

Modern / Modern2020

- Monitoring in the European Context -

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**Development and Demonstration of
monitoring strategies and technologies
for geological disposal**



This project has received funding from the Euratom research and training programme 2014-2018 under grant agreement n° 662177

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The logo for MODERN features the word in a bold, sans-serif font. A yellow circle is positioned inside the letter 'O'. An orange sine wave is overlaid on the text, starting from the left edge of the 'M', passing through the 'O', and ending at the right edge of the 'N'.

MODERN

Monitoring Developments for Safe Repository Operation and Staged Closure

Monitoring of HLW Repositories

2009

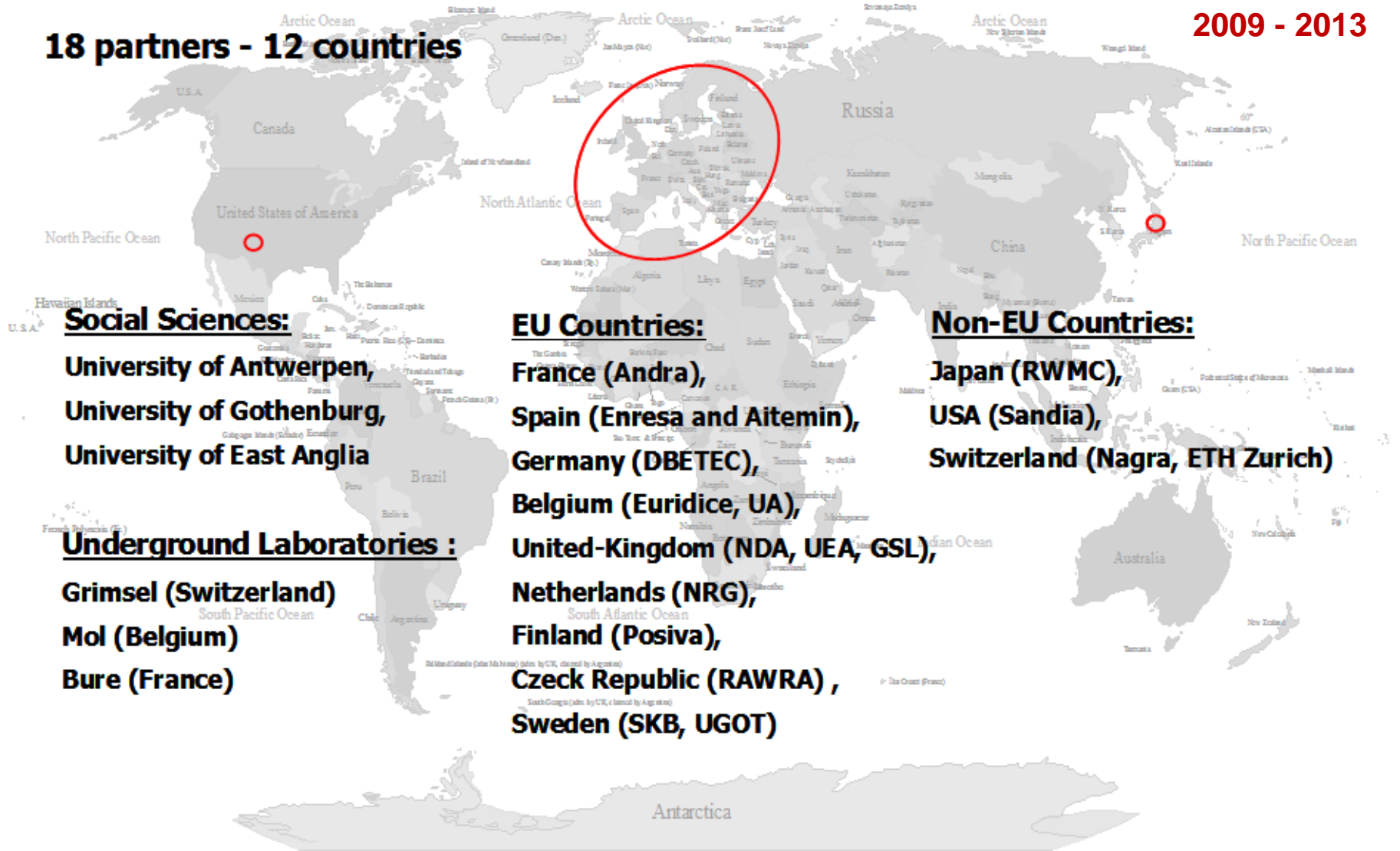
Missing: Common international framework or guideline for repository monitoring



Monitoring Developments for safe Repository operation and staged closure

Aim: providing a reference framework for development and implementation of monitoring activities

18 partners - 12 countries



Social Sciences:

- University of Antwerpen,
- University of Gothenburg,
- University of East Anglia

Underground Laboratories :

- Grimsel (Switzerland)
- Mol (Belgium)
- Bure (France)

EU Countries:

- France (Andra),
- Spain (Enresa and Aitemin),
- Germany (DBETEC),
- Belgium (Euridice, UA),
- United-Kingdom (NDA, UEA, GSL),
- Netherlands (NRG),
- Finland (Posiva),
- Czech Republic (RAWRA) ,
- Sweden (SKB, UGOT)

Non-EU Countries:

- Japan (RWMC),
- USA (Sandia),
- Switzerland (Nagra, ETH Zurich)

MODERN

MODERN proposed a *Monitoring Reference Framework* as a **structural approach** for development, implementation and operation of a monitoring program

covering the topics of:

