scale (tractor camera data), the field or vineyard scale (UAV data) as well as the regional scale (satellite data) considering all vineyards in Luxembourg along the Mosel valley.

### 2.2.2 Living Lab 2 Norway

Here we describe the three use cases (UC 2.1, UC 2.2, and UC 2.3) from LL Norway.

*UC 2.1 Remote operational support from expert for forest machine operator*

This use case is targeted towards supervision of the forest machine operator when they are out in the field during their thinning and logging activities or maintenance work on their machines. The state-of-the-art today is that the machine operator is in large by themselves and make most if not all decisions based on experience during the thinning and logging process. With respect to machine maintenance and solving errors they often must wait until an external party/expert can come into the forest. Lack of connectivity also requires physical presence. To realize the UC2.1 video cameras will be deployed on the forestry machinery that will stream the live high-quality videos to the remote experts for support. Remote experts will guide the machinery operators on the field after analysing the videos. A high-quality private 5G network (mobile trailer) will be required to for transmission of live video streams from the cameras mounted on the forest machinery. This network trailer contains 5G core, 5G radio and an edge server for on premises processing of different applications like video renderer software. The video renderer software will significantly reduce the data to be relayed over the low performance backhaul connectivity options. For video streaming, and to provide the interactive remote support, different solutions will be discussed, including Nokia's Real time eXtended Reality Multimedia (RXRM) software solution.

*UC 2.2 Complex Situational awareness services in the Forest*

Currently monitoring/looking for forest fires is done manually. The operator remains in the area for up to one to two hours to see if any small fires have ignited and searches the area where they can. To realize UC2.2, drones, ground sensors, edge computing (Near Edge and Far Edge) and private 5G Network will be deployed, as illustrated in Figure 2 [7]:

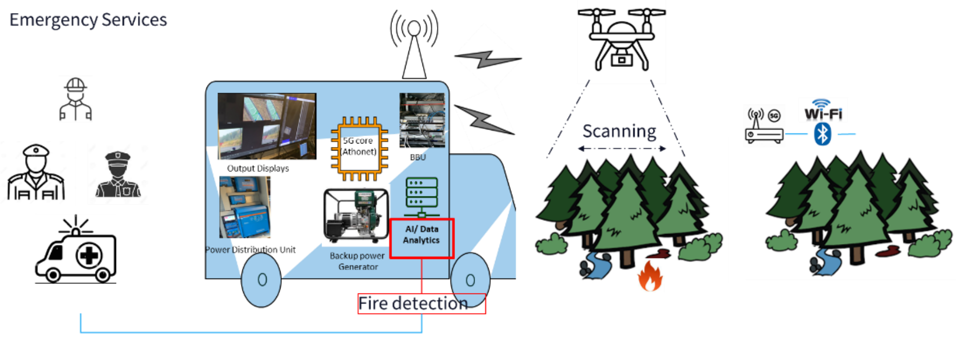


*Figure 2. Overview of enabling technologies for UC 2.2*

The drone surveillance the forest and sends video/image feeds to the Edge server. The data is being processed in edge server using AI and Machine Learning (ML) algorithms and suitable actions are taken based on the decisions. In addition to that the data may also be pushed via backhaul connectivity to the cloud servers. The drones will be equipped with advanced cameras for capturing high resolution and multispectral aerial images of forested areas. These cameras will stream the real time images and videos to an external edge server using the RTMP (Real-Time Messaging Protocol) communication protocol over a 5G network. Additionally, the plan involves integrating on-map analytics for visualizing forest metrics, facilitating an immediate response to alarming changes. Simultaneously, the IoT sensors positioned on the forest floor will employ a 5G network to transmit data to the edge server. The Raspberry Pi console, located at the far edge, will receive the IoT data. Immediate processing will occur at the far-edge device (Raspberry Pi) to identify critical patterns through the combination of IoT data, such as detecting fires or unexpectedly low humidity.

*UC 2.3 Digital decision support for forest machine operators*

Use case 2.3 can be considered as subpart of UC2.1 and UC2.2 where the aim of the use case is to provide the digital support to forest operator in terms of digital maps, applications, pre-installed digital data, route information or even live updates. Thus, the same connectivity solutions along with deployment plan for UC2.1 and UC2.2 will be used in for UC2.3. As in UC2.2, where a drone will take an arial flight and send images and live stream back. The intention is also to utilise the drone to construct a digital image of the entire forest, with estimated tree count and height. This information will be fed into the mobile application along with sensory data collected from on-ground sensors. It will allow the forest operator an additional visual layer of information combining drone images/video with IoT metrics will provide an integrated monitoring tool of the real time conditions of the forest.

### 2.2.3 Living Lab 3 Denmark

Here we describe the three use cases (UC 3.1, UC3.2 and UC 3.3) from LL Denmark.

*UC 3.1 Monitoring of livestock transport along rural routes*

The EU and the Danish authorities have established a series of regulations to ensure the animals welfare before, during and after transport. The regulation requires constant reporting of the welfare within a set interval of 10-30 min, but due to the lack of proper connectivity the transmission of the data does not always succeed. There is also a time limit for the animals to be onboard, which requires very efficient route optimization, which sometimes need to be recalculated depending on current traffic or weather conditions. Additionally, there is a lot of information that could be processed digitally that currently is being registered manually and as such also not being reported whilst the vehicle is on route, such as animals' health conditions, back door status, carrying weight and onboard sensor information.

