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Monitored this issue:

Uranium Mining in Africa

Gunter Wippel, uranium-network.org with information from WISE Uranium Project

1. A few words on history

Uranium mining in Africa can hardly be dealt with without taking a brief look at history. Africa has been intensively colonized by European powers. The first uranium mine in Africa – originating from a radium mine in the Haute-Katanga region of what was then Belgian Congo – was Shinkolobwe mine; it provided – unintentionally – some of the uranium for the first nuclear bomb produced in the US. The mine continued to deliver the raw material for US nuclear weapons until Congo gained independence in 1960.

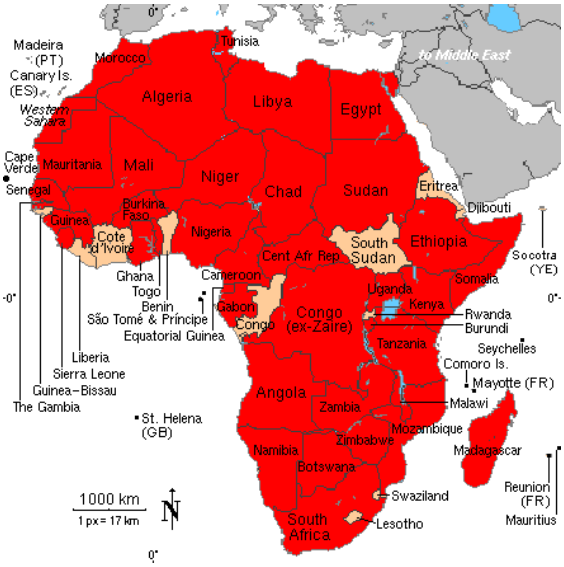
In the 1960s, the French Commissariat à l'Energie Atomique (CEA, Atomic Energy Commission) started to explore for uranium in what had formerly been French West Africa. In 1960, a part of it became the state of Niger. Two uranium mines were started successively: an open-pit mine by SOMAIR (1971) and Akouta underground mine by COMINAK (1978), both majority owned by French entities. The SOMAIR mine is still operating (current situation see below).
France also had exploited uranium in its (former) colony Gabon, leaving behind an environmental legacy.

Similar to France, companies from the UK looked for uranium in its then or former colonies: in Australia and in Africa, in what is now Namibia: from 1976 on, Rio Tinto Zinc (later named Rio Tinto) exploited uranium from Rössing mine, a huge open-pit mine, in what was then South West Africa. The operation was in violation of
UN Decree No. 1[1] , at the time, the area was still a protectorate under the control of South Africa, and exploitation of its resources was not allowed by the said UN Decree.
Uranium mining also happened in South Africa to a similar extent as in Namibia, by a variety of companies, creating a radioactive legacy which haunts the country to date.

2. *fast forward*: The 2007 uranium boom

While the price of uranium repeatedly experienced considerable ups and downs, a uranium price boom occurred in 2007 – followed by a similarly rapid drop of the price.[2]

The boom attracted dozens of exploration companies to nearly each and every country in Africa which was seen as an 'underexplored' continent.[3]



Nearly all of Africa is red – indicating exploration happened in nearly every country shortly after 2007/8.

In retrospect, the results were meager.

[1] https://digitallibrary.un.org/record/111393?ln=en&v=pdf

[2] (see: https://tradingeconomics.com/commodity/uranium).

[3] (https://www.wise-uranium.org/upafr.html

> In **NIGER,** for many years, French AREVA (now ORANO) had been the only uranium mining company.
From 2007 on, then President of Niger, Mamadou Tandja, invited companies from abroad to explore mining opportunities in Niger. 135 exploration licenses were granted. The government under Tandja struck a deal with China Nuclear International Uranium Corporation (or SinoU) for a uranium mine near Azelik, between Agadez and Arlit, the AREVA mining town.

These steps did not go well with France which regarded Niger as its backyard ('Francafrique'). President Tandja was overthrown in February 2010; with the next election, Mahamadou Issoufou became president. Issoufou had been trained as a mining engineer in France and had "served as National Director of Mines from 1980 to 1985 before becoming Secretary-General of SOMAIR" [4] the open-pit mine operated by AREVA near Arlit.

Shortly after Tandja's opening up to other countries, a uranium deposit named **Azelik** was licensed to SinoU, an offspring of China National Nuclear Corporation (CNNC); by the end of 2010, the first drums of uranium were produced and sent to China.
Local protests ensued due to the mining activities disturbing salt production and thus the livelihood of Tuareg women in the area. By 2014, the company said it was struggling with "low output and high costs", and stopped operation by 2015.

The large **Imouraren** deposit, discovered by AREVA, 160km north of Agadez and 80km from Arlit, was said to be one of the biggest uranium deposits in the world (146 000 t U). In 2008, AREVA was licensed to mine it. However, in 2010, it experienced the first of many postponements. In 2011, in the aftermath of the Fukushima-Daiichi disaster, it was postponed again, AREVA announced its start for 2014. The Niger government, partially depending on the income from the mines, frustrated with the new delay, urged AREVA to pay 35 million € as compensation for the delay.

