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# R&D Support of DGR Development in the Czech Republic

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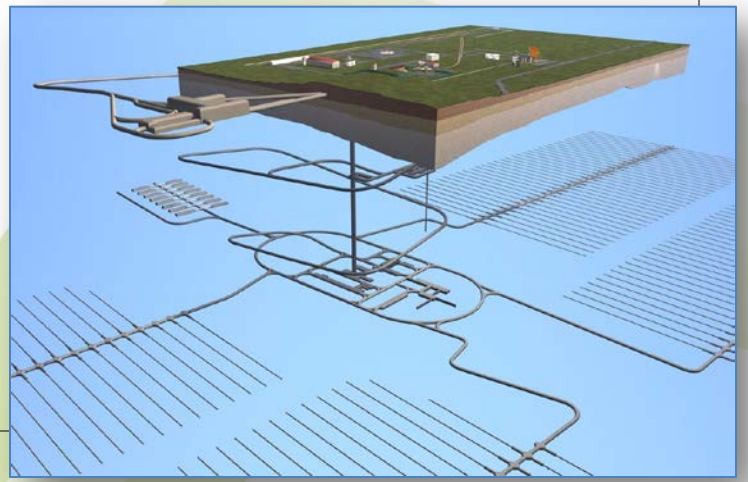
# Background

- The Czech Republic has 6 nuclear reactors in 2 NPPs (at Dukovany and Temelin)
- It is planned that 2 new nuclear units will be built by 2025 and 2030 at Temelin
- The basic fuel back-end concept consists of the direct disposal of spent fuel assemblies in steel-based canisters in a crystalline host rock

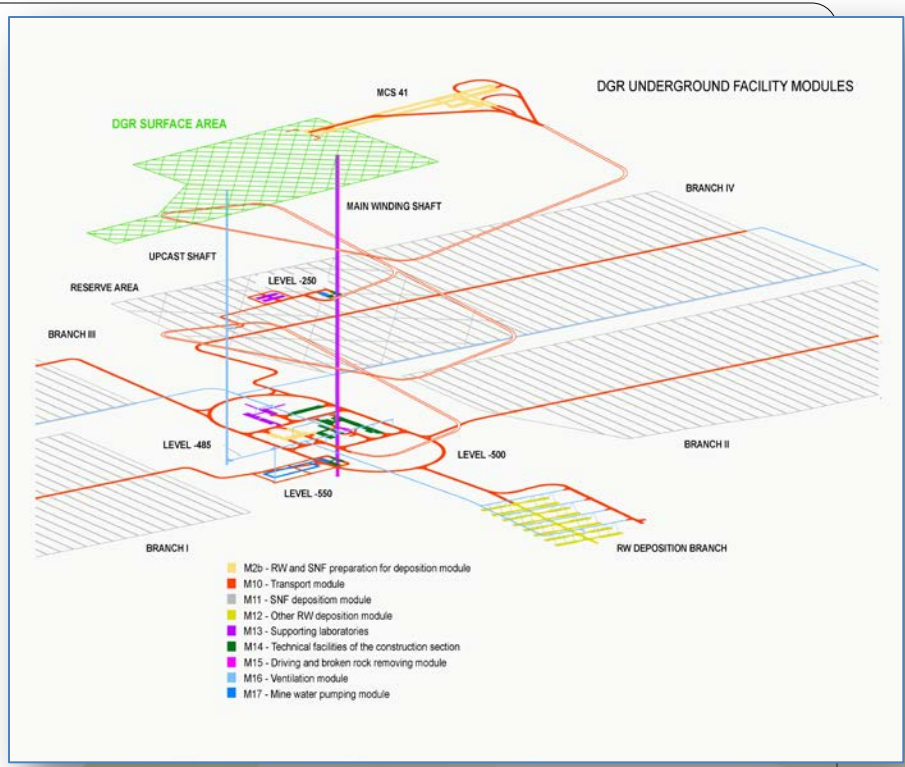
Temelin NPP



# Inventory of Radioactive Waste for the DGR

| | SF | | | HLW |
|---|---|---|---|---|
| | EDU VVER -440 | ETE VVER-1000 | EDU, ETE NJZ | |
| Number of fuel assemblies in a canister | 7 | 3 | 3 | |
| Number of canisters with SF assemblies | 2050 | 1130 | 2700 | |
| Total number of canisters | 5 880 | | | 2 990 |
| Number of drifts for SF and HLW caverns | 45 | 47 | 159 | 16 |

