The LUCOEX project has during the last 4 years produced a total of 60 deliverables. While some of them are linked to the actual planning and execution of the project most of the deliverables are technically focused and are therefore expected to have a larger external value.

Below we have listed some of the key deliverables we expect to have the most external interest. All documents are available on www.lucoex.eu

**Project Management**

- Presentations from Mid-term Workshop
  Summary and presentations from Conference are available as deliverable D1:29. [Link]

- Presentations from End Conference
  Summary and presentations from the end Conference are available as deliverable D1:13. [Link]

- Expert Group Report 3
  This is the final external review that was done of the LUCOEX project by the Expert Group (4 externals and 4 internal experts). Published as deliverable D1:14. [Link]

- Use of LUCOEX-results in other EU countries
  An academic evaluation has been done to analyze if and how the result of LUCOEX could be used by EU Member States. Published as deliverable D1:15. [Link]

- Final Project Technical Report
  This is a summary report of the key LUCOEX findings. Published as deliverable D1:22. [Link]

**MPT-Test**

- Manufacturing of blocks
  Published deliverable D4:01. [Link]

- Upgrade of the deposition machine
  Published as deliverable D4:02. [Link]

- Preparations, assembly and installation
  Published as deliverable D4:03. [Link]

- Steered core drilling of boreholes
  Published as deliverable D4:04. [Link]

- Initial data report
  Published as deliverable D4:05. [Link]

- Comparison of uni-axial and isostatic compaction
  Published as deliverable D4:06. [Link]

- Final Work Package Report
  This is a summary report of the key findings. D4:07. [Link]

**ACL-experiment**

- Preliminary test of forced casing digging
  Published as deliverable D3:01. [Link]

- Digging and emplacement report
  Published as deliverable D3:03. [Link]

- Final Work Package Report
  This is a summary report of the key findings. D3:04. [Link]

**F E-experiment**

- Construction of the emplacement tunnel
  Published as deliverable D2:02. [Link]

- Requirements, manufacturing and QC of the buffer components
  Published as deliverable D2:03. [Link]

- Construction of emplacement equipment
  Published as deliverable D2:04. [Link]

- Emplacement report
  Published as deliverable D2:05. [Link]

- Final Work Package Report
  This is a summary report of the key findings. D2:06. [Link]

**KBS-3 Emplacement**

- Buffer Emplacement test
  Published as deliverable D5:02. [Link]

- Quality Assurance and Problem Handling
  Published as deliverable D5:05. [Link]

- Emplacement process and quality requirements
  Published as deliverable D5:06. [Link]

- Documentary film of buffer installation demo
  Published as deliverable D5:20. [Link]

- Solving the emplacement problem situations
  Published as deliverable D5:08. [Link]

- Final Work Package Report
  This is a summary report of the key findings. D5:09. [Link]

**LUCEOX Homepage**

LUCEOX has now finalised all our installations, written the technical reports and finished the production of our documentary movies. To ensure that this information is available to all interested parties, internal and external, we have published all our findings and deliverables on the LUCOEX homepage. From our monitoring we see that the LUCOEX homepage (www.lucoex.eu) has had between 50 – 500 (1000 max) unique visitors each week downloading our reports and deliverables.

The project will now make one final update of the homepage to ensure that the homepage and our deliverables are easily indexed by search engines like Google and Bing. The homepage will be kept operational during the following years to ensure a continued spreading of the knowledge and experiences gained during the project.

LUCEOX is finalized

The LUCEOX project was initiated in 2010 with the goal to prove the technical feasibility of a safe and reliable gallery construction, manufacturing and emplacement of buffer components, emplacement of waste packages and finally backfilling and sealing of galleries for four different repository concepts. All four of our proof-of-concept installations are now finalised and all deliverables have been posted on the homepage. Three of our installations have also entered a monitoring phase where the goal is to study the early evolution of the clay material and key THM-processes in the host rock. The continued monitoring of the experiments and the publication of the results will from now on be handled by the individual national programs.

