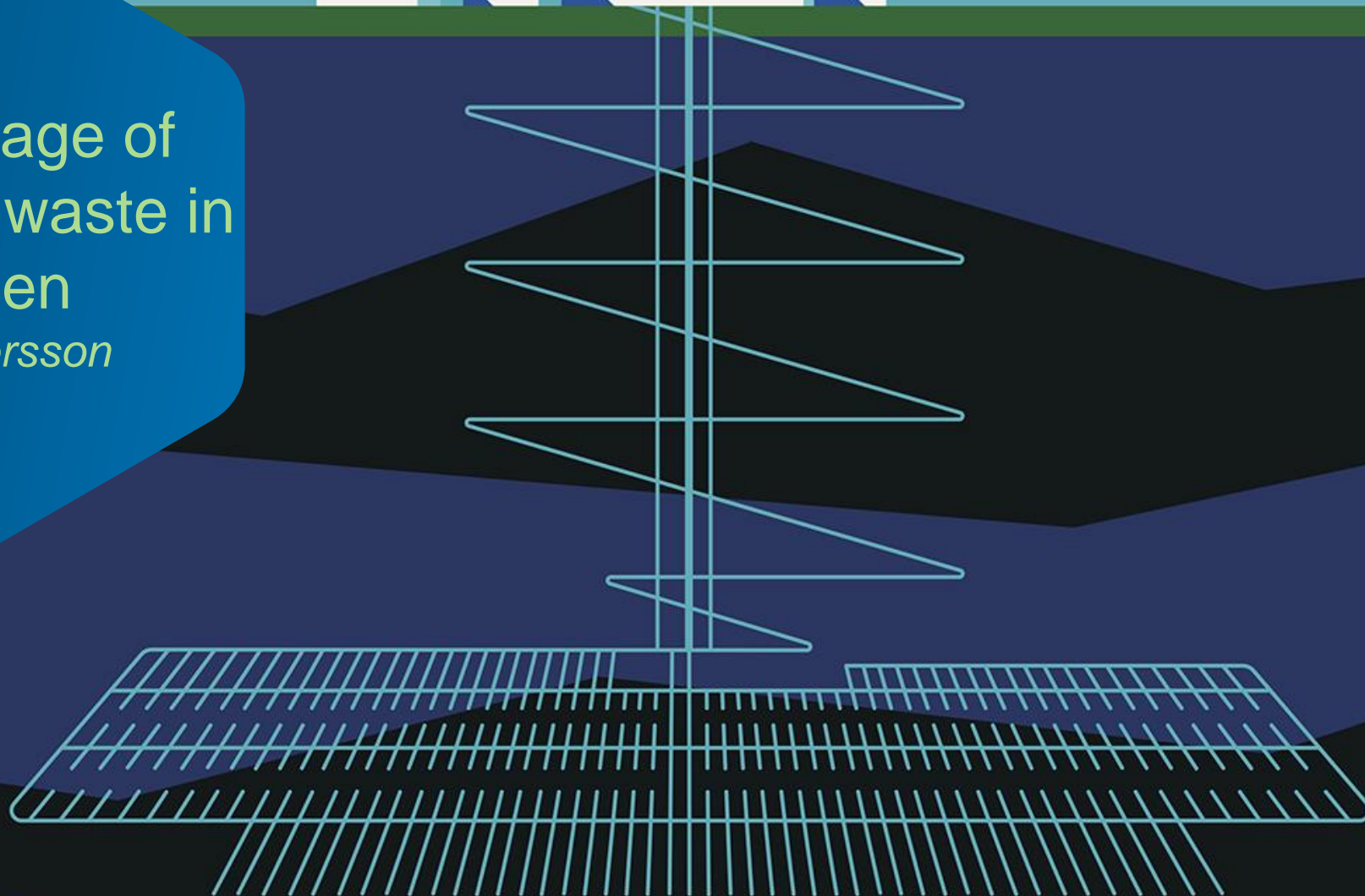


Final storage of  
radioactive waste in  
Sweden  
*Eva Andersson*



# Swedish Nuclear Power Plants

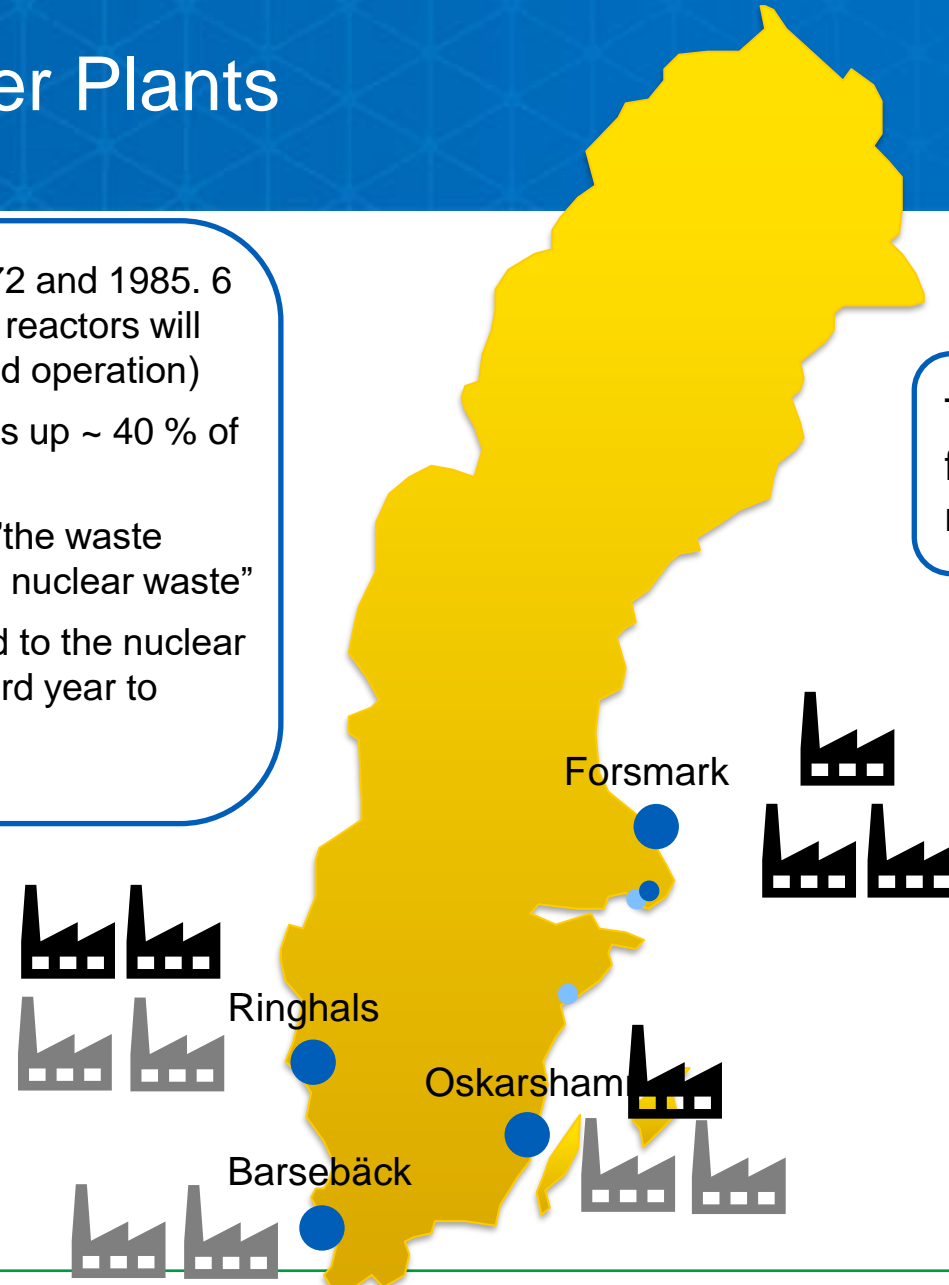
Operation of 12 reactors started between 1972 and 1985. 6 reactors are shut down and the remaining 6 reactors will operate until mid 2040's (60 years of planned operation)

