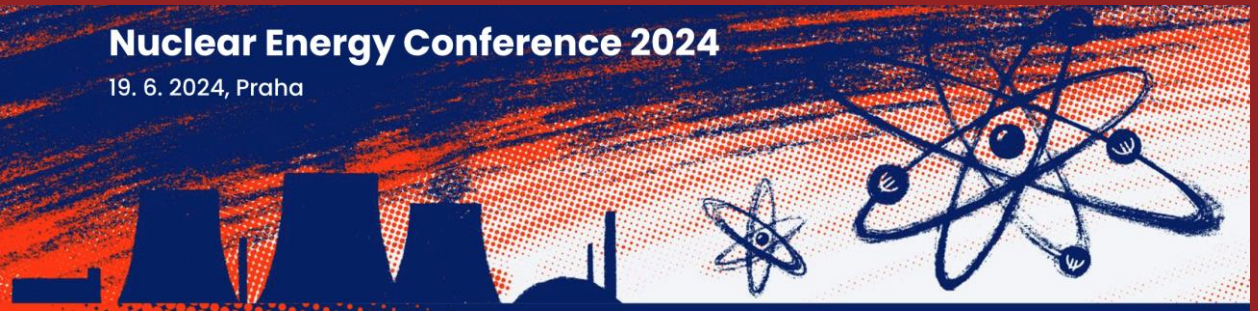
INSTITUT négaWatt

Conference

“Risks of the Czech Nuclear Contract of the Century”

EDF economic performance
and the challenge of new nuclear projects



Yves MARIGNAC

Strategic advisor
Project manager
Fissile & Fossil Energies

French nuclear power: status quo

French nuclear facilities

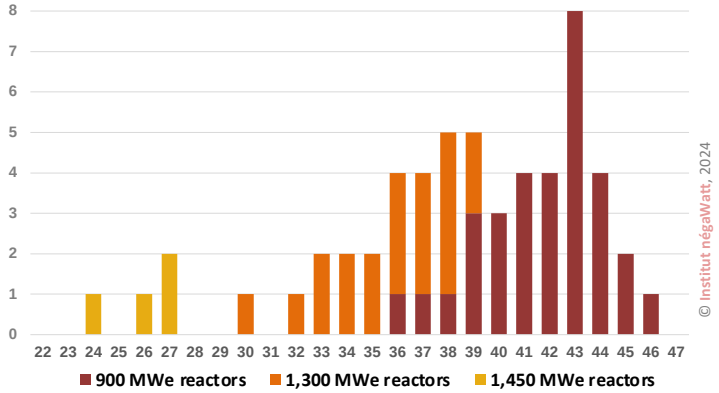
as of 31 May 2024

Source: Institut négaWatt, based on ASN, EDF (2022-2023)

- A comprehensive, integrated **"fuel cycle"** industry
- **56 reactors** operating (of only 3 types) – **61 GWe**
- **38 years** of operation on average
  Last start of a reactor in 2000
- **1 reactor** under construction: EPR (Flamanville-3)

Age distribution of French reactors

Since first grid connection, as of 31 May 2024



< 20% of final energy consumption but **70-75%** of electric generation

3rd largest industrial sector, > 200,000 direct & indirect jobs

Framing the energy system & energy policy

Weighting on economic choices

2012-2022: political turnaround

François Hollande
French President, 2012-2017

*"France needs to reduce its **double dependency** on oil and nuclear power"*
TV debate, presidential campaign, **2 May 2012**

2012 Decisions

- **Capping** installed capacity
  i.e. reactors need to be shut down before EPR starts
- **First closure** at Fessenheim (2 units) by 2016
  (actually achieved in 2020)
- **Reduction** of nuclear share in electricity
  from ~75% to 50% by 2025

What is at stake?
What does that mean for nuclear export capacity?

2022 Decisions

- **Life extension** to 60 years (or more)
  for all operating reactors, unless safety concerns
- **Newbuild** programme
  of 6 to 14 EPR2 reactors
- 1 **SMR prototype** of 340 MW by 2030
  + development of some XMR designs

*"France's energy and **ecological future** depends on nuclear power"*
Speech at Creusot-Forge, **8 December 2020**

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

Emmanuel Macron
French President, 2017-...

