Output 2.1

Virtual Planetarium

Immersive technology application showcasing the dark skies economy adapted in various regions

Introduction

This Output summarizes the results of the Work package 2 *Immersive Technology / Virtual Planetarium (IT/VP) development* activities conducted in the periods 1 – 5 (12.2022 – 05.2025):

- Developing the requirements specification for the IT/VP.
- Design and development of the IT/VP across scalable outputs, including choosing one of the concepts described, establishing the location, star sky recreation and design interaction, and adapting user experience elements to virtual reality.
- Building, testing, and revising across the scalable outputs, including creating an Alpha-version build for testing within the project partners and SMEs, its validation and verification, creating a Beta-version build for testing on a group of the audience, and establishing storytelling and other media of the selected location.
- Identifying the learning journey in each of the regions in the adoption of the relevant technology solution that has been created in that region.
- Development, roll-out, promotion and marketing of all technology outputs.
- Adopting and adapting service design methodologies to support the SMEs in developing their service/product for the Dark Sky's tourism economy.

In this document the development progress, modifying and improving the application to meet tourism SMEs needs is described, as well as application adapting in various regions: learning journeys and regional testing, intentions to take the application into use. Potential benefits for application for tourism sector SMEs of participating regions were evaluated.

VP Development Progress

The Immersive Technology/Virtual Planetarium (IT/VP) application has been developed in periods 1 – 5 by UiT Campus Narvik researcher Marius Wang (MW). The development progress was presented, and functionality of the VP was discussed and commented on by all the partners at all the online and physical partner meetings.

Period 1: 11/2022 – 05/2023

The user needs and expectations were identified via analysis of the survey results conducted in WP1. The concept of VP together with technical requirement specifications for developers and users' hardware was elaborated and delivered (D2.1.1 and D2.1.2). The chosen concept is a full-scale virtual environment with stars, earth, earth's moon, and the possibility to control the day/night-time, clouds, and aurora.

Development of the demo version of the virtual planetarium began in this Period.

Period 2: 06/2023 – 11/2023

Demo-version of the virtual planetarium was developed, finalized and tested (D2.2.1) at the second partner meeting and learning journey in Ireland, September 2023. Design and development included star sky recreation using the star map and planet/moon content collected from NASA, design interaction and adapting user experience elements to virtual reality.

Development of the full version of the VP began in this Period. To support the recreation of the virtual environment of the first chosen destination in Ireland, MW recorded media and pictures in Ballycroy National Park. It was combined with partner meeting and learning journey in Ireland in September 2023.

The drafted expected scalability of the VP full version was as follows: on computers and immersive spaces (projected on walls, floors) depending on the computer running the space. The VP must be rendered into a video, or work as a real-time rendered interactive experience. The most important is scalability and adaptability for SMEs.

Development started on MW's personal computer and continued on Dell workstation when it arrived on 09.10.2023. During the stay in Ireland and for the testing at the physical meeting, a laptop was used to do some adjustments and provide testing of the demo-version.

MW's PC specification: ASUS custom build

64-bit processor and operating system
OS: Win 10
Processor: AMD Ryzen 5950X, 16 core

Memory: 64 GB RAM, DDR4
Graphics: Nvidia RTX 3090 OC, 24 GB GDDR6 VRAM
DirectX: Version 12

Workstation specifications: Dell Precision 7865

64-bit processor and operating system
OS: Win 10
Processor: AMD Threadripper Pro 5995WX, 64 core
Memory: 512 GB RAM, DDR4
Graphics: Dual Nvidia RTX 6000 Ada Generation, 48 GB GDDR6 VRAM
DirectX: Version 12

Laptop specification: ASUS G703

64-bit processor and operating system
OS: Win 10
Processor: i9 9980HK
Memory: 32 GB RAM
Graphics: Nvidia RTX 2080 (8 GB VRAM)
DirectX: Version 12

Period 3: 12/2023 – 05/2024

Development of the full version of the VP included recreating the landscape and its details to create a digital copy of Ballycroy. The IT/VP was previously run only in desktop experience; during this period successful implementation of VR support was added and tested.