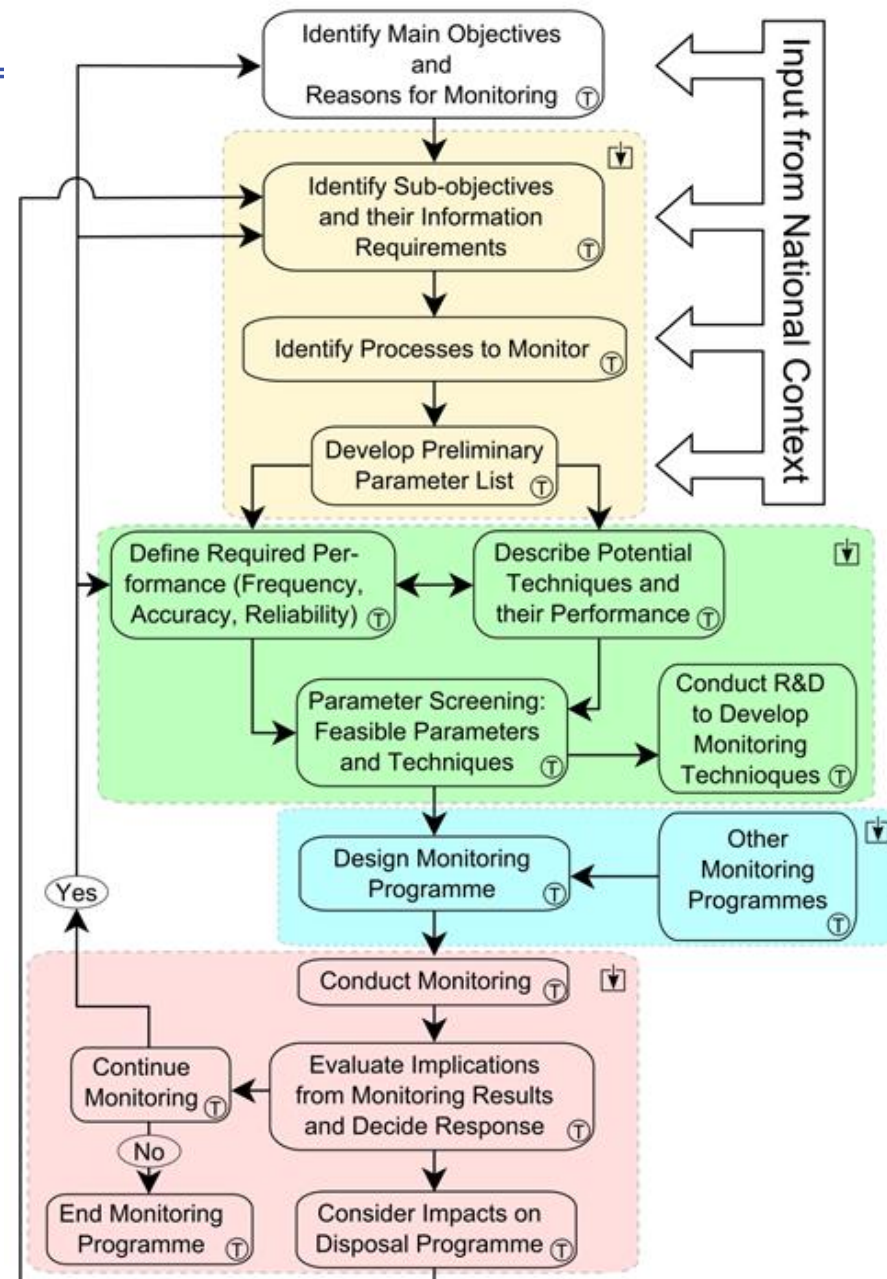
- How monitoring **objectives** may be developed and their role in the disposal process understood
- How monitoring **systems** may be designed and what **strategies** may help in attaining the monitoring objectives
- What can be achieved with monitoring; what are the **possibilities** and **limitations**
- How monitoring might contribute to **stakeholder confidence**

MODERN

The *Modern Monitoring workflow*

illustrates this **structural approach** and provides an overview of key steps to consider when developing a monitoring programme which are:

1. Analysis of objectives and relating these to processes and parameters to be monitored.
2. Analysis of requirements and available monitoring technology to design a monitoring programme.
3. Conducting a monitoring program and using the results as basic information for decision making.



Monitoring systems for the generic **German salt concept** are assumed to be implemented by applying the following

Principles

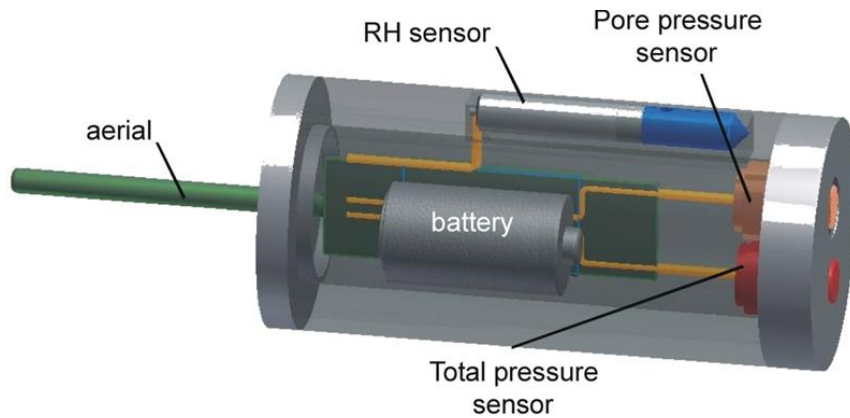
- *No cables running through geotechnical barriers*
- *No cables running along access drifts backfilled with compacting crushed salt*
- *No cable connection from the repository to the surface*



Wireless data transmission is indispensable

MODERN

WDT (short distance): A high-frequency wireless node that allows measurement of several parameters (e.g. pore pressure, total pressure and water content), and transmission of the measured data over distances of **a few meters** has been designed, developed and tested. This potentially provides a method for wireless transmission of monitoring data through an EBS.

