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EEB European Environmental Bureau

NTW NUCLEAR TRANSPARENCY WATCH

GUE/NGL THE LEFT IN THE EUROPEAN PARLIAMENT

Conference

Status and prospects of nuclear energy in Europe

Managing nuclear risks in energy transition scenarios

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Nuclear energy in Europe
and civil society

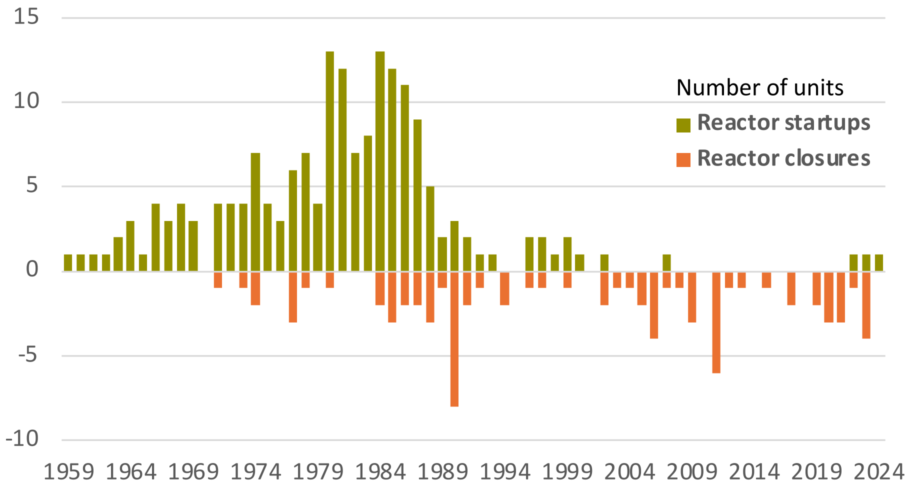
European Parliament and online, 17 October 2024

