

WM2015, March 15-19, Phoenix, Arizona.

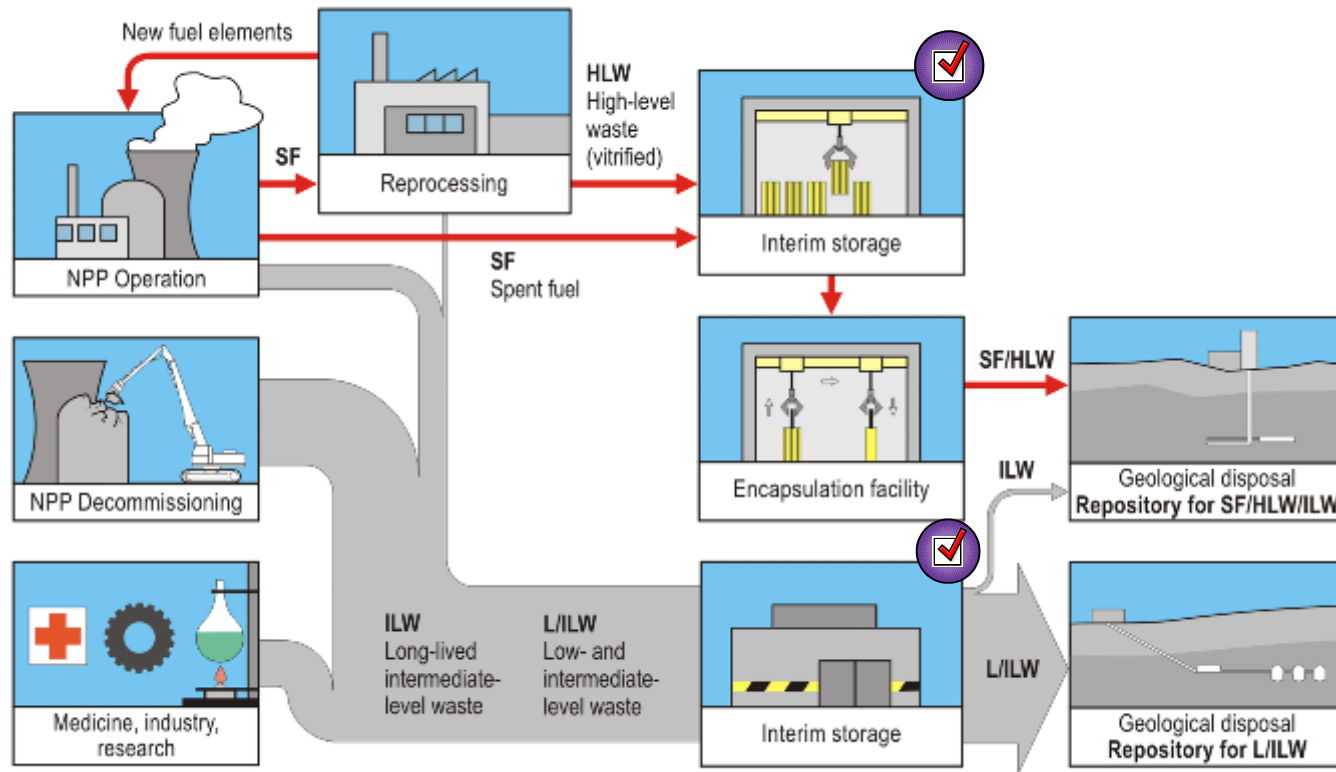
Panel - International deep repository progress

The case of Switzerland

Irina Gaus, RD&D coordinator

nagra.


Swiss waste management concept



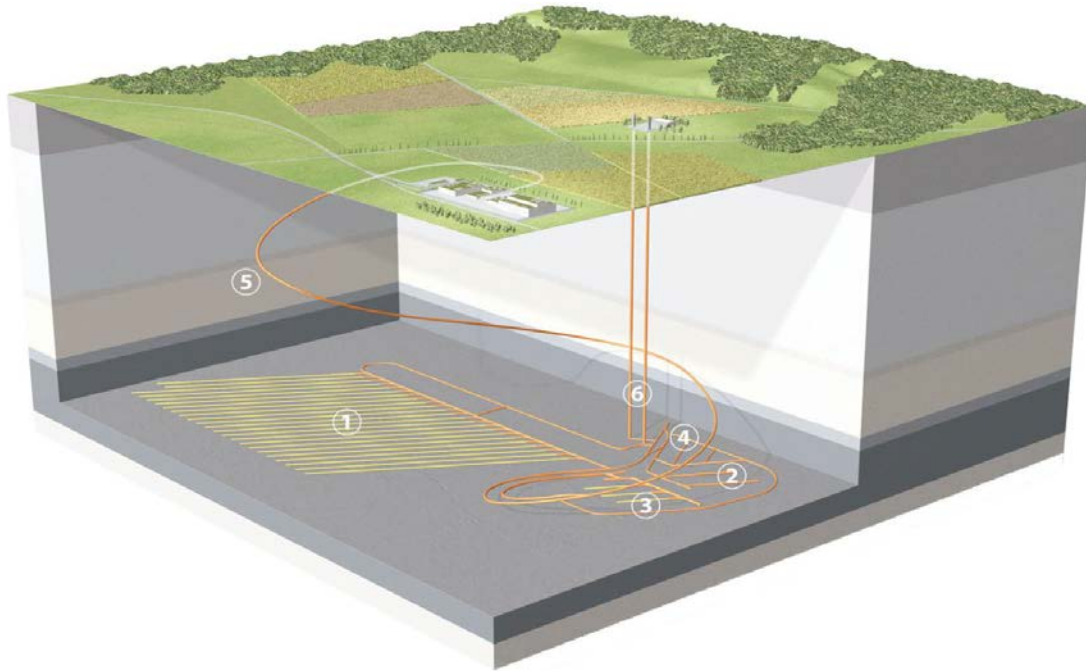
Two geological repositories:

- Spent fuel & vitrified high level waste → HLW repository
- Long-lived intermediate waste → HLW repository (co-disposal)
- Low and intermediate waste (L/ILW) → L/ILW repository

Nagra – Mission

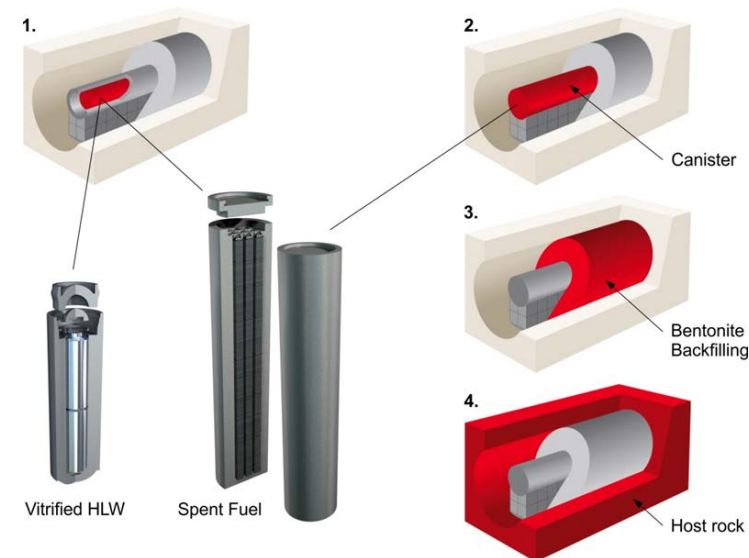
- **Nagra** (National Cooperative for the Disposal of Radioactive Waste) was established in 1972 to **develop and implement safe, sustainable solutions** for the management of **all types of radioactive waste** in Switzerland
 - Financed by the waste producers (NPPs / Swiss Confederation for MIR waste); cost of disposal ~ 1 Rp/kWh
 - Staff: ~ 100, mainly scientists and engineers
- 
- Collaborative research with more than 10 countries
 - Annual expenditure: around EUR 60 million (CHF 60 million)

Swiss concept for the HLW¹ repository



- ❶ HLW/SF repository
- ❷ LL-ILW repository
- ❸ Pilot repository
- ❹ Test area (rock laboratory)
- ❺ Access tunnel
- ❻ Ventilation and construction shafts

High-level radioactive waste, spent fuel and long-lived intermediate level radioactive waste



Research at underground rock laboratories

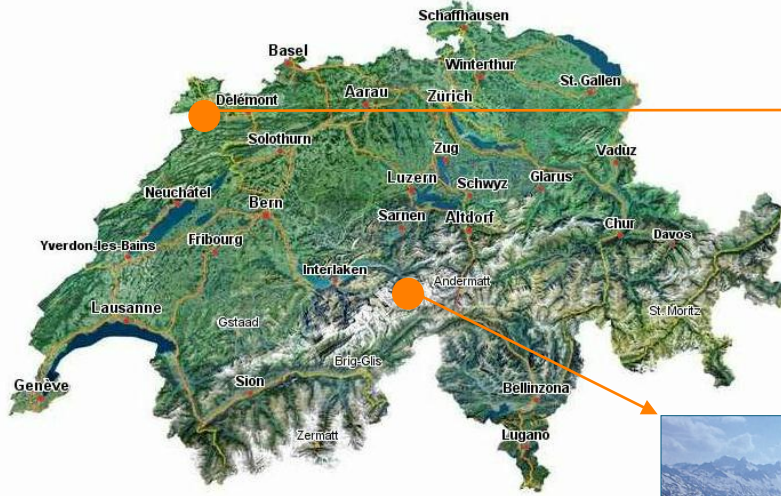
Owned by the
Canton of Jura
Operated by swisstopo
In operation since **1996**