In 2013, AREVA downgraded parts of the uranium reserves at Imouraren from "proven reserves" to "probable reserves". Rumors said the deposit would be "not mineable". By 2014, the start of mining at Imouraren was delayed indefinitely. Decisions on how to proceed with the project was deferred to 2028, although an in-situ leach pilot test was envisaged for 2024.Between 2015 and 2017, AREVA depreciated Imouraren each year in its balance sheets, in total a depreciation of € 688 million.[5]

The **Central African Republic** (CAR) as well as **DR Congo** were also targeted by AREVA for mining uranium – both to no avail (more details in Part 2).

> In **NAMIBIA**, AREVA had acquired Trekoppje project from UraMin in 2007; the deposit turned out to be hard to exploit, definitely not worth the price (around 2 billion €) AREVA had paid for it. The transaction cost then AREVA-CEO Anne Lauvergeon her job, triggered a veritable scandal in France with the French financial police searching AREVA's headquarter, corruption issues and so on.
On top of it, it turned out that the blatant overestimation of the value of the Trekoppje deposit was a result long planned by the Uramin owners Stephen Dattels and James Mellon. Dattels, one of the founders of Barrick Gold, was traced by Quebec newspaper La Presse to two other stock market operations that went awry. Mellon had already been prosecuted by financial prosecutors in South

[4] https://en.wikipedia.org/wiki/Mahamadou_Issoufou]

[5] https://nuclear-news.net/2017/11/03/arevas-new-entity-newco-struggles-with-unprofitable-uranium-mine-in-niger/

Korea.[6]
The failure of the project lead to another considerable depreciation in AREVA's balance sheets: In December 2011, AREVA wrote off the biggest part of the investment in Trekoppje mine, 1,46 billion €.[7]
However, ORANO has applied for a new environmental clearance for Trekoppje in 2023.

The depreciations of Imouraren and Trekoppje contributed significantly to the insolvency of AREVA in 2017. The company was 'restructured', the French government injected 4,5 billion €[8], accepted by the EU Commission. The new company was named ORANO in 2018.

> In **TANZANIA**, in 2007 and the following years, Australian companies URANEX and Mantra explored for uranium in two regions: central Tanzania (Bahi and Manyoni), as well as in the Mkuju River area, a World Heritage Site.
Mantra got lucky by locating and defining the Mkuju River uranium deposit; Mantra Australia sold its Tanzanian subsidiary, and thus the deposit, to Russia's ROSATOM and ARMZ, at a high profit. Mantra's shareholders sacked two- to four times (depending on the point in time they had invested) of the amount invested.
As of now, mining has not started; the project has been put on hold due to the slumping price of uranium after 2008; in 2017, the project was officially postponed for three years. Currently, only maintenance work is reported from the site.
One source suggests that the Russian companies overpaid for the deposit. [9]

Exploration work in Bahi and Manyoni ceased, partially due to poor results, partially due to civil society resistance; at an IAEA presentation, it was admitted that the company had not gotten 'the social license' to mine. One of the opponents was awarded the Nuclear-Free Future Award in 2022.[10]

> In **Malawi**, Australian company Paladin (whose CEO John Borshoff had stated: "*Australia and Canada have become overly sophisticated. They measure progress in other aspects than economic development, and rightly so, but I think there has been a sort of overcompensation in terms of thinking about environmental issues, social issues, way beyond what is necessary to achieve good practice. The future of mining is in Africa.*"
Paladin had bought and started Kayelekera uranium mine, in 2009, against considerable resistance of local NGOs. It produced uranium for about 5 years.
By 2014, it was mothballed due to the uranium price staying "stubbornly low" (as one frustrated mine CEO stated). During its operation, Kayelekera mine made it to WISE Uranium Project's "Hall of Infamy" due to numerous accidents and spills.[11]
By 2020, another Australian company, LOTUS Resources, acquired the mine, announced its re-opening, and considered also to extract rare earth metals (from the tailings).
In 2024, "a potential restart at Kayelekera in late 2025" is reported.

> In **Namibia**, Australian company **Paladin** started **Langer-Heinrich mine;** in 2006, first uranium production was announced. With the

[6] https://en.wikipedia.org/wiki/UraMin
[7] https://business.financialpost.com/commodities/mining/uramin-assets-a-nearly-2-billion-drag-on-areva]
[8] [www.zeit.de/news/2017-01/10/eu-eu-kommission-genehmigt-umbau-des-franzoesischen-atomkonzerns-areva-10160808]
[9] www.mining.com/russian-state-corporation-suspends-1-2-billion-uranium-project-tanzania/)
[10] https://nuclearfreefutureaward.org/anthony-lyamunda-tanzania/
[11] https://www.wise-uranium.org/ucpalhi.html

decline of the price of uranium, the mine had to slow down and finally stopped production by May 2018. (Paladin's other mine, Kayelekera, had already stopped working by 2014).