Use case 3.1 aims to increase the efficiency of the logistics through route optimization and real-time monitoring of the onboard sensor information and transport unit location. The idea is to use a network service to transmit raw sensor and GNSS positional data from the vehicle to the remote operations centre and download essential information to improve navigation and efficiency of the livestock transport. The solution proposed for UC 3.1 is the use of multi-connectivity in two different modes. The first one being cellular (5G), where the satellite link functions as guarantee for global coverage if the primary cellular link fails. The second mode relates to cellular-based multi-connectivity, either within the same operator or between two operators. The main actor of this solution is the multi-access gateway, a small box that should be placed in the roof of the transport unit and would allow to perform multi-connectivity between the same or different technologies (multi-connectivity at transport layer). The box includes a mini-PC with a software that enables multi-connectivity and can be connected to either two cellular modems or a cellular and a satellite modem. While this solution will be tested with real experimental data for both multi-connectivity modes, only the cellular-based multi-connectivity will be tested in one of the Danish LL stakeholders' premises. For that case, the box will be deployed on the truck, which will drive from Denmark through different routes towards Germany and the Netherlands. For the cellular-satellite multi-connectivity mode, several experimental and measurement campaigns are planned to test different configurations (e.g., Low Earth Orbit/Geosynchronous Equatorial Orbit satellite and cellular).

*UC 3.2 License plate recognition and UC3.3 Monitoring of livestock loading/Unloading process*

Whenever a new truck arrives at a farm, for loading or unloading of livestock, it is necessary to have an online check on relevant websites to confirm that the certificates for that truck are in order. Currently this is done manually by the farmer, being a time consuming and cumbersome task that if digitalised would boost efficiency. The intention is to have an automatic license plate recognition/authorisation. A connectivity-based solution for UC3.2 and UC3.3 needs to support a real-time video monitoring stream with sufficient uplink wireless coverage (and capacity) nearby the location of the farm and the livestock transportation truck.

Since the farm locations often are in remote areas, it is necessary to realize a local wireless network coverage at those locations by creating local 5G private networks or local Wi-Fi networks, complemented with either terrestrial networks or in some cases with satellite networks for transporting the real-time video stream to destination. Figure 3 below illustrates the deployment of U3.2 where the video camera at the gate of the farm stream images of the transportation trucks plates which are processed at the authorization server and the truck's credential can be checked to authorize the access [7].

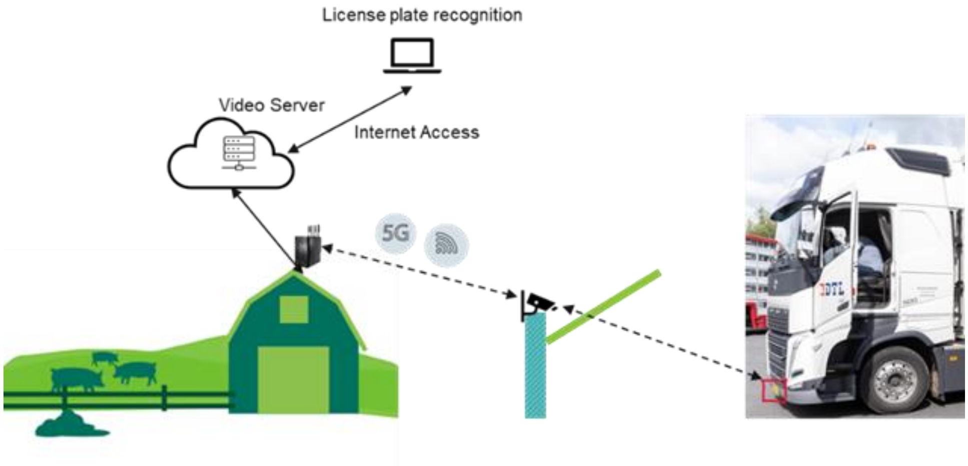


*Figure 3. Solution for truck license plate recognition/authorisation in UC3.2*

A similar solution is suggested for UC 3.3. Here the video camera is either mounted on the truck or the entrance of the loading/unloading facility and a video-stream will be communicated via the local/private 5G or Wi-Fi network. An expert located remotely, or a computer vision algorithm, can perform counting, injuries or illness detection of pigs when monitoring the video stream. The solution is planned to be deployed at a farm in Netherlands in q2/3 of 2024.

### 2.2.4 Living Lab 4 Türkiye

Here we describe the two use cases (UC 4.1 and UC 4.2) from LL Turkey.

*UC 4.1 Microclimate monitoring for early disease and pest detection*

To better make the right decisions at the right time to best produce higher yielding quality olives, rural farmers and refugees must know about the conditions of the environment and soil surrounding the olive farms. Using weather station sensors and models for pathogen-environment interactions the possibility for disease forecast and early warnings for the disease identification should be possible when certain conditions are met. To deploy UC 4.1, weather and soil sensors were installed in the olive tree orchard to provide pest, air temperature, soil data precipitation, and other relevant parameters. Figure 4 below illustrate the connectivity solution relying on NB-IoT and machine-type communications technology (eMTC) [7].