Hosted by Dario Tamburrano, MEP - The Left

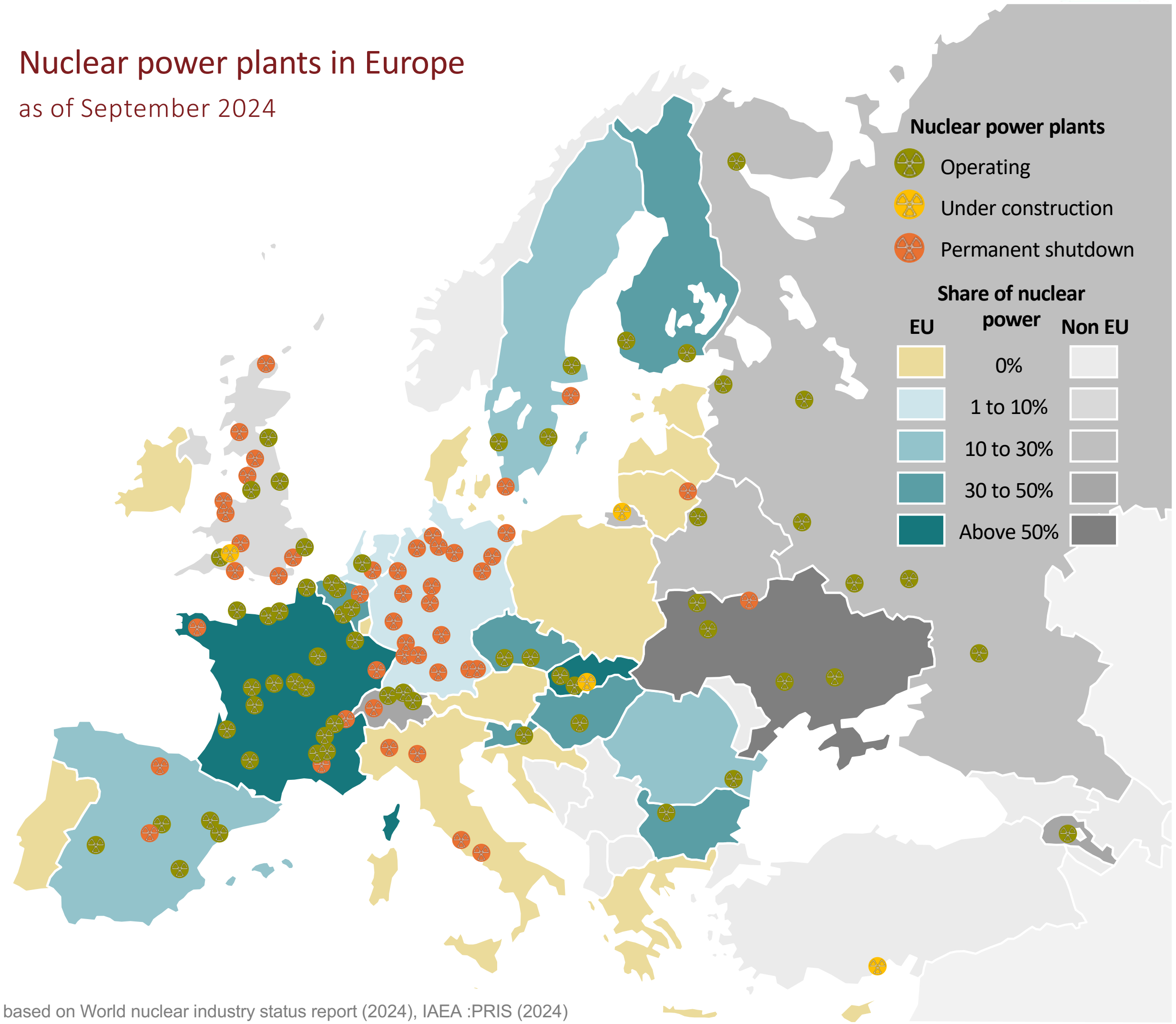
Current status

Nuclear power plants in EU-27:

- 100 operating units
  + 1 starting (Flamanville-3, France)
- 1 unit under construction (Mochovce-4, Slovakia)
- 77 reactors in permanent shutdown
- Since 2000: 5 reactor startups,
  including 2 reactor construction starts
  (Olkiluoto-3, Finland; Flamanville-3)
  39 reactor closures



Nuclear power plants in Europe
as of September 2024



Source: Institut négaWatt, based on World nuclear industry status report (2024), IAEA :PRIS (2024)