With both of its mines causing costs and making no money, Paladin got in serious financial difficulties. In July 2017, the company was placed under administration.
Paladin's Langer-Heinrich-subsidiary was able to secure a long-term contract with French EdF, and received an upfront payment of 200 Mio US$ (to be paid off by future uranium deliveries). However, disaster struck when EdF cancelled the contract in 2017 – and wanted its upfront payment back; Paladin was unable to comply.
["Another hurdle emerges in Paladin Energy's plan to avoid collapse", Australian Financial Review, Jun 13 2017.[12]

To avoid liquidation, a debt-for-equity swap was arranged, with 98% of the existing shareholders' shares transferred to creditors. The remaining shares were re-listed on 14 February 2018. Paladin survived – at the cost of its shareholders loosing most of the value of their shares.

CNNC acquired in 2014 a 25% share in Paladin's Langer-Heinrich Mine[13]
A January 2017 attempt to sell another 24% to CNNC was in the end rejected by CNNC.[14]
As of 2024, Paladin is trying to bring Langer-Heinrich Mine online again (see below).

Also in Namibia**, Chinese companies** were – and are – active. With few uranium resources at home, China looks for uranium elsewhere:

Rössing had discovered a large uranium deposit close to its existing mine, Rössing South. The deposit was renamed into **Husab mine,** and ended up being owned by China Guangdong Nuclear Power Holding Corp. (CGN) by 2012, via subsidiaries. The deposit is said to be the 4th largest uranium deposit in the world (188,000 t U). It **started operating in 2014**. In 2022, it is listed as the second largest uranium mine by production, with 7% of world uranium production.[15]

In 2019, **Chinese National Nuclear Corporation (CNNC) acquired Rio Tinto's 68.6% share** in the ('old') Rössing mine. CNNC is now the majority owner of Rössing mine, one of the longest operating uranium mines in the world.

Another Chinese company, **Zhonghe Resources**, owned via subsidiaries by CNNC, started to develop the Zhonge uranium project from 2010 on. An EIA was made available in 2011 – "two years after completion and four months after license issued".[16] No information of further progress of the project is known.
In 2021, the company applied for a license renewal, but to date no uranium has been produced.

Since the Namibian authorities were flooded with applications in the run for new uranium mines, the Government imposed a **10 year MORATORIUM for new exploration licenses for uranium in 2007**.

12 www.afr.com/business/mining/uranium/another-hurdle-emerges-in-paladin-energys-plan-to-avoid-collapse-20170613-gwpzvj]

13 www.nsenergybusiness.com/news/newspaladin-sells-minority-interest-in-langer-heinrich-mine-to-cnnc-220114-4163814/

14 www.marketscreener.com/quote/stock/PALADIN-ENERGY-LTD-46922997/news/CNNC-Overseas-Uranium-Holding-Ltd-cancelled-the-acquisition-of-an-additional-24-stake-in-Langer-He-35230980/

15 https://world-nuclear.org/information-library/nuclear-fuel-cycle/mining-of-uranium/uranium-mining-overview

16 www.wise-uranium.org/upna.html#ZHONGHE

3. The Current Situation of Uranium Mining in Africa (2024)

In 2022, the World Nuclear Association listed only three African countries producing uranium[17] (2023 figures not yet available):
Namibia (5613 t U, approx. 11.4% of world production),
Niger (2020 t U, 4.1% of world production),
and South Africa with a (neglibile) 200 t U (0.4% of world U production).
Thus, African mines contributed in 2022 15.5% to the world uranium production.

NIGER

Production

By 2024, Niger has only one producing uranium mine left, **Arlit mine,** majority owned by ORANO.

Things had turned worse in 2023/24: When military took over power on 26. July 2023, the ECOWAS states blocked borders in an attempt to bring down the new military junta / government. The Arlit mine continued production, but lacked possibilities to export the yellowcake; the operation also suffers from difficulties to provide the chemical agents for extracting uranium from the ore. **No uranium was exported from Niger in 2024**.[18]

By October 2024, ORANO announced a stop of operation of Arlit mine due to financial difficulties.Currently no uranium is produced in Niger (Azelik mine is not yet producing again.)

Projects

Azelik project by SOMINA

Azelik uranium mine, owned by SOMINA, approx. two-thirds Chinese owned, had been mothballed since 2014.
On 26 July 2023, a military coup overthrew the government. On 28 June 2023, a CNUC delegation discussed a restart of Azelik mine with the Niger government. A team to evaluate a possible restart of the mine had already been sent to the site.
In May 2024, SOMINA announced the restart of Azelik mine.[19]

DASA project by Global Atomic

Since a number of years, **Global Atomic**, a Toronto based company, is developing the Dasa mining project, located between Agadez and Arlit. Originally (2010s), the company had planned for a series of open-pit mines, by 2020, an "optimized plan" provided for an underground mine. Work started in 2023. By 2024, an inclining tunnel is dug to get access to the uranium deposit.
On 5 March 2024, "Global Atomic Corp. announced the results of the updated Dasa Project Feasibility Study. Dasa Mine Life is extended from 12 to 23 years, Mineral Reserves have increased by 50% to 73 million pounds U_3O_8 [28 077 t U], and uranium production from Dasa is projected to increase by 55% to 68.1 million pounds U_3O_8 [26 192 t U]".[20]

In May 2024, the current minister of Mines of Niger, on a visit to the project, encouraged the company to continue; obviously, Global Atomic is at good terms with the (new) Niger government / junta – which, most probably, hopes to profit from the mining activity financially, and thus takes a positive stance towards the project.

