World Nuclear Investment Guide

A $6 Trillion Investment Opportunity

Nuclear Value Chain Investment Through 2050

WORLD NUCLEAR ASSOCIATION

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World Nuclear Association is the international organization that represents the global nuclear industry. Its mission is to promote a wider understanding of nuclear energy among key international influencers by producing authoritative information, developing common industry positions, and contributing to the energy debate.

A $6 Trillion Investment Opportunity:
Nuclear Value Chain Investment Through 2050

The opportunity

If the current nuclear capacity ambitions of governments were to be met, this would more than triple global nuclear capacity from around 400 GWe today to 1446 GWe by 2050.[1] This growth would require cumulative investment throughout the entire nuclear value chain of roughly $6 trillion (overnight capital costs in 2025 $) between now and 2050. This means annual investment needs to grow from around $80 billion[2] in 2025 to an annual average of about $250 billion over this period, significantly less than what the world invested in 2025 in wind and solar combined ($565 billion).[3] Yet, this investment would produce disproportionally more power. A 2025 analysis by EY finds that $1 invested in new nuclear would generate a midpoint estimate of 110 kWh of lifetime electricity generation, compared to midpoint estimates of 86 kWh for wind and 46 kWh for solar.[4] For a financial community weighing where to allocate capital, the expected lifetime generation per dollar[5] is therefore as relevant as the overall scale of the investment requirement.

Financial institutions, investors, and governments are keen to understand how much capital would be required to deliver the benefits of nuclear at scale, and also when, where in the value chain, and in which markets it is needed. This module translates current announced growth ambitions from governments and market actors into a quantified, time-phased investment requirement that the financial sector can act on.

What is included?

This analysis estimates cumulative capital expenditures across the nuclear value chain from 2025 to 2050 to reach the 1446 GWe global capacity by 2050 consistent with current governments' ambitions:

- Front end: fuel cycle that supplies reactors through uranium mining, conversion, enrichment, and fuel fabrication.
- Long-term operation (LTO) of the existing fleet and new reactor build (large nuclear reactors and small modular reactors).
- Back end: decommissioning and interim storage of used fuel. Geological disposal is referenced but excluded from the analysis (see methodological section).

Each segment has different financing needs, financial risk and reward levels, ROI timelines, structures, and mechanisms. Additional analysis on the different nuclear industry value chain segments will set out the financing model and nature of the investment requirement for each industry segment in more detail. A full version of this analysis will be released with additional modules of the *World Nuclear Investment Guide* in September 2026.

Figures throughout this module are overnight capital costs (construction cost excluding contingencies, interest and other charges that accrue during the build period). The capital financiers' commit sits on top of this. Interest during construction adds a further layer of cost that varies with the financing structure and build schedule.[6]

