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Strategic Management of Owner's Costs in the Nuclear Energy Sector of Serbia

The decision to begin developing nuclear energy and building the first nuclear power plant is not simply the purchase of a power plant, but the creation of a new knowledge-intensive industry for 100 years or more. For Serbia, which lifted its 35-year moratorium in November 2024, it is critical to understand the structure of owner's costs, which are not included in the contract with the vendor (EPC contract) but can account for 15% to 30% of the total project cost.

In international practice, especially in the nuclear energy sector (taking into account our experience and ongoing projects in Serbia and Turkey), **Owner's Costs** are expenses borne by the project owner in addition to the cost of the EPC contract (engineering, procurement, construction).

If the Republic of Serbia plans to commission the facilities by 2035, annual contributions to the Owner's Costs (OCS) fund should begin as early as **the Preliminary Technical Investigation/Study (PTI) stage** (2026–2027) to ensure the personnel and infrastructure base is ready by the time the first concrete is poured. Analysis shows that attempting to finance these items on a residual basis will lead to the project's technological default.

This paper presents a comprehensive analysis of the structure and volume of Owner's Costs arising from the implementation of the nuclear energy development program in the Republic of Serbia .

The central theme of the study is overcoming the "price tag trap"—the systematic underestimation of expenses that are not included in the EPC contract with the vendor but are critical to the legitimacy and safety of the project . Based on international experience and IAEA methodology, the need to identify owner's costs as a protected line item in the state budget already at the preliminary study stage (2026–2027) is substantiated.

, the Republic of Serbia must act as a **qualified and independent Contracting Authority** . The establishment of a Special Project Organisation (SPV) directly reporting to the Prime Minister to consolidate all accounts in accordance with **the IAEA Account 70 standard** and the allocation of Owner's Costs into a separate financial instrument at an early stage is, in our opinion, the only way to avoid a "technological default" and ensure the completion of the project on schedule (by 2035–2040) .

The main document that regulates and classifies these costs at the international level is **the IAEA publications** .

Analysis IAEA Nuclear Energy Series No. NG-T-4.4 "Economic Evaluation of Nuclear Power Plant Projects"

1. Basic international regulations

The main guideline for calculating Owner's Costs in nuclear energy is:

IAEA Nuclear Energy Series No. NG-T-4.4 "Economic Evaluation of Nuclear Power Plant Projects".

This document (and its predecessor *, IAEA-TECDOC-1344*) uses the standard Account System. Owner's Costs are typically reported under **Account 70** .

2. What is included in Owner's Costs according to the IAEA?

According to international standards, these costs include everything for which the general contractor (EPC contractor) is not responsible:

- **Site costs:** Land purchase or lease, geological surveys (if not included in the main contract).
- **Licensing and permits:** All government fees and costs for interaction with the regulator.
- **Off-site infrastructure:** Access roads, power transmission lines, water supply, staff housing.
- **Project management from the customer's side:** Maintenance of our own office, salaries of technical supervision engineers, legal support.
- **Taxes and insurance:** Property taxes, owner's risk insurance.
- **Personnel training:** Preparation of operating personnel before the station is commissioned.
- **Public Relations (PR):** Working with the population in the region of presence.

3. Russian regulatory framework (if applicable)

If the project is implemented with the participation of Russian structures or using Rosatom methods, then regulation occurs through:

- **MDS (Methodological documents in construction):** For example, instructions for determining the amount of overhead costs.
- **Chapter 9 of the consolidated estimate:** Where the costs of maintaining the customer-developer service are specified.
- **Rosatom industry regulations:** Internal methods for calculating the life cycle cost of nuclear power plants.

When Serbia moves into the active phase (even if these are SMRs – small modular reactors), the share of Owner's Costs can reach **15–20%** of the total project cost (Capital Cost).

An important nuance: In international practice, lending banks require a clear separation between the EPC contract and Owner's Costs, since the latter are often not covered by export credits and must be financed from the customer's own capital or the state budget.