Commercial production of uranium is set to begin in 2026.[21] On 29 Oct. 2024, Global

[17] https://world-nuclear.org/information-library/nuclear-fuel-cycle/mining-of-uranium/world-uranium-mining-production

[18] www.agenceecofin.com/uranium/1410-122393-zero-tonne-d-uranium-exportee-par-le-niger-en-2024-voici-les-raisons

[19] www.wise-uranium.org/umopne.html#AZELIK

[20] www.wise-uranium.org/upne.html#DASA

[21] https://www.globalatomiccorp.com/investors/new

Atomic stated that the U.S. International Development Finance Corporation may grant a credit for the further development of the project. The company also said " … *off-take agreements we have in place with American and European nuclear power utilities"* without disclosing them.

In view of US legislation aiming to slow down uranium imports from Russia, an engagement of the US in a uranium mining project whose fruition is foreseeable, makes some sense.

Imouraren deposit

On 3 and 4 June 2024, media reported that Russia 'eyes France's Oranos's uranium assets in Niger'.[22]

On 11 June 2024, ORANO announced its intention to start mining at Imouraren, probably an attempt to calm the new Niger government.

According to another source: "The junta effectively blocked Orano from resuming production so it could revoke its permit. France-based *Jeune Afrique* reported that Orano attempted to send employees to restart work on the site multiple times, but Nigerien forces responsible for security at the mines prevented them from entering." [23] On 21 June 2024, the Niger government withdrew ORANO's license for the Imouraren deposit.

Madaouéla project by GoviEx

Company **GoviEx**, based in Vancouver, held an exploration license for the Madouela uranium deposit, discovered in 2010; development was slow, although in 2019 the government of the time envisaged a development of the deposit by GoviEx and the government. However, the project was postponed again and again.

In April 2024, the new government of Niger gave GoviEx an ultimatum to start mining at Madaouéla by 3. July 2024 – a timeframe the company could not possibly comply with. Failure to comply with the deadline would lead to a risk of revocation of the mining permit.

On July 4, 2024, GoviEx Uranium Inc. informed the public that the mining permit for Madaouela has been revoked; the project appears no longer on GoviEx's website.

Other projects

WISE Uranium Project's website lists more uranium deposits in Niger; however, none of those deposits is currently under development.

Summary Niger

Uranium production in Niger had declined since a decade, from 4518 t U in 2013 to 2020 t U in 2020 (WNA), roughly a 55% decline in 10 years (again, 2023 figures are not yet available), putting Niger 7th place of uranium producing countries, behind Namibia.

The 2024 production is of limited relevance since the uranium produced is currently not available at the world market.

France's / ORANO's dominance seems to come to an end: Arlit mine is idle, and ORANO lost the mining license for the Imouraren deposit. Whether a license for exploiting Imouraren will be given to a Russian company remains to be seen.

Chinese CNUC is making a come-back to Niger with re-starting Azelik mine.

The developing Dasa-project by Global Atomic is obviously supported by the current Niger government – which is in need of making money from the mines.

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s/news-details/2024/Global-Atomic-Provides-Update-on-the-Dasa-Project-October292024/default.aspx

[22] www.ecofinagency.com/mining/0406-45584-uranium-russia-s-rosatom-eyes-france-s-orano-s-assets-in-niger,

www.mining.com/web/russia-is-said-to-seek-french-held-uranium-assets-in-niger/

[23] www.understandingwar.org/backgrounder/africa-file-june-27-2024-niger-reallocates-uranium-mine-strengthens-sahel-au-future

NAMIBIA

Production

Uranium production in Namibia **increased** since 2016 from 3654 t U to 5613 t U in 2022, an approx. 65% increase; this puts **Namibia into the third place of world uranium production**, behind Kazakhstan and Canada[24], (2023 figures not yet available).
This output was produced by the (majority) Chinese owned mines **Rössing** and **Husab**.
Paladin announced in 2022 to reopen Langer-Heinrich Mine; in March 2024, the first drums of yellowcake were produced.
However, by 12 Nov. 2024, Paladin revised its production targets for the financial year 2025 (ending June 2025) by 20 – 25% due to "ongoing challenges and operational variability experienced to date in ramping up production".

Projects

With approx. 8% of the world uranium deposits located in Namibia [25], a number of uranium projects are 'in the pipeline'.

