Drone project report

Interreg Sverige – Norge

Medfinansieras av EUROPEISKA UNIONEN

GREEN FLYWAY INTERNATIONAL TEST ARENA

Aviant

1. Introduction

Transportation and logistics solutions in health and care services face major challenges, especially in rural municipalities where long distances, weather conditions and limited resources affect service provision. In Norway, the need for innovative solutions is particularly relevant, as demographic trends show a significant increase in the number of elderly people. According to Statistics Norway (SSB, 2024), the proportion of people over the age of 80 will almost double by 2050, which will put pressure on existing health and care services.

In this context, the use of autonomous drones has been explored as a potential solution to streamline logistics, reduce transportation costs and ensure delivery of food, medicine and other necessary goods. Internationally, such systems have already been tested and implemented in various contexts. The UK's National Health Service (NHS) has carried out several projects in which drones transport blood samples between hospitals and laboratories, which has led to reduced treatment times and increased efficiency in the healthcare system (NHS, 2023). In Norway, the project in Røros is among the first attempts to use drones for regular home deliveries in the municipal sector, making this a pioneering and innovative initiative.

The purpose of this project is to evaluate whether autonomous drones can serve as a sustainable solution for the home care service in Røros municipality. By analyzing both the technical and operational aspects of drone transport, as well as assessing the social acceptance and economic sustainability of the service, this report seeks to answer the following research questions:

- To what extent can autonomous drones streamline the delivery of food and essential goods to homebound users compared to traditional methods?
- What are the biggest technological, regulatory and operational challenges related to the use of drones in home care?
- What impact can autonomous drone deliveries have on the carbon footprint of municipal service offerings?
- How does the use of drones affect the users' experience of the service, and what role can this technology play in reducing loneliness among the elderly?

The report is based on quantitative data from test flights, qualitative feedback from users and healthcare professionals, and comparisons with international experiences.

2. Background and context

2.1 Demographic challenges and the need for new logistics solutions

Røros municipality currently has a population of approximately 5,500 inhabitants, and is facing significant demographic change in the coming years. As of 2024, 22 percent of the population is over the age of 67, and the number of people over the age of 80 is expected to increase by 98 percent by 2050 (SSB, 2024). Such a development will lead to increased demand for home care services and require new and more efficient solutions for the distribution of food, medicines and other necessary goods to elderly people living at home.

At the same time, statistics from the Norwegian Directorate of Health (2023) show that the number of healthcare workers per inhabitant in rural municipalities is declining. This creates challenges for home care services, which already have limited resources and often have to deal with long transportation distances. Traditionally, the home care service in Røros has used car-based deliveries, where employees drive municipal vehicles to deliver meals to users living at home. This involves significant costs in terms of time, fuel and CO_2 emissions. To illustrate this, the weekly mileage for the home care service in Røros municipality is estimated at approximately 6,250 km, which corresponds to over 325,000 km per year. This leads to high operating costs and significant environmental impact. If autonomous drones can take over some of these deliveries, this could contribute to a more efficient use of the municipality's resources, while significantly reducing greenhouse gas emissions.

In light of these challenges, Røros Municipality, in collaboration with Aviant AS and Green Flyway, has carried out this pilot project to test whether autonomous drones can replace or supplement traditional food deliveries. The purpose has been to investigate whether drones can help to:

- Reduce time and resource consumption in home care.
- Minimize greenhouse gas emissions from the transport sector in the municipality.
- Create a more flexible and predictable delivery system for users.
- Explore the possibility of direct home delivery rather than fixed delivery points.

2.2 National and international experiences with drone deliveries

The use of drones in logistics services has increased significantly in recent years, particularly in medical transportation and goods delivery in areas with demanding infrastructure. The UK's National Health Service (NHS) has implemented drone transportation of blood samples and medical specimens between hospitals, reducing transport times by up to 50 percent (NHS, 2023). In Africa, the organization Zipline has used drones to deliver medicines and vaccines to remote areas, improving access to vital healthcare in regions with limited infrastructure (Zipline, 2022).

In Norway, drones have primarily been used for commercial purposes, such as photography, inspection and surveillance, but Aviant AS has been one of the leading players in testing autonomous drone transportation in the healthcare sector. The company has completed several successful projects demonstrating how drones can be integrated into both healthcare and logistics services.

Among the most important projects are:

Nordre Land municipality (2023-2024): In this project, Aviant has tested regular drone deliveries of medicines from pharmacies to elderly people living at home. The aim was to ensure faster and more precise deliveries in areas where the nearest pharmacy is far away. The results showed that the drones could deliver medicines up to 60 percent faster than traditional car transport, while reducing transportation costs for the municipality.

Torslanda and Björkö, Sweden (2023): Aviant conducted a pilot project on the Swedish west coast to test drone deliveries of medicines and blood samples between the mainland and island communities. The project showed that drones could be a stable and reliable solution for medical transportation to areas with limited infrastructure, and the results form the basis for further implementation in Scandinavia.

Funäsdalen, Sweden (2022-2023): In partnership with Green Flyway, Aviant operated drone transportation of blood samples between Funäsdalen and Östersund. This was one of the first projects in Scandinavia to test long-distance drone deliveries for the healthcare sector, showing how autonomous drones can reduce transportation times between medical laboratories in rural areas.

Kyte - commercial drone deliveries to private individuals: Since 2023, Aviant has also operated Kyte, a commercial service for autonomous home delivery of goods to private individuals. Kyte is already operational in Lillehammer, Sjusjøen and Trondheim, where customers can order groceries and medicines via an app and have them delivered by drone. This is one of the first examples in the Nordic region of drones being used for direct deliveries to the private market, and experience from here shows that the technology works in both urban and rural areas.

The project in Røros builds on this expertise and marks an important step towards testing drone transport as an integrated part of home care.

3. Project partners and collaboration

The project was carried out as a collaboration between Røros Municipality, Aviant AS and Green Flyway, with support from research environments and local stakeholders. Each of the parties played a central role in the planning, implementation and evaluation of the pilot project.

3.1 Røros municipality

Røros Municipality initiated the project as part of its efforts to develop sustainable and efficient solutions for home care services. The municipality provided the necessary infrastructure and access to health and care services to test how drone deliveries could relieve home care services and improve the logistics of food and medicine distribution.

Røros municipality also contributed with user involvement, by identifying participants for the project and facilitating interviews and feedback from both users and healthcare professionals.

3.2 Aviant AS

Aviant AS is a leading player in autonomous drone transportation in Scandinavia, with experience from more than 5,000 flights for the healthcare sector, municipalities and private operators since 2021. In order to carry out autonomous drone operations in Norway and Sweden, Aviant has worked closely with national and international aviation authorities to ensure that all operations meet current safety requirements.

Aviant has developed operating procedures according to EASA (European Union Aviation Safety Agency) guidelines for unmanned aircraft and has achieved SAIL-II certification for Beyond Visual Line of Sight (BVLOS) operations in several regions. This means that the drones can operate without a pilot having visual contact, which is crucial for efficient drone delivery over longer distances.

The company has also collaborated with the Norwegian Civil Aviation Authority to develop guidelines for the safe use of drones in the healthcare sector. Furthermore, Aviant has been part of the Green Flyway project, a Scandinavian test collaboration for electric aviation and autonomous drones.

3.3 Green Flyway

Green Flyway is a Scandinavian innovation project focusing on the testing and development of electric aviation and drone technology. The project is a collaboration between actors in Norway and Sweden, and Røros is one of their test arenas for green aviation. Green Flyway had an important role in:

- Provision of airspace for BVLOS (Beyond Visual Line of Sight) operations.
- Regulatory work and applications to the Norwegian Civil Aviation Authority to obtain the necessary permits for drone flights.
- Collaborate with research communities to analyze environmental impact and potential scaling opportunities.

3.4 Other partners

In addition to the three main partners, several other actors contributed to the project:

- Coop Glåmos and Coop Brekken, which served as delivery points and helped facilitate the receipt of goods.
- The janitorial service in Røros, which tested how drones could be used to transport small goods and equipment.
- Research environments, including NTNU and SINTEF, who followed the project to assess energy efficiency, climate benefits and technological challenges.

4. Project implementation and work packages

The project was structured in five work packages covering everything from planning and regulation to operational testing and feasibility studies for further operations.

Arbeidspakker	Leveranser	Pris (KNOK)	Frist for leveranse
AP1: Demo av droneleveranse	L1.1 En demolevering med drone på Røros i forbindelse med «Green flyway 2»	50	Mai 22
AP2: Risikoanalyser og regulativ godkjenning	L2.1: Risikoanalyse av flyruter. L2.2: Godkjenning til gjennomføring.	100	August 20
AP3: Droneflyvninger på Røros	L3.1: 2 måneder med flyvninger, 4 dager i uken.	400	1. Okt - 1. Des
AP4: Mulighetsstudie av drift for kommunen	L4.1: Dialog med kommune om hva drone kan bidra med. L4.2: Klargjøring av de mest lovende bruksområdene.	50	1 Jan 2025
AP5: Rapport	L5.1: En oppsummering av flyvninger, økonomisk potensiale og andre definerte resultater	50	1 Jan 2025

Fig 1 - structure of project and work packages

4.1 Work package 1 - Demonstration of drone delivery

The first phase of the project included a demonstration of the drone technology to create understanding and acceptance in the local community. On May 21, 2024, a test flight was carried out from Røros Airport to Skistuggu, where the drone delivered a test load consisting of two non-alcoholic beers from Røros Bryggeri.

Preparations for this demonstration included 1) risk assessments, 2) flight geography analysis and 3) coordination with airport authorities. The Civil Aviation Authority was consulted to ensure that operations complied with applicable regulations and a detailed flight plan was prepared. Neighborhood notices were sent out to affected households to ensure local acceptance.

The flight itself was carried out at an average speed of 65 km/h, and the drone took six minutes each way. The delivery was carried out using a winch and the entire operation was completed in less than 15 minutes. This demonstration helped to show that the drone technology could work under controlled conditions, but also that factors such as weather and infrastructure had to be taken into account in further planning.

