

Multinational Cooperation in Radioactive Waste Management: - from sharing knowledge to sharing facilities

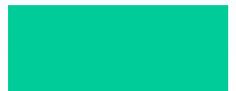
Charles McCombie

Arius Association

Switzerland



INPRO Dialogue Forum on Global Nuclear Energy Sustainability:
Drivers and Impediments for Regional Cooperation
on the Way to Sustainable Nuclear Energy Systems
30 July - 3 August 2012, Vienna



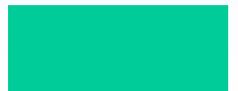
Key WM Cooperation Areas

- ◆ Developing strategies and concepts
- ◆ Knowledge exchange
- ◆ Developing methodologies
- ◆ Producing experimental results
- ◆ Organising joint research projects
- ◆ Communication activities
- ◆ Provision of services
- ◆ Implementing WM facilities
- ◆ Shared storage facilities
- ◆ Shared repositories

the
“easy”
parts

commercial
drivers

**the biggest
challenge!**



Developing strategies and concepts

◆ Developing a national RWM Strategy

- Inventory assessment
- Waste treatments
- Storage technologies and times

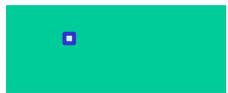
THIS IS NECESSARY FROM THE VERY BEGINNING
I.E. ALREADY IN PART 1 OF LUC'S MIND-MAP

◆ Principles of deep geological disposal

- Multi-barrier concept
- Variety of host-rocks and materials
- Siting approaches
- Staged repository development

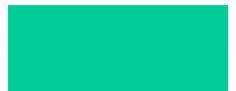
THIS IS THE
HARDEST PART

➔ Enhancing security



Principles of deep geological disposal

- ◆ **Multi-barrier concept**
- ◆ **Variety of host-rocks and designs** 
- ◆ **Siting approaches**
- ◆ **Staged repository development**
- ◆ **Enhancing security**



Geological Repository Designs

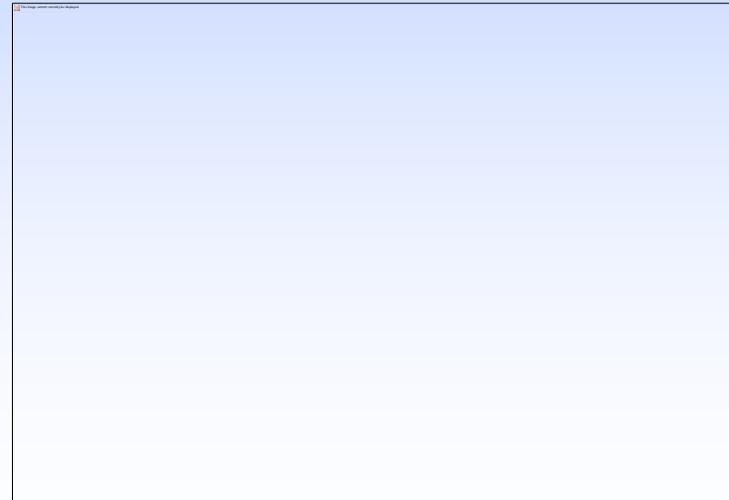


Sweden Crystalline

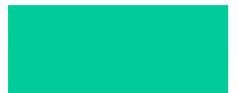
Germany Salt



Switzerland Clay



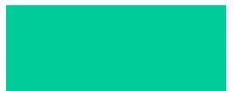
USA Tuff



Developing strategies and concepts

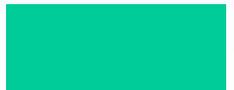
- ◆ Principle of deep geological disposal
- ◆ Multi-barrier concept
- ◆ Variety of host-rocks and materials
- ◆ **Siting approaches** 
- ◆ Staged repository development
- ◆ Enhancing security

THIS IS THE HARDEST PART
.... OF THE HARDEST PART!