Owner's Costs as Hidden Expenses

Below is a detailed analysis of hidden costs and recommendations for evaluating vendor proposals.

The term **"hidden costs" is used** in relation to **Owner's Costs** not because they are deliberately hidden in the accounting sense, but because of their specific nature and how they are perceived at the political decision-making stage.

In the nuclear energy industry, this phenomenon is often referred to as the "price trap." Here are the main reasons why these costs remain hidden until the very beginning of a project.

1. Focus on the EPC contract (the "Price Trap")

When a government or investor discusses the construction of a nuclear power plant, all attention is focused on the cost of the power unit itself. Vendors (EDF, Rosatom, Westinghouse) quote the price of their "product"—engineering, equipment, and construction.

- **Problem:** This figure is just the tip of the iceberg. Owner's Costs aren't included in the vendor's commercial proposal, and inexperienced clients subconsciously perceive the EPC price as **the full** cost of the project.

2. Budget fragmentation (scattering across departments)

Owner's Costs are "spread out" expenses.

- Road construction is financed by the Ministry of Transport's budget.
- Student education is financed by the Ministry of Education budget.
- Strengthening the power transmission line is part of the grid company’s investment program.
- **Hidden Effect:** Because there is no single "receipt," the customer's total costs are not visible in one document until all subprojects are consolidated.

3. Soft Costs vs. Hard Assets

People find it easier to allocate money to things they can touch (a reactor, a turbine, concrete). Owner's Costs are 40–50% made up of "invisible" things:

- Legal consultations.
- Licensing and examinations.
- Insurance and taxes.
- Creation of a technical supervision service.
- **Hidden effect:** These costs seem secondary, “associated”, although without them it is impossible to pour even a cubic meter of concrete.

4. Political optimism (Bias towards underestimation)

At the stage of approval of a national program, there is a psychological (and sometimes political) temptation to present the project as cheaper and more cost-effective.

- **Hidden effect:** Understating Owner's Costs in forecasts allows for a more attractive **LCOE** (Levelized Cost of Energy) indicator to be shown.

If you remove 15% of the customer's costs from the investment, the project looks much more effective on paper than it actually is.

5. Infrastructure lag (The forgotten "last mile")

It is often assumed that the existing infrastructure (ports, railways) will “somehow cope”.

- **Hidden effect:** The real cost of upgrading a bridge that "suddenly" proves unable to support the reactor vessel, or building a communication line to a remote site, is only revealed during the logistics audit. For the budget, this appears as "sudden" additional expenses, although they were inevitable.

6. Summary

Owner's costs are called hidden because they **aren't disclosed on the surface of the contract with the technology provider** . As a result, when the project enters the active phase, the government suddenly discovers that the promised $10 billion must be supplemented with another $2 billion in "overhead" costs, which weren't included in the initial presentations.

This is precisely why we insist on allocating them to **a protected budget line item** at the PTI stage: to make the “hidden” “explicit” and manageable.

Do you think the risk of a financial deficit or the risk of a legal block on the project due to the unpreparedness of the infrastructure is a more convincing argument for the Serbian government?

Owner's Costs Summary for Nuclear Power Plant Project

1. Creation of an institutional and regulatory framework

The vendor supplies the technology, but the customer State is obliged to create an independent regulator.

- **Regulatory Authority:** Establishing a competent regulator from scratch requires approximately 400 man-years in the preparatory phase (Phase 2 according to the IAEA methodology).
- **Costs:** According to international benchmarks, regulatory fees amount to approximately $60 million per reactor in each country, and vendor costs to support the licensing process amount to an additional $180–240 million per design.
- **Regulatory framework:** The development of national standards harmonized with Euratom and IAEA standards requires the involvement of highly paid international consultants (TSO).

2. Personnel training and Human Capital

A 1200 MW nuclear power plant requires 500 to 1000 highly qualified specialists.

- **Training:** Although the EPC contract typically includes basic operator training, training of senior technical management, regulatory inspectors and nuclear law specialists is the responsibility of the Owner.