4.2 Work package 2 - Regulatory approval and route planning

Following the initial demonstration, a comprehensive regulatory process was carried out to ensure that the operations complied with national and international aviation regulations. The Norwegian Civil Aviation Authority approved the project following an assessment of operations manuals, risk assessments and technical specifications.

To ensure safe flight routes, detailed analyses of airspace, 4G coverage and ground risks were conducted. The delivery points were strategically placed at Coop Glåmos and Coop Brekken to ensure easy access, while minimizing the risk of conflict with residents. Early dialogue with the local community showed that some neighbors were skeptical about noise and the visibility of drones in the immediate area. Therefore, an information process was established where affected parties were given access to details about the project and operational procedures.

To monitor the drones in real time, Remote-ID was implemented, making them visible in the UTM system. This ensured that both air traffic controllers and other aviation operators had an overview of the drone's position.

4.3 Work package 3 - Operational drone flights

The main part of the project consisted of operational drone flights between Øverhagaen BHVS and the delivery points at Coop Glåmos and Coop Brekken. A total of 46 flights were conducted over a period of 25 operational days.

Preparations and start-up

Before the operational flights could begin, several preparations were made. One of the first tasks was to establish an operational base at St. Olav's Røros that served as a starting point for all flights. The base was equipped with the necessary infrastructure, including charging stations for the drones, communication equipment and safety materials.

Subsequently, detailed flight routes were developed based on previous risk analyses and regulatory guidelines. These routes were tested through simulations in the planning tool before the first operational flights. The delivery points at Coop Glåmos and Coop Brekken were prepared, and signage and information posters were put up to inform the local community about the project.

The biggest challenge in this phase was to ensure stable 4G coverage along the flight routes. Previous analysis showed that some areas had weak signals, which could lead to temporary loss of communication with the drone. This was solved by optimizing the routes to avoid low-lying areas with limited coverage.

Execution of the flights

The first operational flights started with a series of test deliveries where the drone carried dummy loads to verify stability, navigation and delivery precision. These tests were carried out in various weather conditions to assess the drone's performance in realistic scenarios. After successful tests, regular deliveries for the home care service began. The deliveries were carried out four days a week and followed a set schedule where the drones picked up food packages from St. Olavs Røros and transported them to Glåmos and Brekken.

The flights showed that the drone was able to maintain high precision deliveries and that the winch system worked reliably. Deliveries were made faster than traditional road transportation, with an average reduction in delivery time of 23-33%, depending on the destination.

Challenges:

Weather conditions proved to be one of the biggest challenges in the project. In total, 38 flights were canceled, of which 31 before takeoff and 7 en route. The main reasons were strong winds of 13 m/s or more, fog and 4G connectivity issues. It is important to point out that the flights were carried out during the windiest months in Røros and that, later in the project, there were gradually more stable conditions and a lower cancellation rate.

In addition to wind problems, four flights were aborted due to icing on wings and flaps.

Another challenge was that the food deliveries were scheduled for specific times, but the recipients were not always present. This meant that some deliveries had to be temporarily stored at the delivery point, which required extra coordination between the drone operators and healthcare professionals. However, it was a good solution for users, healthcare professionals and the store, as things moved quickly and the user could walk into the store and perhaps do some shopping at the same time.

Overview of flights

Category	**Number of flights**	**Remarks**
Total flights with cancellations.	46	Number of flights including Kyte deliveries and janitorial services
Flights with food deliveries	23	Dinner delivered to Glåmos and Brekken
Flights with other goods	8	Included deliveries to caretakers
Flights with medicines	1	Real medicine delivery by drone
Kyte flights	7	Food deliveries to private customers

Canceled flights en route	7	Wind, 4G challenges, fog, icing
Cancelled flights before departure	31	Wind of 13 ms/ or more

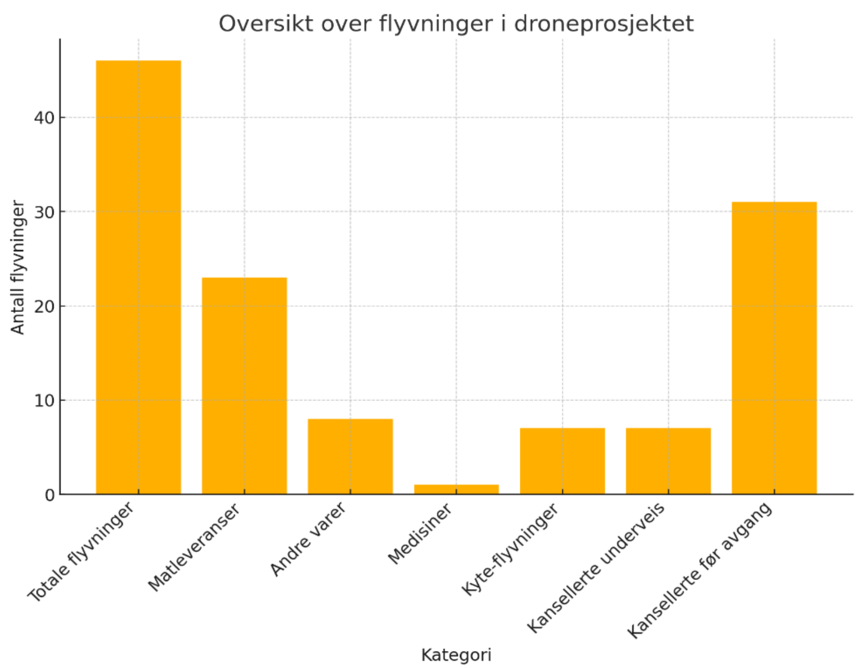


Figure 2 - Overview of completed flights

Weather challenges and cancellations

The weather conditions at Røros proved to be one of the biggest operational challenges in the project. In total, 39 flights were canceled due to unfavorable conditions, of which 32 were canceled before takeoff, and 7 had to be canceled en route.

Main reasons for cancellations:

Strong winds**:** Four flights were aborted in the air due to wind speeds in excess of 12 m/s, making it unsafe to continue deliveries.

Icing**:** On four occasions, icing was recorded on the drone, affecting aerodynamics and leading to flight cancellations.

Fog**:** On some days, the fog density was so high that the drone could not operate safely, even with visual inspections before take-off.

To address these challenges, operating hours were adjusted so that as many flights as possible were carried out in the afternoon, when weather conditions were more stable.

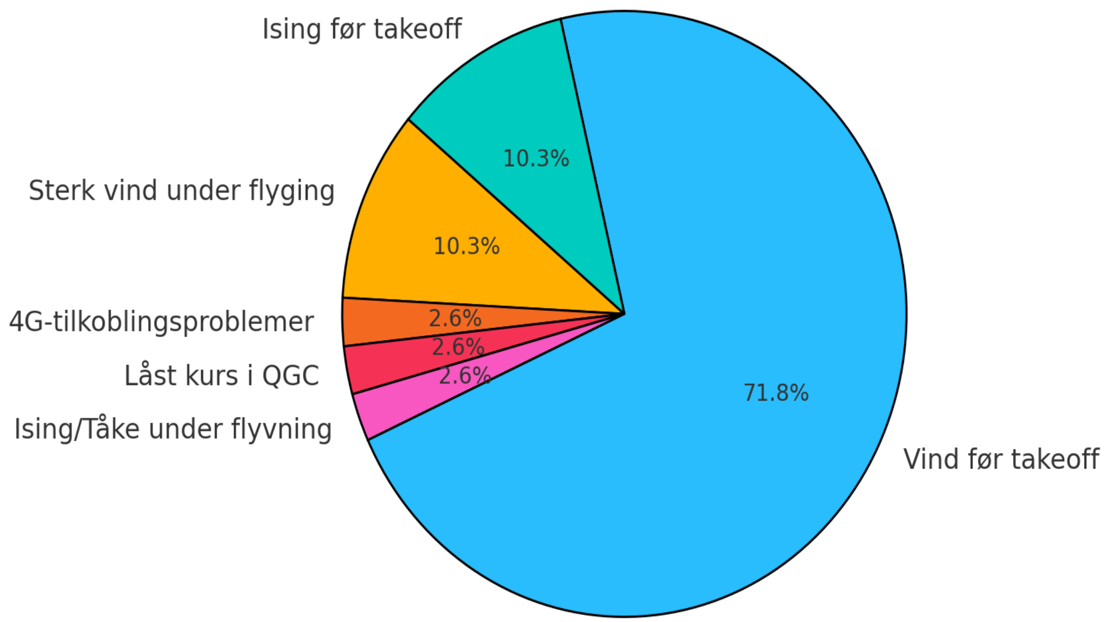


Figure 3 - Distribution of reasons for canceled flights

User acceptance and community feedback

An important part of the project was to assess how drone technology was received by users and the local community. Interviews were conducted with healthcare professionals, food delivery recipients and local residents to gather feedback.

<u>Feedback from healthcare professionals:</u>
Several home care staff expressed that the drones had the potential to relieve them, especially on busy days. Some felt that the technology could be even more valuable if it could deliver directly to patients' homes, rather than to central delivery points.

<u>Feedback from users:</u>
Recipients of food deliveries reported that the drones delivered the food within acceptable temperature limits, but some wanted more flexibility in the time of delivery. Some older users also expressed skepticism about the technology, but acceptance increased as the drones became more visible in the local community.

<u>Feedback from the local population:</u>
There was generally a lot of interest in the project, and several people expressed the wish that the technology could be used for other purposes, such as medical deliveries or emergency transportation. However, some neighbors of the delivery points at Glåmos expressed dissatisfaction with noise and signage, which led to information posters being moved and light installations adjusted.

4.4 Work package 4 - Feasibility study for long-term operation

Throughout the project, it became clear that drone technology has significant potential to streamline home care services in Røros municipality, but that the technology still needs to mature in order to operate on a larger scale and in more complex environments. In the current pilot project, deliveries were made to fixed delivery points, but in order for drones to relieve the home care service to an even greater extent, solutions must be developed that enable deliveries directly to users' homes.