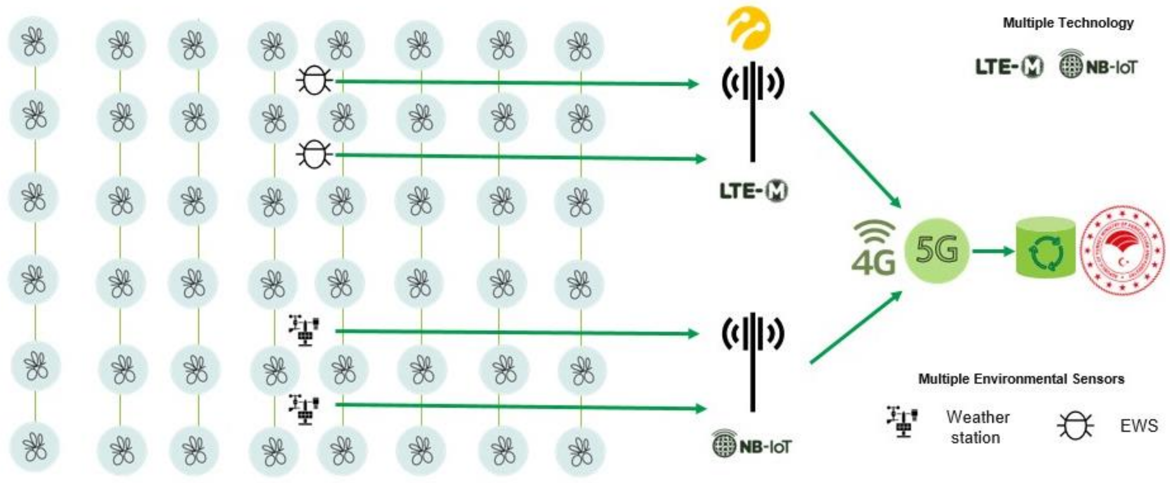


*Figure 4. Overview of enabling technologies for UC 4.1*

In addition, the smart olive tree farming supports former XG technologies like 2G and 3G. The olive oil or table olive producer/farmers can use any XG technology. Two climate stations, two delta traps and cameras, two yellow sticky traps and cameras, two manual traps without cameras, two tractor tracking devices, and one phenology tracking camera are already deployed in two locations in southwest of Turkey - Izmir and Antalya.

*UC 4.2 Monitoring of pest insect traps*

The olive fly can cause a lot of damage to the olive cultivation in a short period of time. To avoid the escalation and growth of the olive fly, there are today some manual food traps and pheromone traps placed in various areas and checked manually. Use case 4.2 aims to create a digital solution using advanced connected electronic pest traps that can capture the olive fly. Using the electronic traps with integrated digital cameras captures a photo a couple of times a day and wireless transfer the images to either a smart phone app or a web application. It reduces the manual labour as well as increases the efficiency tied to monitoring the growth and spread of the olive fly. This will be particularly useful in the long-distance olive groves. To deploy UC 4.2 three production locations were selected south-west of Turkey: Izmir, Antalya and Mersin. The installation of the PoC's contains early warning/pest trap monitoring systems in olive tree orchard to follow the pest population. It relies on enhanced machine-type communications (eMTC) technology offering higher data rates and lower latency compared to NB-IoT and allowing for direct connection to a 4G or 5G cellular network, facilitating seamless Internet connectivity for IoT devices. In addition to NB-IoT and eMTC, the devices deployed in Türkiye smart olive tree farming supports former XG technologies like 2G and 3G.

### 2.2.5 Living Lab 5 Serbia

Here we describe the five use cases (UC 5.1, UC 5.2. UC 5.3. UC 5,4 and UC 5.5) from LL Serbia.

*UC 5.1 Creation of a shared rural infrastructure*

The goal of the first UC is to create a stable power supply and network connectivity infrastructure for the agricultural devices that are using sustainable energy sources. The digital solution requires a mobile generator that will provide a multitude of purposes within the agricultural ecosystem. This use case adds value through that it gives the farmers and the stakeholders access to real-time data, the possibility to optimise and improve their own agricultural practices.

*UC 5.2 Securing crops and equipment*

The goal here is to detect people and vehicles present/moving in the field to support prevention of thefts. Moreover, they also aim to detect the status of the crops (growth status, height, size) to support agricultural operations. Finally, recognition of audio/noise to identify activities in the surrounding area is also an objective in UC 5.2. The shared communication, computing and sensing infrastructure that will be generated by use case 5.1 will be continued here to collect the necessary video and audio streams and manage them on the edge.

*U.C 5.3 Shared environmental monitoring platform*

The objective here is to deploy several devices to monitor air quality, water quality and noise level as to best preserve the park and stop any activities that could contribute towards harming the environment surrounding the park. This use case will be benefiting from the infrastructure described in UC 5.1, so that the collected data will be able to be shared and available to multiple users and stakeholders with the intention to preserve the park and its biodiversity.

*UC 5.4 Shared digital agricultural platform*

State-of-the-art in the current agricultural practice is that it is still quite traditional and in large based on experience. The result of this has often been over spraying or over irrigation of crops, this effects soil degradation and loss of biodiversity negatively as well as having an overall negative impact on the environment. The intention of this use case is to collect a variety of relevant data from the devices installed during UC 5.1 and ensure that this data is analysed and provided to the farmers so that they can improve their everyday practices.

*UC 5.5 Shared community platform*

To deploy the Serbian use cases, a community platform with a set of devices will be deployed setting up the required infrastructure, illustrated in Figure 5 [7].


*Figure 5. Overview over enabling technologies for Serbian LL*

Initially a mobile solar generator will provide power supply to all consumers, supporting communication and computing equipment, sensors, irrigation systems, etc. Furthermore, communication infrastructure is needed (e.g. mobile routers with a mobile network (4G) interface for the backhaul connectivity/Wi-Fi access point, LoRaWAN gateways, and GPS location trackers. Moreover, computing infrastructure such as edge ML gateway will provide edge processing capabilities that will enable creation of autonomous systems capable of controlling and automating agricultural operations. Sensing infrastructure for monitoring of air quality water quality and noise level, soil conditions and other environmental parameters (e.g., air humidity, leaf wetness wind speed/direction) is also necessary. The plan is that all devices and the networks are operational before the start of the vegetation season, i.e., spring 2024.

