



Shaping the Decommissioning of Belgian Nuclear Power Plants

07/10/2026



PUBLIC



INTERNAL



RESTRICTED



CONFIDENTIAL

Shaping the Decommissioning of Belgian Nuclear Power Plants

1. TRACTEBEL OVERVIEW

4. LEARNING FROM EXPERIENCE

2. BELGIAN DECOM PROGRAM

5. DISMANTLING PHASE

3. POST-OPERATIONAL PHASE

6. PURCHASING STRATEGY



Tractebel Overview

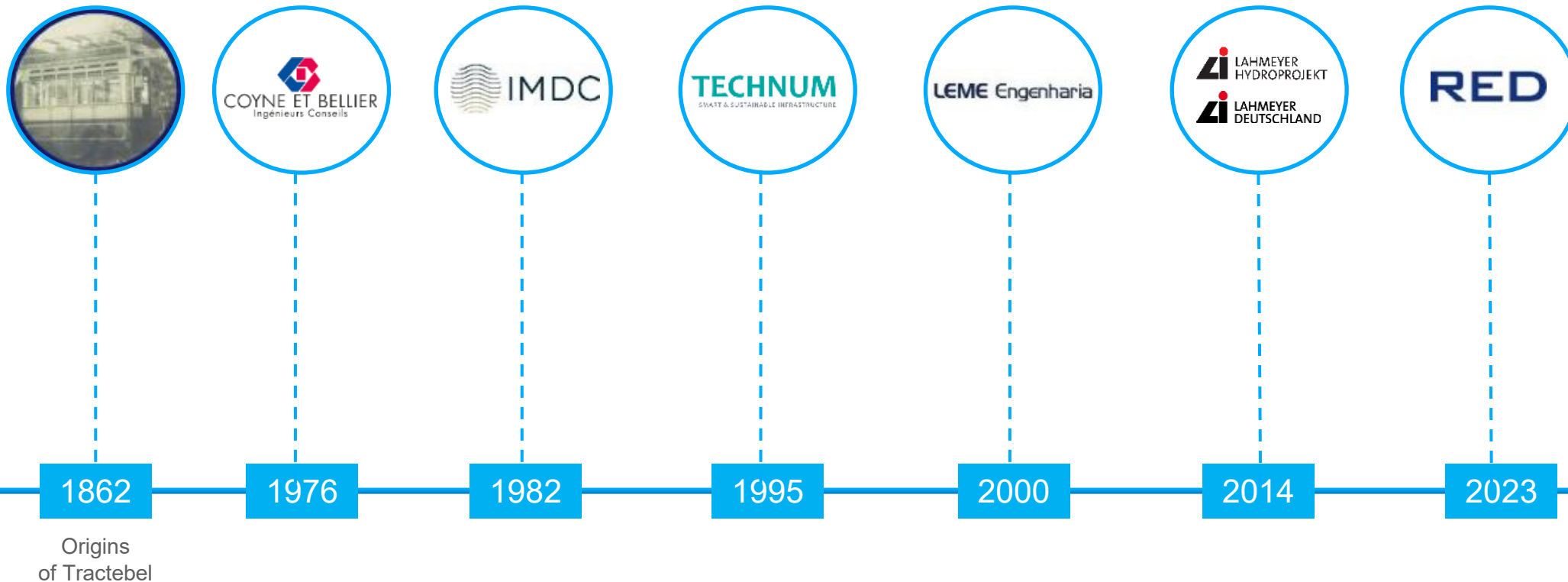




**We are a global
community of
passionate experts
engineering a
carbon-neutral future**

Backed by more than 150 years of experience

Timeline of acquisitions



Part of a strong Group

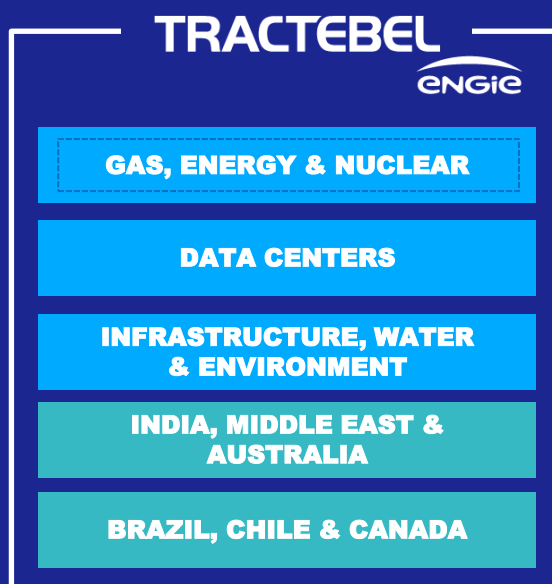
ENGIE GROUP

25 companies divided into GBU's and transversal units.



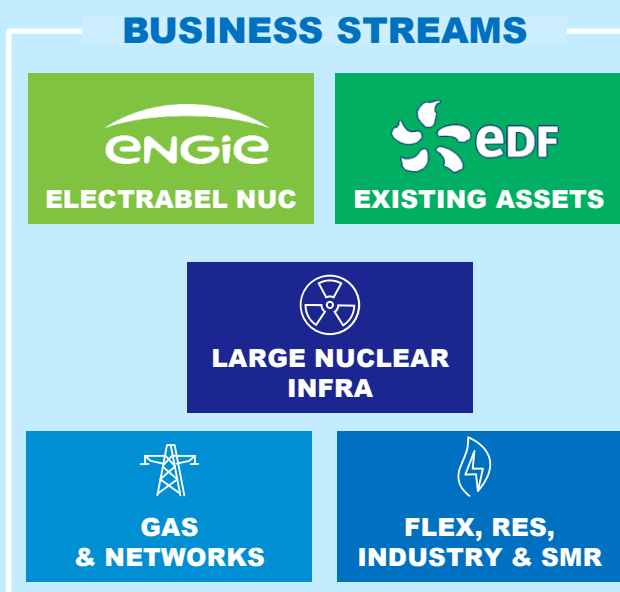
TRACTEBEL

5 Business Areas to better match technical expertise and local experience.



GAS, ENERGY & NUCLEAR

5 Business Streams that manages our P&L and operations.



Key figures

Turnover 2025



740 M€

Employees

> 6000

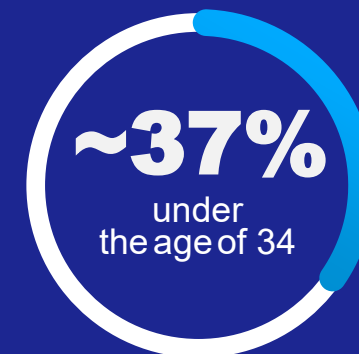


Women

> 27%



Age



Nationalities

> 100



Key experts

210



High safety standard

0.4

frequency rate

Our global operational focus

40 countries

- **Europe**

Austria / Belgium / Czech Republic / Denmark /
Netherlands / Finland / France (incl. Monaco) /
Germany / Ireland / Italy / Luxembourg / Norway /
Poland / Portugal / Romania / Serbia / Spain /
Sweden / Switzerland / UK

