A working model of underground pilot facility

Baltic Sea Underground Innovation Network (BSUIN)

Interreg Baltic Sea Region
EUROPEAN REGIONAL DEVELOPMENT FUND
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Content

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1. BSUIN project introduction

The aim of the BSUIN project is to make the underground laboratories (hereinafter ULs) in the Baltic Sea Region more accessible for innovation, business development and science by improving the information about the underground laboratories, the operation, user experiences and safety.

Baltic Sea Underground Innovation Network (hereinafter BSUIN) is a collaboration project between 13 partners from eight (8) Baltic Sea Region (hereinafter BSR) countries. Besides project partners 17 associated partners contributes to achieving project goals.

In the project participate six (6) underground laboratories around BSR. They all will be characterized and presented to potential customers in order to attract developing innovative activities and active use of those laboratories. Six underground laboratories by name are:

1. Callio Lab, Pyhäsalmi mine, Finland
2. Äspö Hard Rock Laboratory, Oskarshamn, Sweden
3. Reiche Zeche, TU Freiberg Research and Education mine, Germany
4. Lab development by KGHM Cuprum R&D centre, Poland
5. Khlopin Radium Institute Underground Laboratory, Russia
6. Ruskeala Mining Park, Russia

The main outcome of the project is a sustainable network organization, which will disseminate the technical, marketing, operational quality, training and other information about the BSR ULs created during the project.

Project is funded by Interreg Baltic Sea funding cooperation. Its duration is 36 months with total budget 3.4 M€.

2. Content of present Document

2.1 Document justification

The purpose of work package 4 is to describe ULs working environment and disseminate their best practices.

The present document is a part of the project BSUIN work package 4.1 output and it represents a working model of an underground pilot facility. Based on ULs working environment and the best practices outputs, conducted also within WP 4.1, and data gathering from other WPs, we have created a vision of how an optimal underground research facility could ideally look like.

2.2 Content description

A working model of an underground facility summarizes key findings from six ULs working environment, the best practices and key points of other collected data from other WPs developed in the BSUIN project, e.g. organizational characterization. Based on collected data it is possible to visualize what ideal underground facility is. For instance, how accessibility, safety protocols and practices, communication, governance, etc. could ideally look like. Moreover, what characteristics ideal UL should have to be self-sustainable, how UL monitoring system emphasizes prevention instead of dealing with consequences, etc.

In the next chapter is presented a vision as identified key points of an ideal or at least optimal underground facility. A vision is presented as the main key points.

3. Working model of an ideal underground facility

Nowadays ULs are mainly former mines which are not closed but turned into an underground research facility to provide test or production sites for scientific and business purposes. The creation of ULs always comes from the necessity to test and produce/offer services. For example, ÄSPO HRL was created as a test site to develop a safe final solution for storing of spent nuclear fuel. Necessity can be expressed also from the economical and social perspective; besides production and service offerings what the UL brings, the UL could offer work for the former miners in various positions benefitting from the expertise and if local residents also from the site-specific know-how. The latter contributes to the local region's sustainability and economic growth, where former miner`s stay to work in the region. Of course, their work tasks will be transformed into the UL needs.

Every UL is unique and there is no model completely suitable for all. The differences in ULs depend on many factors, e.g. location, size, depth, surrounding bedrock, available halls and caverns with different sizes, etc. Therefore, possible services in ULs differ.

Accessibility and access control to the UL

Working conditions in underground facilities are mostly challenging and therefore, people with physical disabilities are usually not allowed to the underground due to safety reasons because everyone should be able to evacuate themselves. In the ideal underground facility, accessibility to the UL is not restricted to people with physical disabilities, e.g. people in a wheelchair. It is foreseen that ramps, clear pathways, elevator access etc. exists for the people with limited bodily capabilities. For instance, in the Ruskeala Mining Park, in former marble mine transformed now into the touristic site, is organized convenient accessibility also for the people in a wheelchair or people with crutches. Moreover, in the ideal laboratory an elevator for persons and small-scale equipment transport should be used to gain convenient access as it is done in one of the main level Labs in Pyhasälmi mine for Callio Lab research activities. For big-size equipment, transport accessibility to the UL should also be in place. Usually a former mine tunnelsystem can be used for this with relevant vehicles suitable to use in the underground conditions. In many countries, safety regulations dictate that there needs to be two separate exit ways. Besides convenient access routes, in an ideal underground facility the laboratories would be accessible 24/7. Typical practice is that underground facilities provide access only during the office or operational hours of the day due to safety reasons, e.g. blasting and ventilation or lack of supervisors, if operating only in one daily shift. In an ideal case, the access is provided around the clock. It could be achieved via well-established access control which automatically registering in and out or even inside movements via personal ID, whether card, tag, illuminator or VOIP beacon system, and in principal allows access even out of operational hours if access is really needed. This system allows easy monitoring of a person's movements and identifying their location in the UL. Knowing in and out movements is also extremely important in case of emergency and it is relevant prerequisite to ensure safety in the UL.