Political lock-in

by ïoO

Emmanuel Macron
French President, 2017-…

*Neither 100% nuclear **nor 100% renewables**,*
*"**no** expert says these two schemes are **realistic, serious or possible** for the nation"*
Speech in Belfort, 10 February 2022

*"From both an economic and a security of supply point of view, a 100% renewable scenario is **not sustainable**"*
Public hearing by a committee of the National Assembly as Prime Minister, 2 March 2023

by ïoO

Elisabeth Borne
Prime Minister, 2022-2024

Meanwhile… 100% renewables scenarios meet sustainability, electricity security and economic objectives

*Energy **scenarios** for France, published by late 2021*

		Electric demand in 2050 (% compared to 2020)	Share of renewables vs. share of nuclear in 2050	Complete costs of the electric system by 2050
Association négaWatt — Scénario négaWatt 2022	Carbon neutrality (footprint)	**530 TWh** +13%	**Ren. 100%** Nuc. shutdown by 2045	—
Rte — Futurs énergétiques 2050	Carbon neutrality Electricity security (regulatory criteria)	**555 to 752 TWh** +18% to +60%	**Ren. 50% to 100%** Nuc. 50% to 0%	Lower demand: ~€10 bn/y savings Scenarios with nuclear cheaper only if **financed on the same footing**
ADEME — TRANSITION(S) 2050 — Choisir maintenant agir pour le climat	Carbon neutrality Electricity security	**408 to 839 TWh** -13% to +79%	**Ren. 72% to 97%** Nuc. 16% to 3%	Lower demand: ~€500 bn cumulative savings For a given demand, **no significant difference** between complete costs related to the mix

Political lock-in

1 The military motive

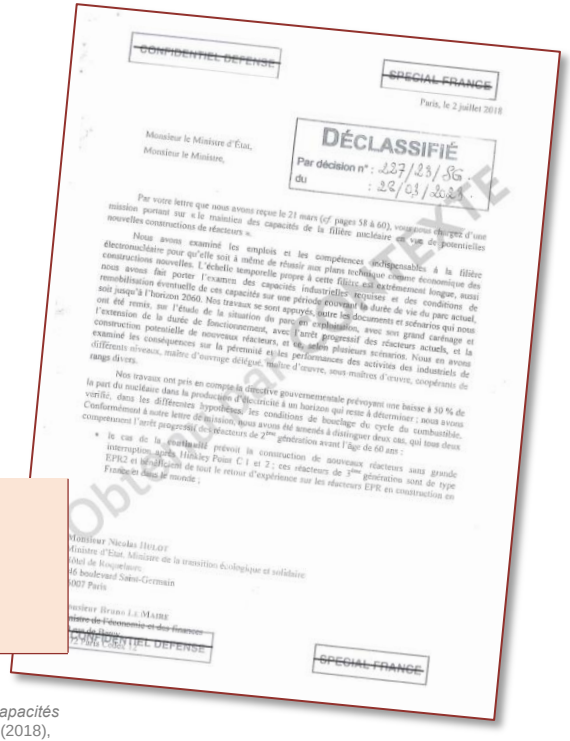
"You can't have one without the other.
Without civil nuclear power, no ***military nuclear****,*
and without military nuclear, no civil nuclear power"
Speech at Creusot-Forge, **8 December 2020**

Emmanuel Macron
French president, 2017-…

Confidential 2018 report,
declassified in 2023

High-level report to the Government
on long-term capacities to build new reactors,
with a focus on nuclear power
and an eye on nuclear propulsion

