



Univerza v Mariboru

Fakulteta za energetiko



Društvo jedrskih strokovnjakov Slovenije
Nuclear Society of Slovenia

Radioactive waste management in Slovenia

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GMF / ENWD meeting
Krško, Slovenia, 16-17 May 2022



Content

Slovenia – Small Nuclear Country

- 2.050.000 inhabitants
- area of 20.000 km²

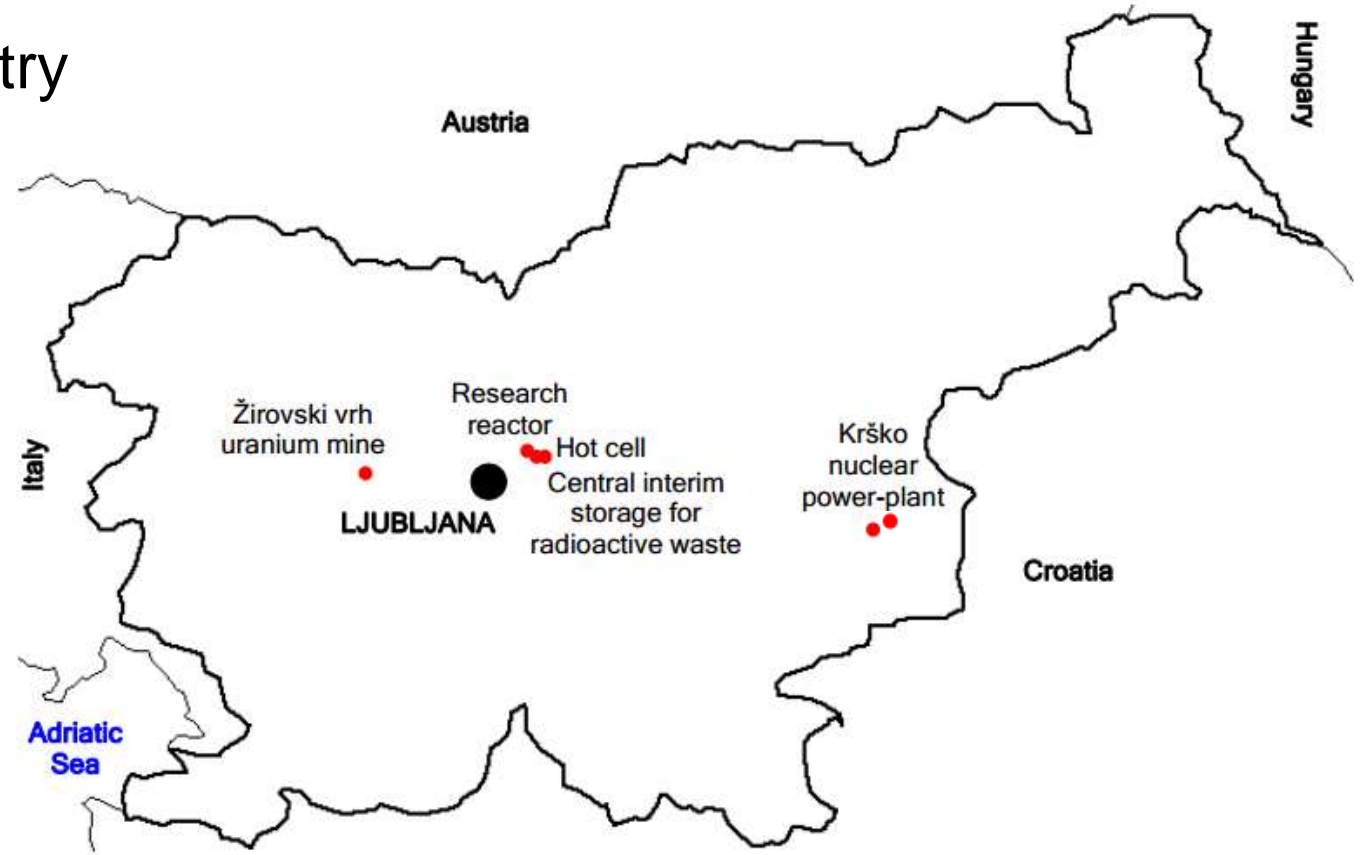
Stakeholders

Sites

Strategy & Policy

LILW repository

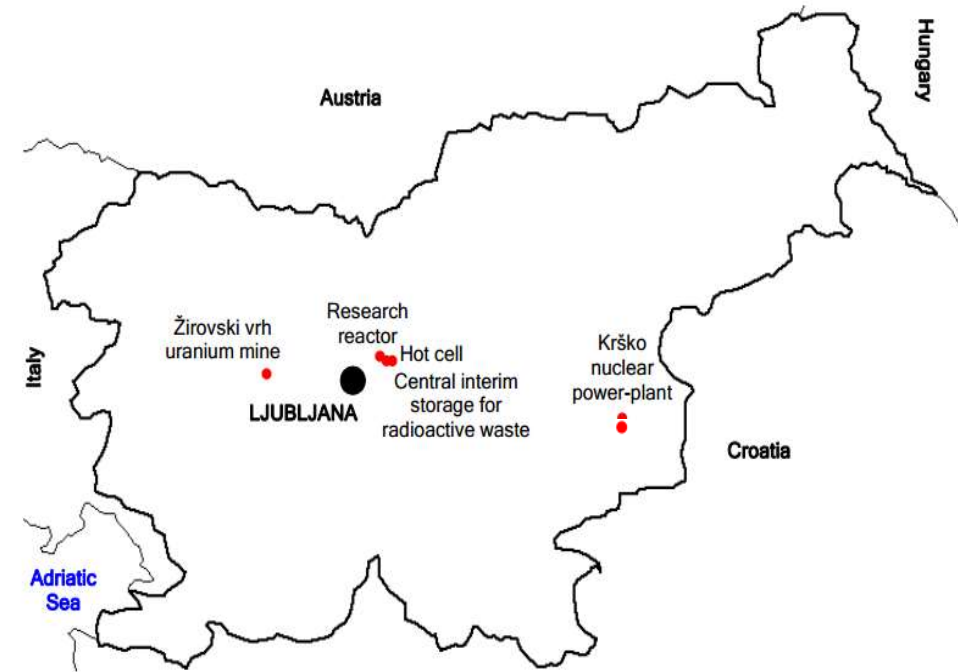
International & Multinational Approaches



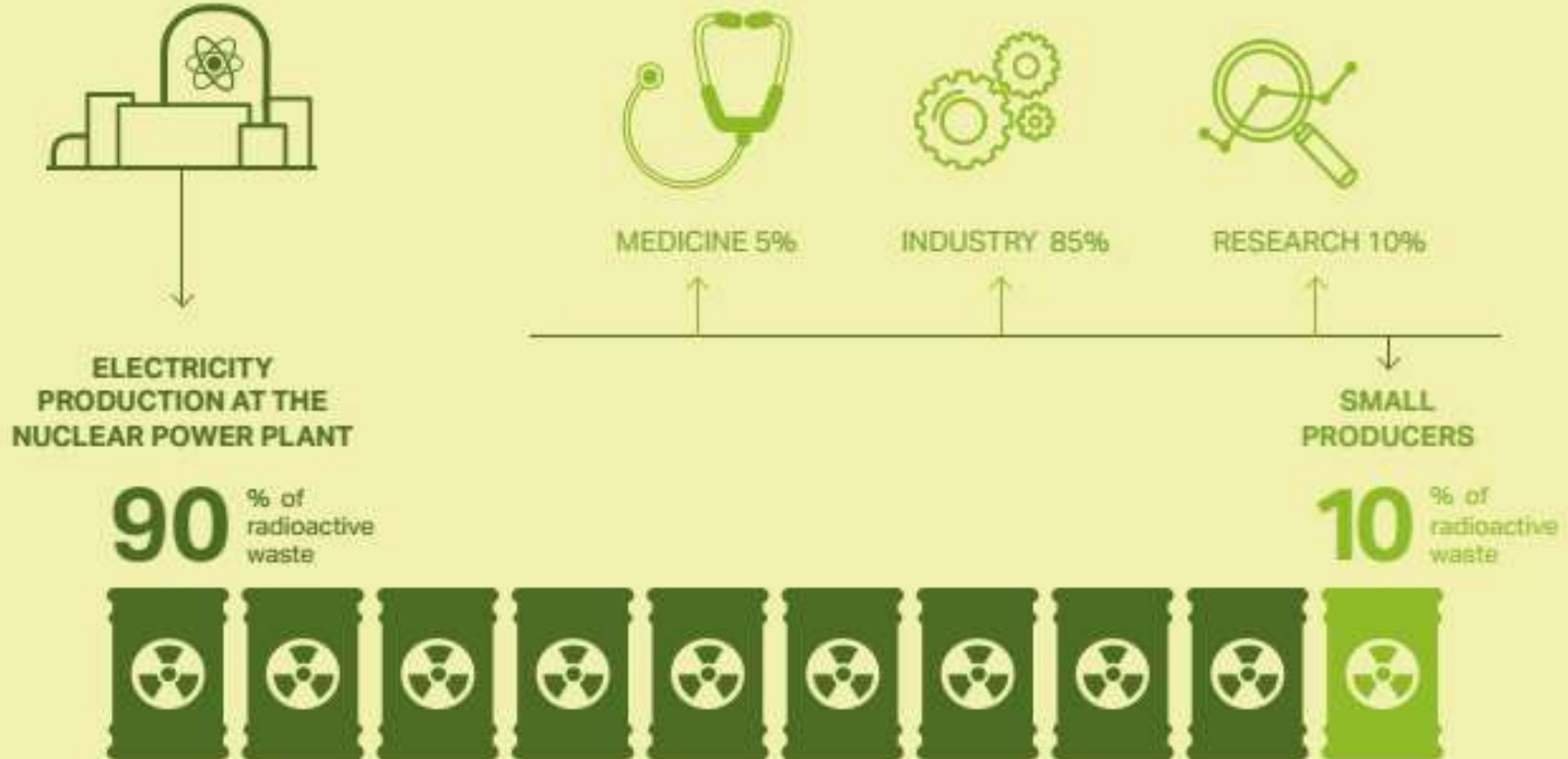
Slovene Nuclear Programme

Small nuclear country: Republic of Slovenia co-owns one NPP with Republic of Croatia in 50:50 share

