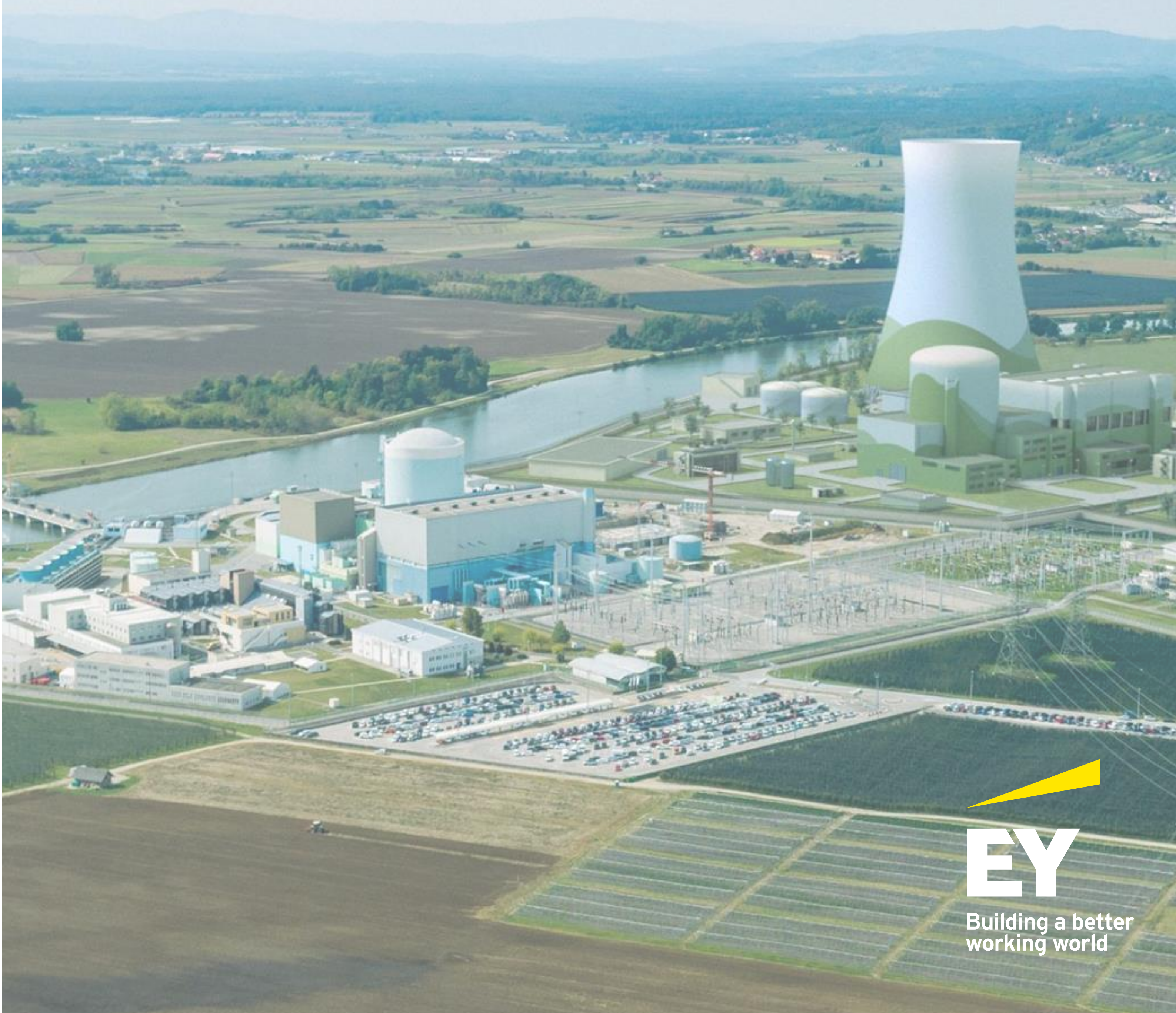
Independent Review of Economic Analysis Input Data of the JEK2 Project

GEN energija

15 October 2024



Disclaimer

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The report reflects information as of October 15th, 2024. Material events may therefore have occurred after this date which are not reflected in the report.

Table of Content

Foreword

This report, commissioned by GEN energija (GEN) and prepared by EY, aims to provide insights into the key construction and operational cost components of a large-scale nuclear newbuild project in Slovenia. Drawing from GEN's previous analysis, the latest academic and industry research on nuclear newbuild costs in Western countries, and EY's experience, the report also offers an updated perspective on the expected costs Slovenia may face in its efforts to decarbonize its electricity generation.

The data points have been anonymized and categorized to offer insights into how cost segments could be evaluated on an international scale. The report was developed to offer an independent assessment for the wider public on the competitiveness of nuclear technology in Slovenia.

The findings presented reflect EY's extensive research and analysis, incorporating observed trends and market-standard assumptions for nuclear newbuild projects in Slovenia, consistent with available literature and anticipated outcomes.

It is important to note that the views expressed in this report represent the results of EY's research and do not necessarily reflect the institutional positions of EY or GEN.

Ljubljana, Slovenia
15 October 2024




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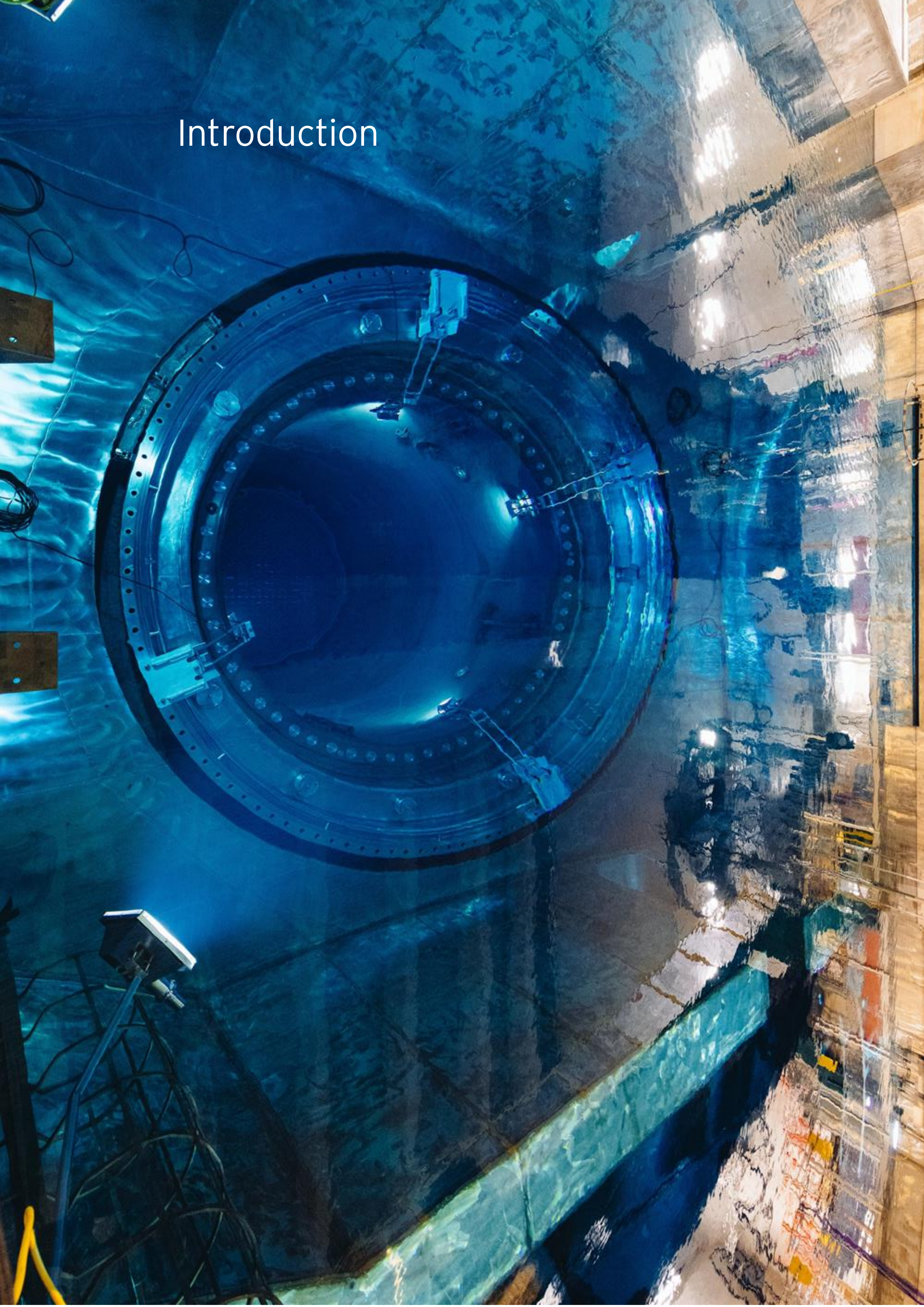
JEK2 images provided by GEN

Introduction



Purpose of this report

The purpose of this report is to inform and support the decision-making required by GEN and the Republic of Slovenia for the future role of nuclear in the country's supply of domestically produced, emissions-free electricity.

The JEK2 project involves the commissioning of a second nuclear reactor unit in Krško, legally-separate from the existing NEK power plant, and is one GEN's most strategic project which seeks to address some of the key energy challenges facing Slovenia, including rising demand, the phase-out of fossil fuels, and the limitations of solar and wind energy storage. The new reactor will both complement the existing reactor, and in the longer term replace its capacity. The country needs to upgrade and replace aging energy facilities and comply with EU climate regulations, which require reducing fossil fuel use. To meet these demands, building a new nuclear power plant at the existing Krško site is essential. This plan, aligned with the recent extension of the existing plant's operational life, will contribute to ensuring a reliable, safe, and carbon-free energy supply. JEK2 project involves significant financial investment and will take about a decade to complete, during which economic and financial conditions may shift. In this context, GEN's internal study, "Preliminary Pre-Investment Economic Analysis of the JEK2 Project", used insights from experts, vendors and the existing NEK operational data to provide a first analysis of the economic feasibility of the new plant. The findings have been publicly shared.

Considering this context, this EY's report aims to provide an independent review of the GEN's data study and a comprehensive benchmark of construction and operational costs of nuclear newbuild in the selected projects in comparable geographies. This data can be used to provide a baseline estimate of the anticipated cost of nuclear newbuild for Slovenia and GEN. The independent review aims to verify the accuracy of the input data used in the study and to enhance the credibility and confidence in the results shared so far. At the same time, the JEK2 project will be financially extremely demanding, and the Republic of Slovenia will need to play a substantial role in supporting the financial model that will enable the construction of the project. As such, three vendors (EDF, KHNP, Westinghouse) have been preselected based on their proven technology, and the availability of a reference plant for each of the reactor designs that will potentially be built at Krško.

Basis for preparation

Slovenia is on the verge of making a pivotal decision about the future of its energy sector, with GEN positioning the JEK2 project as its central strategic development initiative. The project will require several key decisions to be made in the short to medium term, with dedicated workstreams needed to reach final investment decision (FID). These decisions will focus on areas such as power capacity, reactor type, financing models, etc.

The selection of power capacity is a strategic national decision, shaped by factors such as Slovenia's future energy strategy, projected electricity demand, grid resilience, and the financial resources allocated to the project. While opting for a higher reactor capacity typically leads to increased electricity production, it also requires a higher upfront investment and additional spending on electrical infrastructure. However, economies of scale may contribute to lower operating costs over time. Furthermore, studies conducted so far have demonstrated that JEK2 is a feasible project that can ensure Slovenia's future reliable supply of domestically produced, electricity generated without producing any greenhouse gas emissions.

Considering this, the Slovenian parliament has decided to put the question of advancing JEK2 to a public referendum in on November 24th, 2024. If the referendum leads a positive result, it is expected that Slovenia will start construction of JEK2 by the end of 2028.

1. EY’s methodology for costs assessment

The purpose of this independent review, conducted by EY, is to assess the accuracy of the input data used in GEN’s study on the construction and operating costs of a nuclear newbuild in Slovenia, with the aim of enhancing the credibility and reliability of the results.

To ensure the highest level of confidence, EY performed a comprehensive, multi-phase analysis of the available data. This systematic review consisted of four key phases, each designed to validate and scrutinize the data thoroughly.