Mont Terri Project



Opalinus Clay



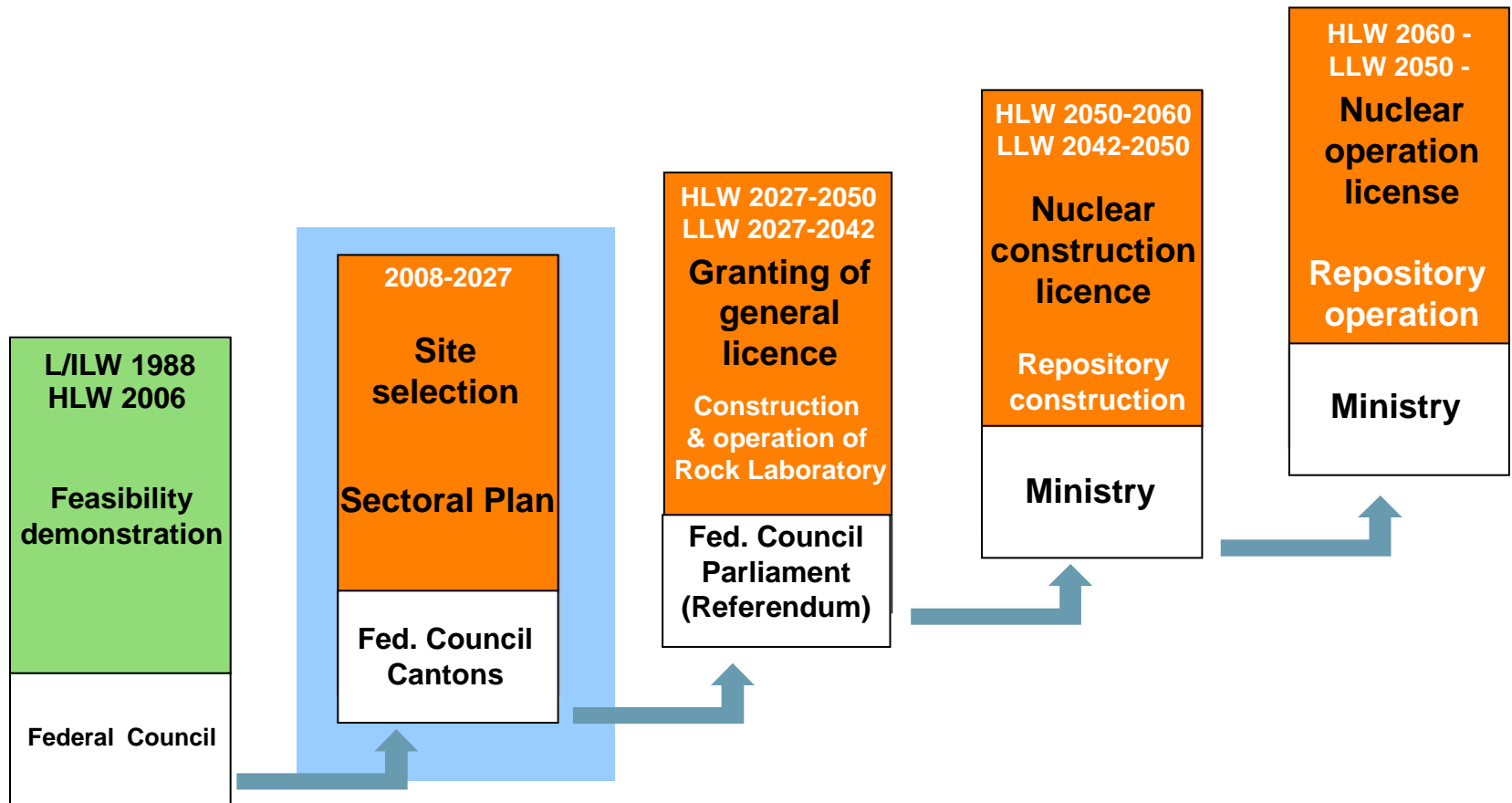
Grimsel Test Site



Crystalline rock



Development of the geological repositories - Milestones



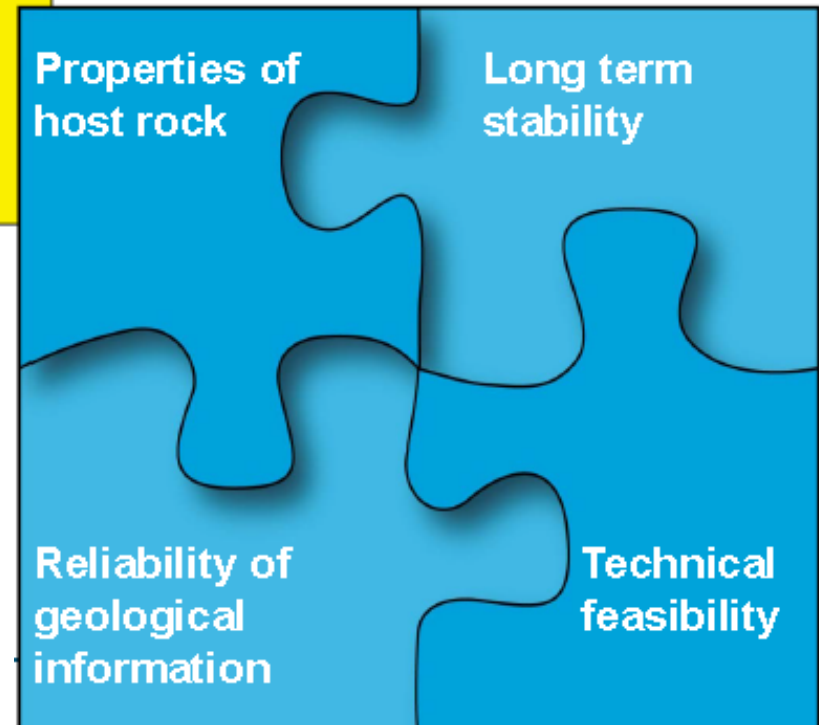
The 'Sectoral Plan' (the rules for site selection) ¹



... with strong societal involvement

- Process & responsibilities
- Criteria (safety, environmental impact, socio-economic issues)

**Safety: 13 technical criteria
(4 interrelated groups)**



Sectoral Plan – Stepwise Approach

Selection of potential siting regions for LLW & for HLW

Criteria

- Safety & engineering feasibility
- Preliminary evaluation from land-use perspective

1. Stage

ca. 3 years



Selection of at least two sites for LLW and for HLW

2. Stage

ca. 5 years



Site selection & general licence procedure for a LLW and a HLW repository

3. Stage

ca. 5 years



Source: Bundesamt für Energie (BFE)

Stepwise narrowing-in (HLW)

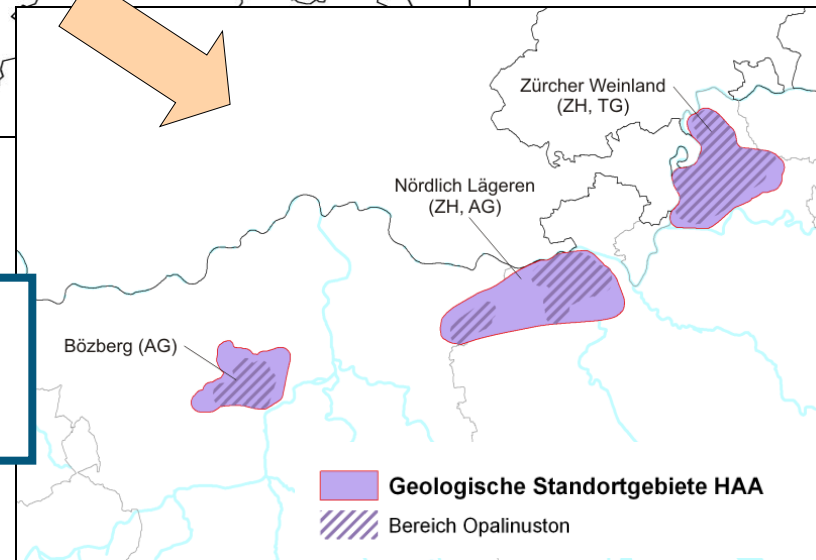
Stability & large-scale geometry:
Suitable geotectonic units

