Overview of nuclear in EU with 2050 perspective

Yves Desbazeille – Director General

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About nucleareurope

We act as the voice of the European nuclear industry in energy policy discussions with EU Institutions and other key stakeholders

Membership: nucleareurope represents 15 national nuclear associations

Corporate Members:

CEZ (Czech Republic)
Fermi Energia (Estonia)
Nuvia (France)
PEJ (Poland)
Rolls-Royce SMR (UK)
Urenco (Global)
KGHM (Poland)
NAAREA (France)

What does nuclear contribute to the EU's economy?

100 Nuclear reactors in operation in the EU

1 million jobs

€ 100 billion/year

24% of the electricity Production (2024)

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The EU's needs to decarbonize are massive…across all sectors

Electricity

1600 TWh/y
EU Low carbon electricity production to be deployed by 2040

80GW
European Nuclear capacity to be replaced by 2050 (end of life)

Hydrogen

>20 Mt H_2/y
REPowerEU Market Estimate for 2030

1000 TWh/y
Equivalent additional clean electricity demand

Industrial heat

~1250 TWh_{th}/y*
Iron – Steel, Non-metallic minerals and chemicals heat demand in EU

> 45% market
Heat < 400°C

District heat

~500 TWh_{th}/y**
Current district heat demand in EU

> 2/3 fossil-fueled
Assets to be retired and replaced in the coming two decades

[European SMR pre-Partnership-WS1 Market Analysis Final Report-3 July 2023]

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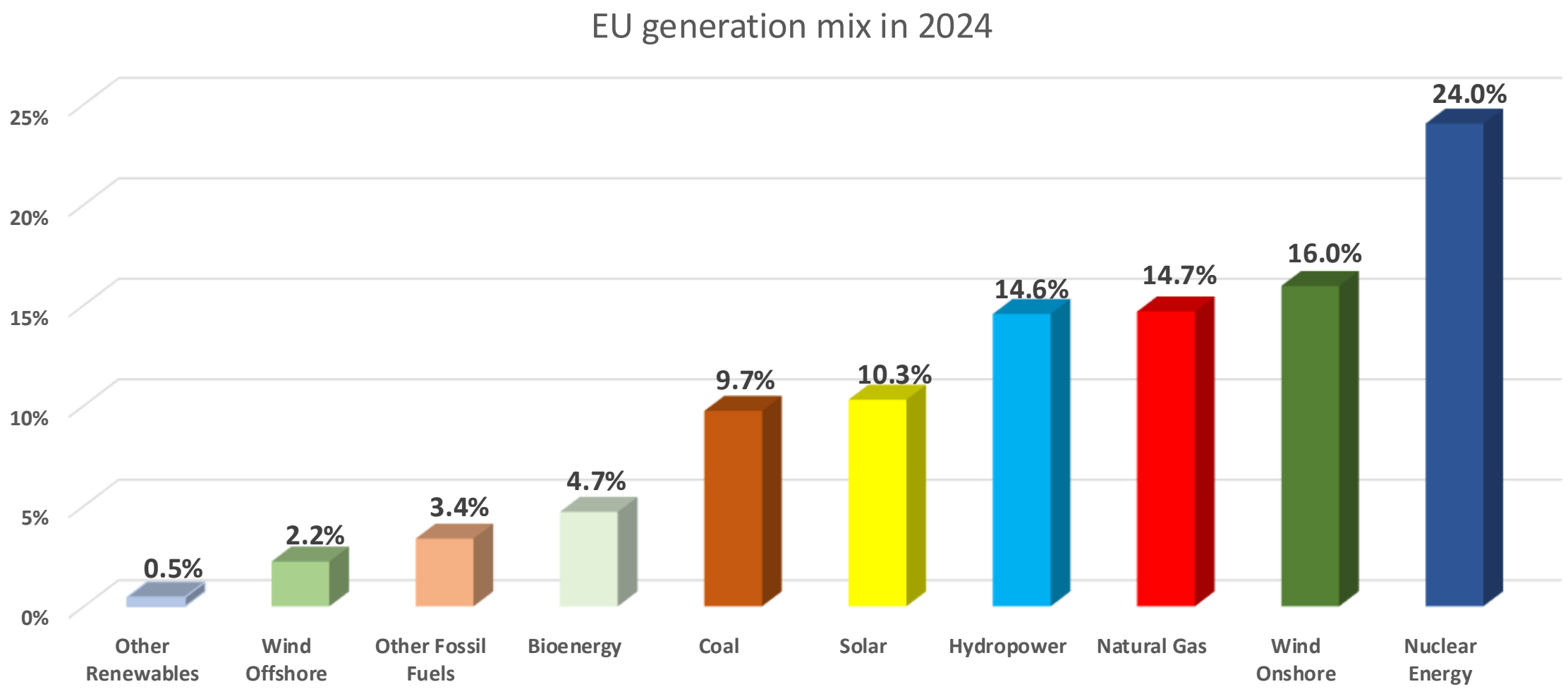
Status of EU's power sector