Information mapping

Based on the information provided by GEN, EY conducted a detailed review of the available data provided, utilizing operational and financial data from the NEK power plant, alongside a comprehensive information mapping process. This approach ensured consistency and that no discrepancies in costing information were found across the various documents shared to date.

Review of available benchmarks and studies

For this assignment, EY compiled a list of recent studies, reports, and benchmarks related to nuclear power plant construction and operating costs. Additionally, historical data from nuclear projects was analyzed to identify trends and cost variations.

This data served as a reference point to compare the GEN’s information with industry benchmarks, allowing EY to identify any discrepancies and align cost estimates with industry standards. The adjusted analysis aims to enhance the accuracy of the costs assessment.

EY’s analysis based on industry insights

After completing an initial review of the data provided by GEN and of public research, EY leveraged its proprietary information and expertise to offer more precise industry insights into cost estimates observed for other nuclear power plants worldwide.

Grading system

GEN’s input cost data was then evaluated and graded as "Acceptable", "Acceptable with observation", or "Unacceptable" based on its alignment with EY’s independently developed benchmarks. This rigorous and objective evaluation ensures that the accuracy and reliability of GEN's cost data are measured against established industry standards.

Table 1: Grading system of EY independent review

Category	Methodology
	▶ The methodology and assumptions used by GEN allow to conclude on a satisfactory estimate (i.e., neither underestimated nor overestimated) based on available data, international practices (see minimum and maximum values extracted from benchmarks) and particular conditions of the Slovenian local market.
	▶ The methodology and assumptions used by GEN allow to conclude on a satisfactory estimate (i.e., neither underestimated nor overestimated) based on available data, international practices (see minimum and maximum values extracted from benchmarks) and particular conditions of the Slovenian local market. However, this estimate could be improved in the next phases of the project by taking into account some additional elements highlighted in our analysis. ▶ Results could be considered as acceptable however assumptions and/or methodology must be developed further to conclude positively without observation.
	▶ The methodology and assumptions used by GEN do not allow to conclude on a satisfactory estimate (i.e., neither underestimated nor overestimated) based on available data, international practices (see minimum and maximum values extracted from benchmarks) and particular conditions of the Slovenian local market, and lead to a significant underestimation or overestimation of the cost. ▶ The lack of detail shared on the methodology and assumptions used do not allow to conclude positively.

Legend  Acceptable Acceptable with observation  Unacceptable

Overview of Slovenia's nuclear energy plans and NEK & JEK2 related cost breakdown structures

JEK2's 3D projection on Krško nuclear power plant site

The purpose of this section is to provide background on Slovenia's electricity market, review the experience of the NEK nuclear power plant, and offer comparative insights between the NEK and JEK2 projects to better contextualize the analysis that follows. Additionally, this section highlights the typical cost structure of a nuclear power plant using NEK and JEK2 as examples, giving the reader a clear sense of the scale and magnitude of the costs discussed throughout the document.

Slovenia's nuclear energy plan

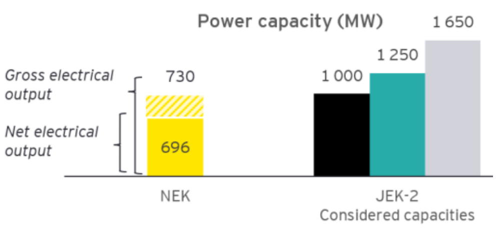
The proposed nuclear newbuild project, JEK2, would not only enhance Slovenia's energy production capacity but also reduce its dependence on energy imports, thereby bolstering the nation's strategic development and long-term energy sovereignty.

To meet future energy demand and diversify its energy mix, Slovenia plans to phase out fossil fuels. Slovenia also faces the dual challenge of aging energy infrastructure and the need to comply with EU climate regulations. Nuclear power, as a low-carbon and stable energy source, offers a solution for reducing CO2 emissions and stabilizing electricity prices. In response, Slovenia views the construction of a new nuclear power plant at the existing Krško site as essential, complementing the recent extension of the current plant's operational life of NEK until 2043. This initiative aims to ensure a reliable, safe, and carbon-free energy supply.

Currently, nuclear power accounts for about one-fifth of Slovenia's electricity generation. To expand this capacity, the country is considering the construction of a new unit, JEK2, at NEK before the existing plant is decommissioned. This is a critical step, as electricity consumption is projected to more than double by 2050, and the closure of the Šoštanj Thermal Power Plant (TEŠ) after 2033, along with NEK's extended life cycle ending in 2043, creates additional urgency.

The proposed JEK2 plant would not only increase Slovenia's energy production capacity but also reduce its reliance on energy imports, strengthening the country's strategic development and long-term energy sovereignty.

Figure 1: Power capacity of NEK and the considered capacities of JEK2



The JEK2 project is currently in its preliminary and planning stages, with feasibility studies underway to assess the economic, technical, environmental, and legal aspects of the project. Various financing options will then be assessed and discussed, which could include state funding, loans from international financial institutions, and potentially private sector involvement through partnerships, investment vehicles, or vendor investment. The final investment decision on JEK2 is expected to be made by the Republic of Slovenia no later than the end of 2028. According to the projected timeline, JEK2 would begin operations by 2040, three years before the end of NEK's extended operational life.

Figure 2: Timeline for JEK2 project

Overview of the NEK & JEK2 cost breakdown structures

Nuclear newbuild costs are composed of capital expenditures (CAPEX) and operating expenditures (OPEX). To meet the capital expenditures, nuclear newbuild projects need to raise enough financing prior to the construction to cover for total project costs (including but not limited to CAPEX). Cashflows generated during the project lifetime, usually by the electricity production of the power plant, will be used to cover for OPEX and generate sufficient financial resources to remunerate capital (equity and debt) providers.

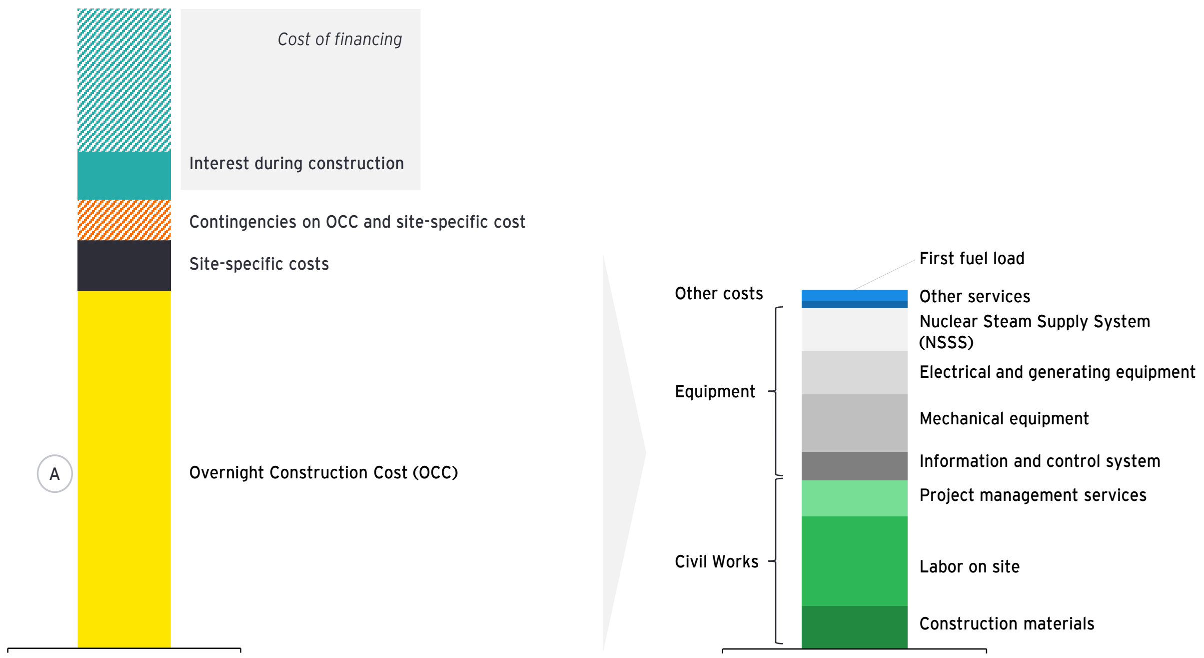
Capital expenditures

Nuclear power plants are capital intensive energy generation assets. The construction of the nuclear power plants as well as its operation will be reflected on the final price of electricity (Levelized Cost of Electricity, LCOE). GEN seeks to achieve a competitive cost of electricity that would be ideal for the Slovenians.

For the construction of the nuclear power plant such as JEK2, its final cost is defined by overnight construction costs (OCC) as well as financing costs. OCC represents the cost of building a plant as if it happened "overnight" with no cost of capital. It includes all costs which are incurred to design, construct and commission the plant, as seen in the figure 3 below.

This is inclusive of all civil works, engineering and design of the plant, procurement, installation, and commissioning of major equipment and components. Cost of financing includes financing fees such as commitment fees, upfront fees and interests during construction incurred for the use of borrowed funds.

Figure 3: Breakdown of a nuclear power plant's capital cost



In recent nuclear newbuild projects, equipment has generally represented around 30-50% of the overall cost of construction, while civil works and other activities (such as transportation, design, engineering, etc.) vary considerably due to the quality of project management, the availability and cost of a pool of qualified labour force, and the quality of the materials supplied.

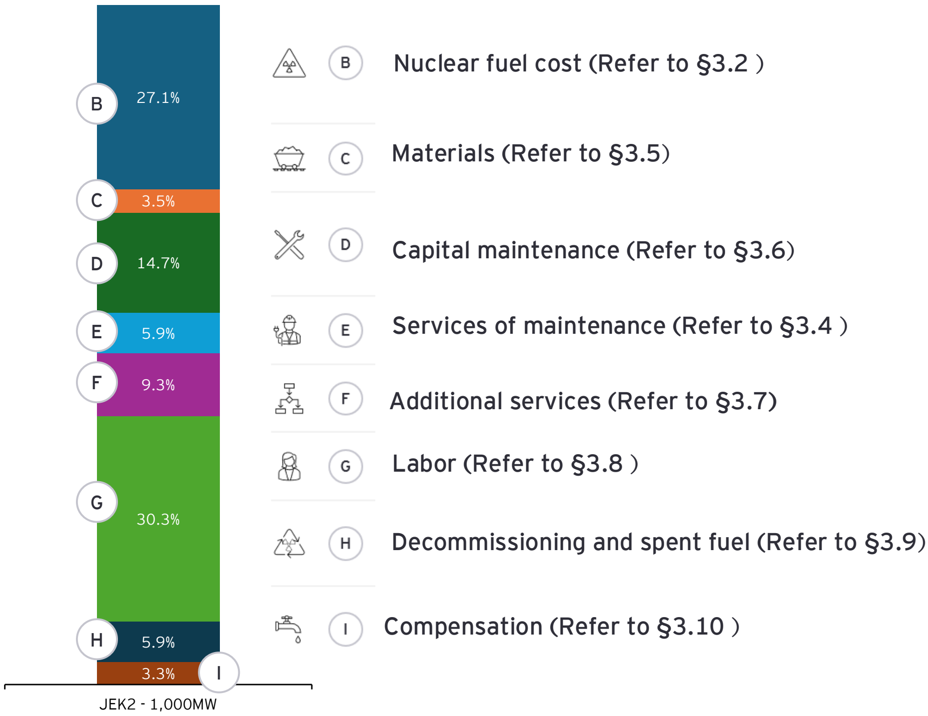
Operating expenditures

To maintain a steady supply of electricity to the market, JEK2 will incur operating costs over its lifetime. The nature of these costs is similar to those faced by the nuclear power plant currently in service in Slovenia (NEK). These operating costs are related to:

- Hiring a workforce responsible of piloting the nuclear power plant;
- Maintaining the nuclear power plant;
- Purchasing nuclear fuel and treating the associated waste;
- Decommissioning at the end life of the nuclear power plant;
- And executing compensation.

In Figure **4**, the estimated operating cost breakdown for JEK2 is illustrated considering a capacity of 1000MW. Expenses related to labour, nuclear fuel and capital maintenance account for around 72% of total operating costs.