The 10 year MORATORIUM for new uranium exploration license, imposed in 2007, was lifted, as planned, in 2017; a run for new licenses ensued.[26]

Russian **ROSATOM is pushing forward with Wings project** (via a subsidiary, Headspring) in Omaheke region in the east of Namibia, bordering Botswana, an arid region: Rosatom plans to mine uranium via in-situ leaching in an artesian basin which is the source of water for humans as well as for agriculture in the area; the practice is considered a no-go by environmental protectors.
ROSATOM's plans are met by resistance from locals and Stampriet Aquifer Uranium Mining Association (SAUMA).

Deep Yellow Limited, led by John Borshoff, former CEO of Paladin which barely evaded bankruptcy, plans to develop **Tumas uranium mine project.** A mining license was issued on 18 Dec. 2023 to Reptile Uranium Namibia (Pty) Ltd, a 100% subsidiary of Deep Yellow. The license is valid for 20 years.

There is a number of projects in Namibia in different stages of development. One project (**Etango**) applied for a new Mining License; for another project (**Valencia and Namibplaas**), a reassessment of a 2015 Feasibility Study is under way. However, none of these projects is close to production.
We will take a closer look on these projects in Part 2.

Concerns

Water supply remains a serious concern in arid Namibia since uranium mines are in need of big quantities of water. One desalination plant, originally built for Trekoppje mine, is in operation, a second one is discussed; construction may begin in 2025.

Power supply remains another concern in Namibia; in the 2010s, construction of a coal-powered plant was discussed, but did not go forward.

Summary Namibia

"What AREVA dreamt of, the Chinese have done …" was a headline in a 2015 presentation on uranium mining, and it is more true today than it was then: Chinese companies run uranium production in Namibia, and hold a share in Paladin's mine – which is not going too well, again.
France's Areva has lost out big time.

[24] https://world-nuclear.org/information-library/nuclear-fuel-cycle/mining-of-uranium/world-uranium-mining-production

[25] www.statista.com/statistics/652996/distribution-of-global-uranium-resources-by-country/

[26] www.wise-uranium.org/upna.html

SOUTH AFRICA

South Africa – for most of the past the only African country with nuclear power – had produced uranium only as a by-product of gold mining. Uranium production has continuously gone down, the quantities of uranium produced in the years before were negligible (< 500 t U / year, declining).

In the mid-2010s, **Australian company Peninsula Energy** attempted to mine uranium in the Karoo, but 'divested' from the project in October 2017, after strong protests.

S.A. company **Sibanye-Stillwater** worked for a number of years on extracting uranium (as well as other metals), in parts from old mine tailings; in 2024, no uranium was produced.

However, S.A. has a serious legacy from past mining activities, including uranium contamination.

* * *

In Part 2, we will look at a number of other countries in Africa with no current uranium production, but with uranium projects in different stages of development; some of those projects might become productive in the future.
We will also go into the impacts on the environment, workers' health and safety, economic and socio-economic impacts of the mines in general and also address specific issues.

Financing new nuclear power plants, governments pay the price

Gerard Brinkman, WISE Netherlands

Nuclear power plant construction is not business as usual in a privatised energy market. Governments regularly intervene heavily, either through direct financing, providing loans and guarantees, or via risk-sharing and interference with price measures. This raises the question of how much a government will have to pay when planning a new nuclear power plant. Based on recent examples, what is the range of cost estimates that can be expected?

To this end, in a study by Dutch investigator Jeroen Walstra from Profundo a detailed analysis of the actual costs and timelines of typical and recent large-scale construction projects of new nuclear power plants is provided.

Six nuclear power plants have been selected for this research. They are among the latest to be put into operation globally:

- Olkiluoto 3 (Finland),
- Shin Hanul 1-2 (South Korea),
- Barakah 1-4 (United Arab Emirates),
- Vogtle 3-4 (United States),
- Flamanville 3 (France) and
- Hinkley Point C 1-2 (United Kingdom).

The six power plants use Generation III+ Pressurized Water Reactors. The technologies are from France, the US and South Korea. This matches the technology choices the Dutch government is exploring.

The outcome of the research is compared to the proposals for Borssele 2-3 and Dukovany 5-6. The latter is a Czech project for which the preferred bidder has just recently been chosen: Korea Hydro & Nuclear Power Company (KHNP), the nuclear subsidiary company of Korea Electric Power Corp (KEPCO). This is an interesting example because, on the one hand, KEPCO has shown its ability to realise nuclear construction

projects domestically in South Korea, at cost-competitive prices. On the other hand, its bidding price for the project in Europe lies considerably higher, almost a factor of 4. This may point to additional costs caused by first-of-a-kind characteristics.