- **Training infrastructure:** Creating a national training center with full-scale simulators can cost tens of millions of dollars. Experience with programs in the UK shows that doctoral programs for nuclear scientists alone can require investments in the range of £65–100 million.

3. Site infrastructure and logistics for super-heavy loads

For Serbia, logistics is a bottleneck. The weight of a reactor vessel (for example, the VVER-1200 or APR-1400) ranges from 330 to 500 tons.

- **River transport:** The Danube is an ideal artery, but the Port of Belgrade or Smederevo lacks fixed cranes with a lifting capacity exceeding 150 tons. This would require the construction of specialized berths or the rental of unique floating cranes.
- **Roads and bridges:** Every kilometer from the pier to the nuclear power plant requires a separate engineering project. This will require reinforcing bridges, removing power lines, and removing road signs.
- **Resettlement:** With a population density of approximately 125 people/km² in Europe, land acquisition and relocation of residents can become a significant expense. Housing compensation in Serbia/the Balkans ranges from 300 to 600 euros per m².

4. Safety and Sanitary Protection Zone (SPZ)

- **Physical Security:** The cost of creating a physical security system (perimeter, detection systems, armed guards) is often underestimated.
- **Planning Zones:** The standard emergency planning zone in the United States is approximately 16 km (10 miles). Within this zone, economic activity is restricted, leading to indirect budget losses.

5. Back-End of the cycle: RAW, Spent Nuclear Fuel and Decommissioning

The longest-term financial burden.

- **Spent Fuel Management:** Building a dry storage facility for spent fuel is a multi-billion dollar investment. The UAE benchmark shows that developing an SNF interim storage strategy could cost approximately $4.3 billion over its lifecycle.
- **RAO:** The creation of a national repository for low- and intermediate-level waste should begin in parallel with the construction of nuclear power plants. The creation of **a national RAO operator** should begin simultaneously with PTI .
- **Decommissioning:** Although decommissioning costs constitute less than 1% of annual operating expenses, the formation of a decommissioning fund must be legally established from day one of operation. The "green lawn" option is the most expensive and time-consuming.

6. Recommendations for Serbia (List of questions for the vendor)

When conducting a preliminary evaluation of proposals (RFI/RFP), the Customer is advised to request answers to the following critical questions:

1. **Localization and supply chain:** What percentage of work (civil engineering, installation, materials) can be performed by Serbian companies? What investments will be required for their certification?

2. **Transport project:** Does the price include delivery "to the site" or only "to the port of entry"? What are the dimensions of the heaviest module, and is the vendor prepared to conduct an audit of Serbia's bridges and roads?
3. **Logistics "Digital Twin":** T he requirement to provide digital models of transport dimensions for conducting virtual simulations of the passage of Serbian bridges and tunnels.
4. **Licensing Compatibility:** How compliant is the design with Euratom requirements? What portion of the documentation (SAR – Safety Analysis Report) does the vendor submit for adaptation by the national regulator?
5. **Fuel Cycle and Spent Nuclear Fuel:** Does the vendor guarantee the return of spent nuclear fuel to its country of origin? If not, does the proposal include the design of an on-site waste reprocessing/storage facility?
6. **Technical Support Organization (TSO):** Which organizations from the vendor's country will support the Serbian regulator during the first 10 years? What is the value of these contracts?
7. **Repair Facilities:** What unique equipment (flange machining machines, NDT systems) should the Customer purchase to perform scheduled preventive maintenance? What is the recommended number of in-house repair personnel?
8. **Owner's Cost Financing:** What portion of the credit line (if a government export credit is provided) can be used for site infrastructure and staff training not directly related to equipment delivery? It is worth emphasizing that **export credits** from vendors (for example, from France or the USA) almost never cover Owner's Costs. Serbia will have to find cash in its budget (approximately $1.5–2 billion) alongside the principal loan repayments. This is the main financial risk of the PTI phase .