- **Africa**

Ethiopia / Ivory Coast / South Africa

- **India, Middle-East, Australia**

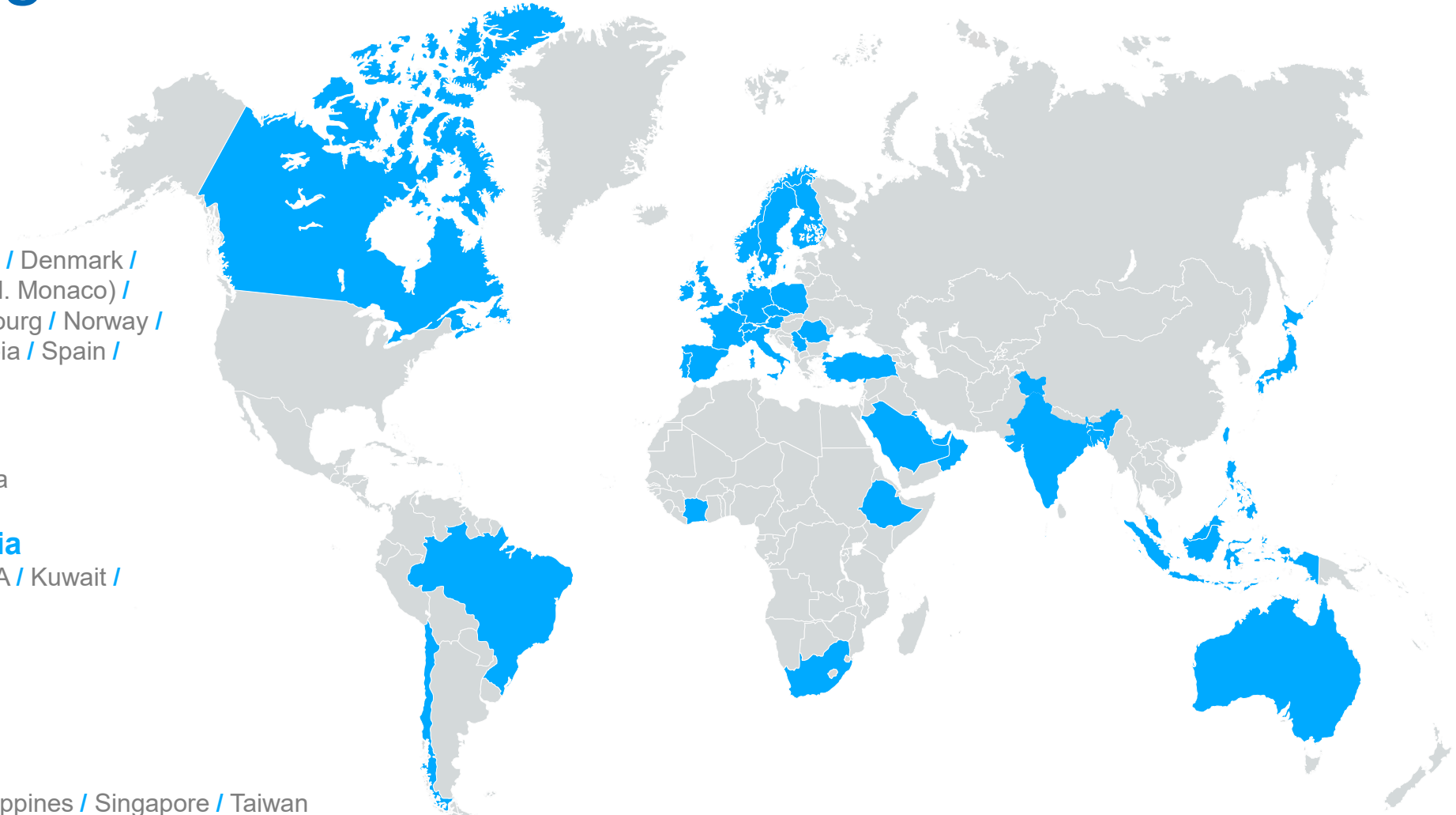
Australia / Bangladesh / India / KSA / Kuwait /
Oman / Turkey / UAE