Source: nucleareurope calculations based on eurelectric ELDA

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Political commitment and what it entails for LTO

Meeting of the Nuclear Alliance in Paris on 16 May

- Member states participating: France, Belgium, Bulgaria, Croatia, Estonia, Finland, Hungary, Netherlands, Poland, Czech Republic, Romania, Slovenia, Slovakia and Sweden.
- Italy participated as observer and UK as invited country.
- During the meeting, a statement has been released.
- *Ministers discussed the positive impact of nuclear energy on the European economy: they acknowledged that nuclear power may provide up to 150 GW of electricity capacity by 2050 to the European Union (vs roughly 100 GW today)*

Photo by @Paul_Messad @EURACTIV_FR

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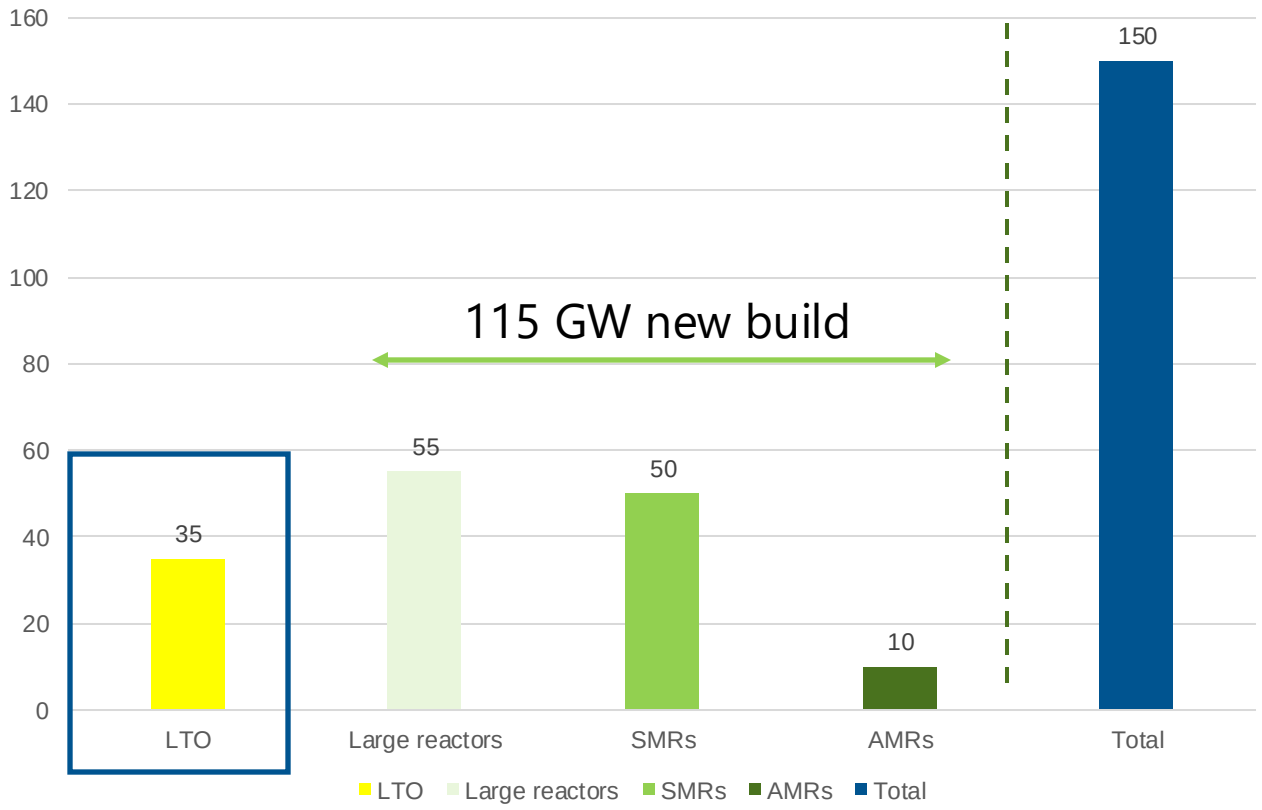
An increased ambition for a European nuclear future