Evolution of Site Selection Approach

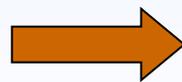
- ◆ **'Decide-Announce-Defend'**
 - **Technical Criteria used (in secret)**
- ◆ **"Techno-Social Approach"**
 - **Identify potentially technically suitable areas of land and then approach potential host communities**
- ◆ **'Volunteerism'**
 - **Publish technical requirements and ask for volunteers that would meet them**
- ◆ **'Mixed Mode'**
 - **Pre-select potentially technically and socially suitable areas and solicit volunteers**



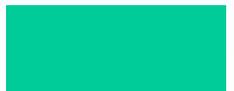
Developing strategies and concepts

- ◆ Principle of deep geological disposal
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- ◆ Staged repository development

◆ **Enhancing security**

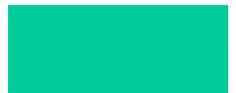
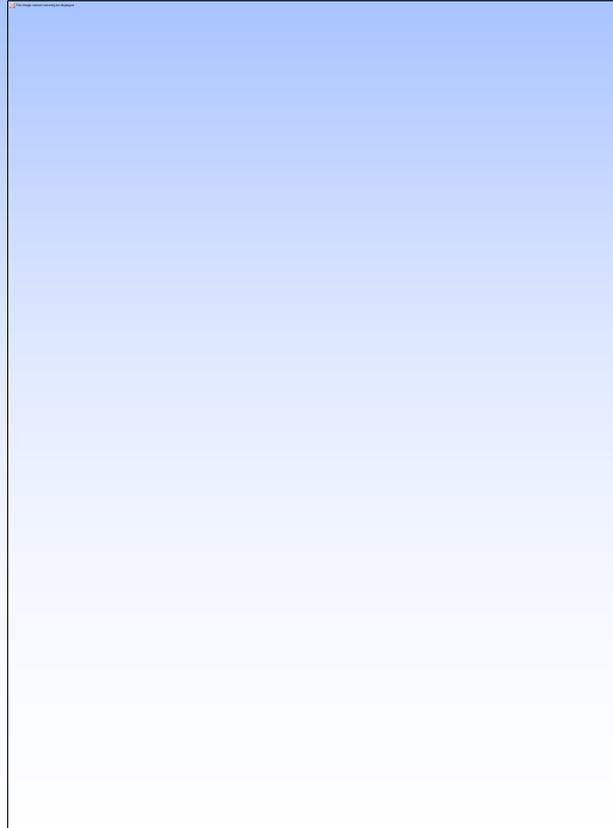


**EFFORTS IN THIS AREA
MUST BE INTENSIFIED!**



Strengthening the Nuclear Non-Proliferation Regime

It is important to tighten control ... which could be done ... under some form of multilateral control, in a limited number of regional centers....."

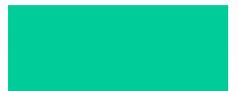


Growing Nuclear Programmes

Growing Security Concerns

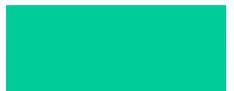
- ◆ All the security issues affect all programmes
- ◆ Possible new entrants
 - Europe, Middle East, Africa, Asia Australia
- ◆ Most attention is being given to the front-end (e.g. by IAEA, WNA, GNEP-IFNEC, GNPI)
 - Avoid spread of enrichment and reprocessing
 - Provide security of fuel supply for all users
 - What about the spent fuel and radioactive wastes??

→ Secure Multinational Solutions



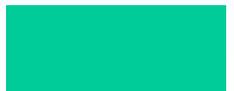
How Hazardous is Spent Fuel?

