

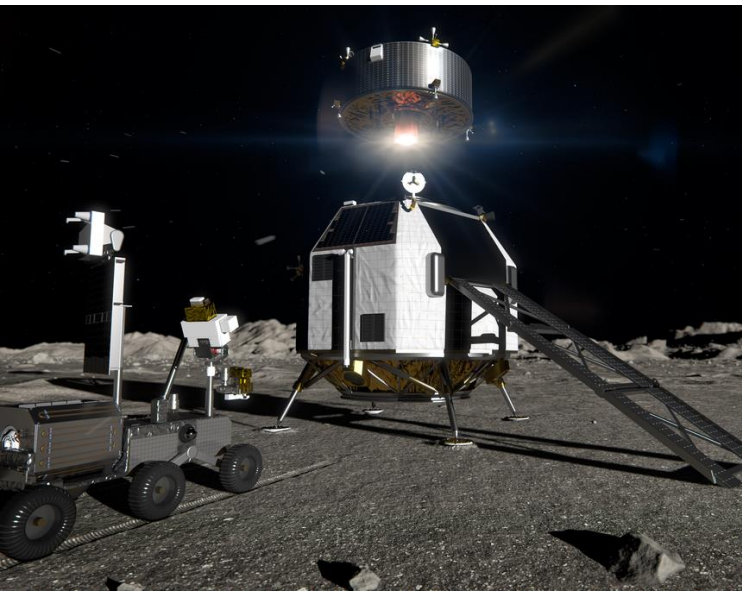


NUCLEAR  
FORUM

**.AGORIA**

# Belgian Experience, Expertise and Infrastructure in Nuclear Energy Science&Engineering : An Asset for the future Low Carbon Energy Mix