The latest EC scenarios updates from the projected share of nuclear show a steady decrease despite the obvious benefits that a significantly higher scenario provides to the EU system in a deep decarbonization scenario.

Based on this, nucleareurope promotes an upscaled scenario of at least 150 GW* capacity in 2050

This scenario requires:

- The current share of 25% electricity production to be maintained in the EU.
- Part of the needs from hard-to-abate heavy industries in terms of decarbonized heat, hydrogen, etc. to be covered by SMRs (from early 2030s) and AMRs later on (from 2040s).
- Mobilization of industry and decisionmakers both at EU & national levels



*Aggregated figure based on recent national intentions / declarations

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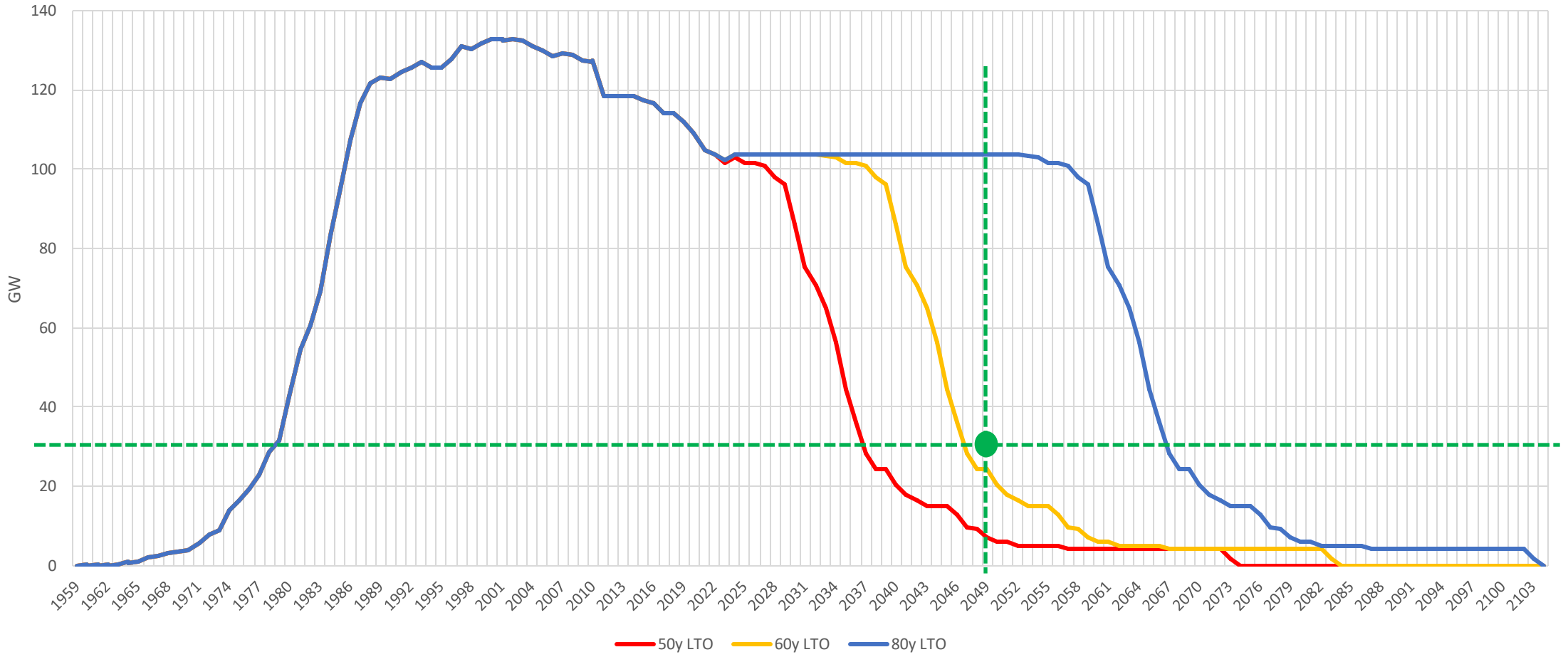
Lifetime extension scenarios of the existing fleet