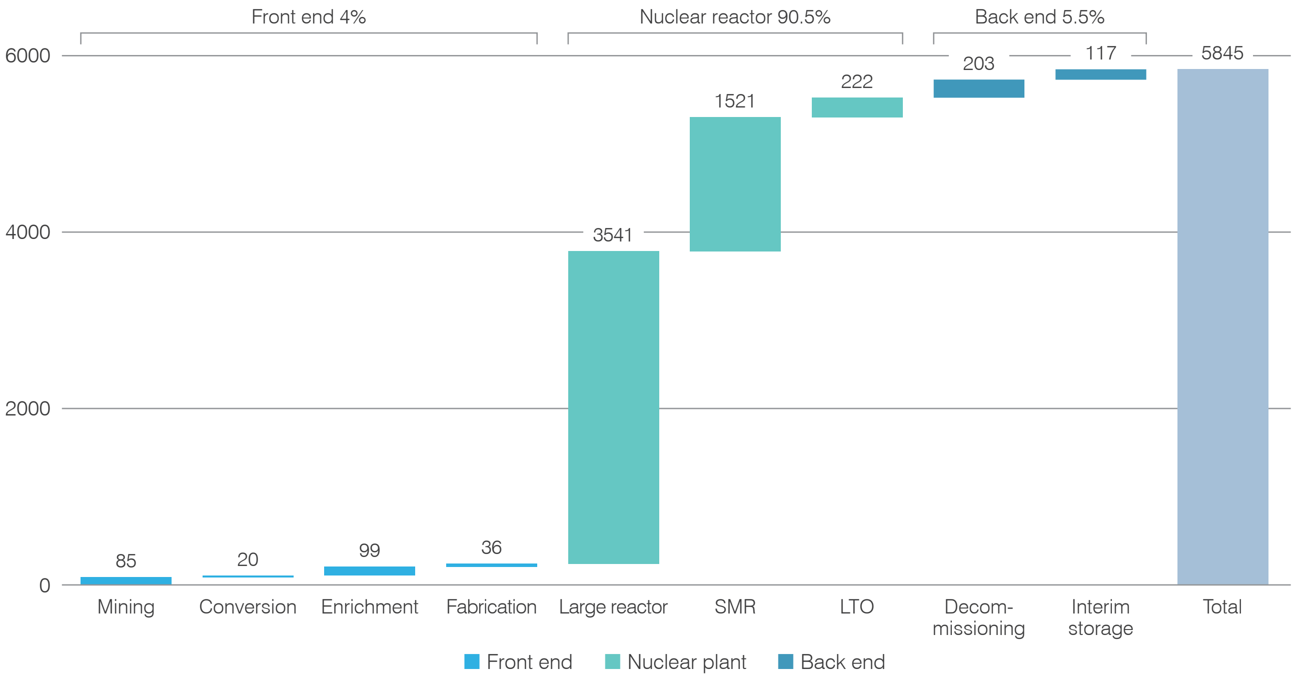
The apparent decline in investment during 2046-50 is a result of the analysis time horizon, not a projected slowdown in nuclear deployment. The model's capacity projections run to 2050 (per the *World Nuclear Outlook Report*), so reactors connecting to the grid after 2050 are not included, even though the capital required to build them may fall before 2050. Because new-build investment must be committed several years ahead of commercial operation, sustaining deployment beyond 2050 depends on investment decisions made within, not after, the 2046-50 window (or earlier). The figure shown for the 2046-50 period should therefore be read as a boundary of this investment analysis model, not a signal that investment in nuclear diminishes.

Key takeaways

- The global nuclear value chain requires a cumulative investment of around $6 trillion between 2025 and 2050 (overnight capital costs in 2025 $). Reactor investment accounts for the large majority of investment needs, 90.5% of the total. Front end and back end together account for less than a tenth of the total, but they represent strategically critical enablers to deliver new reactors. Front end fuel cycle investment, in particular, is a potential bottleneck to fleet growth and merits attention disproportionately to its dollar size.
- Enrichment dominates the front end, making up about $100 billion of a $240 billion requirement to 2050. Mining follows at about $85 billion, ahead of fabrication ($36 billion) and conversion ($20 billion).
- Nuclear reactor investment accounts for 90.5% ($5.3 trillion) of the entire value chain, split between large nuclear reactors ($3.5 trillion), small modular reactors ($1.5 trillion) and the long-term operation of existing plants (around $0.2 trillion). The $1.5 trillion investment in SMRs corresponds to around 260 GWe, about a quarter of new capacity.
- Investment in the back end (about $320 billion to 2050) is driven by the accumulated volumes of used fuel, waste, and decommissioning of retiring reactors.
- In this analysis, nuclear new build (and hence investment) would need to accelerate in the mid-2030s to meet governments' nuclear capacity goals. Investment rises from around $700 billion in the 2025-2030 period to around $2.3 trillion in the 2031-2040 decade as the wave of new build and the first sizeable SMR fleet start construction. Another $2.3 trillion capital deployment would be required in the ensuing ten years between 2041 and 2050. The shape of investment will change as governments and private actors modify their goals and timelines. Although this analysis only looks at capital requirements to build governments' current nuclear goals up to 2050, investment in nuclear will continue past 2050.

Nuclear plant investment need by type, 2025-2050

Overnight capital cost in 2025 $ billion: i.e. excluding financing costs and interest during construction.