VP development progress was demonstrated at the online partner meetings, where special discussions between UiT and Udaras about ambience sounds and storytelling took place; suggestion such as folklore, facts from the region, stories about the stars etc. Some stories could be included to the meeting in Iceland in October 2024, but main plan was to start with the implementation in January 2025.

Partners discussed various equipment compatibility with VR, post development possibilities and functionality, e.g., adding/attaching SME/ place specific stories/marketing content in audio or 360-degrees video format. Udaras conducted research on storytellers. UiT-team shared the current document of technical specifications (D.2.1.2) with the project partners.

One Location established:

- Ballycroy, Ireland (54.023625512826825, -9.821070438792622)

Period 4: 06/2024 – 11/2024

Development work included sculpting and remaking locations, testing using Googles API for height maps and terrain for quicker and easier workflow. A new VR menu was developed, and the outlines for the main menu according to the concept were made. This menu will allow users to switch between locations.

Regarding scalability, a standalone version of the VP was suggested. This version does not include a PC but requires a powerful headset equipped with chipsets. Meta Quest 3 VR headset (512 Gb) was considered as the best option and procured by UiT. MW considered the possibility of remote updating the headsets. Finnish and Ireland partners started planning to buy PC and headsets for testing the VP in their regions. Reality showed that it was problematic to find hi-end PCs in their regions.

The UiT team held post learning journey discussions with Karelia UAS on ways to further develop virtual content, continuing the discussion jointly with all partners during Nov 2024 meeting. MW instructed the next steps, equipment needs and VP content needs from their regions. Partners were asked to provide audio files of desired local stories that they would like to include in the Virtual Planetarium. When the files are provided, the testing will start by including interactive stories inside the VP.

UiT-team started planning for the VP testing at the Science Center in Mo i Rana, North Norway (Vitensenter Nordland) in Period 5.

Multiple locations established:

- Ballycroy, Ireland (54.023625512826825, -9.821070438792622)
- Narvik, Norway (68.43839912909186, 17.427195711951054)
- Koli, Finland (63.094396322339804, 29.808824282527556)

Period 5: 11/2024 – 05/2025

The Beta version of the VP was finalized at the end of Period 5 (described separately in D2.3.1). Multiple locations were established:

- Ballycroy, Ireland (54.023625512826825, -9.821070438792622)
- Narvik, Norway (68.43839912909186, 17.427195711951054)
- Koli, Finland (63.094396322339804, 29.808824282527556)
- Hafnir-Rekavatn, Iceland (66.08909898169254, -20.38473778450503)

The locations were added together in the same application as they had been developed separately, and a menu for selecting them was added. The issues with the compiler have been resolved, as Microsoft has provided an updated version. The compiler is a core component that is used for building applications, and the game engine is using this for

packaging projects. However, after the application was built some of the features were behaving differently than expected. In addition, UiT team hasn't received any storytelling media files from the partners.

The list of technical specifications (D2.1.2) was substantially revised and appended with recommendations for SMEs and partners that want to implement the VP into their portfolio. So, the computer must be equipped with a minimum 20BG graphic card what yields to an estimated price of a minimum of 10,000 EUR (for SMEs). A headset compatible with SteamVR is required, it means approx. 600-800 EUR extra.

The VP application is uploaded to Sikt Filesender and will be accessible to the GLOW2.0-team for download. The download link is available in D2.3.1. However, the installing and adjusting the VP application can be challenging since external support from UiT-team will be impossible after the end of the project (firewall, security issues etc), the offline version of the VP with 3-5 minutes long rendered videos is considered as the best option. This version is uploaded to Sikt together with the VP application.

Sikt (Norwegian Agency for Shared Services in Education and Research) is a collaborative body that develops, purchases, and delivers products and services designed to enhance education and research experiences.

The purpose of the Sikt software is to send a large file, have that file available for download for a certain number of downloads and/or a certain amount of time, and after that automatically delete the file. The software is not intended as a permanent file publishing platform.