- NPP, 727 MW_e; 5 to 6 TWh/y; operated by NEK, owned by: ½ Republic of Slovenia (RS): GEN energija and ½ Republic of Croatia (RC): HEP
- 1 research reactor; 250 kW_{th}; operated by JSI, owned by RS
- 1 central storage facility (CSF) for institutional waste; operated by ARAO, owned by RS
- 1 approved site for LILW repository (2009-); preparation of the documentation needed for construction permit approval; operated by ARAO, owned by RS
- 1 closed, remediated uranium mine (operation period '84 - '91); two mine waste tailings sites; operated by ARAO and RŽV, owned by RS



Where Does Radioactive Waste Come From?



Stakeholders

- **Government of Slovenia**

- Ministry for Infrastructure (implementer)
- Ministry for Environment (regulator)
- other Ministries ...

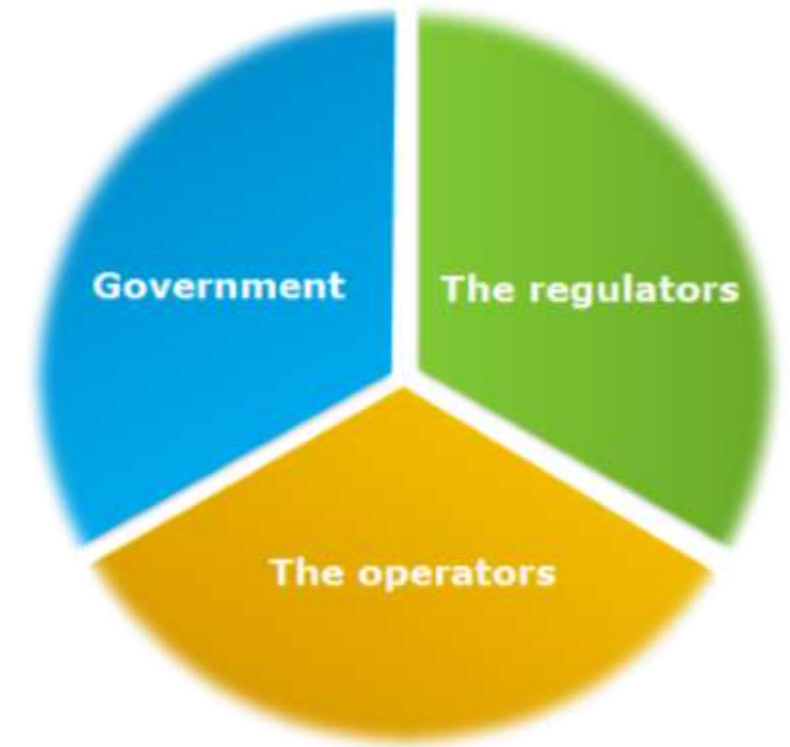
- **URSJV (Uprava RS za jedrsko varnost)**

- SNSA (Slovenian Nuclear Safety Administration)

- **License holders (operators, implementers)**

- ARAO (Slovenian radioactive waste management organization)
- NPP Krško (NEK)
- Research Reactor TRIGA (Jožef Stefan Institute)
- ...

- 50% NEK owner from RS: GEN energija
- 50% NEK owner from RC: HEP (Hrvatska elektro privreda)
- Municipalities
- Research institutions, Universities
- Citizens ...



National Radioactive Waste Management Organization

ARAO j.g.z. (javni gospodarski zavod)

arao

- Founded in 1991 by the Slovenian government
- A professional organization specialized in the field of radioactive waste management
- Organization with commitment and responsibility to environment and society
- Financed from decommissioning fund, state budget and income from small waste producers
- www.arao.si



arao Central storage facility (CSF)

- Located in Brinje, about 15 km north-east of Ljubljana (at JSI Reactor Infrastructure Centre)
- Constructed before 1991
- 2008 1st license for operation
- 2018 1st 10 years PSR, new 10-year license
- Storage of solid LILW from medical, industrial and research applications