Infrastructure to travel to the UL

Another aspect of the ideal UL is its site accessibility. In general, ULs locate away from larger human settlements. This influences client`s capability to visit and use UL. Therefore, proximity to the closest airport, harbour, bus stop or train station has high importance. In an ideal situation, the infrastructure to access the UL site should be fast and convenient as much as possible. Cooperation with the local government helps to achieve this issue, e.g. set bus routes and schedules according to the UL worker's and customer's needs.

No less important is the availability of restaurants and accommodation in the UL region what the local community can offer for the UL users who stay and use UL over a longer period. A well-established example of site accessibility and cooperation is seen in Ruskeala Mining Park, where access is most convenient via cars or buses. They have cooperated with tourist agencies who transport people from St. Petersburg to the site early in the morning (travel time is around 5 hours). The tourists can spend the rest of the day in the

Mining Park, consume services offered by the Mining Park, and in the evening they return to the city.

Safety monitoring and practices

Another important feature is the safety of persons working or visiting an underground facility, which is always a top priority. Therefore, an ideal underground facility has established safety procedures and escape routes to all UL users and regularly monitors compliance with them via the safety trainings. Moreover, progressive UL have also rescue shelters put in place to ensure the safety of the operators in case of an emergency. The rescue chambers offer temporary and safe access in the event of a major emergency and therefore save lives. Moreover, the existence of the first-aid kit or trained first-aid personnel appointed for emergency cases is an obvious and absolute must in an ideal underground facility. The UL users are trained to use first-aid kit, self-rescue devices, and shelters accordingly.

In addition, from the facility supervisor point of view it is good to know where the users are, and especially in the case of emergency have the capabilities and means to see who are and who are not in the safety, and how to guide those not yet in the safety to a safe location. Using different type of location determining sensors or beacons like in Äspö HRL or in the KGHM Cuprum mine where the VOIP phones or the headlights are used to identify a person and the network of sensors to determine the position.

Communication

Safe and secured communication is vital from the safety perspective and from a convenient daily work perspective. A wide range of modern communication channels should exist in an ideal underground facility. Besides typical radiophone and fixed telephone connection, the progressive UL has also fast optical fiber network, high speed WiFi network, and the server providing solutions at least in designated places in the UL.

Today`s modern working conditions without these possibilities is unimaginable. Their existence in the UL significantly facilitates the customer's daily work and improves user experience. In many cases in research or production, fast data transfer possibility is an absolute must and ideal UL should have it.

Energy efficiency

The usage of an underground facility requires electricity. Therefore, in ideal UL energy connection according to the European standard and client needs is an absolute must. In addition, several alternative connection possibilities, which give a high degree of redundancy, to minimize the impact of a power outage, should exist as well. Moreover, the availability of compressed air is an additional advantage because quite often clients require that service.

One characteristic that distinguishes progressive UL from less progressive is the usage of local possibilities to achieve a higher energy efficiency rate and therefore reduce daily costs. For instance, the use of geothermal energy in UL can be one of the ways. This approach is used in the Reiche Zeche underground facility. In the Callio Lab, in former Pyhäsalmi mine, they use for mine air heating existing heat sources such as wastewater from flue gas scrubber and mine wastewater. In Äspo HRL, Sweden, smart lighting solutions are used to save energy and be more environmentally friendly.

Water management

Access to the technological and drinking water is another relevant prerequisite that usually UL clients require. In the ideal UL, it is provided to the client and UL has established powerful and redundant pump stations with pipelines for that. Moreover, water treatment via technical dewatering and sedimentation pit to prevent access of untreated water to the environment are relevant components in the ideal underground facility.

Additional and value-added services

Besides services such as support client`s with space, electricity, water, access, logistics etc, an ideal UL should also offer more diversified set of services. These value-added services for instance are office space for meetings, toilets, and shower availability, kitchen area or restaurant for eating, and locker rooms for personal or activity related belongings directly in the underground or surface.

In order to reach a larger customer base, a progressive UL also offers meeting and conference rooms for businesses, and a variety of social and educational activities. The latter could be for example musical concerts and theatre performances, thematic events, such as weddings, “underground” nightclub parties etc., thematic activities, such as underground hikes, orientation, paintball competitions, shooting range, teambuilding services etc., training sessions for professionals, and educational guided tours and shows for children and adults. A good example of diversified social and educational services in the underground facility is developed in Hagerbach Test Gallery in Switzerland.

UL governance

An ideal underground facility applies more requirements in its daily work than are required by national laws and regulations. This means that although all activities in ULs are subordinated to local laws and regulations, the ideal UL has also established its own company policy. In the latter, UL has defined parameters what are the possible risks to their working environment and monitor them accordingly. The law might not require the parameter monitoring, but UL does it voluntarily because they want to assure the safety of the facility and workers. For instance, temperature or radiation monitoring (concentrating on the radon monitoring) is periodically conducted, although officially its observation might not be required by regulations.