nucleareurope chart based on IAEA PRIS database

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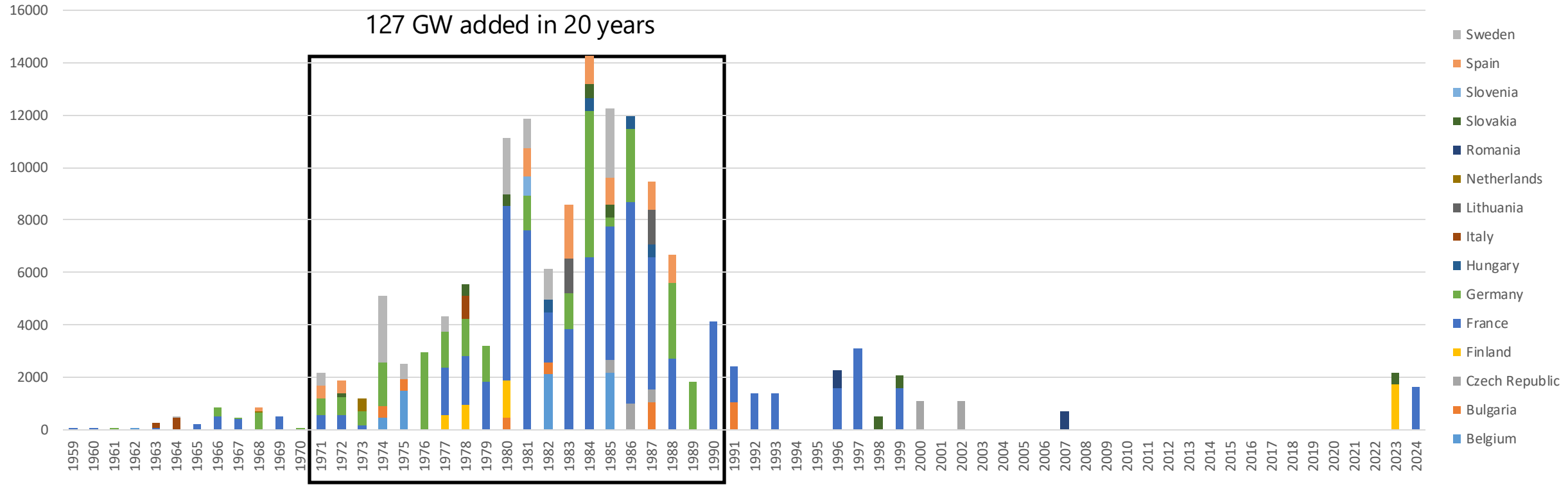
History of EU's nuclear fleet deployment



nucleareurope chart based on [IAEA PRIS database]