Nuclear Energy Summit  
21 March – Brussels, Belgium







TRACTEBEL



FORUM  
NUCLEAIRE

# Belgian Nuclear Industry A 70-year pioneering DNA

21 March 2024

Anicet Touré  
Head of Nuclear Strategy, Innovation and Business Development



# Belgium's world-renowned expertise

More than half of century of nuclear excellence

## NUCLEAR QUALIFIED COMPANIES



**+300**

## NUCLEAR PROFESSIONALS

**> 20,000**



## SUPPLY CHAIN



**1<sup>st</sup>**

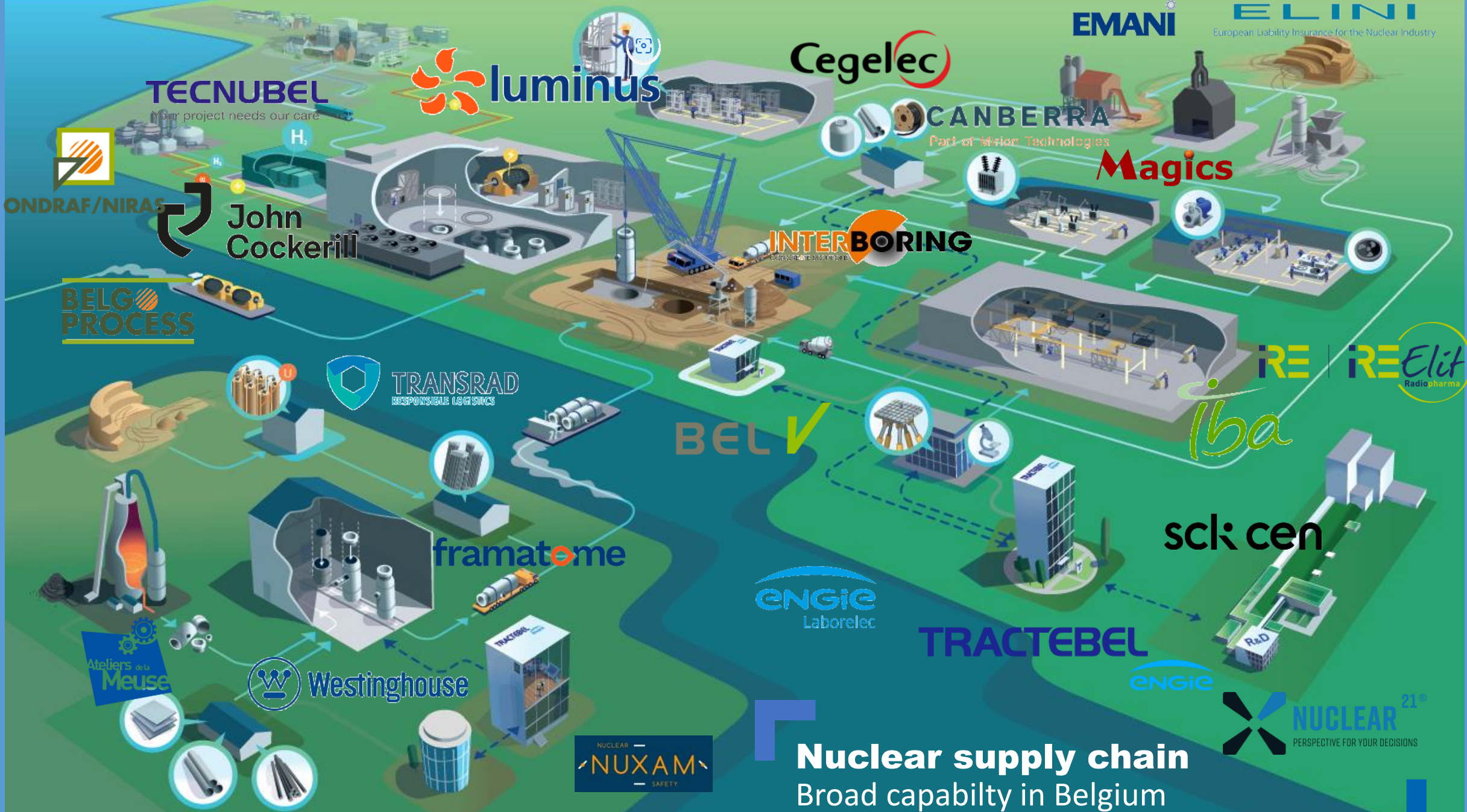


**PRESSURIZED-WATER REACTOR  
IN EUROPE**

## NUCLEAR EXPERIENCE

**> 70  
YEARS**

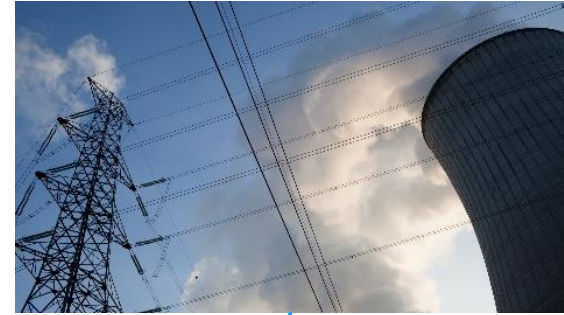




**Nuclear supply chain**  
Broad capability in Belgium



# An Everlasting Pioneering DNA



BR3 – first PWR connected to the European Grid

1969 - 1985

HADES Geological Deep Disposal prototype  
1993 - 2004

LTO G1 Containment Filtered Venting System  
2012 - 2020

2023 - 2025

Paving the way for Small Modular Reactors

1962

Construction of the 7 Belgian Nuclear Units

1980 - 1987 Steam Generator Replacement & Power Uprate

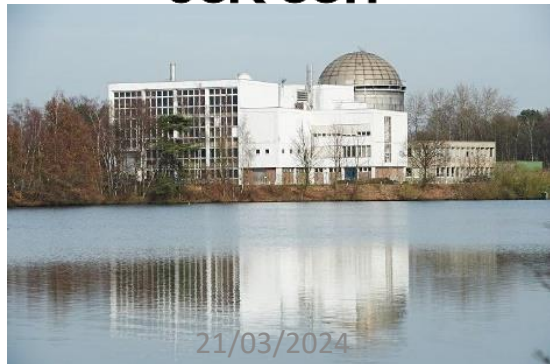
2012 - 2020

Making an LTO within 3 years

2018 - 2050+

sck cen

sck cen



21/03/2024



AEA Nuclear Energy Summit - BNS Side-Event



01/23/2024

# Lifetime extension of Tihange 3 and Doel 4

- Welcome decision for Belgian Energy Transition
- Retooling opportunity for the Belgian Nuclear Industry to prepare its future with serenity
- Real challenge because of time constraints..
- .. building on the successful experience of First LTO projects (Doel 1 & 2 and Tihange 1 conducted on time and on budget)