Demonstrations and testing

All the consequent versions of the IT/VP were demonstrated and tested by the project partners and stakeholders in Periods 2 – 5. Critical feedback on user-friendliness, technology specifications and technical requirements was provided by partners and stakeholders along with all phases of development. All the project partners promoted VP in their countries for different target groups, and stakeholders from the partner countries attended learning journeys.

Period 2: 06/2023 – 11/2023

The demo-version of IT/VP was tested and demonstrated by MW in desktop experience to partners and stakeholders during the partner meeting/learning journey in Belmullet, Ireland in September 2023 (Fig.1).

Figure 1. Demonstration of the demo-version in Ireland (desktop experience)

The demonstration was planned by UiT together with UnaG. Since no hardware/devices satisfying the technical requirements for testing and demonstration were available in the specific area, MW brought equipment from UiT, Norway to Ireland. The demonstration

session included feedback for design interaction and user experience elements to virtual reality.

The computer used for demonstrations and testing was the ASUS G703 laptop, and the VR headset HTC Vive Pro Eye (Fig.2).

Figure 2. HTC Vive Pro Eye VR headset

In Norway for the first time the project progress was presented at the Norsk Opplevelseskonferanse in October 2023, where several target groups were engaged. The details related to IT/VP were discussed with an initial showcase to target groups (short video instead of a full testing session). The interested stakeholders were registered to engage them with a learning journey event in Narvik in February 2024.

Period 3: 12/2023 – 05/2024

The VP was demonstrated and tested by the partners and stakeholders during the partner meeting/learning journey in Narvik (Fig. 3) co-located with a regional workshop "Embracing Dark Sky Tourism in Northern Periphery and Arctic Region". The testing session was conducted at UiT Campus Narvik, Norway on 6-7 February 2024, and included 360-video played on the walls in our laboratory for Extended Reality – XR-Lab, and individual testing using VR headset.

The initial idea of the VP and the benefit of virtual production were introduced; the possibility of creating endless different scenarios by tweaking parameters within the VP, such as sun, moon, stars, aurora, skies, and weather. The workshop featured a diverse lineup of speakers considering Northern Norway's tourism industry in different perspectives.

This session showcased the current version of the VP showing the potential applications of VR technology within the context of our project, sparking enthusiasm among participants, and stimulating further exploration of innovative solutions. Subsequent discussions included the impact of VR and planetarium experiences in science tourism, as well as insights into the feasibility of science tourism in Northern Norway.

For the testing a build of the VP was created, qualified as an Alpha build of the software, and this was running standalone through SteamVR and to the VR headset. The development computer (Dell 7865 workstation) and the VR headset HTC Vive Pro Eye were used for demonstration and testing.

Figure 3. The stakeholder from Ireland and MW testing the VP in Narvik

Period 4: 06/2024 – 11/2024

Regional workshop in Narvik "Scope of opportunities surrounding Dark Sky Tourism"
UiT-team together with Visit Narvik AS arranged a regional workshop involving agencies and enterprises in Northern Norway, making them understand the scope of opportunities surrounding Dark Sky Tourism, and their potential role in this. The workshop was held on 26th September 2024 at the UiT Campus Narvik. A total of 22 participants attended, 3 online

and 19 onsite. Visit Narvik AS significantly contributed to the workshop marketing/promoting.

At the event, UiT-team tried to make visible how we can help a company to improve existing or new products using AR/VR technology. MW presented the actual version of the VP (also in video format) in our XR-lab to the workshop participants as well as gave a short overview of immersive technologies accessible on the market. Visit Narvik AS, Fjellkysten AS and Quality Grand Royal Hotel Narvik provided us with written feedback, which can be found in Appendix 1.

The development computer (Dell workstation) and HTC Vive Pro Eye headset were used for demonstration and testing.

Learning journey in Iceland

The IT/VP was tested and demonstrated to partners and stakeholders during the partner meeting in *Blönduós*, and the learning journey in the *1238* – THE BATTLE OF ICELAND VR/AR Museum, *Sauðárkrókur*, Iceland in October 2024 (Fig. 4).