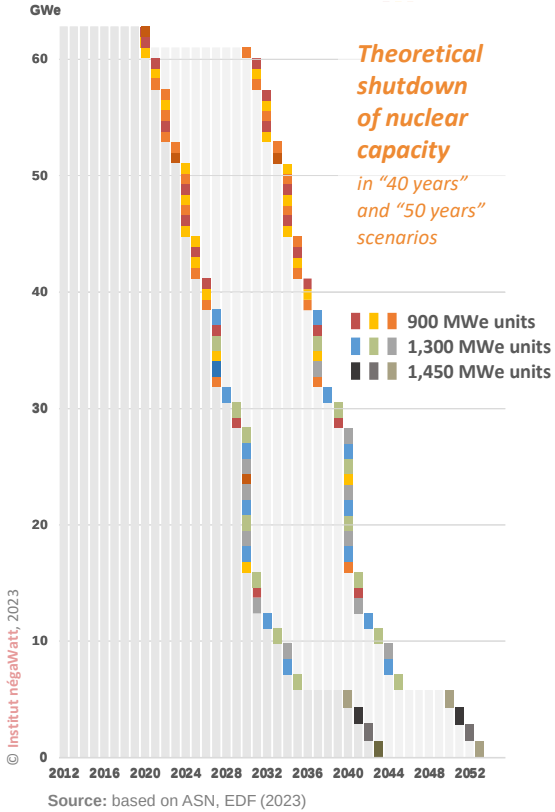
"The key point is the announcement by 2021 at the latest of the decision to launch a series of 3 pairs of 3rd generation EPR2 reactors."



Source: D'Escatha, Y., Collet-Billon, L., *Rapport de mission sur le maintien des capacités de la filière nucléaire en vue de potentielles nouvelles constructions de réacteurs* (2018), declassified March 2023, disclosed by *Contexte*, April 2023

Political lock-in

2 The "cliff effect"



Source: based on ASN, EDF (2023)

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

Jean-Bernard Lévy
CEO of EDF, 2014-2022

- **80% of the 56 reactors were started in 10 years**
- **Electric heating** accounts for up to **30% of peak load**
  In cold winter days, **1°C less = 2.4 GW more…**
- **Shutting down a reactor** means less revenues and decommissioning expenses

Shutting down 1 GWe of nuclear capacity is… **challenging!**
Shutting down 50 GWe within 10 years is… **postponed**

"Grand carénage" (major refit)

- Life extension beyond 40 years for all reactors
- Official EDF estimate: €50 bn investment
- Official correction by Court of Account: €100 bn

3 The "too big to fail" excuse

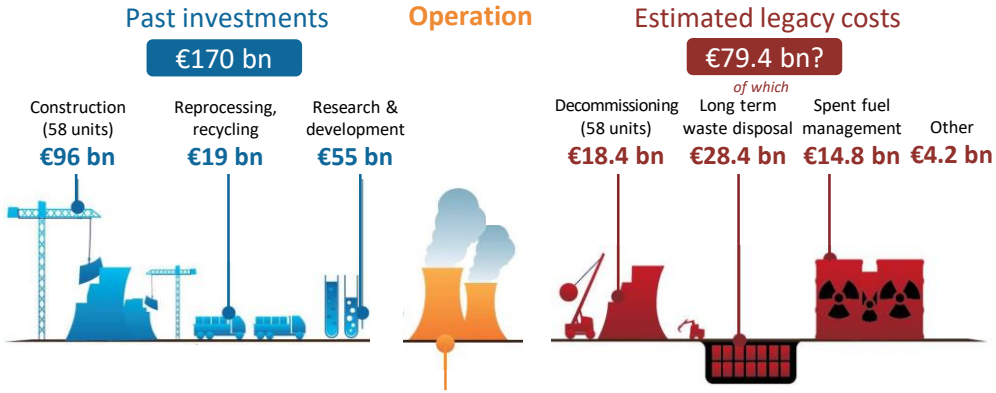
- **Life extension** to postpone liabilities
- **New build** to raise financial input

*"Renationalisation was essential to **enable EDF to accelerate** decisive projects: increasing production from existing nuclear power plants (…) and the programme to build six EPR2 nuclear reactors by 2050"*
Press release, 8 June 2023


by ïoO

Bruno Le Maire
Minister of economy, 2017-…

2012: first comprehensive cost assessment by French Cour des Comptes



Maintenance costs: from €0.6 bn/y in 2003 to €1.5 bn/y in 2009, projected €3.7 bn/y for 2011-2025

Source: Cour des comptes, *Les coûts de la filière nucléaire* (2012)

EDF net financial **debt**, end 2023: **€54.4 bn**

Future costs: uncertain and rising

Increasingly **non-profitable assets** set to massively turn into **heavy liabilities**

Ongoing costs: increasingly up

Wishful thinking


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**


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**

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


by ïoO

Emmanuel Macron
French President, 2017-…

First, **objectives** were missing to sustain capacities
Now, **capacities** are missing to meet objectives

Yet, no one considers adjusting objectives to capacities…
… and **increasingly ambitious objectives** pile up!