Grossräume für Tiefenlager HAA

- Günstig bis sehr günstig
- Ungünstig bis bedingt günstig
- Ungenügend

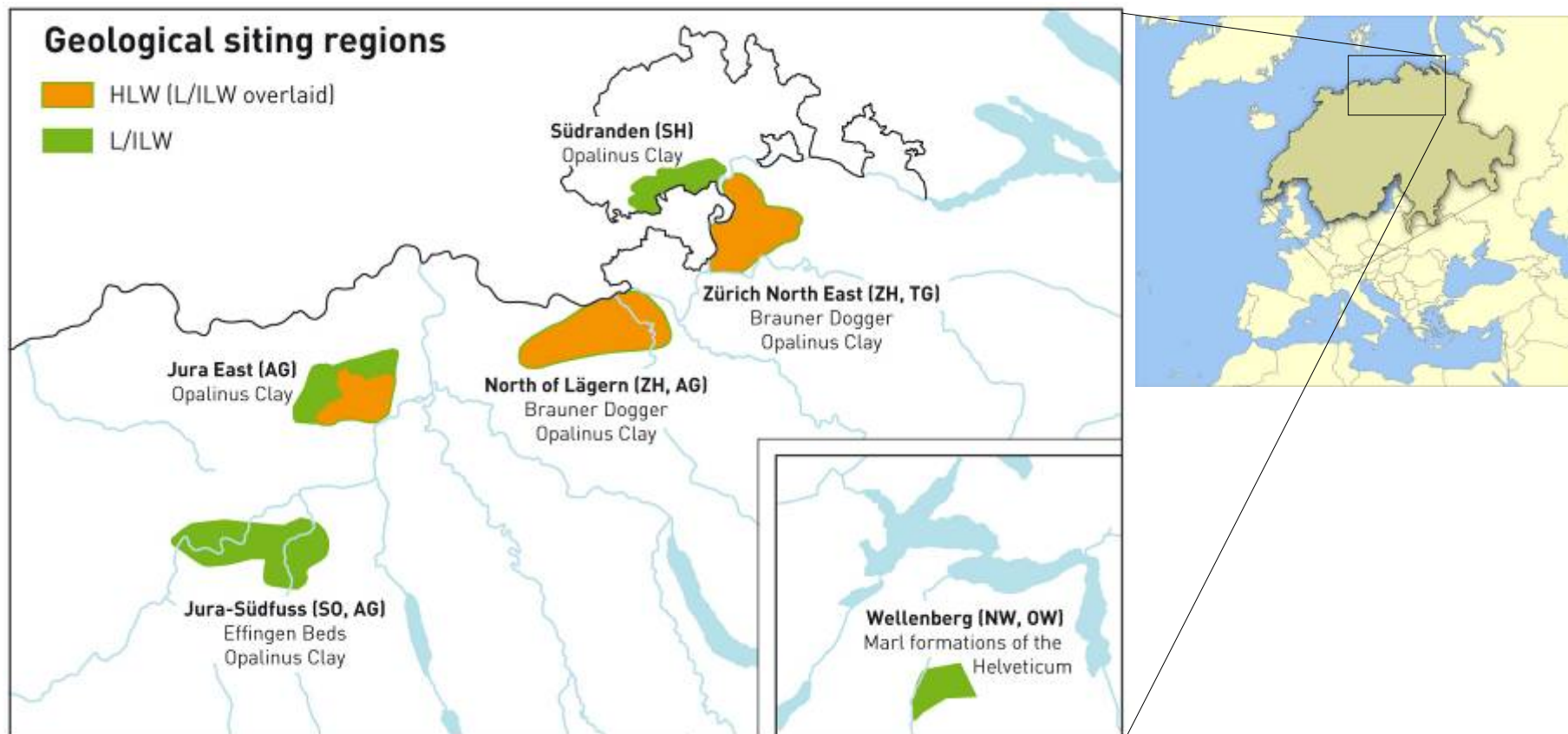
Barrier performance & construction
feasibility: Suitable host rocks
&
their occurrence

Host rocks of sufficient extent, at
appropriate depth and little disturbed
(local tectonics): Siting regions