- **Americas**

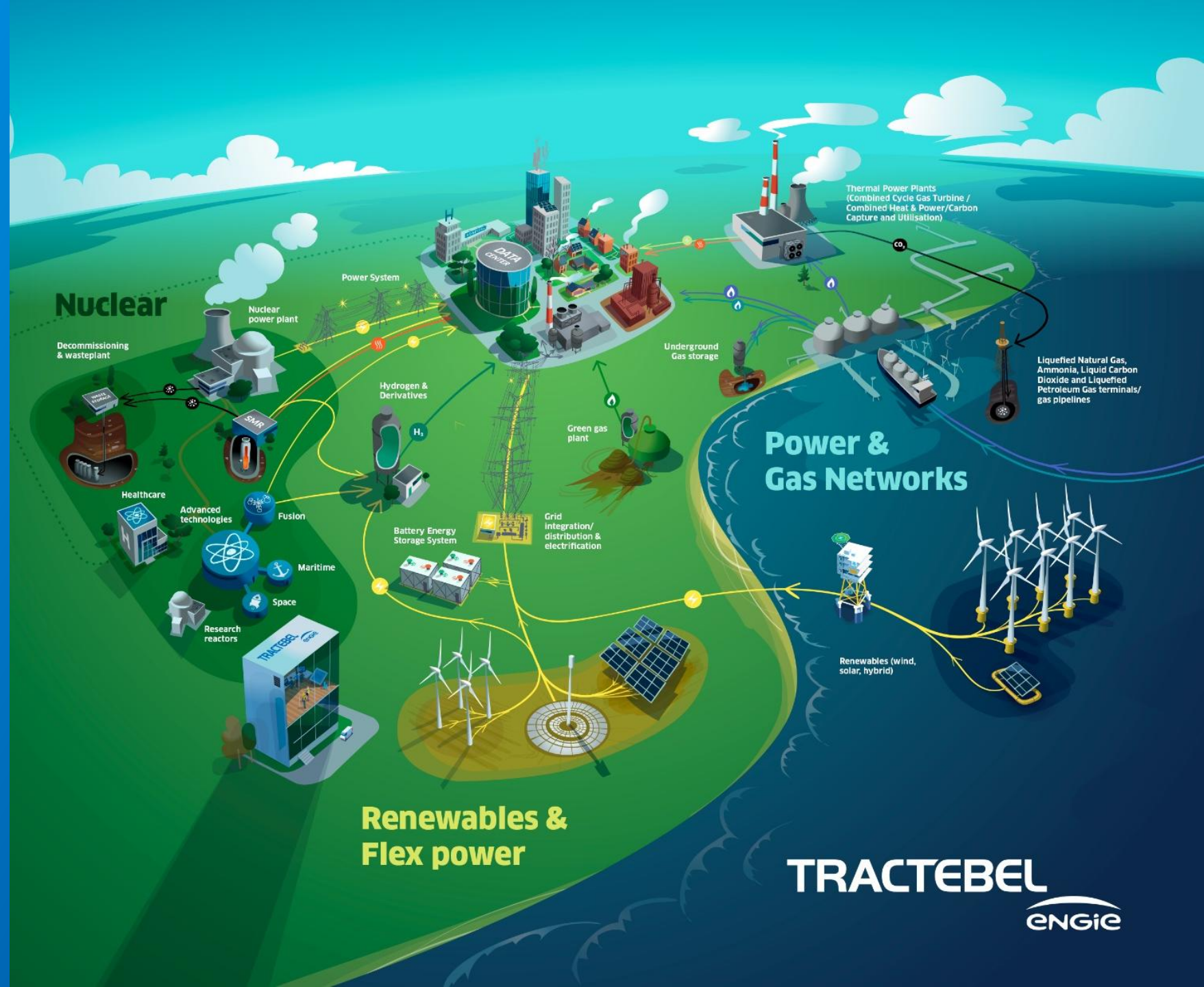
Brazil / Canada / Chile

- **Asia - Data Centers only**

Indonesia / Japan / Malaysia / Philippines / Singapore / Taiwan



Zoom on BA GEN





Belgian DECOM Program



GENERAL

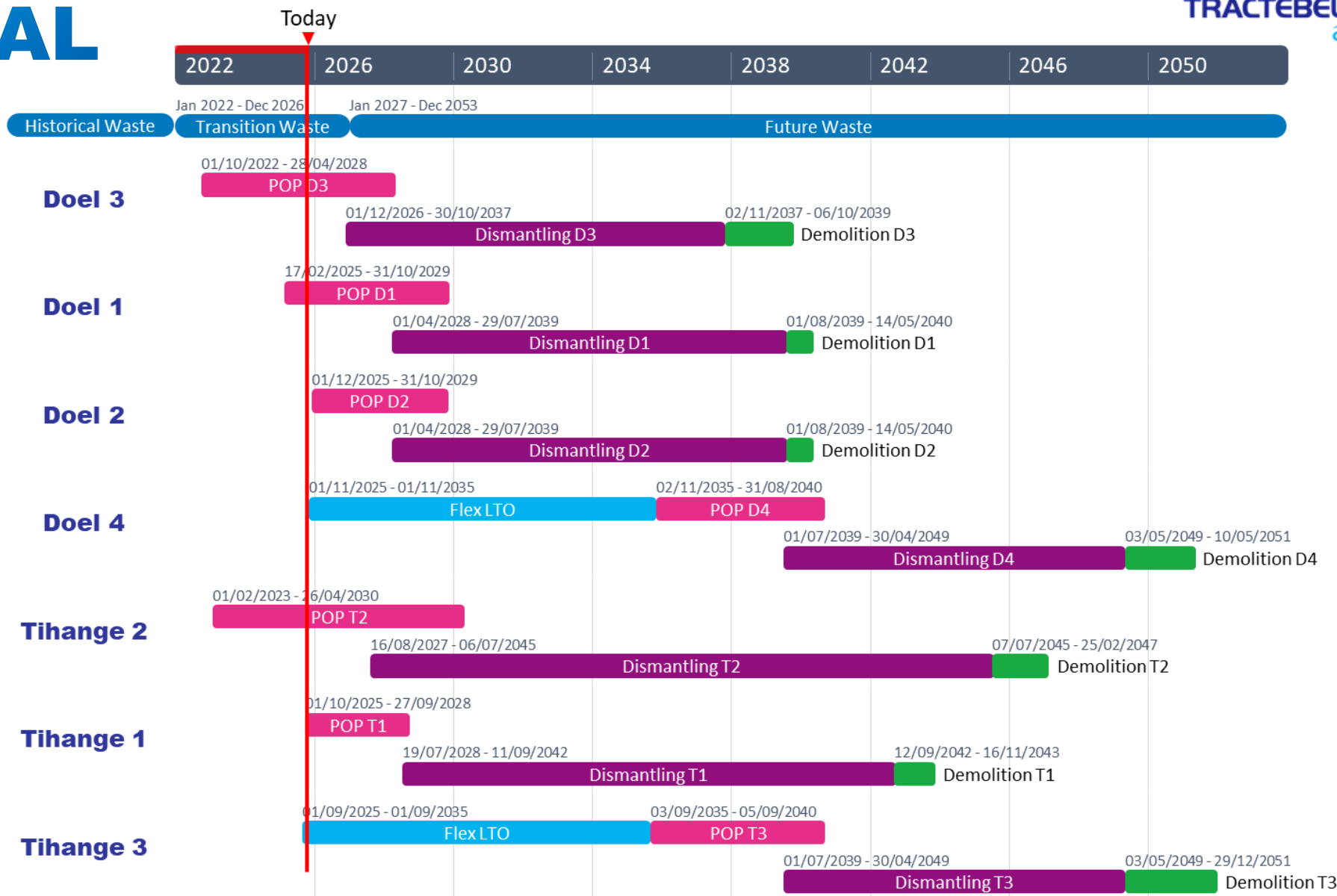
Engie Decommissioning Scenario

The Engie/Electrabel Decom scenario is based on the ***Immediate Dismantling Strategy*** and results from following considerations:

- **Availability of experienced personnel** having the necessary knowledge in the nuclear installations.
- **Total cost of ownership must be minimized and secured.** Costs for a delayed decommissioning scenario will accumulate (waste processing and disposal, security, maintenance, long term storage, etc.).
- **Maximum availability of existing infrastructure** (i.e. buildings and equipment), which avoids new investments.