The research conducted for WISE calculated factors for both budget overruns and lead time escalations. Both these exceedances are expressed in multiplication factors, to emphasise how many times the initially planned construction cost and construction period have gone over the top. Based on the data of the six construction projects case studies, the calculated factors are:

Factor	Low	Mean	High
Budget overrun factor	1.6	3.1	6.0
Lead time escalation factor	1.7	2.6	4.6

The identified realised construction costs (in EUR billion) are:

Project	Budgeted cost (EUR bln)	Realised cost (EUR bln)	Budget overrun (EUR bln)	Budget overrun factor
Olkiluoto-3	3.2	11.0	7.8	3.4
Shin Hanul 1-2	4.0	6.4	2.5	1.6
Barakah 1-4	14.1	24.0	9.9	1.7
Vogtle 3-4	9.2	33.9	24.7	3.7
Flamanville 3	3.3	19.9*	16.6*	6.0*
Hinkley Point C 1-2	24.7	46.1*	21.4*	1.9*

Note: * Projected values

The identified realised construction lead times (in years) are:

Project	Scheduled lead time (Years)	Realised lead time (Years)	Lead time escalation (Years)	Lead time escalation factor
Olkiluoto-3	3.9	17.7	13.8	4.6
Shin Hanul 1-2	5.7	11.7	6	2.1
Barakah 1-4	5.9	12.1	6.2	2
Vogtle 3-4	8.5	14.9	6.3	1.7
Flamanville 3	5.1	17.1*	12.0*	3.4*
Hinkley Point C 1-2	6.6	12.1*	5.5*	1.8*

Note: * Projected values

Based on the results from the six case studies, it has been calculated what this would mean for the preparation of Dukovany 5-6 and Borssele 2-3.

According to the Dukovany 5-6's bid, the project is budgeted at EUR 15.8 billion and a lead time of 12.8 years. The analysis shows that this initially budgeted cost is close to the mean value that is expected based on the case studies. The calculated low expectation is considered unrealistic and ruled out. The mean expectation would be a realised cost of EUR 17.4 billion and a budget overrun factor of 1.1. The high expectation would be a realised cost of EUR 27.3 billion with a budget overrun factor of 1.7.

Table 26 Exploration of cost and lead time for Dukovany 5-6

	Proposal	Low expectation	Mean expectation	High expectation
Budgeted cost	15,800	15,800	15,800	15,800
Realised cost	15,800	4,183	17,396	27,314
Budget overrun	0	-11,617	1,596	11,514
Budget overrun factor	**1.0**	**0.3**	**1.1**	**1.7**
Construction start date	1-Apr-25	1-Apr-25	1-Apr-25	1-Apr-25
Scheduled commercial operation date	1-Jan-38	1-Jan-38	1-Jan-38	1-Jan-38
Commercial operation date	1-Jan-38	26-Dec-36	5-Jul-39	19-Dec-42
Scheduled lead time	12.8	12.8	12.8	12.8
Realised lead time	12.8	11.7	14.3	17.7
Lead time escalation	0	-1.0	1.5	5.0
Lead time escalation factor	**1.0**	**0.9**	**1.1**	**1.4**
Reference net capacity (MWe)	1,800	1,800	1,800	1,800
Cost in EUR per kWe	**8,778**	**2,324**	**9,665**	**15,175**

Sources: See text.

For Borssele 2-3 a cost estimate is not available yet. The Dutch government intends to make a reserve of EUR 7 billion (for two units), but the financing model has not been chosen, and the proposed budget reserve is awaiting parliamentary approval. Therefore, the analysis took a rough estimate of the available budget (EUR 19 billion) based on the proposed reserve to enable the exploration of the expected cost range. An initial schedule mentions Borssele 2-3 to start operations in July 2035.

Table 27 Exploration of cost and lead time for Borssele 2-3

	Proposal	Low expectation	Mean expectation	High expectation
Budgeted cost (rough estimate)	19,000	19,000	19,000	19,000
Realised cost	19,000	6,275	26,094	40,971
Budget overrun	0	-12,725	7,094	21,971
Budget overrun factor	**1.0**	**0.3**	**1.4**	**2.2**
Construction start date	1-Jan-28	1-Jan-28	1-Jan-28	1-Jan-28
Scheduled commercial operation date	1-Jul-35	1-Jul-35	1-Jul-35	1-Jul-35
Commercial operation date	1-Jul-35	27-Sep-39	5-Apr-42	19-Sep-45
Scheduled lead time	7.5	7.5	7.5	7.5
Realised lead time	7.5	11.7	14.3	17.7
Lead time escalation	0	4.2	6.8	10.2
Lead time escalation factor	**1.0**	**1.6**	**1.9**	**2.4**
Reference net capacity (MWe)	2,700	2,700	2,700	2,700
Cost in EUR per kWe	**7,037**	**2,324**	**9,665**	**15,175**

Sources: See text.

The calculated low expectation is considered unrealistic and ruled out. The mean expectation would be a realised cost of EUR 26.1 billion and a budget overrun factor of 1.4. The high expectation would be a realised cost of EUR 41.0 billion with a budget overrun factor of 2.2

Financing models

Several financing models have been found. All six cases have a mix of corporate and government financing. Barakah 1-4 and Flamanville 3 have the highest share of government contributions. Olkiluoto 3 and Hinkley Point C 1-2 the lowest. Olkiluoto 3 and Vogtle 3-4 have a cooperative financing model in which the power off-takers participate. In Finland, this is called the Mankala model, and the participants are both corporations and governments. In the US, the participants are also corporations and governments, but also customer cooperatives. Government price regulation in the form of a Contract for Difference, which guarantees the operator a minimum price, supports the financing of Hinkley Point C 1-2. A price measure is not known for the other five cases. The proposed Dukovany 5-6 project takes three (EU-approved) price measures: direct price support via a power purchasing agreement (PPA), a two-way Contract for Difference, and a partly closed price market (30%) through government auctioning.

