

Status of nuclear energy Belgium

Update July 2019

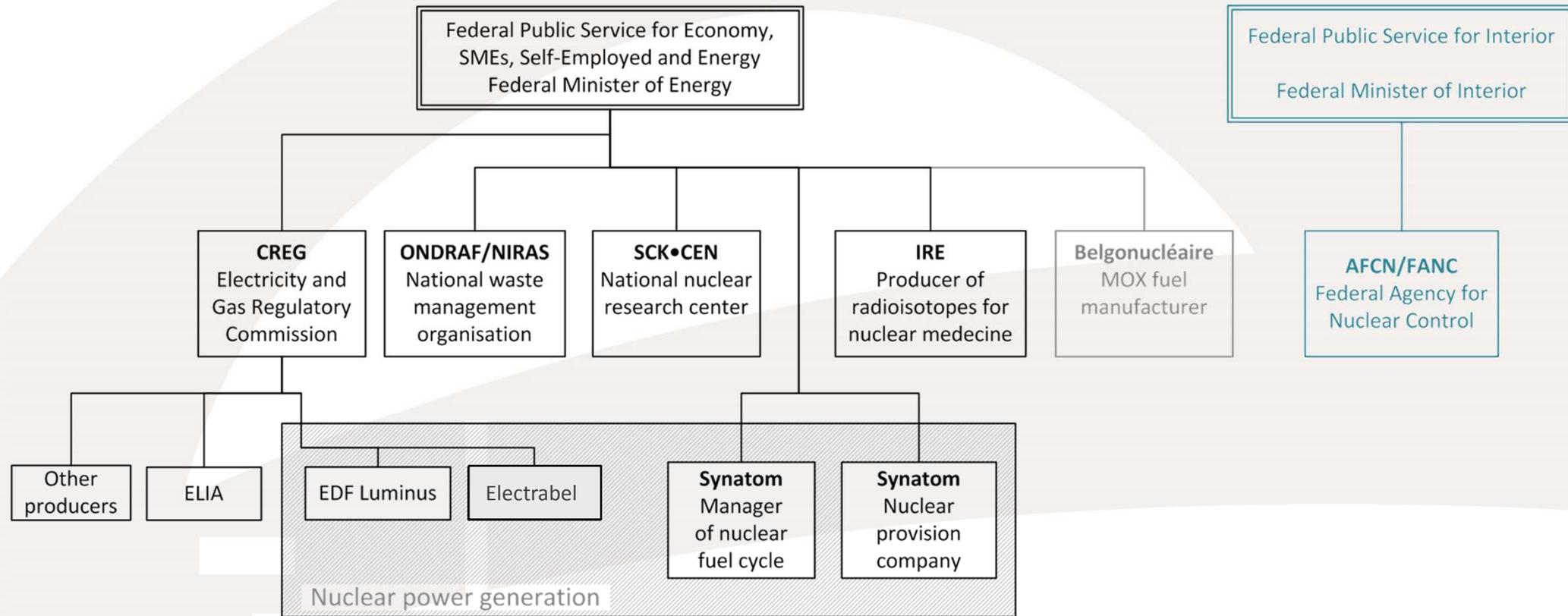
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- 1. Overview of the status of nuclear energy in Belgium

1.1. The nuclear sector in Belgium in a nutshell



1.2. Overview NPP's in Belgium

- 2 sites: Doel and Tihange (7 units)
- Total installed capacity (2019) 5.931 MW
- Only one nuclear operator: ELECTRABEL - ENGIE (part of ENGIE (FR))
- EDF BELGIUM owns 50% of Tihange Unit 1
- EDF LUMINUS owns 10,2% of Tihange 2 & 3 et Doel 3 & 4

Reactor Unit	Type	Net Capacity [MW(e)]	Status	Operator	Reactor Supplier	Construction Date	First Criticality Date	First Grid Date	Commercial Date
DOEL-1	PWR	445	Operational	ELECTRAB	ACECOWEN	1969-07-01	1974-07-18	1974-08-28	1975-02-15
DOEL-2	PWR	433	Operational	ELECTRAB	ACECOWEN	1971-09-01	1975-08-04	1975-08-21	1975-12-01
DOEL-3	PWR	1006	Operational	ELECTRAB	FRAMACEC	1975-01-01	1982-06-14	1982-06-23	1982-10-01
DOEL-4	PWR	1039	Operational	ELECTRAB	ACECOWEN	1978-12-01	1985-03-31	1985-04-08	1985-07-01
TIHANGE-1	PWR	962	Operational	ELECTRAB	ACLF	1970-06-01	1975-02-21	1975-03-07	1975-10-01
TIHANGE-2	PWR	1008	Operational	ELECTRAB	FRAMACEC	1976-04-01	1982-10-05	1982-10-13	1983-06-01
TIHANGE-3	PWR	1038	Operational	ELECTRAB	ACECOWEN	1978-11-01	1985-06-05	1985-06-15	1985-09-01