The shared communication, computing and sensing infrastructure provided by UC 5.1 will be used in UC 5.2 to acquire relevant video and audio streams and process them on the edge. These video/audio streams will be analysed through ML algorithms to (i) detect people and vehicles in the field and around the equipment, status of the crops and recognition of audio/noise in the surrounding area. UC5.3 is focused on transferring the parameters gathered from the sensors etc. to an environmental monitoring platform. UC 5.4 provide decision support advice to the farmers helping them to timely apply adequate agriculture measures and to increase efficiency of the irrigation management. The AgroNET (DNET's proprietary solution) platform will work as the basis for the shared agriculture platform and management system, integrating functionalities implemented in UC 5.2. UC 5.5 collect data from the shared platforms implemented by UC 5.3 and UC 5.4 as well as from Internet sources and direct contributions from farmers and other stakeholders. The community platform will act as a central place for collaboration, exchange of data, sharing best practices and advice among the farming community, facilitating easier adoption of digital technologies in the rural areas.

## 2.3 Method for assessment of innovation degree in LL use cases

The objective of this assessment is to safeguard the strategic management of the use cases, and to measure the degree of technology and market newness of the different use cases from the five LLs. This measurement is intended to occur twice, to register changes related to increased knowledge and pilot results. The first measurements are reported in this deliverable (D7.3 Report on Strategic and Innovation Management version 1 (February 2024)) and the second measurement will be provided in D7.5 (Report on Strategic and Innovation Management version 2 (August 2025)). The assessment is performed by the stakeholders managing the use cases within the LL's. Below we describe the questions distributed to the LLs to be reported. These tables are filled in with answers from stakeholders further below. We start with a request for selecting the level of newness both technology and market wise. The mix of alternatives is described in Figure 6 below. The matrix is inspired from Tidd and Bessant [8].

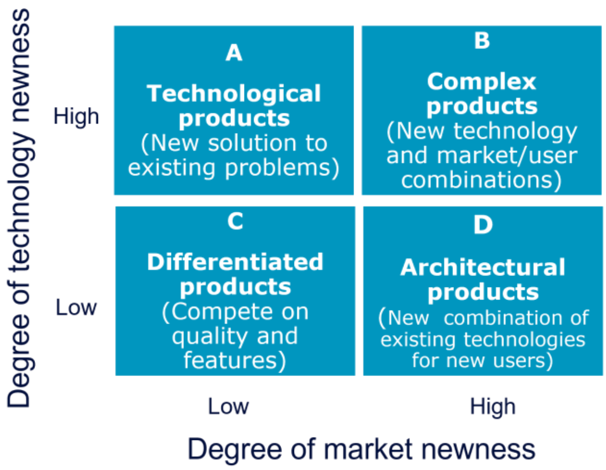


*Figure 6. Four quadrants' matrix on degree of technology and market newness*

Two questions (I and II) are introduced in relation to the technology/market newness matrix:

*I: Pick the most promising use case(s) from your Living Lab and suggest where each of them is in the matrix (degree of novelty on technology and market – based on when the use case solution is available for stakeholders/launched commercially). You may combine use cases if necessary (should be described in the title).*

*II: Based on the selected use cases above provide a **short** description of the most important characteristics in relation to technology and market. It should tie with the selected location in the matrix.*

*The tables can be found in the Annex but also the completed versions from the LLs are provided below. Finally*, we asked the LL stakeholders to assess where the maturity of the use case solutions on a technology readiness scale. This scale describes how far the use case solution has reached in the development process and the level of documentation of performance of the solutions. At the same time, it provides some insight into the level of interaction and feedback with user/market through level of feedback on the minimal viable product/proof of concept. (MVP/PoC's), protocepts [9] or prototypes. The governmental agency "Innovation Norway" support innovation and development of Norwegian enterprises and industry trough competence, capital, and network [10]. They use TRL scale to assess what kind of prospects they can fund and support. Figure 7 below illustrates the TRL scale from level 0 to level 9.

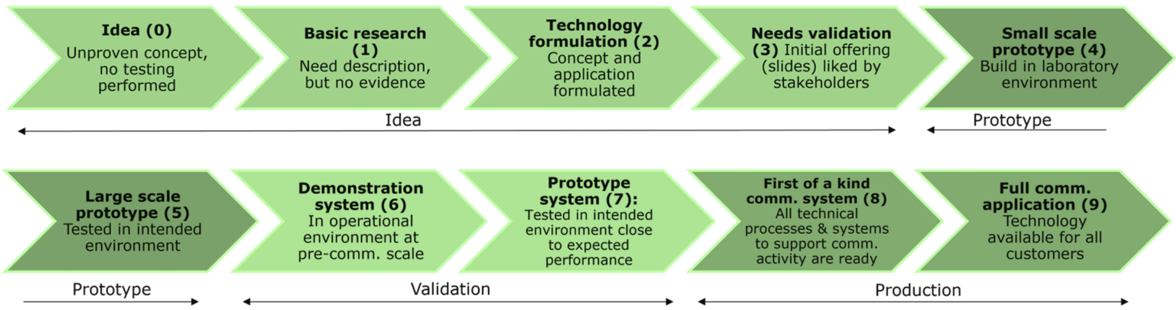


*Figure 7. Technology readiness level (TRL)*

The LL stakeholders are here asked to respond to the following question, see III. The points of time we refer to (q1 2024 and q2 2025) are identical to the deadlines for deliverable D7.3 and D7.5.

### 2.3.1 Results from the Living Labs assessments

***Living Lab 1 Luxembourg***

1) Most promising use cases and their placed in the technology and market matrix

*Table 1. Selected locations in matrix for specific use cases (LL Luxembourg)*

| UC # | Use case title | Location in matrix, e.g., A, B, C or D |
|---|---|---|
| UC 1.1 | In-field microclimate and crop monitoring in vineyards | A -Technological products |
| UC 1.2 | Digital Twin for Digitalized Management of Vineyards | D – Architectural products |

2) A short description provided tied with the selected location in the matrix.