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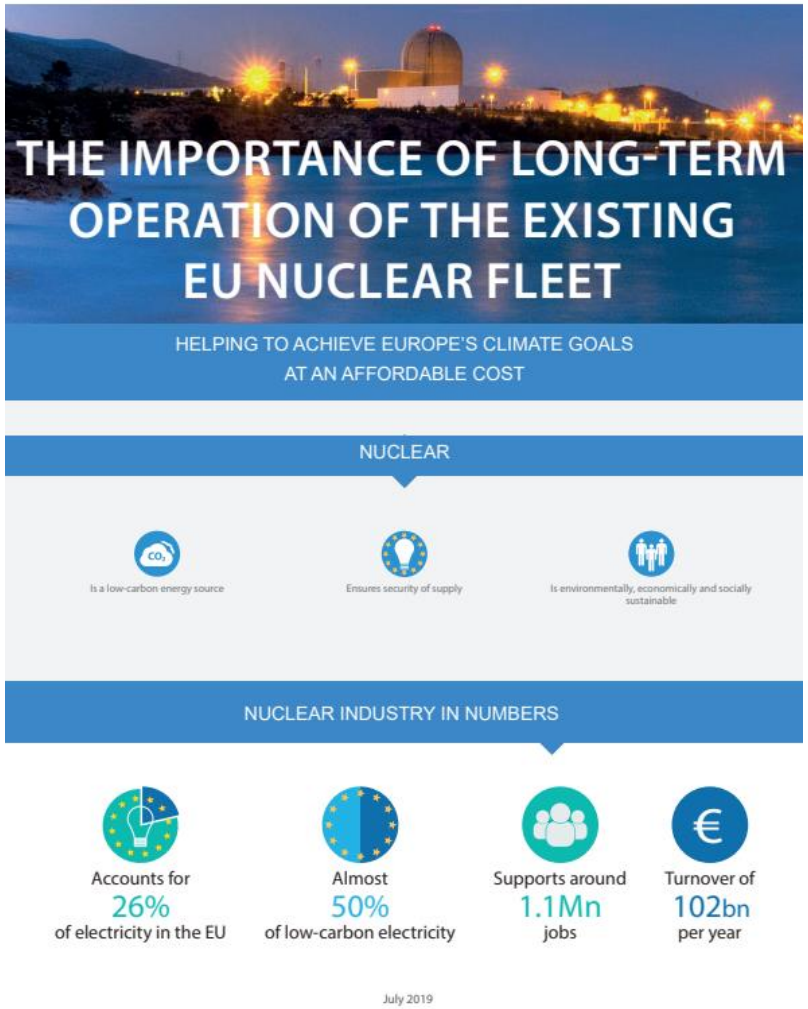
The main challenges of LTO in Europe

LTO of NPP: an important topic for nucleareurope for a long time



- Position paper released in July 2019
- All the points made in the position paper are still valid:

• *LTO is unarguably economically advantageous compared to other power sources. It requires a much lower capital investment cost, leading to low investment risks for investors and capital markets, and lower consumer costs.*

• *From a technical point of view, the LTO of nuclear reactors provides a great advantage thanks to the "…timely implementation of reasonably practicable safety improvements to existing nuclear installations" which brings older generation reactors to a level of nuclear safety standards in compliance with the amended Nuclear Safety Directive.*

• *LTO reduces the EU's energy import dependency – mainly fossil fuels – and provides reliability to the grid.*

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Challenges for the lifetime extension of the existing reactors