1.3. Nuclear waste management in Belgium

- Low and intermediate level short-lived waste
 - 2006: government decided on near **surface disposal** at Dessel (cAt)
 - 2012: request to obtain the license for the disposal facility has been introduced with the safety authorities (FANC)
 - **February 5th 2019: new safety case introduced by ONDRAF/NIRAS with FANC**
- Medium high-level and long-lived waste
 - R&D program since 1974 on **geological disposal** started by SCK•CEN, presently managed by ONDRAF/NIRAS
 - ONDRAF/NIRAS prepared a « Waste plan » in 2011 that was submitted to the government to obtain a decision-in-principle on the geological disposal in clay (Boom & Ypresian clays)
 - ONDRAF/NIRAS asked to open the siting to all types of suitable host formations
- In 2016 Belgium and Luxembourg signed a bilateral treaty for the final disposal of Lux waste in Belgium
- First National Programme on nuclear waste management published in 2016 (transposition of the EU nuclear waste directive 2011/70)

https://economie.fgov.be/fr/binaries/National-programme-courtesy-translation_tcm326-279459.pdf

1.4. National policy for spent fuel management

- The national policy for the management of spent fuel from commercial nuclear power plants is the safe storage of spent fuel followed by its reprocessing or direct disposal

Table 7 – Synoptic view of the national programme for the management of spent fuel and radioactive waste, at 31 December 2014, according to several key indicators. [✓ : yes; ✗ : no; ● : interim situation]

	MANAGEMENT BY PRODUCERS / OWNERS					TRANSFER	MANAGEMENT BY ONDRAF/NIRAS										
	National policy?	Regulation		Operational management?	Financing mechanism?		SHORT AND MEDIUM TERMS (treatment, conditioning and storage)					LONG TERM (disposal)					
		general?	dedicated?				National policy?	Regulation general? dedicated?	Operational management?	Financing mechanism?	National policy?	Regulation general? dedicated?	RD&D?	Operational management?	Financing mechanism?		
Very short-lived waste	✓ [1]	✓	✓	✓	✓		not applicable					not applicable					
Category A waste	n.a. [2]	✓	✓	✓	✓	⇔	✓ [3]	✓	✓	✓	✓ [4]	✓ [5]	✓	● [6]	✓	✗ [7]	✓ [4]
Category B waste	n.a. [2]	✓	✓	✓	✓	⇔	✓ [3]	✓	✓	✓	✓ [4]	✗ [8]	✓	● [6]	✓	✗	✓ [4]
Category C waste (reprocessing)			not applicable				✓ [3]	✓	✓	✓	✓ [4]	✗ [8]	✓	● [6]	✓	✗	✓ [4]
Category C waste (spent fuel)			not applicable				✓ [3]	✓	✓	✓	✓ [4]	✗ [8]	✓	● [6]	✓	✗	✓ [4]
Spent fuel from Synatom	✓ [9]	✓	✓	✓	✓		not applicable					not applicable					
Spent fuel from SCK•CEN	✓ [10]	✓	✓	✓	✓		not applicable					not applicable					
Radium-bearing radioactive waste (UMTRAP and Bankloop)	n.a. [2]	✓	✓	✓	✓	⇔	✗	✓	✓	✗ [12]	✓ [4]	✗	✓	● [6]	✗	✗ [12]	✓ [4]
"Potential" radium-bearing radioactive waste [13]	n.a.	✓	● [14]	✓	✓	⇔ ? [14]	✗	✓	✓	✗ [12]	✓ [4]	✗	✓	● [6]	✗	✗ [12]	✓ [4]
"Potential" NORM radioactive waste [13]	n.a.	✓	● [14]	✓	✓	⇔ ? [14]	✗	✓	✓	✗ [12]	● [15]	✗	✓	● [6]	✗	✗ [12]	● [15]