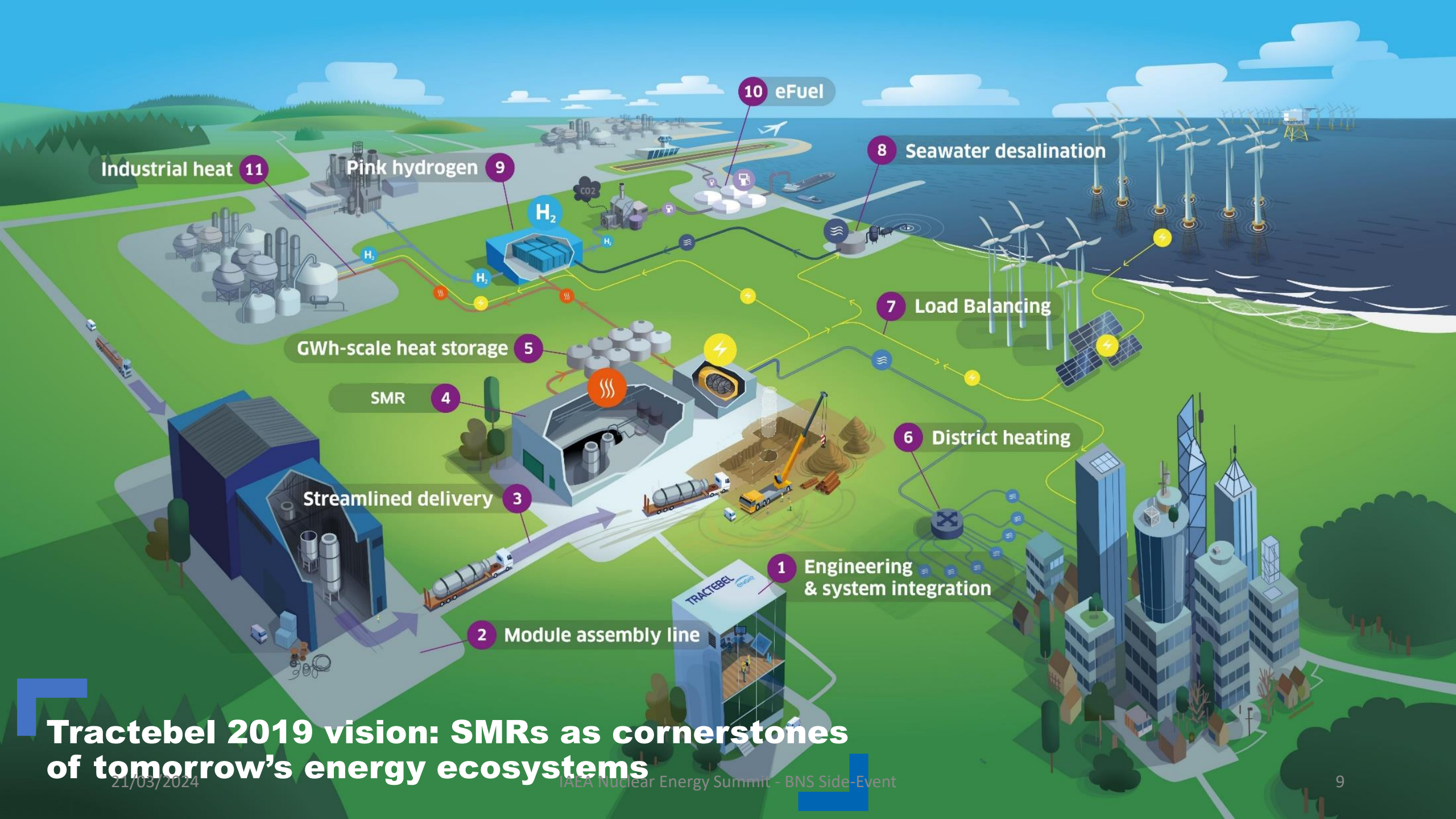
# Lifetime extension Expectations from the Safety Authorities

- FANC Requirements for LTO units published – 20<sup>th</sup> July 2023 [replaces previous Strategic Note]
  - <https://fanc.fgov.be/nl/documents/2023-07-20verwachtingen-fanc-lto-d4t3nl>
  - <https://afcn.fgov.be/fr/documents/2023-07-20approche-afcn-lto-d4t3fr>



- Specifies FANC's **final** expectations with respect to the LTO of KCD4 and CNT3 considering the evolved (political) context (= **Flex LTO**)
- Provides more time for some specific topics, e.g. implementation of design improvements ( $T_0 + 3$  years)
- **5 areas:**
  - Preconditions
  - Ageing
  - Design upgrade
  - Knowledge Competence & Behavior
  - Test & Inspections (**NEW**) compared to LTO G1