The municipality recognizes that if drone technology is further developed to fly in more urban areas and carry out precise door-to-door deliveries, the need for such services will increase considerably. Scaling up this technology could make it possible to relieve healthcare professionals by automatically delivering necessary supplies such as food, medicines and medical equipment to people living at home. This could free up time for healthcare professionals and ensure more efficient deliveries, especially during peak service periods. To gain a better understanding of how drones can be implemented on a larger scale, there is a need for more pilot projects that can investigate the technological and logistical challenges associated with fully integrated operations in home care. Such projects should focus on both technical aspects such as weather robustness, as well as regulatory and societal factors such as safety, community acceptance and financial sustainability.

Further projects will be able to map current routines in the home care service to identify which routes, areas and times can be relieved through the use of drones. This includes a detailed analysis of the frequency of deliveries, the type of supplies transported, and the proportion of deliveries that can be automated without affecting the quality of the service. Such a study will be crucial for developing a scalable and sustainable model for drone deliveries in the municipal sector. By analyzing operational data and combining this with the experiences of healthcare professionals and users, it will be possible to draw up concrete recommendations for further development and implementation. It is also important to consider the interaction between drones and existing means of transportation to ensure an optimal combination of technologies.

Further testing will therefore be necessary to ensure that autonomous drones can become an integral part of home care services in the future. Røros municipality considers this an important area of innovation and will, in collaboration with Green Flyway, continue to explore the possibilities of expanding the use of drones in the health and care sector.

4.5 Work package 5 - Project report and evaluation

The evaluation of the project built on the findings of the feasibility study and aimed to assess the extent to which drone deliveries could be integrated into home care services in Røros municipality. The project represented an important milestone for Green Flyway, as this was one of the first long-term test projects with a municipal player as a customer. The results showed that the technology has great potential, but that there is a need for further testing and a gradual implementation process to realize the full benefits.

Compared to previous drone technology pilot projects in Norway and Scandinavia, the test period in Røros was particularly valuable. Green Flyway conducted a long-term operational test with the municipality of Røros as a real customer, which made it possible to evaluate the service in an actual operational context, rather than through short-term demonstrations. This was a unique step in the development of autonomous drone delivery in the public sector.

The results of the project confirmed the assumptions that drones can streamline food and medicine distribution in rural areas. At the same time, the test period revealed several operational challenges, particularly related to weather conditions and the need for more flexible delivery solutions.

One of the key learnings from the evaluation was that the duration of the test period played a crucial role in collecting relevant data and assessing community acceptance. During the two months of operation, a growing understanding and acceptance of drone delivery was observed among both users and the local community. This strengthens the argument that future test projects should have an even longer duration to ensure that all factors, including seasonality and changes in service needs, are thoroughly analyzed. Further implementation of drone technology in home care depends on the technology becoming even more robust and reliable in demanding weather conditions. It is also necessary to explore how drones can be integrated with the municipality's other transportation infrastructure to create a hybrid model where drones supplement car-based deliveries.

Another important factor is how the service can be scaled financially. The project showed that drone deliveries can be cost-effective, but broader implementation requires a thorough assessment of operating models and financing. The evaluation therefore recommends that further pilot projects look at how drones can be part of a cost-effective and sustainable transportation model for home care.

Dato	Matleveringer	Medisinleveringer	Kyte	Test	Kansellert in flight	Kansellert før flight	Luftfartøy	Oppsummering	Flyvninger
30. September 2024	1					0	NT15, NT16	Første demonstrasjonsflyvning fullført med Greenflyway og Røros helsevesen. Flyvning til Glåmos gikk etter planen. Levering av middag og dessert (874g).	Flight #5507: Rute transportlevering, OK
1. oktober 2024	1					0	NT15, NT16	Mange besøkende inkludert NRK og ordføreren. Perfekt flyvning til Glåmos.	Flight #5516: Rute transportlevering, OK
2. oktober 2024	1		1			0	NT15, NT16	To leveranser, én til privatkunde og én til helsevesenet. Noe misnøye fra nabo i Glåmos.	Flight #5517: Kyte Rute transportlevering, OK; Flight #5519: Rute transportlevering, OK
3. oktober 2024	2			1		0	NT15, NT16	Stor interesse på Røros, første flyvning til Brekken. Utførte manuell levering.	Flight #5525: Rute transportlevering, OK; Flight #5534: Flyvning fra Brekken til Røros; Flight #5544: Rute transportlevering, Manuell levering
7. oktober 2024	1					1	NT15, NT16	Avbrøt operasjonsdag etter én flyvning på grunn av sterk vind.	Flight #5580: Rute transportlevering, OK Vindfull flyvning
8. oktober 2024						2	NT15, NT16	Operasjonsdag avlyst på grunn av sterk vind.	Ingen flyvninger
9. oktober 2024						2	NT15, NT16	Operasjonsdag avlyst på grunn av sterk vind.	Ingen flyvninger
10. oktober 2024						1	NT15, NT16	Operasjonsdag avlyst på grunn av sterk vind.	Ingen flyvninger
14. oktober 2024			1		1	1	NT15, NT16	En produktiv dag med mange små oppgaver. Leveransen på flyvning to ble avbrutt på grunn av vind.	Flight #5603Kanselert i loiter: Kansellert; Flight #5607: OK
15. oktober 2024				1	1	2	NT15, NT16	Levering av mat avlyst på grunn av 4G-tap. Feilsøkte fail-safe-problemer.	Flight #5608: Temperaturtest; Flight #5609: Flere feil, men returnerte trygt.
16. oktober 2024	2			1		0	NT15, NT16	Perfekt dag, tåke lettet etter kl. 12. Leveringer til Glåmos.	Flight #5614: Temperaturtest; Flight #5615: OK; Flight #5617: OK
17. oktober 2024						1	NT15, NT16	Ingen flyvning på grunn av sterk vind.	Ingen flyvninger
21. oktober 2024						2	NT15, NT16	Operasjonsdag kansellert på grunn av sterk vind.	Ingen flyvninger
22. oktober 2024				2		2	NT15, NT16	Levering av mat kansellert på grunn av vind.	Flight #5643: Vindtest, kansellert; Flight #5646: Svevetest.
23. oktober 2024			1			1	NT15, NT16	Gjennomførte leveranse til en Kyte-kunde. Avlyste helsetjenestelevering på grunn av sterk vind.	Flight #5649: OK.
24. oktober 2024			1	1	1		NT15, NT16	Besøk fra DSV. Perfekt demoflyvning.	Flight #5653: hover på 80m; Flight #5658: Demoflyvning, OK. Flight #5662
25. oktober 2024			1				NT15	Gjennomførte én flyvning for innhold med 360-kamera.	Flight #5663: OK.
28. oktober 2024						2	NT15	Ingen flyvninger på grunn av vind (13 m/s).	Ingen flyvninger
29. oktober 2024			1		1	2	NT15, NT16	Mistet Insta 360-kamera. Dialog med helsetjenesten om å fly før vinden øker.	Flight #5670: OK; Flight #5671: Kansellert pga. vind.
30. oktober 2024						2	NT15, NT16	Operasjonsdag kansellert på grunn av kraftige isingsforhold.	Ingen flyvninger
31. oktober 2024						1	NT15, NT16	Operasjonsdag kansellert på grunn av kraftige isingsforhold.	Ingen flyvninger
4. November 2024	2					0	NT15	Perfekte flyforhold. NT15 ble satt på bakken grunnet gnistrende QS8-kontakt.	Flight #5701: OK; Flight #5703: OK.
5. November 2024	2					0	NT16	Gode værforhold. NT16 viste bedre 4G-dekning enn NT15.	Flight #5707: OK; Flight #5709: OK.
6. November 2024						2	NT15, NT16	Operasjonsdag kansellert på grunn av kraftige isingsforhold.	Ingen flyvninger
7. November 2024			1				NT15, NT16	3-4 flyvninger planlagt, men kun én utført pga. isingsforhold.	Flight #5723: OK.
11. November 2024	2					0	NT15	To flyvninger til Glåmos gikk knirkefritt, noe is på vingene etter første flyvning.	Flight #5743: OK; Flight #5747: OK.
12. November 2024				1		0	NT15, NT16	Vel gjennomført demoflyvning med flere viktige deltakere til stede.	Flight #5764: OK, Manuell levering.
13. November 2024	2					0	NT15, NT16	Perfekt flyvær, to leveranser for helsetjenesten fullført.	Flight #5771: OK; Flight #5772: OK.
14. November 2024						1	NT15, NT16	Operasjonsdag kansellert på grunn av kraftige isingsforhold.	Ingen flyvninger
18. November 2024						2	NT15, NT16	Operasjonsdag kansellert på grunn av kraftige isingsforhold.	Ingen flyvninger
19. November 2024	2					0	NT15, NT16	Leverte varm mat til Glåmos, og planla demoer for skoler.	Flight #5802: OK, Varm mat; Flight #5804: OK, Varm mat.
20. November 2024					1	2	NT15, NT16	Avlyste levering av pizza til Glåmos pga. tåke og ising.	Flight #5808: Kansellert pga. tåke.
21. November 2024					1	1	NT15	Demonstrasjon for skolebarn, logg måtte trekkes ut manuelt.	Flight #5810: OK, Leveranse avlyst pga. vind.
25. November 2024	1				1	1	NT15, NT16	Gjennomførte én flyvning før vinden økte og avlyste videre leveranser.	Flight #5816: OK; Flight #5817: Kansellert pga. vind.
26. November 2024	2	1				0	NT15	Første levering av reseptbelagte medisiner fra Røros til Brekken.	Flight #5818: OK; Flight #5822: OK; Flight #5823: OK.
27. November 2024	2					0	NT15	To leveranser til Glåmos. Gikk veldig bra.	Flight #5829: OK; Flight #5828: OK.
28. November 2024				1		0	NT15	Vellykket demo for videregående skole, NRK og Airdodge.	Flight #5832: Demoflyvning, OK.
SUM	**23**	**1**	**7**	**8**	**7**	**31**			

Figure 5 - overview of all live flights performed in the project

6. Work package execution

This section outlines the implementation of the five planned work packages for the drone pilot project at Røros. Each work package was successfully completed and contributed to the overall goals of the project.