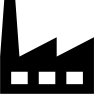

Today, power generation from nuclear makes up ~ 40 % of Sweden's electricity demand

Swedish government early on decided that "the waste producers are responsible to take care of all nuclear waste"

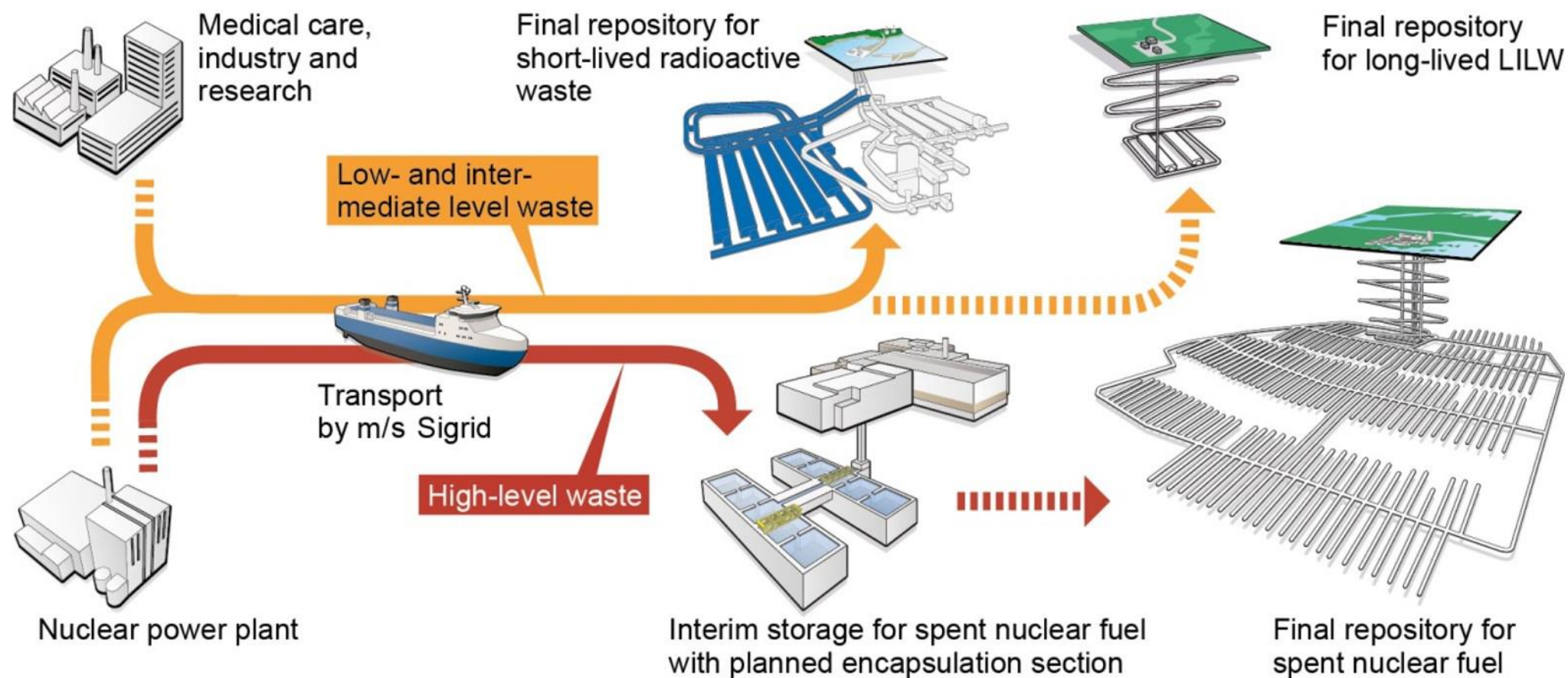
"For every produced kWh a fee shall be paid to the nuclear waste fund. The fee will be adjusted every 3rd year to secure adequate financing

The Nuclear Power Plant owners formed SKB as waste management organisation.