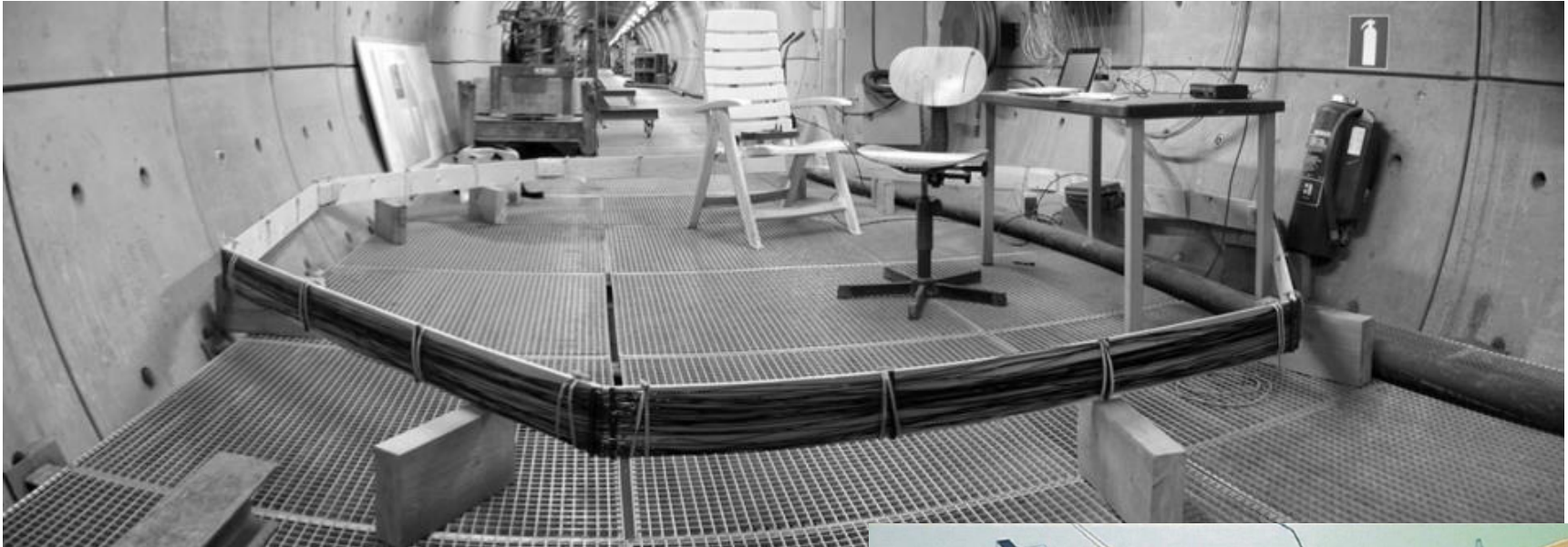


Aitemin, Spain

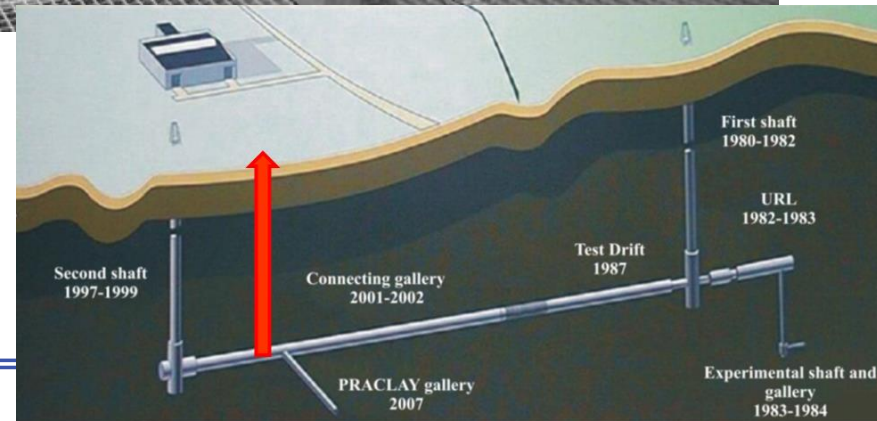


MODERN

WDT (long distance): A low-frequency data transmission system, capable of transmitting data through **225 m** of an electrically highly-conductive geological medium, at frequencies up to 1.7 kHz has been designed, developed and tested at the HADES URL. This potentially provides a method for wireless transmission of monitoring data from a repository to the surface following repository closure.



NRG, The Netherlands



Level 1 Report - Public

(Target audience has a good understanding of geological disposal)

MODERN Reports

Project Synthesis Report Deliverable D6.1.1

Level 2 Reports

(Target audience has a good understanding of safety case)

Monitoring Reference Framework Report Setting out a *Process* for monitoring Deliverable D1.2.1

Technology Summary Report Summarising *Technical* Studies

Level 3 Reports

(Target audience has a good understanding of monitoring)

Case Studies Report Examples for 3 rock types Deliverable D4.1

Proceedings of International Conference & Workshop Deliverable D5.4.1

Stakeholders

D1.3.1: Monitoring the Safe Disposal of Radioactive Waste: A combined Technical & Socio-Political Activity