Before reconstruction

After reconstruction



Closed mine and mine disposal sites

arao

Closed uranium mine Žirovski vrh

- cca 600 t of U_3O_8 mined before '91
- cca 14.000 t of U_3O_8 in the mine

Mining waste disposal site Jazbec

- 1,9 mio t mining waste
- area 74 000 m²

Milling waste disposal site Boršt

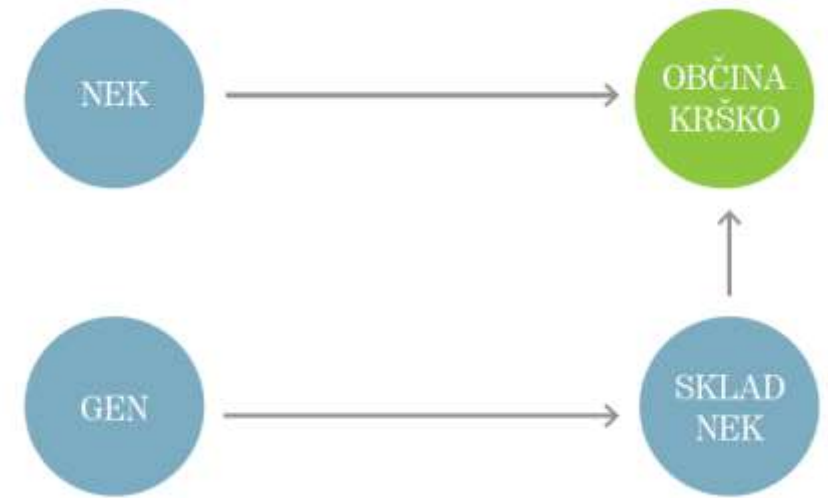
- 0.73 mio t of waste
- area 42 000 m²



Sklad za financiranje razgradnje NEK in za odlaganje radioaktivnih odpadkov iz NEK (Sklad NEK)

Fund for financing the decommissioning of the Krško NPP and for the disposal of radioactive waste from the Krško NPP (Krško NPP Fund)

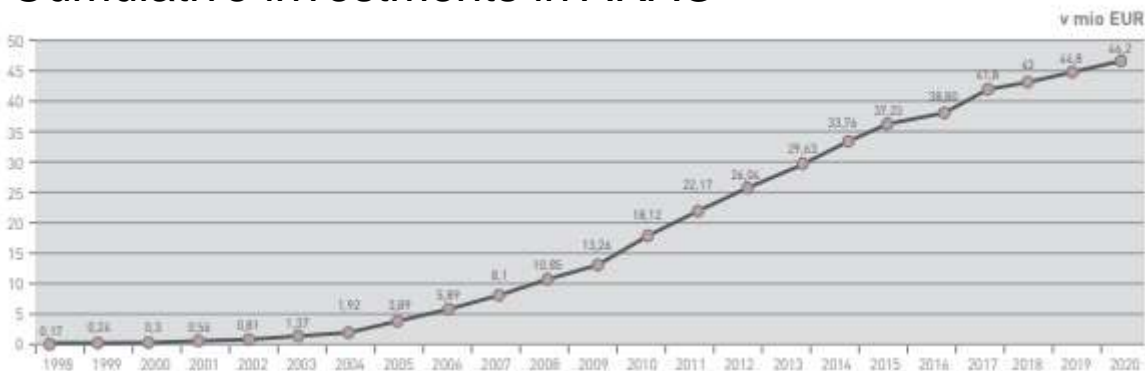
<https://www.sklad-nek.si/>



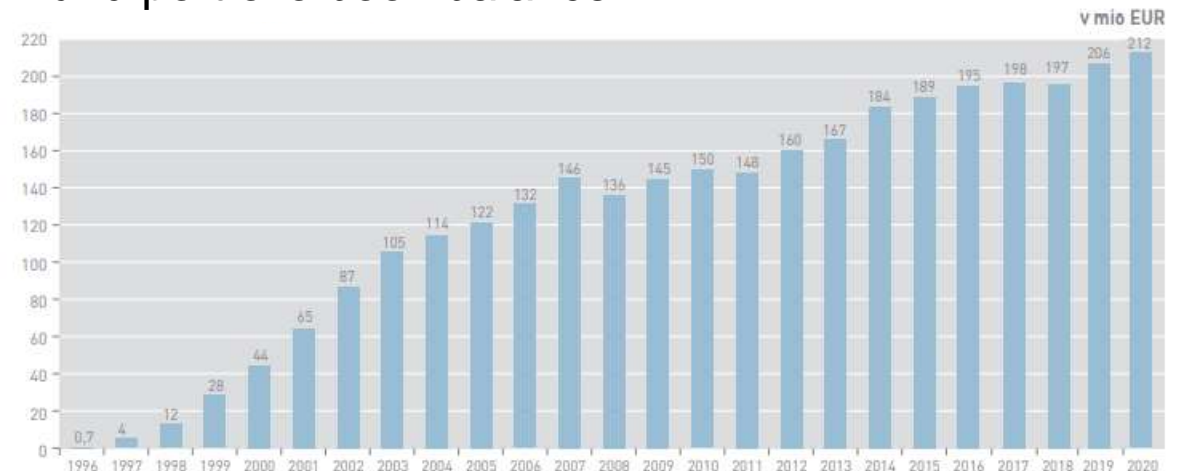
Sklad za financiranje razgradnje NEK in za odlaganje radioaktivnih odpadkov iz NEK

