

Actuarial Association of Europe

***actuarial methods
supporting radioactive waste issues***

Kurt Lambrechts, Milliman

“An actuary is a professional trained in evaluating the current **financial implications of future contingent events.**”

“ Actuaries work primarily in fields such as life insurance, general insurance, enterprise risk management, health insurance, health care financing, investments, banking and corporate finance, pensions and other employee benefits, as well as social security and overall social protection programs, but they are **not limited to those areas.**”



- 1. Radioactive waste**
- 2. Actuarial aspects**
- 3. Other areas**

Radioactive waste

Radioactive waste is generated by different kinds of companies

- Nuclear power plants
- Universities and research facilities (medicine, physics)
- Hospitals
- Other industrial and commercial organisations (like fire detectors)

This waste needs to be processed.

Nuclear facilities must also be dismantled after use.

In Belgium it is being organised by a semi-public organisation, operating under non-profit principle.

The radioactive waste is transferred to this organisation for processing. Companies pay their own specific premium for future dismantlement .





Collection

Disposal of high-level activity waste

- Requires cool-down of several decades before processing
- Should be kept well isolated during a decay period of more than 100.000 year



Preliminary storage

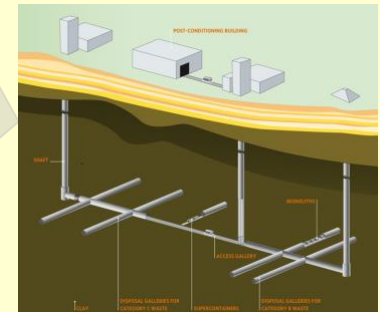
Processing



Temporary storage

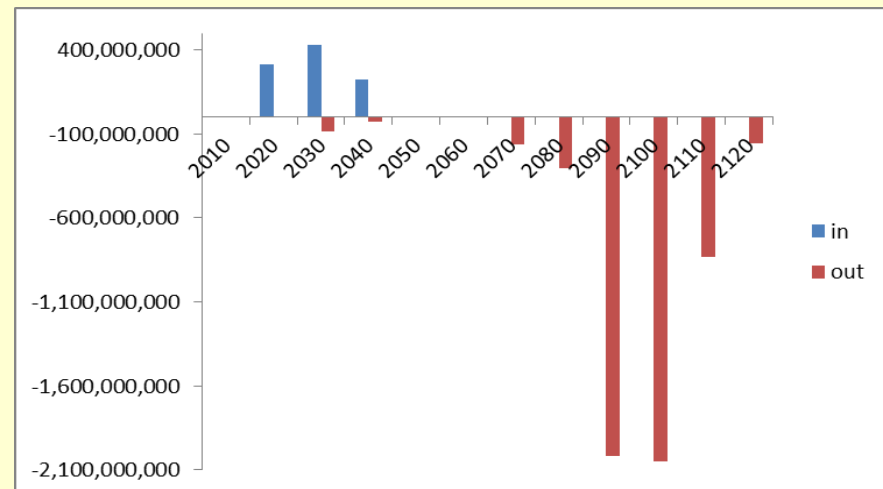
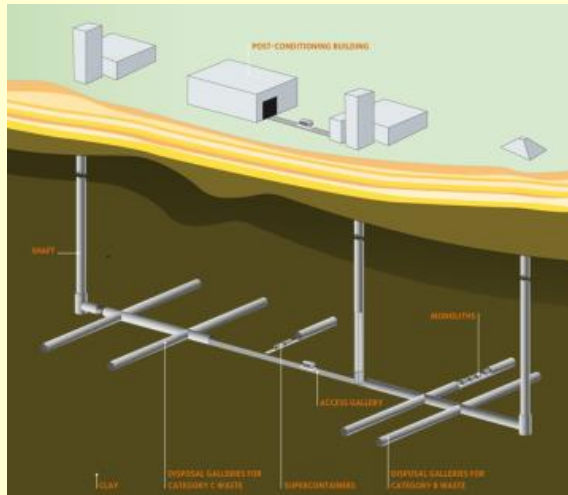


Disposal



Radioactive waste: expected cash flows

- Radioactive waste is currently collected at a tariff that spreads total costs over total expected volume of highly-active waste
- Processing and 60 year cool-down period require immediate industrial projects
- Permanent storage solution is still in a study phase
- Execution will only start as of 2090



There are different types of uncertainties in the process.