- ◆ One nuclear weapon:
 - Needs ~13 kg reactor grade Plutonium (R. Garwin)
- ◆ 10,000 t spent fuel are produced annually
 - These contain 100 t Pu
- ◆ Current separated Pu Inventories:
 - ca 500 t - 50:50 civilian and weapons programs (SIPRI)
- ◆ A single 1000 MWe NPP, 50 year lifetime
 - 1,250 t spent fuel = 12,500 kg Pu



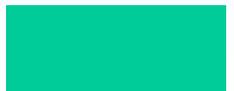
Key Messages

- ◆ Spent nuclear fuel is very hazardous for a very long time
- ◆ Lots of proposals are being made for the reducing risks at the front end of the NFC
- ◆ Too little is being done about the back-end
- ◆ Initiatives for multinational cooperation in storage and disposal of spent fuel/HLW are needed



Knowledge Exchange

- ◆ Open publications, incl. reports
- ◆ Bilateral agreements
- ◆ International organisations (IAEA, EC, WNA etc.)
- ◆ Conferences, workshops
- ◆ Personnel exchange
- ◆ International Advisory Groups
- ◆ Dedicated courses (IAEA, ITC, etc.)



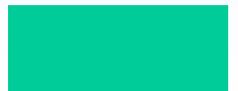
Developing methodologies

◆ Experimental

- Lab measurements
 - leaching, sorption, diffusion, etc.
- Field testing
 - seismic, drilling, hydrology, core mapping, etc.
- Underground Labs
 - construction methods, in-situ migration, geophysics

◆ Theoretical

- Safety Assessment
 - hydrogeology, geochemistry, transport, biosphere, scenario analysis, etc.
- Safety Case approach
 - **STILL DEVELOPING**



Grimsel Test Site - Phase V Project Partners



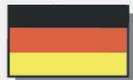
NAGRA

National Cooperative for the Disposal of Radioactive Waste



ANDRA

Agence nationale pour la gestion des déchets radioactifs, Châtenay-Malabry



BGR

Bundesanstalt für Geowissenschaften und Rohstoffe

BMBF

Federal Ministry for Education, Science, Research and Technology

FZK/INE

Forschungszentrum Karlsruhe, Institut für Nukleare Entsorgungstechnik

GRS

Gesellschaft für Anlagen- und Reaktorsicherheit



Obayashi

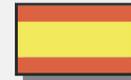
Obayashi Corporation

JNC

Japan Nuclear Cycle Development Institute, Japan

RWMC

Radioactive Waste Management Center



ENRESA

Empresa Nacional de Residuos Radiactivos



SKB

Svensk Kärnbränslehantering AB



ERL/ITRI

Energy and Resources Laboratories Industrial Technology Research Institute



DOE/CAO

Department of Energy, Carlsbad Area Office

SNL

Sandia National Laboratories



European Atomic Energy Community



RAWRA

Radioactive Waste Repository Authority

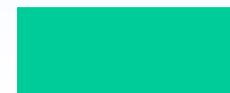
Organising joint research projects

◆ Internationally coordinated, e.g.

- EC: Framework Programmes
- IAEA: Coordinated Research Programmes

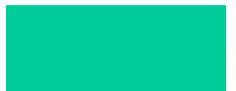
◆ Numerous ad-hoc, e.g.

- Swedish-American SAC - URL
- JSS - waste form
- Pocos de Caldas - analogues
- Alligator River - analogues
- Intracoin family - safety assessment

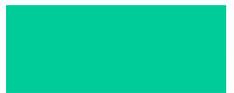


Communication activities

- ◆ Shared documentation
- ◆ Joint projects (e.g. analogue film)
- ◆ Provision of foreign speakers
- ◆ Visits to foreign facilities
- ◆ Joint governance projects (e.g. EC FP6, NEA FSC)



The public worries when they receive mixed messages from the scientific community



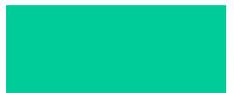
Archaeological Analogues: a powerful communication tool

Textiles ~10,000y old

Glass: ~3350y old



Spirit Cave, Nevada, plaited cremation bag 9,040 RCYBP

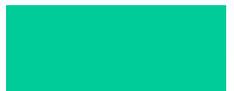


Babylonian copper and bronze farm tools: about 3900 years old



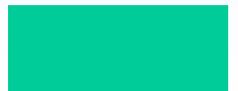
Provision of Services

- ◆ **Consulting activities**
 - Advisory and review roles
 - Lab measurements
 - Field investigations
- ◆ **Reprocessing; waste conditioning**
- ◆ **Implementation of Stores**
- ◆ **(Limited) transfer of wastes**