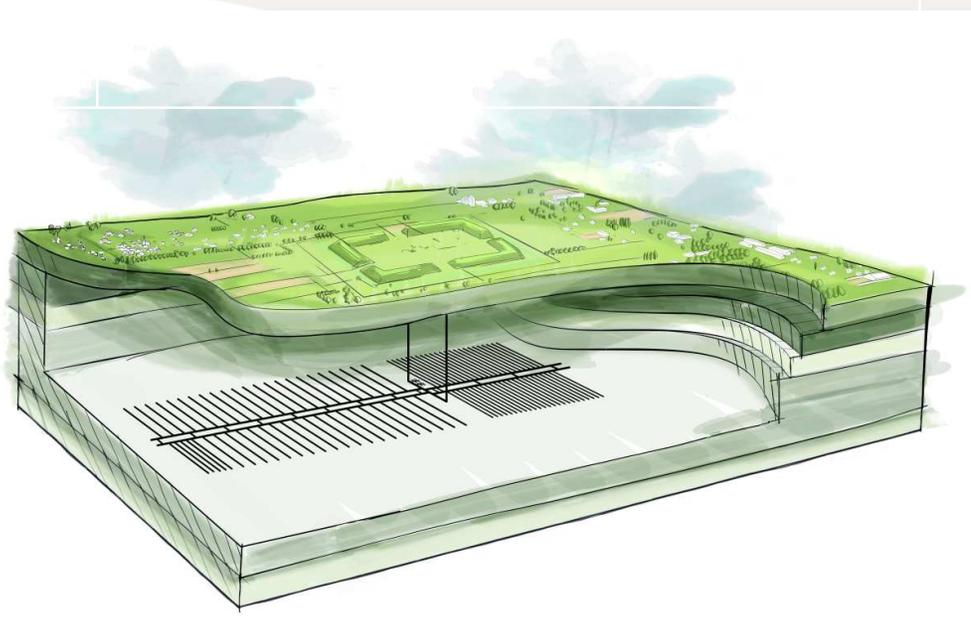
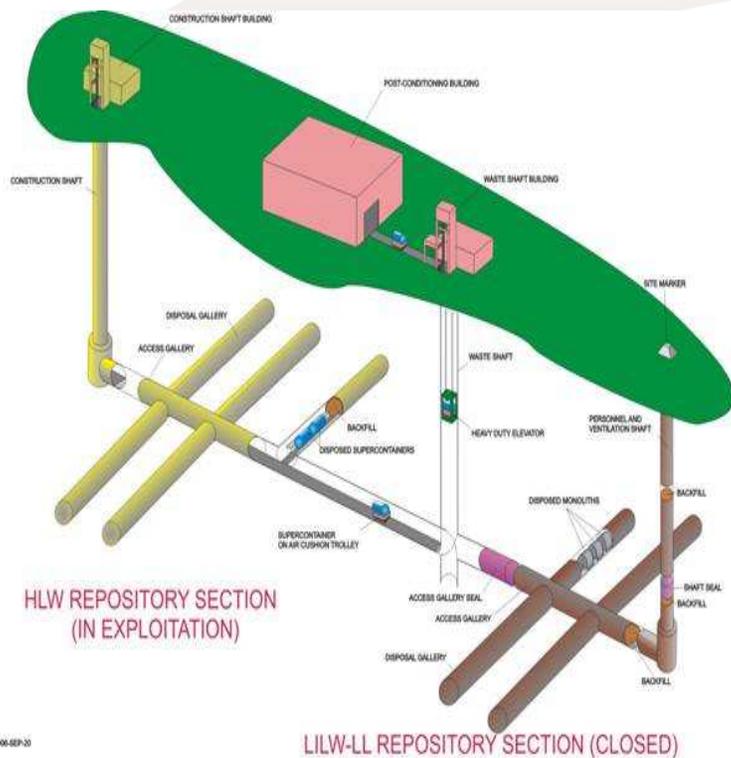
- 2. New elements and decisions

2.1. New reference scenario ONDRAF/NIRAS for intermediate (category B-waste) and long-lived waste (category C waste – spent fuel)

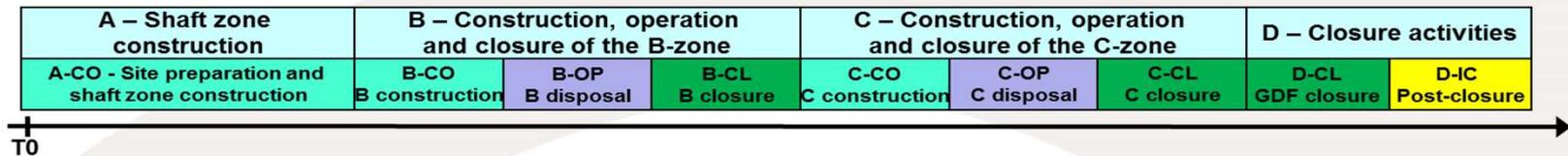
- No decision yet on host formation and site by the government
- It is a financial reference scenario that serves as an input to calculate the financial contributions of the waste producers
 - Repository for both intermediate (B) and long-lived waste (C)
 - Based on the reference programme of the waste producers
 - Spent fuel: change from 100% reprocessing of spent fuel to +/- 30% reprocessing of the spent fuel – change in volumes of types of waste
 - Presumption of 400 m depth for the repository instead of 230 m
 - New dual-tube layout with experimental zone
 - Includes measures to favor reversability and retrievability
 - Operational safety aspects taken into consideration