D1.4.1: National Engagement Research Report

D5.3.1: Expert Stakeholders Workshop

WP2 Reports

Research & Development: Monitoring Technology

D2.1.1: Technical Requirements Report

D2.2.1: Monitoring Technologies Workshop Report

D2.2.2: State-of-the-Art Report

D2.3.1: Development Report of Monitoring RTD

WP3 Reports

In situ Testing and Demonstration of Monitoring Techniques

D3.1.1: Site Plans and Monitoring Programme Report

D3.2.1: Seismic Tomography at Grimsel Test Site

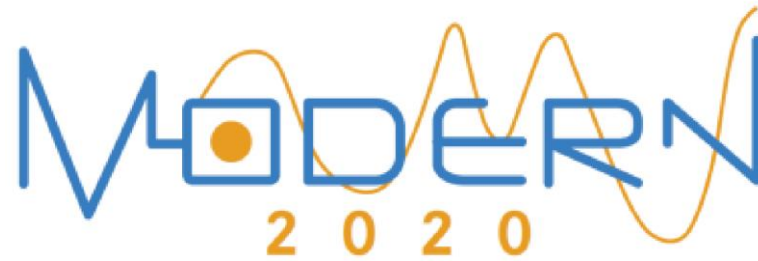
D3.3.1: Wireless Sensor Network Demonstrator Report

D3.4.1: HADES Monitoring Demonstrator Results and Analysis Report

D3.4.2: Wireless Data Transmission Experiments at HADES URL

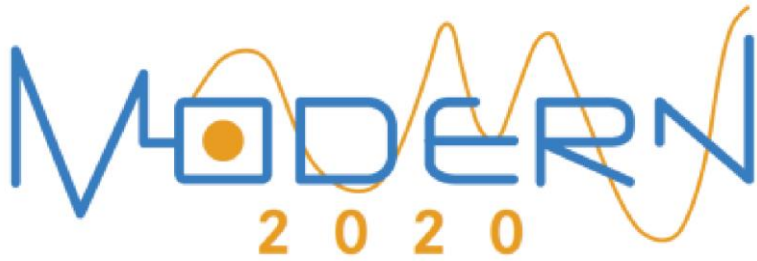
D3.5.1: Disposal Cell Monitoring System Installation & Testing Demonstrator in Bure URL

Download:
[www.dbe-technology.de
/Media/F&E-Berichte](http://www.dbe-technology.de/Media/F&E-Berichte)

The logo features the word "MODERN" in a blue, stylized, sans-serif font. The letter "O" is replaced by a square containing a solid orange circle. An orange wavy line, resembling a sine wave, passes through the letters. Below "MODERN" are the numbers "2020" in a bold, orange, sans-serif font.

MODERN
2020

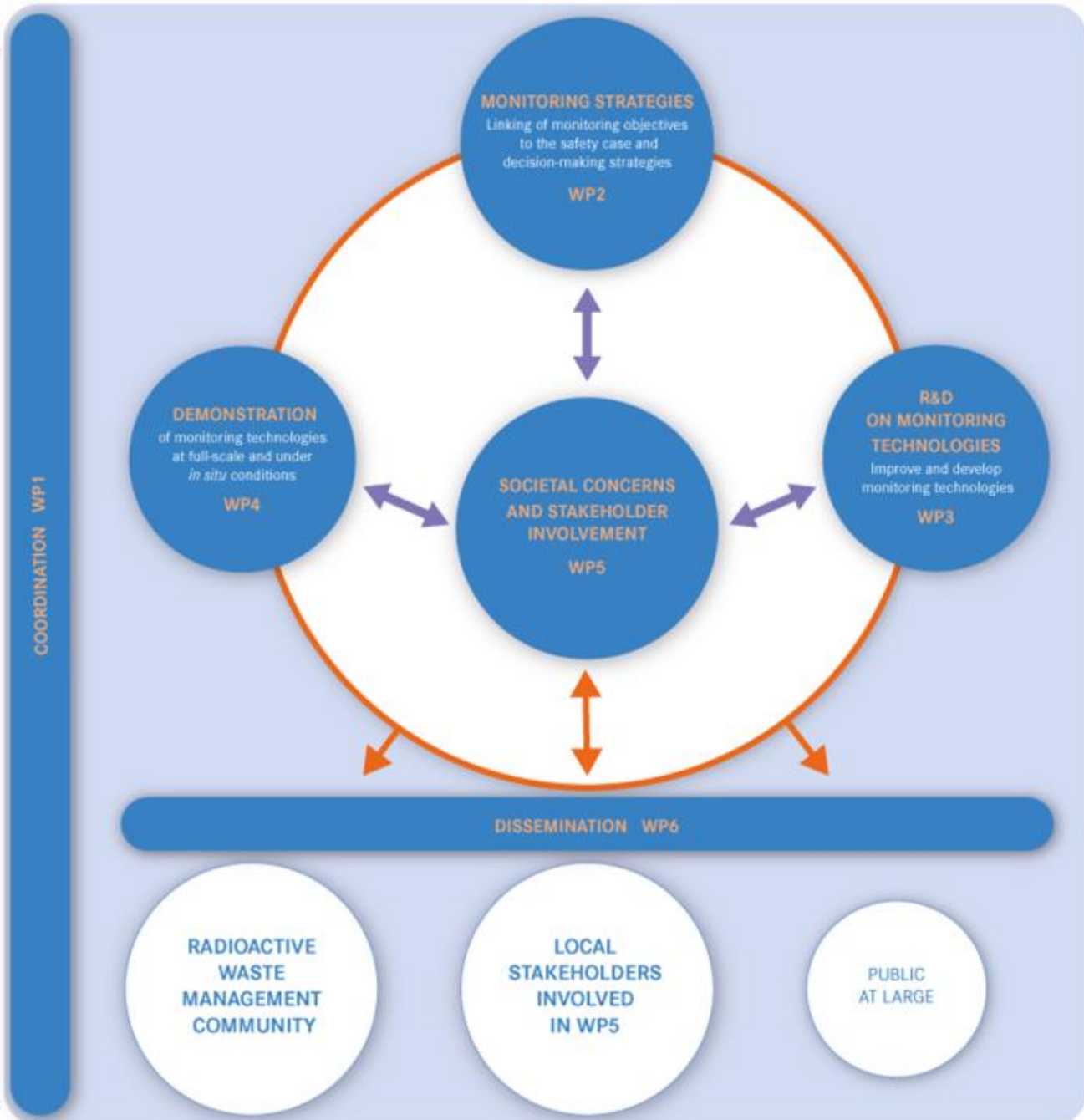
*Development and Demonstration of monitoring strategies
and technologies for geological disposal*