Figure 4: Breakdown of a nuclear power plant's operating costs



Source: GEN Energija

Figure 5: 3D Simulation of the next nuclear power plant JEK2

2. Summary of findings on JEK2 forecasted items

As explained in the previous section, EY's analysis drew on a variety of sources to corroborate and detail the results presented in the following section. EY followed the steps outlined below to gather and analyze data on the costs associated with the construction and operation of the nuclear power plant, utilizing input from GEN as well as relevant international data.

Table 2 presents the results of EY's independent review of each cost item estimated for the JEK2 project, whether capital expenditure, operational expenditure, or other costs. Each item is classified according to its level of acceptability, as defined in the methodology. For items categorized as "Acceptable with observations," EY has provided recommendations for refining the analysis.

Further details of the analysis and recommendations can be found in the itemized analysis in Section 3, with references provided at the start of the table. It is important to note that no item was classified as "unacceptable," meaning all cost estimates are considered acceptable at this stage, though some areas could benefit from refinement through short- and medium-term recommendations.

Figure 6: Future nuclear power plant JEK2 at Krško site

Table 2: Summary of findings on JEK2 forecasted items

Reference	Item	Acceptability	Comment
3.1	Overnight construction costs (OCC)	~	▶ **Overnight construction costs**: estimate seems to align with recent observed market data and supply chain feedback but needs a broader bandwidth to provide a buffer *(i.e. contingencies)* against adverse events.
3.2 3.3	Operating costs – Nuclear fuel costs	~	▶ **Initial loading**: estimate is high when compared with recent benchmarks and needs to be scaled with the size of the plant. ▶ **Fuel costs**: in line with market standards with a high degree of confidence.
3.4	Operating costs – O&M costs	✓	▶ **Headline O&M costs**: estimates are in line with market standards with a high degree of confidence.
3.5	Operating costs – Material costs	~	▶ Limited data availability does not allow for a high degree of confidence in rating this item.
3.6	Operating costs – Investment maintenance costs	~	▶ Limited data availability does not allow for a high degree of confidence in rating this item.
3.7	Operating costs – Costs of services	~	▶ **Costs of services**: estimate aligns with the most conservative benchmarks, but with a low degree of confidence.
3.8	Operating costs – Labor costs	✓	▶ **Labor costs**: estimate aligns with available benchmarks and local labour market expectations.
3.9	Estimate for the NPP decommissioning cost	✓	▶ **Decommissioning cost**: when scaled up, the estimate aligns with recent benchmarks and recommendations from international institutions (OECD-NEA, IAEA).
3.10	Estimate for NORP	✓	▶ **NORP and water reimbursement**: GEN should provide further details on the assumptions used based on NEK's existing regulation cost.
3.11 3.12 3.13	Other assumptions	~	▶ **Load factor**: estimate is high when compared with market standards. ▶ **LTO costs**: estimate is high when compared with market standards. ▶ **Depreciation**: estimate aligns with market standards.

Legend ✓ Acceptable ~ Acceptable with observation ✗ Unacceptable

3. Analysis of forecasted items

This chapter reviews each of the cost items covered in this report. Each section provides a description of the cost items under assessment, put in perspective of other projects and relevant literature. Finally, each section highlights key considerations for evaluating the acceptability of the cost items and proposes a set of potential steps to improve cost estimates in the future.

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3.1. Overnight construction costs

Overnight construction costs represent the total estimated expenses for completing a project as if it could be built instantly (overnight), without accounting for the time value of money, inflation, or interest accrued on loans during the multi-year construction period. These costs also exclude any additional site-specific expenses.

Overnight construction costs serve as a widely used benchmark for assessing the competitiveness of electricity-producing technologies, as they directly impact the overall cost of a plant's output through capital cost recovery charges.

GEN's methodology and assumptions

GEN provided estimates for the following items:

- Overnight construction costs,
- Contingencies.

The value for overnight construction costs provided by GEN is based on values provided by the three nuclear technology vendors (EDF, KHNP, Westinghouse) as an initial estimate of the total cost of the engineering, procurement, and construction (EPC) contract. These costs are only a preliminary estimate, as they do not yet take into account adjustments reflecting the Slovenian context, both in terms of contracting the supply chain (meaning how much of the equipment and content of the plant is localized or sourced abroad), the Slovenian regulations on construction, licensing, and other miscellaneous costs.

EY's analysis

Following a prolonged pause in nuclear development within OECD countries, the latest nuclear endeavours have contributed to the revitalization of the supply chain infrastructure. Concurrently, the sector has undergone substantial organizational transformation and has embraced a variety of new technological innovations.

With several nuclear projects nearing completion in OECD countries, the upcoming ten years present a critical period to leverage the accumulated expertise to enhance the financial viability of both conventional large-scale reactors and novel, cutting-edge designs like various small and advanced modular reactors.

Indeed, costs in recent decades have trended upwards in the Western countries due to a lack of nuclear energy development at scale for the last forty years, and recent industry analysis have generally forecasted high costs for nuclear newbuild (US DoE, EIA, IEA, MIT). However, more optimistic assessments do provide significant upside in case of adequate project management and support (US DoE, RTE, NREL), which can be expected once the industry finds its footing in the coming years.

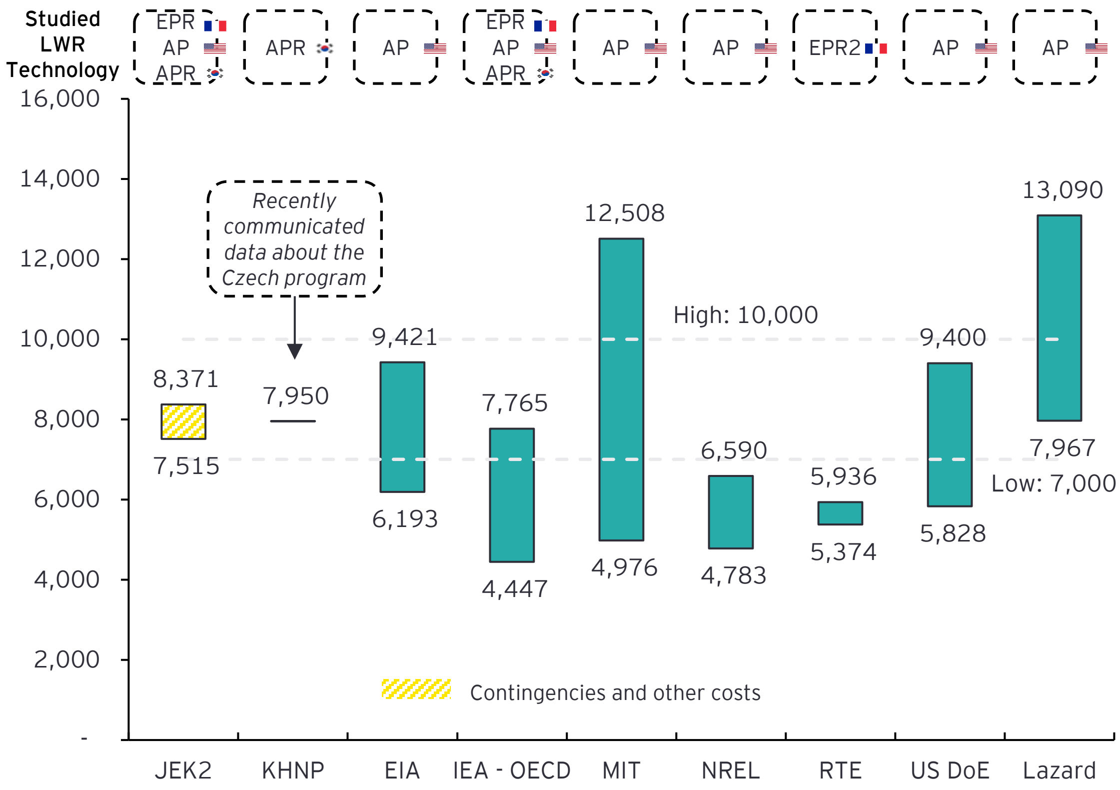
This has been observed in countries such as South Korea, where the costs of nuclear newbuild have generally been much lower than in the Western countries, competing with other low-carbon sources of energy. In certain instances, capital costs account for more than 70% of total new nuclear plant production costs (similar to hydropower projects). Due to its capital-intensity, nuclear projects require large amounts of capital to be mobilized upfront. Construction lead times and costs, together with the cost of capital, determine a plant's economic performance. Once a nuclear power plant is built, its operational costs are relatively low and predictable.

GEN provided initial estimates for its overnight construction costs of EUR/kW 7,515 when excluding initial contingencies (which are estimated to amount to EUR/kW 856, thus bringing the total cost to EUR/kW 8,371). This figure is obtained based on feedback from the nuclear technology vendors, and internal estimates from GEN.

Recent projects and literature have provided wide ranges of estimates (as seen in the chart below), which reflect the variations in supply chain readiness, construction experience, design maturity, technology, speed and efficiency of the regulatory process of various projects and jurisdictions. As such, a first-of-a-kind plant (i.e. FOAK, or first commercial-scale plant of its kind to be constructed and operated) typically faces higher risks, costs, and uncertainties compared to subsequent plants, known as nth-of-a-kind (NOAK), which can benefit from the experience, lessons learned, and economies of scale achieved from FOAK projects. The JEK2 project should be a NOAK plant, as its likely designs (AP1000, APR1400, or EPR1650) have all been built in various geographies, and benefit from ample accumulated experience from vendors on both the technological maturity and project development aspects.

While it is difficult to provide a definitive view on the final cost of the project, the estimates provided by GEN are in line with recent projects announced costs in Europe (Olkiluoto-3, Flamanville-3, Dukovany-5, EPR2 program). They also align with the upper end of the studies made by various reputable organizations assessing the anticipated costs of nuclear newbuild in the Western countries.

Figure 7: Overnight construction costs (EUR/kW)



- **On GEN's methodology and assumptions:**

The current estimates are mostly based on aggregated data from nuclear technology vendors, which is a sound methodology. Nonetheless, the price provided is very preliminary and needs to be significantly firmed up to provide greater cost certainty. To achieve this, it is recommended to proceed with a technical feasibility and costing study, whereby the vendors will be able to provide an initial review of their supply chain cost structure.

- **On GEN's output:**

While the data is highly preliminary, it mostly conforms with conservative estimates seen in the literature and recent announced project costs in Europe.

EY's recommendations

- Final overnight construction costs are highly dependent on supply chain readiness, mobilization and identification, project management capabilities of the vendor and the owner, and technological maturity of the chosen design. These assumptions need to be further detailed by the vendors when providing their costing analysis.
- GEN should firm up the price through guided technical and feasibility studies with the vendors and technical advisors to give a clearer picture of the anticipated costs considering the local context.

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3.2. Nuclear fuel costs

The nuclear fuel costs include the following items:

- Initial fuel loading of the power plant;
- Front-end fuel cost (i.e., the costs associated with the purchase of raw materials, conversion, enrichment and fabrication of the nuclear fuel assemblies, and its transportation to the site of the reactor);
- Back-end fuel cost (i.e., the costs associated with reprocessing of the spent fuel, and/or long-term storage by direct disposal of the spent fuel).

Nuclear fuel costs are a relatively small portion of the total cost of nuclear power generation when compared to the high capital costs of building the plant. However, they are still significant in the long-run, as one of the key components of operating expenditures and must be managed carefully to ensure the economic viability of the nuclear power plant.

The initial fuel loading cost for a nuclear plant is the expenses associated with the purchase, processing, and assembly of the nuclear fuel required to start up a nuclear reactor for the first time. This cost is a part of the overall capital investment for a nuclear power plant and is typically higher than subsequent fuel reloads due to several factors:

- **Quantity of fuel used**: a new reactor requires a full core load of fuel, which is more than what is needed for later refuelling when only a portion of the core is replaced during each refuelling outage.
- **Enrichment level**: the initial fuel may require a higher enrichment of U-235 than the fuel used for later reloads, which can increase the cost.
- **Fabrication costs**: the cost of fabricating the fuel assemblies, which includes the costs of materials (such as zirconium for cladding), labour, and quality assurance processes.

- **Engineering and design**: the initial fuel load may require additional engineering and design work to ensure optimal core performance and safety.
- **Licensing and regulatory fees**: there may be fees associated with the regulatory approval of the initial fuel design and loading pattern.