Challange	Example of challenge	Mitigation
Aging Infrastructure	Many components of nuclear power plants, such as reactors and cooling systems, degrade over time. Ensuring these components can continue to operate safely and efficiently requires extensive maintenance and upgrades	Good opportunity on research on aging materials
Regulatory Compliance	Extending the life of a nuclear plant often requires approval from regulatory bodies, which involves rigorous safety assessments and compliance with updated safety standards	Brings older generation reactors to a level of nuclear safety standards in compliance with NSD
Technological Upgrades	As technology advances, older plants may need to be retrofitted with modern systems to improve safety, efficiency, and reliability. This can be both technically challenging and costly	Same as above
Economic Viability	The cost of extending the life of a nuclear power plant can be substantial. Operators must weigh these costs against the potential benefits, such as continued energy production and reduced carbon emissions	With the initial capital investments costs amortised, the investments for lifetime extension are much lower
Supply Chain Issues	Procuring replacement parts for older plants can be difficult, especially if the original manufacturers are no longer in business	3D printing, digital twins, reverse engineering among other possibilities
Knowledge Transfer	As the workforce ages, there is a risk of losing valuable expertise. Ensuring that knowledge is transferred to newer generations of engineers and technicians is crucial for the continued safe operation of extended-life plants	Competences assessed under Euratom funded projects as ENEN+, ANNETT, ENEN++,Skills for Nuclear

LTO of NPP: Espoo convention and Impact assessment

IAEA definition on LTO *"Operation beyond an established time frame defined by the licence term, the original plant design, relevant standards or national regulations." (IAEA, 2018).*

- With the adoption and entering into force of the Convention on Environmental Impact Assessment in a Transboundary Context ("Espoo Convention"-All EU Member States are contracting parties of), it must be determined whether the LTO of NPP falls under its scope of application, rising international obligations.
- Appendix I of the Espoo Convention includes nuclear activities in their scope of application, but **no direct mention to LTO** as part of the proposed activities. Therefore, a **legal determination must be made**.
- At the beginning no Environmental Impact Assessments (EIA) for the LTO of NPP was foreseen but it changed following the discussions/conclusions of UNECE guidance in 2020.

Article 41 of the Euratom Treaty and LTO of NPP

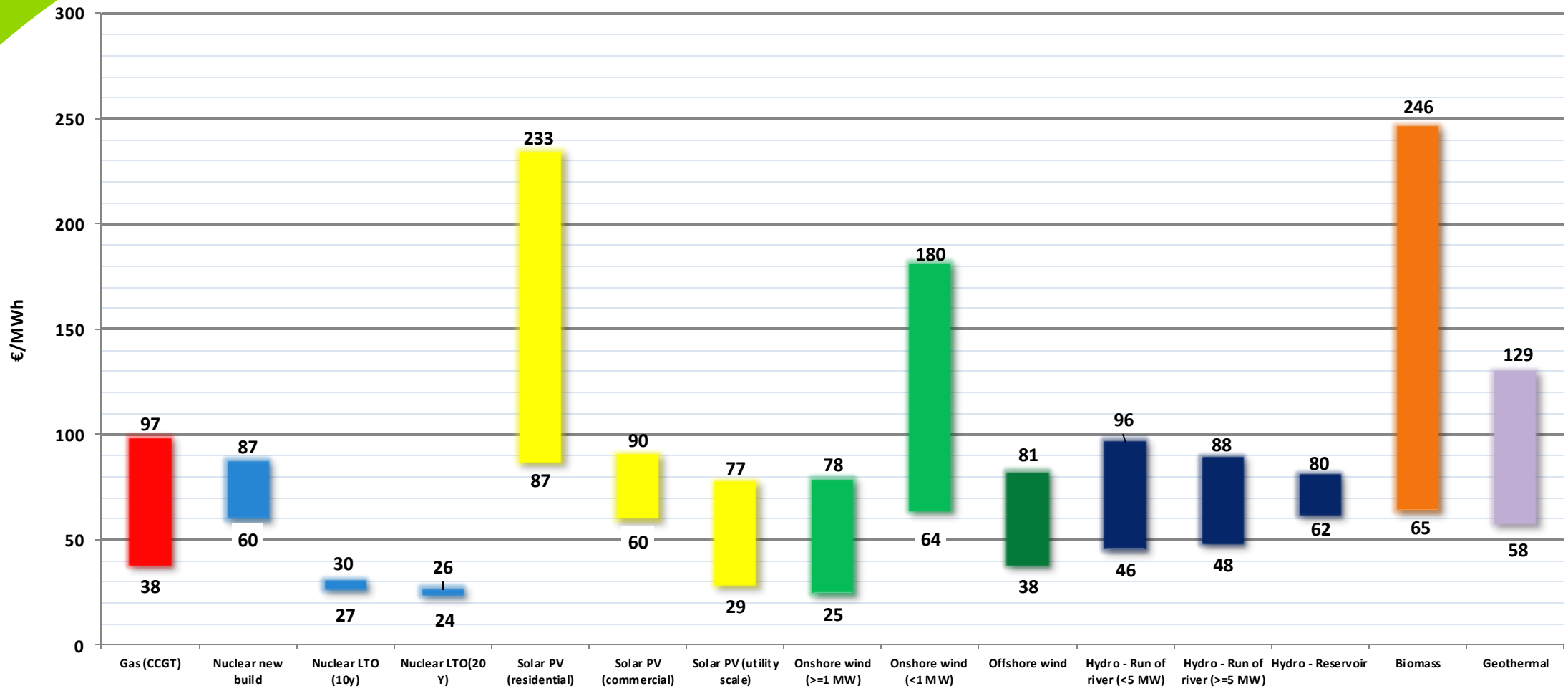
Art 41 of the Euratom Treaty requires nuclear undertakings to notify the European Commission about investment projects. This covers new investments and significant modifications to nuclear installations, **including projects related to the LTO of NPP.**