Cesta 4. julija 42
SI-8270 Krško

Cumulative investments in ARAO



Fund portfolio book balance

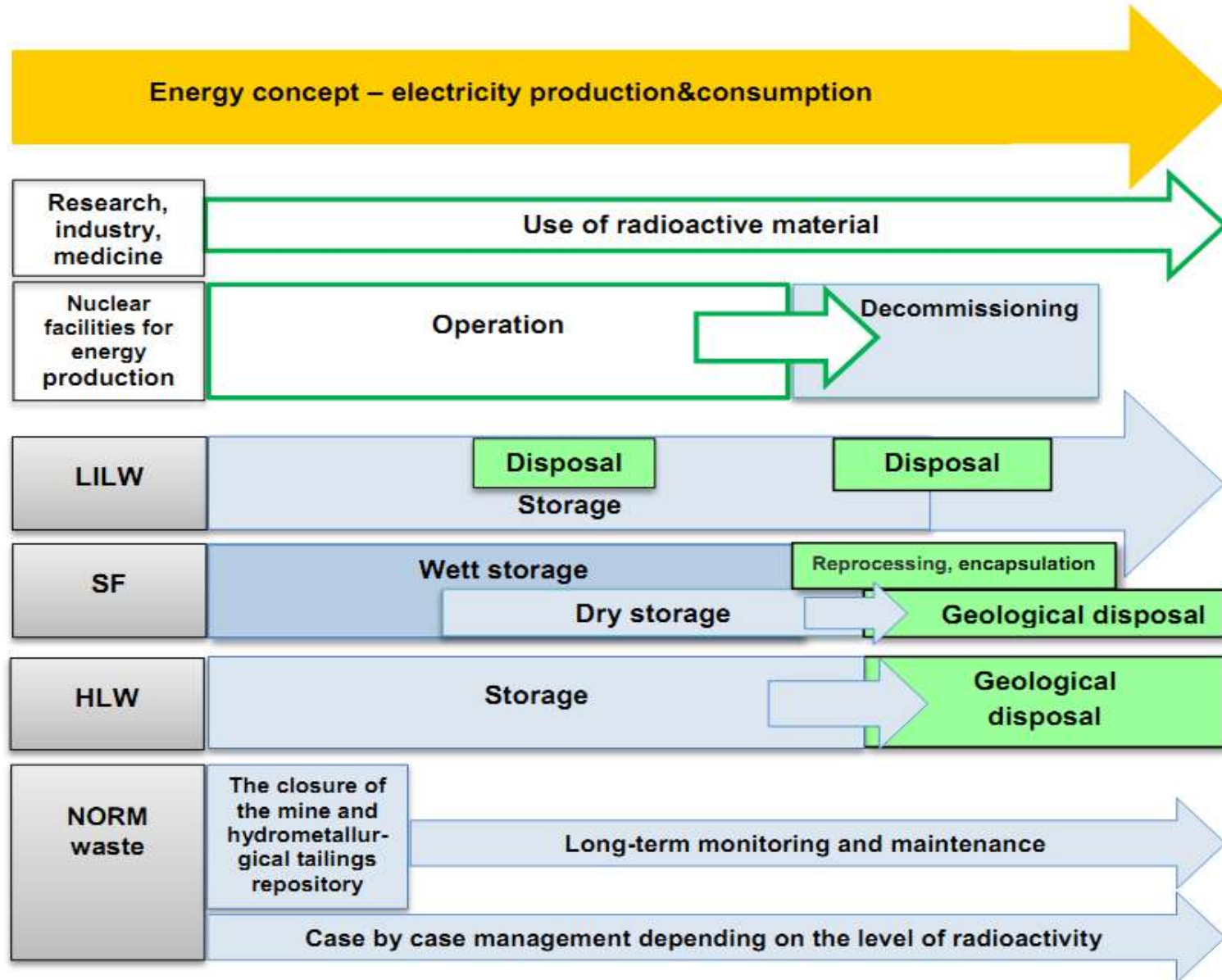


Resolution on National Policy

- Council Directive 2011/70/Euratom (19. 7. 2011)
- **First 2006-2015 (ReNPROG)**
- **Second 2016-2025 (ReNPRRO16-26)**
- **Third 2023-2032 (ReNPRRO23-32 in procedure)**
 - Safe, secure and efficient management of radioactive waste.
 - Preventing negative impacts on environment and human health arising from radioactive waste.
 - Providing infrastructure and expert support to all current and future users of nuclear and radiation technologies in Slovenia.
- **Principles of operation**
 - 1st principle: Minimization of waste generation principle
 - Reduce, Reuse, Recycle - 3R
 - 2nd principle: The polluter pays principle
 - Historical waste, orphan sources - state budget
 - 3rd principle: Safe storage followed by final disposal principle
 - 4th principle: Research and development of disposal and management



Resolution on National Policy in One Picture



Small amounts of waste

Batch-wise operation of repository

National or multinational repository (repositories)