The demonstration was planned by UiT together with Karelia UAS and SSNV such that stakeholders could test it in the form of a service in a tourism service provider's premises. Planning for testing was started early September, with SSNV and the manager at 1238 VR/AR Museum, Freyja Rut Emilsdóttir. First information regarding the equipment and hardware located at the museum was provided to map the capabilities of running the VP, and if adjustments needed to be made. Next step was to downscale the application so it would run on the computers that 1238 had available. The location planned to show during this test was the location in Ireland.

MW guided the testing session for partners and stakeholders brought along. The stakeholders and partners got to both test the VP and the application that was owned by 1238. All the ones that tested the VP were able to navigate and use the VR headset. The computer that was provided for testing also had an additional TV screen connected so others could watch the session inside the VP.

All the aspects of the VP that were ready till that date were shown and experienced (dark skies, northern lights, physical location), also in video format. Feedback from the testing was positive, but from one person that knew the stars well noticed that the alignment of the stars compared to the North was off. After some investigation, some errors occurred during the transfer of the application.

For the testing sessions, a custom build of the VP was created, running standalone through SteamVR on the system that 1238 had available. The HTC Vive Pro headset was used.

The minimum requirements for the computer are as follows:

64-bit processor and operating system

OS: Win 10
Processor: i7 7700k or Higher
Memory: 16 GB RAM or Higher
Graphics: Nvidia RTX 3090 or Higher (20 GB VRAM)
DirectX: Version 12

While the computer at the 1238 VR/AR museum didn't have enough powerful graphics:

64-bit processor and operating system
OS: Win 11
Processor: i7 7800x
Memory: 32GB
Graphics: Nvidia RTX 2080 (8GB VRAM)
DirectX: Version 12

As the hardware was less powerful, it made it unable to run the graphics at full resolution, and this decreased the intended visual experience.

Figure 4. Testing at the partner and stakeholder meeting in Iceland

Mørketidsmagi

VP was demonstrated and tested using the development workstation along with the Meta Quest 3 headset by approx. 70 persons (public, UiT students and employees) at *Mørketidsmagi "The Magic of Polar Night"* event arranged by UiT Campus Narvik together with Narvik municipality, and Narvikfjellet (Fig. 5). The event took place at the UiT campus on Friday 8 November 2024 and was devoted to beginning of the polar night in Narvik

region and preparing for the upcoming alpine ski world championships (will be held in Narvik in 2029). The demonstration and testing session were actively promoted by representatives from our supportive partner Visit Narvik AS.

Figure 5. Testing at Mørketidsmagi

Period 5: 11/2024 – 05/2025

Partner meeting in Finland

The IT/VP testing and demonstration session was planned for partners and stakeholders during the partner meeting at the Karelia UAS in Joensuu and the learning journey in Koli, Finland, on 25 – 26 March 2025.

The equipment specifications to be purchased by Finnish partner for the testing and demonstration were discussed before procurement. Finnish team received the PC on 20 March 2025.

Unfortunately, no one from UiT-team was able to physically attend the meeting. However, MW offered online guiding and support. The Karelia UAS IT-department asked MW for

support one hour before the session start, what was not enough for preparing the software to run on their new computer. However, the issue only affected the landscape since this was streaming with Google's API, and the new system blocked this in the firewall on the system or in Karelia UAS's network. Nevertheless, the dark skies and aurora was working as intended. The remote access/ transfer was only tried once, and UiT-team was not given any other opportunities to resolve the issue or test again.

Testing in the Science Center in Mo I Rana

During January 2025, the Virtual Planetarium was prepared and packaged for the Beta build, that was planned to be used during the testing at a SME's location.

The chosen SME is a science center located in Mo i Rana, [Vitensenter Nordland](). Its marketing manager Georg Enga was engaged by UiT-team at the Norsk Opplevelseskonferanse in October 2023 and participated at the workshop and VP testing in Narvik in February 2024. The center in Mo i Rana is one of 13 regional science centers in Norway and offers an exciting way to learn about mathematics, science and technology. The center is designed to be interactive and experiential, allowing visitors to learn through experimentation.