GENERAL

Schedule

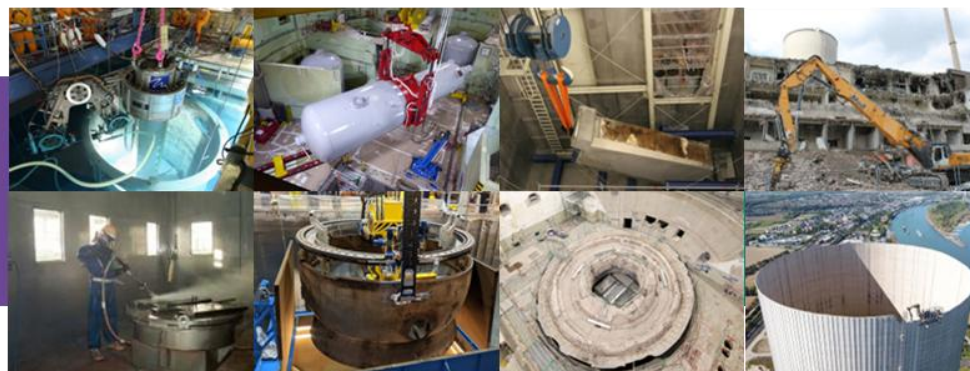


GENERAL

Every unit passes through the same phases



Decommissioning is part of the life cycle of a nuclear power plant. It includes all administrative and technical measures taken from the final shutdown decision to the release of the site for new industrial activities.



MATERIALS AND WASTE are treated on site in designated buildings.

OUR AMBITION: Maximum waste reduction and recycling of parts and materials.

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Post-Operations

GRADUAL DECOMMISSIONING OF CIRCUITS REMOVAL OF ALL HAZARDOUS PRODUCTS AND LIQUIDS

REACTOR DISCHARGE

(± 1 month)



REMOVAL OF RADIOACTIVE PARTICLES FROM THE PRIMARY CIRCUIT (CSD)

(± 6 months)



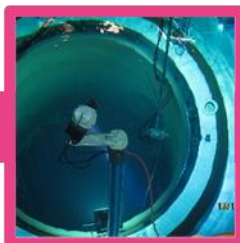
LOADING OF FUEL IN CONTAINERS AFTER COOLING PERIOD OF ± 3 YEARS

(± 24 months)

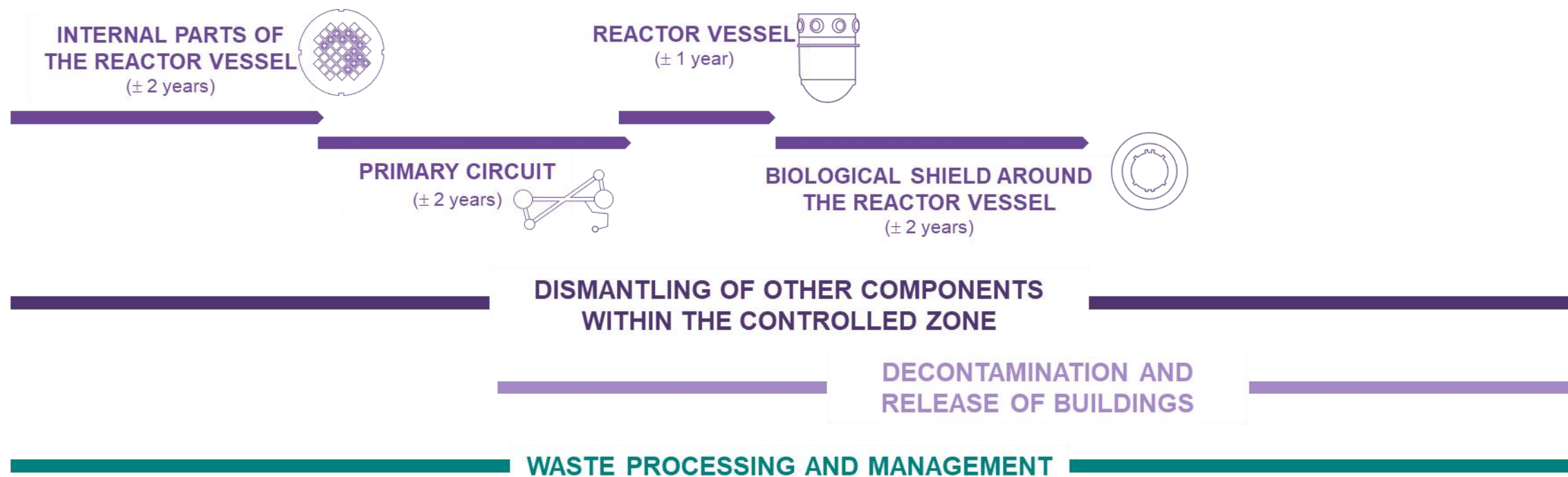


FINALE CLEANING OF CIRCUITS

(± 4 months)