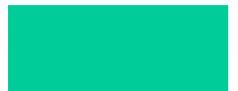
Cooperation on WM facilities

- ◆ Design & Construction of Interim Stores
- ◆ Design & Construction of LLW repositories
- ◆ Design of reprocessing/vitrification plants
- ◆ Operation of underground laboratories
- ◆ Design of deep repositories
- ◆ No shared repositories (yet)



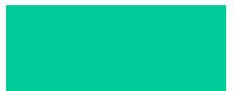
Interim Conclusions

- ◆ Non-commercial approaches helped early cooperation on waste management
- ◆ A large body of shared results and knowledge exists - but not sufficiently widely known
- ◆ Therefore, there has been and is significant duplication between national programmes and also international organisations
- ◆ Nuclear expansion (AND Fukushima!) has intensified need for knowledge transfer and cooperation in RWM
- ◆ Future directions ?



Future directions

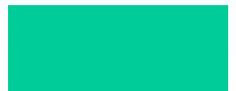
- ◆ Increased Education and Training
- ◆ Technology transfer (e.g. CATT)
- ◆ Provision of commercial services
- ◆ Standardised technologies
- ◆ Shared WM facilities
 - Conditioning
 - Encapsulation plants
 - Repositories



Nuclear services offered internationally by limited numbers of nations

- ◆ Uranium production
- ◆ Enrichment
- ◆ Fuel fabrication
- ◆ Reactor construction
- ◆ Reprocessing
- ◆ Electricity supply

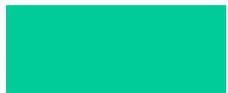
**WHY NOT ALSO
STORAGE
and/or
DISPOSAL??**



Operational Dates: Spent Fuel & HLW Repositories?

Belgium: c.2025	Belgium: c.2025
Bulgaria: open	China: open
Czech Republic: c.2065	Czech Republic: c.2065
France: c.2025	France: c.2025
Hungary: 2047	Hungary: 2047
Japan: open	Japan: open
South Korea: open	Romania: 2049
Spain: open	Slovenia: 2066
Sweden: c.2020	Rep. of Korea: open
United Kingdom: c.2070	Switzerland: c.2040
	USA: open

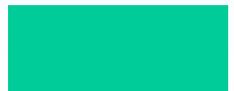
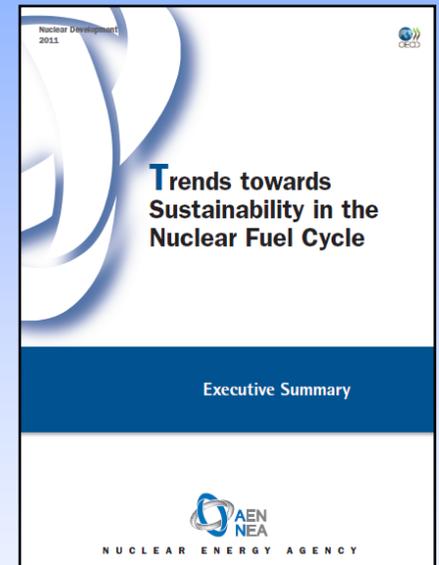
**THE "WASTE PROBLEM" HAS HELD BACK
NUCLEAR DEVELOPMENT IN
MANY OR EVEN MOST COUNTRIES**



IAEA Questionnaire on Concerns

NEA on Sustainability in NFC: 2011

- ◆ Clearly the implementation of deep geological disposal remains a key challenge ..., with opinion polls in many countries suggesting that this still represents a fundamental objection to the use of nuclear energy
- ◆ Progress towards implementation of deep geological repositories must remain a high priority as it is crucial for the future sustainability of nuclear energy...
- ◆ A holistic view of the overall economy of the fuel cycle (including long-term waste management) should be developed...