*Development and Demonstration of monitoring strategies
and technologies for geological disposal*

The **ambition** of **Modern2020** is to address the key challenges and to advance the state-of-the-art associated with:

- **Strategy:** Identify methods to link a monitoring program design to real-world safety cases and repository implementation programs
- **Technology:** Address key technology gaps existing with (wireless) data transmission, power supply, (new) sensing systems, reliability and qualification
- **Demonstration and Practical Implementation:** Illustrate how monitoring systems can be designed to the requirements identified by the strategy work and to use the technologies developed
- **Societal concerns and Stakeholder Involvement:** Evaluate the active engagement of public stakeholders in monitoring research and monitoring program specification
- **Dissemination:** Develop ways of establishing a common understanding on monitoring requirements and approaches.



MODERN2020

Consortium: 28 Partners out of 12 countries
 Coordinator: Andra

2015 - 2019

Total budget: 8.6 Mill €
 EC funding: 6.0 Mill €

<p>8 radioactive waste management organisations</p>	
<p>5 organisations undertaking research on radioactive waste management in their respective country</p>	
<p>1 technical support organisation</p>	
<p>4 organisations with specialist technical monitoring expertise</p>	
<p>8 academic research units</p>	
<p>2 specialist consultants</p>	



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- Compare and evaluate **existing monitoring strategies**
- Identify **decisions requiring support from monitoring** and **what kind** of monitoring **data** is required
- Identify and update approaches that could be used to **compile and screen parameter lists**
- **Involve Stakeholders** to explore how their early involvement in developing monitoring plans could be addressed appropriately

Special issue: Development of monitoring concepts for EBS.

performed during the operational safety
related to long-term safety (safety case)
responding to the reversibility principle (France)

MODERN2020 (Technology)

State-of-the-art Technology: Update the MODERN state-of-the-art on monitoring technology status and highlighting gaps that still need to be bridged

- **Technology Readiness Levels (TRL)** -

Wireless Data Transmission (WDT): Further develop systems for (short + long range) WDT. The required progress is related to the enhanced propagation of radio waves across the different repository materials and components

Sustainable Power Supply: Investigate power supply sources capable of extending the expected lifetime of the WDT

Thermoelectric-Generator (TEG), NRG

Radioisotope Thermoelectric Generator (RTG), AREVA, Andra, RWMC

Sensor System Improvements: Further develop and adapt available (or new) technology to monitor e.g. H₂, Temperature, strain, radiation, pH, displacement (new FOS) to improve geophysical methods (SWFI, ERT/IPT)

Qualification: Develop a common multi-stage qualification methodology applicable to each component of a monitoring system

ONKALO (Finland)

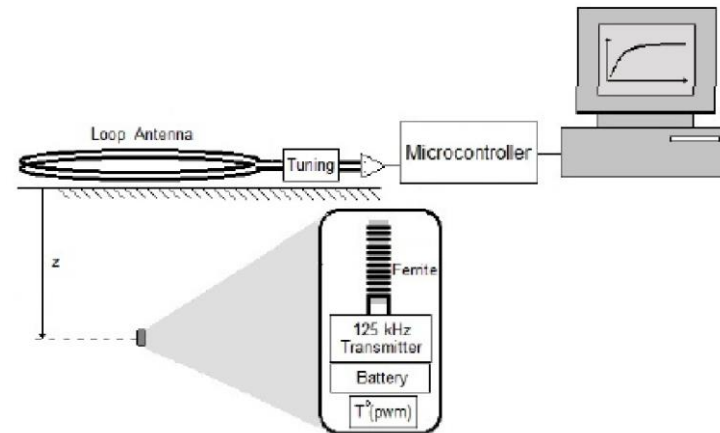
Improving the existing wireless system for data transfer through rock, soil, and water

- 125 kHz system

Key further improvements pursued

- Increased transmission range
- More reliable and robust data transfer
- Longer sensor lifetime

Evaluation of the use of combination of different wireless solutions



Organisation of a monitoring training school (1 week)

... **for early-career scientists/engineers** in the field of geological disposal monitoring
(advanced PhD candidates, Postdoctoral scientists and engineers affiliated to European research institutions)

- **Training sessions** will comprise a series of key lectures given by international experts and discussions alongside practical exercises.
- **Visit** of an Underground Research Laboratory

- **Topics:**
 - Main **regulation texts** (e.g. Directive 2011/70 EURATOM)
 - Explain monitoring **challenges** for geological disposal (e.g. long term monitoring)
 - Main **technologies** used in such environment
 - **Methodology** to elaborate a suitable monitoring system
 - Monitoring data (results) and **decision making**
 - Address **data archive** management
 - **Stakeholders'** involvement

Development of **monitoring concepts** for **EBS**



Development of “synthetic” monitoring results in and around the EBS for different scenarios



Identification of how “bad” monitoring results must be to indicate a risk for the safety of a repository by sensitivity analysis of barrier (component) performance