Perceived dynamics

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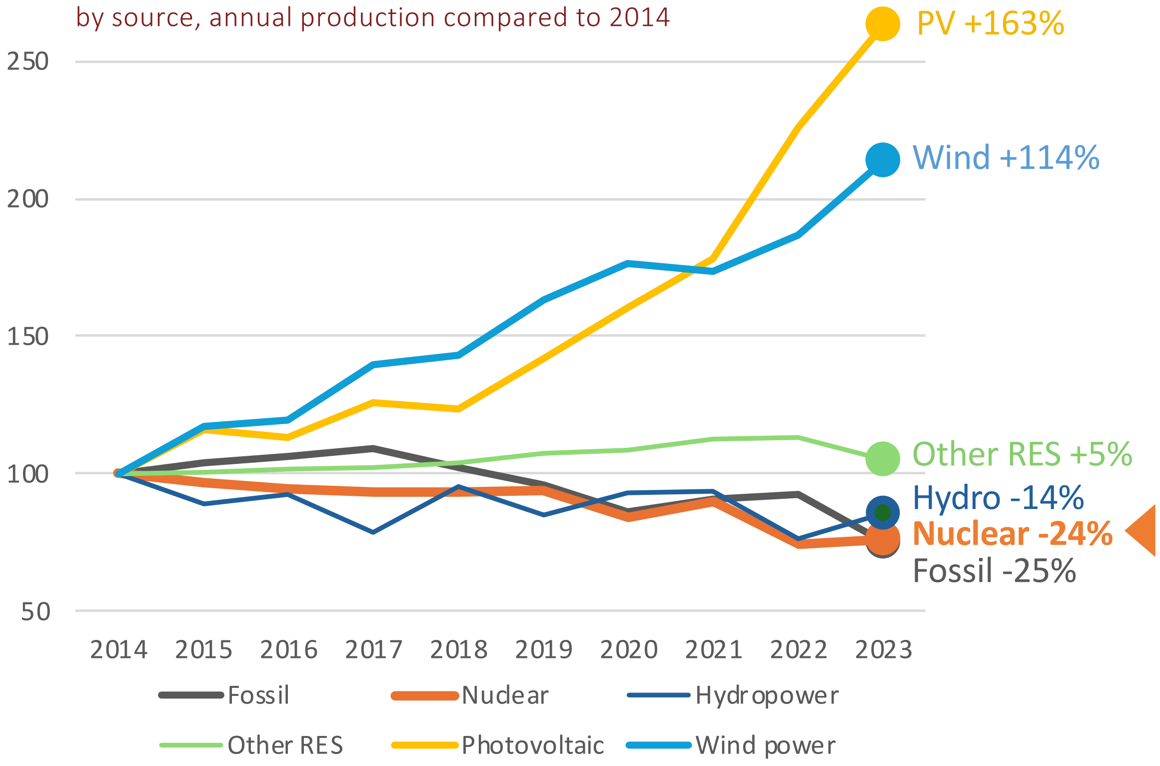
Evolution of power generation in the EU-27

by source, annual production compared to 2014



(en TWh)	Fossil	Nuclear	Hydro.	Other RES	PV	Wind
2014	1 174	812	370	151	93	222
2023	880	619	317	159	245	475
Variation 2014-2023	*-294*	*-193*	*-53*	*+8*	*+152*	*+253*