Inventory of canisters with SF and HLW containers and number of disposal drifts and disposal caverns




Scheme of DGR underground modules from Reference Design 2011

# Current Schedule for DGR Development in the Czech Republic

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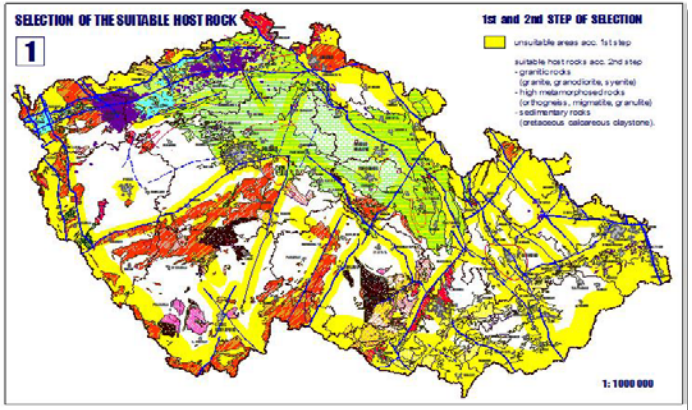
- CZ DGR site selection programme started in 1992
- In 2003 - 6 potential sites in crystalline rock have been selected according to general criteria for nuclear facility siting and conflict of interest evaluation + 1 additional site in 2010
- By 2018 (Government decision) a proposal containing 2 candidate sites should be submitted to the Government on the basis of a more detailed geological survey
- By 2025 a license application should be submitte to the regulatory body (SÚJB/SONS) for final site
- By 2050 a licence application for repository construction should be submitted to the SÚJB
- The DGR should be commissioned in 2065




# Main Objectives of the R&D Programme in the period 2014 - 2025

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- ✓ To support the siting programme for the selection of the most suitable candidate sites in the Czech Republic for DGR siting
- ✓ To adapt a DGR design suitable for candidate sites
- ✓ To demonstrate SÚRAO's capability to prepare the safety case with supporting DGR safety and environmental impact assessments
- ✓ To facilitate the communication of the results to stakeholders and
- ✓ to increase DGR acceptability

# R&D Structuring

- ✓ R&D on methods for siting and site characterization
- ✓ R&D on design and construction activities, preparation of feasibility studies
- ✓ R&D on safety-related processes
- ✓ R&D on preparation of the safety case and supporting safety assessments
- ✓ R&D on an evaluation of the environmental impact of the repository
- ✓ R&D on an evaluation of socioeconomic and other aspects