**External Participation**

One of the most important parts of the LUCOEX project has been the inclusion of external parties into the project which during the project has included representatives from fourteen countries in the European Union, North America and Asia who participated in the events hosted by the project. Also included are the recipients of the 28 LUCOEX-scholarships which were awarded to support the participation at key LUCOEX-events and the participation in the work at the underground research laboratories during the course of the project through the training scholarships. The LUCEOX project considers that we have been successful in sharing the knowledge and experiences from the project to these external participants who have been given in-depth knowledge about the work that has been performed. Many have also contributed back to the project through their work and through further spreading the information about the work performed in the project when returning back home.
DATA REPORT, PRESSING TECHNIQUES AND DRILLING

The Multi-Purpose-Test (MPT) is a proof-of-concept installation for KBS-3H horizontal disposal in crystalline rock. The proof-of-concept installation was successfully completed during the beginning of 2014. The focus has since then been to study the early evolution of the buffer material and to show that we are able to drill the pilot holes for the up-reaming of the drifts with the necessary precision.

All key steps of the MPT-installation have been successfully executed and we have shown the ability to manufacture full scale components, assemble the super-container with sensors and carry out the installation according to the KBS-3H reference design DAWHE.

Initially the MPT was planned to run for approximately 400 days but research shows this being far too short as the swelling processes after the artificial water filling is much slower than previously expected. Since the operational time is now assessed to be longer than the extension of the LUCOEX project we have chosen to deliver a data report (D4.04) available on the homepage.

In addition to the originally planned scope 5KB, supported by Posiva and Nagra, have done a comparison of uniaxial and isotropic compression of buffer components published as deliverable D4.07 available on the homepage.

The final scope change was the inclusion of steered core drilling. The KBS-3H design has strict requirements on the straightness of the deposition holes and steered core drilling is the method currently assessed as the best option for fulfilling the requirements. The drilling performed within the LUCOEX project is a step towards verifying that we are actually able to produce the necessary tunnels using conventional machinery combined with new techniques.

The method developed was successfully proven over the full length of 94 m, requiring only 2 steering actions. The results provide confidence that technology is available that should be able to achieve production of the 300 m deposition drifts with the required precision. Methodologies and strategies for drilling and steering were improved and will be used at Posiva facility, ONKALO, where a 300 m long core drilling test will be carried out 2015. For further details on the Åspö HRL drilling operation see D4.05.

TESTS FINALIZED IN ONKALO, FINLAND

The KBS-3V emplacement test in Onkalo is a proof-of-concept emplacement for vertical disposal in crystalline rock where individual canisters containing the spent nuclear fuel are emplaced in vertical disposal holes at a depth of about 400-500 m in the bedrock. The technique for the emplacement test has been updated based on feedback from other work packages and the test is now being prepared.

The excavations of horizontal disposal tunnels with vertical disposal positions in crystalline rock, KBS-3V, are planned to be constructed using conventional technology while the sealing is studied in the EU project DOPAS.

In LUCOEX the Finish WMO, Posiva, has, at the Onkalo underground rock characterization facility, focused on disposal issues for this concept, including:

- the development of the final prototype machinery necessary for the transportation and installation of buffer components,
- method and tools for filling the gap between the bentonite blocks and the host rock with bentonite pellets
- methods and strategies for quality assurance and problem handling.

The work in Finland following design and manufacturing of the machines presented earlier, was focused on the verifying emplacement tests and practical tests of techniques for fault handling in full scale. Initial tests were done above ground to verify key functionality. Modifications were done based on the results of the first tests before the tests in Onkalo demonstration tunnels were initiated. The tests in the tunnels utilized the protection containers for buffer and pellets, the installation machinery complemented with the QA and positioning system. In addition Posiva also verified the processes and tools developed for the removal of the buffer material in case of a mishap.

An evaluation following the underground Proof-of-Concept emplacement tests concluded that the techniques work in practice but the processes need to be optimized to increase precision and reduce installation times.

The monitoring will continue as the best option for fulfilling the requirements. The THM impact of the thermal loading on the surrounding rock is assessed to be longer than the extension of the MPT project.

The THM impact of the thermal loading on the overall behavior of the cell and the surrounding rock is assessed to be longer than the extension of the MPT project.

The conclusion today is that the measured hydro-mechanical impact of excavation is consistent with the observations made during previous drilling campaigns. We also see that the sleeve is subjected to a mechanical load less than 2 months after the drilling despite an initial annular space of 25 mm.

The THM impact of the thermal loading on the surrounding rock mass is also consistent with the results obtained in previous experiments where the heating leads to overpressures related to the difference in thermal expansion coefficient between pore water and rock. Measurements have also shown that the thermal expansion of the sleeve occurs both towards the end and towards the head of the cell.

The monitoring will continue and further development will be reported through Andras regular reports.