Dismantling



Dismantling
licence



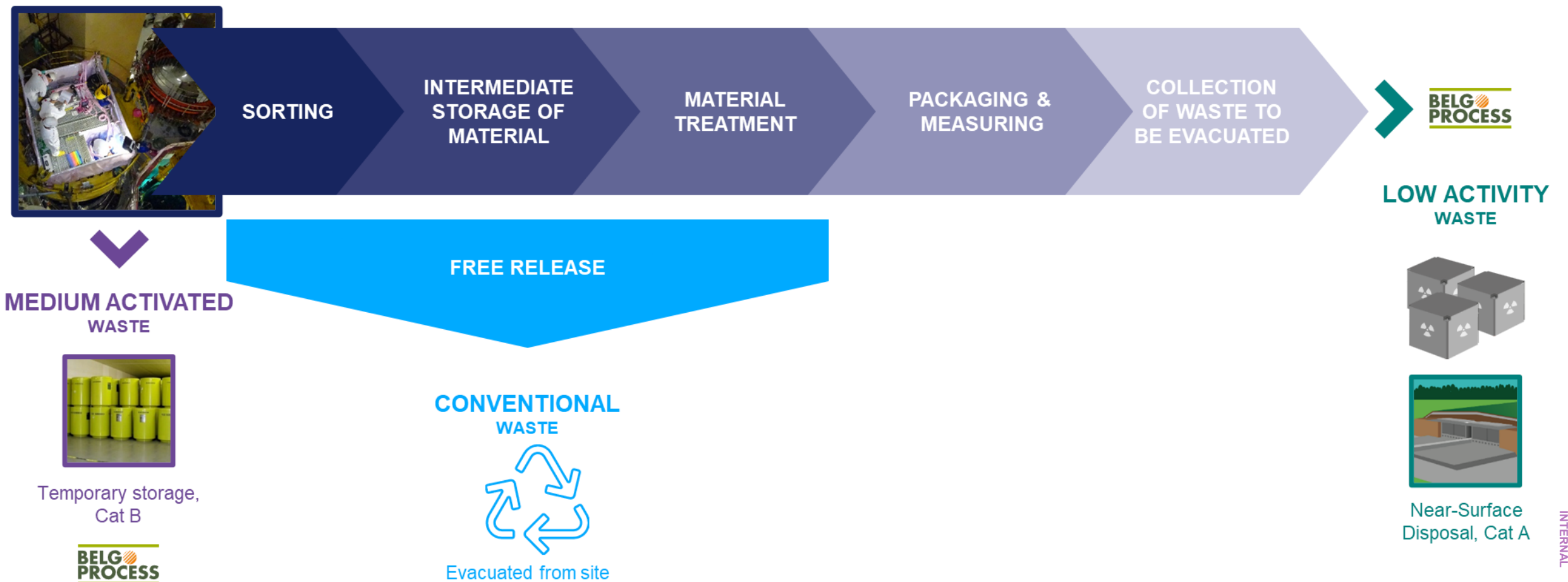
Clearance of
nuclear
regulations

PUBLIC

Courtesy of ENGIE Electrabel

Waste management units on site

Material & Waste Facilities and Waste Management Units (WMU)



Tractebel services and capabilities

- **Goal:** Ensure successful Decommissioning of Belgian Nuclear Power Plants (NPPs) by delivering high-end engineering on time and on budget through project management excellence and with a graded approach towards nuclear safety and client's requirements
- **Clients:** Electrabel (NPPs owner) | Synatom (Nuclear Fuel owner)
- **Missions Type:** Project Development (PFS, FS, BD) | Project Execution (OE, AE, EPCM, PMC) | TA (w. Syngenia)
- **Type of Activities based on Clients Program Breakdown Structure**
 - Program Management (PGM): Cost Estimations & Nuclear Provisions, Planning & Interfaces Management, ...
 - Post-Operations Shutdown (POSHD): Reconfiguration of Nuclear Island, Chemical System Decontamination, ...
 - Pool Activities Post-Operational Phase & Spent Fuel Management (PAPOP & SFM): Spent Fuel Storage Facilities, SF Casks, ...
 - Dismantling (DISM): Licensing, Activated and/or Large Components Dismantling, Bulk Dismantling, Conventional Dismantling, ...
 - Material & Waste Facilities (MWF): Modification and Reconversion of Existing Facilities, Building of New Facilities, ...
 - Material & Waste Processing (MWP): Material & Waste Inventory, Radiological Characterisation, Waste Packages, ...
- **Countries:** Front offices in Tihange and Doel | Back offices in Belgium, France, UK, Netherlands, and South Africa
- **Key Figures:** 60 MEUR Annual Turnover | 170 Projects | 240 FTEs



Post-Operation Phase (POP)



Post-Operational Phase

Scope

The Post-Operations Phase has two subtopics:

1. POSHD – Post Operational Shutdown, tasks:

- Reactor defueling → fuel transferred to Spent Fuel Pools (SFP)
- Chemical System Decontamination (CSD) of primary circuits
- Adapt Nuclear Safety Requirements Documentation (NSRD)
- Shut down non-safety/non-essential systems for dismantling (“Cleared For Dismantling”)
- Remove remaining waste, hazardous products, and liquids (including CSD resins)

2. PAPOP – Pool Activities Post Operational Phase, tasks:

- Repair leaking and/or damaged fuel (including encapsulation)
- Remove fissile material from pools → spent fuel casks → storage buildings on site
- Design, Build & Commission new Spent Fuel Storage Facilities (SF²)
- Extract dedicated number of fuel rods for sampling (as requested by Belgian Government)

Goal: Reach “Spent-Fuel Free” milestone by promptly removing all fissile material from the reactor units (reactor and spent fuel pools) to reduce nuclear risk and operational costs

Full Chemical System Decontamination

Minimizing occupational exposure while maximizing alternative waste routes

SERVICES PROVIDED

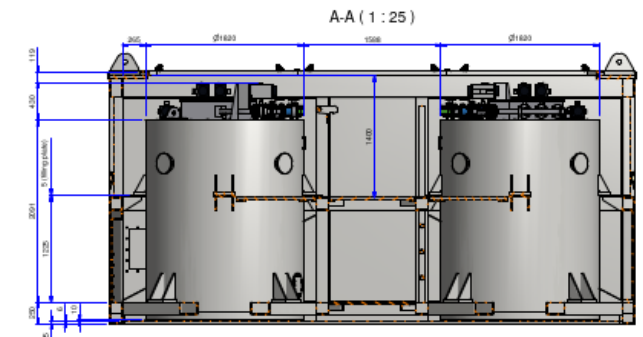
- Full systems analyses and modifications
- Gaseous effluent tanks converted in resins storage tanks
- Feasibility, dose rate calculations, licensing support
- Basic Design, Technical specifications for the detailed design and execution of FSD, offers analysis and follow-up of execution
- HSE documentation, HAZID, HAZOP, ALARA, Rad. Conseq.
- Radiological (pre-)characterization (modelling and sampling) of resins, filters, effluents and qualification as a new waste stream for declaration with Waste Authority
- Specification and procurement of resins transport packages
- **Attention points:** melting criteria (prepare decision making additional cycle), alpha contamination, KCD12 as a twin plant allows synergy