7. Conclusion:

For Serbia, the construction of a 1000–1200 MW nuclear power plant by 2040 will require not only finding $6–10 billion for the contract itself, but also mobilizing approximately $1–2 billion for internal infrastructure, training, and a regulatory system over the next 10–15 years.

To implement a nuclear power plant project in Serbia (including both potential gigawatt units and SMRs), the owner's cost structure must be detailed already at the PTI (Preliminary Technical Study) stage. This will prevent the project from being financially strangled in the later stages.

Owner's Costs Structure for a Nuclear Power Plant Project

Below is a detailed checklist, structured according to the international standard **IAEA Account 70** , adapted to the specifics of the Balkans.

1. Site preparation and survey (Site Development)

This is the block that **EDF/Egis is now starting to work on** .

- **Geodesy and cartography:** Creation of accurate plans of the area and reference to the national coordinate grid.

- **Special surveys:** Seismic microzoning (critical for the Balkans), hydrological studies (Danube or Sava regime), meteorological monitoring (at least 2 years).
- **Archaeology and ecology:** Clearance of the site from archaeological objects (mandatory according to Serbian laws) and flora/fauna impact assessment (EIA).
- **Land Acquisition and Resettlement:** Legalization of Land Rights and Buffer Zones.

2. Licensing and interaction with the regulator

The costs of making a project legitimate.

- **Support for the national regulator:** In Serbia, it will be necessary to actually finance the strengthening of the nuclear safety agency (**SRBATOM**) to assess the project.
- **Preparing a License Justification:** Payment for the services of consultants for the preparation of a Preliminary Safety Analysis Report (PSAR).
- **State duties:** Fee for issuing construction and operating permits.

3. Off-site Infrastructure

These are costs that are almost never included in the EPC contract.

- **Power distribution:** Construction or modernization of substations and transmission lines (cooperation with **EMS - Elektromreža Srbije**).
- **Logistics hubs:** Modernization of berths on the Danube for receiving heavy equipment, strengthening of bridges and roads.
- **Temporary construction camp:** Housing, medical care and social infrastructure for thousands of workers.
- **Water supply and drainage:** Installation of main channels for the cooling system.

4. Project Management (Owner's Project Management)

Expenses for the customer's "think tank".

- **Owner's Engineer:** Paying an international company (such as Worley, Assystem, or Egis) to review the general contractor's documentation. It's important to note that **Egis** cannot simultaneously perform PTI and act as an independent inspector (Owner's Engineer). This would be a conflict of interest. Serbia will require completely independent technical supervision.
- **Legal and financial support:** Consultants on loan structuring and risk management.
- **In-house staff:** Salaries, office expenses, IT infrastructure of the project team.

5. Human capital and training

Preparing those who will press the button in 10 years.

- **Recruitment:** Search for internationally qualified specialists.
- **Training programs:** Contracts with vendor training centers, internships at reference NPPs.
- **Simulators:** While a full-scale simulator is often included in the EPC, preparing the building and personnel for it is an owner's expense.

6. The Fifth Barrier and Public Relations (PR & Security)

A specific block for protecting the project from the "surrounding world".

- **Physical security (external perimeter):** Exclusion zone equipment, UAV early warning systems, corporate perimeter cybersecurity.

- **Public Awareness:** Community outreach programs, creation of information centers, real-time environmental monitoring accessible to citizens (combating radiophobia).

7. Economic benchmark

Category	Approximate % of total cost
Site preparation and EIA	2–4%
Licensing and regulator	1–2%
External infrastructure	5–8%
Project management and training	4–6%
Total Owner's Costs	**12–20%**

8. Why is this critical?

When calculating the cost per kWh (LCOE) for the Serbian government, it's important to consider that if the EPC budget is, say, **$10 billion** , Serbia will need to find an additional **$1.5–2 billion** in its Owner's Costs budget. Failure to disclose this figure at the PTI stage is the main reason for the machine getting stuck at later stages.