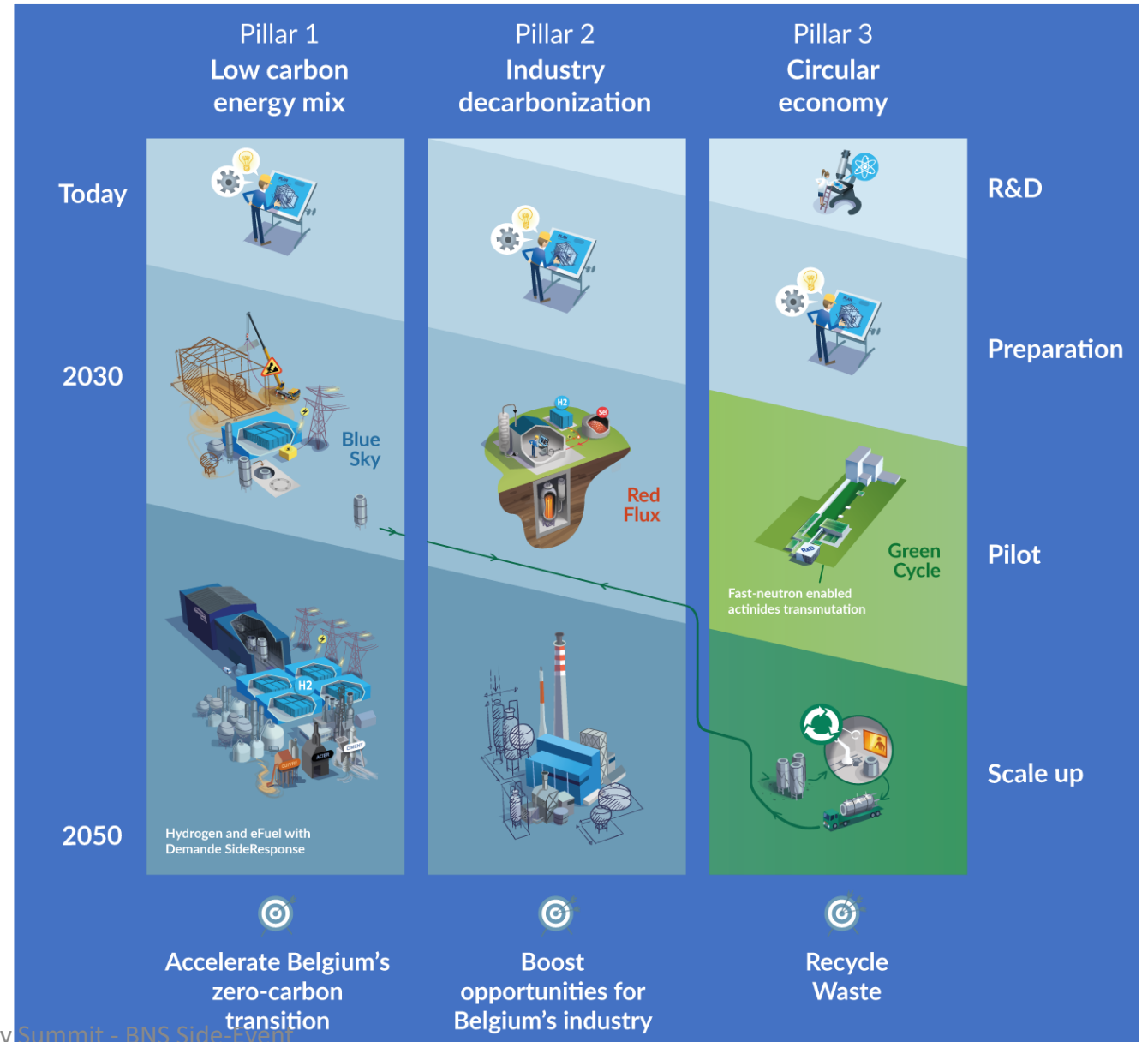
# Tractebel 2019 vision: SMRs as cornerstones of tomorrow's energy ecosystems

21/03/2024

IAEA Nuclear Energy Summit - BNS Side-Event

# Small Modular Reactors From vision...

- **Integrated vision** with all energy solutions
- **Multi-technology** approach
  - Pillar 1 – Water-cooled SMRs
  - Pillar 2 – High T° SMRs
  - Pillar 3 – Fast spectrum SMRs





# Small Modular Reactors ..to action



**ONTARIO**POWER  
GENERATION

- Leveraging our presence on First-Of-Their-Kind Project...

- .. To make it happen in the European market at large



 **nuward**  
EDF GROUP



21/03/2024

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# Engineering a carbon-neutral future