Type B(U) container for ion exchange resins



Chemical system decontamination preparatory works at CNT2



IP-2 container for ion exchange resins

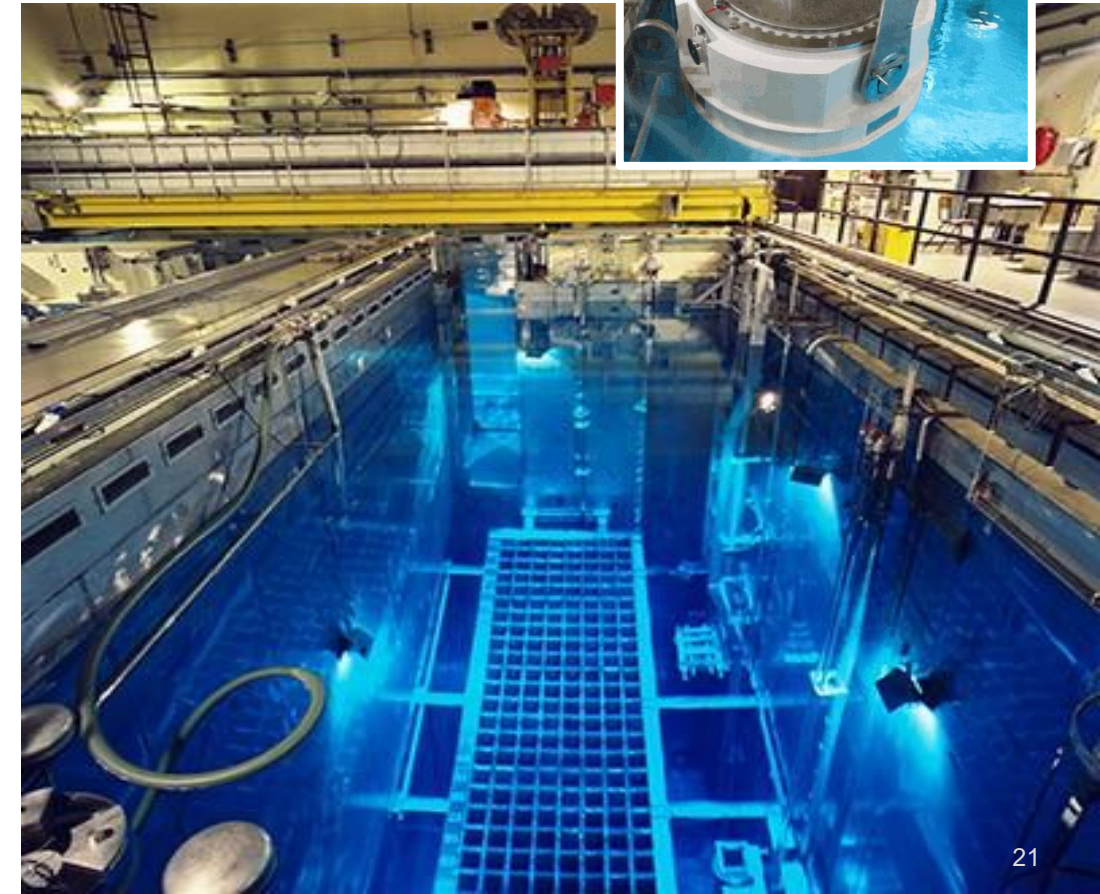
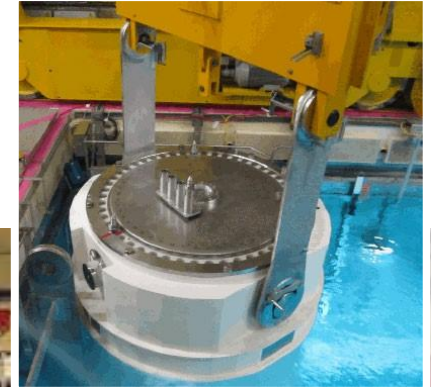
Unit	FSD	Unit	FSD
CNT1	On Hold	KCD12	On Hold
CNT2	Successful	KCD3	Successful
CNT3	LTO	KCD4	LTO

Accelerated Spent Fuel Evacuation

Reducing Post-Operational Phase cost profile while ensuring optimal safety levels

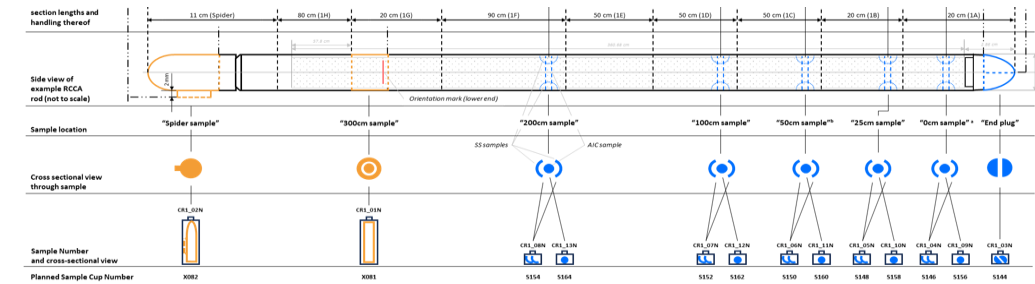
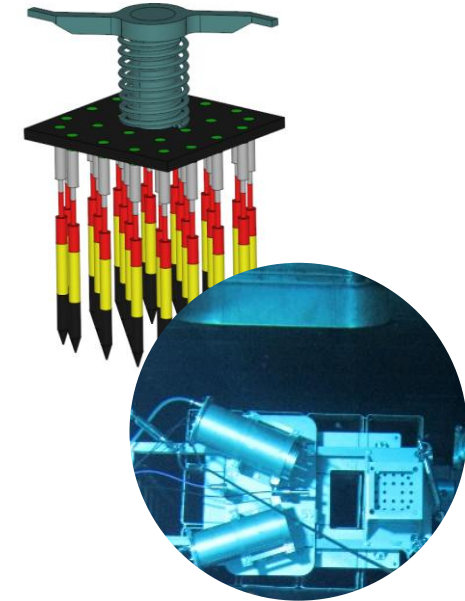
SERVICES PROVIDED

- New build of Spent Fuel Storage Facilities (basic design, procurement, execution follow-up)
- Procurement of high-capacity dry spent fuel casks
- Spent fuel assembly repair (design, procurement, execution follow-up)
- Robustness of spent fuel evacuation routes (reliability increase & logistic optimizations)
- Spent Fuel Pool Islanding (design, follow-up of execution)
- Integration with other main activities (FSD, Irradiated core accessory evacuation, ...)
- **Attention points:** ramp-up and industrialization from normal operations to post-operations, dependency on critical handling equipment and spent fuel cask supply chain



“Emptying of pools” from all remaining waste and opening new waste evacuation route for LILW-LL

- Strategy & categorization (control rods, thimble plugs, poison rods)
- (Pre-)characterization and waste management
 - Activation and contamination modelling
 - Under Water Gamma Spectrometry
 - On-site sampling and laboratory analysis
 - Waste tracking & declaration tool
 - Qualification to Waste Authority (method, radiological)
- Basis of Design, Technical Specification, Offers Evaluation, Manufacturing & Execution Follow-up for procurement packages
 - Type B(U) casks and associated equipment
 - Cutting equipment and operations
- **Attention points:** Opportunity to launch before end of normal operations, pilot for reactor internals removal





Learning from Experience



Post-Operational Phase

Learning from Experience

The importance of a waste-led project organization in place at a very early stage, to:

- Collect operating history data, in-service characterizations for future studies i
- Identify, define and maintain the necessary assumptions, hypotheses and decoupling values and centralize them into the configuration management tool;
- Organize the first anticipated works before the last drop of the control rods;
- Manage the issues of the last cores of the final cycles and evacuate the Spent Fuel Pool (SFP).
- Change Management (People, Processes, Performance) from producing electricity to producing waste

The importance to be free of Spent Fuel concerns, to secure dismantling activities

- Be aware and deal with the complexities of fuel evacuation. (thermal heat load limits, unavailability of treatment/conditioning, storage and disposal routes, ...)
- Islanding of the SFP, allowing to start major decommissioning tasks earlier and with less risks in other buildings.