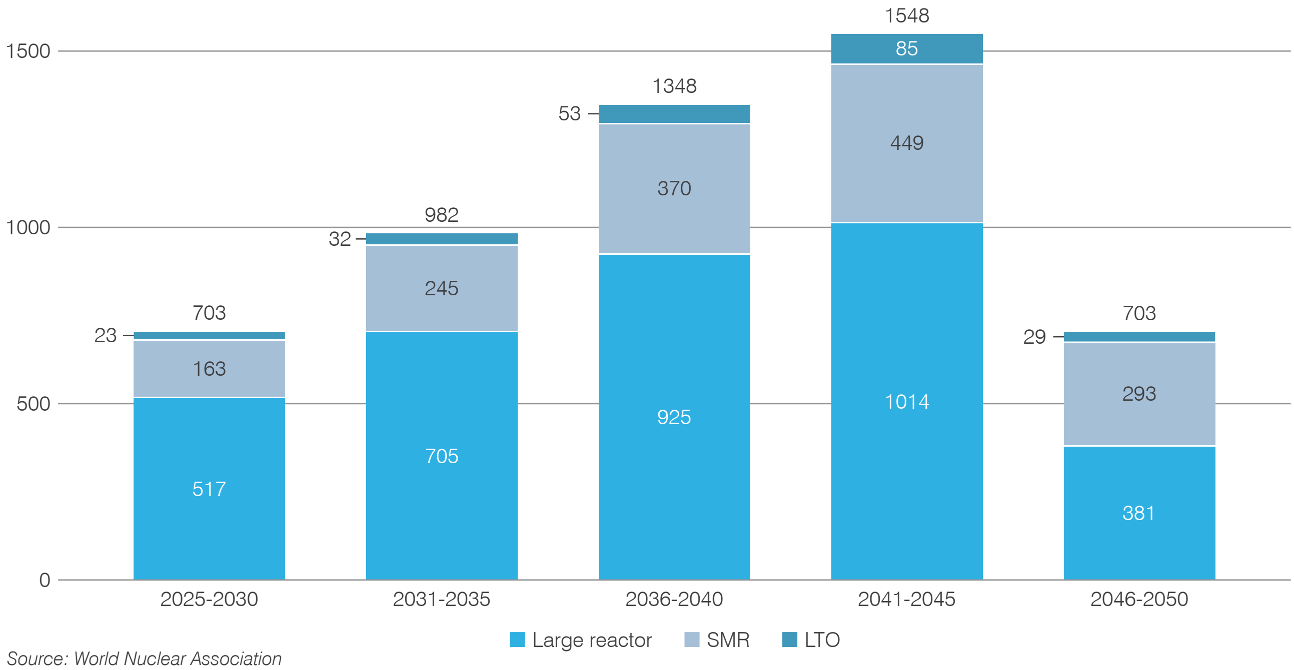


Source: World Nuclear Association

Note: SMR = small modular reactors; LTO = long-term operation. Geological disposal is excluded from the analysis. It represents an additional $514 billion.

Total investment need by step of value chain, 2025-2050*

Overnight capital cost in 2025 $ billion: i.e. excluding financing costs and interest during construction.



Source: World Nuclear Association

Note: SMR = small modular reactors; LTO = long-term operation

Investment is spread evenly over the reactor's construction period assumed to be 5 years for large units in Asia, 7 years in all other regions; 4 years for SMRs in all regions.

**Although this analysis only looks at capital requirements to build governments' current nuclear goals up to 2050, investment in nuclear will continue past 2050.*

Methodology and assumptions

The model used to estimate the investment requirement throughout the nuclear value chain is built bottom-up in three linked parts: nuclear power plants; the front end of the fuel cycle; and the back end. Each is driven by the same nuclear fleet trajectory, and each is costed on an overnight basis, excluding financing, grid connection, and transmission costs.

The model maps investment needs over seven regions that broadly cover distinct markets with differentiated nuclear and financial characteristics: China, India, East Asia, North America, West & Central Europe, Eastern Europe and Russia, and the Rest of the World which includes emerging and newcomer markets throughout the world. The full version to be released in September will include regional results.