6.1 Work package 1 - demonstration of drone delivery

Skistuggu in Røros 21.05.2024

The first work package involved demonstrating a successful drone delivery to showcase the potential of the technology. A flight was conducted between Røros Airport and Skistuggu.

6.1.2 Planning

A risk analysis and route planning was carried out to ensure a safe BVLOS operation. A flight geography was created that we also used later for work package 2, but with some adjustments. Flight geography is an area we create that we can fly within, in this area we must assess all ground and air risks, see more info in work package 2. Coordination with the flight tower and airport was carried out in advance via email about access to the airport and who we should talk to when the operation was carried out.

Aviant had to provide a description of flight plans and times.

It was coordinated with GreenFlyway what we should deliver and where the recipient of the package should stand for and maintain safety distances. There were about 20 people present when the delivery was made.

6.1.3 Implementation

At 10:00 a.m., Aviant showed up at Røros Airport and gained access to an area at the south end where we could set up the drone and see that everything was ready before the demo flight. We operated with one pilot who did the Ground Crew job at the same time. The demo flight was carried out at 14:00. The pilot talked to Lars Erik Fagernæs from Aviant during delivery. Lars Erik was responsible for informing people about what the drone did and how the system works. There was a successful delivery of two non-alcoholic beers from Røros brewery.

The flight time to Skistuggu was 6 minutes, delivery was made in 3 minutes and the flight time back was 6 minutes. Below are pictures of the takoff, flight route and delivery area.

6.2 Work package 2 - Regulations and route planning

All necessary permits were obtained from the Norwegian Civil Aviation Authority. As part of the preparations, extensive risk assessments were carried out to ensure the safety and efficiency of the operations. Delivery points were carefully selected to ensure access and minimize disturbances in the surrounding areas. Neighborhood notification and information was provided to affected communities to ensure community acceptance and reduce resistance *(see section 9 in report*) for more info on this.

Furthermore, the routes were visually presented using maps and digital tools to clarify the plans. Safety systems included integration with the Unmanned Traffic Management (UTM) system for digital visibility, as well as monitoring via HEMSWX. These measures helped ensure both operational safety and social acceptance of the project.

Our drones are equipped with Remote-ID, which allows us to appear in the SafeSky app. We tested this and our drones were visible 100% of the time, even when we lost 4G connection for a few seconds along the route.

HEMSVX contacted Greenflyway and Aviant at the start of the project to test a proprietary HEMSVX box that would pick up signals from the drone and provide a more precise position when flying close to the receiver. We quickly discovered that the box had a very low range, with an average of about 600 meters, and that it seemed less precise than our own Remote-ID system.

This was communicated to HEMSVX, and we agreed to leave the box on the base on the roof of the work truck for the duration of the project, so that they could collect data on activity in the lower airspace around Røros city center.

Risk	Probability of occurrence	Consistency	Measures
Wind over 12 m/s	Hay	Hay	Cancel flights
Limited 4G coverage	Low	Medium	Adjusting flight routes
Social resistance	Medium	Medium	Early dialogue and neighbor notification

Risk matrix

6.3 Work package 3 - Drone flights at Røros

During the operational period, flights were conducted four days a week on average with some variations due to weather conditions such as fog and wind. Mainly cold meals were delivered to users. In addition, two hot meals were delivered from Røros hospital to Coop Glåmos and three flights with successful temperature measurements. In one case, the drone had to return to base due to a lack of staff from Green Flyway at Glåmos. In collaboration with the local caretaker, we facilitated the delivery of books and essential hardware items such as nails and screws. This was something that the school, the library and the caretaker were very committed to. We collaborated well by phone on deliveries and goods. Aviant also had a day at Brekken school where they talked about the drone system to students, teachers, kindergarten and local people.

At the same time, we conducted flights for our Kyte food delivery service, which offers takeaway with drones to private consumers in the Røros area during hours when municipal deliveries were not scheduled. This allowed us to investigate the interest of the local population in the area. See *appendix 1* for a complete overview of all flights with time codes. The deliveries of cold meals were consistently successful.

6.4 Work package 4 - Feasibility study for long-term operation

In connection with the drone project in Røros, work was carried out to explore the financial, environmental and operational benefits of drone delivery services. The ambition was to create a feasibility study that could provide a comprehensive picture of how drones can be integrated into existing logistics and service provision in the municipality. However, as the project progressed, it became clear that the scope of such a study was greater than initially anticipated and that none of the parties had a full understanding of how extensive and resource-intensive this work would actually be.

To structure the work, weekly meetings were held between the project partners, where experiences, challenges and opportunities from the previous week were discussed, and measures for the coming week were planned. We also talked about what we could test during the project that the municipality would benefit from. These meetings contributed to an important exchange of experience, but were documented to varying degrees, making it difficult to use them as a direct part of a formal feasibility study.

On November 12, a conference and workshop was organized by Aviant, Greenflyway and Røros Municipality. Although the event was not specifically aimed at the feasibility study, drone opportunities for the municipality were discussed in the workshop. This provided valuable input on how drones can be used in different sectors, but was not sufficient to cover all aspects of a full analysis.

During the project period, several attempts were made to gather information on existing logistics and transportation needs to assess how drones could contribute as part of future solutions. This proved to be more time-consuming than expected, and access to relevant data was a challenge. An important lesson from the project is that a thorough feasibility study requires a more structured framework, as well as dedicated resources and more clearly defined roles for data collection and analysis. As well as insight into how the work is done today.

Although the feasibility study was not carried out in its original form, the project has provided valuable insight into how drone technology can be used in the Røros region. The work done forms an important starting point for further exploration of drone solutions, and the experiences from the project provide useful learning for future initiatives.

Figure 6 shows a picture of how delivery by drone can help when healthcare professionals are out to the user and have forgotten something from the hospital/residential center. As it is done today, healthcare professionals have to drive back to pick up the item. But with the use of a drone, healthcare professionals can order the item via an app and thus spend time with the user or drive to the next user while the drone flies out the item.

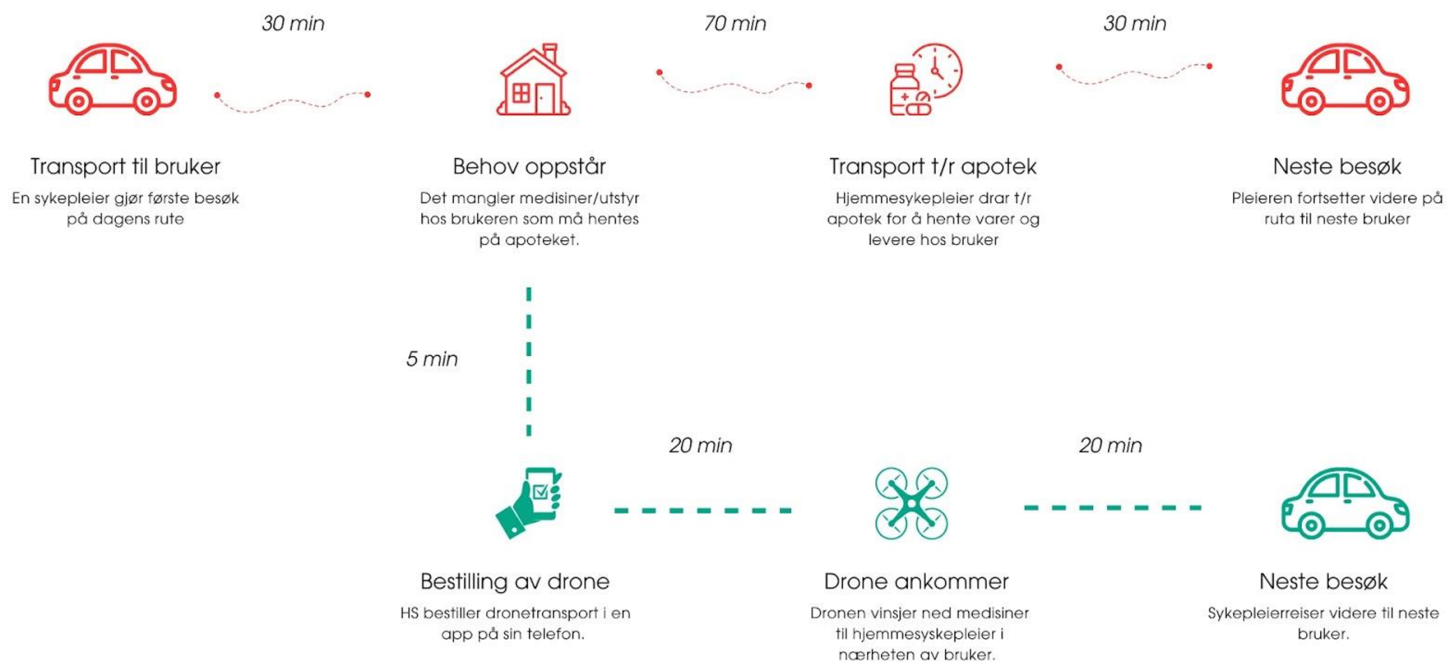


Figure 6 – Delivery by healthcare professionals

6.5 Work package 5 - Project report

This report summarizes all aspects of the drone project in Røros and includes a comprehensive review of collected data, environmental, economic assessments and stakeholder feedback. The report aims to provide a holistic picture of the project's results and act as a guide for the future development of autonomous drone solutions. The key findings include:

Data analysis:

- A total of 46 flights were completed, of which 23 were sharp flights for the delivery of food, and 8 were dedicated to the transport of other goods such as books, screws, 1 with medicines, 7 Deliveries of food to private customers, 7 Cancelled flights en route.
- Fuel and energy consumption was documented, with the drones using 0.32 kWh for flights to Brekken and 0.13 kWh to Glåmos, respectively, which is significantly lower than equivalent car transportation (13.36 kWh and 5.68 kWh for electric cars).
- The project documented a 96% reduction in CO_2 emissions compared to electric vehicles, based on life cycle calculations.