 NPP in operation  
 NPP under decommissioning

# SKB's system

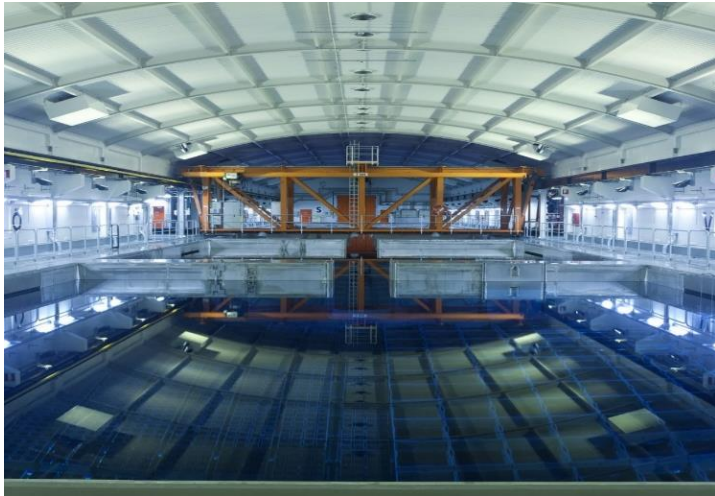




# Our existing operations



**Clab, Central Interim Storage  
Facility for Spent Nuclear Fuel**



**SFR, Final Repository for  
Short-lived Radioactive Waste**



**m/s Sigrid**

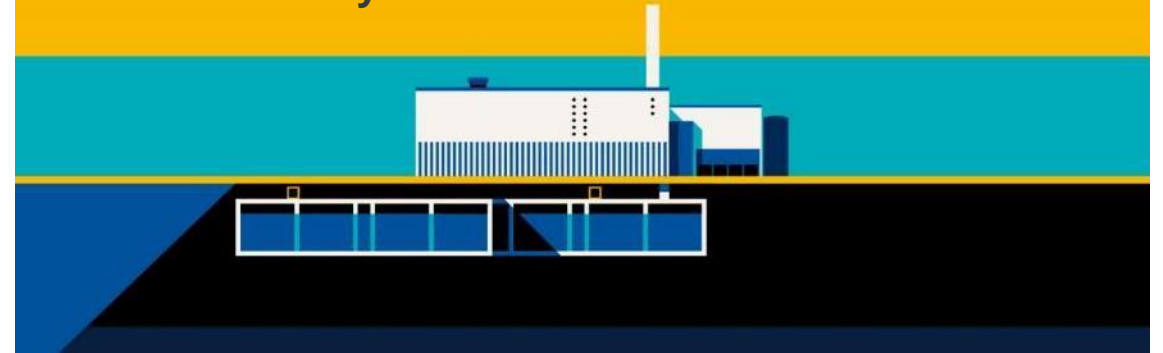


# Ongoing and Future projects

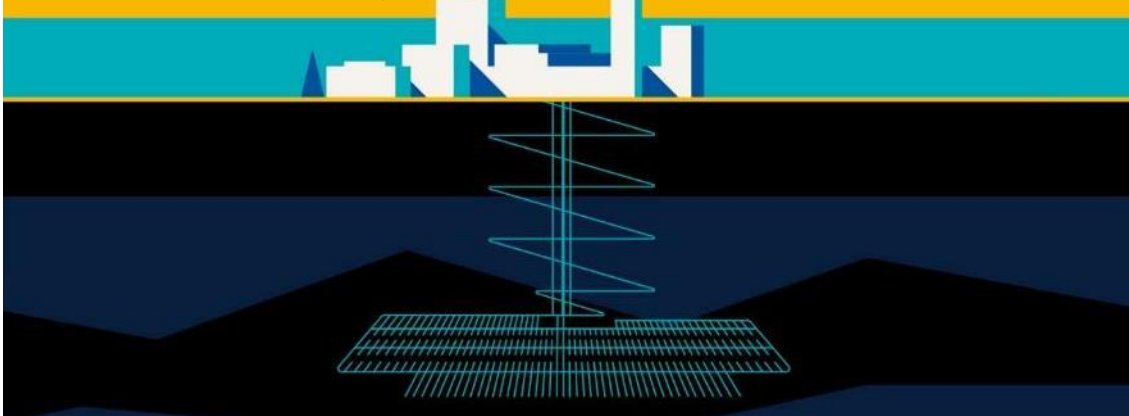
**Extending the SFR Low and intermediate level repository - Construction 6 years**



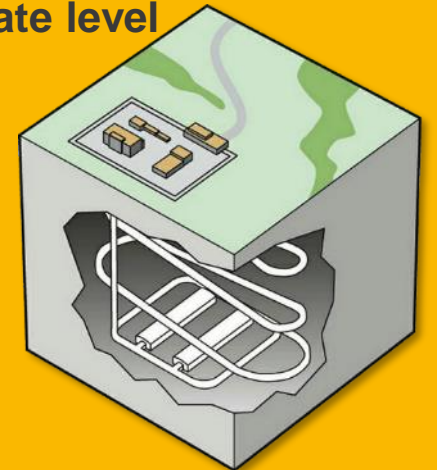
**Clink, Clab + Encapsulation plant Construction 6 years**