Projects & objectives		Additional projects
LTO 60 years	▶	LTO 80 years
6 EPR2	▶	14+ EPR2
1 Nuward SMR	▶	by 2030
1 XMR	▶	multiple designs
	+	Uprating capacity
	+	Export EPR
	+	Export EPR1200
	+	New facilities

Implementation gap

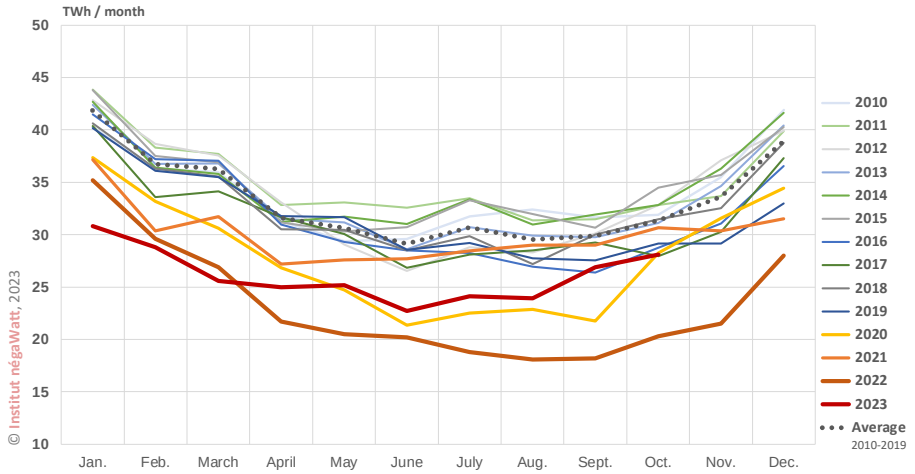
1 The performance gap

- Up to **28 reactors out of 56** in planned or unplanned outage
  Historical low of **52% load factor** over 2022
- Combination of increasing planned outages (periodical safety assessment) and significant unplanned factors (stress corrosion cracks)
- The **availability** of existing reactors is structurally decreasing over time, while the **uncertainty** on production increases

*"By 2030, we could be counting on **30% more nuclear** electricity than today"*
Quoted in *Le Figaro*, 3 October 2023

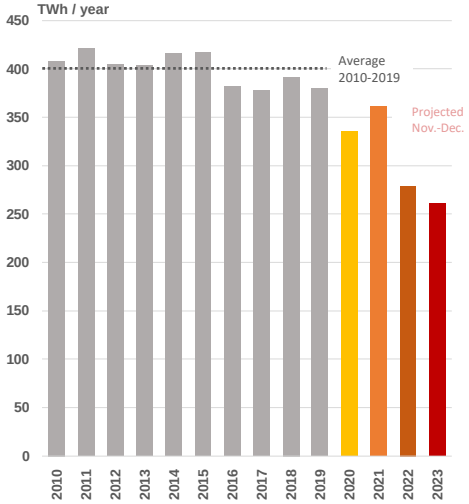
by ïoO
Agnès Pannier-Runacher
Minister of energy transition, 2022- …

Evolution of monthly nuclear output, 2010-2023



Source: based on RTE, EDF (2023)

Evolution of nuclear production, 2010-2023



Implementation gap

2 The capacities gap

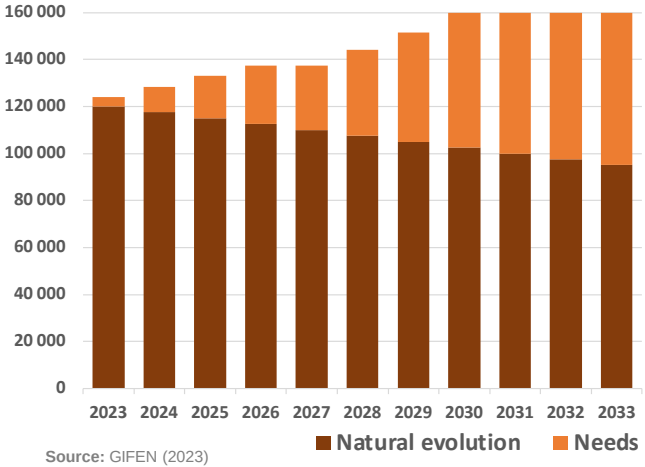
*"We need to **recruit and train** on a **massive scale**, (to) create 10,000 new jobs a year" and reach "100,000 new jobs in 2030"*
Public statement during a field visit, 10 April 2023