Stakeholder feedback:

- Positive feedback from users on the drone's delivery precision. They also had a couple of hot dinners delivered and found the food to be at an acceptable temperature.
- Local partners such as Coop expressed interest in continuing deliveries, especially for logistics to remote areas. They talked about how this could be an offer for people who live in the district and how this could help people stay there longer. The stores would probably also benefit from such a permanent solution to expand the range of goods from the larger store in Røros. "There used to be a more varied selection, such as freshly baked bread and hot chicken on Fridays. That's largely gone now.

Environmental impact:

- The project showed how the use of drones can help reduce local traffic congestion, emissions and energy consumption.
- A combination of data from NTNU and the project's own calculations estimates a total reduction of 98.5% in carbon footprint for drone transportation versus electric cars.

Economic assessment:

- Potential for reduced fuel costs and labor costs by replacing road transport for deliveries.
- Potential for future expansion into commercial deliveries, including private customer schemes through the Kyte service.

Identified challenges:

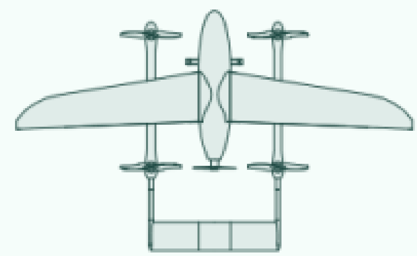
- Wind and fog were highlighted as key factors affecting operations, with four cancellations due to wind and one due to icing.
- Limited 4G coverage in some areas required careful route planning, but this was solved by adapting the routes to the terrain conditions.

It recommends increased focus on community acceptance and education ahead of future projects, as well as exploring alternative delivery locations to minimize neighbor-related challenges. It also suggests further development of drone models to improve weather and wind resistance.

7. Drone specifications

Two drones were used in this project: NT15, NT16. NT is short for Notus, the name of the Greek god of the south wind. Both drones are VTOL (vertical take-off and landing) aircraft. VTOLs are significantly efficient as they combine the vertical flight of a multi-rotor aircraft with the overflight of *a fixed wing* aircraft. This combination of techniques therefore provides a solution with several advantages, such as long range, high speed, efficient maneuverability, ability to hover smoothly and minimal horizontal space required to launch a VTOL aircraft as opposed to a fixed wing aircraft which requires a runway or a large open space.

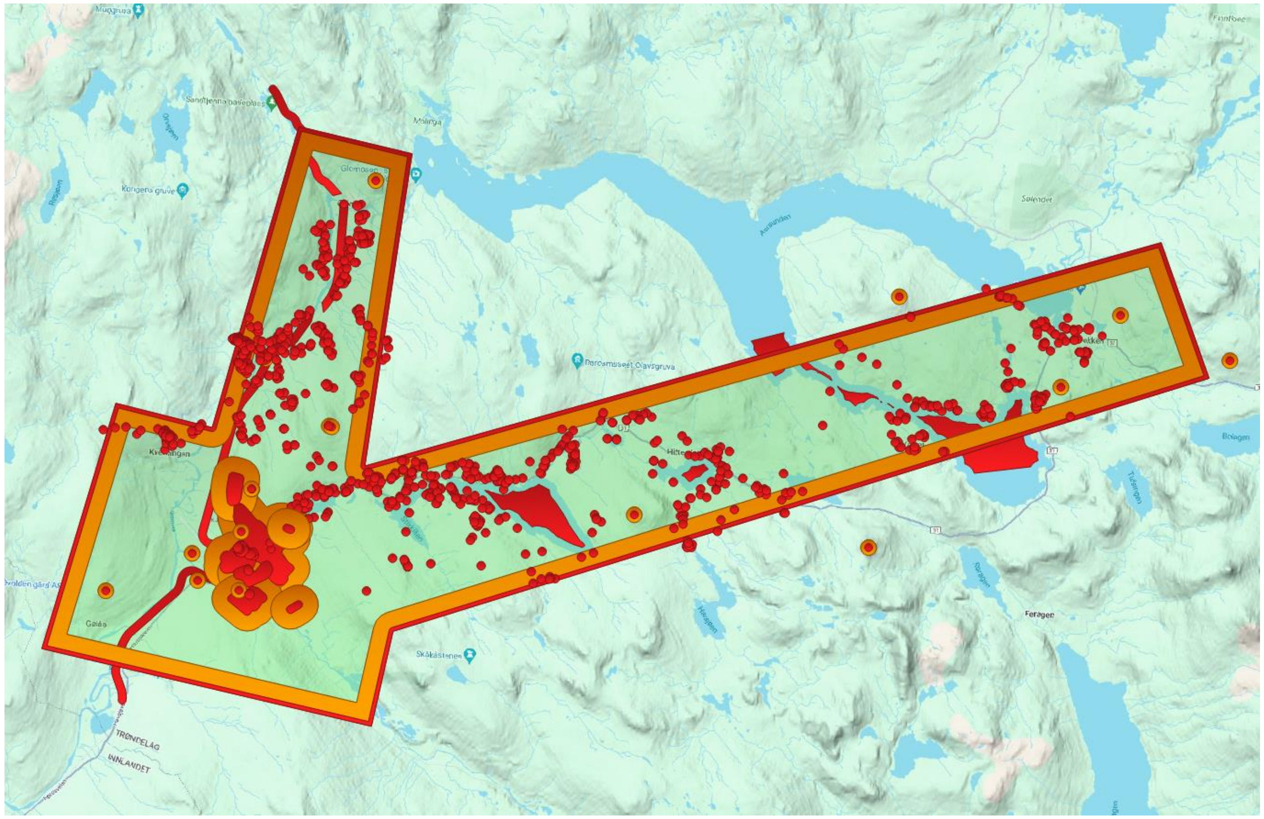
Type:	VTOL
Weight:	7.5 KG
Wingspan:	2.6 m
Max range:	135 KM
Max load:	2.5 KG
Speed:	95 KM/H
Battery:	40,000 mAh



8. Data from risk analysis

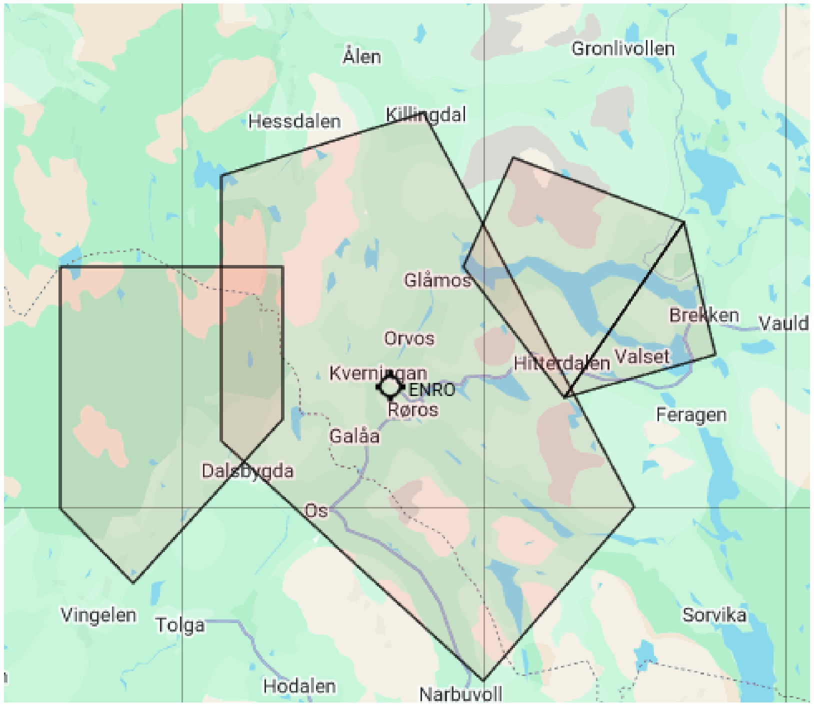
The flights in Røros encountered several operational challenges related to terrain and weather conditions. The analysis showed that:

- Wind speeds above 12 m/s resulted in cancellations in four cases. This affected 10% of scheduled flights.
- Fog created challenges at start-up, but the use of the DJI Mavic 2 Pro allowed manual assessment of the flight route.
- Mountainous terrain with limited 4G coverage was mapped and avoided when planning alternative routes.



Ground risk is shown in the image above with red and orange color

Schools, kindergartens, housing estates, Røros Airport, the town of Røros, lakes and roads



Map of airspace around Røros.

1. In the middle TIZ, Class G airspace ranging from 0FT to 4500FT
2. In the far west is a *danger area* that was last active in 2022
3. Furthest east are two danger areas that were last active in 2022

8.1 Assessed risks and strategies

- Weather such as wind, fog and temperatures were key challenges that were closely monitored. To address this, the HEMSWX real-time weather data system was used and operations were canceled when wind speeds exceeded 12 m/s.
- 4G coverage was analyzed. Mountainous terrain with limited coverage was avoided by choosing routes through flat terrain with stable signals.
- Flight routes were planned to minimize terrain gradients, reducing battery consumption and increasing operational efficiency.
- Landing sites are designed for safety and functionality, including demarcated areas to avoid accidents. Conflicts with neighbors at Glåmos highlighted the importance of early dialogue and community acceptance.