**Spent Fuel Repository Construction 10 years**

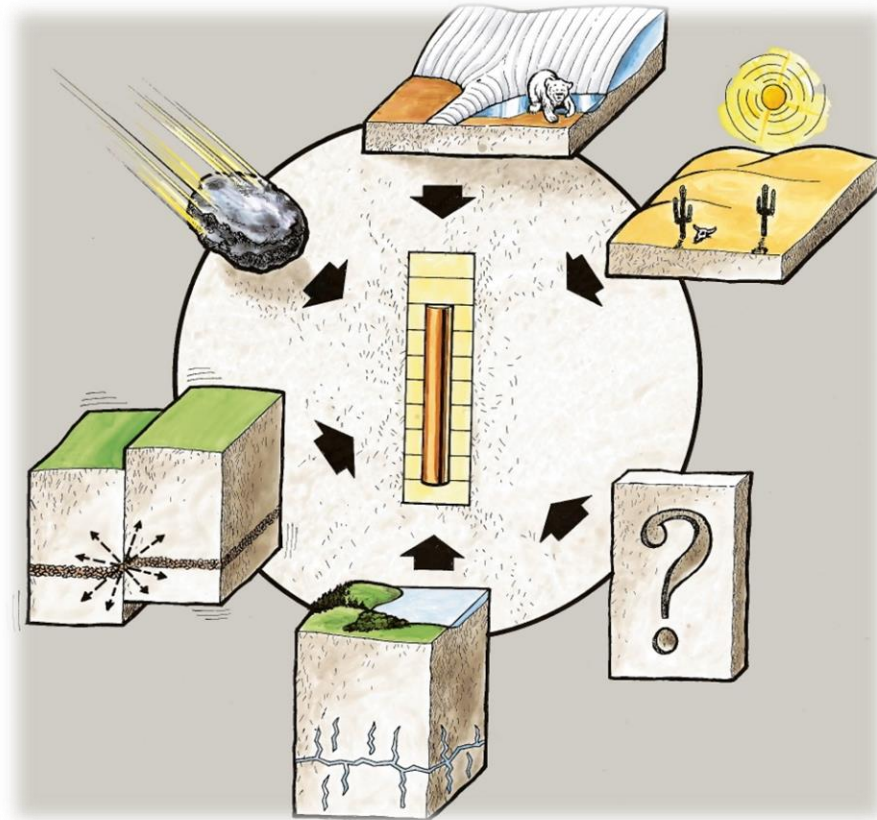


**Long-lived low- and intermediate level waste Construction 8 years**



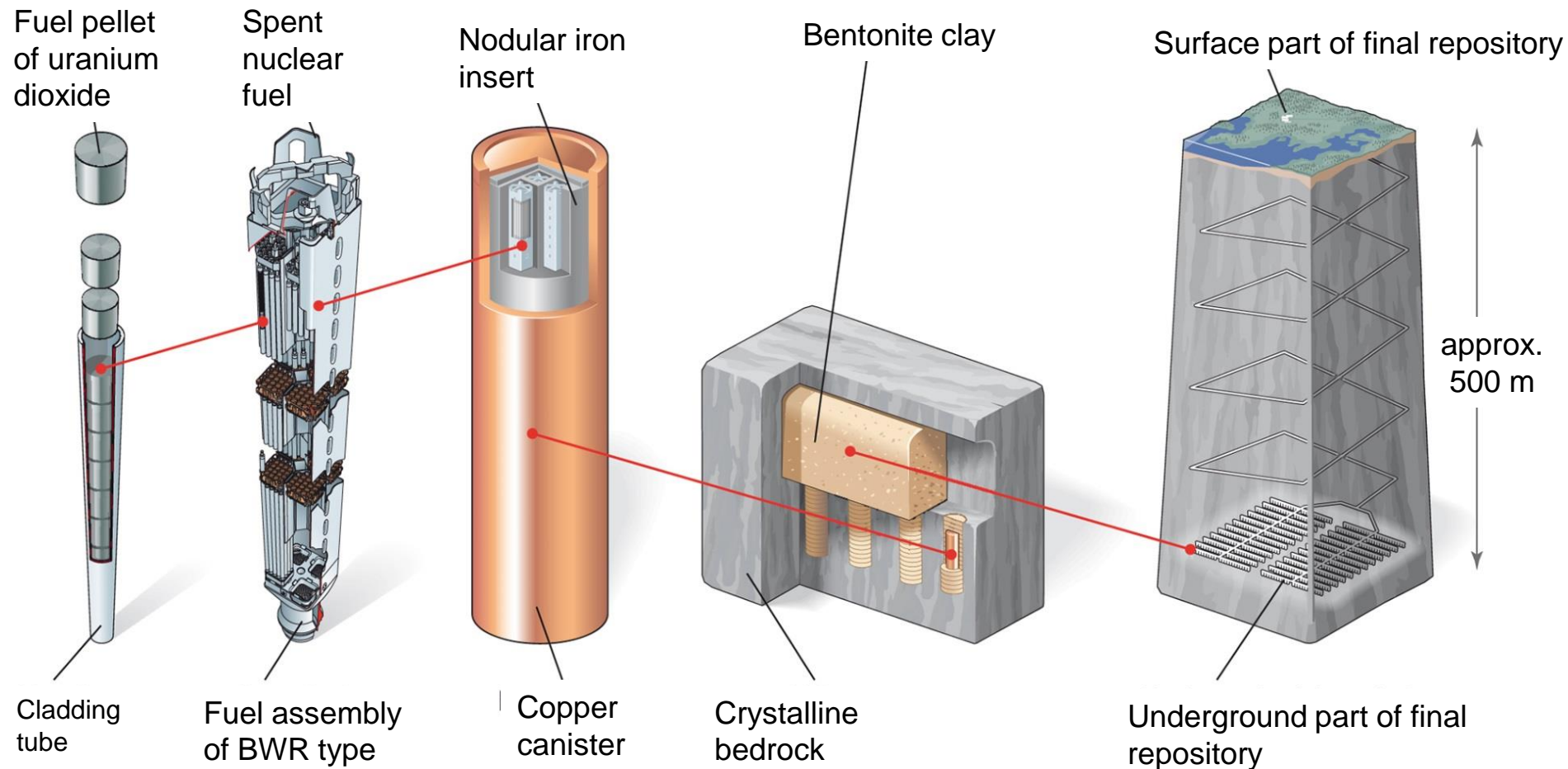
# Clear regulations for final storage

- Handling of Radioactive waste needs to be safe for humans and the environment.
- Analysis of post closure safety for spent fuel repository cover **one million years** and for low and intermediate level waste up to 100 000 years.
- A repository for spent nuclear fuel or nuclear waste shall be designed so that the annual risk of harmful effects (cancer or hereditary damage) after closure does not exceed  $10^{-6}$  for a representative individual in the group exposed to the greatest risk. Corresponds to an annual dose of  $14 \mu\text{Sv}$  which is **1 % of the background radiation**.





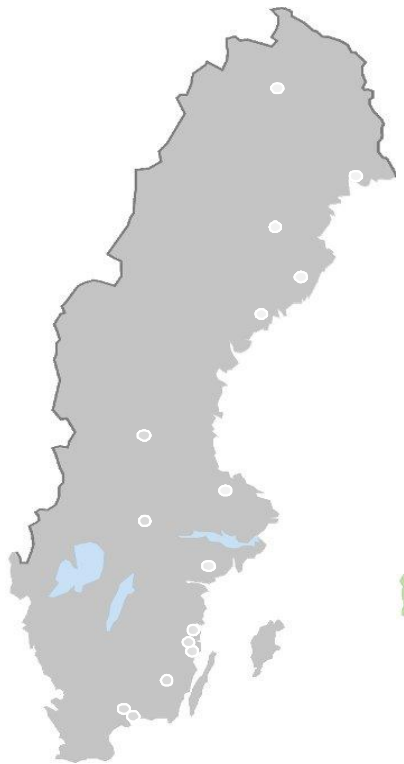
# SKB's method: KBS-3



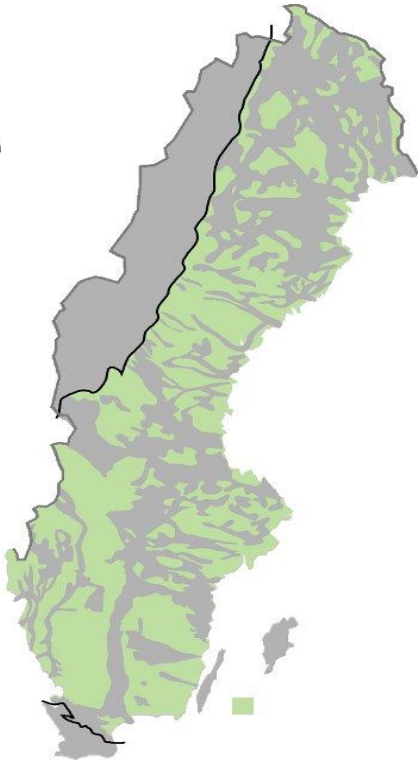
## Three barriers

1. Copper canister
2. Bentonite clay
3. Rock

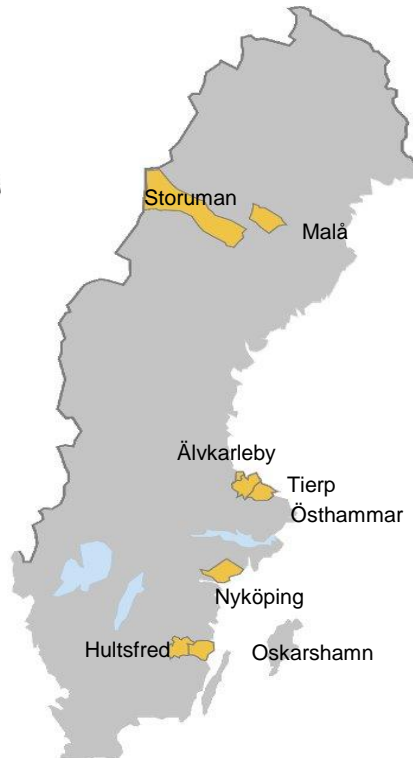
# Siting process



Type areas  
1977-1985



General siting studies  
1990-ies



Feasibility studies  
1993-2002

## Early conclusions

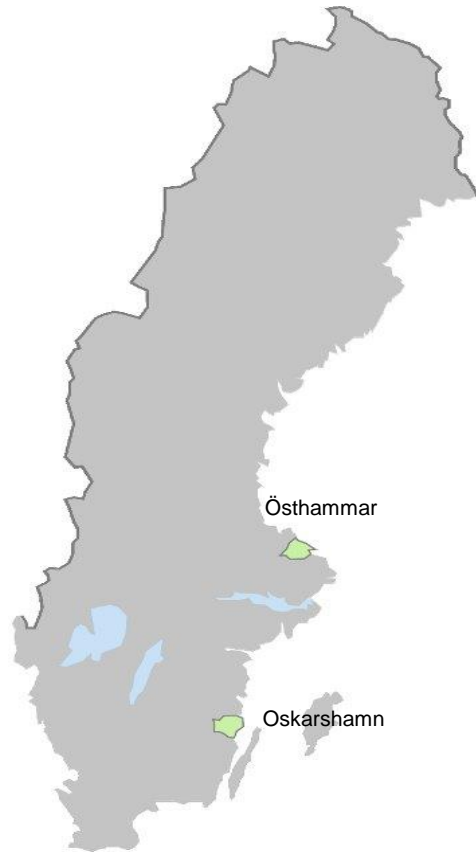
- Crystalline bedrock suitable for a repository can probably be found in most parts of Sweden
- One geology – one disposal concept
- Decision to construct underground laboratory
- Local acceptance is a prerequisite for siting. The process must thus be based on voluntarism.