National Policy Strategy on One Page

Storage ARAO

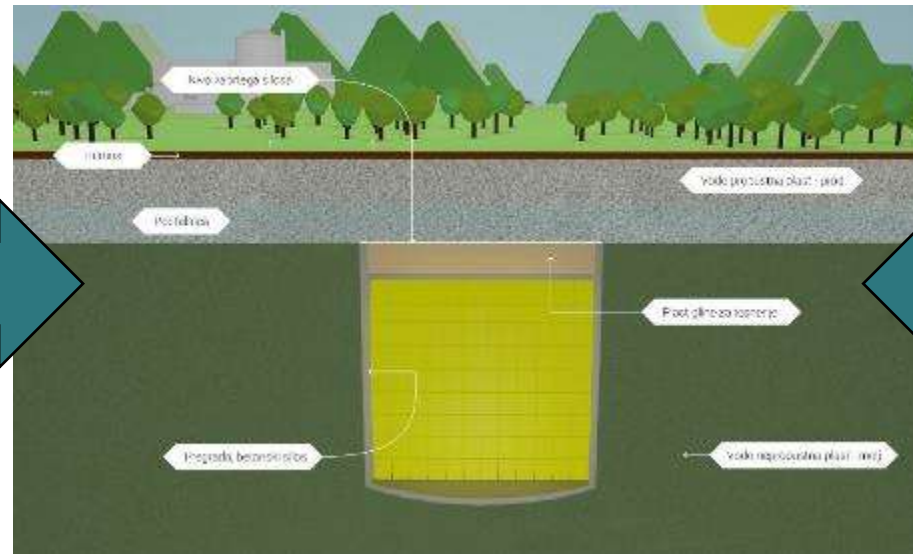


Storage NEK



~ 100 m³

Disposal (planned LILW repository)



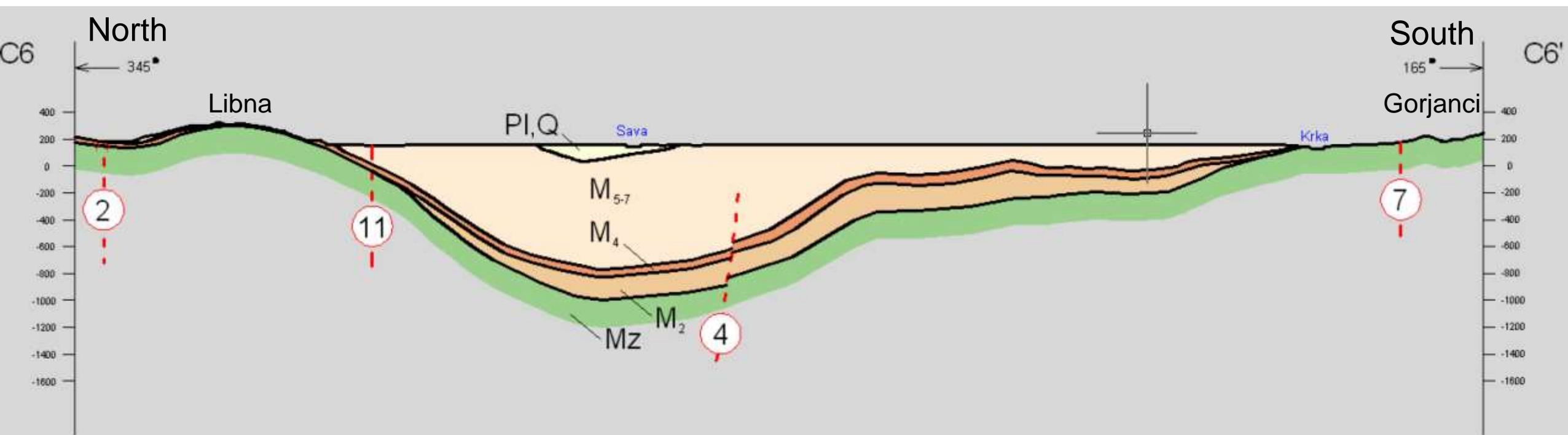
~ 2500 m³

LILW Repository Siting

- 1st attempts in 90'
- 2nd attempt: participatory
- Local municipalities are free to join
- 7 municipalities, 3, 2
- 5 variants, 3, open top silo
- Site confirmed (municipality, government)
- December 2009