Risk mitigation strategies include

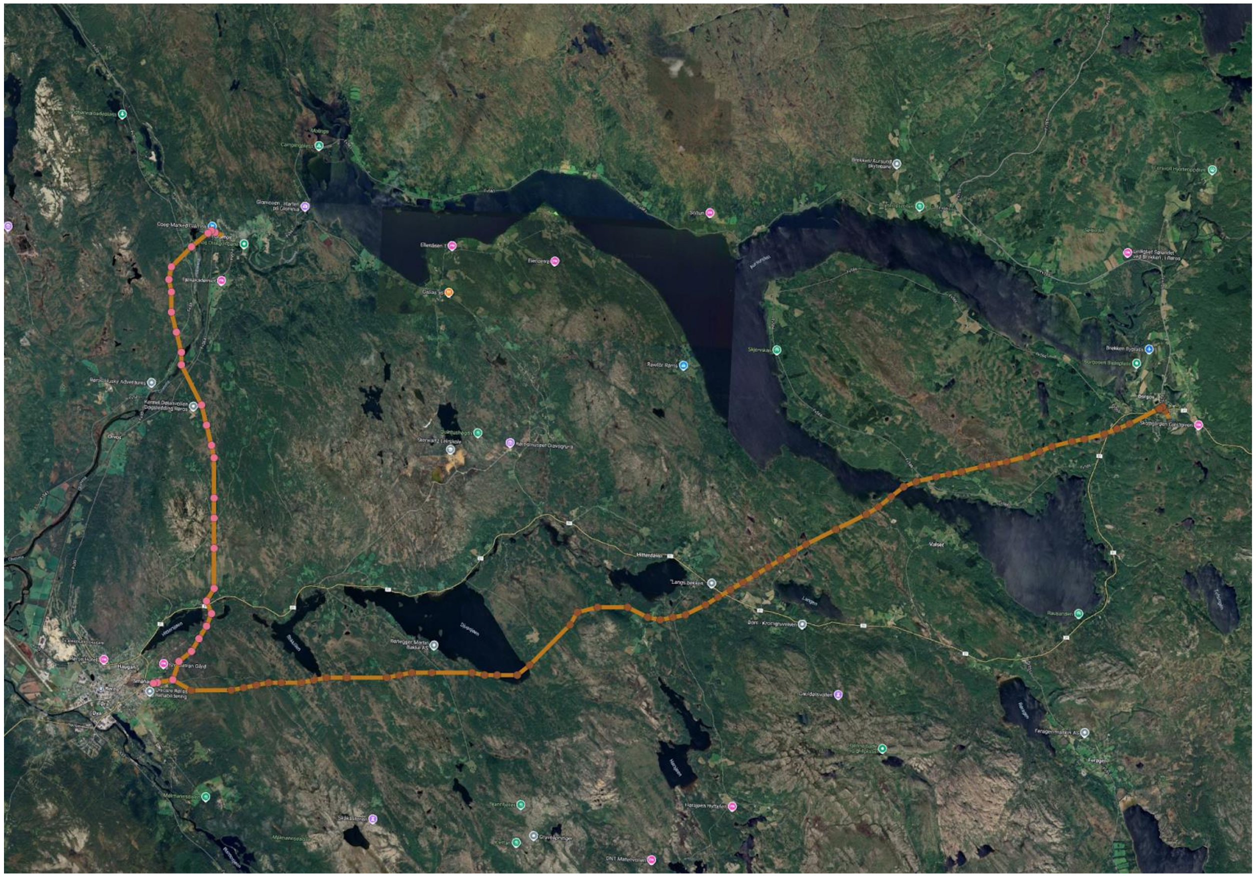
- Redundant failsafe systems to ensure drone stability in critical situations.
- Training of pilots in emergency handling.
- Use of advanced digital tools for route planning and monitoring.

8.3 Site analysis

The location analysis includes assessment of the flight from Øverhagaen BHVS to both Brekken and Glåmos. The analysis consisted of documentation of satellite overview, terrain maps, endpoints, alternative airspace and 4G coverage. These elements ensured that the route was safe and efficient.

8.4 Satellite overview

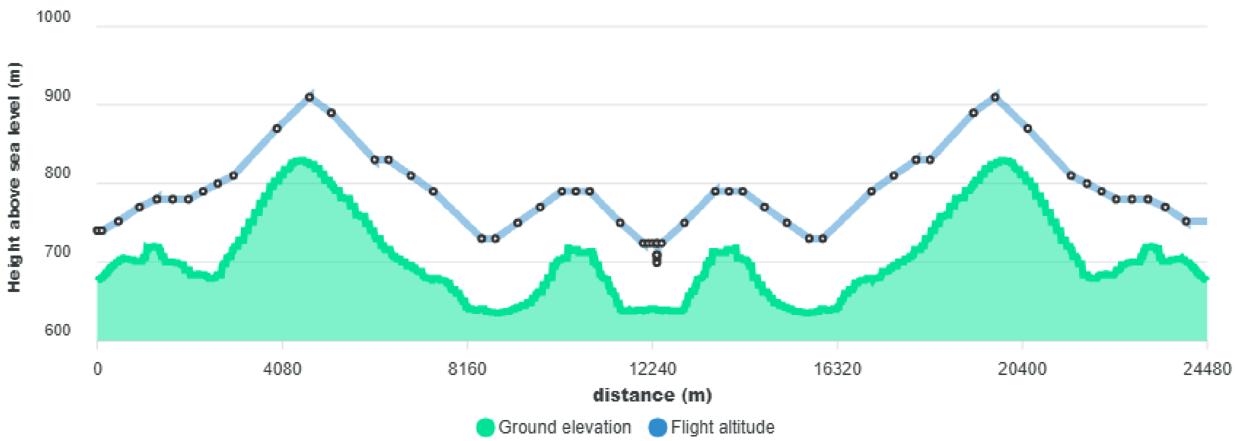
In the flight between Røros and Brekken and Glåmos, specific take-off and landing locations were identified. These locations took into account accessibility and safety, as well as minimizing noise and impact on the local population.



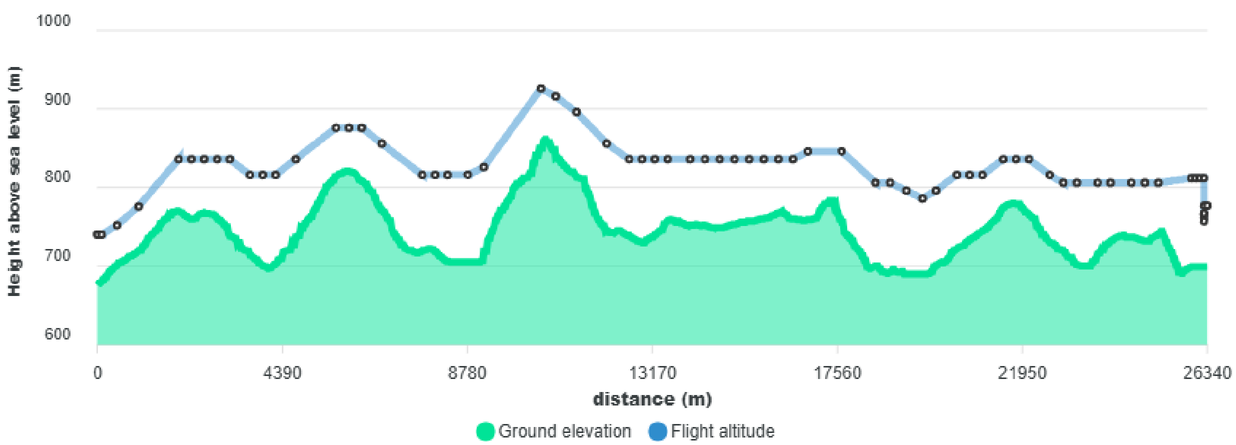
8.5 Overview of terrain maps

As shown in the terrain map and altitude profile below, the flight routes were chosen with a focus on the flattest possible terrain to reduce battery consumption. Flying in mountainous areas was avoided as much as possible due to high energy consumption and limited 4G coverage. This helped to ensure stable flights without technical interruptions.

Elevation profile



Elevation profile



8.6 Overview of endpoints and alternatives

Necessary documentation for flight mission plans was prepared in accordance with Aviant's operations manual. The route's take-off and landing points were assessed for accessibility, safety and local conditions. It was decided to place the delivery areas at Coop Brekken and Coop Glåmos instead of at customers' and users' homes, based on the following reasons:

1. Aviant has approval to operate scheduled transportation from fixed points throughout Norway. If we were to perform on-demand delivery end-to-end at Røros, this would have required an extensive application to the Norwegian Civil Aviation Authority, which has a processing time of several months. This could not be done before the start of the project.

2. It was also agreed with GreenFlyway and Røros municipality that they wanted to have delivery areas at the Coop stores to gather people there and make it a meeting point, where we in the project could also talk to people and gain more community acceptance. This seemed to be very successful as many people saw the drone and talked about the project.

The takeoff/landing platform was built by Aviant with sufficient lighting and signage about drone flying. Barrier tape was also set up.

The delivery areas were prepared by Røros municipality. Euro pallets were laid out and stakes were set down on which a barrier rope was hung. An information board was also erected at Glåmos and Brekken, close to the delivery platform, providing information about the project. Lights were also hung there that were automatically activated when it got dark.

Aviant drove by car and visited the neighbors of both the takeoff and delivery sites to inform about the project and its duration. Employees were greeted with a smile at the door and curious people who didn't see this as a problem, but rather thought it was good to have some activity in the area. No contact was made with a neighbor to the takeoff area before the start of the project as they had gone abroad on holiday. Nor was contact achieved with a neighbor to a delivery area before the start of the project.

These neighbors showed some dissatisfaction after the start of the flights. Aviant then visited the neighbors and provided better information about the project, and they then agreed that this would go just fine. One person did not want contact with Aviant or Greenflyway. Aviant attempted to call, visit and send a complementary SMS with information about safety procedures. The neighbor was supposed to get all the information from the municipality, so this was passed on to them, and Røros municipality took over the dialogue with the person. "This shows how important it is to have clear communication and information in advance of such projects. Especially when it's something completely new and unfamiliar that needs to be done.

Takeoff: Øverhagaen Health Center
Starting point in Røros

Øverhagaen BHVS is located 33.6 km west of Coop Breken and 15 km south of Coop Glåmos.

Delivery: Coop Brassen *in Glåmos*

The planned delivery location in Glåmos is close to the regional road and the Coop store.