GEN's methodology and assumptions

The initial fuel loading cost is a significant upfront investment and can represent a substantial portion of the non-construction capital costs of a nuclear power plant. Subsequent refuelling costs will occur at regular intervals throughout the plant's operational life, estimated to happen every 18 months for JEK2, and will involve replacing only a fraction of the core with new fuel assemblies.

EY's analysis

GEN estimated its initial fuel loading costs at EURm 262.5, regardless of plant capacity. However, research indicate that this cost might be overestimated when looking at similar costs from recent nuclear power plants in the Western countries, as we have been able to find costs for several recent cases ranging from EURm 119 for a 1,350MW plant up to EURm 184.3 for a 1,650MW plant.

This indicates that the current cost should be adjusted for the size of the plant and decreased significantly when looking at recent fuel loading costs.

However, GEN's estimate could reflect that a high level of caution was used in the estimate, in line with increased nuclear fuel prices in recent years. Indeed, U2O8 long-term prices increased from USD/lbs 32 in January 2019 to USD/lbs 80 in July 2024 and are expected to increase further in coming years. This is expected to significantly alter the cost of initial fuel loading if confirmed.

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3.3. Operating fuel costs

The cost of fuel also incorporates the purchase of additional fuel reloads over the lifetime of the plant, used to power the reactor while it is operational.

GEN's methodology and assumptions

GEN provided initial estimates (based on NEK performance and vendor-supplied data), that the costs of JEK2 should be EUR/MWh 8.5-9.1, a marked increased from NEK's costs of EUR/MWh 5.6.

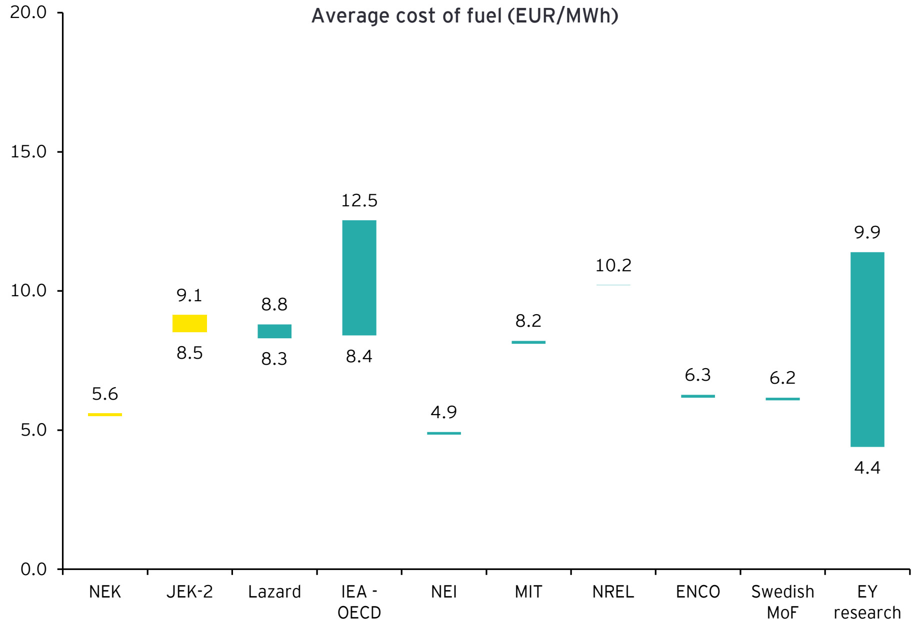
EY's analysis

Public data was made available in various landmark studies published in recent years on the cost of nuclear fuel for various operating plants such as the AP1000 (Lazard, IEA, EIA, MIT and NREL), the European Pressurized Reactor (IEA), and the APR1400 (IEA) which are all potential options for the JEK2 project.

These datasets project that costs in nuclear plants around the world are spread between a EUR/MWh 4.5 at the lowest (according to the NEI based on the average cost of fuel in plants in the US) and EUR/MWh 12.5 at the highest (according to data from the IEA based on Slovakia's older VVER V-213 plant).

However, the available data is heavily concentrated in the EUR/MWh 6-10 range across the studies that we find, which is also corroborated with EY proprietary data of a fuel cost of EUR/MWh 4.4-9.9 for new plants in recent years.

Figure 8: Annual cost of fuel (EUR/MWh)



- **On GEN's methodology and assumptions:**

Initial fuel loading cost: the final cost of the first fuel loading should be commensurate with the capacity, and not flat as has been shown previously in GEN's documentation. The calculation needs to be refined to consider critical elements such as the anticipated quantity of fuel used, its individual cost, reactor core information, fuel power, thermal efficiency, and power level.

Fuel cost: The current methodology should be reviewed as it is based on a pro-rated increment of NEK's fuel cost. Instead, GEN should share its analysis of the fuel consumption and future fuel price estimates.

- **On GEN's output:**

Initial fuel loading: while the lack of data does not allow to provide a high degree of confidence, the output seems in line with expected costs provided by the literature, but above recent available market benchmarks. Additionally, the cost of the initial fuel loading should be included in the initial capital expenditures of the plant.

Fuel cost: the data provided seems in line with both the available literature and observed market benchmarks, with a high degree of confidence.

EY's recommendations

- The methodology for both assumptions used by GEN needs to better integrate traditional market costing elements using technical data made available by the vendors.
- While the results seem to align relatively well with the available data from the literature and market benchmarks, further research is needed to firm up the eventual price of both data points.

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3.4. Operations & Maintenance costs

Operations & Maintenance (O&M) costs are the estimated annual costs of running and maintaining the plant to its most operational state, and include all the non-fuel-related costs such as the following:

- Materials costs (cost of consumables, parts and materials needed for the smooth functioning of the plant);
- Annual maintenance, investments and repairs of equipment and infrastructure;
- Services costs for the plant (e.g., additional hiring of services for outages, and other services such as the production of inputs, banking, insurance services, and additional miscellaneous items);

Labor costs for paying the salaries and emoluments of the staff operating the plant.

GEN's methodology and assumptions

O&M costs are the estimated annual costs of running and maintaining the plant at its highest performance level, and include all the non-fuel-related costs such as the following:

- Materials costs (cost of consumables, parts and materials needed for the smooth functioning of the plant);
- Annual maintenance, investments and repairs of equipment and infrastructure;
- Services costs for the plant (e.g. additional hiring of services for outages, and other services such as the production of inputs, banking, insurance services, and additional miscellaneous items);
- Labor costs for paying the salaries and emoluments of the staff operating the plant.

EY's analysis

These costs will be further studied in later sections, while this section proceeds with a top-down approach of O&M costs. This is due to a methodological difference between the literature and the data that EY could collect during its research from operational power plants and proprietary information available to us.

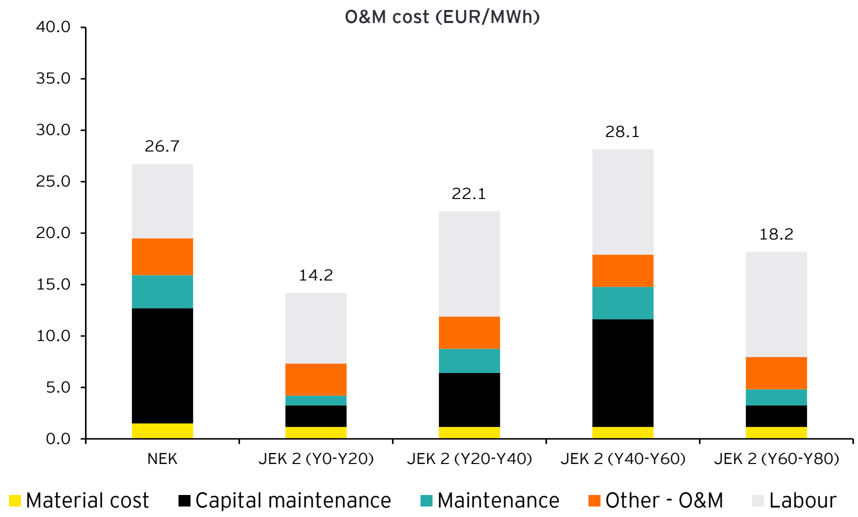
While the literature generally looks at the O&M using variable and fixed costs parameters, they do not provide a detailed breakdown of O&M by subsection as described above.

Nonetheless, EY's view is that public research inputs provided a credible benchmark for total O&M costs, and a reasonable backstop to the data provided by GEN in its analysis.

As shown in the graph below, GEN has estimated that the costs of operating JEK2 would escalate over time as the plant ages. While the total O&M costs would be of only EUR/MWh 14.2 in years 0-20, they would increase to EUR/MWh 28.1 in years 40-60 due to increasing labour and maintenance costs. However, when the plant will be close to reaching its full operational lifespan, the cost to maintain it should decrease significantly, leading a lower O&M cost of EUR/MWh 18.2 in years 60-80.

These assumptions will be further explained in the relevant sections.

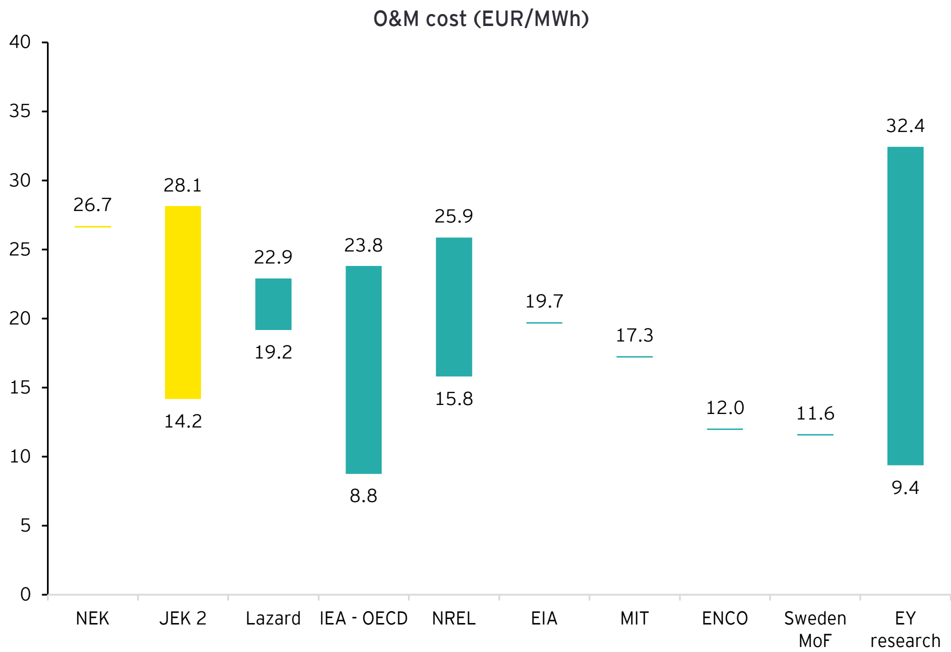
Figure 9: Operations & Maintenance costs



As such provided figures are benchmarked with other reputable academic sources, which estimate that the total O&M cost should be between EUR/MWh 8.8-25.9 depending on the age of the plant, with new nuclear generally trending on the lower end of the figure and older installed plants on the upper end.

This data is corroborated by research, which also provides a wide range of studied O&M costs representing between EUR/MWh 9.4-32.4. However, most newbuild projects are distributed around the EUR/MWh 10-15 range, which indicates a high degree of certainty for this cost distribution.

Figure 10: Operations & Maintenance costs



- **On GEN's methodology and assumptions:**

While most of the costs are based on historical costs of NEK, this should not be seen as an optimal factual basis for predicting the actual O&M cost. An independent assessment based on the vendors' feedback should be the main source of information for the final anticipated cost of the plant.

- **On GEN's output:**

While the proportion of variable cost to O&M cost is relatively low in comparison to market standards, the overall O&M cost is in line with market estimates. The evolution of overall O&M costs also reflects well the increasing burden of maintaining ageing plants and seems to conform to international comparable.

EY's recommendation

- O&M price certainty needs to be studied with the vendors using data points from their recent operational plants (Vogtle-3 and 4 for Westinghouse, Barakah for KHNP, and Olkiluoto-3 and Flamanville-3 for EDF) to guide GEN in better estimating its final cost.