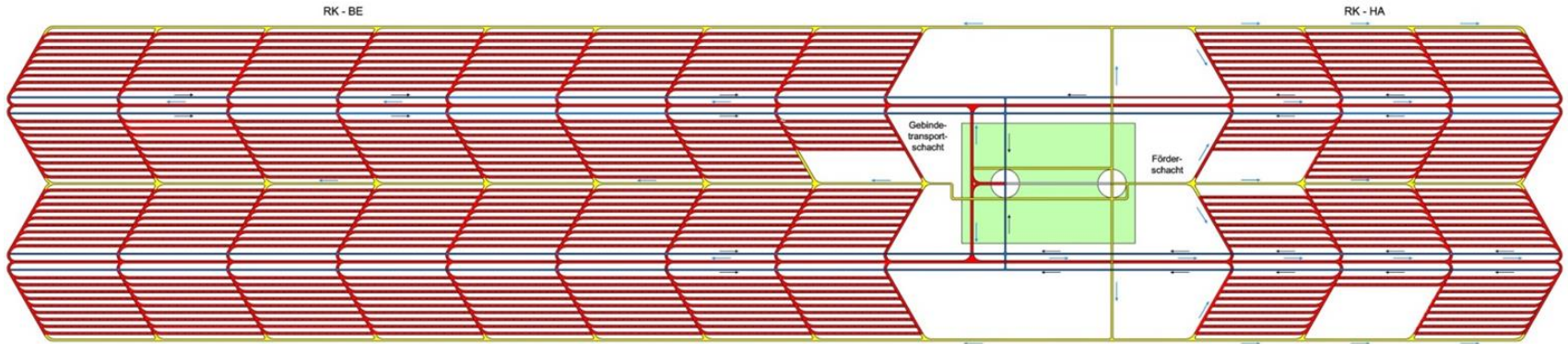
Develop “**trigger values**” or “trigger evolutions” for EBS monitoring concepts



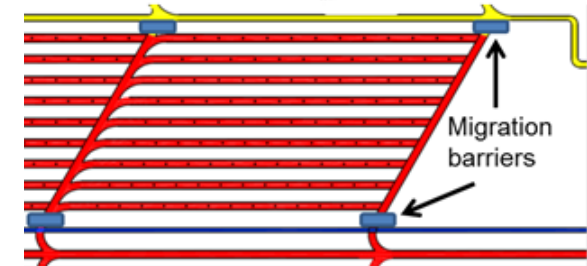
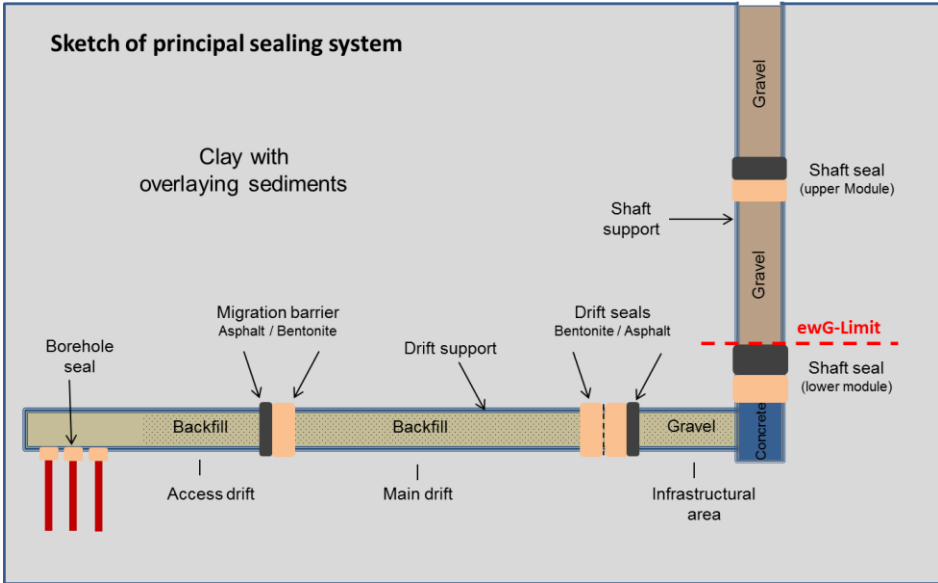
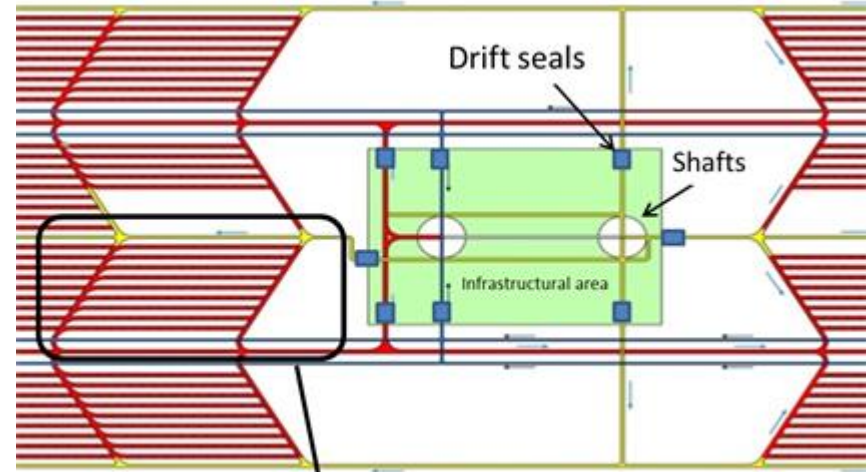
Identify specific **requirements for sensing system**

Development of **response plans** for scenarios exceeding specific trigger values