Strategic justification for the allocation of Owner's Costs to a protected budget line item

1. Definition and economic nature

In the context of the implementation of the National Nuclear Energy Development Plan, it is crucial to make a clear distinction between **the Investment in the Construction (EPC contract)** and **the Owner's Costs** .

According to the international methodology (IAEA NG-T-4.4), **owner's costs** refer to all expenses incurred by the Republic of Serbia as the project owner to ensure infrastructure readiness, human resources, and the regulatory framework. These costs typically amount to **12–20%** of the total investment cost.

$$TCI = C_{EPC} + C_{Owner} + C_{Contingency}$$

Where:

- TCI — Total Capital Investment;
- C_{EPC} — Turnkey contract cost (design, supply, construction);
- C_{Owner} — Customer's Costs;
- C_{Contingency} — Unforeseen expenses.

2. Justification for the status of "Protected Article"

The allocation of these funds to a separate protected budget item is necessary for the following reasons:

1. **Institutional Independence of the Regulator:** Expenditures on the development and expertise of the national nuclear safety agency cannot be dependent on the General

Contractor's commercial schedule. The regulator must be funded by the state in advance to ensure impartial oversight.

2. **Synchronization of infrastructure "behind the fence":** the EPC contractor is not responsible for connecting power lines, upgrading riverbeds, or strengthening public roads. Delays in these works (funded from the Owner's Costs) result in penalties from the contractor for downtime.
3. **Formation of the "Fifth Security Barrier":** In the current geopolitical situation, expenditures on external security (air defense, anti-drone defense, cybersecurity) and strategic communications with the population must be directly controlled by the state. This guarantees sovereignty over the facility.

3. Recommended structure and resource allocation

It is proposed to establish the following structure for distributing Customer Costs in budget planning:

Group of Accounts (IAEA)	Name of cost items	Recommended share in Owner's Costs
Account 70.1	Project management and engineering (including Owner's Engineer services)	30%
Account 70.2	Site preparation and licensing (EIA, seismic, geology)	15%
Account 70.3	External infrastructure (roads, networks, temporary camps)	25%
Account 70.4	Recruitment and training of personnel (training of national personnel)	15%
Account 70.5	Taxes, insurance and PR support (social acceptability)	10%
Account 70.6	Ensuring external security (the "Fifth Barrier")	5%

4. Risks of non-targeted or residual financing

The absence of a protected status for Owner's Costs will inevitably lead to:

- **Project “stuckness”:** Unpreparedness of the licensing base or personnel by the time construction work is completed.
- **Financial dependence:** Forced expansion of high-interest credit lines to cover operational needs that were not budgeted for.
- **Loss of control:** Transfer of critical project management functions into the hands of a foreign vendor due to a lack of funds to maintain a competent Customer.

Conclusion and recommendation

To ensure energy sovereignty and minimize the risks of long-term construction, the government is recommended to approve **Owner's Costs** as a separate financial instrument within the National Plan. This will allow Serbia to act as a **qualified and independent Contractor** , capable of overseeing the foreign General Contractor at every stage of the NPP lifecycle.

This point is the logical conclusion of the strategy to transform "hidden costs" into a manageable public asset. The creation of a single point of responsibility will allow Serbia to avoid the managerial chaos that often arises in complex megaprojects.

In order to overcome **budget fragmentation** and consolidate all areas of the Client's activities, it is recommended to create **a Special Project Organization (SPV/Project Office)** with direct reporting to the Prime Minister of the Republic of Serbia.

1. Eliminating the management gap

In the current model, the costs of implementing the project are distributed among various departments (the Ministry of Transport, the Ministry of Education, energy companies, etc.), which creates the effect of "invisible" costs.

- **SPV Function : Consolidation of all Account 70** items into a single legal entity.
- **Authority** : The organization must have the right of interdepartmental coordination to synchronize the development of the site infrastructure with the main construction schedule.

2. Financial sovereignty and budget protection

The creation of an SPV allows **Owner's Costs to be allocated** as a protected budget line item, independent of the vendor's credit lines.