# R&D on Siting (Past work)

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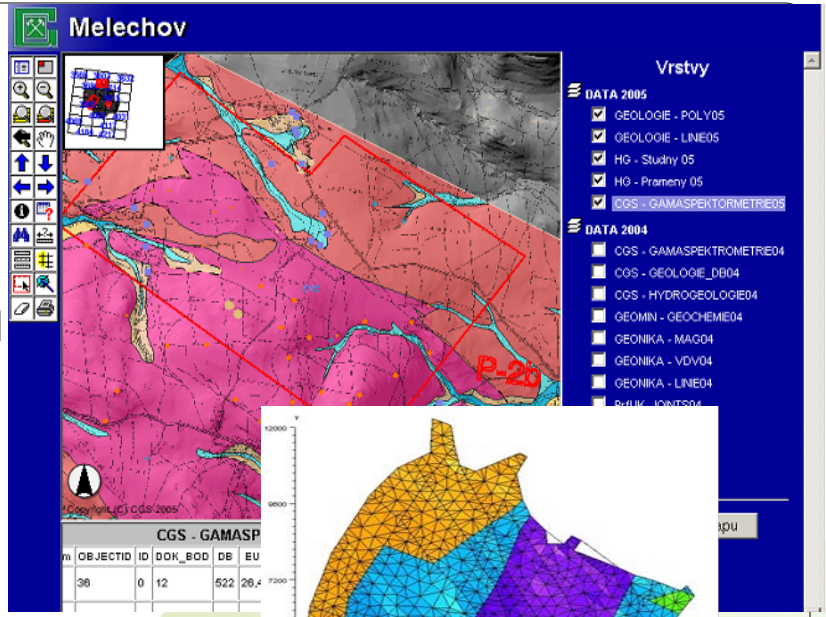
- ✓ **1992–1997** - **27 sites were evaluated** on the basis of the analysis of pre-existing geological information.
- ✓ **1998–2005, 2010–2011** - 7 sites have been evaluated on the basis of excluding criteria (surface nuclear facility, socioeconomic, political and environmental criteria)
- ✓ Geological survey **methods** for crystalline rock have been tested in crystalline rock areas that are not being considered for DGR siting
- ✓ Descriptive site **geological and hydrogeological models** have been prepared based primarily on the investigation of similar sites to those considered for DGR siting.




Network visualization

# Support for Siting (Planned work)

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- ✓ Near surface geological survey of preselected sites (7 + 1??) – project recently in the approval stage (2014 – 2016)
- ✓ Evaluation of primary data from sites and selection of 4 of the most suitable sites on the basis of preliminary safety evaluation and other socioeconomic, political and environmental criteria (2016)
- ✓ Geological survey of 4 sites with deep boreholes (2016 – 2018)
- ✓ Detailed evaluation of 4 sites and selection of 2 candidate sites for Government decision (2018/2019)
- ✓ Continuation of geological survey work at 2 candidate sites (2020 – 2025)
- ✓ Detailed evaluation of the sites and selection of the final site (2025)

# R&D on site characterization (Planned work)

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- ✓ Continuation of **R&D of geological survey methods** specific to the DGR (e.g. development of a special multipacker system for the evaluation of very low transmissivity systems, sampling under reducing conditions, etc.)

- ✓ Preparation of **site descriptive models**, **data acquisition and storage system**

# R&D on design and construction (Past work)

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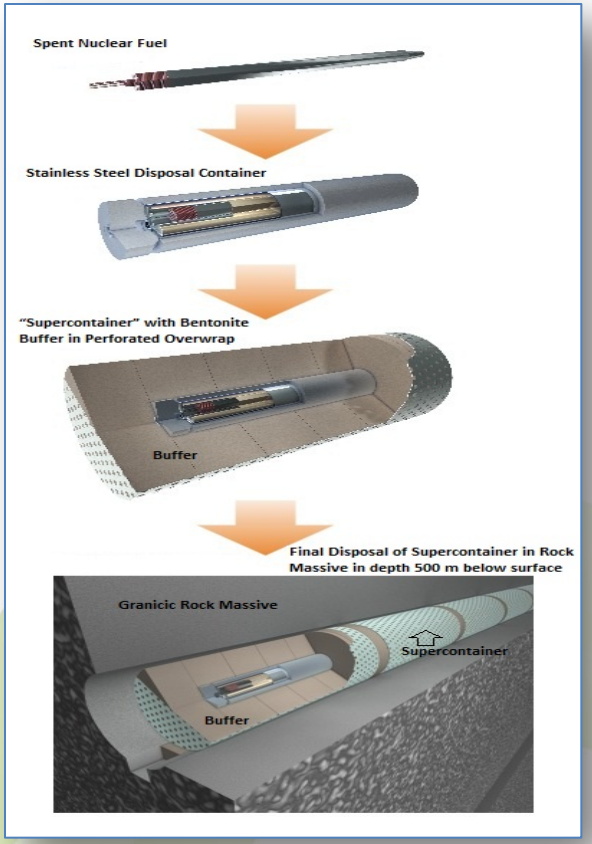
- **Preliminary reference design 1999**
  - based on the KBS-3 V concept with steel canisters.
  - It was intended primarily for the identification of the basic parameters of the DGR,
  - material consumption levels,
  - cost estimates and further activities required.
- **Update of the reference design 2011**
  - based on the KBS 3 H concept with steel-based canisters.
  - Waste from possible new reactors was considered
  - New data on the area required,
  - material consumption levels and costs were estimated and further activities proposed.