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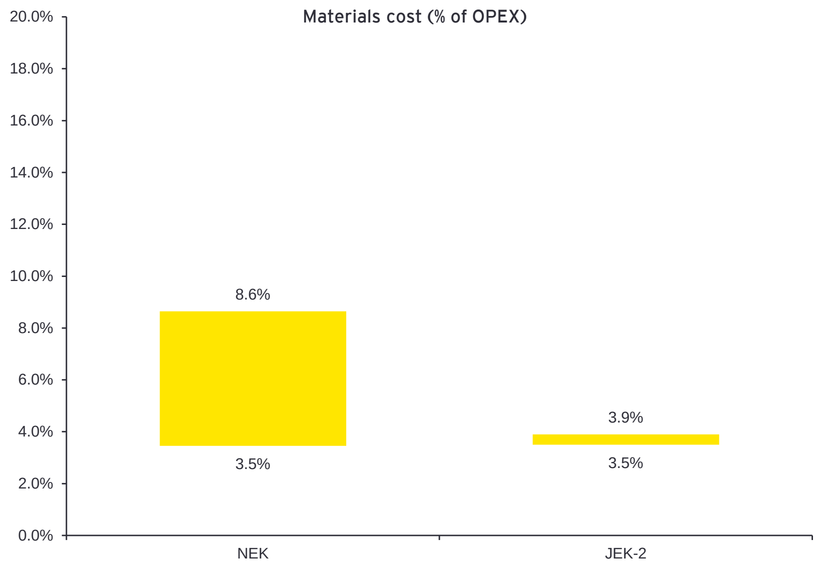
3.5. Operating expenditures – Materials costs

Material costs include the materials and consumables required for the operations and maintenance of the nuclear power plant, considering operating standards and other activities.

GEN's methodology and assumptions

While the cost of materials is reduced significantly for JEK2 in comparison to NEK (as seen in the graph below), it should remain constant at EUR/MWh 1.17 over the lifespan of the project but decrease as a share of OPEX due to increasing maintenance and labour costs over time.

Figure 11: Operating expenditures — Materials costs



EY's analysis

When looking at the financial statements from other nuclear power plants in the Western countries, this cost is generally not separated from other additional items (such as services, or nuclear fuel), which makes it difficult to provide adequate benchmarks for this item as the available data from similar plants generally does not cover a similar breakdown of costs. Indeed, "materials" costs can range to nearly non-existent to above EUR/MWh 10.3, depending on the dataset that is considered. Therefore, it is difficult to state whether this item conforms to market standards.

Materials costs are difficult to estimate with a high degree of confidence considering the lack of consistent benchmark available (nuclear projects do not disclose materials costs in a consistent and similar way). GEN should further detail the anticipated volume and cost of each item required for the optimized operations of the plant, in order to provide a more detailed estimate on the final cost of materials.

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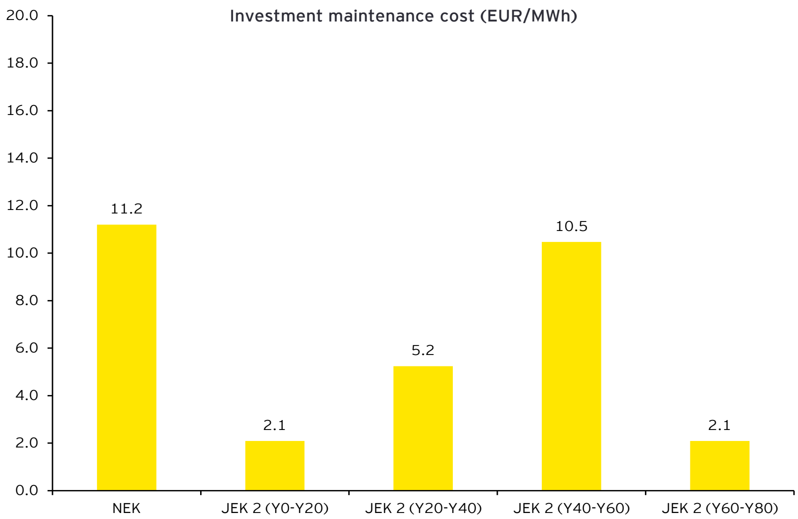
3.6. Operating expenditures – Investment maintenance costs

Capital maintenance costs encompass investments in maintaining plant and equipment to ensure operations at the highest performance. They evolve over time depending on the age of the plant and its expected operational lifespan.

GEN's methodology and assumptions

While its costs increase rapidly over time due to parts and equipment ageing and increased maintenance needs, from EUR/MWh 2.09 in the years 0-20 to EUR/MWh 10.47 in the years 40-60, they then fall back to their original level once maintenance is reduced in the years leading up to decommissioning.

Figure 12: Operating expenditures Investment maintenance costs



In the years 40-60, the costs escalate significantly from EUR/MWh 5.2 to EUR/MWh 10.5, in great part due to the cost of the refurbishment of JEK2 which has been set in year 40 for a cost of EUR/kW 864.

This refurbishment adds around EUR/MWh 5.2 in investment maintenance costs in the years 40-60. This estimate is considered high when looking at similar benchmarks, and we recommend a EUR/kW 400-700 bandwidth for the LTO cost, which would lead to an additional cost of EUR/MWh 2.43-4.24 for the period, and thus a total cost of investment maintenance for the years 40-60 of EUR/MWh 7.6-8.4.

When looking at the financial statements from other nuclear power plants in the Western countries, this cost is highly dependent on external conditions for the project, such as the remaining operational lifetime of the plant, the likelihood of a refurbishment, and the country's policy towards nuclear (e.g., a nuclear phaseout encourages lower spending on maintenance as the asset will be retired soon). This does not allow to provide a high degree of confidence for the assumptions taken.

The assumptions provided are difficult to estimate with a high degree of confidence due to project specific costs. Investment maintenance costs are not necessarily broken down identically in other benchmarking reports, which makes it difficult to estimate the accuracy of this assumption.

EY's recommendation

- The overall cost of investment maintenance needs to be adjusted using additional input from vendors, and the qualitative assessment that a technical feasibility study will provide on the exact breakdown of cost per technology.

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3.7. Operating expenditures – Services costs

The cost of maintenance services includes expenses related to maintaining the power plant, such as the additional hiring of services for outages, and other services such as the production of inputs, banking, insurance services, and additional miscellaneous items.

GEN's methodology and assumptions

The cost provided by GEN are based on an extrapolation from NEK's own operational services expenditures, which account for EUR/MWh 6.8 for the period 2017-2022, while JEK2 is estimated to see its cost increase from EUR/MWh 4.1 in the years 0-20 up to EUR/MWh 6.3 in the years 40-60 due to the plant's aging.

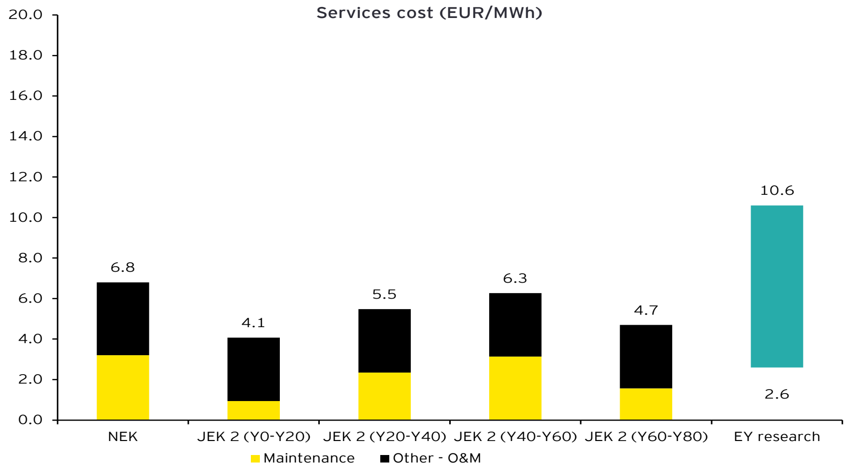
EY's analysis

Additional data made available by EY research provides a large bandwidth of costs for services procured by operating power plants, which impacts the total cost of this subitem. Currently, the cost of most nuclear power plants studied fall in the range of EUR/MWh 6-7, due to their age which leads to a higher cost of maintenance than a new power plant. Indeed, the cheapest services cost registered is EUR/MWh 2.6 for a new generation-3 reactor, as the one envisaged for JEK2.

Therefore, two conclusions can be drawn from the dataset:

- The cost of services falls within a conservative cost range when compared to other nuclear power plants both at the onset of operations and as it ages, which provides a high degree of confidence when looking at the estimates provided by GEN;
- The plant's current estimates include a standard of externalization for the services of the plant, in line with peers in Europe and the Western countries.

Figure 13: Operating expenditures — Service costs



EY's recommendation

- The overall cost of investment maintenance needs to be adjusted using additional input from vendors, and the qualitative assessment that a technical feasibility study will provide on the exact breakdown of cost per technology.

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3.8. Operating expenditures – Labour costs

The labour costs of a nuclear power plant can vary significantly depending on several factors, including the location of the plant, the specific design and technology used, the regulatory environment, and the labour market conditions. Labor costs encompass a wide range of expenses such as salaries and wages for the workforce involved in the operation, and maintenance of the plant, as well as training, benefits, and other associated costs.

GEN's methodology and assumptions

The average cost per full time equivalent (FTE) provided by GEN for JEK2 are in line with existing monthly labour costs for NEK of EUR 7,347 as of 2022. These costs will escalate by 1% above the headline inflation rate, leading to an escalating share of total operational expenditures being related to labour costs over the lifespan of the plant.

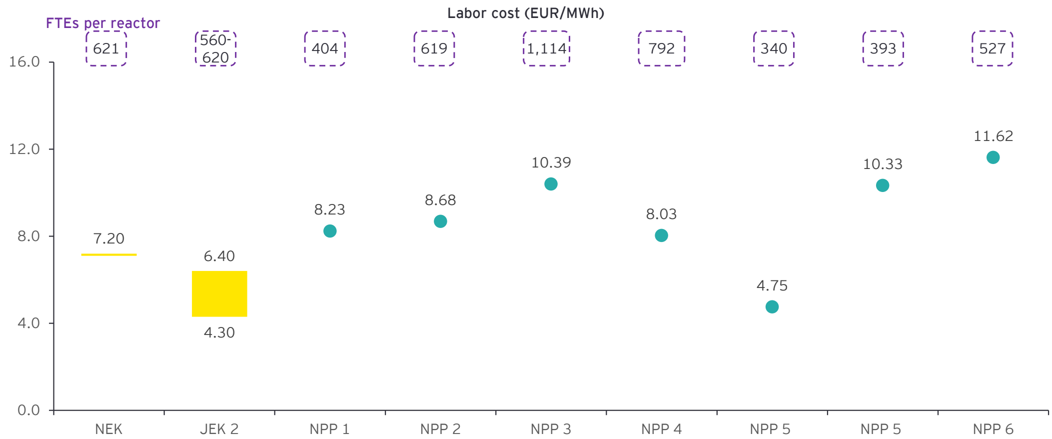
Another assumption used is the number of FTEs per reactor, which should be reduced for JEK2 when compared with NEK, with a much-increased power capacity of 1,000MW up to 1,650MW, compared to NEK's 696MW. This higher productivity of the plant is due to its modern design, additional safety and instrumentation & control features, which reduce the need for personnel despite scaling up.

EY's analysis

While the cost of labour for JEK2 is anticipated to fall markedly when compared with NEK (from EUR/MWh 7.2 down to EUR/MWh 4.3 in the best case), this due to the increased production of the plant.

When compared with other operational plants, the benchmarks point to the overall low cost of labour of NEK and JEK2 on a MWh basis, with other designs having much higher costs associated with personnel (from EUR/MWh 8.03-11.62). However, this is not due to lower salaries at NEK, as they are on par with the upper end of the studied European plants. The lower end point of the graph below belongs to a new unit with similar features to those of the new design and are a good indication that such costs reductions could be expected for JEK2.

Figure 14: Operating expenditures — Labour costs



EY's recommendation

- GEN should further detail the level of remuneration for each of the salaried positions that will be filled in the future, and benchmark them according to local and international data for similar roles.
- The level of inflation for the labor costs could be reviewed according to local standards.

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3.9. Decommissioning and disposal costs

Nuclear decommissioning and waste management costs refer to the expenses associated with the safe closure and dismantling of nuclear power plants and the proper handling, treatment, storage, and disposal of radioactive waste generated during the operation and decommissioning of these facilities.