- **Centralized Budget** : All allocations for the **PTI phase (2026–27)** and subsequent phases are directed directly to the SPV.
- **Transparency** : This eliminates the "price tag trap" and allows the government to see the total cost of ownership (TCI) of an asset throughout its life cycle.

3. Formation of a "Qualified Customer"

Direct reporting to the Prime Minister gives SPV the necessary political weight to make decisions on critical aspects of the project.

- **Owner's Engineer** : SPV acts as an employer for the Owner's international Engineer, providing independent technical supervision of the General Contractor's activities.
- **Preventing Infrastructure Reactivity** : SPV is solely responsible for ensuring that the production base and transport corridors are ready **before** the first concrete is poured, avoiding the mistakes made in other regional projects.

Summary for the report

> **Without the creation of a dedicated stakeholder (SPV) directly subordinate to the country's top leadership, Serbia's nuclear project risks schedule deterioration due to interdepartmental conflicts. The SPV will ensure a transition from passive vendor oversight**

to proactive management of national interests within the context of the creation of a new high-tech industry.

This structure not only protects the budget, but also creates a clear "interface" for international creditor banks.

Estimated Owner's Costs for Different Types of Reactors

The table below shows the estimated amounts that should be included in the Serbian budget *in addition to* the cost of the construction contract itself.

The average market figures for 2026 were used as a basis: for **EPR (1600 MW),** the full cost of the EPC contract is estimated at approximately **€11–12 billion** , for **SMR (300 MW)** – in the region of **€2.5–3 billion** (taking into account the "premium" for the novelty of the technology).

Group of Accounts (IAEA)	Name of cost items	Share in OC	SMR (300 MW) [Million €]	EPR (1600 MW) [Million €]
70.1	Project Management, Owner's Engineer, IT	30%	150	540
70.2	Licensing, surveys, EIA	15%	75	270
70.3	External infrastructure (networks, roads, water)	25%	125	450
70.4	Recruitment and long-term training	15%	75	270
70.5	Taxes, insurance, PR and social package	10%	50	180
70.6	Ensuring external security (the "5th barrier")	5%	25	90
TOTAL	**Total Owner's Costs (estimate)**	**100%**	**€500 million**	**€1.8 billion**

Explanations for calculations:

1. **SMR share:** Please note that for small reactors the share of Owner's Costs in the overall project budget is usually higher (**~18–20%**), since the costs of site licensing, geology and creation of the customer service are almost independent of the unit capacity.
2. **Infrastructure gap:** For a giant unit (1600 MW), the costs under Article **70.3** could increase sharply if the current **EMS (Elektromreža Srbije) network** requires extensive reconstruction of nodal substations to accommodate such concentrated power.
3. **Budget protection:** These figures show that even for a "budget" SMR solution, the government needs to have **€500 million** in "cash" or direct government guarantees, which are not covered by the vendor's export credit.

Summary for the report section:

Analysis shows that attempting to finance these items on a residual basis will lead to a technological default of the project. If the Republic of Serbia plans to commission the facilities by 2035, annual contributions to the Owner's Costs Fund should begin as early as the **Preliminary Technical Investigation/Study (PTI) stage** (2026–2027) to ensure the personnel and infrastructure are ready by the time the first concrete is poured.

In the context of 2026–2027, PTI (Preliminary Technical Investigation/Study) refers to the critical phase of the "zero cycle", when the project still exists only on paper and in research, but it is now that its success or failure is **determined .**

For Serbia, this period is **a "planning window"** when it is necessary not only to study sites, but also to conduct an audit of the entire national infrastructure.

What exactly is included in the PTI scope (2026–2027)?

At this stage, the project goes through three filters: technical, legal and financial.

1. Technical filter (Characterization)

This is what we discussed in terms of seismicity and logistics.

- **Seismic verification:** Confirmation that the selected site (e.g. on the Danube) is in principle capable of supporting a 1200+ MW unit or a group of SMRs.
- **Hydrological audit:** Will there be enough water in the river in 50 years, taking into account climate change, to cool the condensers?
- **Logistics Simulation:** A real-life answer to the question: "How do we transport a 600-ton reactor vessel across Serbian bridges?"