Article 41

"Persons and undertakings engaged in the industrial activities (…) shall communicate to the Commission investment projects relating to new installations and also to replacements or conversions which fulfil the criteria (…)"

The goal of this notification is to provide visibility and ensure full transparency in nuclear investment projects, uphold regulatory compliance, and verify that the notified projects adhere to safety standards, all while reinforcing energy security across the EU.

LCOE for LTO is very competitive



Comparison of LCOE (levelized cost of electricity) for different technologies in Europe (7% discount rate)
Source: IEA report on "Projected Costs of Generating Electricity 2020"

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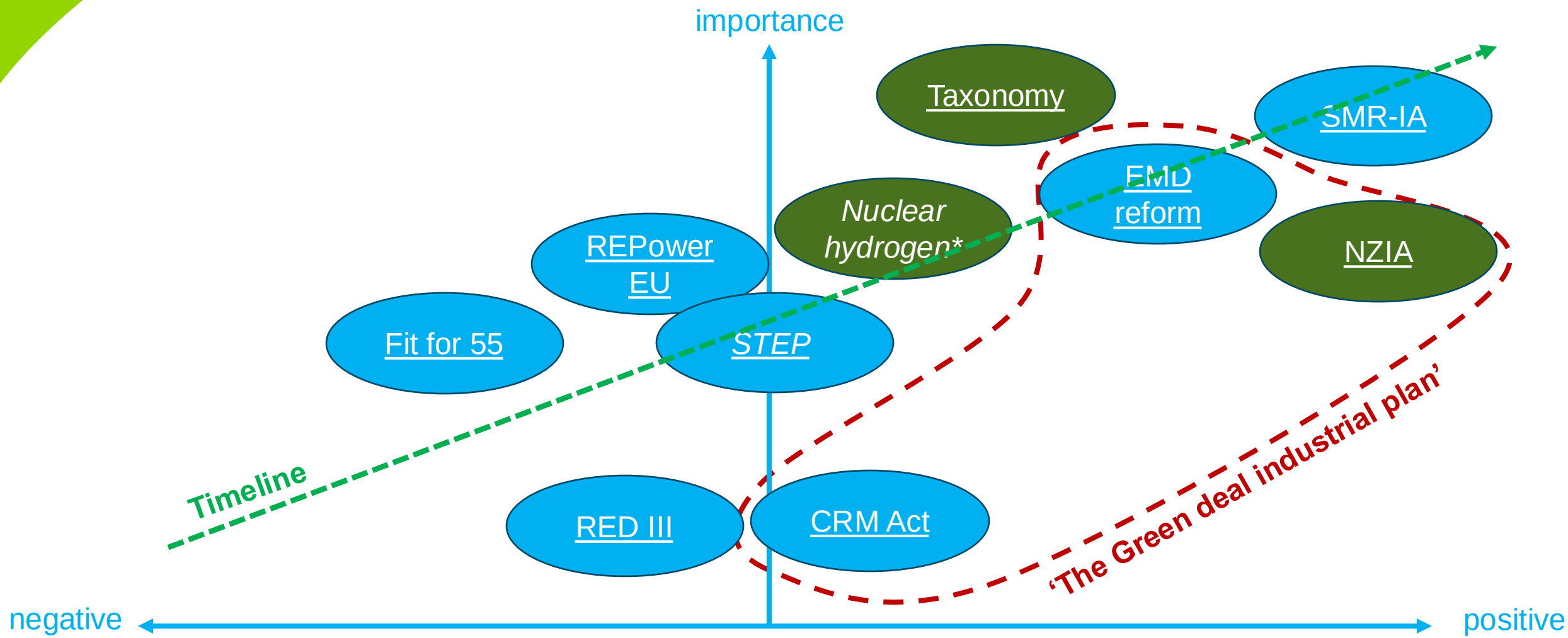
EU policies and initiatives: state of play for nuclear



Files with impact on nuclear sector

Files with impact on nuclear sector and LTO in particular

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*Ongoing file

Transformation challenges of EU nuclear Supply chain

	Long term operation	New large reactors	SMR	Gen IV / AMR
Main challenges	• Component availability • Knowledge management • On site constraints (RP, Sched., co-interv.)	• Big components manufacturing • On site constraints (co-interv., interfaces,…) • Civil works complexity • Project management	• Engineering • Licensing • Modularity management • Manufacturing engineering & implem. • Serial production & standardization	• Engineering • Licensing • Hi degree of components / material / system innovation needs • Manufacturing for dedicated components / needs