Source: Institut négaWatt, based on Ember (2024)

Main evolutions:

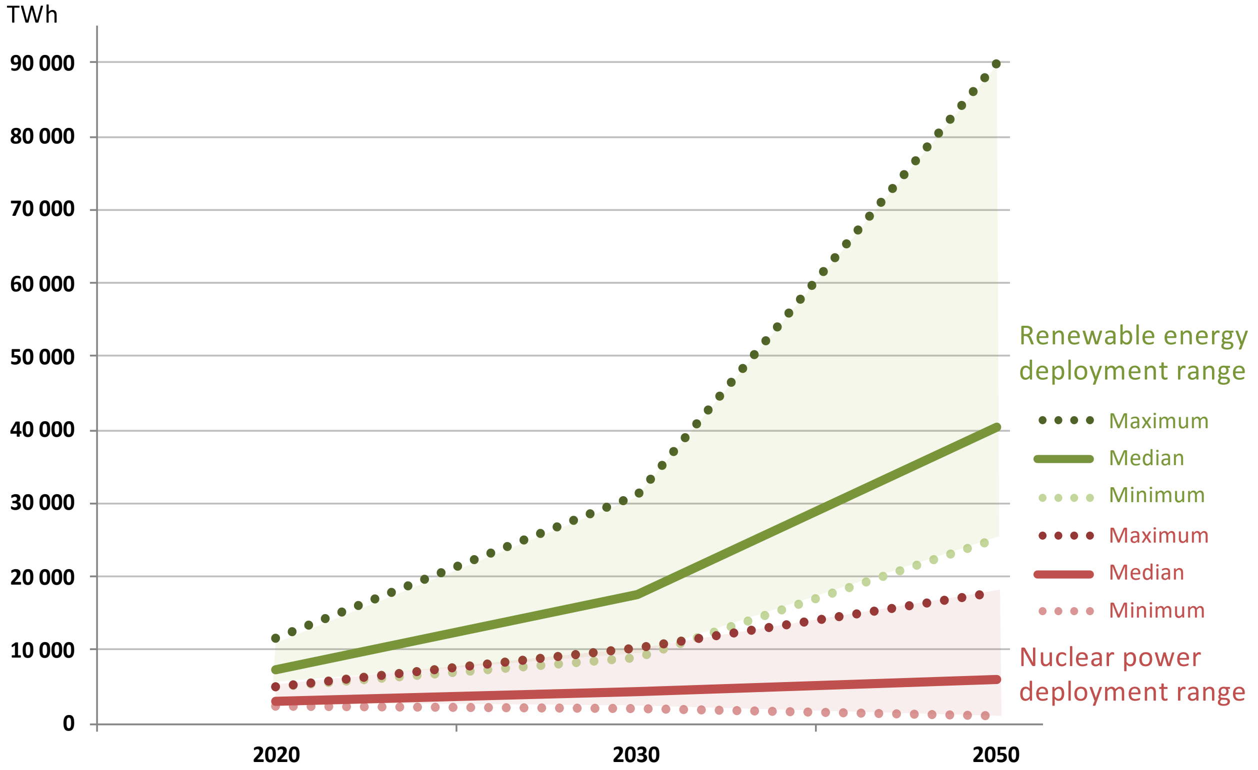
- Fast growth of renewables,
  slow decrease of nuclear power output
- Ageing of the fleet: **38,4 years of operation** on average for reactors operating in EU-27
- Considerable delays and additionnal costs for nuclear projects
  Ex. Flamanville-3: €12bn additional, 12 years delay