1. Timing and volume of waste

- depends on energy demand (power plants)
- depends on legal changes (e.g. mass fire detector replacements)
- depends on political decisions (shutdown of radioactive power plants)

2. Methodology to define tariffs

- incorrect volume forecasts from producers (due to uncertainty and on purpose)
- producers pushing costs forward
- decreasing expected volume of waste

3. Lapse behaviour of producers (linked to tariff levels)

- producers may stop cooperation with NIRAS and transfer to other organisations for dismantlement (possibly to other countries) or take over some processing themselves

4. Defaulting producers

- leftover waste will need to be disposed of and contaminated installations will need to be decommissioned

5. Extremely long-term liabilities

- exceeding the terms of any available assets

6. Relative timing of cash in- and outflows

- premium payments now
- expenses in the very distant future
- when expenses are incurred, no way to compensate for any deviations

7. Timing and size of expenses

- planning solutions 25 – 60 years into the future
- technology can change completely, costs can be completely off the current estimates



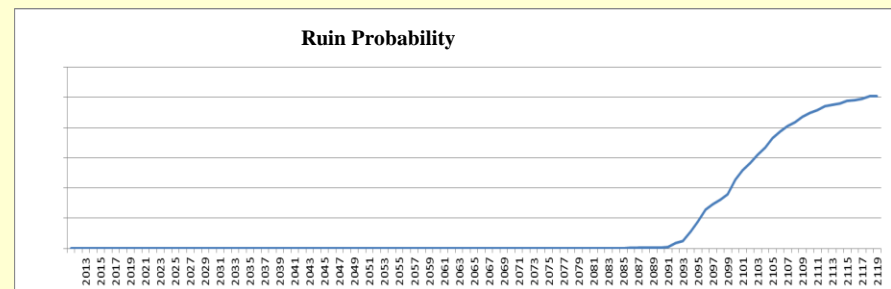
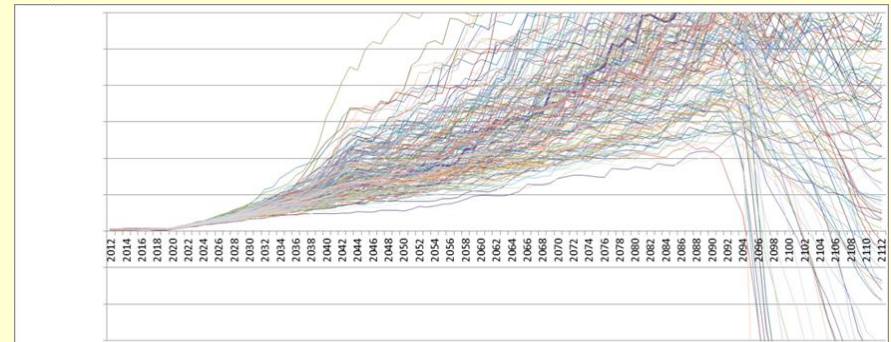
- 1. Valuation of contingent liabilities**
- 2. Ruin probabilities**
- 3. Risk management**
- 4. Pricing**

- Diagnosis of the current financial health
 - Consider current best estimate cash flow projections
 - Include industry standard risk margins for technologies that have never been applied before
 - Consider a proper discount rate for the specific context and 100 year period

- Best estimate liabilities
- Economic balance sheet
- Scenario analysis

Economic Balance Sheet	
Bonds	NPV variable expenses
Equities	NPV fixed expenses
Cash	
Total Financial Assets	Total Future Liabilities
NPV future premiums	
Total Future Premiums	Economic Surplus
TOTAL ASSETS	TOTAL LIABILITIES

- Make investment risk more tangible
 - Real world stochastic projections
 - Ultra long term asset projections
 - Inflation factor on future building costs
 - Shortfall only becomes clear once permanent storage infrastructure is getting build
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- Search for most sensible investment strategy
 - Timely mitigation of shortfall to waste producers



ALM and inflation risk

- Huge timing mismatch between assets and liabilities
- Choice of discount rate: swap rate, Belgian government bond, expected return on assets...
- Future expenses are inflation-linked infrastructure costs

Liquidity risk

- Timing of dismantlement of contaminated infrastructure is uncertain
- Requires specific -expensive- equipment and buildings
- Liquidity and treasury monitoring required

Counterparty risk

- Scale of future storage facilities and required budget depends on future volumes and fees from producers of radioactive waste
- Belgian law requires producers to pay for all costs: budget revisions are on behalf of the producers
- Insolvency of a producer between now and 2120 affects the financial resources

Belgian law

- Requires waste producers to pay for all storage expenses
- Limits the asset types that are allowed for investment

Pricing factors

- Fixed storage expenses
- Variable storage expenses: depending on the actual total waste volume

Current pricing methodology

- When expense estimate increase, price per future barrel waste increases exponentially
- Not a solution once the last barrel of waste is received

➤ Management action

- Introduce back service premium for expense increase on already received volumes
- Change the law!



- Actuarial techniques outside the financial sector
- In some aspects - change of perspective, new view on things for the client
 - Long term thinking vs. short term thinking
 - Impact of uncertainties upon the business
 - Reconsideration of pricing methodology
- Extra demand of communication skills

Our actuarial skills and techniques are useful for very different types of organisation

- Long term business
- Level of uncertainty in future cash flows / contingent liabilities (amount, timing)

Other areas with these types of characteristics

- Other waste producers (with long-term waste disposal needs)
- Solar panel energy companies (large investment – solar panels, long term business – energy production)
- Housing corporations (large investment - houses , long term business – rental incomes)
- The new metro/subway in Amsterdam (large investment, long term business – subway tickets)
- Hospitals (operational risks of the business)

Our added value

- Pricing of contingent liabilities
- Risk identification of business
- Modelling the uncertainty of business
- Managing the uncertainty

Thank you!

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