Post-Operational Phase

Learning from Experience

The need to anticipate certain preparatory work,

Modifications for functional simplifications, treatment / storage / disposal of future waste, construction of new facilities and optimisation of the dismantling projects;

The benefits of quickly adapting, or even eliminating, existing installations,

Following the “Cold & Dark” doctrine, and if necessary, maintaining and using them to the best of their ability, in order to limit as much as possible post-operating costs and benefit from the operator's still strong presence;

The need for improved cost forecasts

By identifying new activities (to be confirmed: functional simplifications, modifications to cooling and ventilation systems, etc.).

Post-Operational Phase

Learning from Experience

Make or buy for critical path projects

Need to have back up plans when buy option is selected for critical path projects: Repair of damaged fuel assemblies awarded to a contractor (strategy « buy ») → impact on POP critical path not mitigated

Multisites contracts

Attention point on multi-sites contract : if prices are not locked and supply chain's capacity is limited, contractor can revise the price for the next intervention → loss of scale economy



Dismantling Phase

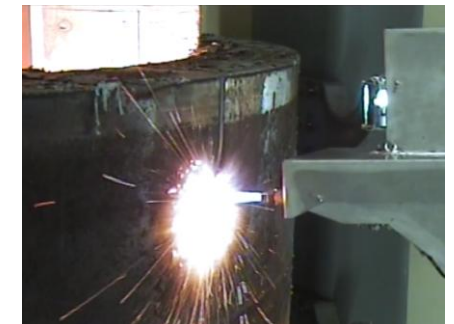


Dismantling approach and sequencing

Strategic orientations to reduce the critical path of the decommissioning project

SERVICES PROVIDED

- Consultancy on dismantling sequence definition at Fleet, Site and Unit level, accounting for constraints and strategic drivers
- Orientation of strategic decisions on main decommissioning activities
- Basic design of main decommissioning activities, procurement, follow-up of execution, ... (RPV/I, activated concrete, bulk, ...)
- Licensing strategy, drafting of licensing documentation for dismantling authorization request
- Identification and planning of pre-requisites (site modifications, support systems, ...)
- **Attention points:** availability and capabilities of contractors may vary, change management is paramount (e.g. scope of packages)

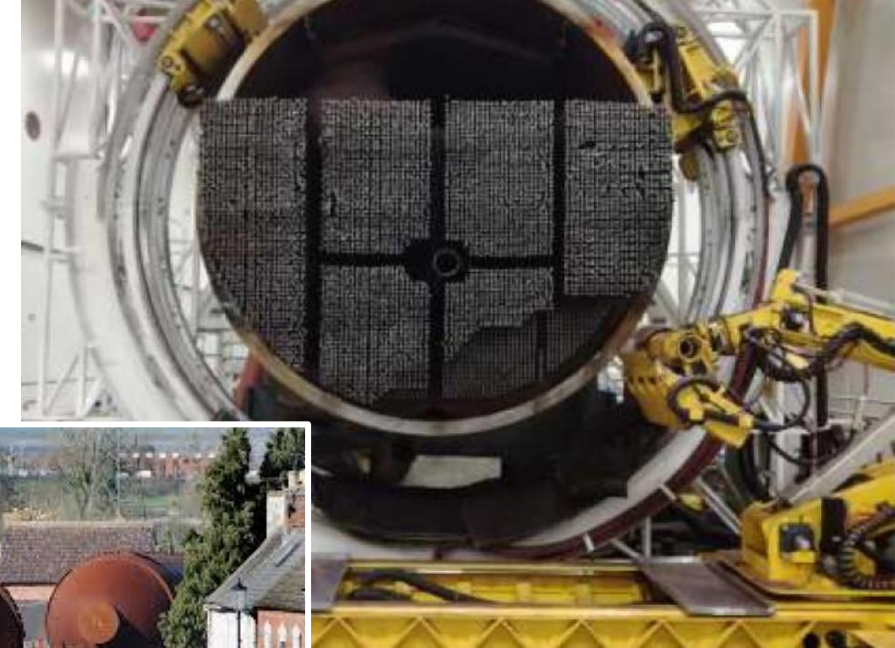


Strategic choices on waste management

From producing electricity to producing waste & materials – A paradigm shift –

SERVICES PROVIDED

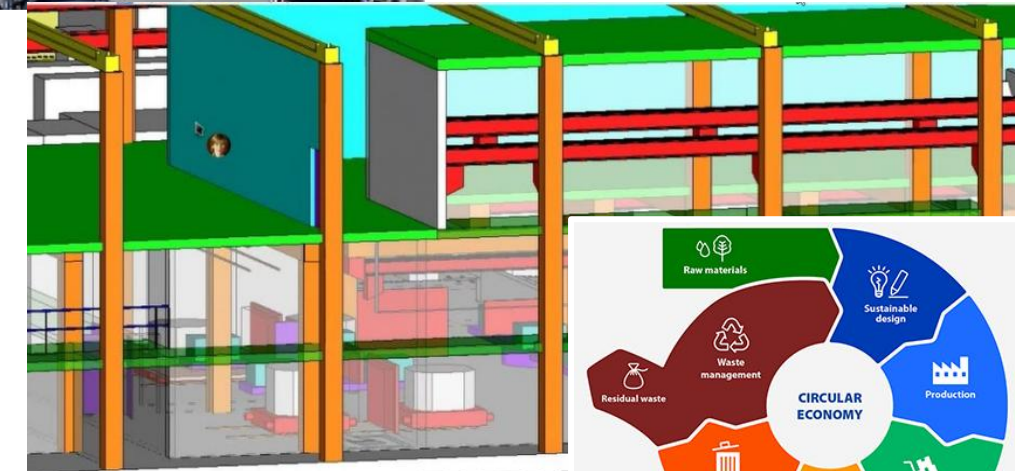
- Positioning on Rip-&-Ship for small & large components
 - In-situ dismantling
 - In fit-for-purpose new build
 - External treatment (BelgoProcess, E/S, Cyclife, ...)
- Sizing of on-site treatment, measurement & storage capacities
 - Basic design, procurement, execution follow-up (Buildings, processes, techniques, ...)
 - Transversal studies (logistics, packages, ...)
 - External services procurement (melting, conditioning, ...)
- Maximization of (conditional) clearance, re-use, recycling, metling, ...
 - Radiological impact assessment studies
 - Total cost of ownership studies
 - Procurement of external services



Transport and management of Large Components
(Credits: Javys, WNTI)



Waste Management Units



Bulk Dismantling

Objective

- The 'bulk' project includes the removal from the plant and the delivery to the collecting points of all structures and components from the controlled area, in a safe way, and at the lowest possible cost (TCO (Total Cost of Ownership) as a main driver), with the exception of a number of specific components, called the Big 4 :
 1. Reactor Pressure Vessel Internals,
 2. Reactor Pressure Vessel,
 3. Primary Circuit,
 4. Activated concrete.
- The expected final state after Bulk dismantling is completely empty rooms and bare walls, ready for the handover to the project in charge of the decontamination and the Nuclear Release of the buildings.
- It must also be avoided that the bulk project becomes critical (Critical path normally determined by “the big 4” sequence).