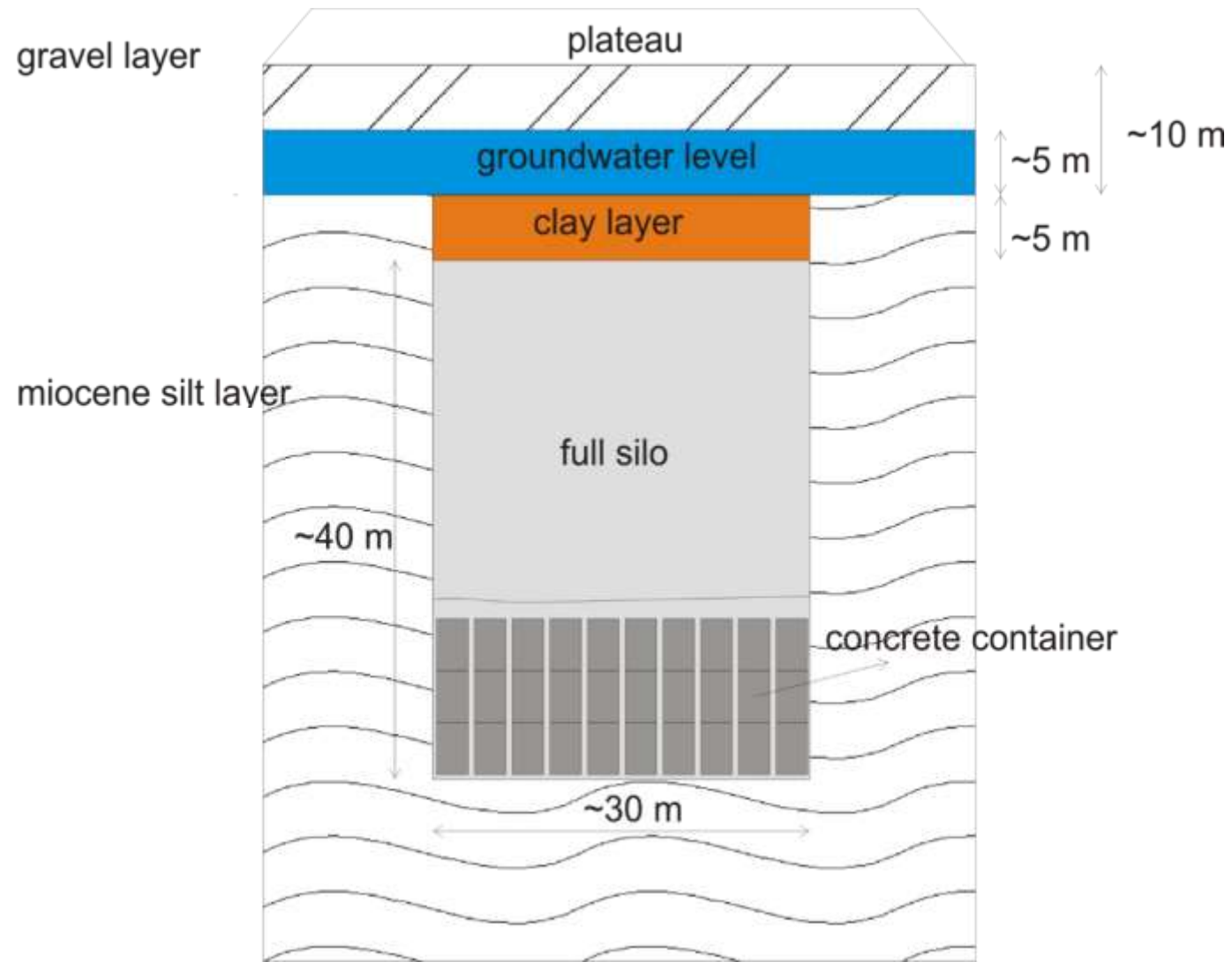


Wider Area Geological Profile



PI, Q – Sava sediments, Gravel (Q, holocen)
M – Silts (M₅₋₇ muskovit, karbonat; M₂, M₄) (M)
Mz – Limestone

LILW Repository Disposal Concept

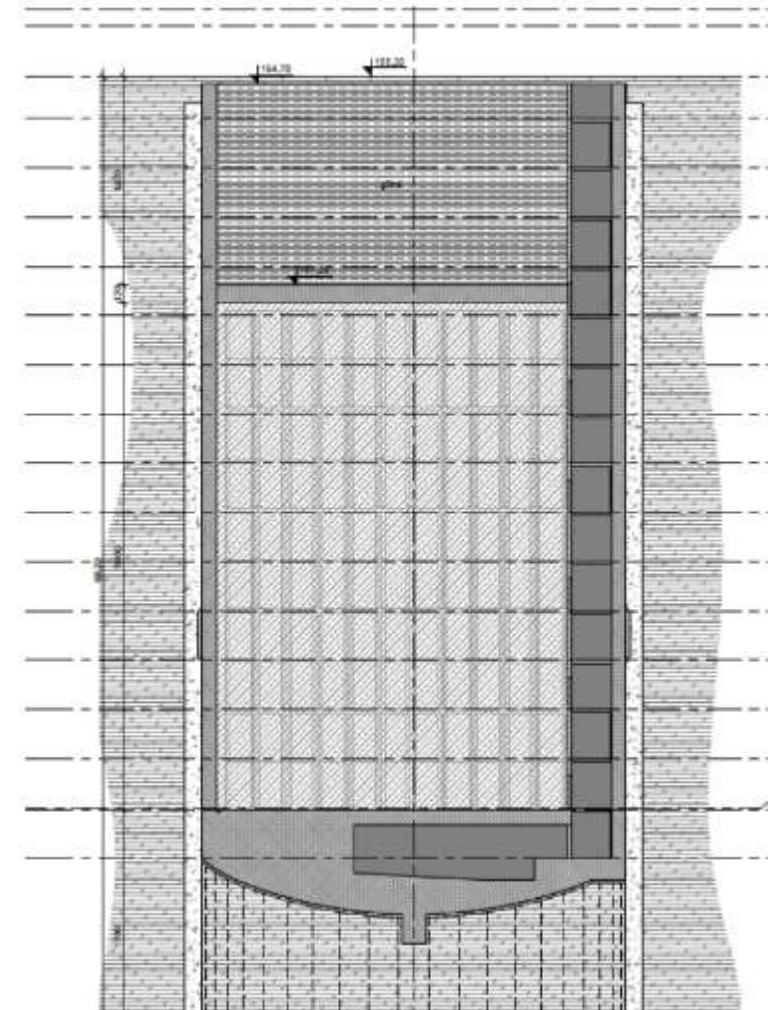
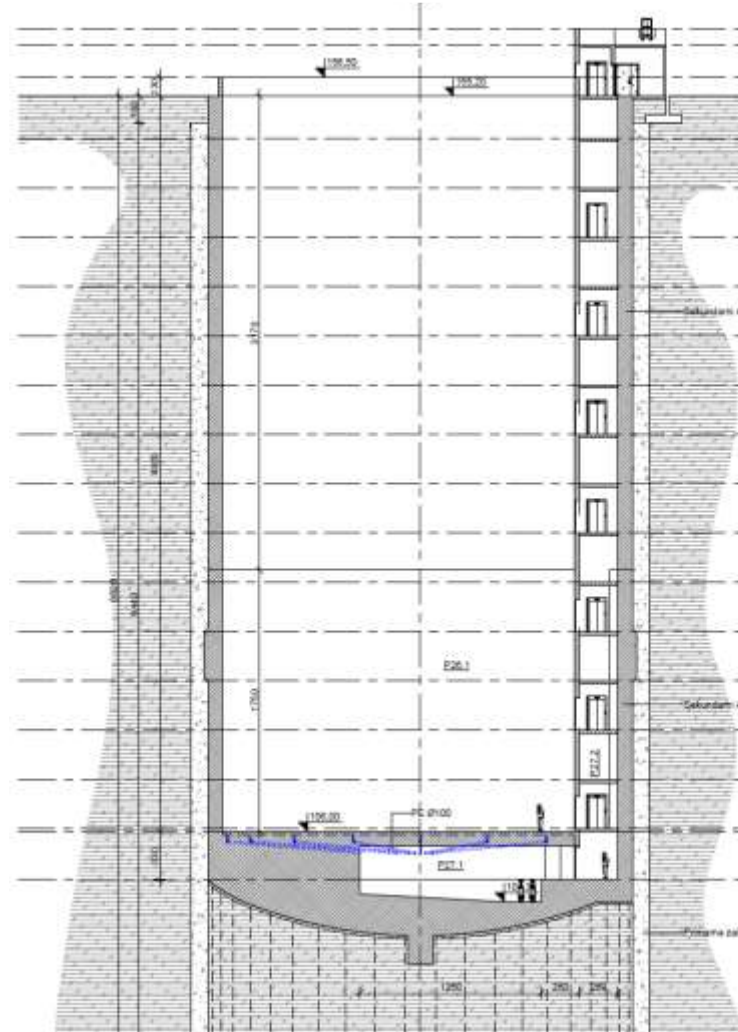