A Secure, Safe, Energy Future

◆ Global goals:

- Security of supply of energy resource and geopolitical concerns)
- Low-carbon electricity generation

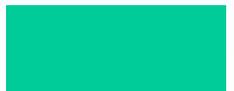
◆ Expanded nuclear power can help but we must have:

- Safe and secure NFC facilities & materials
- Security of supply of front-end services
- Security of availability of back-end services including reprocessing - if requested
- Access to geologic disposal - in all cases



Nuclear power in new user countries: “the small print”

- ◆ NPPs produce waste that needs expensive storage and geological disposal
- ◆ The problem is easier if your fuel supplier takes back the fuel
- ◆ But, even then, you will have long-lived wastes
- ◆ You need a comprehensive long-term WM strategy and plan
- ◆ Your nuclear supplier or the international community can help with this
- ◆ The disposal options are: national, multinational and dual track

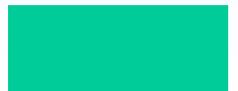






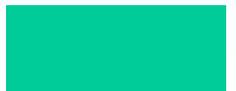
Advantages of Multinational Repositories

- 😊 Economy
- 😊 Access to safe disposal facilities
- 😊 Enhanced global nuclear security
- 😊 Lower environmental impact
- 😊 Wider choice of geological conditions
- 😊 Increased technical potential



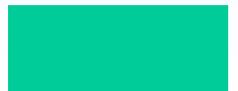
Challenges of Multinational Repositories

- 😊 Transport
- 😞 Different (national) legislations, definitions
- 😞 Diversity of waste streams
- 😞 Cost distribution amongst partners
- 😞 Different time schedules
- 😞 **Siting ... and politics!**