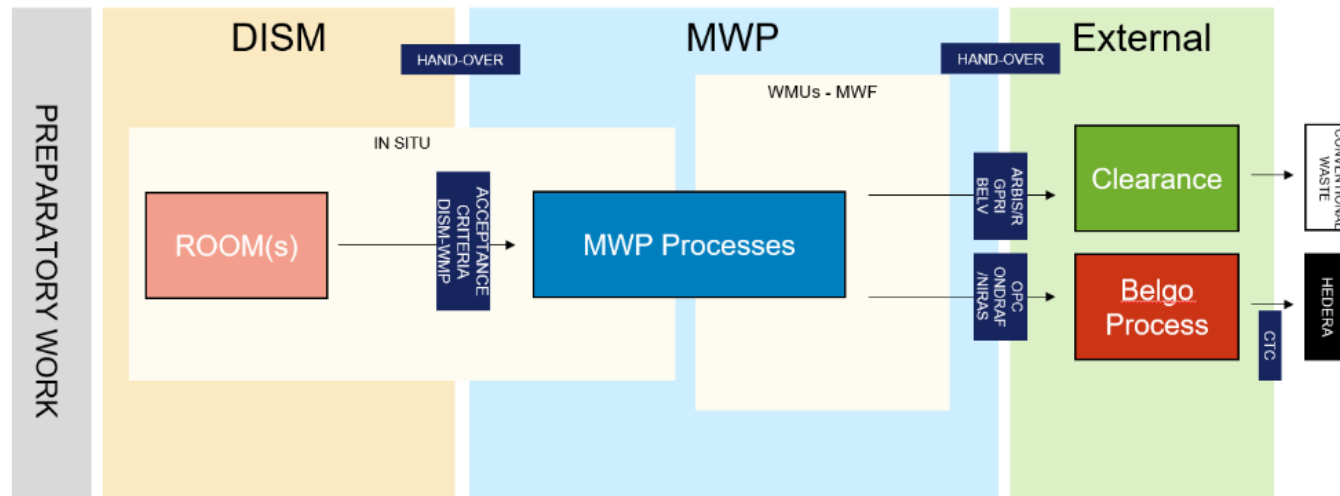
Bulk Dismantling

Strategy

- The focus remains on the Reactor Building, followed by the Fuel Building and the auxiliary buildings (sequence depending on site constraints, differences between Doel and Tihange).
- The dismantling of the buildings housing fuel and supporting systems adjacent to the reactor building will not start as long as there is still fuel present.
- The dismantling of the internal parts of the reactor takes place under water, in the docks of the reactor pools => All the (water) systems required must therefor remain operational until after the dismantling of the reactor internals.
- Bulk must take into account temporary storage of waste :
 - KCD3 : in the docks of the Fuel building.
 - CNT1 1/2 : in the SG/PP/PRES cubicles, as storage under water is not the favoured solution in CNT

Bulk Dismantling Process

Application of an iterative improvement principle



- 1) **Best estimate** - dare to start, make a draft based on what is known to date
- 2) **Test and learn** - challenge best estimate with stakeholders and/or operational REX
- 3) **Improve** - Implement what was learned in the next iteration/best estimate
- 4) **Repeat** - Reiterate this process towards a stable end result

DISM: Dismantling
MWP: Material and Waste Processes
WMU: Waste and Material Utilities



Purchasing Strategy



Purchasing Strategy

Learning from Experience

- Market/competition knowledge can influence the approach and the structure of the program, projects and even the Project Breakdown Structure.
- Staying connected with the market from the start and development of the projects is crucial.
- Global market explorations are started in collaboration with the Procurement organization
- Program/project managers can schedule targeted meetings with suppliers to create a framework from which
 - Requests for Information,
 - Make or Buy Analysis,
 - Package bundling across project boundaries,...can be started.
- Strategies (make or buy, ...) have a major impact on internal resources and competences (Electrabel / Tractebel /...) and must be taken into consideration project by project (Total Cost of Ownership approach).

Purchasing Strategy

Learning from Experience

For DECOM projects, it's important that the "Allotment Strategy" is agreed upon before the end of project development, as the type of requests towards the market will influence the scope and schedule:

- 1) In case of a **Request for Proposal**, the complete range of Feasibility Studies, Basic Design, Detailed Design, Equipment Procurement, Execution, and Test & Commissioning will be performed by the supplier, and the Feasibility Studies will be submitted in his Proposal by applying a business needs-based request or a dedicated Qualification Round (e.g. External Treatment of Large Components).
- 2) Client developed Feasibility Studies and Basic Design will lead to a **Call/Request for Tender**, in which Functional and/or Technical Specifications will be published, based on which the Suppliers will emit a Tender for the Detailed Design, Equipment Procurement, Execution, and Test & Commissioning (e.g. Chemical System Decontamination)
- 3) In case Feasibility Studies, Basic Design and Detailed Design are developed by the Client a **Request for Quotation** with a list of standardized commodities (manpower, materials, equipment, ...) describing a defined solution will be published, for which only a tender price matters (e.g. Waste Packages)

Purchasing Strategy

Learning from Experience

- The DECOM organization is ensuring that the applied purchasing method is as close as possible to the realization of **economies of scale** for the entire program.
- In addition, DECOM purchase files are **shared in advance with a broad DECOM team** to discuss the aspects of market knowledge, respect governance, economies of scale, learning from experience, and to verify the presence of sufficient expertise within the DECOM team and the Procurement Committees.
- Depending on the maturity of the technical specifications and the complexity of certain decommissioning scopes, the set up of traditional lump sum contracts must be challenged, while other contracting format might be more suitable on the long term when risks are shared. Contracts based on **target price with pain and gain mechanisms on large scope** should be considered to ensure sustainable dynamics between client and contractor.



Questions?