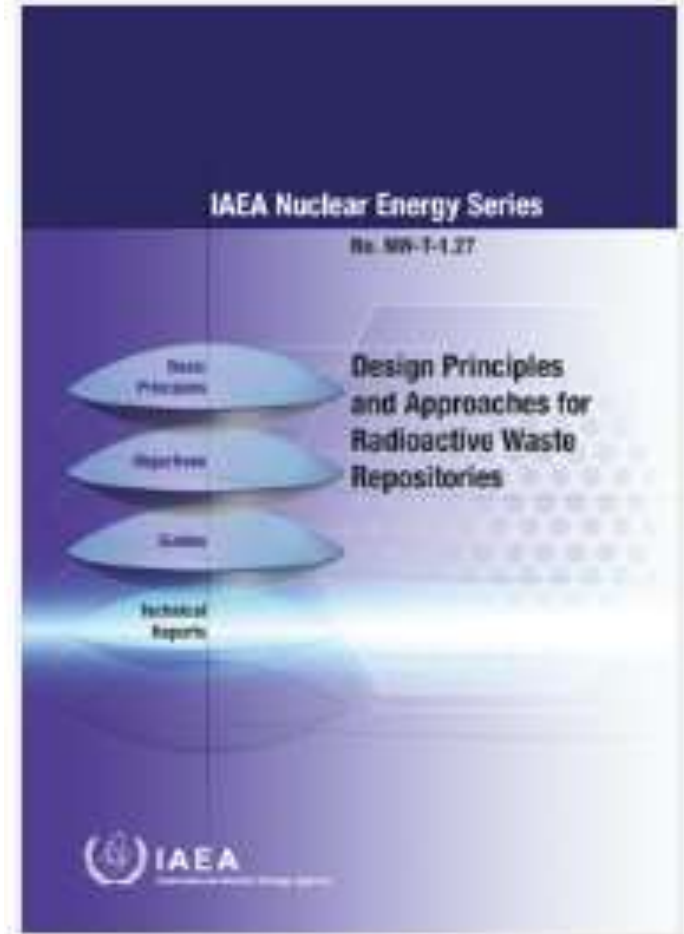
Repository Silo

Container

Kota terena 155,20 m n.m.
Zgornja kota silosa 156,50 m n.m.
Kota dna silosa 106,00 m n.m.

Notranji premer silosa 27,3 m
Globina silosa 50 m
Koristna višina 10 slojev zabojnikov
Kapaciteta 990 zabojnikov





The Slovenian disposal silo is designed for the disposal of LLW and ILW -SL

Description of Slovenian disposal design given also as an example of standard silo near surface type repository in IAEA NW-T-1.27 document.