# R&D on design (Planned work)

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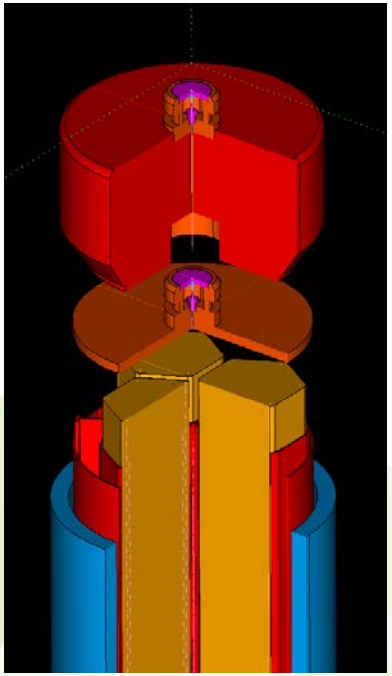
- ✓ **R&D on steel-based canisters** for SF assemblies (project in approval stage)
- ✓ Update of the **inventory of SF** and radioactive waste intended for the DGR – in cooperation with the Czech Technical University
- ✓ Development of **DGR layout specific to candidate sites** including thermal dimensioning, manipulation and transport dimensioning and evaluation of geotechnical factors
- ✓ R&D on **engineered barriers** (e.g. bentonite pellets versus blocks)
- ✓ R&D on **excavation methods** and their impact on the host rock
- ✓ Participation in **international R&D projects** (e.g. DOPAS plug and seal system development project)



Scheme of proposed steel-based canister – VVER 1000

# R&D on safety-related processes (past work)

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**Long-term safety - a large number of studies have been conducted since 1993 to gain a deeper understanding of processes occurring in repositories and the behaviour of EB components; some of them with EC support or in cooperation with foreign partners**

- **Conceptual modelling** (RED-IMPACT, PAMINA, SPIN)
- Laboratory experiments **investigating processes in repositories** (NF-PRO, FUNMIG, RECOSY, FORGE, Grimsel-LTD)
- **Process modelling** (DECOVALEX, PAMINA, EBS)
- **Mock-up experiments** under laboratory and in situ conditions (URL Josef) – DOPAS
- **Testing of hydro and transport codes** at the Bedřichov site (DECOVALEX, EBS Task Force )
- Study of **Ruprechtov natural analogue** site (co-operation with GRS)
- **Matrix diffusion study** (LTD-Grimsel)