*Table 2. Explanation of the linkage between UCs and locations in matrix (LL Luxembourg)*

| UC # | Explanation of why use case is linked to the location in the matrix |
|---|---|

| | |
|---|---|
| UC1.1 | The model for disease severity itself exists already but we feed it with additional in-situ data collected remotely from IoT devices, equipped with different sensors, increasing the accuracy of the model estimation. |
| UC1.2 | UAV data, smartphone images, and satellite data have long existed. But we combine and analyses the data in a new way to make them of real use for the winegrowers. |

3) Assessment of TRL level.

*Table 3. Table of TRL Level for specific use cases (LL Luxembourg)*

| UC # | Use case title | TRL level (0-9) per Q1 2024 | TRL level (0-9) per Q4 2025 | Est. launch of comm. solution |
|---|---|---|---|---|
| UC1.1 | In-field microclimate and crop monitoring in vineyards | 6 | 8 | NA |
| UC1.2 | Digital Twin for Digitalized Management of Vineyards | 4 | 7 | NA |

***Living Lab 2 Norway***

1) Most promising use cases and placed in the technology-market matrix

*Table 4. Selected locations in matrix for specific use cases (LL Norway)*

| UC # | Use case title | Location in matrix, e.g., A, B, C or D |
|---|---|---|
| UC 2.1 | Remote operational support from expert for forest machine operator | A – Technological products |
| UC 2.2 | Complex situational awareness services in the forest | D – Architectural products |

2) A short description provided tied with the selected location in the technology-market matrix

*Table 5. Explanation of the linkage between UCs and locations in matrix (LL Norway)*

| UC # | Explanation of why use case is given the location in the matrix |
|---|---|
| UC 2.1 | We are planning to use Nokia's RXRM solution, which is available to the industries, however we would like to test the solution in Rural areas specifically Forestry to test and evaluate the solution. |
| UC 2.2 | The use case consists of multiple parts, including drones, ground sensors and different AI models to provide real time monitoring and surveillance. Drones and sensors are already available in the market. However, to accomplish Norway Living lab use case all these components need to be integrated together to provide end to end Forest monitoring and surveillance system. |

3) Assessment of TRL level.

*Table 6. Table of TRL Level for specific use cases (LL Norway)*

| UC# | Use case title | TRL level (0-9) per Q1 2024 | TRL level (0-9) per Q4 2025 | Est. launch of comm. solution |
|---|---|---|---|---|
| UC 2.1 | Remote operational support for expert for forest machine operator | 6 | 9 | NA |
| UC 2.2 | Complex situational awareness services in the forest | 5 | 8 | NA |

***Living Lab 3 Denmark***

1) Most promising use cases and placed in the technology-market matrix

*Table 7. Selected locations in matrix for specific use cases (LL Denmark)*

| UC # | Use case title | Location in matrix, e.g A, B, C or D |
|---|---|---|
| UC 3.1 | Monitoring of livestock transport along rural routes | B – Complex products |

2) A short description provided tied with the selected location in the matrix.

*Table 8. Explanation of the linkage between UCs and locations in matrix (LL Denmark)*

| UC # | Explanation of why use case is given the location in the matrix |
|---|---|
| UC 3.1 | Two existing technologies (cellular and satellite networks) are combined here to provide a new service: The use of integrated Terrestrial Networks (TN) and NTN (Non-Terrestrial Networks) to provide seamless connectivity for logistics (including livestock transport) is a new use case/market that can be realized thanks to the combination of different technologies. |
| UC 3.2 | Existing local 5G networks products (also WiFi) are used for providing new and customized solutions for livestock transportation. The enhanced connectivity enables video stream analysis in almost real-time enabling automated license plate recognition (UC3.2) and remote (or computerized) monitoring of the livestock (un-)loading process. |

3) Assessment of TRL level.

*Table 9. Table of TRL Level for specific use cases (LL Denmark)*

| UC# | Use case title | TRL level (0-9) per q1 2024 | TRL level (0-9) per q4 2025 | Est. launch of comm. solution |
|---|---|---|---|---|
| UC 3.1 | Monitoring of livestock transport along rural routes | 4 | 7 | NA |
| UC 3.2 and UC3.3 | License Plate Recognition and Monitoring of Livestock Loading/Unloading Processes | 5 | 7 | NA |

***Living lab 4 Türkiye***

1) Most promising use cases and placed in the matrix

*Table 10. Selected locations in matrix for specific use cases (LL Turkey)*

| UC# | Use case title | Location in matrix, e.g., A, B, C or D |
|---|---|---|
| UC 4.1 | Microclimate Monitoring for Early Disease and Pest Detection | A – Technological products |
| UC 4.2 | Monitoring of Pest Insect Traps | D – Architectural products |

2) A short description provided tied with the selected location in the matrix.

*Table 11. Explanation of the linkage between UCs and locations in matrix (LL Turkey)*

| Use case # | Explanation of why use case is given the location in the matrix |
|---|---|
| UC 4.1 | With the use of early warning systems, sustainability of olive cultivation will increase, and rural farmers and refugee workers are aware of planning their olive orchard activities and make the right timely decisions to produce higher-yielding quality olives. |
| UC 4.2 | With an integrated digital camera that acquires pictures two or three times a day and wireless transmission of images, that can be displayed via a smart phone App or web application; we will combine and analyze the data for users. Digital traps are effective in terms of detection of pests and stable transmission of data, they will be made available to technical staff and producers. |

3) Assessment of TRL level.