The study analysed the government contribution to the financing of the six selected construction projects. This has led to some remarkable observations:

• In the Olkiluoto and Hinkley Point cases, the financial contribution of the domestic governments (Finland and the UK, respectively) was limited, while the contribution of foreign governments was significant. In literature, this is sometimes called government-to-government financing, but a more accurate term is government-supported vendor financing. In the mentioned cases, the governments support the export opportunities in favour of their national nuclear sector.

• Remarkably, this has come at a considerable price, especially for the French government, which had to restructure and nationalise Areva and EDF.

• Furthermore, especially in the cases of Olkiluoto, Hinkley Point and Vogtle, the domestic government turned out to be more involved in the financing than it was thought. This is caused by governments owning significant company shares through their ultimate beneficial ownership of the project sponsors, which is not visible at first sight.

• Due to EDF's nationalisation and its presence in three of the case studies, these projects started with a larger corporate share of equity and ended up with a larger government share of equity.

• The financing of Barakah 1-4 may be described as nearly pure government financing. The government financing of Shin Hanul 1-2 is set at 51%, following the government share in KEPCO. However, as the Government of South Korea is the majority owner, KEPCO is statecontrolled and, therefore, the financing decisions of Shin Hanul 1-2 are in the hands of the government.

• The financing of Flamanville 3 may be described as a mix of government and corporate financing, with the government share getting larger in time, due to the covering of losses, shareholders buy-out and nationalisation. Part of the losses were also borne by the shareholders in the form of missing out on dividend payments and the loss of shareholder value. Although fully government-owned, EDF is a corporation, and part of the losses have been covered by internal accounting at the expense of returns of operations of other business activities. Also, a part of the financing has been provided by commercial lenders.

• The realised construction cost per installed kWe varies from EUR 2,324 to 15,175 per kWe. There is no clear relationship between government participation and lower costs.

• The government's participation in the ultimate beneficial ownership of the project companies varies from roughly a quarter (24.3% of Vogtle 3-4) to full ownership (100% of Flamanville 3). Remarkable is the large government participation in the projects in France and the UK. Also remarkable is the government participation in the projects in Finland (24.3%) and the US (24.3%), which have only private companies as project sponsors. On average, government participation (UBO) is 64.3%.

Table 24 Key findings for the six selected construction projects (cost in EUR million, lead time in years)

	Olkiluoto-3	**Shin Hanul 1-2**	**Barakah 1-4**	**Vogtle 3-4**	**Flamanville 3**	**Hinkley Point C 1-2**
Location	Finland	South Korea	United Arab Emirates	United States	France	United Kingdom
Reactor type	EPR-1600	APR-1400	APR-1400	AP-1000	EPR-1650	EPR-1650
Reactor supplier	Areva/EDF	KHNP	KHNP	Westinghouse	Areva/EDF	Areva/EDF (France)
Country of supplier	France	South Korea	South Korea	United States	France	France
Financing model	Government/ Corporate/ Cooperative	Government/ Corporate	Government/ Corporate	Government/ Corporate/ Cooperative	Government/ Corporate	Government/ Corporate/ CfD
Budgeted cost	3,200	3,950	14,100	9,200	3,300	24,700
Realised cost	11,000	6,400	24,000	33,900	19,900*	46,100*
Budget overrun	7,800	2,450	9,900	24,700	16,600*	21,400*
Budget overrun factor	**3.4**	**1.6**	**1.7**	**3.7**	**6.0***	**1.9***
Construction start	12-Aug-05	10-Jul-12	19-Jul-12	22-Jun-09	3-Dec-07	11-Dec-18
Scheduled commercial operation	30-Jun-09	1-Apr-18	1-Jul-18	31-Dec-17	31-Dec-12	30-Jun-25
Commercial operation start	1-May-23	5-Apr-24	1-Sep-24	29-Apr-24	1-Jan-25*	31-Dec-30*
Scheduled lead time	3.9	5.7	5.9	8.5	5.1	6.6
Realised lead time	17.7	11.7	12.1	14.9	17.1*	12.1*
Lead time escalation	13.8	6.0	6.2	6.3	12.0*	5.5*
Lead time escalation factor	**4.6**	**2.1**	**2.0**	**1.7**	**3.4***	**1.8***
Reference net capacity (MWe)	1,600	2,754	5,321	2,234	1,330	3,260
Cost in EUR per kWe	**6,875**	**2,324**	**4,510**	**15,175**	**14,962**	**14,141**
Government participation (UBO)	28.5%	51.1%	91.2%	24.3%	100.0%	90.8%

For Dukovany and Borssele, the cost per kilowatt (electric) is taken from the case studies and varies from EUR 2,324 (low) to 9,665 (mean) and 15,175 (high expectation). The Dukovany bid translates into EUR 8.778 and the Borssele rough budget estimate into EUR 7,037 per kilowatt (electric).