As defined by the IAEA (1999), "decommissioning encompasses all technical and administrative activities aimed at releasing the nuclear site or installation, removing (some or all of) the regulatory requirements and making it suitable to be used for other purposes (with or without restrictions)". As such, decommissioning is a lengthy process whose preparation starts well before any physical decommissioning activity, through the provision and revision of appropriate plans, during the lifetime of the facility, or even at the stage of its design.

Traditionally, owners and licensees of nuclear power plants are responsible for providing accurate cost estimates of decommissioning and waste disposal plans. These cost estimates are essential for the accumulation of adequate financial reserves, with the objective of guaranteeing the availability of sufficient funds to finance the real costs associated with decommissioning efforts when the time comes.

GEN's methodology and assumptions

Based on the Resolution on the National Radioactive Waste and Spent Fuel Management Program for the period 2023-2032, the Commission adopted the Nuclear Decommissioning Regulation (NPRM) 2023. This regulation is designed to address the extended operational life of the NEK and provides a detailed framework for the handling and storage of radioactive waste and spent fuel until their ultimate disposal. Additionally, an assessment has been conducted to compare the decommissioning expenses of NEK with those of JEK2, considering potential extra costs associated with the power output of the plant and the constraints of the radioactive waste disposal facility.

The projected costs for decommissioning the NEK nuclear power plant stands at EURm 571. For the JEK2 plant, which has a power output ranging from 1,000 to 1,650MW, the estimated decommissioning costs are between EURm 820-1,354. In Slovenia, the facilities for disposing of Low and Intermediate Level Waste (LILW) will be constructed within the operational lifespan of JEK2, necessitating only an expansion of the existing disposal capacity rather than the creation of a new site. This expansion involves the construction of additional storage silos and an increase in operational expenses. The Slovenian Agency for Radioactive Waste Management (ARAO) estimates the cost for each new silo to be between EURm 40-50. Including the costs for licensing, the total additional expenses for the LILW repository are conservatively estimated to range from EURm 217-267 for the above-ground components and the construction of an extra silo, with an additional EURm 25 for operational costs.

For the High-Level Waste (HLW) from JEK2, there will also be a need to expand the capacity of the HLW repository, which will already be operational to accommodate Slovenia's share of NEK HLW. This expansion will entail additional costs for extending the disposal galleries in the planned deep geological repository. A conservative estimate for constructing an additional gallery, including the existing above-ground section and access shaft, is EURm 121, with an additional EURm 28 for operational costs.

Table 3: Waste management and decommissioning costs

	NEK 696MW	Slovenia's share	Additional funding for 1,000MW	Additional funding for 1,250MW	Additional funding for 1,650MW
	EURm	*EURm*	*EURm*	*EURm*	*EURm*
LILW	483	320	242	242	292
HLW	1,369	685	149	149	149
Decommissioning	571	286	820	1,026	1,354
Total	**2,423**	**1,291**	**1,211**	**1,417**	**1,795**

Source: GEN

The total cost of JEK2 decommissioning, including HLW and LILW funding is estimated at EURm 1,211-1,795, which needs to be funded over the 80-year lifespan of the plant through a dedicated decommissioning and disposal fund. This fund has a real return target of 1.5% (i.e. above the headline inflation rate), and anticipated contributions of EURm 7.9-11.8 per annum which will accrue to cover the obligations of the plant. This target would translate to EUR/MWh 0.86-0.95.

However, to provide a significant buffer against decommissioning obligations, whose uncertainties are very high at this stage, GEN has decided to use a significantly higher value of EUR/MWh 2.0 to finance its decommissioning and waste disposal obligations, thus amounting to EURm 16.6-27.2 per annum depending on the design that will be used for the plant.

EY's analysis

First, the estimated cost for the High-Level Waste (HLW) and Low and Intermediate-Level Waste (LILW) treatment liabilities is based on the estimate shared by Slovenian authorities on the final repository cost for the waste generated by NEK and JEK2. As such, they remain unchanged in our calculations.

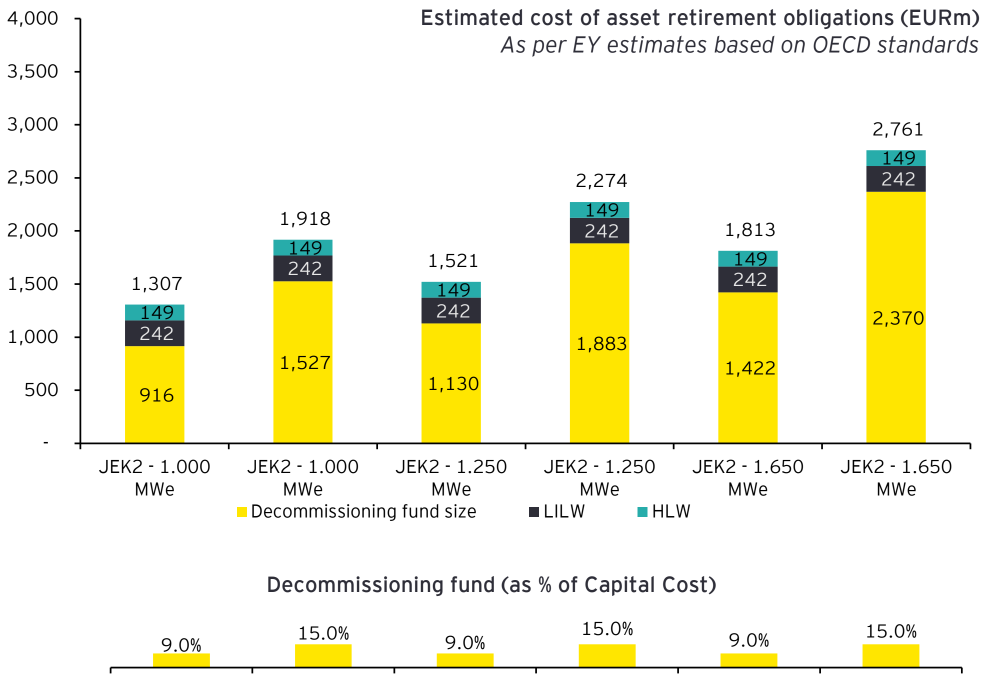
The duration of the fund, its size as a share of capital cost, and its anticipated annual return could have a significant impact on the final amount that JEK2 will need to commit yearly to the fund to ensure that the decommissioning liabilities are met.

Indeed, the duration matches the lifespan of the plant, which is market practice for such projects and thus benefits from accrued compounded returns over time to limit the size of the annual commitments.

Second, the decommissioning fund size is usually calibrated using the OECD-NEA standard recommendation of 9-15% of capital costs engaged during the construction of the plant. On this metric, the current decommissioning fund size that was recommended in the calculations was too low (between 8.1-8.6%) and needed to be revised upwards.

Given the capital cost for the project (i.e., the sum of OCCs, site-specific costs, contingencies, and cost of financing the project), our calculations show that the minimum fund size should increase from EURm 820 to between EURm 916-1,527 for a 1,000MW plant, from EURm 1,026 to EURm 1,130-1,883 for a 1,250MW plant, and from EURm 1,354 to EURm 1,422-2,370 for a 1,650MW plant. These calculations were made using a real return of the fund of 1.5% as suggested by GEN.

Figure 15: Decommissioning and waste disposal costs



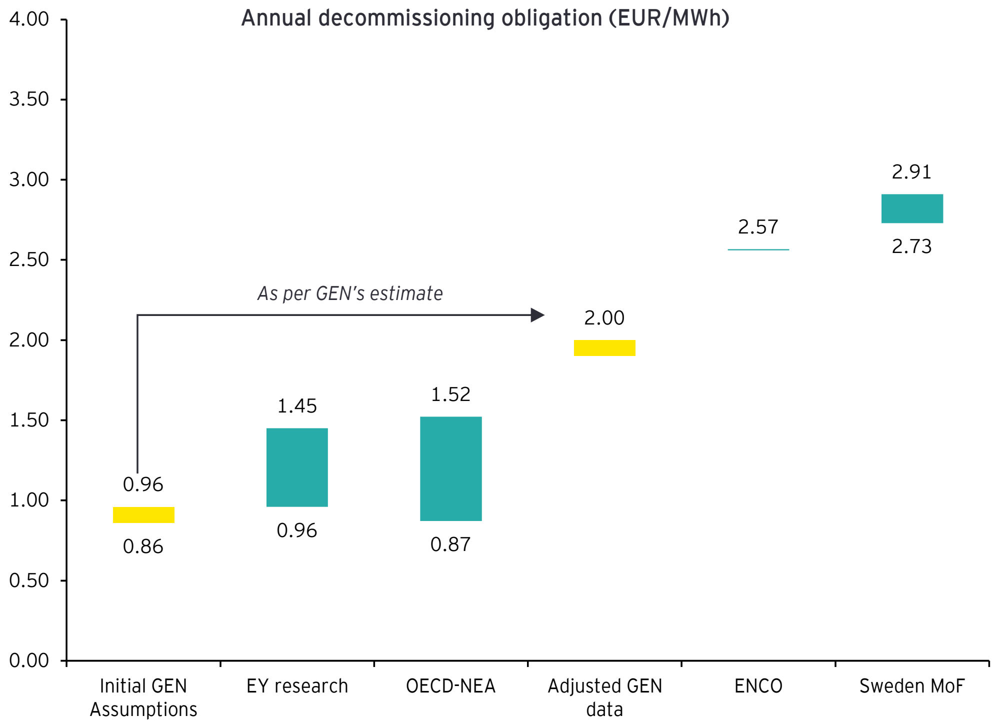
Third, EY studied the expected minimum annual returns for decommissioning funds for other nuclear power plants and found similar real return targets as provided by GEN, with a range of 1.0-3.0% depending on how aggressive the strategy of the fund was.

These adjustments compound to a minimum of EUR/MWh 0.87 (decommissioning fund of 9% of capital cost and 3.0% real return) to EUR/MWh 1.52 (decommissioning fund of 15% of capital cost and 1.5% real return). These benchmarks align closely with our proprietary data, which also give a range of EUR/MWh 0.96-1.45 for other plants in Europe.

Outliers include Sweden where the Ministry of Finance has provided a high bandwidth of nuclear waste and decommissioning fee of EUR/MWh 2.73-2.91 (SEK/MWh 31-33) based on the anticipated needs of nuclear newbuild in Sweden, and their impact on the number and cost of new repositories that will warehouse the spent fuel. Additionally, the existing fees are set at EUR/MWh 3.93-7.51 for the reactors in Forsmark, Oskarsham, and Ringhals, with the spread mainly due to the early shutdown of reactors in Oskarsham and Ringhals whose costs must be distributed over a smaller number of units.

The second outlier is ENCO, which anticipates lower costs of OCCs (c. EUR/kW 4,500 as of 2018), and a high discount rate of 3.0% for the decommissioning fund. However, the anticipated spent fuel management obligation is estimated at EUR/MWh 2.07, which brings the total cost to EUR/MWh 2.57.

Figure 16: Decommissioning and waste disposal costs



The new assumption of EUR/MWh 2.0 made by GEN is therefore in line with international recommendations, but a revision of the anticipated size of the decommissioning fund needs to be made.

EY's recommendations

- Additional consideration needs to be given to the final cost of the decommissioning of the plant and disposal of spent fuel using updated capital costs once the project reaches a higher level of maturity.
- The current decommissioning fund size is underestimated when compared to international benchmarks and needs to be revalued accordingly. However, the adjusted decommissioning and disposal obligation of EUR/MWh 2 is in line with such a revalued fund size.

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3.10. Compensations for the restricted use of space and water

As per Official Journal RS, n. 92/14, 46/15, 76/17 – ZVISJV-1 in 8/201 the operators of nuclear facilities (as specified by regulation criteria) are bound to cover compensation to municipalities in which the use of space in the area of the nuclear facility is limited, due to radiation and nuclear safety measures. A municipality is entitled to only one compensation and duty charge for an individual part of its area, regardless of the number of nuclear facilities that partially or fully cover this part of the municipality's area.