**Mock-up in Josef**

# R&D on long-term safety (Planned work - 1)

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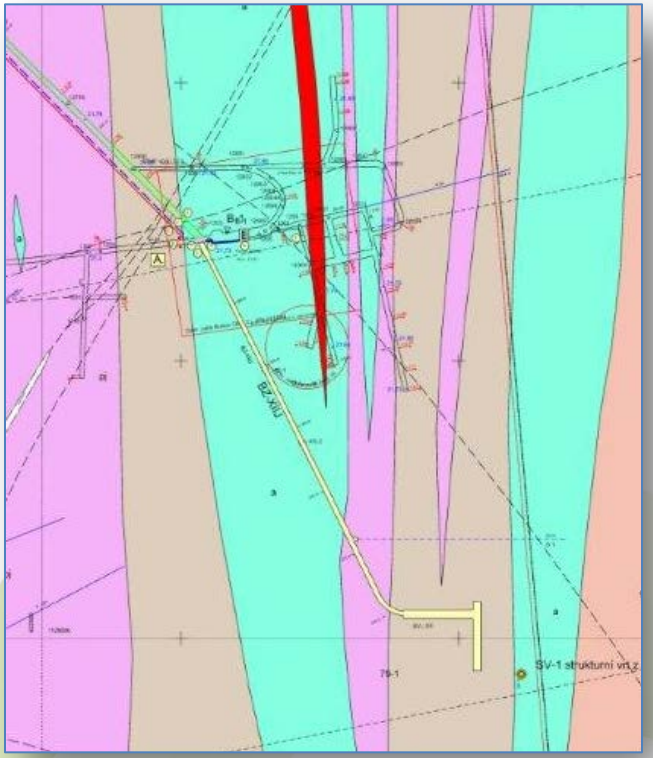
- **Systematic acquisition of data for the safety case and supporting assessments**
  - **Update of inventory** on, and properties of, SF and HLW in the DGR environment
  - **Host rock specific data** for safety assessment purposes based on a systematic literature review
  - Establishment of a **long-term laboratory and in-situ programme** for the confirmation or exclusion of using **steel-based canisters** in the Czech DGR concept
  - Establishment of a **long-term laboratory and in situ programme for** the safety-related properties of **EBS**
  - Modelling and **prediction of the THMC properties** of the host rock and EBS
  - Modelling and **prediction of the transport properties** of the host rock and EBS
- **Active participation in international projects: IGD-TP (CAST, DOPAS), Grimsel (LTD, MACOTE), DECOVALEX, EBS Task Force)**

# R&D on safety-related processes (Planned work - 2)

- ✓ Establishment of an in situ experimental programme at the **Bukov Underground Research Facility (BURF)**
- ✓ 600m below the surface, near the Kraví Hora preselected site – construction 2013 – 2014, experimental work 2014 - 2020
  - ✓ In-situ experiments to confirm the **long-term properties of canisters under in situ reducing conditions**
  - ✓ Determination of **matrix diffusion properties in crystalline rocks** of types other than granite (comparison with LTD experiment at Grimsel)
  - ✓ Evaluation of **impact of excavation methods on host rock properties**
  - ✓ In situ experiments to confirm the **thermal properties of the host rock** under in situ conditions
  - ✓ **In situ corrosion tests** of container material



**Scheme of the Bukov URF**

# Safety Case and supporting safety assessments (Past work)

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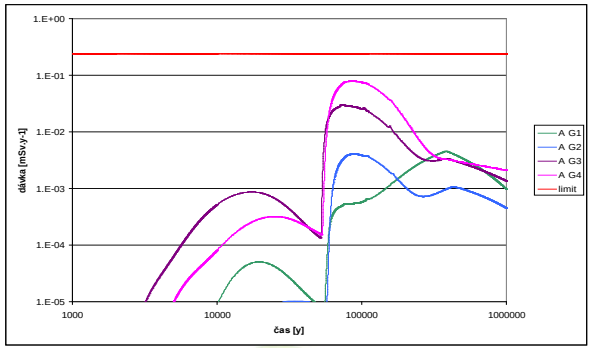
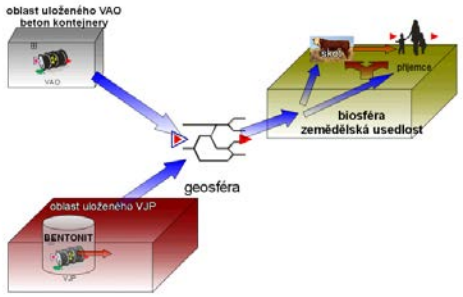
- ✓ The **first safety case (SC)** study prepared in **1999** was intended for summarising SC requirements
- ✓ **SC study prepared in 2011** was based on data from literature, limited laboratory experiments and near-surface geological survey investigations
- ✓ **Only one preferential path was considered for RN release**
- ✓ Safety assessments were performed using
  - ✓ **Scoping calculations** (MS-Excel) and
  - ✓ **GoldSim** transport code.