Main positions:

- Binding EU objective of 42.5% renewables in energy consumption by 2030
- **European nuclear alliance**, led by France:
  11 nuclear Member States + 4 non nuclear
  (BE, BG, FI, FR, HU, NL, CS, RO, SK, SL, SV + HR, ET, IT, PL)
  Objective: x 1.5 EU nuclear capacity by 2050
- European Industrial Alliance on Small Modular Reactors (SMRs) set by the European Commission
- 12 Member States non committed or opposed

Net-zero strategies

Projected nuclear and renewable electric generation in the world
in scenarios meeting 1.5°C objective with no overshoot



Source : Association négaWatt, based on IPCC (2018), 1.5°C Special Report

Main lessons from IPCC:

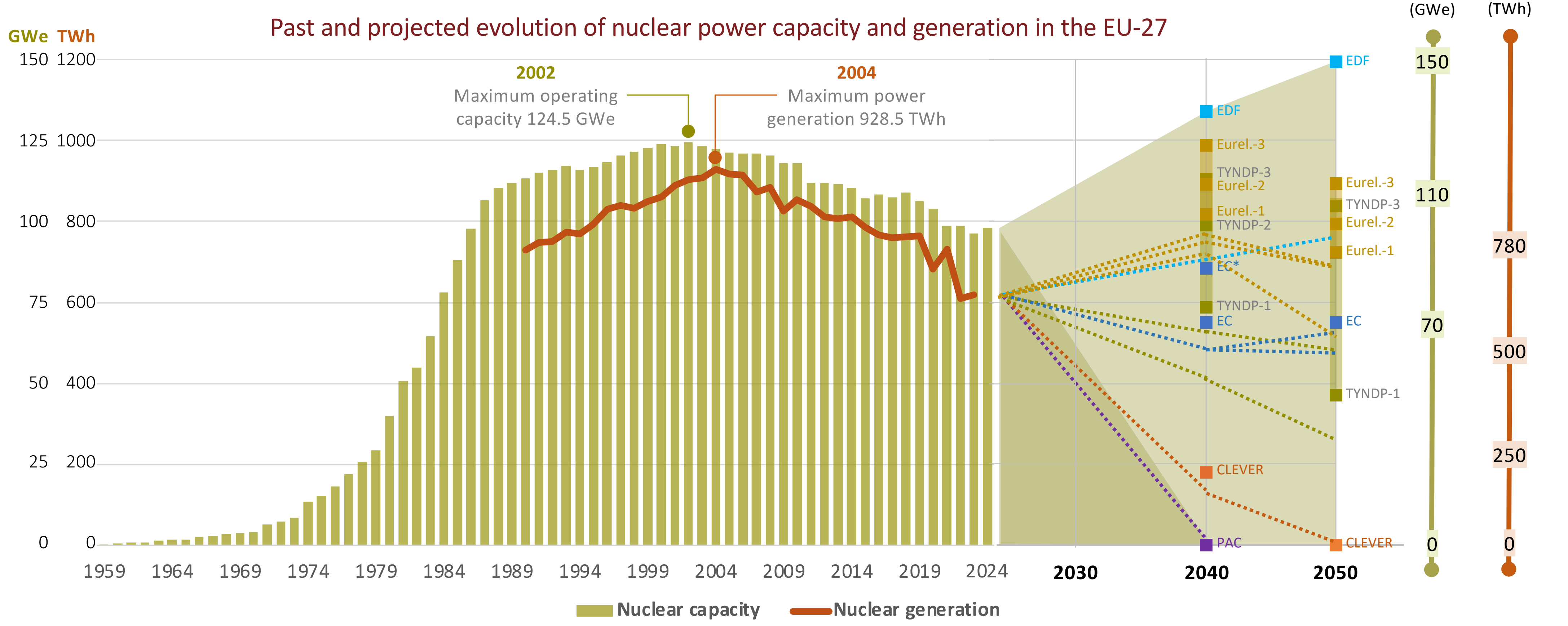
- Demand-side is an important factor
- Electrification through low-carbon power is key for energy supply
- Massive growth of renewables is central, additional nuclear power is an option
- Growing evidence of the technical feasibility and economic relevance of high penetration of renewables, though non fully conclusive yet

Share of nuclear power in electric generation (2023)	
World	9.2%
EU-27	22.6%

▶ As the most nuclearized region in the world, EU-27 has specific questions to deal with on the role of nuclear in net-zero strategies

Past trend and projected scenarios

- Low carbon / net zero scenarios for 2040-2050 range from a strong restart to no replacement and/or life extension



Source: Institut négaWatt; past data: based on World Nuclear Industry Status Report (2024), with IAEA-PRIS (2024); projections based on data and estimates from EDF (2024), Eurelectric (2024), Entso-e & Entso-g (2024), European Commission (2024), négaWatt (2023), CAN-Europe (2024).

Contrasted visions re. nuclear needs

		A Steady revival		B Timed decline		C Natural extinction	
	2023	2040	2050	2040	2050	2040	2050
Nuclear capacity (GWe)	97	120-130	140-150	70-80	50-70	25-30	0
Nuclear output (TWh)	619	700-750	780-800	250-500	250-500	135-145	0
Electric demand (TWh)	2,700	5,000-6,000	6,000-7,000	4,600-5,200	6,000-7,000	4,200-4,700	4,500-5,000
Nuclear - Wind+PV shares	23% - 26,6%	20% - 60%	15% - 80%	10% - 70%	10% - 90%	5% - 95%	~0% - ~100%
Example		**EDF scenario**		**EC scenario – S3**		**CLEVER scenario**	
Electric narrative		High electrification, nuclear power used as dispatchable, load following source		Strong electrification, nuclear power rather used as baseload, with a limited share		Electrification combined with efficiency and sufficiency, shifting to 100% renewables	
Nuclear narrative		Existing nuclear capacity extended up to 60 years, but only accounts for 15% of capacity needed in 2050		Life extention of existing capacity and the development of new reactors follow current stated policies		Nuclear capacity is shut down along progress with demand-side and renewables, up to 2050	
Life extension of reactors (PLEX)		Life extension to 60 years of most of the existing fleet, 80 years for a large share of it		Life extension of existing reactors to 50 years is foreseen, and to 60 years for some of them		No life extension beyond 50 years is needed	
New reactors		Between 60 GWe and 130 GWe of new capacity needed (depending on post 60 years PLEX), both large units and numerous SMRs		About 50 new large units are needed by 2050 to replace closed reactors A moderate number of SMRs are introduced, starting in 2030		No new reactors of any type are needed	