The International Energy Agency (IEA) uses a value of EUR 6,230 per kWe for nuclear in its scenarios. A 2021 KPMG study identified an average cost per kW installed capacity of EUR 4,973 per kW. The 2022 Witteveen+Bos study identified an average cost of EUR 7,959 per kW but applied a cost of EUR 3,520 per kW in its scenarios. Since the current research identified a mean cost of EUR 9,665 per kWe, it is clear that updating the actual cost of the six projects was necessary. This outcome provides the opportunity to update, reassess, and improve the cost estimates for Borssele 2-3. Higher cost estimates may also lead to changed insights into cost-effectiveness by comparing scenarios of the future energy mix.

The costs per kilowatt (electric) for renewable energy sources range from 1,050 (solar PV) to 1,850 (wind onshore) and 3,620 (wind offshore). The study identified a mean cost per kilowatt (electric) for nuclear power plants of EUR 9,665. This price difference makes solar and wind highly favourable compared to nuclear when considering cost efficiency, lead times and financial risk.

Profundo identified an average construction lead time of 14.3 years. The expected construction lead times for Dukovany and Borssele are taken from the case studies and are in the range of 11.7 (low) to 17.7 years (high expectation). For Dukovany 5-6 this would result in a commercial operation date between December 2036 and December 2042; and for Borssele 2-3 a commercial operation date between September 2039 and September 2045.

A new nuclear power plant will come too late to result in carbon savings that will contribute to the climate targets for 2040 and earlier. Clearly, a contribution to the 2035 target of carbon-neutral electricity production in the Netherlands is out of sight. Potentially, Borssele 2-3 could contribute to reaching the 2050 climate targets. Whether this may be a significant contribution is a question open to further research.

Source :
Profundo. (2024 27 September). Financing new nuclear Governments paying the price?

World Nuclear Power Status

Number of Reactors
(as of November 2024)

Compared to the last edition of the Nuclear Monitor (920);

- ✓ The status of 1 nuclear power reactor (Shidaowan Guohe One 1) in China has been changed from under construction to operating.
- ✓ In Japan 1 nuclear power reactor (Onagawa-2) was restarted from long-term outage.

Continuing safety problems French nuclear power plants

Jan van Evert

In late 2021, cracks were identified in the pipes of the primary cooling system of the latest generation of French nuclear power plants (N4 of 1,450 megawatts). That is why the regulator ASN decided that these plants should close down pending a solution to the problem.

Subsequently, the owner of the nuclear power plants (EDF) also investigated the slightly older series of 1,300-megawatt nuclear power plants and the same problems were found there. Every reason therefore to investigate the 33 oldest generation nuclear power plants of 900 megawatts as well. Here too the same problems were found in a number of plants. All in all, the bottom line was that twelve nuclear power plants were no longer allowed to supply power and were temporarily shut down.

The repair of all nuclear plants would take several years, according to Bernard Doroszczuk, the chairman of the ASN. The repair would require the nuclear plants to be shut down piece by piece. This is no easy task, as was evident at the nuclear power plant Penly. Indeed, workers generally incur the maximum permissible annual dose in forty hours, despite their protective clothing. Sometimes that maximum is reached in just a few minutes and they are allowed to spend a year absorbing such work.

As of early 2022, France therefore imported power from Germany almost daily. The amount is equivalent to what the three German nuclear power plants operating until April 2023 could supply. According to EDF, it will take several years to complete all the repairs.

Units 1 and 2 of the Flamanville nuclear power plant were under enhanced surveillance by ASN from 2019 to 2022 because of shortcomings in some operating activities, a high number of maintenance faults, poor mastery of certain maintenance operations, and inadequate quality of the ten-year inspection documentation of unit 1. ASN warned already in 2021 that the number of 'significant incidents' is increasing in France.

An anonymous former head of safety at the Tricastin plant told Le Monde that incidents are reported too late or even covered up to keep the power plant running longer.

Despite many voices calling for a reduction in the country's nuclear dependence, the government is pushing ahead with its plans to build fourteen new reactors before 2050.

France returns last nuclear waste to Germany

Jan van Evert

The French company Orano has announced that the last rail shipment of vitrified high-level nuclear waste has reached the intermediate storage facility in Philippsburg in Germany on the 20th of November. Orano has processed in total 5310 tonnes in its reprocessing plant at La Hague. In August 2021 Orano signed contracts with the German companies PreussenElektra, RWE, EnBW and Vattenfall for the return of all the German nuclear waste remaining at La Hague. Germany still hasn't chosen a site for the permanent storage of high-level nuclear waste. A recent report concluded that a site could be designated in fifty years at best.