*Table 12. Table of TRL Level for specific use cases (LL Turkey)*

| Use case # | Use case title | TRL level (0-9) per q1 2024 | TRL level (0-9) per q4 2025 | Est. launch of comm. solution |
|---|---|---|---|---|
| UC 4.1 | Microclimate Monitoring for Early Disease and Pest Detection | 4 | 8 | NA |
| UC 4.2 | Monitoring of Pest Insect Traps | 4 | 8 | NA |

***Living lab 5 Serbia***

1) Most promising use cases and placed in the matrix

*Table 13. Selected locations in matrix for specific use cases (LL Serbia)*

| UC # | Use case title | Location in matrix, e.g. A, B |
|---|---|---|
| UC 5.1 | Creation of a shared rural infrastructure | B – Complex products |
| UC 5.2 | Securing crops and equipment | A – Technological products |
| UC 5.3 | Shared environment monitoring platform | C – Differentiated products |
| UC 5.4 | Shared digital agriculture platform | D – Architectural products |
| UC 5.5 | Shared rural community platform | C – Differentiated products |

2) A short description provided tied with the selected location in the matrix.

*Table 14. Explanation of the linkage between UCs and locations in matrix (LL Serbia)*

| UC # | Explanation of why use case is given the location in the matrix |
|---|---|
| UC 5.1 | Involves different technologies, including mobile solar generators, LoRaWAN connectivity, edge Machine Learning (ML) devices, and video |

| | |
|---|---|
| | cameras. The complexity arises from integrating these technologies for diverse applications such as power supply, connectivity and monitoring in rural areas. It targets users in rural areas, providing shared infrastructure for various needs like power supply, irrigation, and crop monitoring. The complexity caters to the specific challenges and requirements of rural communities. |
| UC 5.2 | This use case focuses on the application of edge ML computing algorithms to enhance security and provide insights into crop development. The emphasis is on the development and deployment of machine learning algorithms for edge devices. Primarily targets users in agriculture by addressing security concerns and providing valuable insights. The technology applied is innovative in its approach to solving existing problems. |
| UC 5.3 | Utilizes technology such as LoRaWAN for data transfer, solar (optionally battery) power, and a variety of sensors for air and water quality monitoring. The differentiation lies in the specific focus on environmental monitoring in a nature park with target on local users concerned with environmental preservation and activities harming the environment. The differentiated approach sets it apart from generic monitoring solutions. |
| UC 5.4 | Use case 4 establishes a comprehensive platform (agroNET) by integrating data from in-field devices, predictive models, and environmental parameters. The architectural aspect lies in the combination of these data to provide a holistic solution for digital agriculture. Targets farmers by offering a shared platform with insights into irrigation, disease predictions, machinery tracking, and more. The architectural approach addresses the need for a complete solution in digital agriculture. |
| UC 5.5 | Utilizes existing communication technologies for creating a centralized platform. The differentiation comes from its focus on serving as a hub for data exchange, best practices, and advice, fostering collaboration in the farming community. This use case targets the farming community by providing a unique platform for collaborative data exchange and knowledge sharing. The differentiation lies in its role as a community-centric platform. |

3) Assessment of TRL level.

*Table 15. Table of TRL Level for specific use cases (LL Serbia)*

| UC # | Use case title | TRL level (0-9) per q1 2024 | TRL level (0-9) per q4 2025 | Est. launch of comm. solution |
|---|---|---|---|---|
| UC 5.1 | Creation of a shared rural infrastructure | 5 | 8 | 2026 |
| UC 5.2 | Securing crops and equipment | 4 | 8 | 2026 |
| UC 5.3 | Shared environment monitoring platform | 6 | 8 | 2026 |
| UC 5.4 | Shared digital agriculture platform | 7 | 8 | 2026 |
| UC 5.5 | Shared rural community platform | 6 | 8 | 2026 |

### 2.3.2 Results Analysis Summary

As we can see based on the feedback from the LLs most of the use cases land within category A "Technological products" and D "Architectural products". Meaning that they are either low on market newness and high on technological newness, or that they are high in market newness but low on technological newness. 9 out of 13 use cases landed within these two, 5 on category D and 4 on category A. Category B and C had two use cases each. Based on this information it shows that most if not all the LLs have had a sense of innovation in their development. Some will have to focus more on the testing of the technological solutions whilst others will have to focus more on the use in the market.

As for the technological readiness level (TRL) 5 out of 13 have been categorised as level 4 "Small scale prototype" meaning it is at a laboratory level. The rest of the use cases were mainly defined within levels 5 and 6- and one-use case was categorised within level 7. All use cases have been categorised to be at level 7 or 8 by the second quarter of 2025. This means that they will be either tested in the intended environment and close to perform as expected or it is at the stage where it is ready at a technical and systematic level.

## 3. IPR Management

Management of IPR can be an important component in innovation process. Getting new research results into products and services for the market is one of the main goals of the program. The Intellectual Property Rights (IPR) management in Horizon Europe is mostly based on the framework in Horizon 2020.

Results are achievements during the implementation of the project. Outcomes (and effects) are that which is achieved through the use and implementation of the project results. The impacts are the long-term effects of these outcomes. Pathway to impact is described by the EU'.

*"A pathway begins with the project's results, continues with their communication, dissemination, and exploitation leading to the expected outcomes, and ultimately ends with wider scientific, economic, and societal impacts of the project"* [11].

IP questions may arise during the project, and IP should be used when relevant and need to ensure the protection of innovations. Some partners may have existing IP that can be used in the project [11]. Below is an overview of how Horizon Europe approaches IP management, in case any applications for IP should occur in COMMECT this approach will be utilised.