Agnès Pannier-Runacher
Minister of energy transition, 2022- …

Projected needs over 10 years:

- +25% workload
- **+50% to 220%** jobs in key competitive sectors
- **10%** of of all young engineers trained each year

Estimated needs of the nuclear industry



Source: GIFEN (2023)

Before new domestic and export projects…

GIFEN Report, April 2023
Groupement des industriels français de l'industrie nucléaire
on capacities and needs

Implementation gap

3 The exportation gap

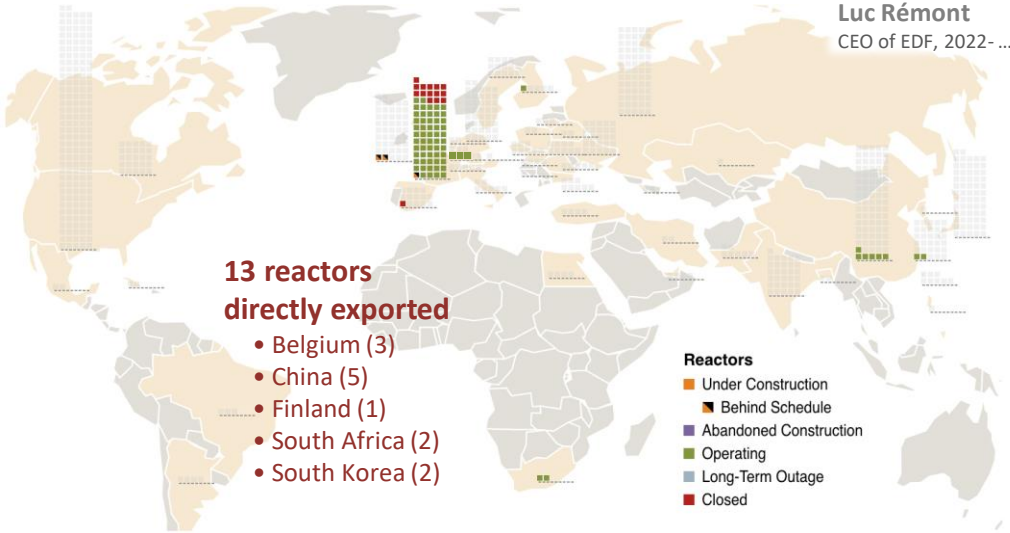
*Our ambition, on a European scale, is to deliver **two reactors a year**"*
Interview in *Contexte*, 22 March 2024

by ïoO

Luc Rémont
CEO of EDF, 2022- …

*One can anticipate "an annual average" of 20-30 GWe of new build, and "a determined player in this market [can have] the ambition of taking **a quarter of the market**"*
Special report to the President of the French Republic, 16 June 2010

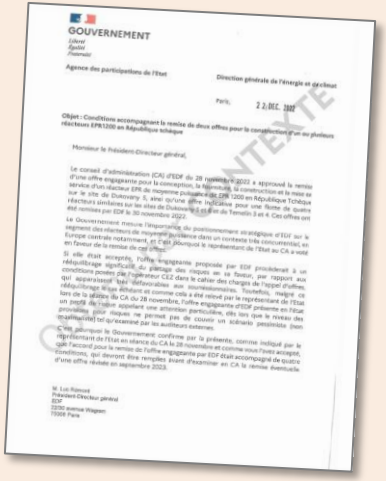
François Roussely
President of EDF, 1998-2004



Leaked letter from the French government to EDF

22 December 2022

"The capacity of the French nuclear industry and of EDF [to carry out these projects simultaneously] **must be studied in a consolidated manner**, taking into account the various provisional timetables and their possible updating."