# Supply security For a better tomorrow

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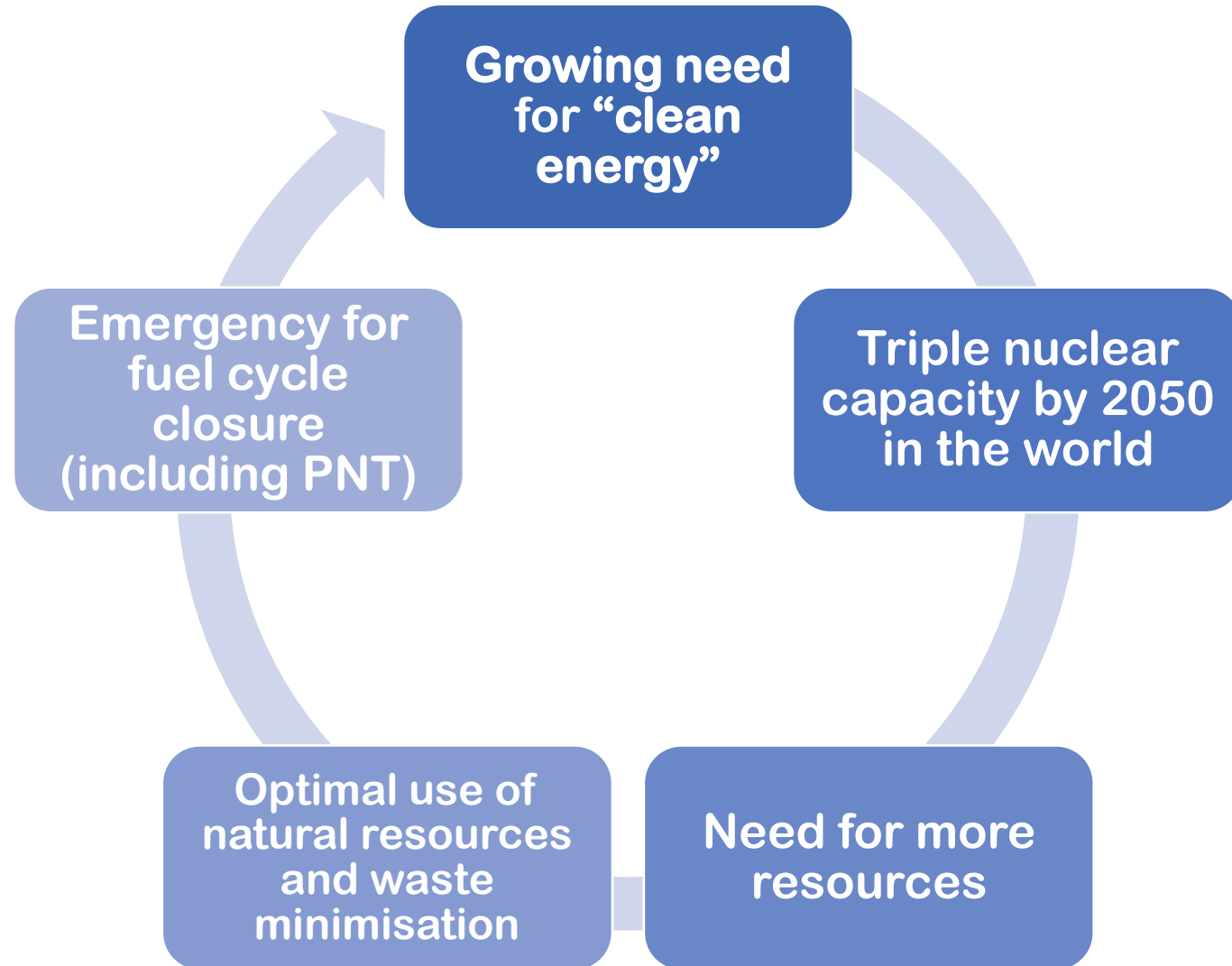
Hamid Aït Abderrahim

General Manager - MYRRHA

Rue Egmont 11, 1000 Brussels

[haa@myrrha.be](mailto:haa@myrrha.be)

# Why full recycling nuclear fuel today

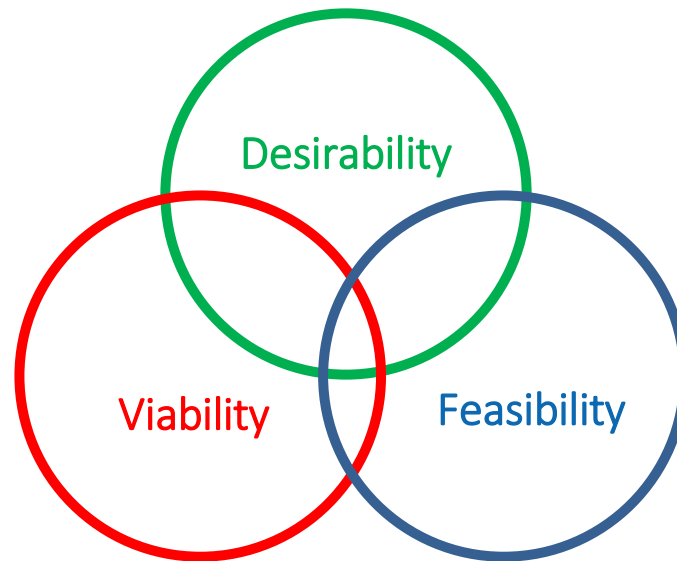




# Holistic approach thx technology maturity

## Societal aspects

- Focus on society's worries and concerns



## Economics

- Identification of the return on investment of the pre-industrial demonstration of full recycling

## Advanced technologies for full recycling

- Advanced separation technologies for used fuels from Gen II-III LWRs
- Advanced fuel fabrication and performance
- Transmutation systems: SFR, LFR, **ADS**, MSR
- Reprocessing of advanced fuel
- Advanced fuel technological aspects: transportation, cooling, and handling