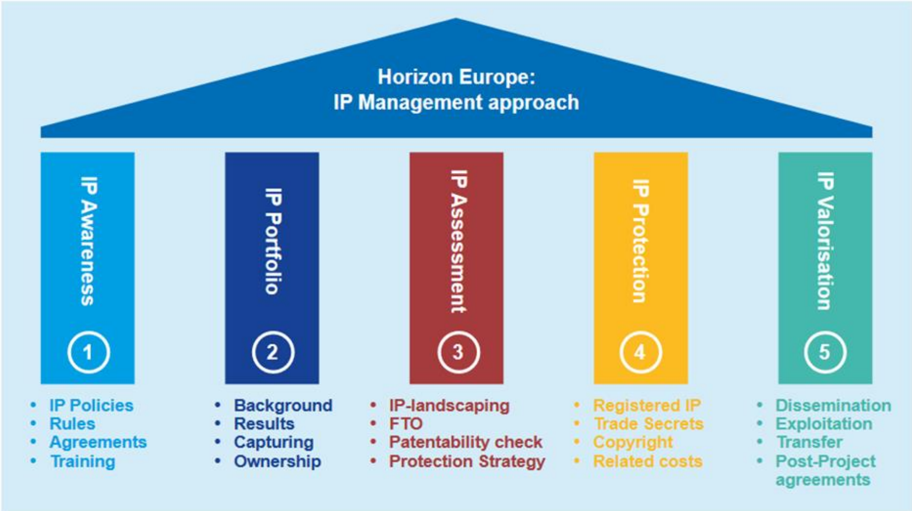


*Figure 8. IP management approach in HE projects [11]*

## 3.1 Collaborative project results

A collaborative project such as COMMECT with partners from small and medium businesses (SMBs), academia, and larger companies, will naturally have different business interest and commercial goals as well as other metrics such as academic publication for the research institutions. Ideally both interests can be fulfilled without compromising, but both have to keep in mind the interests of other types of partners in the project. This can for instance be publication of results that could have been exploited also through IP. The Grant agreement (GA) and the Consortium agreement (CA) is the legal basis for the project that partners have signed. And all COMMECT partners are bound by the agreements, including an effort to secure impact of the results. The GA are the general rules regarding IP and the CA is specific for the COMMECT consortium.

Results from collaborative efforts using expertise from more than one partner is considered jointly created, and exploitation and commercialization should therefore be agreed upon together. This includes questions related to IP and the Open Science and Open Innovation in EU projects. The project partners should regularly exchange expectations for dissemination, exploitation, commercialization among each other. If necessary, joint ownership agreements can be used to commercialize results together. It is also possible to issues licenses to third parties [11] [12].

A benefit of collaborative projects is the prospect of future collaborations between partners or other stakeholders, end-users, etc. This can in turn open new markets, new technologies and other positive collaboration effects.

## 3.2 Help services

The European Intellectual Property Helpdesk can provide help to SMBs and teams in EU funded projects. They can provide information material and a helpline service.

Horizon IP Scan is a first-line support for starts-ups and SMEs in EU projects. They can aid in providing a strategy for IP management and prevent IP conflicts. The service is cost-free but requires an application process.

Horizon Results Booster is a new service aimed at maximizing impact of results from projects. Among the services are business planning and go-to market [12] [11]

# 4. Decision support tool (DST)

## 4.1 Main goals and benefits of the DST

The Decision Support Tool (DST) can be envisaged as a consultant who knows a lot about communication technologies, rural regions, agriculture, forestry, understands societal, environmental, business impacts of certain choices, and is able to articulate it when asked the right questions. It has a similar structure to that of ChatGPT. The COMMECT project aims to equip that consultant with the required knowledge (project documents, surveys, etc.) as well as making the consultant capable of driving the conversation to get all necessary information before generating a response.

The principal objective of the DST is to empower end-users, including farmers, foresters, municipalities, community members, and end-user advisors, in making informed decisions regarding the selection of optimal technological setups tailored to their unique needs. Developed as part of Task 3.4, the DST primarily focuses on facilitating the initial investment decision. Operational optimization is also supported through subsequent interactions using local knowledge and the Intelligent Connectivity Platform (ICP). The DST acts as a comprehensive guide, utilizing data collected from various sources, to aid users in navigating the complex landscape of available XG technologies and selecting configurations that align with EU defined socio-economic and environmental goals.

- The DST brings substantial benefits to its users by providing a structured approach to decision-making in the realm of technology adoption. Users, ranging from individual farmers to larger organizations, stand to gain in the following ways: Informed Decision-Making: The DST aggregates data from LLs experiments, surveys, and interviews, offering users a wealth of information to make well-informed decisions. This ensures that choices align not only with their immediate needs but also with broader socio-economic and environmental considerations.
- Socio-economic and Environmental Impact Assessment: The tool evaluates different technologies based on their socio-economic and environmental impact. Users can weigh the implications of their choices on a macro, regional, and micro level, providing a nuanced understanding of the potential effects.
- User-Friendly Interface: With a novel natural language prompt (chat) interface the DST ensures accessibility for a diverse range of end-users. Its design facilitates easy interaction, allowing users to navigate through data, visualize outcomes, and receive tailored recommendations.
- Business Model Proposals. The DST goes beyond assessing impacts and supports the design of appropriate business models for the chosen technological setup. This assists users in understanding the economic viability of their choices and potentially opening new avenues for sustainable business practices.

The DST is more fully explained and described in D.3.3 in the COMMECT project [13].

## 4.2 Technological architecture

The architecture of the DST is multifaceted, involving the key components described in the logical architecture. Initial foundation knowledge for DST is collected, incorporating information from LLs experiments, macro-level methodologies, regional surveys, and micro-level interviews. At the heart of the DST are sophisticated decision models and algorithms based on generative AI and LLM technologies. These analytical tools process the collected data to evaluate technologies, assess impacts, and propose business model. The “chat” user interface acts as the front-end, providing users with a linguistically intuitive platform to interact with the DST. It facilitates input, visualization of results, and user feedback. The knowledge base will be populated as repository of domain-specific knowledge, the knowledge base incorporates best practices, expert guidelines, and historical data to enhance the decision-making process. DST incorporates a feedback loop (i.e., prompts and responses), allowing users to provide input or commentary on the effectiveness of recommendations.