## SKB's goals and principles for the decision was:

- The site with the best conditions for long term safety will be selected.
- If there is no clear difference in conditions for long term safety, the site that is most suitable for the repository project in other aspects will be selected.



# Site investigations 2002-2008



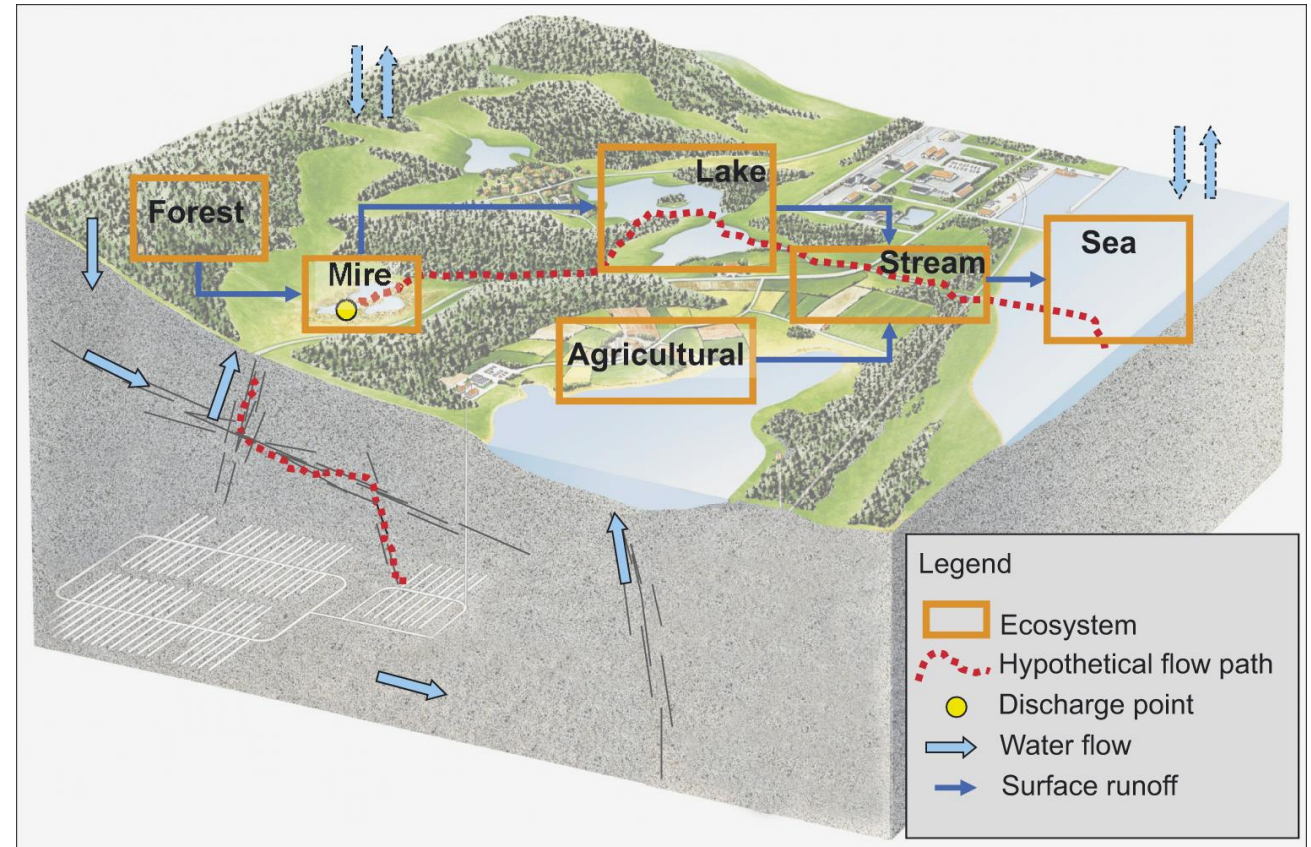
Site investigations  
**2002-2008**

- Two site investigations in parallel, Östhammar and Oskarshamn.
- Openness and involvement of the local stakeholders.
- Information to nearby residents 1995-2009 e.g. by local SKB news letter distributed to all households in the municipalities.
- Funding to municipalities to maintain a local organization.
- Oskarshamn and Östhammar were competing to have the final repository.
- 7 years of investigations, analyses, modelling and safety assessment.



# Assessment of long term safety

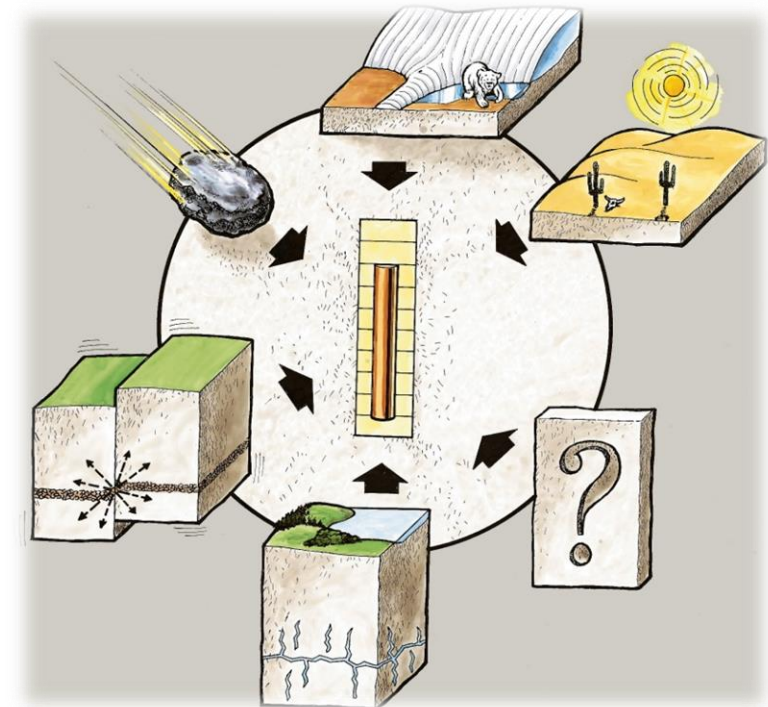
- In order to evaluate long term safety of a repository SKB has taken into account all the processes that can affect the barriers or the transport, accumulation and uptake of radionuclides.
- SKB has performed research for over 40 years and has a good knowledge of processes acting on a repository and surroundings on large time scales.



# Analysis of post closure safety

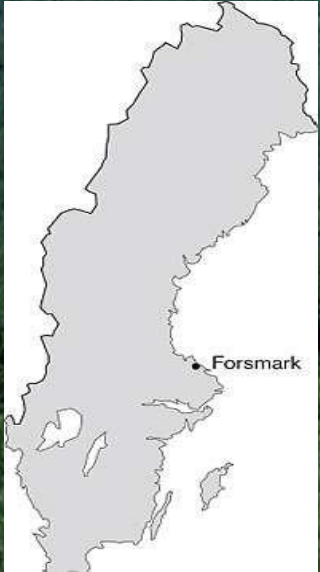
**Even with 40 years of research, how is it possible to say something about safety in a 1 million year perspective?**

- Siting to a stable rock environment.
- Have barriers of natural materials that are stable in the long term rock environment.
- Dimension to take into account known processes that can affect the repository system and its environments.
- Have a structured assessment methodology that handle uncertainties with pessimistic assumptions.