SC structure adaptation	Good	Fair (depends on countries)	Mild	Poor
Digital challenges	• 3D modelling • Digital twins • Augmented reality • 3D printing	• 3D modelling • Collaborative platforms • Dynamic construction simulation tools • Additive Manufacturing	• Ditto Gen III+ • 'Industry 5.0' incl. robotics, prod. Management	• Ditto SMR • TBD
Other challenges	• Commercial grade items • SC capacities / availability in some MSs • Fuel supply: enrichmt/ conversion capacities • R&D on component aging	• Serial effect on construction • Component production capacity ramping up • Fuel supply: ditto	• SC Standardization at EU level • Utilization of C&Ss • Manufactory capacity ramping up • Fuel supply: ditto	• TBD • Fuel supply: potential availability issue of new / "exotic" fuel needs
HR	• Adapted but aging	• New staff needed (replact & reinforcemt) • Specific issues (welders…)	• Ditto Gen III+ • Reskilling / upskilling for manufacturing	• High level of dedicated expertise • Skills scarcity (Research…)

Conclusions

Despite all the identified challenges, many Member States considered lifetime extension of the existing nuclear reactors as an opportunity as it can:

- Provide electricity produced at very competitive prices
- Help to preserve the supply chain knowledge and capabilities
- Maintain and prepare the workforce for the expected new nuclear build campaign

This can materialized if the technical and economical challenges are properly addressed by the industry and policy makers


Thank you!
Andrei Goicea (andrei.goicea@nuclearеurope.eu)
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