Global nuclear capacity calculation

The nuclear capacity illustrating the demand of nuclear energy that drives all three parts of the model is drawn from the 2026 edition of the *World Nuclear Outlook Report*,[7] reaching 1446 GWe of operating capacity in 2050. Of this, about 1043 GWe is new build (260 GWe of small modular reactors and 783 GWe of large reactors) with the remainder made up of the existing fleet (402 GWe).

Large reactor capital costs use a region-specific starting overnight cost per kilowatt based on publicly available information on recent projects, reduced along a regional learning curve at a 10% learning rate per doubling of installed capacity.[8] For this investment analysis, reactor technologies and fuel infrastructure data come from recent nuclear project data, which is largely based on water-cooled reactor designs.

SMR capacity calculation

SMR capacity is assumed to reach 260 GWe by 2050. This amount is allocated across regions according to near-term committed projects together with each region's share of new build. SMR capex starts from a small early fleet of about 3 GWe and declines along a single global learning curve at a 12% rate for each doubling of capacity, until it reaches a floor of 40% below the starting cost, after which costs stop falling.

World Nuclear Association's SMR estimate is based on current assumptions on penetration rate. The actual mix between SMRs and large reactors could shift materially depending on the relative pace of learning-curve cost reduction achieved by each reactor class, grid size and network connection constraints, the relative maturity of each technology's supply chain and financing track record, as well as other factors.

LTO capacity calculation

Long-term operation (LTO) cost is based on investment needed to extend reactor operating lifetimes from 40 to 60 years and 60 to 80 years. No significant cost reduction is assumed for LTO.

Front end fuel services calculation

Front end includes mining, conversion, enrichment, and fuel fabrication. Fuel services are estimated using a supply-gap methodology. For each segment, fuel services demand is based on global nuclear capacity from the *World Nuclear Outlook Report* and fuel services supply data are from the 2025 edition of the World Nuclear Association's *World Nuclear Fuel Report*.[9] Fuel services facilities investment costs are a capacity-weighted average of publicly available project costs.

Back end decommissioning and waste management calculation

Back end includes decommissioning and interim storage of used fuel. Used fuel is estimated at 26 tonnes of heavy metal per GWe-year,[10] and decommissioning is based on 123 GWe of current and planned reactor shutdown by 2050.

Disposal is costed on the inventory routed to direct disposal, around 70% of total used fuel, with the remaining 30% reprocessed. Costs are a capacity-weighted average of publicly available project costs. Geological disposal ($514 billion in investment) is excluded from the $6 trillion figure as it is historically funded through generator-paid waste management levies (charged per unit of electricity sold) held in dedicated national funds, and the decision to move forward with their construction and the implementation of the programme is a governmental responsibility.

References

1. World Nuclear Outlook Report, World Nuclear Association, 2026
2. World Energy Investment 2026, International Energy Agency, June 2026
3. Ibid
4. Making Investment in the Nuclear Value Chain Attractive, EY, 2025. EY estimates ranges of 69-152 kWh/$ for nuclear (2036 vintage), 42-131 kWh/$ for wind and 24-68 kWh/$ for solar. The figures cited in the text are the midpoints of these ranges. Existing nuclear shows an even greater differential with other sources at 113-250 kWh/$ invested.
5. Additional information on nuclear's value is included in *World Nuclear Investment Guide - Nuclear Must Knows*, World Nuclear Association, September 2026 [forthcoming]
6. Financing structure and cost of capital are addressed in *World Nuclear Investment Guide - Nuclear Must Knows* and *Investment Model* modules, World Nuclear Association, September 2026 [forthcoming]
7. World Nuclear Outlook Report, World Nuclear Association, 2026
8. All learning rates are based on learning curves from Meta-Analysis of Advanced Nuclear Reactor Cost Estimations. INL-RPT-24-77048. Idaho National Laboratory, 2024
9. World Nuclear Fuel Report, World Nuclear Association, 2025
10. Radioactive Waste – Myths and Realities, World Nuclear Association, February 2026

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