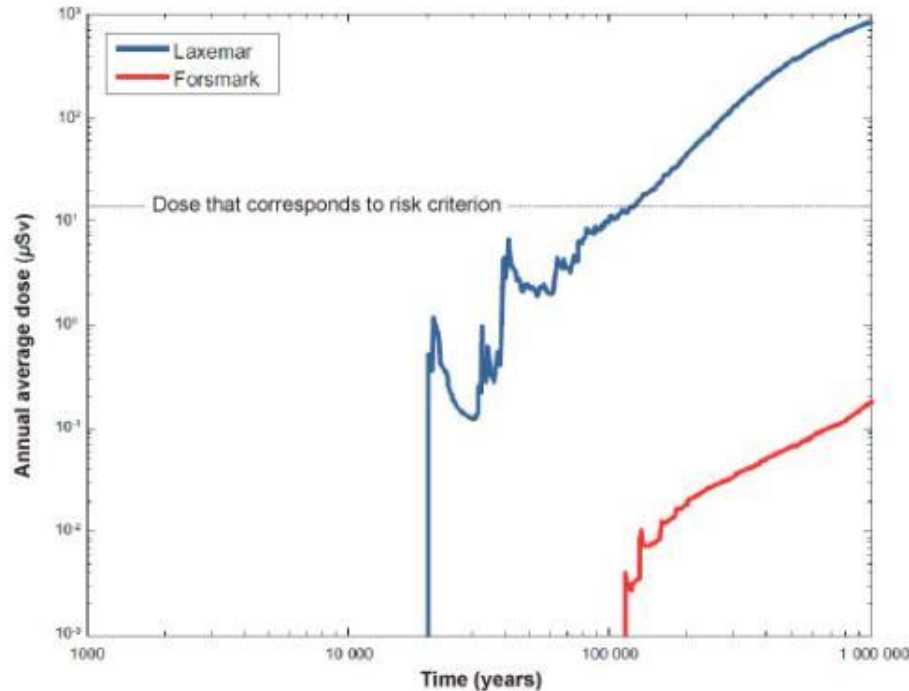




# SKB chose Forsmark as site for the spent fuel repository



Site selection  
2009

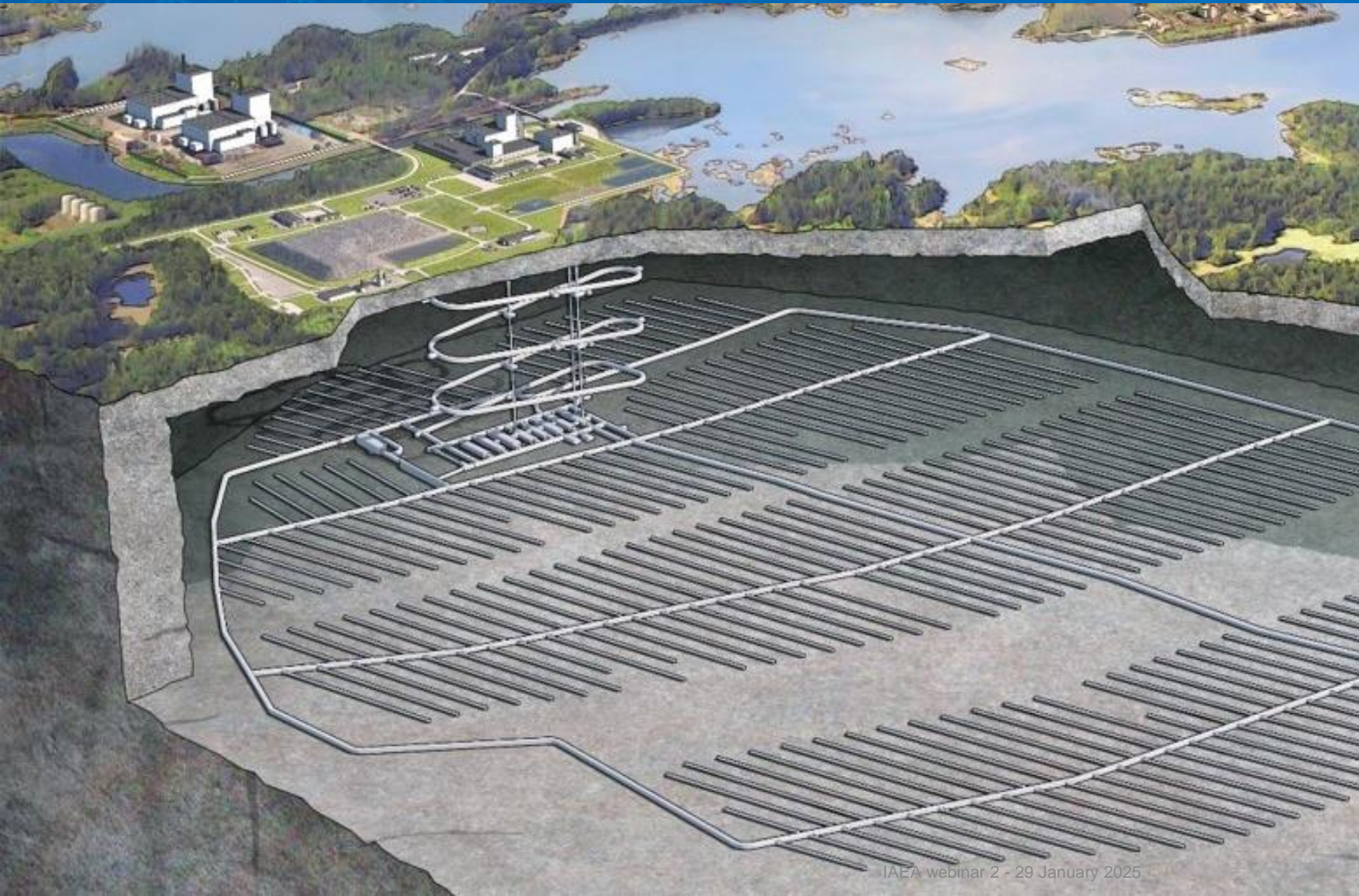


## SKB chose Forsmark

- Forsmark has good condition for long term safety
- The rock is homogenous with few water bearing fractures at repository depth
- Favourable termic conductivity enables a more compact repository
- Above ground facility can be built on own land
- Access to existing infra structure
- Limited environmental impact



# Final repository for spent nuclear fuel



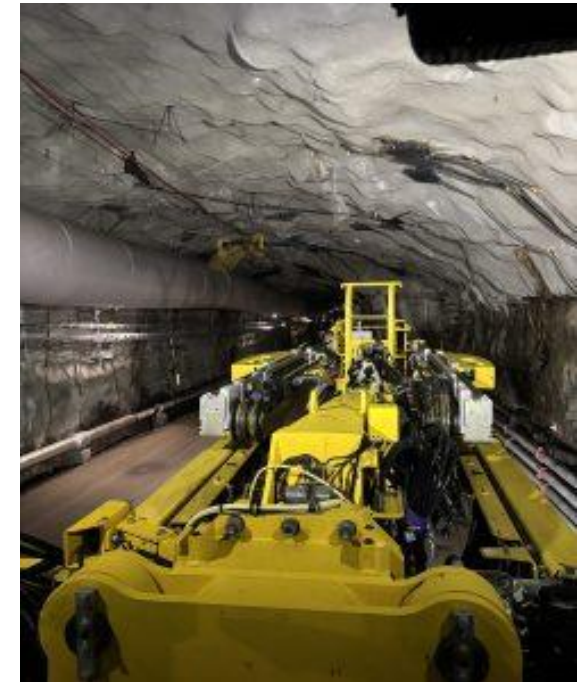
“At a depth of 500 meters in rock that is 1.9 billion years old we intend to deposit approximately 12,000 tons of spent nuclear fuel in a final repository.”