Delivery *in Brekken*

The planned delivery point in Brekken is located in a small open area close to the Coop store on the association premises. A separate point was set for the delivery of packages by winch, about 100 meters away from the landing point. See red marking on the map.

8.7 4G coverage

Stable 4G coverage was essential to secure operations. Mountainous areas with limited coverage were mapped and avoided, and alternative routes were planned to ensure continuous communication between the drone and the control center.The blue color in the image below shows the areas with good 4G coverage by Telenor, providing high data rates and giving the operator a more stable video feed.

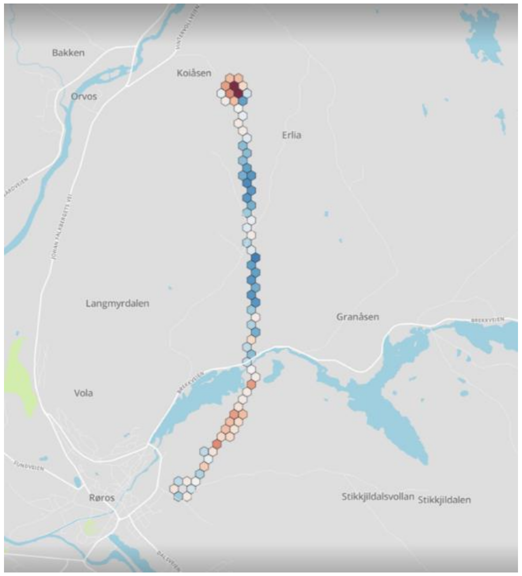
Coverage map: Telenor

Along the flight route to Glåmos, we discovered an area where the drone experienced a loss of 4G coverage. This is most likely due to the drone switching antennas for 4G during the flight. We have now found a solution to this, but during the project period the failsafe settings were adjusted so that the drone could tolerate loss of 4G coverage for up to 30 seconds, instead of the original 15 seconds.

One of the main issues we've identified with the quality of the 4G signal during drone operations is high noise levels. As the drone flies over the terrain, it is within the line of sight of several base stations. This causes it to receive signals from several neighboring towers at the same time, which disrupts the stability of the signal.

To mitigate this issue, we've enabled a feature that allows the drone to switch between different 4G frequency bands. This allows it to automatically select the frequency band with the lowest noise level at all times, ensuring more stable communication.

The image below shows a visualization of the 4G signal, with color codes for areas with good and poor coverage on the flights we did before the improvements.



9. Temperature data from food deliveries

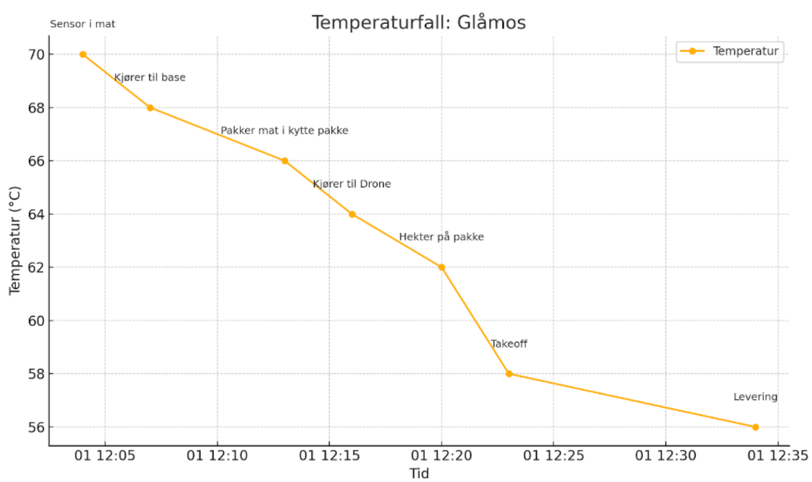
Maintaining the right temperature for food during transportation is crucial to ensure food safety and quality. Throughout the test period, temperature data was recorded for all food delivery flights to evaluate the drone's ability to maintain optimal conditions. The data highlights the system's ability to meet regulatory standards for food transportation. On these flights, the food maintained a temperature of approximately 50*C at serving and given the time taken for delivery, there is no risk of bacterial growth.

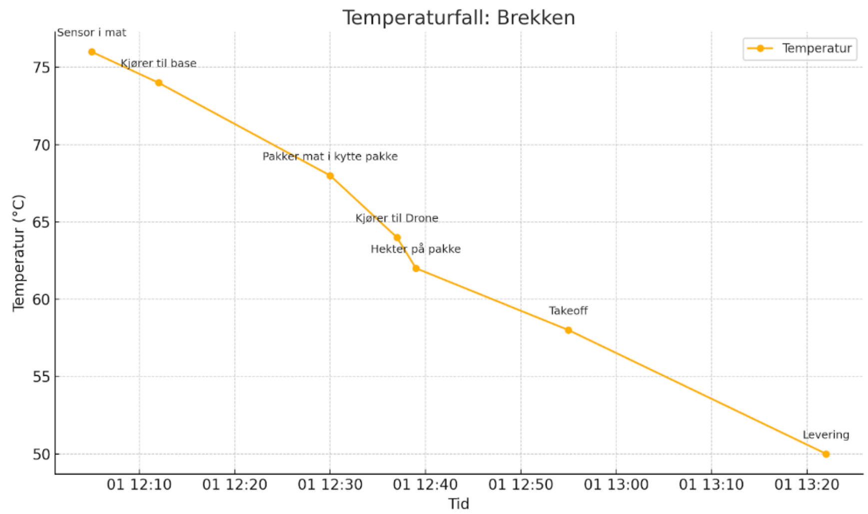
Ref § 13.Special provisions for heat treatment and heat retention

Food that is traded hot shall be given a heat treatment sufficient to prevent microbial growth and then kept at 60°C or higher.

With a view to delivery to the end consumer, the temperature during transport and serving may be lower than 60°C, if

this does not pose a health risk.





The images below show how Aviant packaged the food to retain temperature and protect the packaging.


10 Average time spent from start to finish per flight.

Times included ground handling of the drone, food pickup and driving, flight duration and delivery times.

1. Pre-flight preparation
    - Set up the drone and prepare for takeoff:
        - Time: 12 minutes
        - *Setup is done once a day.*
    - Pick up food in Øverhagaen/Hospital:
        - Time: 2 minutes/10 minutes
    - Prepare the package:
        - Time: 1 minute
    - Prepare for flight:
        - Time: 2 minutes
2. Time spent on multiple flights on the same day
    - Change the battery and prepare for the next flight:
        - Time: 5-6 minutes
        - *This applies to the completion of several trips in one day.*
3. Flight routes and delivery times
    - Flight route to Glåmos:
        - Takeoff and flight time: 9 minutes
        - Delivery time: 2 minutes and 30 seconds
    - Flight route to Brekken:
        - Takeoff and flight time: 17 minutes
        - Delivery time: 2 minutes and 30 seconds

With repeated flights in a row, this gives a total time spent (from drone landing to return to delivery point) of:

- Glåmos: approx. 16 min
- Breaking approx. 24 min

These figures show that we can make four deliveries per hour to Glåmos with two drones, and two deliveries per hour to Brekken. Further development of our systems, which we are working on, will enable the pilot to operate several drones simultaneously. This will further increase the number of deliveries per hour and at the same time make the service more flexible for multiple operators in the same time frame.

10.1 Time for canceled flights

Cases were also identified where flights were canceled at the landing sites due to wind. This meant that the drones had to return to Røros with the cargo, which was then taken out by car. This detour caused delays of up to 45 minutes for some users.

The municipality's involvement in receiving deliveries at the delivery points was an important part of the project and took place daily between 14:00 and 15:30. It was considered whether the deliveries could be carried out without the presence of the municipality, but two main factors supported continued participation. Firstly, the council's representatives acted as a valuable information resource at the delivery sites, helping to increase community acceptance and communicating the project's objectives to residents. This work was supplemented by Green Flyway, which actively participated in several of the deliveries to normalize the use of drone technology. Secondly, it turned out that some users with regular deliveries did not always show up at the agreed time. In these cases, healthcare professionals took over responsibility for storing the food in the Coop stores' refrigeration units until the user picked it up. This collaboration between the municipality and the local stores ensured that the food deliveries maintained their quality standards and were available to users in a convenient way.

11. Drones compared to road transport

11.1 Time savings

Autonomous drone transport significantly reduces delivery time compared to traditional road transport. For deliveries between Øverhagaen BHVS and Coop Brekken, travel time decreased by 33% (from 30 minutes to 20 minutes). For Coop

Glåmos, travel time is reduced by 23% (from 13 minutes to 10 minutes). These time savings increase service efficiency and provide a faster response to urgent delivery needs.

11.2 Reduced CO_2 emissions

In terms of the environment, using a drone to transport food has 99% less CO_2 emissions compared to a gasoline car and 95% less emissions than an electric vehicle. When we consider the lifecycle analysis of an electric car, we see that over a ton of raw materials, such as aluminum and lithium, need to be mined. The parts also need to be transported to the factory where the car is built, and it takes up to 10 tons of CO_2 equivalents just to produce the car. On the other hand, a drone has only 6 kg of materials and significantly less emissions are involved in producing it.

In this project, we have used an average of 0.32 kWh to fly from Røros to Coop Brekken and 0.13 kWh from Røros to Coop Glomås, where an electric car would use approximately 13.36 and 5.68 kWh for similar distances. This is 41 times as much energy. Over the past year, the energy mix in Central Norway has been approximately 31 grams of CO_2 equivalents per kWh (energiogklima.no). Daily driving between Røros - Brekken and Røros - Glomås corresponds to emissions of 0.15 tons of CO_2 equivalents, while a drone uses 0.005 tons of CO_2 equivalents. This corresponds to (0.15t - 0.0052g) / 0.1508g = 96.6% less CO_2 emissions when using a drone compared to an electric car if we only consider emissions related to power consumption during the actual transportation.