- Depending on the strategy, different pressures are exerted on nuclear issues at different timescales

Nuclear risk management

- Nuclear trajectories arising from contrasted scenarios come with different **challenges** and **requirements**
  Nuclear **objectives** and **capacities**, and their **adequacy** need to be questioned from a risk management perspective

"EDF is like a cyclist who has to ***pedal not to fall****"*
Public hearing by an enquiry committee of the National Assembly, 7 June 2018

by ïoO
Jean-Bernard Lévy
CEO of EDF, 2014-2022

"A ***Marshall plan*** *is needed to revive the nuclear industry"*
Public hearing at the National Assembly, 14 September 2022

Objectives are needed to sustain capacities…

What if this falls short… ?

Capacities are needed to meet objectives…

"We need to get back on track with the ***great adventure*** *of civil nuclear power in France"*
Speech in Belfort, 10 February 2022

- Life extension to 60 years
- From 6 to 14 new EPR2 reactors
- 1 Nuward Small modular reactor
- 1 prototype micro modular reactor

by ïoO
Emmanuel Macron
French President, 2017-…

by ïoO
Bernard Doroszczuk
President of ASN, 2018- …

"If the nuclear choices are confirmed, the industry and public authorities will have to put in place a real Marshall Plan to make this prospect ***industrially sustainable****"*
Public hearing by the Parliamentary Office for Scientific and Technical Choices, 17 May 2022

1. Life extension

Programme of life extension (PLEX):
a mix of nuclear safety, electric security,
and cost and implementation concerns

- Massive ageing (unbalanced age pyramid)
- Uncertainty regarding the **feasibility**
  Oldest operating reactor: Beznau-1 (Switzerland) – 55 years

  No experience yet in PLEX to 60 years
  PLEX to 80 years: unknown safety territory
- Higher **dependency on PLEX** in the electric system
  - higher risk of failure - safety issues, risk of generic problem
    e.g. stress corrosion cracks in French reactors
  - higher pressure on industrial and financial capacity
  - higher risk of situations of **arbitration** between nuclear safety and electric security
- PLEX implies adjusting to growing penetration of renewables
  - higher need for **load following**
    - increases safety concerns
    - puts further pressure on costs and competitiveness

A Steady revival	B Timed decline	C Natural extinction
Need for massive and uncertain PLEX to 60 years; high bet on the need for significant PLEX to 80 years	Need for significant yet uncertain PLEX to 60 years	Reduced need of PLEX, mostly limited to 50 years, reducing uncertainties
High pressure on PLEX programmes, as key for the success of high electrification	Mild to strong pressure on PLEX programmes	Reduced dependency, allowing for smoother management of reactors' closure
Possibly strong need for load following with ageing reactors	Reduced need of load following	No or limited need for load following

2. New reactors

The building of new reactors raises issues about safety objectives, delays, costs and quality of construction

- Limited new reactors can be provided by EDF (EPR, EPR2, EPR1200), if not by European suppliers, raising **sovereignty** concerns
- Higher **dependency on new large units** in the electric system, with electric security, cost and competitiveness concerns
  - higher risk of failure of big projects
  - higher pressure on safety objectives, risk of regression
    e.g. discussion on "simplified" EPR2 design compared to EPR
  - higher pressure on quality of construction
- Introduction of **small modular reactors** (SMR) is open to question
  - not ready for deployment, still highly uncertain
    - failure of "big" SMR projects (Nuscale, US; Nuward, France)
    - no proof of concept yet regarding micro/advanced SMR
  - a new kind of nuclear power, disseminated, with big issues about **new ways of regulating** safety, security, transport, etc.
- Too many projects would stretch **industrial and financial capacities**, while the absence of new units challenges their future