GOUVERNEMENT

Alexis Zajdenweber, Commissaire aux participations de l'État
Sophie Mourlon, Directrice générale de l'énergie et du climat

4 The completion gap

*"The EPR is a thing that's too complicated and virtually **unbuildable**"*
Public hearing by the National Assembly, 13 December 2022

by Nalair

Henri Proglio
CEO of EDF, 2009-2014

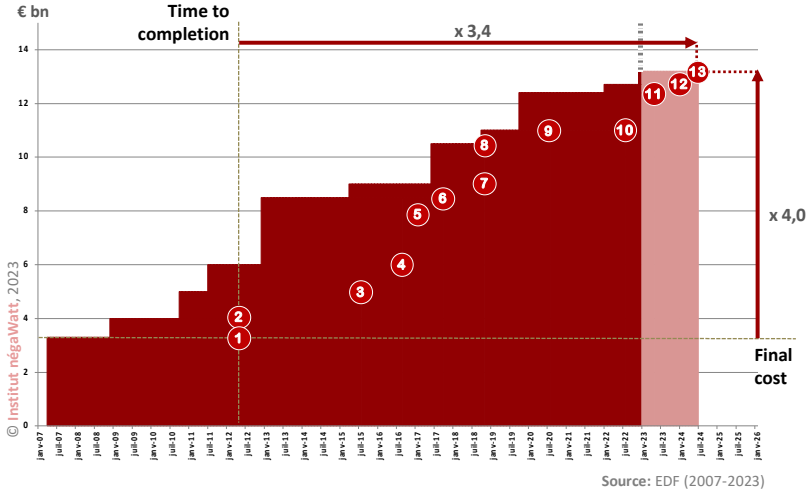
Building EPRs in Europe

	Initial plan	Current status
Olkuluoto-3 started 2003	€3 bn, 5 years (one unit)	> €11 bn, 16.6 years completed
Flamanville-3 started 2007	€3.3 bn, 5 years (one unit)	€13.2 bn, 17.5 years ongoing
Hinkley Point C started 2013/19	£16 bn, 5 years (two units)	£32 bn, > 8 years ongoing

Flamanville-3:
evolution of EDF's official estimates, 2007-2023

EDF revised estimates

1 April 2007
2 December 2008
3 October 2010
4 July 2011
5 December 2012
6 November 2014
7 April 2015
8 June 2017
9 October 2018
10 June 2019
11 October 2019
12 January 2022
13 **December 2022**



Source: EDF (2007-2023)

Plans to build new EPRs

EPR2 of 1650 MW in France

- Simplified design, risk of **safety recession**
- Still in **early design** phase, generic license planned 2025
- Projected completion: **2035 at the very earliest**, best official estimate 2037

EPR 1200 proposed for export

- Simplified design, based on the EPR2 design with 3 loops instead of 4
- DOS (dossier d'options de sûreté) approved:
  - not yet a generic design
  - not a binding regulatory step

Still far from a detailed design and its licensing

5 The trust and quality gap

EPR Flamanville

- Pressure vessel's bottom/top
- Secondary circuits weldings
- Primary circuit tappings
- …

Severe loss of competency

Quality-related safety issues

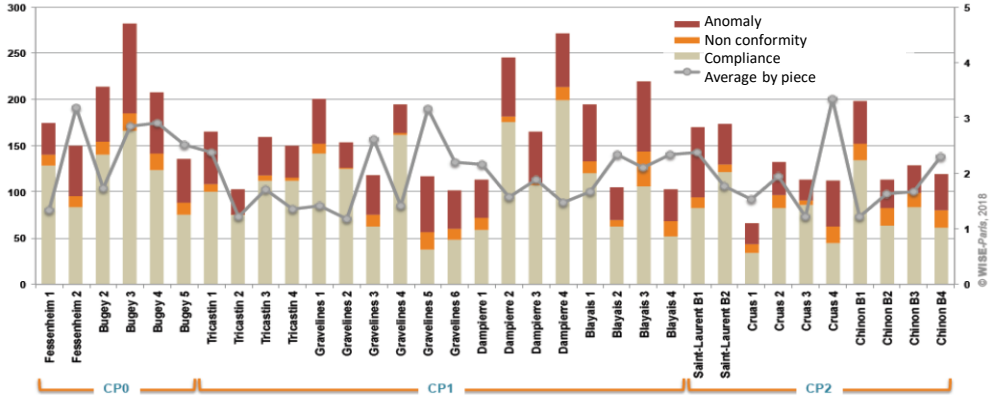
Responsibilities

Fraudulent intention

*"In spite of the progress, the ASN's inspections (…) still highlight recurring **weaknesses in industrial rigour**"*
*"In a context of strong growth (…), the fight against **falsification and counterfeiting** (…) must remain a major point of vigilance for the entire sector"*
Press conference of ASN, **30 January 2024**

Creusot Forge files - Example of the 900 MW reactors fleet

34 units ⇔ **827 pieces** of heavy components ⇔ **1,591 hidden non compliances** re. regulatory or contractual requirements



Non-transparent practices?