Repository concept in clay



The development of a monitoring concept for a HLW repository has been started



R&D Project ANSICHT

Open Issues



18 Partners
12 Countries

→ Open Issues →



28 Partners
12 Countries

- **Strategy:** EBS monitoring concepts
- **Technology:** WDT, power supply, improvement of sensing systems, qualification
- **Demonstration:** Illustrate how monitoring systems can be designed to the requirements identified
- **Stakeholder Involvement:** explore their early involvement

Stakeholder Involvement in:





Monitoring is not only a technical topic
Monitoring is limited through a number of **societal** factors

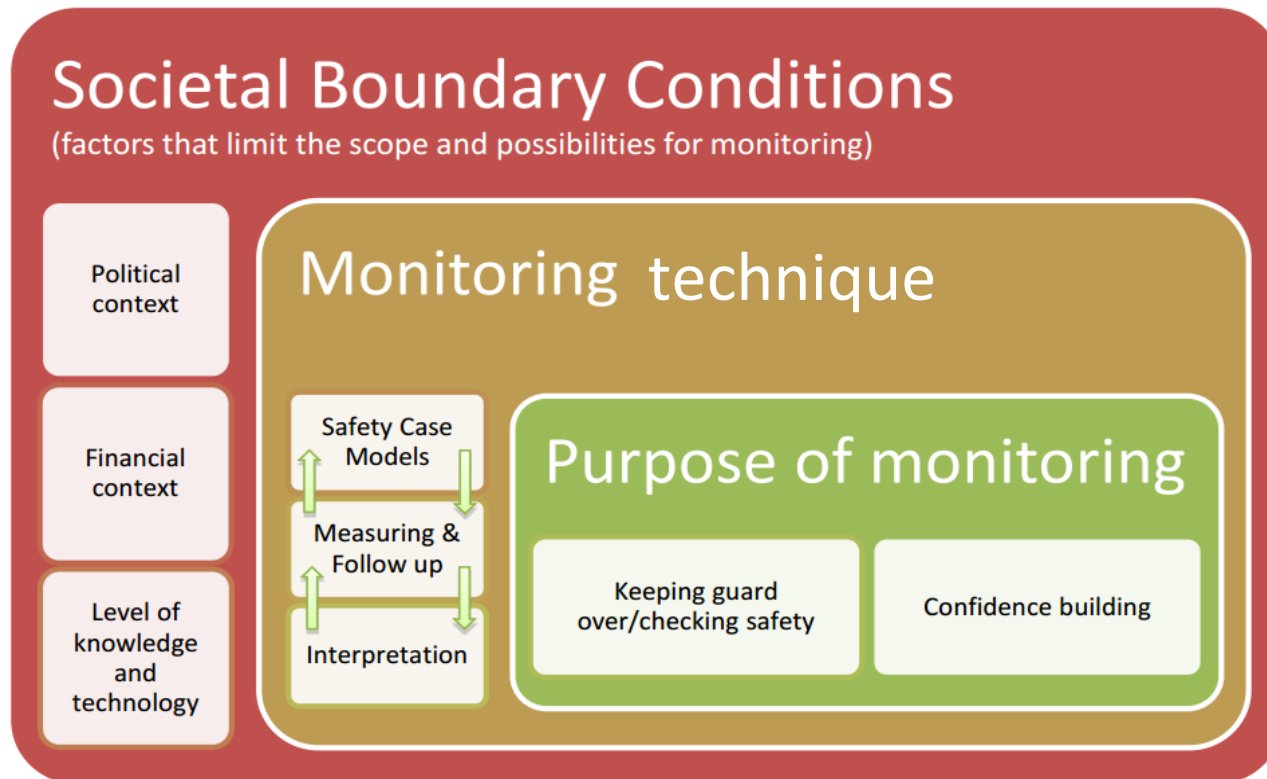


Figure 2 The Belgian participants' collective view on monitoring objectives

'Experts' vs. 'Lay'?

Conclusion: experts (NWMOs) and citizens have different perspectives on monitoring

Experts:

- Aim of monitoring = 'performance confirmation', Reassurance, Confirmation
- Monitoring supports decision making processes

Lay:

- Citizens are more careful: „***Check whether the disposal is safe***”