2013

2018



Planning



Phase	Phase	Start date	End date
National Policy			2018
Participative process for site selection		2019	2035
Preparation of the license application		2035	2045
Review of the license application by the Safety Authority		2045	2050
Granting of the creation and operating license			2050
Preparation of the site, construction of the shafts and of the shaft zone, and construction of the B-Zone	CO	2050	2070
Construction of the post-conditioning facility for the B-waste	OP	2065	2070
Disposal of the B-Waste	OP	2070	2090
D&D of the post-conditioning facility for the B-waste	CL	2090	2095
Closure of the B-Zone and Construction of the C-Zone	CL/CO	2090	2110
Construction of the post-conditioning facility for the C-waste	OP	2105	2110
Disposal of the C-Waste	OP	2110	2130
D&D of the post-conditioning facility for the C-waste	CL	2130	2135
Closure of the GDF	CL	2130	2135
Post-Closure activities	IC	2135	

Costing

- Total costs concept 2018 for B and C category waste repository 10,7 GEUR₂₀₁₇ including ~40% margins for uncertainties (EPRI-methodology)
- Potential optimisation margin : 2,7 GEUR₂₀₁₇
 - Optimisation to follow – analysis ongoing by all parties
 - 2 years of study on these potential optimisations
 - In 2020 new bottom-up costing
- Basis for contributions by waste producers
 - *total overnight costs: 7 982 M€₂₀₁₇*
- Recommendation for nuclear provisions accounts 10,7 GEUR₂₀₁₇

2.2. New dry storage facilities for spent fuel at NPP's

- Current situation at the NPP's:
 - **Dry storage** in special containers at **Doel**. The Fuel Container Unit building (SCG, standing for *Splijtstof Container Gebouw* in Dutch) was commissioned in 1995 and was designed to house 165 containers, each of them holding between 24 and 37 assemblies. On average, five additional containers a year are brought to this storage building.
 - **Underwater storage** in a central building at **Tihange**. At Tihange, a special building, called "DE", was commissioned in 1997. It contains eight pools that can hold a total of 3,720 assemblies, which are stored in racks covered by boron water 8 metres deep.

- Given the active life of the nuclear units, new interim storage capacities are to be built at both **Doel and Tihange** in the next years.
- Electrabel and Tractebel are currently planning these additional facilities to enhance the spent fuel storage in Tihange and Doel site. The solution retained will be a **dry spent fuel storage facility with the use of dual purpose casks**. At the end of the year 2018, the basic design activities were finalized, and the licensing and permitting activities are ongoing. Once the required permits are obtained, the construction of the new facilities can start (2020). It is foreseen to have the new facility operational by 2023 in Tihange and by 2024 in Doel.



2.3. Belgium decided to build a new large nuclear research infrastructure MYRRHA

- Belgium will continue to invest in nuclear research despite her decision to progressively phase out nuclear electricity production in 2025
- Belgium intends to remain at the forefront worldwide in :
 - Transmutation (Partitioning & Transmutation) of radioactive waste.
 - Nuclear medicine and medical radioisotope production
 - Accelerator technology
 - Research in new materials
- The MYRRHA project consists of three phases:
 - Phase 1:
 - MINERVA: Accelerator 100 MeV + target stations (ISOL and Fusion material testing facility)
 - Fully modular infrastructure able to function independently as of 2026-2027, and generate scientific results and revenue
 - Phase 2: accelerator upgrade to 600 MeV
 - Phase 3: Nuclear reactor