EDF and its former CEO Henri Proglio on trial in mid-2024 on suspicion of **favouritism** over more than 40 consultancy contracts between 2010 and 2016, worth a total of €22 bn.

by ïoO

Bernard Doroszczuk
President of ASN, 2018- …

Implementation gap

6 The financial gap

*"**Decarbonised electricity** costs between €60 and €80/MWh. Sovereignty (…) and ecological transition have a cost."*
Quoted in *L'Humanité*, 20 September 2023

*"The aim is for a **[regulated] model** to be defined and shared by the end of the year"*
Quoted in *La Tribune*, 14 September 2023

*"[I request] EDF to propose the **lowest possible** average price"*
Unofficial quote in *Le Figaro*, 23 September 2023

EDF operating nuclear fleet

- Energy Regulation Commission (CRE) +36% to +78% compared to 2012
- **Dispute** mostly on financing scheme
- **Failure** to find a market design to finance the life extension of French reactors without losses for EDF

New nuclear projects

- EPR2 programme: **€70/MWh objective**, unlikely and uncompetitive
- First official estimate: at least **€46 bn** for 6units
- Leaked Government estimate: €52 to 56 bn, up to **€64 bn** in industrially "degraded" scenario

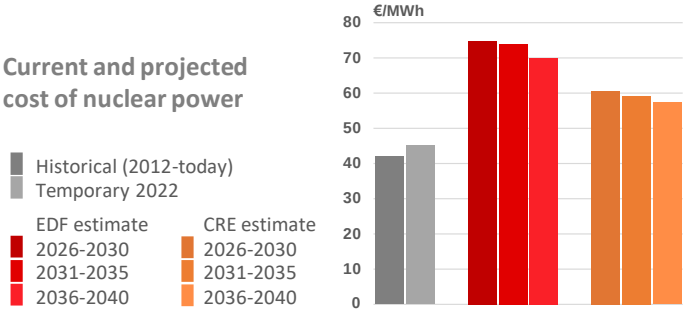
Regarding the cost of new EPRs, "I refuse to have a **fixed idea at this stage** because that would mean that I'm not going to push the work (…) to evaluate each of the building blocks that make up the cost"
Interview in *Contexte*, 22 March 2024


by ïoO
Emmanuelle Wargon
Chairwoman of CRE, 2022-…


by ïoO
Elisabeth Borne
Prime Minister, 2022-…

ARENH *Regulated access to historical nuclear electricity*

Current and projected cost of nuclear power



Source: CRE (2023)


by ïoO
Luc Rémont
CEO of EDF, 2022- …

Conclusions

Bruno Le Maire
Minister of economy, 2017-…

*"France must rhyme with «**puissance**» (i.e. power): energy power, nuclear power, economic power"*
Speech at Penly nuclear power plant, 9 December 2022

*Building six new EPR2s is a "**gigantic scale**" project, "in a sector that unfortunately has had its ups and downs (…) has lost a lot of skills and now needs to rebuild"*
*"It seems to me a **reasonable amount** for our nuclear industry to absorb"*
Public hearing at the Senate, 5 June 2024

1. France's nuclear "renaissance" is rooted in **political lock-ins** that have little to do with climate urgency
2. Before 2022 decisions, the nuclear industry was struggling with obvious signs of a **deep crisis**
3. Now, thanks to new political support, it feels as its problems are gone…
4. … and keeps rising the bar of its **ambitions**, at home and abroad, away from any **reality check**
5. The **implementation gap** is wide, and the industry is still lacking capacities, market conditions, financial resources to deliver
6. EDF will struggle to meet the **minimum objectives** set in France, which will be its priority
7. Regarding export, **EDF cannot provide any guarantee** as to the quality, deadlines or costs to which it would commit

Thank you for your attention!

More information:

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