A Steady revival	B Timed decline	C Natural extinction
Need for new units significantly over domestic capacity	Need in excess of domestic building capacities	No new reactors are needed
Highly exposed to the risk of new building programmes of large units not delivering in time and budget	Important need for new large units, although adjustable to some extent	No need for new reactors, avoiding the associated risks
The evolving role of nuclear power in the energy system calls for SMRs, adding uncertainty and risks	SMRs might be part of the strategy, bringing added uncertainty, but are not strongly needed	No SMRs (although safe and sustainable ones, if they exist one day, could be accomodated by the system)
New projects likely to strongly stretch skills and capacity	Industrial and financial capacity likely to limit plans	Need to maintain capacities without new projects

3. Fuel and waste management

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As nuclear power comes with nuclear fuel and produces radioactive waste, new projects come with new manufacturing, storage and disposal needs

- Nuclear fuel is mostly based on uranium, that is essentially imported, including from places under Russian influence
- Continued fuel supply needs maintained conversion, **enrichment and fuel fabrication capacities**
  - for PLEX and new large units of similar types, need to build new fuel capacities to cover their lifetime
  - for advanced type of reactors and SMRs, existing fuels, facilities, transport options need to be designed first…
- Increased use of nuclear fuel, in capacity and over time, calls for adjusted **storage and disposal** capacities
  - extended and/or additional storage capacities might be needed, on site or centralised, to cope with piling-up spent fuel and waste, and possibly adjust to new categories
  - disposal facilities, when they are planned/are developed, are neither dimensionned to cope with arising quantities nor designed for new, exotic spent fuel and waste

A Steady revival	B Timed decline	C Natural extinction
Much increased dependency on uranium-related imports	Maintained dependency on uranium-related imports	Reduced and ultimately cut-off dependency
High pressure and risk of failure due to the need of increased fuel-related capacities, including undesigned ones for SMRs	Need for renewal of fuel-related capacities, with uncertainties on delays and costs; additional uncertainty if SMRs are included	No need for new fuel enrichment of fabrication capacity; caution about the need to properly coordinate closures
Increasing need for storage capacity, with risks over implementation and delays, high pressure on disposal plans	Progressive need for storage capacities to be deployed, foreseen overshoot of current estimates of quantities in disposal plans	Visibility regarding the final inventory, no need for additional storage or disposal capacity compared to what's already considered

4. Evolving concerns

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The evolution of the electric system, as well as broader and longer-range environmental or geopolitical changes bring new challenges

- Nuclear reactors and plants being built by 2050 as part of net-zero strategies will be introduced in a changing electric system, possibly bringing new stress situations
- Once started, nuclear reactors and plants could run **until ~2100**, and their waste be dealt with **until ~2200**
- Towards 2050 and beyond, the growing and uncertain impacts of **climate change** must be considered
  - limitation to operation (heat waves, drought…)
  - increased risks (flooding, tornadoes…)
  - limitation regarding inland siting compared to coastal, both for PLEX and for new units
- Geopolitical instability, **security issues** and the vulnerability of nuclear facilities must be considered, in the short to long terms
  - large existing units were not conceived re. modern threats
  - small, scattered units are more difficult to protect

A Steady revival	B Timed decline	C Natural extinction
Need to cope with new stress by the electric system multiplied	PLEX and new reactors need to adapt to the evolution of stress	Limited need to adapt existing reactors
Higher exposure to climate change related limitations, due to the large number of PLEX and new built projects	New projects and PLEX programme might be conditioned by climate change constraints, e.g. regarding siting	No new reactors nor plants means reduced adaptation challenges;climate related issues can be considered to prioritise reactors‘ closures
High exposure to risks associated to security, both with large units and a strong number of disseminated SMRs	Significant and lasting exposure due to the lifetime of vulnerable equipment	Reduced exposure to security issues and related geopolitical concerns over time

Thank you for your attention!

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