Impact of preferential paths on effective dose vs




GoldSim modules

# Safety case and safety assessment (Planned work - 1)

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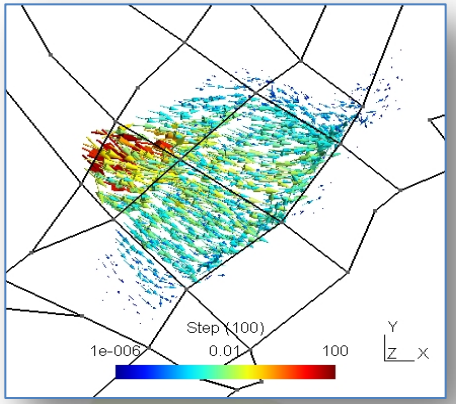
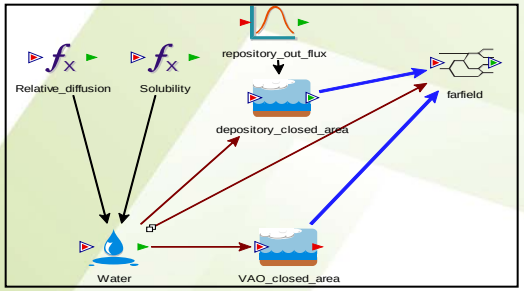
- To prepare safety case study templates for various stages of the siting process (preferably in agreement with the regulatory body (SÚJB)
  - Reducing number of preselected sites from 7 to 4 (2016)
  - Further reduction - 4 to 2 candidate sites (2018)
  - Selection of the final site (2025)
- To summarise all the data from the R&D programme and foreign studies in order to compile safety case studies with supporting safety assessments for all candidate sites




Visualization of spread of contaminants using the FLOW123D hydro and transport code




Transformation of FLOW123D results into GoldSim code

# Safety case and safety assessment (Planned work - 2)

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## SC and SA priorities in the siting process

- ✓ To confirm (by means of expert judgment) that preselected / candidate sites will not be significantly affected over relevant time-scales by:
  - ✓ Seismo-tectonic events
  - ✓ Uplift and erosion
  - ✓ Climate changes
  - ✓ Human intrusion
- ✓ To demonstrate that it will be possible **to describe selected sites using site descriptive models** (particularly hydrogeological models for evaluating preferential paths for radionuclide release from the repository to the surface) and to show that there are no evident preferential paths at selected sites
- ✓ To demonstrate that there is **no indication** of the presence **of "aggressive" waters** at selected sites which could cause the premature degradation of canisters and other EBs
- ✓ To show that there is **sufficient capacity** at all the selected **sites for the disposal of all the waste** generated in the Czech Republic (including from planned new units) and to confirm the feasibility of the construction of a DGR at selected sites

# Environmental Impact (Past work)

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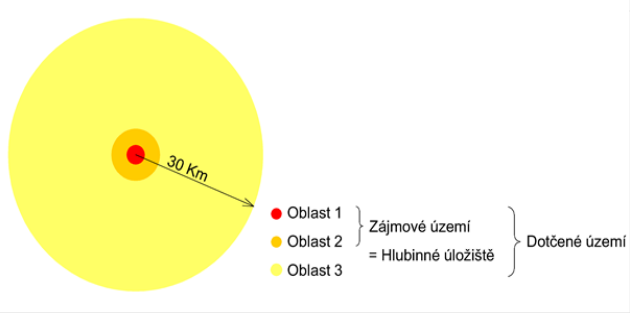
- ✓ Reference design project 1999
- ✓ Reference design project 2011




The preliminary impact of a DGR on the environment was described in the above reports in accordance with related legislation and based on data available at the time.

- Three zones were identified (see scheme).
- In addition, several "**Pre-feasibility studies**" dealing particularly with environmental impact assessment issues were conducted for the 7 candidate sites over the last 10 years (*GeoBariera* Project, SÚRAO, 2005).