# Priority actions

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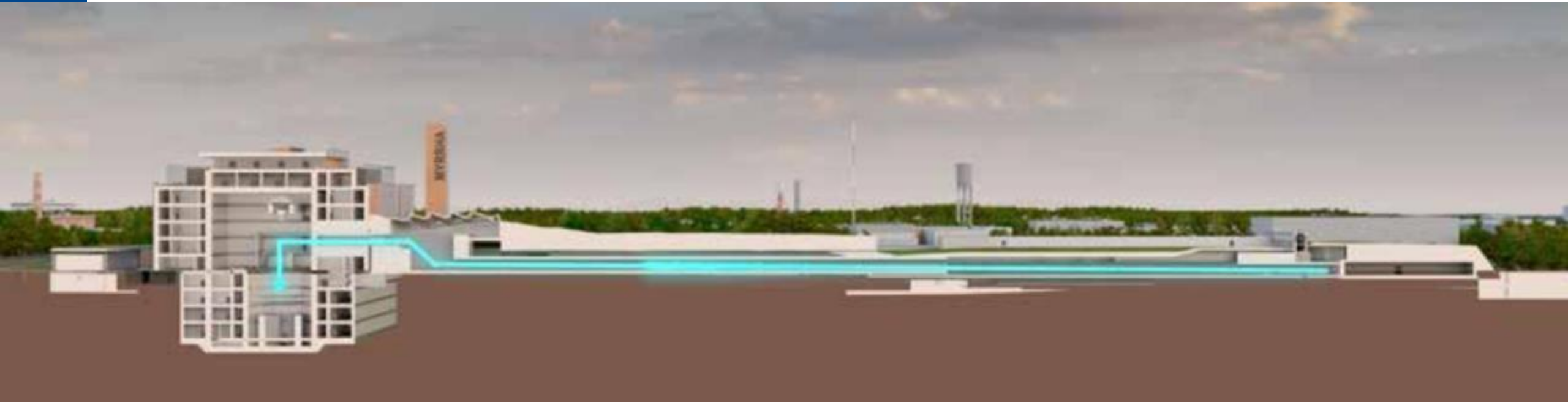
- Increase the technology maturity for **pre-industrial demonstration** and trigger **international joint projects**
- Be opportunistic and **take advantage** of existing facilities and **projects**

**industrial** advantage  
**technology**  
international **take** existing  
**projects**  
**maturity** joint  
**demonstration**

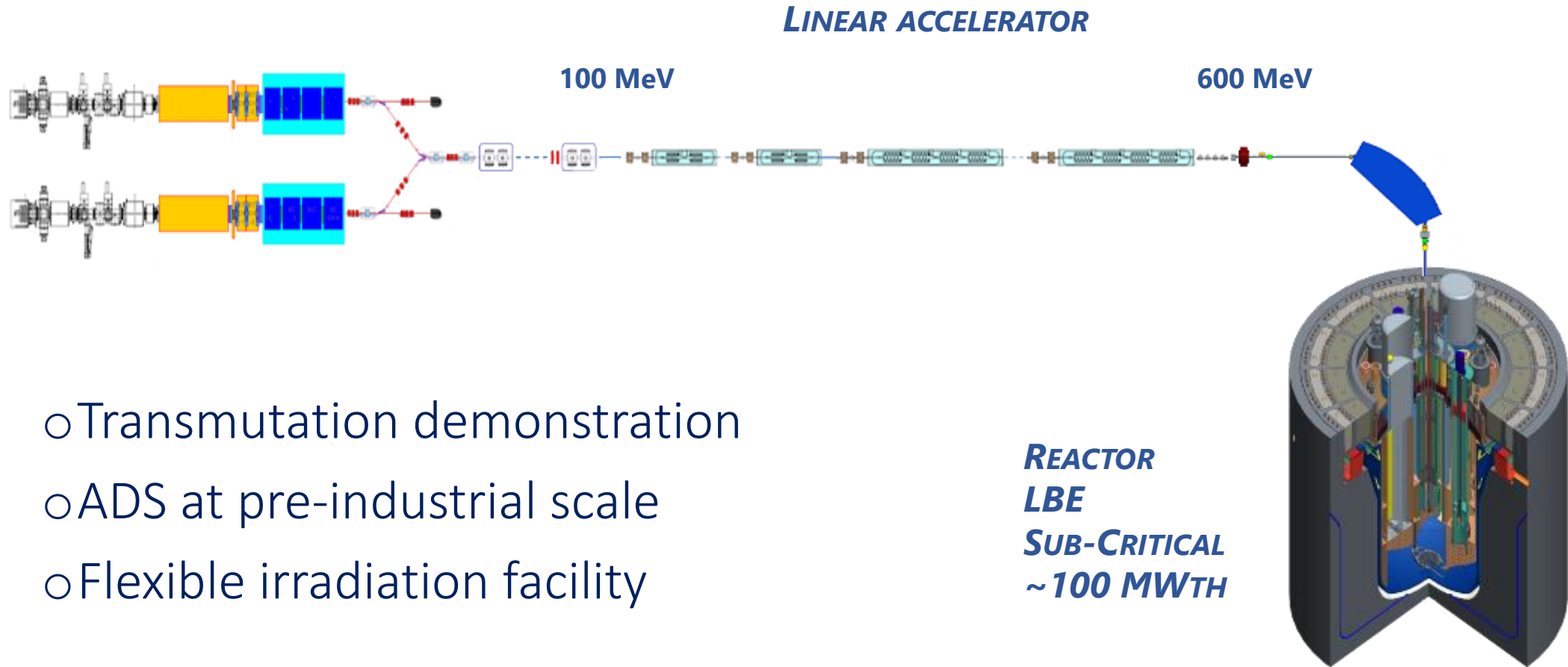


# Transmutation systems and ADS: MYRRHA

- A pan-european multipurpose research infrastructure
- A key facility contributing to energy transition



# Based on Accelerator Driven System (ADS)



- Transmutation demonstration
- ADS at pre-industrial scale
- Flexible irradiation facility