Testing process

The computer used to showcase and demonstrate the virtual planetarium is a desktop computer custom built for graphical workload, such as VR. The computer is loaded with a script that automatically launches the application when it is booted and powered on the headset when it is ready. The only thing the staff must do is push the power button to turn the system on and off. Use of the standalone version with 10 min long rendered video was rejected as it can only render video file for Quest, while the HTC Vive Pro Eye headsets used for the demo was not powerful enough.

The specification of the custom computer is as follows:

64-bit processor and operating system
OS: Windows 10
Processor: AMD Threadripper 2990WX
Memory: 64 GB RAM
Graphics: Nvidia RTX 4090 (24 GB VRAM)
DirectX: Version 12

The system with the VP preloaded was installed in the science center on 27.02.2025. For the testing, a custom location was created, showing Mo I Rana in the VP.

The initial setup and training of the SME staff (Fig.6) were conducted on the same day.

The system was out for testing till 08.04.2025, it was decided to end the testing at this point due to damage to the headset – one of the center's visitors accidentally dropped it on the floor (Fig.7).

Figure 6. Test setup and training of the staff at the science center in Mo i Rana

Figure 7. Damaged headset

Testing results and feedback

Georg Enga estimated that around 10% of visitors used the VR activity during the test period. This equates to around 350 people during the approximately two months the VP was in the exhibition.

The audience expressed that the VR experience, especially with the Northern Lights as a theme, was both exciting and visually engaging. Many found it a nice and different way to experience and learn about natural phenomena.

The VP was used as a supplement to the VR experiences the Science Center has already offered. Georg reported that they experienced some technical challenges, and they see that if the technology is to stand more independently – without close monitoring by hosts – it will require further development and programming to ensure the most intuitive and interactive experience possible. Hardware requirements and operational reliability in public areas are also factors they must consider.

Talking about short-term impact, the VP has contributed to increased interest and curiosity among the audience. In the long term, the Science Center could see potential for including such experiences as a permanent part of the dissemination offer. This can make the Center more attractive to younger target groups and help strengthen both content, relevance, and financial sustainability.

As the Center is always looking for good opportunities to integrate VR as a natural part of their communication, both thematically and educationally, they would like to continue using VP in the exhibitions, as this is a popular activity among the public.

Feedback from other SMEs in Norway

In addition to direct feedback on VP provided by the science center, UiT-team got positive feedback from several SMEs during two regional workshops at UiT Campus Narvik described above. Participants of the workshops looked engaged and interested in the IT/VP presented. Most of the questions were about costs and technical requirements; an SME expressed interest in implementing VR-headset to play 360 videos, another idea was to include the IT/VP technology in Aurora Basecamp northern light experience at Narvikfjellet.

Based on the surveys performed by Visit Norway, tourists visit the Arctic destinations to experience the northern lights. This is exactly what the developed VP can contribute to.

At the same time, we are unaware of any businesses implementing any immersive technologies while GLOW 2.0 has been running. Based on the information provided by Visit Narvik, one of the reasons why SMEs are not focused on implementing immersive technologies into businesses is that they lack the competence and resources to deliver. The digital readiness of SMEs to adopt immersive technologies could be estimated as eager to adopt, but don't know how, or have some knowledge about technology and understand what they would like to implement.

SMEs are unlikely to take the initiative to work on implementing immersive technologies independently unless they are integrated into overarching strategies, initiated by owners, or driven by the regional DMO through a business network project or a similar framework.

Concluding remarks

- The developed Beta version of the IT/VP can be implemented at SMEs with assistance from the developer or trained staff.
- There is still room for IT/VP development; to add media, make the user interface more friendly, advance the northern lights theme, etc.
- The technical requirements to hardware lead to high investments at SMEs, in addition it could be challenging to buy this hardware in the project partner countries since it is not widely presented in the markets.
- Nevertheless, it is desired to test the IT/VP in other regions in Period 6: Finland received the needed hardware in March 2025, Ireland is receiving it in the end of June 2025, and Iceland has ordered it.
- Using rendered videos instead of the full version is an option.

FURTHER INFORMATION
GLOW2.0 - Green Energy Technologies for Tourism Project has been funded by Interreg Northern Periphery and Arctic Programme.

Link to project website: NPA GLOW