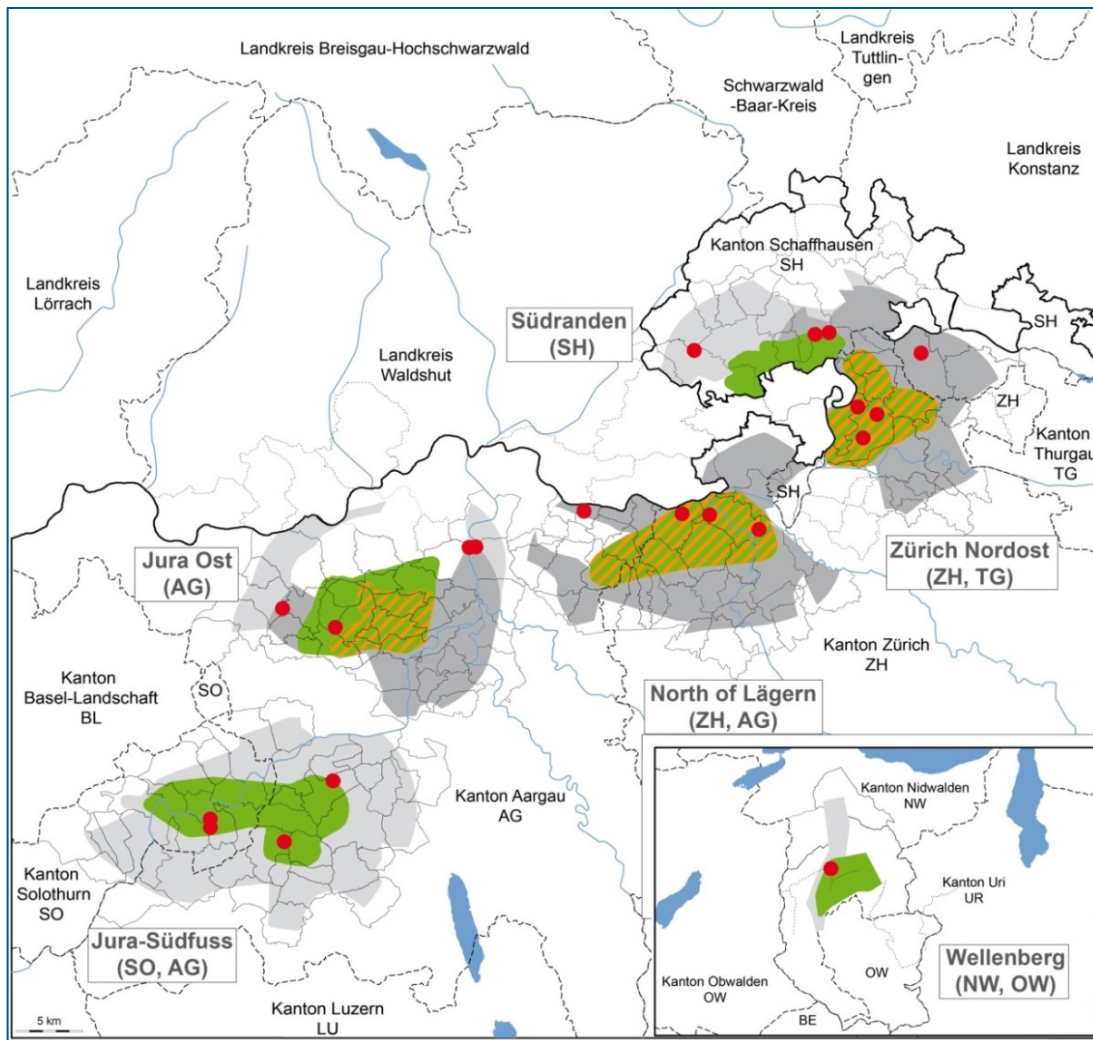
Stage 1: Siting regions proposed by Nagra

- Approved by the Swiss Federal Government – November 2011



- Derived in a systematic, step-wise narrowing-down process based on safety and engineering feasibility

Stage 2: Proposed siting areas for surface facilities



Narrowing-down process with site selection criteria based on:

- Safety and engineering feasibility
- Environmental protection and land use planning
- Integration of facilities in the siting region

In Switzerland – there is always someone close

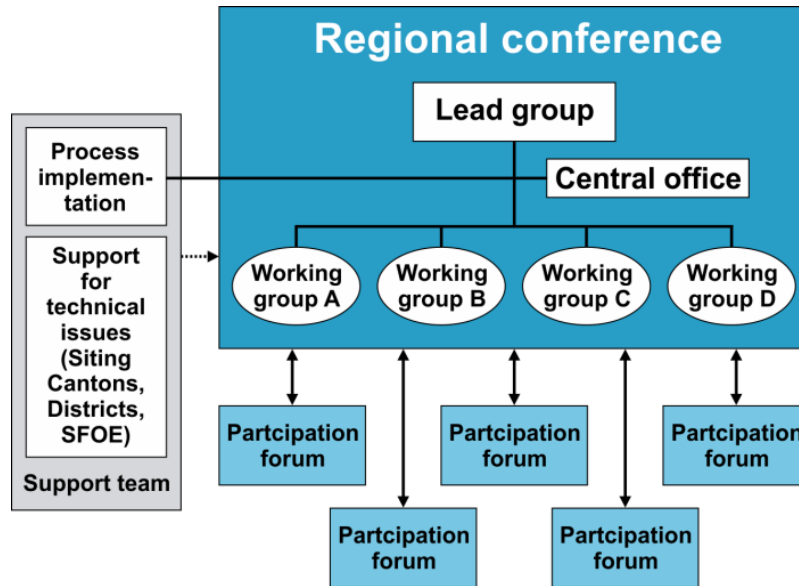
... and this leads to strong public involvement through a participatory process (in an critical, but constructive manner)



(NTB 11-01)

Participation in Stage 2

Regional Conference



About 100 members
from:

Authorities	Organised interests	Public
30% - 50%	30% - 50%	10% -30%

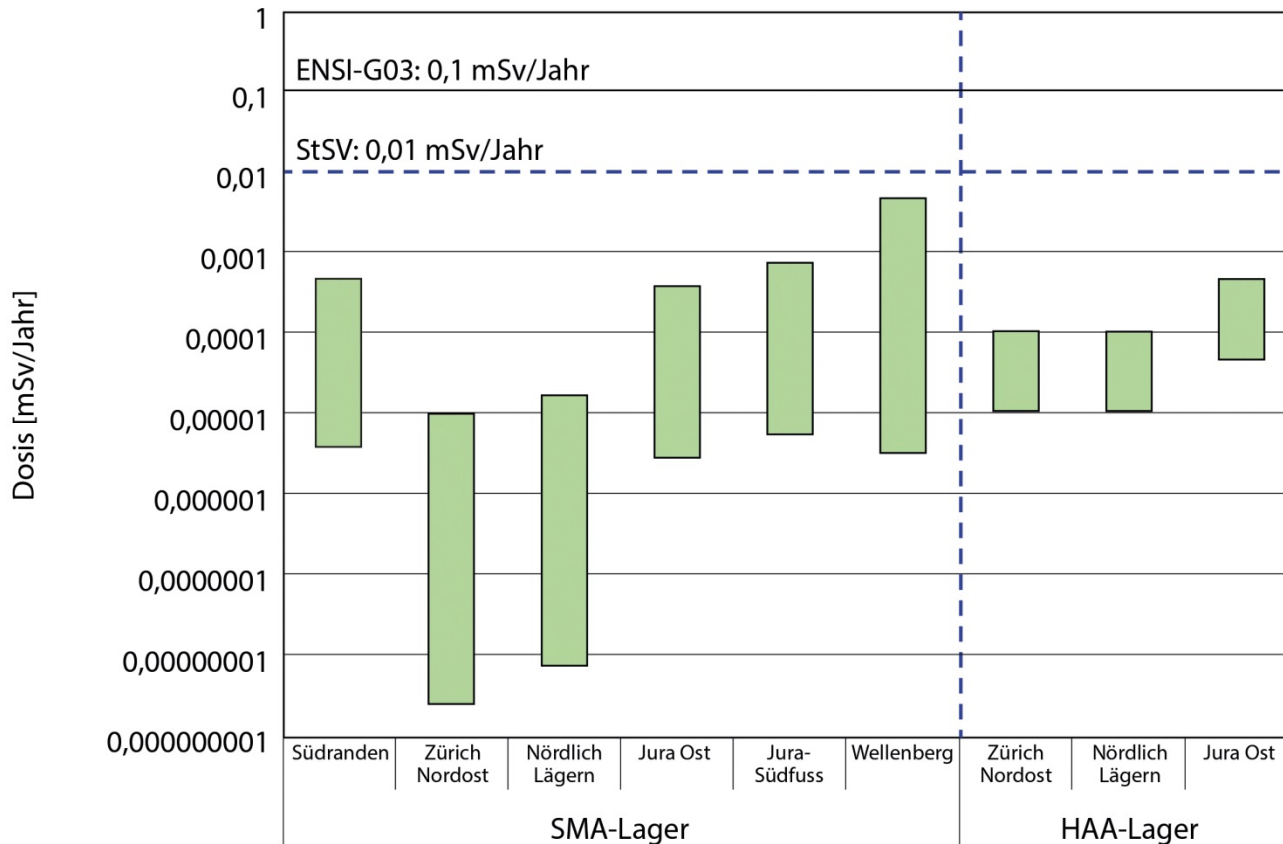


Activities

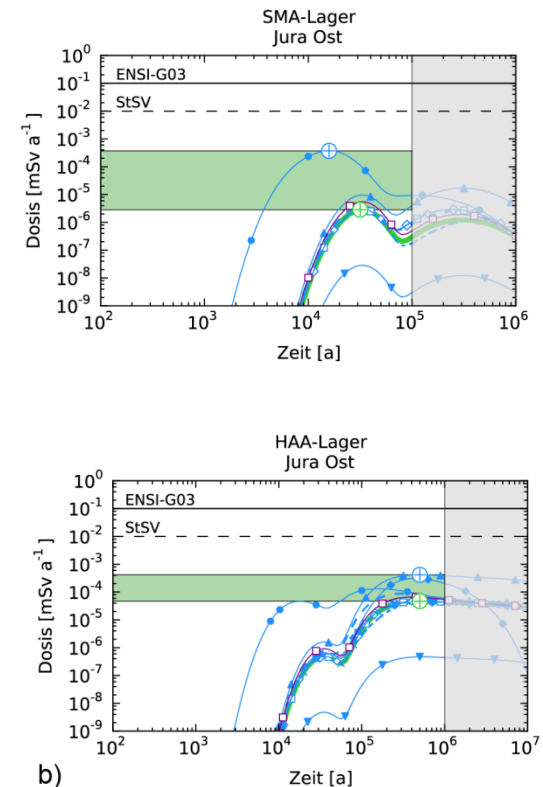
- Discussion of surface facilities
- Studies related to land use and socio-economic aspects
- Projects for the sustainable development of the region

Stage 2: Site evaluation – Long-term Safety

- Range of maxima from the calculational cases for a site as specified in the regulatory guideline
- All sites below the regulatory limit