2. Legal and regulatory filter

- **EIA Development:** Preparing an environmental report that won't be torn apart in an international court.
- **Preparation of the licensing basis:** The Serbian agency **SRBATOM** must determine under which standards it will accept the project (Finnish, French or American).
- **Intergovernmental agreements:** Definition of site status and cross-border notifications.

3. Financial Filter (Owner's Costs Blueprint)

- **Budgeting:** Precisely defining the amount that Serbia should allocate from its budget (the same 12–20% of Owner's Costs).
- **Deal structuring:** Deciding whether it will be a classic EPC contract, a BOO model (as in Turkey) or a public-private partnership.

Why is PTI tied to 2026–2027?

These aren't random numbers. In the atomic chart, this time is called **the Pre-Project** Phase.

Year	Status	The main task

2026	**Data collection**	Logistics audit, installation of seismic stations, water level measurement.
2027	**Verification**	Completion of the EIA, site approval, selection of technology (Vendor).
2028+	**FID (Final Investment Decision)**	Making the final investment decision and ordering equipment.

PTI is "long-term construction insurance"

If you fail to identify logistical bottlenecks or justify seismic surveys at the PTI stage (2026–2027), then in 2030, when construction is already underway, any mistake will cost millions of euros a day.

In simple terms, PTI is when we check whether the floor in the room can support the weight of the heavy safe that we are just about to buy, and whether this safe will fit through the doorway.

NUCON's Role in PTI

For NUCON, participation in the PTI is an opportunity to help shape the rules of the game. We strongly recommend including a requirement for **a Logistics Audit** and **a Multimodal Plan in the PTI** , which will help protect the Serbian customer from the very same "Infrastructure Gap " we witnessed at Akkuyu.

In your opinion, is the Serbian side (the ministry and relevant agencies) ready for such a volume of work in such a short time frame (2026–2027), or will they need strong external support in the form of a “Customer Engineer” already now?

Comparative Analysis and Lessons Learned (Akkuyu NPP Case, Türkiye)

This subsection is an important addition to the report, as it translates the IAEA's theoretical analysis into real-world risks using the example of the largest ongoing project in the region. A comparison with the Turkish experience (Akkuyu NPP) will allow Serbian decision-makers to understand the "cost of error" when planning customer costs.

When planning the National Plan of Serbia, it is necessary to take into account the experience of the Republic of Turkey, which, despite the successful implementation of the technological part, faced serious challenges in **the Owner's Costs part** , which arose due to the desynchronization of schedules.

1. Critical Error: "Site Advanced Readiness Deficit"

One of the key challenges at the initial stage of the Akkuyu NPP project was that the development of external infrastructure (roads, port facilities, external power supply systems, and residential areas) began almost simultaneously with the pouring of first concrete at Unit 1.

Budget and schedule implications:

- **Logistics Collapse:** Existing regional roads were not designed to handle the volume of heavy construction equipment traffic. This necessitated an urgent (and more expensive) expansion of the road network while construction was already underway.
- **Housing and social shortages:** The lack of pre-planned housing for thousands of engineers and workers led to uncontrolled rent increases in the region and social tensions. Temporary accommodation costs for staff ultimately significantly exceeded Owner's Costs estimates.
- **Construction Power Supply:** Delays in establishing dedicated external power lines forced the client to use temporary (diesel or mobile) solutions, which increased operating costs during the construction phase.

2. Comparison of implementation models

Unlike the Turkish **BOO (Build-Own-Operate) model** , where many risks are borne by the vendor, Serbia will likely follow the classic path of state ownership or consortium ownership. This means that "Turkish mistakes" in Serbian conditions will **directly burden the state budget** .