As per Official Journal RS, n. 103/02, 122/07 and 3/212 holders of water rights are obliged to pay water reimbursement. Water rights are granted with a water permit or concession for water rights are in accordance with the provisions of paragraph 1 of Article 124 of the Water Act (Official Gazette of the Republic of Slovenia, No. 67/02, 2/04 – ZZdrI-A, 41/04 – ZVO-1, 57/08, 57/12, 100/13, 40/14 and 56/15).

The annual cost of the water reimbursement is calculated based on consumption (in m3).

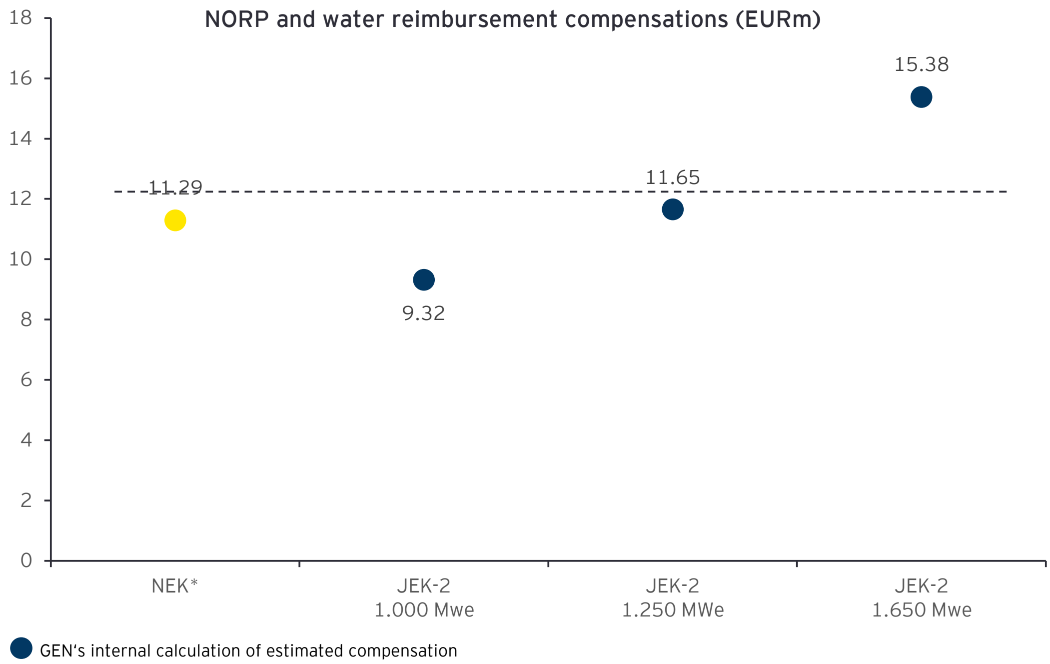
GEN's methodology and assumptions

The annual compensation for restricted use of space (NORP) and use of building land assumes payment of compensations and duty charges to the relevant municipality. The formula for the compensation takes EUR 6,053,000 as a basis of compensation, which is then adjusted based on various factors as specified by the regulation and annual inflation, while the basis of duty charge is tied to a specific year.

Key considerations

The costs related to compensations for the restricted use of area and for the use of building land and water refund are governed by the Slovenian law and tailored to the country's unique economic and geographical context. This specificity makes it challenging to draw direct comparisons with the costs of nuclear power plants in other countries, as there is absence of directly comparable cost data for nuclear power plants elsewhere.

Figure 17: NORP and water reimbursement compensations



Note: (*) 2017 – 2022 average

Sources: NEK Annual reports; GEN's Study

The only available benchmark is NEK (other power plant in Slovenia would be irrelevant), which is using former technology using more water. Thus, we believe that GEN has correctly drafted its assumptions, but a lack of similar charges in other geographies does not allow for the data provided to be benchmarked.

EY 's recommendations

- The costs related to compensations for the restricted use of area and for the use of building land and water refund are governed by the Slovenian law and tailored to the country's unique economic and geographical context.
- This specificity makes it challenging to draw direct comparisons with the costs of NPPs in other countries, as there is absence of directly comparable cost data for NPPs elsewhere.

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3.11. Other assumptions – Load factor and outage duration

The load factor of a nuclear plant, also known as the capacity factor, is a measure of the actual output of a power plant compared to its maximum possible output over a given period of time. It is expressed as a percentage and is calculated by dividing the actual electricity produced by the plant over a specific period by the amount of electricity the plant would have produced if it had operated at full power capacity for the same period. If the load factor is high, it means that the nuclear power plant is using its capacity to the best of its ability, producing a maximum amount of electricity over a given period. However, it is necessary to take reactor technologies into account when comparing load factors between several power plants.

The load factor of the plant is critical in recouping its initial investment costs and ensuring a high level of performance for the plant. As such, nuclear power plants have been used as a source of baseload energy for the electricity system, where they operate year-round at maximum efficiency and ensure the reliability of the grid.

The normal outage duration for a nuclear power plant, often referred to as a refuelling outage, typically ranges from 20 to 40 days. However, the exact duration can vary based on several factors, including the specific design of the reactor, the scope of maintenance work to be performed, and whether any upgrades or inspections are planned during the outage.

During a refuelling outage, about one-third of the reactor's fuel is replaced with fresh fuel, and various maintenance tasks and inspections are carried out to ensure the safe and efficient operation of the plant. Some outages may be longer if they include major upgrades or replacement of large components, such as steam generators or reactor vessel heads.

Additional unplanned outages can occur due to regulatory enforcement (such as the reviews carried out post-Fukushima), or due to maintenance and safety issues during the normal operations of the plant.

GEN’s methodology and assumptions

Based on vendor feedback, the load factor has been set at 94.2%, with an 18-month fuel cycle (including a 30-day planned outage for refuelling) and unplanned outages of 5 days per year.

EY’s analysis

According to the World Nuclear Association and the IAEA, the number of plants which reach the highest levels of load factor is in constant increase due to improving performance standards, shorter planned and unplanned outages.

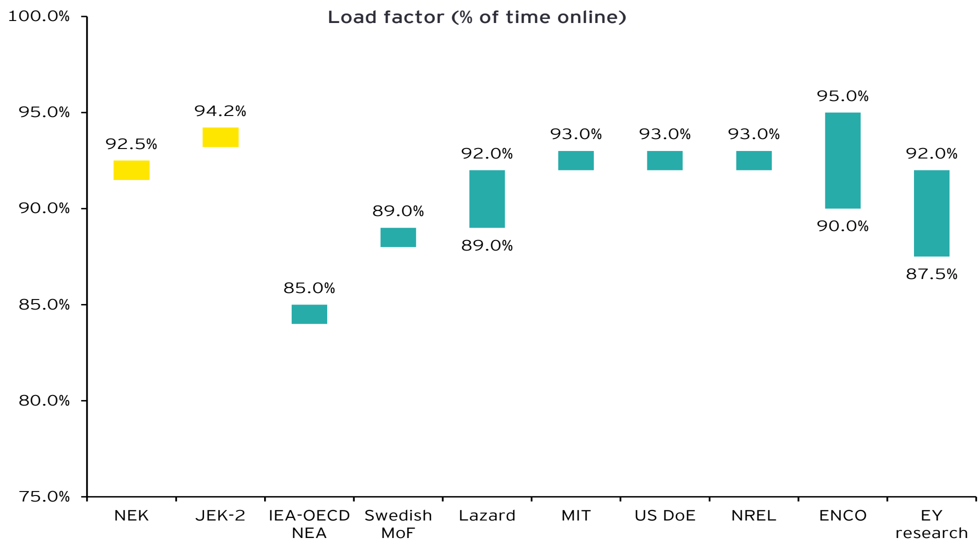
For instance, the current light-water reactor (LWR) fleet of reactors in the United States operates at a very high-capacity factor—an average of 92.7% (EIA, 2020). The American Nuclear Society (ANS) also tracks U.S. capacity factors and noted between 2020 and 2022, that the median capacity factor of 91.13% (Gallier, 2023).

The ARIS database tracks all nuclear reactors throughout the world, with a large fraction of reactors over the 90% level (IAEA, 2024), which has been continually growing over time to reach 39% by 2023.

Additionally, the literature has provided a consistent number of estimates (see chart above), with the upper band of the range generally reaching 92.0-93.0%. Additional benchmarks for recent nuclear power plants also provide a lower expected band of 87.5-92.0%.

This indicates that the current projections by GEN are too ambitious and need to be revised downwards. As such, this report advises a lower bound matching NEK's current operational performance of 92.5%, and an upper band matching the literature of 93.0%.

Figure 18: Load factor and outage duration



EY's recommendations

- The datapoint seems relatively high in comparison to observed standards and should be adjusted downwards to better match the benchmarks that were available.
- While most studies use a 92.0-93.0% load factor, this report would argue using NEK's recent performance as a soft benchmark for the lower end of the anticipated load would be more appropriate, while using 93.0% as a maximum would be in line with the literature.

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3.12. Other assumptions – Long term operation costs

An LTO in the context of nuclear energy typically stands for "Long-Term Operation". Long-Term Operation refers to the extension of a nuclear power plant's operating life beyond its originally designed or licensed lifespan. This involves a thorough assessment and potential upgrading of the plant's systems, structures, and components to ensure that it can continue to operate safely and reliably.

LTO programs are implemented as part of the plant's aging management strategy and require regulatory approval. They often include detailed safety analyses, the replacement or refurbishment of aging equipment, and the implementation of modern safety features that may not have been part of the original design. The goal of LTO is to maintain a high level of safety while allowing the plant to provide electricity for additional years, which can be economically beneficial and help to maintain energy security and reduce greenhouse gas emissions.

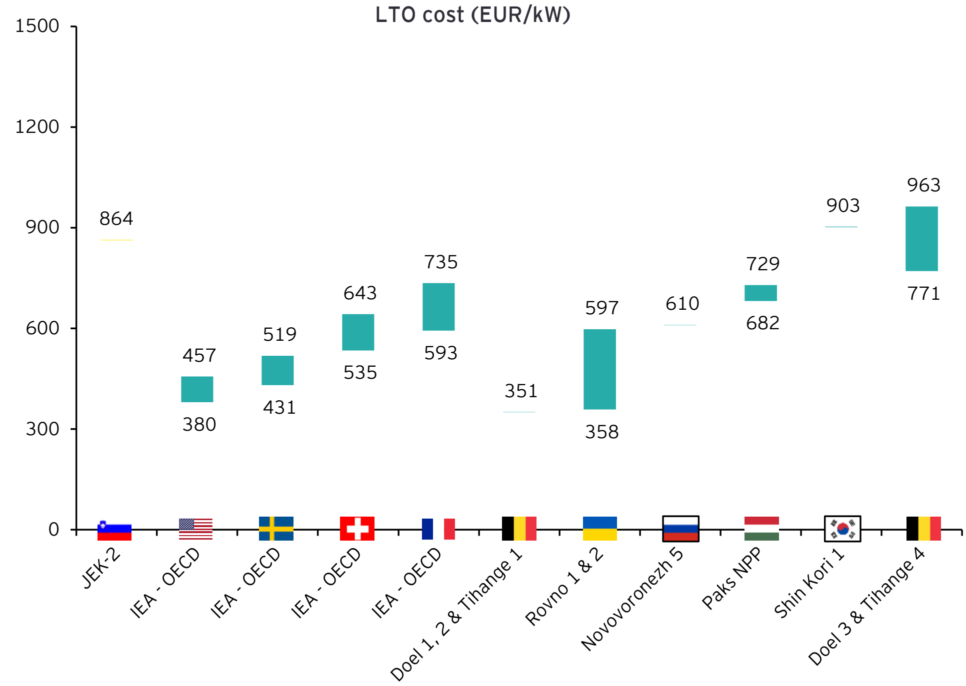
GEN's methodology and assumptions

GEN provided an estimate of the cost to refurbish JEK2 in year 40 of operations, of EUR/kW 864.

EY's analysis

This report considered both academic input from the OECD-NEA and observed data for recent LTOs worldwide. The wide bandwidth that is displayed in the chart below is caused by conflicting cost accounting methodologies for each project, where costs vary due to the initial conditions of the plant, the applicable regulatory framework, and the amount and distribution over time of LTO capital expenditures (which are affected by the level of maintenance that the operator provides during the operational period).