After a very long licensing process lasting from our application in 2011 we finally got government approval for the spent fuel repository in 2022.



# What's happening in Forsmark 2025

- The construction has started on Swedish Spent Fuel Repository. Minister for Climate and Environment Romina Pourmokhtari was present to officially start the work.
- Expansion of SFR, final repository for short-lived radioactive waste to make room for decommissioning waste.
- Expansion of Forsmark Harbour.





# Repository area in March 2024





# Site preparation phase 2025-2026

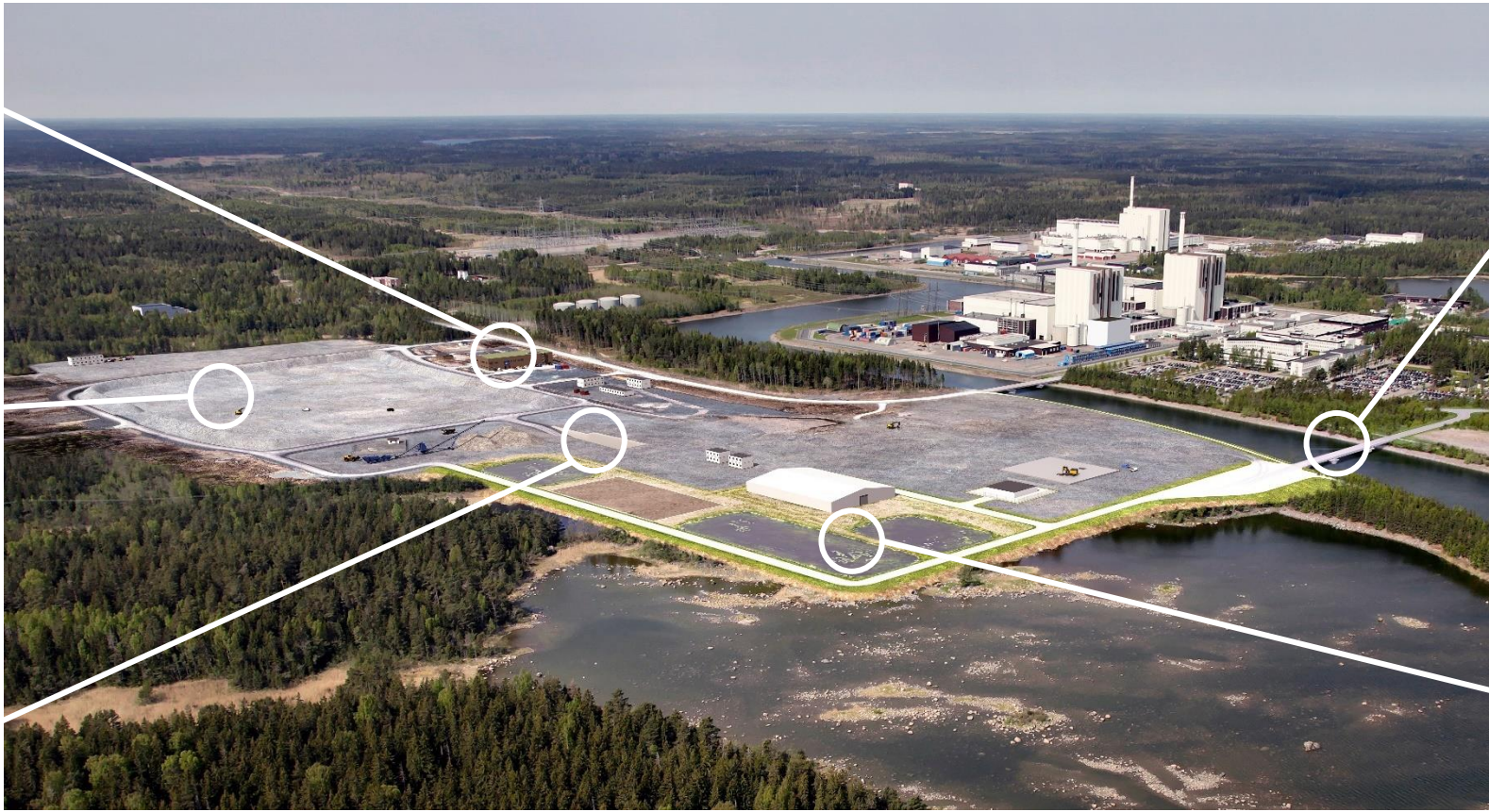
Geology building



Area for rock storage



Grouting from ground surface and tunnel entrance



Bridge

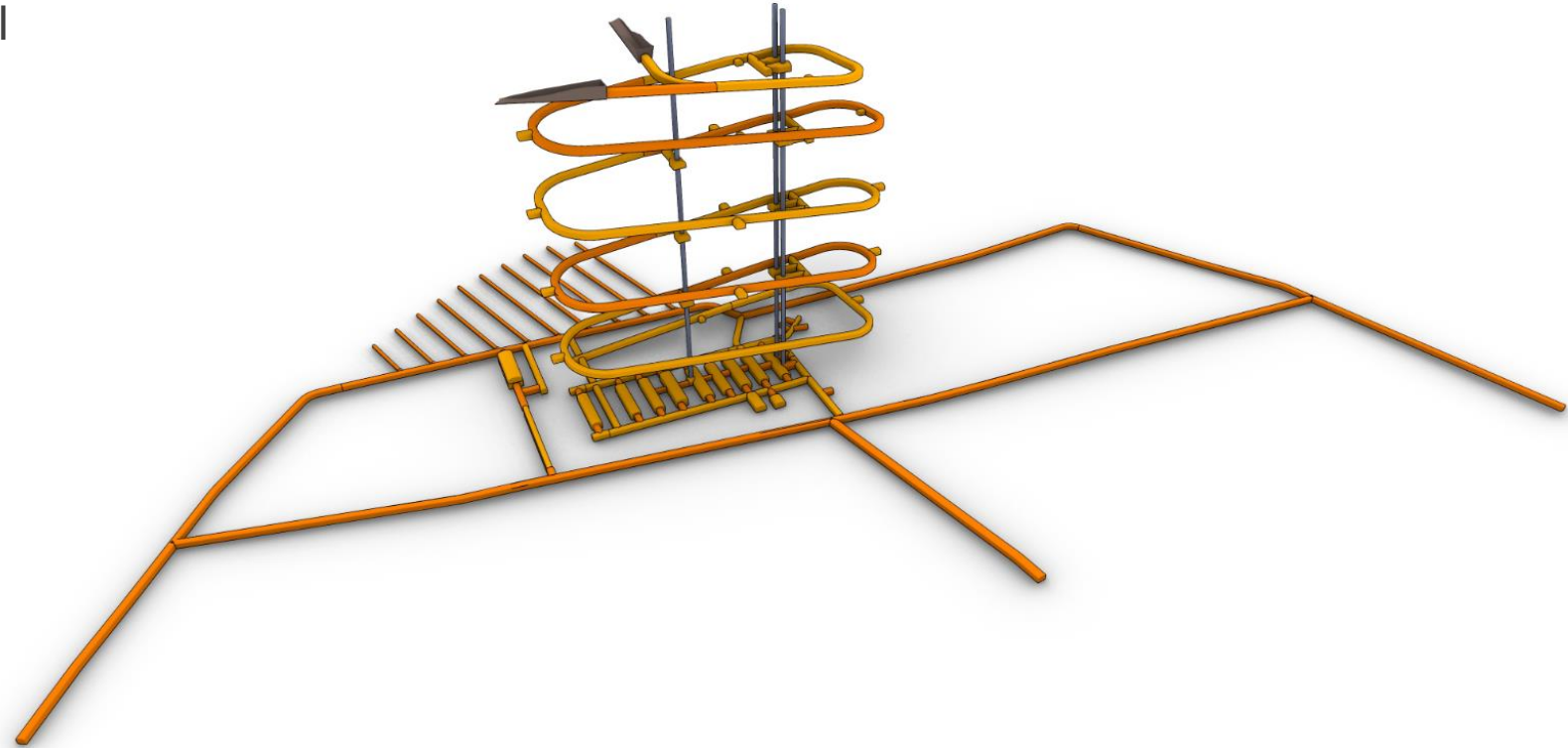


Water treatment plants



# Rock excavation phase

- Ramp tunnel down to repository level
- Three shafts
- Central area
- Initial part of tunnel system on repository level
- A number of deposition tunnels





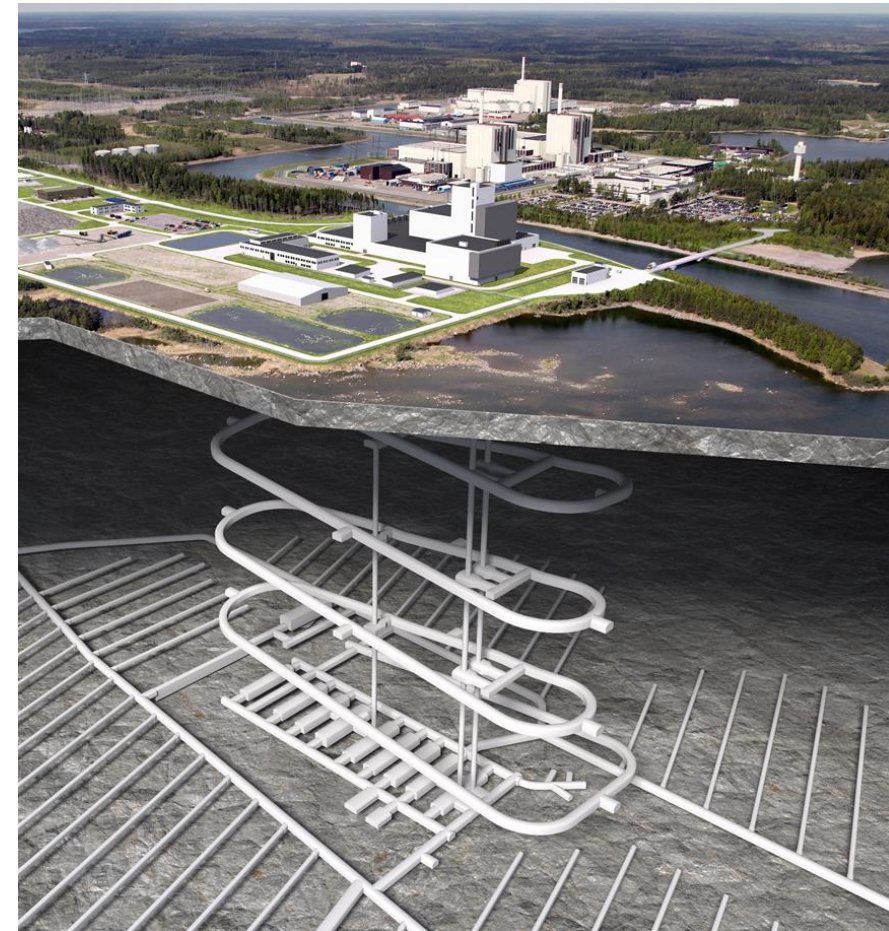
# Repository area in 2036



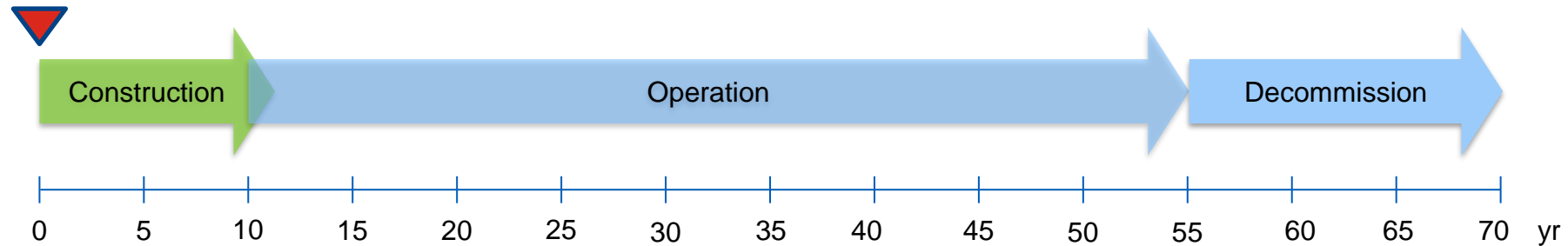


# Possible challenges for the coming period

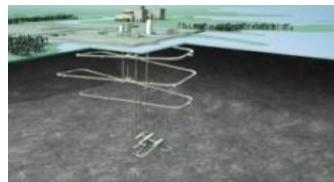
- Knowledge and cultural management, between generations, but more urgent between disciplines, e.g. between post closure assessment experts and construction team
- SKB will handle major construction contracts and must rapidly become an attractive client for the construction market
- During rock excavation new information will be collected and this information will give input to the final layout of the repository areas. How to coordinate site investigations with tunnel production?
- To take the time to take advantage of new innovations and possible optimization.



# The spent fuel repository: still a 70+ years project



## CONSTRUCTION



## OPERATION



## POST-CLOSURE





# Our success factors



- Strong and active ownership by the nuclear industry in Sweden with clear roles and sound financing system is a good basis.
- High confidence for SKB and for the authorities has been essential in building national support.
- We always prioritise safe method and safe operations.
- Dialogue, openness and accessibility.
- International collaboration. We would not have come this far without collaborations with IAEA, OECD-NEA, universities and other waste management organisations, e.g. Posiva, NWMO and NAGRA.



# Thanks for listening



[www.skb.se](http://www.skb.se)



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