# 5. Strategic Management

## 5.1 Suggested solutions

Viewing all COMMECT LL use cases in Section 2 we find different deployments of 5G Private Networks or Low Power Wide Area Networks (LPWAN) to extend last mile coverage networks in the LLs. LoRaWAN technology was selected by LLs Luxembourg and Serbia to provide access for IoT devices, while eMTC and NB-IoT were selected by LL Türkiye. Moreover, satellite communications in access or backhaul networks to ensure broadband connectivity was identified to deploy some of the UCs and edge computing techniques are developed in several LLs to meet the requirements of communication efficiency and data exploitation. For broadband connectivity, LLs Norway and Denmark will be deploying 5G Private Networks (PNs) with terrestrial and satellite backhauling using different configurations and hardware. LL Luxembourg also will be testing satellite backhauling. All the Living Labs provide automated monitoring solutions to track environmental parameters in agricultural fields (LL Luxembourg: vineyard, LL Türkiye: olives and LL Serbia: arable lands) in forest (LL Norway) or in Livestock transportation (LL Denmark). These environmental parameters are based on IoT data collected from sensors (UC 1.1: microclimate and field monitoring in vineyards, e.g. UC 2.2: environmental monitoring to protect forest and UC3.1: monitoring of animals' health during transportation as well as Image and video data collected from cameras (e.g., UC 1.2, UC 3.3 and UC 5.2).

The overview of the suggested use case solutions/deployments presented earlier provides an array of examples of how the benefits from deploying 5G private networks can be applied in rural areas. The application of 5G private networks and LPWAN networks in rural areas has the potential to revolutionize farming practices by making it more efficient, data-driven, and environmentally friendly. IoT devices integrated with LPWAN and 5G private networks can support optimized and sustainable practices within rural communities such as water management systems and environmental monitoring. Forestry is also a vital industry in rural areas, and the implementation of 5G private networks could support real-time forest monitoring and management, involving connected sensors and cameras to track temperature, humidity and fire risk, hence aiding forest managers in quickly detecting potential threats.

Finally, the public sector and residents can enjoy faster download and upload speeds, reduced latency, crucial for real-time applications like video conferencing, telehealth services, and remote monitoring and accommodate a vast number of connected devices simultaneously, ranging from smartphones and tablets to IoT sensors and autonomous equipment. Moreover, 5G private networks ensures that professionals (e.g. forestry experts) can facilitate smooth video conferences, cloud-based collaboration, and large file transfers, promoting productive remote work with less need for transportation and reduced Co2 emissions.

## 5.2 Applying technology to use case domains and standards

The selection of access network technologies across different LLs is done based on the requirements of use cases where the existing technologies will be adapted to the end-user needs. In most of the LLs the data is processed on the edge, to equip the Living Labs with real-time processing and help in decision making. Living Labs also use innovative and efficient solutions to backhaul the data based on availability of backhauling networks. For example, in the case of the Denmark LL the backhauling router efficiently switches between satellite and mobile commercial networks based on network availability. This is also the case in the

Norwegian LL where the backhauling router is equipped with network connections from multiple operators and selects the one with better coverage and quality. All these connectivity solutions are not novel, though they are adapted to be used more efficiently in rural communities based on the defined use cases. However, we see several similarities between the use cases, hence effects considered in one LL can be relevant for other LL's. Examples of synergies are candidates for further exploration in the next version of this deliverable (D4.2 Results and Outcomes of Living Labs, June 2025). In the UC 2.2/UC 2.3 in LL Norway UAVs are proposed for real time monitoring of the forests. An exchange of expertise between the LLs can help reproduce the connectivity platform in the LL Luxembourg's UC 1.2 and digital twin implementation in UC 2.3. Similar exchanges can be identified also with LL Serbia from UC5.2, many LLs will be interested in securing the equipment deployed in the field. More details in the use case synergies are described in chapter 7 in D4.1 deliverable [7].

Next steps to ensure that the approach adopted by COMMECT is applicable to a service to be placed on the market it is necessary that the proposed COMMECT results are distributed and presented in relevant standardization alliances and bodies. This involves standards set by 3GPP (Third Generation Partnership Project) on evolving access technologies, including 2G, 3G, 4G, 5G, and Non-Terrestrial Networks (airborne and space-borne) to ensure connectivity (reachability) everywhere. The solution developed by COMMECT meets the standards set by the 3GPP, e.g. energy efficiencies at the base stations. ETSI (European Telecommunication Standards Institute) and ITU (International Telecommunication Union) on climate mitigation and increase the resilience and sustainability of rural communities. Moreover, aligning the development of the DST tool with TM Forum's work on generative AI for Autonomous Networks project guides is preferable to enhance connectivity solutions in agroforestry sectors, particularly under the scope of AI-driven autonomous networks. Participation in these alliances also secures the opportunity to mitigate the impact from new standards on the technologies being applied for the different COMMECT use cases, hence supporting the sustainability for current technologies chosen.

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# Appendix

*Table 16. Example of location of use cases in technology/market matrix*

| UC # | Use case title | Location in matrix, e.g., A, B, C or D |
|---|---|---|
| Use case I | | |
| Use case II | | |
| Use case III | | |

*Table 17. Example of reasoning of use cases located in technology/market newness matrix*

| UC # | Explanation of why use case is given the location in the matrix |
|---|---|
| Use case I | |
| Use case II | |
| Use case III | |

*Table 18. Example of the TRL level per use cases*

| UC # | Use case title | TRL level (0-9) per Q1 2024 | Estimated TRL level (0-9) per Q2 2025 | Estimated launch of comm. solution |
|---|---|---|---|---|
| Use case I | | | | |
| Use case II | | | | |
| Use case III | | | | |