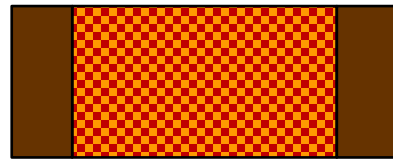
# 3 options for Minor Actinide (MA) transmutation

FR  
heterogeneous



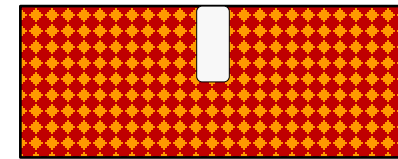
Driver fuel  
Blanket with MA

FR  
homogeneous



Fuel with MA  
Blanket

ADS



Fuel with MA

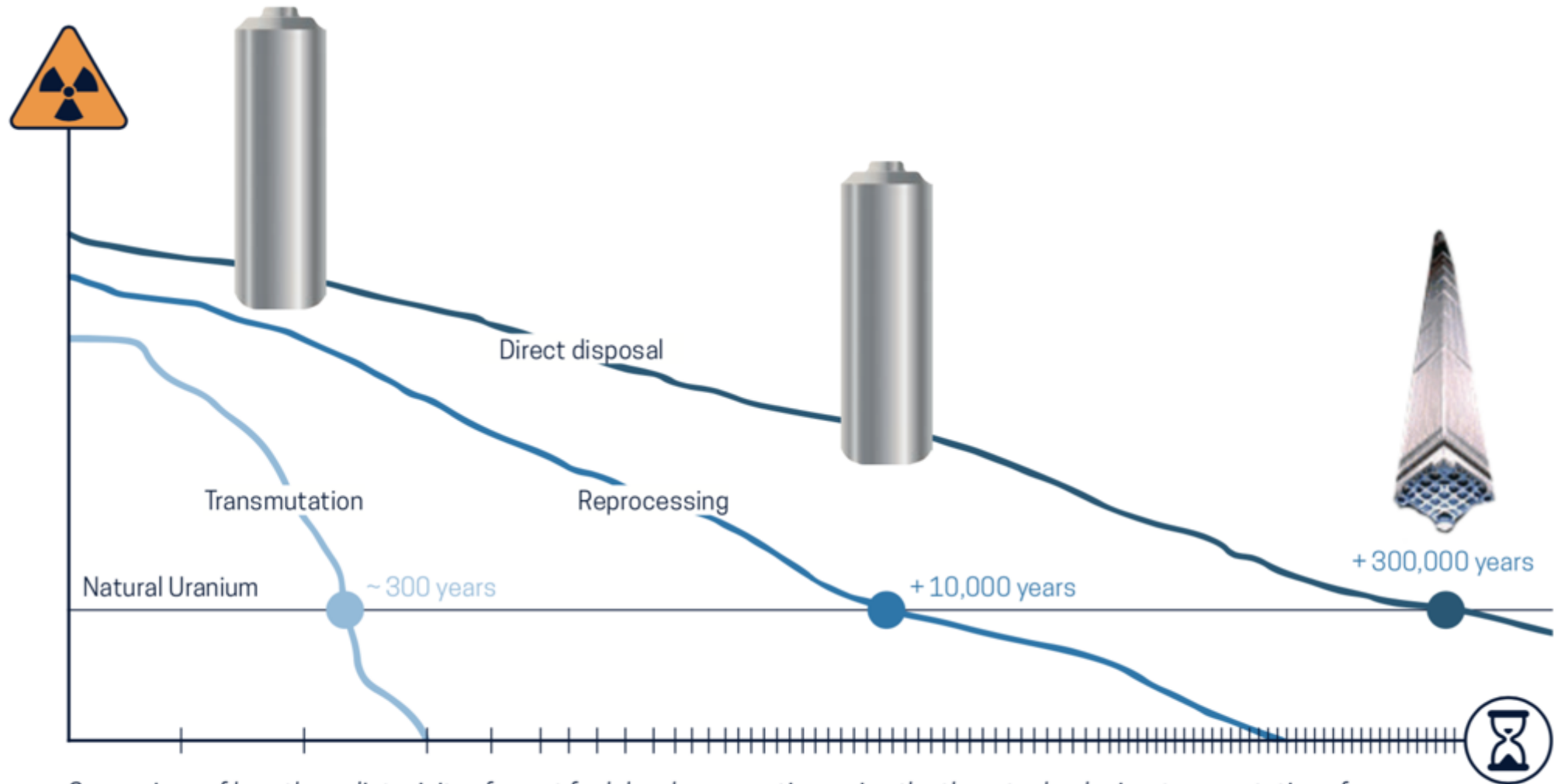
Core safety parameters limit the amount of MA that can be loaded in the critical core for transmutation, leading to transmutation rates of:

FR = 2 to 4 kg/TWh

ADS = 35 kg/TWh

**ADS performs the best for Minor Actinides burning**

# Radiotoxicity of spent fuel over time



Comparison of how the radiotoxicity of spent fuel develops over time using the three technologies: transmutation of spent fuel, current spent fuel reprocessing system, direct geological disposal without reprocessing.