Example of safety analysis calculations

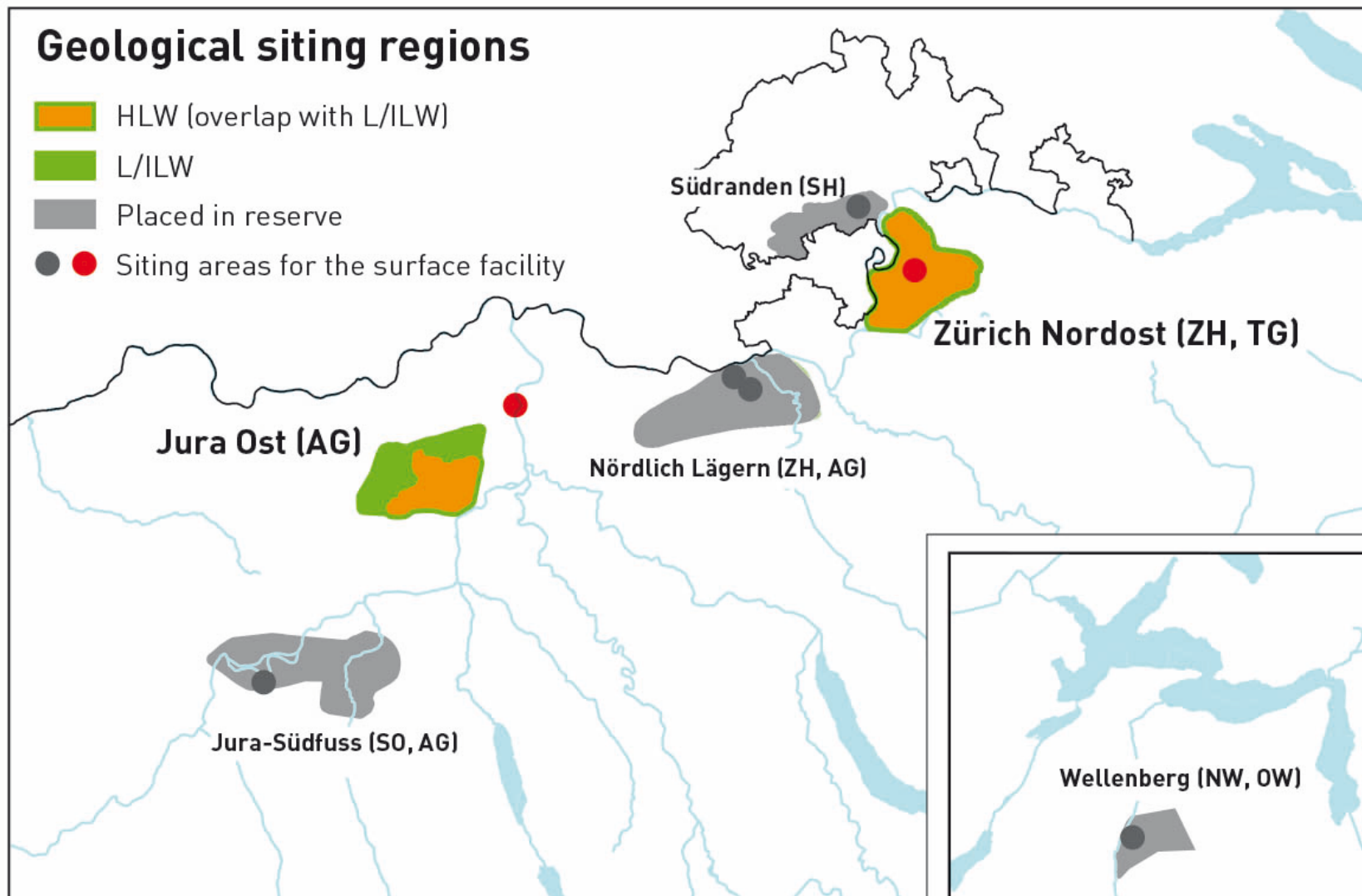


Stage 2: Site evaluation - Indicators

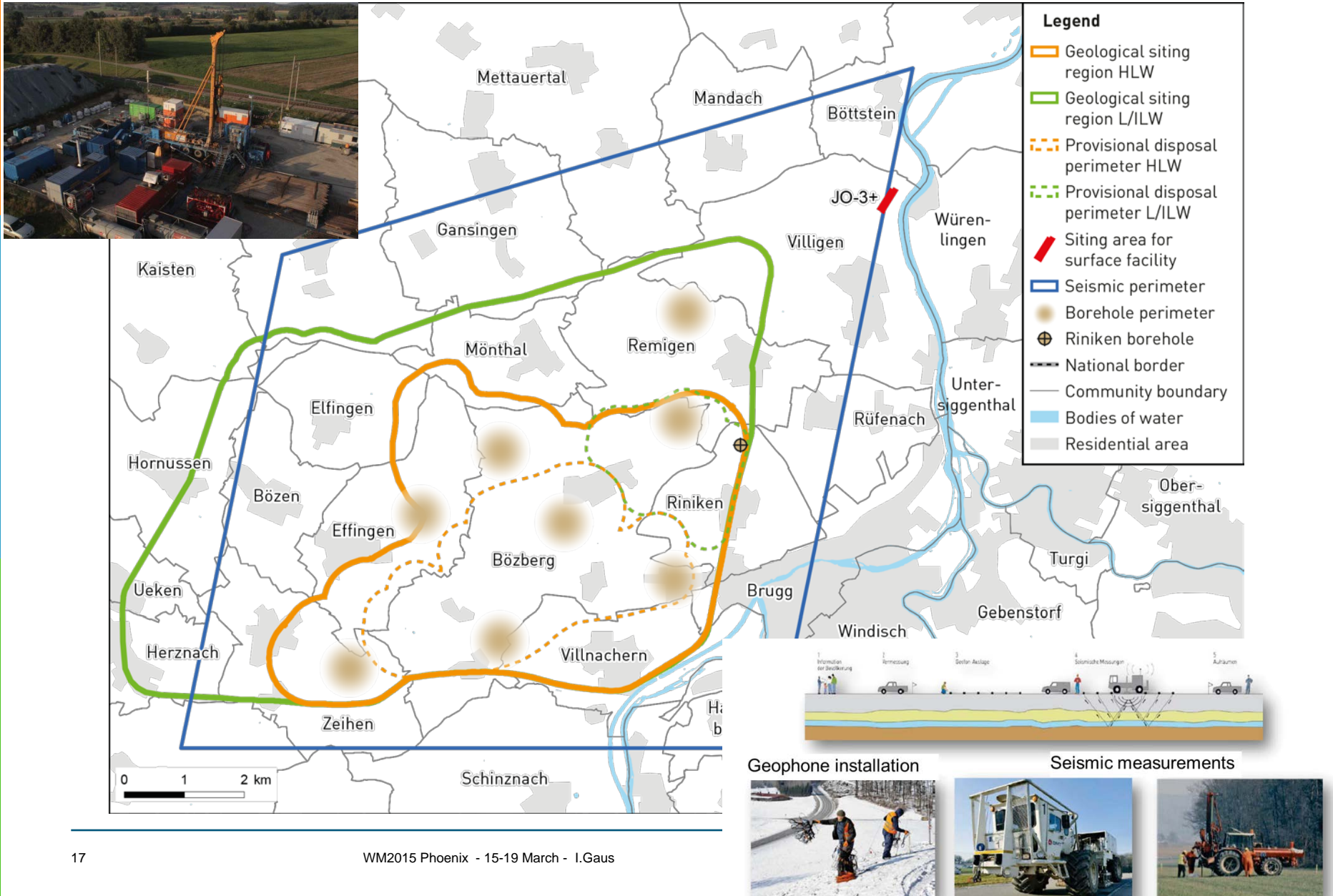


Decision-relevant features / Decision-relevant indicators	HLW repository				L/ILW repository					
	Zürich Nordost	Nördlich Lägern	Jura Ost	Südranden	Zürich Nordost	Nördlich Lägern	Jura Ost	Jura-Stüfnes	Wellenberg	
Effectiveness of the geological barrier (E)										
Hydraulic conductivity										
Type of transport pathways and structure of the pore space										
Transmissivity of preferential release pathways										
Self-sealing capacity										
Homogeneity of the rock structure										
Thickness										
Length of critical release pathways										
Colloids										
Long-term stability of the geological barrier (S)										
Conceptual models of long-term evolution (geodynamics and neotectonics; other processes)										
Self-sealing capacity										
Potential for formation of new water flowpaths (karstification)										
Erosion during the time period under consideration										
Depth below the local erosion base level as relevant for formation of new ice-marginal drainage channels										
Depth below terrain as relevant for rock decompaction										
Depth below top bedrock as relevant for glacial overdeepening										
Seismicity										
Explorability and ease of characterisation of the geological barrier in the siting region (C)										
Variability of the rock properties as relevant for their ease of characterisation										
Exploration conditions in the geological underground										
Engineering feasibility (F)										
Depth with respect to engineering feasibility (considering rock strength and deformation properties)										
Geotechnical and hydrogeological conditions in overlying rock formations										
Available space underground										