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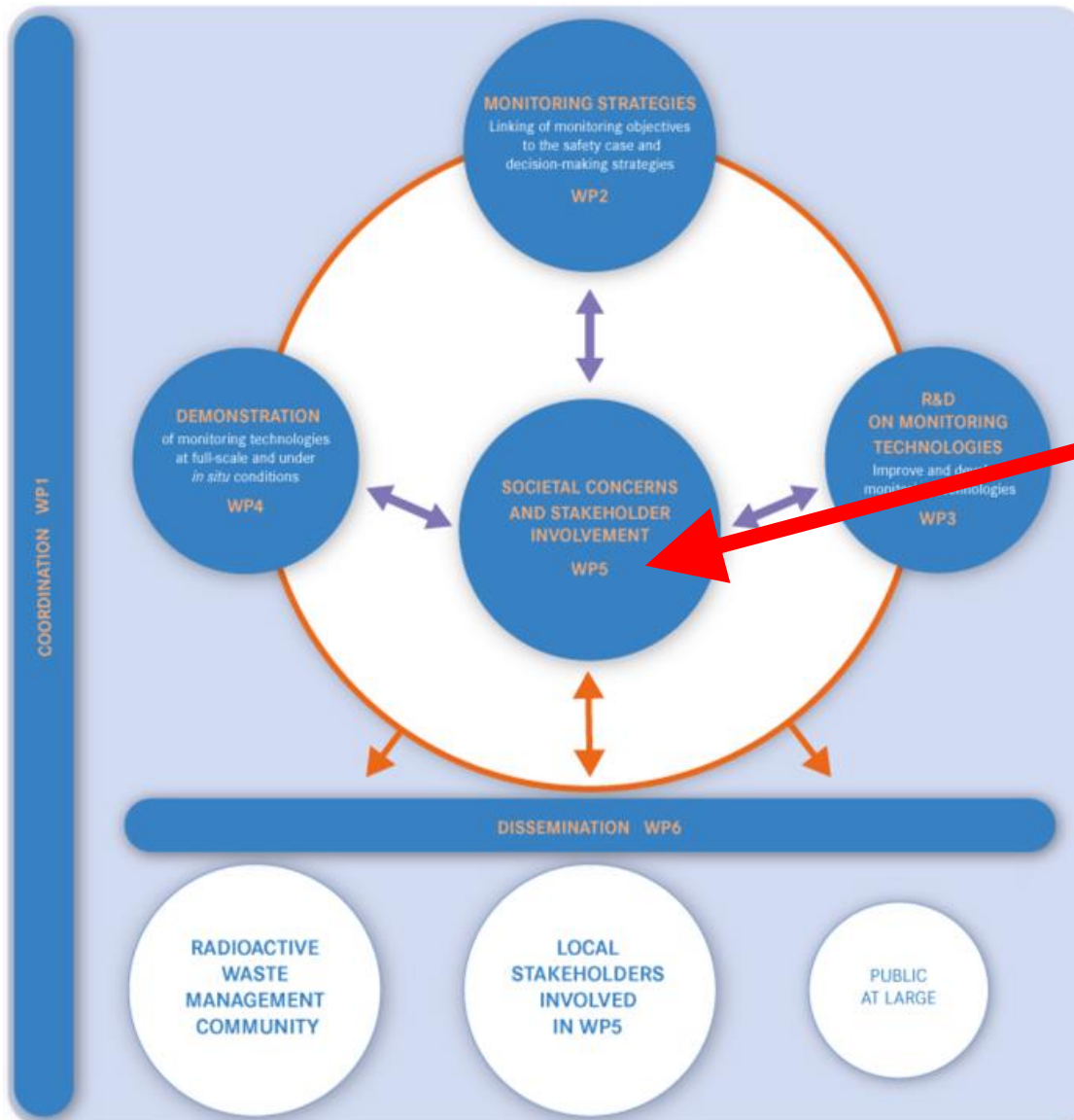
Aim of the research



Development and Demonstration of monitoring strategies
and technologies for geological disposal

The development and implementation of an effective and efficient operational monitoring program for geological disposal for high level radioactive waste (B&C) and spent nuclear fuel

- *respectively of the national context (eg. Host rock, legislation)*
- *involvement of different **stakeholders** (citizens)*



WP5:
Societal concerns
and stakeholder
involvement

WP5

Task of UAntwerpen (together with University of Gothenburg):

Stakeholder-Involvement in R&D activities on monitoring on two levels:

a) Involvement of **representatives** from local partnerships within **internal** Moden2020 project workshops

At the project level

b) Creating 'at home' **engagement sessions** in (potentially) concerned communities

At home



Belgium Finland Sweden

The role of local stakeholders

The role of local stakeholders



Analytical basis for public participation

- Geological disposal is not only a question of technical know-how
- Dividing between ‘experts’ and ‘lay’ is a faulty perspective
STS-perspective: “*Lay knowledge is **qualitatively different**, but neither wrong nor useless!*”
(Bucchi & Neresini, 2008, Handbook of STS)
- What is the citizens’ **local knowledge**? (Wynne, 1989)
- How to create a **socially robust** monitoring system? (Nowotny, 2003)
- Try **Upstream Engagement** in practice (Wilsdon and Willis, 2004)
- Establishing a **dialogue basis**, out of which mutual **trust** can be achieved
- More general research question: *How can **successful participation look like?***

1. Research results

1. Dialogue workshop in Belgium (May 2016, Dessel)

- ca. 15 citizens from the communities of Mol and Dessel (partnerships Mona & Stora),
- 2 Niras-Ondraf / Euridice representatives
- WP3 leader
- UAntwerpen
- 2 presentations (held by UA and Niras-Ondraf)
- Open discussion round, facilitated by questions and moderation by the UA



1. Research results

Guiding Questions:

- *How do citizens frame **successful participation in Modern2020**?*
- *What do citizens know on the topic already?*

→ Great **interest** and curiosity in monitoring, follow-up of the current research

→ Citizens consider themselves as **experts**: long experience with the topic nuclear waste (CatA project)

→ **Middlemen** between waste managers, politics and society at large:
(*Monitoring is too specific topic to be discussed with society' at large*)

= help to build up a **societal support basis**

→ **Watchdog** over the waste manager (=Niras-Ondraf)



Problems: → Topic Monitoring is quite abstract ! Technic/System not sharp enough defined
→ Mere ‚rupperstamping‘ of solutions made within Modern2020 explicitly denied!

→ *When is the correct/best suitable **point in time** to involve citizens in such a complex research?*

Research outlook 2016/2017

Monitoringdocument / Handbook: *'From Safety to Monitoring'*

Development of a document (handbook) explaining monitoring technologies and strategies

- **Aim:** Monitoring als Technologie erklären, Transparenz schaffen, Offenheit gegenüber der verschiedenen Monitoringansätze in den verschiedenen Laendern (v.a. Frankreich, Schweden, Finnland), Diskussionspunkte darstellen, Dialog statt Kommunikation
- **Audience:** Citizens, local communities, policymaker, other interested groups
- **Standard:** IPCC Policy documents
- **Workshop:** End November to concretize shape of document

Many Thanks!

More information is available on the MODERN2020 website

www.modern2020.eu

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