MYRRHA applications portfolio



**Spent Nuclear
Fuel/ Waste**

**Multipurpose
hYbrid
Research
Reactor for
High-tech
Applications**



Radioisotopes

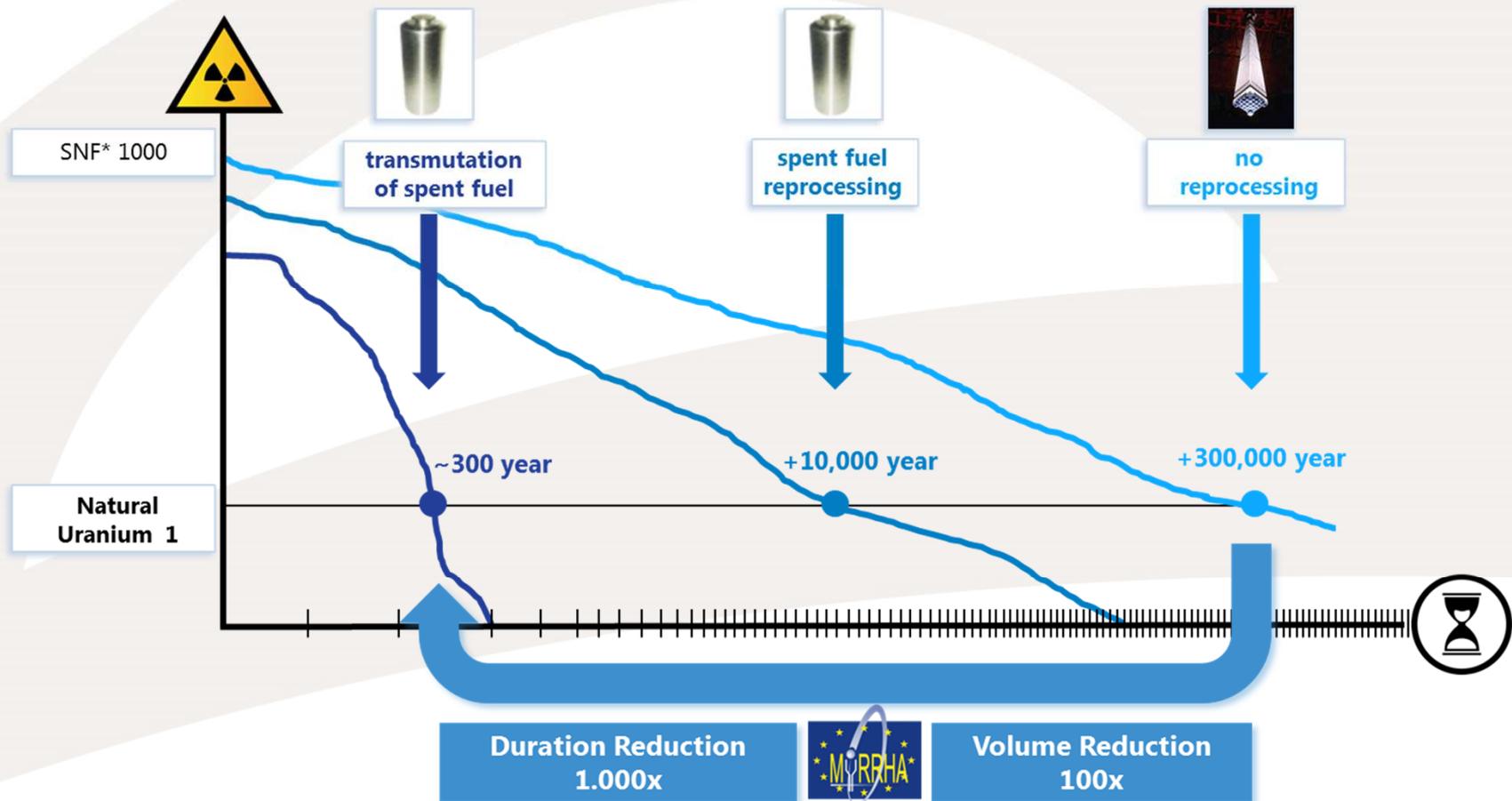


Fusion



**Fundamental
research**

MYRRHA key objective: Pre-industrial demonstrator of transmutation as viable solution for Spent Nuclear Fuel



*SNF = Spent Nuclear Fuel

- Belgium allocated 558 MEUR₂₀₁₈ for 2019 – 2038:
 - Phase 1
 - 2019 – 2026: 287 MEUR investment (CapEx) for building MINERVA (Accelerator up 100 MeV + PTF)
 - 2027 – 2038: 156 MEUR for OpEx of MINERVA
 - Phases 2-3
 - 2019 – 2026: 115 MEUR for further design, R&D and Licensing
- A stage-gate decision will be taken in 2026 whether to proceed with phases 2 and 3, either sequentially, or in parallel
- Belgium will establish an International non-profit organization (AISBL/IVZW) in charge of the MYRRHA facility for welcoming the international partners

THANK YOU FOR YOUR ATTENTION