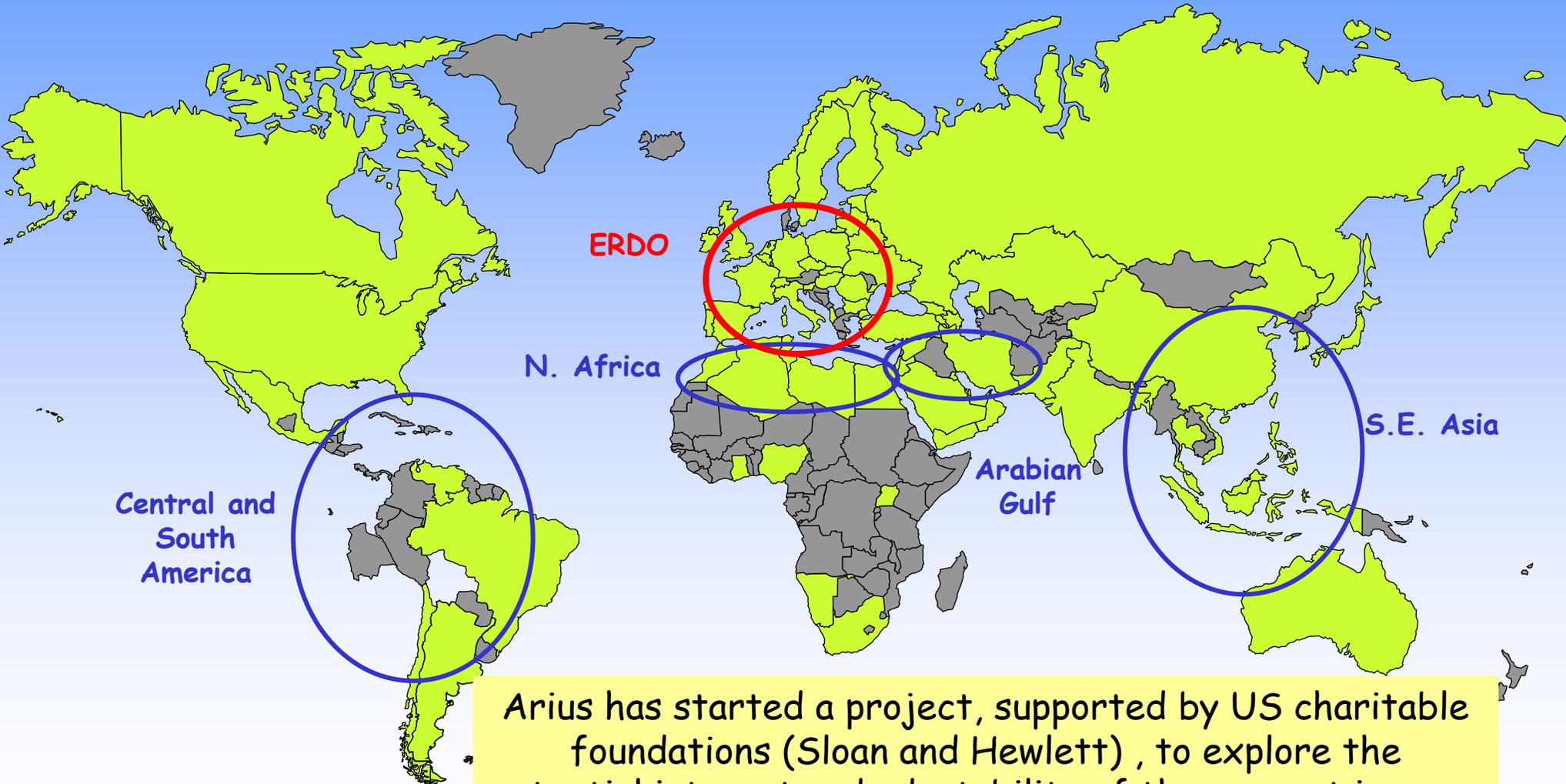
IAEA: Multinational Scenarios

- ◆ **ADD-ON Scenarios (Service Providers):** the host complements its national inventory by imported wastes
- ◆ **Co-operation scenarios:** partner countries develop a repository jointly together with the potential hosting country or countries
- ◆ **Full international or supranational scenarios:** a higher level of control and supervision is implemented





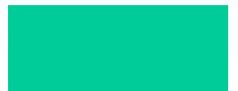
Existing and potential new nuclear power nations: can the ERDO model be adapted for use in other regions?



Arius has started a project, supported by US charitable foundations (Sloan and Hewlett), to explore the potential interest and adaptability of the concept in some of these regions

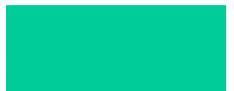
Ingredients for success: shared solution option

- ◆ Recognition of a **common need** for shared facilities
- ◆ A number of countries that are openly interested in being **potential users**
- ◆ A number of countries that are prepared to consider the possibility of **hosting**
- ◆ **Inter-governmental agreements** on economic issues, liabilities etc.
- ◆ **Support** from international organisations, large national programs, nuclear vendors, environmentalists **AND** publics and politicians

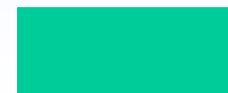


Conclusions

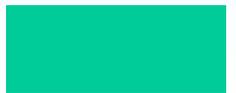
- ◆ We neglected waste disposal during the first “nuclear expansion”; do not neglect it now
- ◆ Safety and security are both important
- ◆ New and small nuclear programmes should adopt “dual track” disposal strategies
- ◆ Multinational repositories may be the “carrot” that can best convince new nuclear nations to accept further constraints on their nuclear fuel cycle activities



The End

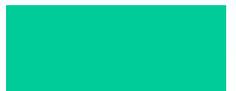


Extras



Developing strategies and concepts

- ◆ Principle of deep geological disposal
- ◆ Multi-barrier concept
- ◆ Variety of host-rocks and materials
- ◆ Siting approaches
- ◆ **Staged repository development** 
- ◆ Enhancing security



Security: How can multinational solutions help?

- ◆ Limited numbers of facilities to be secured
 - replace disconnected organisations
 - single facility easier to control and monitor
- ◆ Earlier underground disposal for smaller nations
 - with no realistic repository programmes at present
- ◆ Enhanced security measures (engineered and institutional)
 - ensure highest standards of safety & security
 - encourage harmonisation of standards (e.g. EU: 15 NP States)
- ◆ Enhanced safeguards oversight
 - simpler surveillance
- ◆ Improved financing arrangements
 - general economic advantages of sharing well-known
 - less chance of diversion of security funds