# Environmental impact (Planned work)

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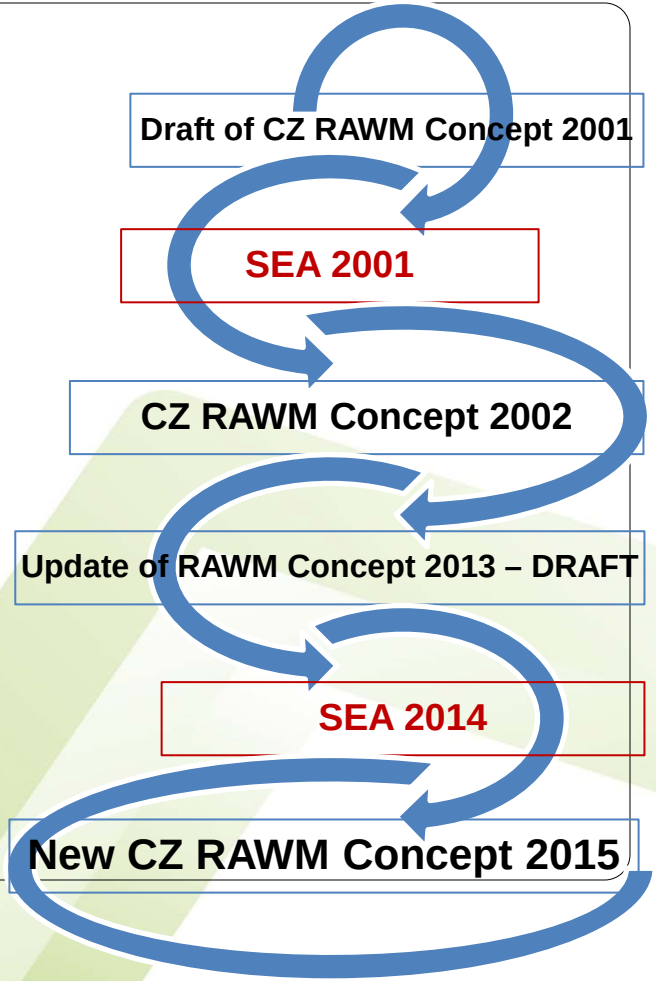
- **Environmental aspects will be incorporated into all DGR investigation and monitoring plans**
  - with the aim - minimising risk to the environment
- **Comprehensive R&D will be needed in order to assess and account for environmental and sustainability issues**
  - The “iteration principle” (see scheme) for strategic environmental assessments (SEA) will be applied to further analysis
  - E.I.A on the final site in 2025 based on the same principles



# Communication with stakeholders (Past work)

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**2007 – 2009 ARGONA project**

- **first „open“ discussion across stakeholders**

**11/2009 - Conference „Deliberation – the way towards a deep geological repository “**

**6/2010 - „Round table discussion“**

- **with the participation of municipalities and non-governmental organisations**

**11/2010 - „Working Group for Dialogue on a DGR“**

- **to increase the transparency of the siting process respecting public interests**
- **to strengthen the role of municipalities in administrative processes related to site selection for a DGR**
- **Support by EC / IPPA project** (Implementing Public Participation Approaches in Radioactive Waste Disposal)

# Communication with stakeholders (Planned work)

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## Research (??) support

- how to demonstrate safety of DGR?
- to share approaches from countries, case studies, etc.
  - participation of public in a decision making process,
  - to „transparency“ – how public to „give the necessary opportunities to participate effectively…“ **EC Directive 2011/70/EUROATOM**

**Participation in / support / international projects:**

- **PLATENSO - Building a platform for enhanced societal research related to nuclear energy in Central and Eastern Europe**
- **IGD-TP ???**

# Management Plan for the R&D programme

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## Approval by RAWRA Board in the end of 2013 / beginning of 2014

| Processes | Implemented by |
|---|---|
| Management, coordination, requirements and data management, QA | SÚRAO expert team is gradually being built + external PM Team + external Supervising and Experts Team |
| Data and arguments acquisition for SCs, EIA and feasibility studies through siting, design and research, development and demonstration (R&D&D) activities | Research and engineering consortia established through 3 public tenders should be selected in 2014 - for **siting (1)**, **design (2)**, **safety R&D activities (3)** |
| Compilation of Safety case, EIA and Feasibility study reports | SÚRAO expert team + External Independent Experts Team |
| External audit and support of SÚRAO experts | (International) expert review and advisory team established through public tender procedure |
| Regulatory body audit/advice | Regulatory body (SÚJB) experts |

# Thank you for your attention

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