One of the characteristics of good governance in the UL is easy to do business and its main prerequisite is one single authority body who is managing with all licensing matters. For the client, it is extremely important that they have one single contact point with whom they can contact, discuss, and to whom they could send relevant documents to get license/approval to use the underground facility. A good example of this is in Reiche Zeche UL where Saxon mining authority is a bundling authority for all licencing matters and all other authorities are contacted via the mining authority.

Moreover, in the modern UL the clients are often international companies. Therefore, it is relevant that in the ideal UL permitting, daily instructions, and other activities can be done not only in the local language but also in the most commonly used international language, e.g. in English for instance.

UL monitoring system

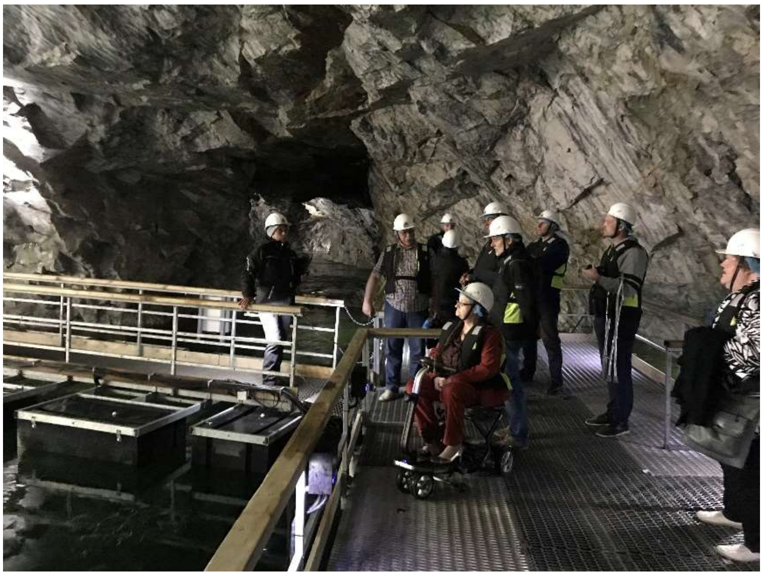
One of the features of an ideal underground laboratory is that it constantly monitors important safety, environmental and other indicators. For example, groundwater or floodwaters are monitored to detect and prevent flood risks. The main emphasis is on preventing risk by measuring it and implementing countermeasures before the risk materializes.

The effective monitoring network of natural hazards like occurrence of gases, radiation, ground control, and seismic activity should also be in place in progressive UL. The named hazards are major cause of risks and fatal incidents in underground facilities and they need to be monitored to alarm on time if any of the activities at the underground laboratory or around the laboratory could cause a threat to the safety of the personnel.

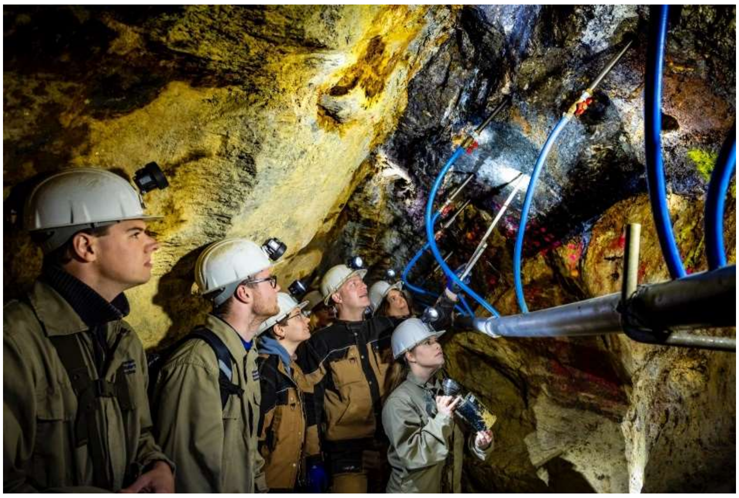
4. Conclusion

To conclude, an ideal UL can be characterized by their desire to be innovative and constantly look for ways to keep their daily costs low, e.g. investing in research and equipment that uses less energy. No less important is a modern safety monitoring system and practices, as well as customer-friendly UL management practices. Moreover, an ideal UL is also looking ways to offer wider variety of services to diversify customer segments to earn enough revenue to be self-sustainable. The economic sustainability of underground facilities is one important yardstick in assessing the ideal UL.

The best practices from different underground facilities, which contribute towards to an ideal laboratory, is showcased in following examples.



Picture 1. Underground platform in Ruskeala Mining Park, Russia. Platform is accessible also for the people in wheelchairs.



Picture 2. Bioleaching experiment in Reiche Seche underground laboratory, Germany. An ideal study opportunity for students as well.