Stage 2: Sites proposed by Nagra (Dec. 2014)



Next: Exploration program – Example: Jura Ost



Next steps in the site selection process

- **Stage 2:** Selection of at least two sites for each repository
 - 2015-2017:
 - Review of Nagra's proposals by:
 - ENSI (Nuclear Safety Inspectorate) and EGT (Expert Group Geologic Disposal)
 - NSC (Nuclear Safety Commission)
 - Federal Offices, Cantons, Regional Conferences
 - Public hearings
 - Position and recommendation to the Federal Council by Swiss Federal Office of Energy
 - 2017: Federal Council decision on Stage 2

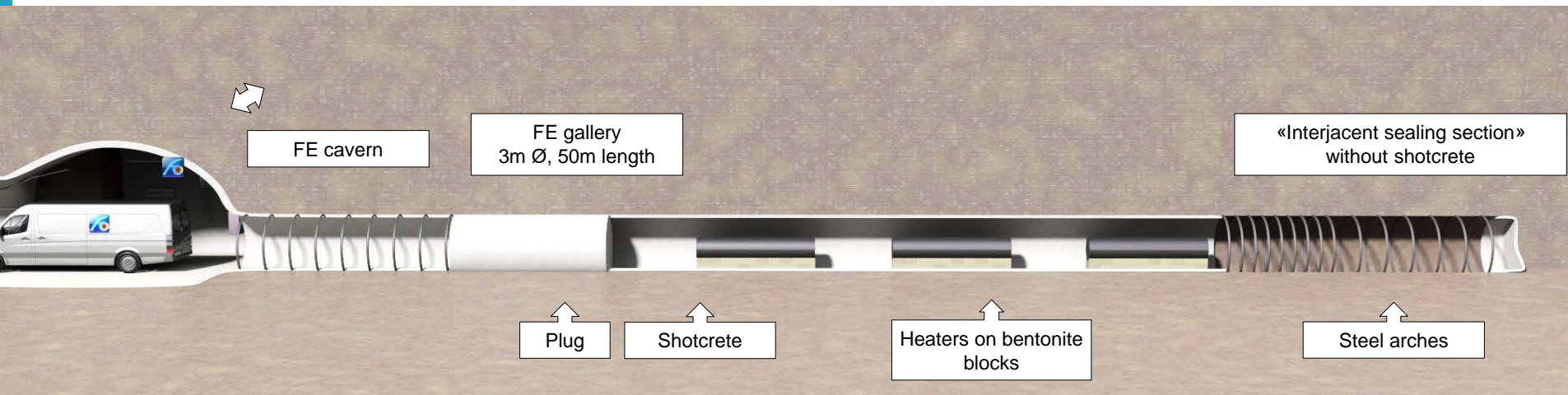
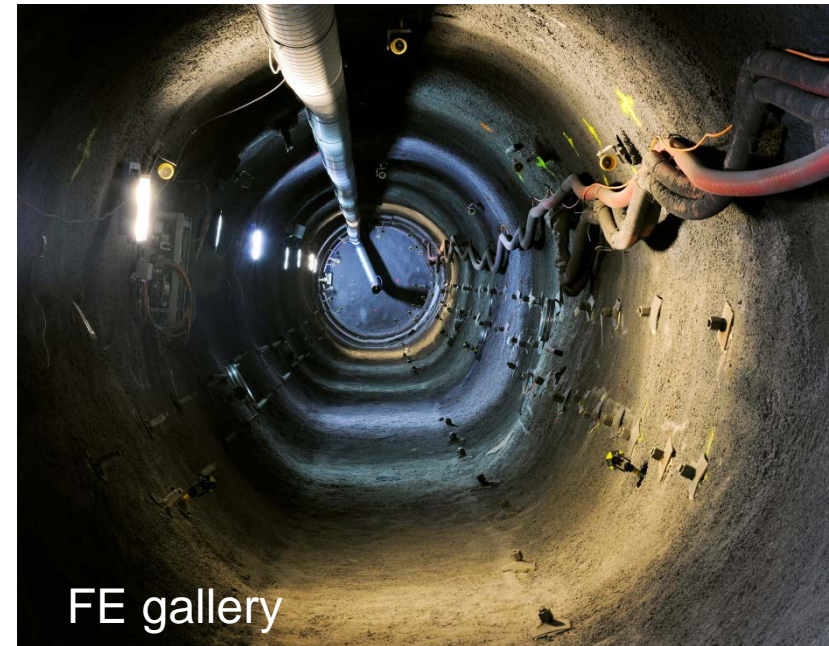
- **Stage 3:** Selection of **one site** for each repository (with the option of building both repositories at the same site):
 - **Announcement** around 2019/2020
 - Submission of **general license application** (around 2022)

- Followed by a decision of the Federal Council on site selection, a debate in Parliament and an optional referendum at the national level

FE/LUCOEX – Full scale emplacement experiment



- Demonstration of buffer emplacement technology
- Study of the early time evolution of the SF-HLW disposal system – THM: thermal, hydraulic, mechanical
- Layout based on Spent Fuel emplacement tunnel design
- Heating phase started in Jan 2015 (~150°C at canister surface)



FE: construction and backfilling



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Thank you
for your interest

nagra ●