Parameter	Akkuyu Experience (Türkiye)	Recommendation for Serbia
Site preparation deadlines	In parallel with the start of construction and installation work	**At least 2–3 years until** “first concrete”
Residential infrastructure	Emergency creation in progress	Completion of the town **before** the start of mass works
Logistics (roads/ports)	Reconstruction under load	Prepare routes for oversized cargo transportation **in advance**
Owner's Costs Financing	Blurred in overall expenses	**Protected** budget line item from 2027

3. Lesson for Serbia: Clear demarcation of areas of responsibility

The Turkish experience has proven that everything "beyond the fence" of a nuclear power plant is a critical factor in the success of what happens "inside the fence." If Serbia plans to begin the active phase by 2035, then 80% of the costs under **Account 70.3 (External Infrastructure)** must be utilized before the first heavy equipment arrives on site.

Section output:

The approach of starting infrastructure construction simultaneously with the pouring of the first concrete must be eliminated. For Serbia, this would create the risk of the project becoming bogged down during the logistics phase, leading to an increase in owner's costs of **25-30%** over initial estimates due to the need to carry out work in an "emergency" mode.

An addition to the report section focusing on the critical technical and regulatory risks of the Turkish project that led to additional costs and delays.

4. Untimely deployment of the construction production base (CPP)

The experience of Akkuyu has shown that underestimating the scale of temporary buildings and structures (TBSS) at the “zero cycle” stage creates a “bottleneck effect”.

- **The problem:** At the Turkish site, construction of the main workshops for the production of reinforced concrete blocks, concrete plants, and specialized warehouses for storing long-cycle equipment (LCE) lagged behind the pace of soil excavation.
- **Consequences:** This resulted in disorganized storage of expensive equipment in the open air and the need for cargo handling, which increased the risk of damage to components and increased the owner's logistical costs.
- **Lesson for Serbia:** The production base (concrete plant, pre-assembly shops, warehouse terminals) must be fully functional **before** the start of mass concrete pouring into the containment shell contour.

5. Difficulties in choosing and implementing a cooling system

The selection of a technical water supply system for the Akkuyu was one of the most complex engineering challenges, requiring large-scale offshore hydraulic engineering work.

- **The essence of the problem:** The use of a once-through seawater cooling system required the construction of deep-water water intake and discharge structures. During implementation, difficulties arose in maintaining thermal conditions (limited heating of coastal waters), necessitating the redesign of individual components on the fly.
- **Lesson for Serbia:** For Serbian sites (mainly river sites), the choice between direct flow (Danube/Sava) and cooling towers is critical.
    - *Risk:* Seasonal declines in river levels or increases in water temperatures in summer may lead to forced reductions in nuclear power plant capacity.
    - *Solution:* PTI should include long-term climate modeling for 60 years into the future to avoid costly cooling system upgrades during operation.

6. Problems with the Environmental Impact Assessment (EIA) document

The Akkuyu project's EIA documentation has been the subject of years of litigation and criticism from environmental groups, creating serious reputational risks for the project.

- **The crux of the matter:** The initial EIA report was challenged in court due to concerns about the quality of seismic data and the analysis of the impact on the local ecosystem and tourism. The approval process was delayed, formally delaying the issuance of the main construction license.
- **Lesson for Serbia:** In the context of strict EU environmental legislation, the Serbian EIA must be flawless in terms of transboundary impact (in accordance with the Espoo Convention).
    - *Risk:* Any inaccuracy in the EIA will become a legal tool for neighboring countries (for example, Austria) to block the project through international courts.
    - *Recommendation:* Allocate the development of the EIA into a separate subproject with the involvement of independent international auditors at an early stage.

Taking into account the lessons of Turkey, it is critical for Serbia to fulfill the following conditions of the “zero stage” (2026–2028):

1. **Logistics and infrastructure audit:** Complete construction of the PBS and road junctions before the start of the main works.
2. **Cooling Technology Selection:** Make a final decision on the cooling system (cooling towers vs. once-through) based on conservative climate projections.
3. **Legal "purity" of the EIA:** Ensure maximum transparency and scientific validity of the environmental report to neutralize external political pressure.