Figure 19: Long term operation costs



Source: International Atomic Energy Agency, International Energy Agency

As such, the current hypothesis provided by GEN seems overly conservative when looking at the available benchmarks.

EY's recommendation

- The LTO cost be adjusted downwards, with an estimate of EUR/kW 400-700 to form the basis of the sensitivity analysis.

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3.13. Other assumptions – Depreciation methodology

GEN's methodology and assumptions

The basis for depreciation costs is the initial investment, which is mainly depreciated on:

- A straight-line basis over a period of 40 years for equipment;
- A partly over a period of 80 years for construction works.

EY’s analysis

On the useful life:

- The duration reported by GEN seems conservative (long), which is prudent.
- Shorter and faster depreciation would diminish the initial tax burden and improve the net present value of the project investment.

On the depreciation methods:

- The depreciation duration is ruled by the local tax and agreed between the owner and the tax authorities.
- The estimated amounts of depreciation costs used for JEK2 are in line with the market standards for comparable plants.

EY’s recommendations

- Impairment tests on long-term assets are sensitive to macroeconomic and sectoral assumptions - notably in terms of energy price trends - as well as to medium-term financial forecasts (discount and inflation rates) and costs to completion for assets under construction.
- GEN should therefore review its estimates and underlying assumptions on the basis of regularly updated information.

4. Conclusion and next steps

4.1. Conclusion

Based on our analysis, we find that all the inputs provided by GEN in its economic study fall within an acceptable cost range when compared to recent academic research and industry benchmarks for new nuclear.

Nonetheless, certain items (such as "materials", "services", and "investment maintenance costs") need to be further refined to provide a more detailed estimate of the likely operational cost of the JEK2 plant.

We acknowledge GEN's proposed changes on October 11th, 2024, to the input data and model for the economic analysis of the JEK2 project (see reference [16]). The changes were made based on the findings of our report dated October 9th, 2024, consisting of a review of the inputs to the preliminary pre-investment economic analysis of the JEK2 project (TS-TR-2024-007, 2024). We have not reviewed or verified the revised model and input data.

The changes appear to be consistent with our observations contained in our report, and the updated outputs appear to be within the acceptable ranges reported on the basis of internal and external data available to date. We note that changes to the input data are made at a Class 4-5 accuracy level under the American Association of Civil Engineers (AACE), where variance is high.

While these updates allow GEN to refine the cost estimate to date and in the current state of knowledge, our main recommendations to get closer to Class 1 are to:

- Initiate a project development to derisk the project cost and duration (site characterization, technical feasibility study);
- Engage in a contracting road map with the technology vendors and assessing the local supply chain;
- Improve the robustness of the project's financial model (confirmation of WACC and market design: PPA, CfD).

If Slovenia votes in favour of pursuing new nuclear development following the referendum, the adopted strategy should focus on improving the accuracy of project cost estimates and establishing a transparent pricing framework with the selected vendor. GEN must collaborate with vendors to refine cost estimates for all components, including nuclear and conventional equipment as well as civil works.

This detailed process is expected to span several years, requiring a careful balance between the desired accuracy of the estimates and the investment of time and resources to achieve it.

Following vendor selection, GEN needs to comprehensively account for and categorize all construction costs, assigning them appropriately to either the vendor or the owner. This includes early-stage expenses such as environmental impact studies and technical feasibility assessments, as well as ongoing costs related to project management and legal support once the project is underway.

Effective governance and oversight of the project will incur both internal and external costs for the owner. Looking ahead, the project's long-term objectives extend beyond supplying power to the Slovenian market, aiming to harness additional benefits such as power exports and the production of clean hydrogen. These elements are key to the project's enduring success and its contribution to a sustainable energy future, pending the support of the Slovenian public through the referendum.

4.2. Next steps

If the decision is made to progress with JEK2, some key next steps are crucial to refine the project profile and reduce the risks involved in its execution and financing.

Derisk the project costs

One major risk driver is the cost accuracy, which is classified by the American Association of Civil Engineers (AACE) from a Class 5 to 1. Class 1 corresponds to the most advanced stage of the project with a high level of cost accuracy, while Class 5 corresponds to preliminary stages with a high level of uncertainty when estimating costs.

To improve cost estimates from a Class 4 to 1 estimate, the vendors need to perform multiple key activities, such as adapting the nuclear island and its specifications to Krsko site constraints, preparing plans for the development of the conventional island, estimate quantities of materials, inquire market prices to their suppliers, develop a roadmap for civil works and bulk mechanical to process site data, and many more.

The vendors need to start a multi-year process to reach a level of accuracy sufficient to enable a vendor selection. To select a preferred bidder, the owner shall trade-off between the accuracy of the bid and the time and cost to get to such accuracy, as giving more time to the selection process will enable a higher level of accuracy to the bids. The current schedule seems to imply that the vendor will be selected at an intermediate level of accuracy such as Class 2 or 3 and will reach the final costs during the exclusivity period.

As part of the exclusivity, the owner and vendor shall agree clear transparency rules to firm up the price from the "selection price" to the "final contract price".

The owner shall list the total extent of its construction costs and ensure exhaustivity of all costs and allocate them to either the vendor or the owner.

Before starting the project (reaching the final investment decision) the owner project development costs include:

- Environmental and grid impact studies;
- Technical feasibility studies by the vendors;
- Market consultation to check bankability;
- Tendering (specification writing, commercial & legal negotiation).

Once the project is started, the owner will incur the costs related to the governance and the control of the project, such as internal costs (project management, construction and commissioning supervision), and external costs (owners engineering, commercial & legal support).

Clarify the WACC

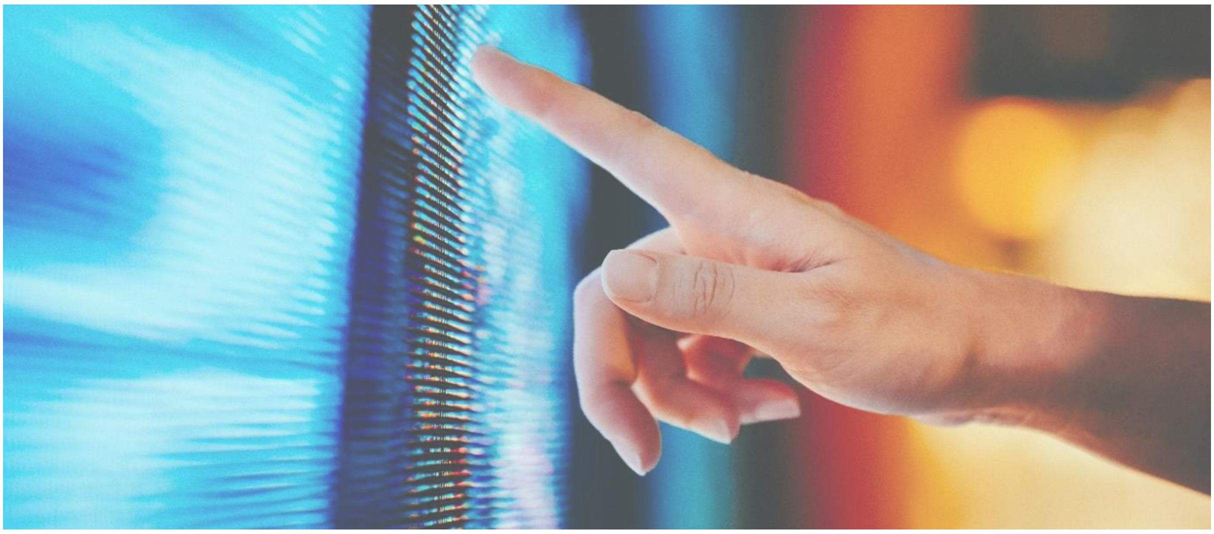
The main driver of the economics of the projects is a low WACC (weighted average cost of capital) which can only be obtain through an adequate risk sharing between parties to the project and government support package. Due to the capital-intensive nature of a nuclear power project and its long construction schedule, a low cost of financing is essential to ensuring its competitiveness vs. other low-carbon energy sources.

WACC must also consider expectations from potential private investors.

Develop opportunities

The JEK2 project, in addition to supplying power to the Slovenian market, is anticipated to yield additional economic benefits.

These include gaining insights and enhanced expertise from similar European projects, the potential for power exports to the Balkans and Austria where there is a shortage of reliable production and hence JEK2 could capitalize on high capture prices, the possibility of a capacity market mechanism, and the production of clean hydrogen through High Temperature Steam Electrolysis, particularly during periods of low power prices, such as when there is an excess of renewables on the grid.



5. Appendices

5.1. Abbreviations

Abbreviation	Meaning
# or no.	number
%	Percent
€ or EUR	Euro
bn	billion
CAGR	Compound annual growth rate
CAPEX	Capital expenditure
COD	Commercial operation date
EBIT	Earnings before interest and taxes
EBITDA	Earnings before interest, taxes, depreciation and amortization
EDF	EDF Energy Ltd
eg. or ex.	For example
EIA	Energy Information Administration
EPEX	European Power Exchange
EPC	Engineering, Procurement, and Construction
Etc.	et cetera
EU	European Union
EY	Ernst & Young
FID	Final investment decision
FOAK	First-of-a-Kind
FY	Financial year
GEN	GEN energija d.o.o.
GEN Group	GEN Group of companies incl parent company GEN
GSP	Government support package
HEP	Hrvatska Elektroprivreda
IAEA	International Atomic Energy Agency
i.e.	id est or that is
IRR	Internal rate of return
JEK2	Jedrska elektrarna Krško 2; Second nuclear plant in Krško
JV	Joint Venture
k	thousand
KHNP	Korea Hydro Nuclear Power
KSF	Knowledge and Skills Frameworks
kW	Kilowatt
LCOE	Levelised costs of generating electricity
Lbs	pound
m	million
MIT	Massachusetts Institute of Technology
MoF	Ministry of Finance
MRC	Multi-Regional Coupling
MW	megawatt
MWh	megawatt hour
NEK	Nuklearna Elektrarna Krško
NNB	Nuclear Newbuild
NOAK	Next-of-a-Kind

Abbreviation	Meaning
NORP	Compensations due to restricted use of space and for planning intervention measures in the area (sl. Nadomestilo zaradi Omejene Rabe Prostora)
NPP	Nuclear Power Plant
OECD	Organization for Economic Co-operation and Development
O&M	Operation and Maintenance
OCC	Overnight capital cost
OPEX	Operating expense
PWR	Pressurized Water Reactor
Q&A	Question and answer
RS	Republic of Slovenia
SIT	Slovenian tolar
SMR	Small Modular Reactor
SNSA	Slovenian Nuclear Safety Administration
sqm/m2	square meter
SURS	Statistical Office of the Republic of Slovenia
t	ton
TEŠ	Termoelektrarna Šoštanj
TWh	terawatt hours
TVA	Tax value Added
USD	United States Dollars
VS.	versus
WACC	Weighted average cost of capital
Wh	Watt-hour
YoY	Year-to-year

5.2. Main References

[1] The Preliminary Economic Analysis of the JEK2 Project, TS-TR-2024-007, 2024

[2] An overview of the financing and business models of current NPP construction projects worldwide, TS-TR-2023-003, 2023

[3] JEK2 Economic model EY, 2024

[4] Instructions for the independent review of Input Data of Economic Analysis of JEK2 project, 2024

[5] Tehtano povprečje stroškov kapitala (WACC) in stroški financiranja, TNA-2024-088, 2024

[6] Financing and risk sharing for investments in new nuclear power, Swedish Ministry of Finance, 2024

[7] Lazard LCOE+, Lazard, 2024

[8] Capital Cost and Performance Characteristic Estimates for Utility Scale Electric Generating Technologies, EIA, Sargent & Lundy, 2024

[9] Pathways to Commercial Liftoff: Advanced Nuclear, US Department of Energy, 2023

[10] Overnight Capital Cost of the Next AP1000, MIT, 2024

[11] Nuclear Costs in Context, Nuclear Energy Institute, 2023

[12] Penly EPR public consultation (in French), EDF, 2022

[13] Comparison of complete electricity production costs (in French), Cérémé, 2022

[14] Projected Costs of Generaing Electricity, OECD-NEA, IEA, 2020

[15] Possible role of nuclear in the Dutch energy mix in the future, ENCO, 2020

[16] New Revision of JEK2 Economic Analysis provided by GEN, October 2024

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