The calculations are taken from a master's thesis written at NTNU, where a full analysis was carried out of the distance between Røros and Trondheim, with daily trips over the lifetime of a car. The thesis concluded that there were 98.5% fewer CO_2 emissions when using a drone than an electric car.

12. Weather conditions and canceled flights

The weather in Røros, which is located inland in central Norway, is heavily influenced by the regional topography and prevailing wind patterns. Average wind speeds are highest in January, at around 14.5 m/s, and lowest in August, at around 7.9 m/s. This means that flights between Røros and destinations such as Brekken or Glåmos often experience headwinds in one direction and tailwinds on the return. Headwinds can extend the flight time by 5 to 7 minutes compared to tailwinds.

During deliveries, the pilot observes the wind conditions at the delivery location by circling the drone over the area. This allows the pilot to assess whether the wind speed is within operational limits. If the wind measurements are too high, even if it seems calm on the ground, the safest option is to abort the delivery and fly back. To onlookers, this may seem odd, especially if the gusts are few or sporadic. But as a pilot, you can't predict when the next gust will come, and safety must always be prioritized over waiting for conditions to calm down.

12.1 Limitations for wind:

To justify the Aviant's wind limitation, we have conducted countless tests during our flight time. Our 10 m/s wind restriction for the NOTUS 2.0 drone has several reasons. In short, some of the reasons are as follows:

1. **Range:**
   We need to limit the wind limit to achieve the range we want.
2. **Weight of package and performance:**
   We need to balance the MTOW (maximum takeoff weight) of the drone with the desired wind constraint. The heavier the drone, the more the engines have to work to keep the drone in the air, and the less surplus the engines have to counteract the wind.
3. **Winching:**
   When winching from a height of 60-70 meters, the package can sway up to 15 meters sideways when there is a 10 m/s wind. In our route planner, we make sure there are no tall objects within this radius, and we plan for areas where no objects are higher than 1 meter within a radius of 4 meters.
4. **Measurement**
   The way we measure wind in flight is an airspeed sensor that the drone is equipped with. and the limitation of the drone is more than 10m/s for a period of over 3 seconds.

12.2 Weather restrictions

The weather conditions in Røros can be challenging for drone operations, especially in terms of temperature, precipitation and wind. Based on climate data and experiences from the project, the main limitations are summarized below:

Temperature:
- Operational temperature range for the drones: -25 °C to +30 °C
- Recorded temperatures during the project: -15 °C to +10 °C

Extreme temperatures in the region:
- Down to -30°C in winter (typically in January) and up to +25°C in summer (typically in July)

Precipitation:
- Maximum precipitation limit for operation: 7 mm/h

Wind:
- Average wind speed: 7 m/s

Maximum wind gusts
- Over 15 m/s, especially in the winter months

During the project period, no problems related to temperature were registered, as the weather conditions were within the operational limits of the drones. However, high humidity combined with sub-zero temperatures was identified as a potential risk, as this can lead to ice formation on the drone's surfaces and components.

The weather in Røros varies considerably, which makes planning drone deliveries challenging. Previous experience from similar projects shows that fog, humidity and rapidly changing wind conditions can affect operations. The graph below illustrates the wind conditions during the two-month duration of the project, showing how often the wind speed approached or exceeded the operational limitations of the drones.

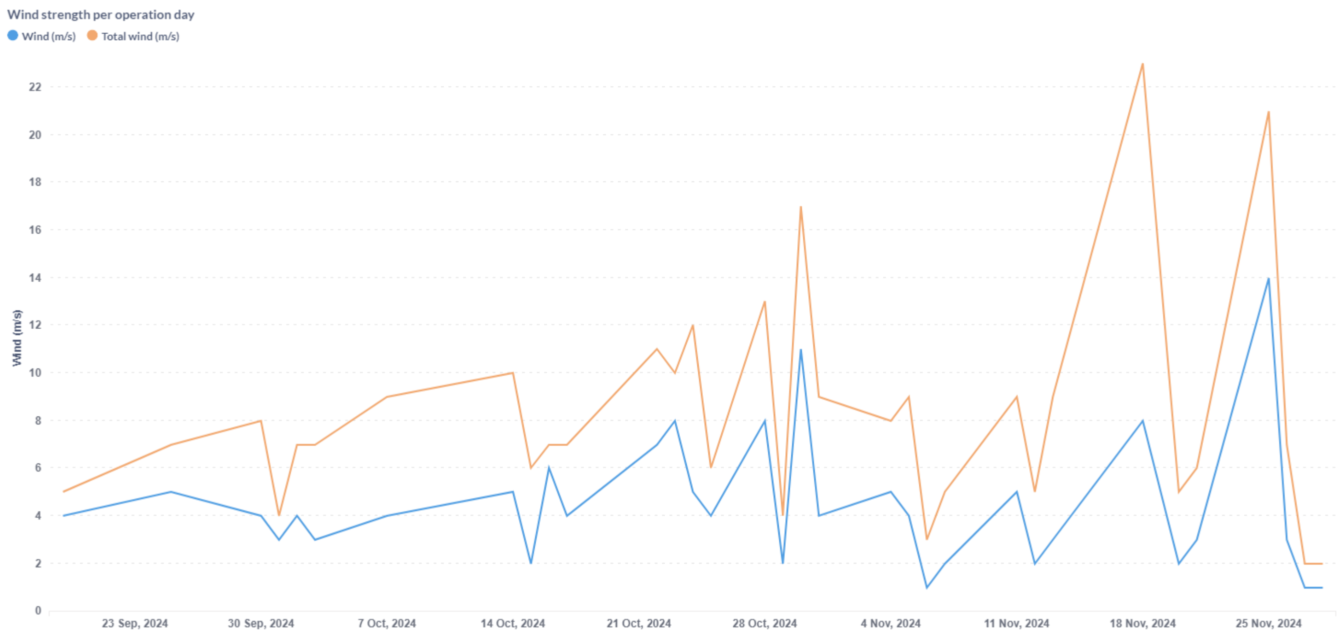


Figure 12.2 - Wind statistics from flight period

12.3 Restrictions with fog:

Fog was a significant challenge during some of the operational days of the project, especially in week 5. We quickly observed that fog tends to settle heavily in the center of Røros and around the designated start location.

During the first few days, we canceled operations due to sub-zero temperatures and fog, risk of icing and uncertainty about fog conditions along the flight route. However, after about three days of fog, we used a DJI Mavic 2 Pro drone. This drone allowed us to take off in the fog and assess its density and height, as well as determine whether it extends along the intended flight route.

Through this method, we discovered that the fog was typically at a height of around 50 meters below the cruising altitude of the NOTUS drone and was primarily around the take-off area. In particular, the fog rarely extended along the flight path. There were only four days during the project when fog was present at the mountain church, which is located midway towards Glåmos.

This approach enabled us to continue flying in foggy conditions, while ensuring safe and efficient operations.

A flight was canceled after takeoff due to fog.

A total of 4 flights were canceled before takeoff due to fog.

Procedure in flight to see if there is a risk of icing

Look at power, consumption, throttle, pitch, altitude and camera. With this data, the pilot can quickly see if there is an icing hazard in flight and thus turn the drone to fly back to base without other consequences such as emergency landing and unstable drone.

12.4 Summary Weather conditions:

The wind in Brekken and Glåmos is reasonably predictable, but presents challenges locally due to its strength and the topography of the area. To deal with this, Aviant moved most of the flights to the afternoon when the weather seemed to be more stable. When deciding whether it's safe to fly, the drone pilot makes assessments regarding wind strength, degree of turbulence, funnel effect and amount of precipitation.

14. Summary of the pilot project

The pilot project in Røros municipality has shown that autonomous drones can be an efficient, sustainable and cost-saving supplement to traditional transportation in the health and care sector. Through 46 operational flights, the project has documented significant time savings, a reduced environmental footprint and relief for healthcare professionals. At the same time, the project has revealed challenges related to weather conditions, logistics and regulatory restrictions, which must be addressed before the technology can be used on a large scale.

Key findings:

- **Weather conditions:** Wind and fog led to the cancellation of 38 flights, of which 31 before takeoff. The drones' operational limitations must be further developed to withstand more demanding weather conditions and ensure stable year-round operations.
- **Capacity:** The drones handled deliveries of up to approximately 2.5 kg. Achieving greater scale requires a more robust system with higher delivery volumes and home delivery to the customer/user.
- **Logistics:** Drone deliveries reduced delivery time by up to 33%, but the current solution requires further customization for door-to-door deliveries and more flexible pick-up points for users.
- **Community acceptance:** The local community was generally positive, but some neighbors expressed concerns related to noise and location of delivery points. Early dialog and facilitation are crucial for further implementation.
- **Environmental impact:** The project showed that drones can reduce CO_2 emissions by up to 98.5% compared to road transport, underlining their potential for sustainable logistics in rural areas.
- **Financial sustainability:** Drone deliveries have the potential to reduce transportation costs, but further studies are needed to map out long-term operating models and funding opportunities.

The road ahead

To realize the potential of autonomous drone deliveries, the following measures are recommended:

1. **Technological development:** Improve weather robustness, increase capacity and further develop door-to-door deliveries to optimize service.
2. **Regulatory work:** Ensure adaptation of regulations/approval to fly door-to-door for more flexible and efficient use of drones in the healthcare sector.
3. **Scaling studies:** Conduct new pilot projects to validate financial sustainability and expand applications, including transportation of goods to private individuals, medical samples and emergency medical supplies.

4. **Community integration:** Strengthen outreach and collaboration with local communities to increase acceptance and understanding of drone technology.

In order to build on the results of this pilot project, there will be a need to carry out further processes that analyze home care costs and time spent delivering food and medicines, with the aim of quantifying the potential benefits of autonomous drones. Further testing will be necessary to develop scalable solutions that can be integrated into municipal operations.

The project marks an important step towards the implementation of autonomous drones in the public sector. Further success will depend on close collaboration between research environments, public actors and industry to ensure a sustainable, reliable and cost-effective implementation of drone technology in health and care services.

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