# MYRRHA start construction June 2024





# MYRRHA under construction till 2036



## MYRRHA Phase 1

Construction first part of the MYRRHA linear accelerator up to 100 MeV, complemented by User Facilities.

## MYRRHA Phase 2

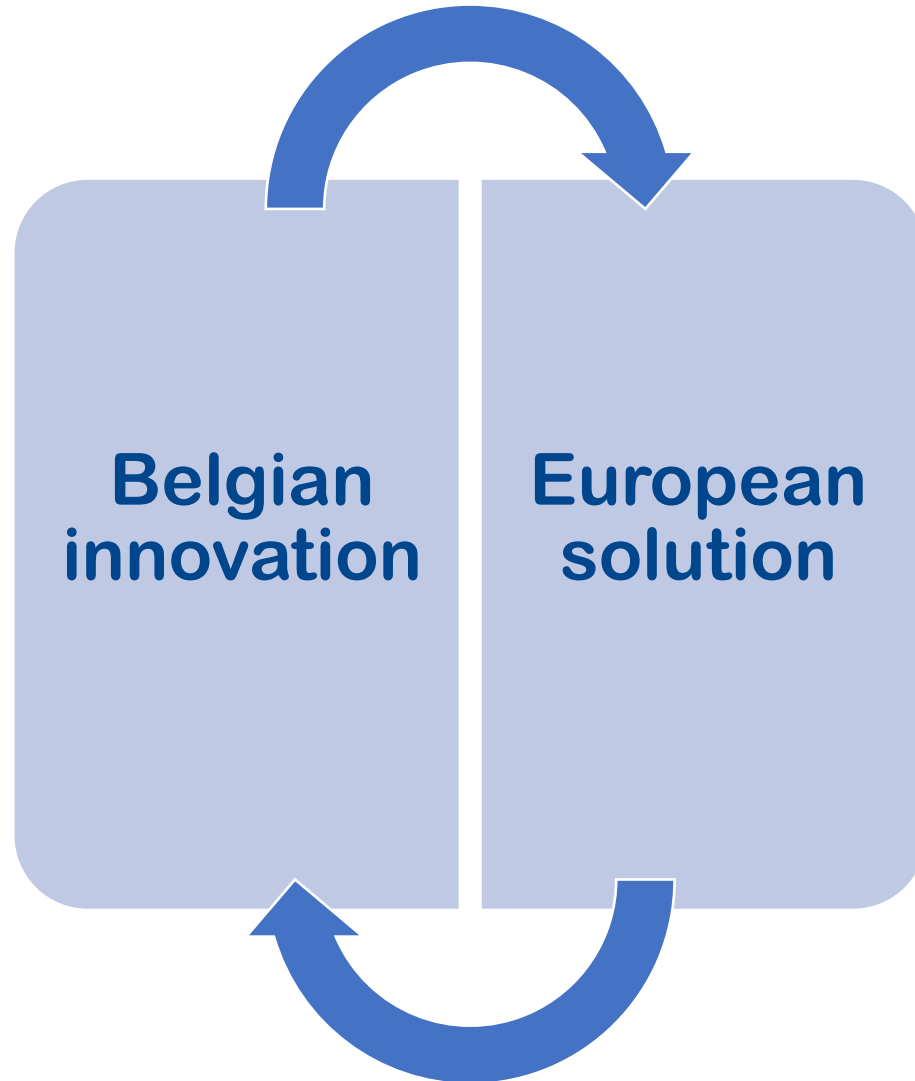
Upgrade of the MYRRHA linear accelerator from 100 MeV to 600 MeV.

## MYRRHA Phase 3

Licensing and construction of the MYRRHA nuclear reactor.



# A holistic win-win



*This win-win collaboration allows us to send a message to the general public: yes, research is concerned about finding technological solutions to society's challenges, such as managing nuclear waste."*

**Holger Podlech**, Institute of Applied Physics (IAP), Frankfurt

# Thank you



**For more information**

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myrrha.be  
hello@myrrha.be

BELV

Magics

sck cen

BELG  
PROCESS

TECNUBEL  
Your project needs our care



ONDRAF/NIRAS

TRACTEBEL

ENGIE

IRE | RE Elit  
Radiopharma

TRANSRAD  
RESPONSIBLE LOGISTICS

iba

Cegelec

NUCLEAR  
NUXAM  
SAFETY

FORUM  
NUCLEAIRE

BNS  
Belgian Nuclear Society

.AGORIA

ENGIE  
Laborelec

luminus

NUCLEAR<sup>21</sup>  
PERSPECTIVE FOR YOUR DECISIONS

INTERBORING  
CONCRETE SOLUTIONS

John  
Cockerill

framatome

Westinghouse

EMANI

ELINI CANBERRA  
European Liability Insurance for the Nuclear Industry  
Part of Mirion Technologies





**THANK YOU**