NUCLEAR CAPITAL PORTFOLIO OPTIMIZATION: MAINTAIN SAFETY AND RELIABILITY, REDUCE COSTS AND SURPRISES

Executive Summary

MCR helps clients engage in rigorous project valuation and capital portfolio optimization to stabilize out-of-control scope and reduce capital spending. This approach starts at a plant component level to identify all the known and knowable issues affecting plant assets. Complete discovery drives the development of well-defined problem statements, which serve as the basis for a project request and associated solution alternatives. Accurate cost estimates and probabilistic risk analyses roll up into a project net present value (NPV). With MCR's facilitation, executives can use this quantitative NPV along with defined qualitative factors to clearly rank projects for implementation on a "go/no-go" basis and optimize the entire capital portfolio in short order, even under the constraint of a finite budget.

Using this approach, MCR has, for a single client alone, identified over $100 million in capital project costs that could be eliminated or shifted, all with safety in mind. Combined with MCR's approach to process improvement, these benefits and efficiencies can be sustained for years after the initial engagement.

Introduction

Nuclear utilities commonly invest tens to hundreds of millions of dollars in capital funding annually to maintain and extend the life of their nuclear plants and fleets. On average, each nuclear unit requires about $50 million of annual capital investment to continue safe and reliable operations. However, MCR has observed that more than 50% of projects in short-range plans are never implemented on schedule, as "emergent" projects displace scope funded within the first one or two years. This forces reallocation of millions of dollars in limited capital funds, despite original strategic objectives. What value does a strategic plan have if it can be changed in the 11th hour?

To reduce these surprises, capital portfolios must holistically support station reliability, direct limited resources to the highest-value problems, and stay aligned with strategic objectives. However, this is easier said than done, as nuclear executives must prioritize hundreds of project candidates with insufficient capital to fund them all. The sheer volume and variability of capital funding requests demand disciplined approaches to proactively identify all risks and **optimize the capital portfolio.** In this light, nuclear executives must ask themselves, "Am I appropriately and consistently funding the right projects at the right time?" Capital portfolios can be destabilized and diverge from strategic objectives when business planning fails to incorporate the fundamental reasons for each project's existence in the portfolio.

Common portfolio planning missteps include:

- Incomplete discovery of all issues affecting long-term asset safety and reliability
- Substandard problem statements that fail to define project scope
- Inadequate project alternatives to address the problem statement
- Unreliable cost estimates for project alternatives
- Absence of robust risk-benefit evaluations to determine project value
- Unverified claims of impending asset obsolescence
- Deficiencies in dynamic portfolio optimization using project valuations

MCR's proven sequential approach to capital portfolio optimization remedies these missteps and provides nuclear executives a framework to evaluate hundreds of project candidates and effectively prioritize them with reasonable effort. When paired with MCR's approach to process improvement analysis, it ensures durable cultural changes driving long-term performance, **millions of dollars in cost savings,** and portfolio stability.

The Approach

Exhibit 1: MCR's Approach to Capital Portfolio Optimization

Discovery

"That's a good-looking long-range plan. What concerns me is not what's in it, but what's missing."

–MCR's Nuclear Generation Practice Vice President Tim Schlimpert speaking to a nuclear unit asset manager

Inadequate discovery leads to churn in nuclear project portfolios. Capital budgets are always filled with candidate projects, but urgency dictates their execution. When previously unidentified issues become urgent, they displace planned work, driving cost increases, contract renegotiations, and engineering rework.

The cure for churn is **complete discovery** of all known and knowable issues affecting plant assets. This enables the most value-adding projects to be aligned with their optimal execution windows. Most importantly, though, it mitigates last-minute emergent portfolio changes.

Discovery must be continuous and data-driven, leveraging both quantitative and qualitative data from sources such as:

- Work management system work order history
- Condition reports
- System health reports
- Vendor information
- Nuclear Regulatory Commission Generic Letters
- Original equipment manufacturer owners groups
- Institute of Nuclear Power Operations working groups

Ownership of complete discovery lies with the custodians of the asset. Normally they are system or component engineers, who are best positioned to identify the most critical issues and the appropriate time to address them.

Problem Statement

A problem statement should always precede a project request. A precise problem statement is the foundation for the project scope, aligns funding requests to a defined goal, and controls scope for the life of the project. Developing a strong problem statement may require considerable effort, but it's time well spent: A project without a robust problem statement is a project with no clear purpose.

Development of Alternatives

A list of robust alternatives helps challenge assumptions of how many resources are required to resolve the stated problem. Submitting one primary solution with one "do-nothing" alternative does not drive creation of solutions tailored to the problem. Instead, a menu of alternatives spanning scope, schedule, and cost (e.g., basic refurbishment to full replacement) enables executives to allocate the precise level of funding

needed at the right time. This is not to say that status quo or do-nothing alternatives are inadmissible (often they may be the right choice), but a variety of creative alternatives is required to get a full picture of available solutions.

Cost Estimation

Project valuations can fluctuate wildly when not supported by meticulous cost estimates. Cost estimates for implementation should have a high level of confidence, be driven by corporate processes, and include total cost of ownership over the life of the asset. Objective data from field walkdowns and vendor quotes are required to confidently substantiate valuations. Estimates based only on hearsay will lead to unpleasant surprises as project implementation begins and true costs become evident. Every inaccurate cost estimate erodes the integrity of the entire capital portfolio, resulting in unexpected deficits and idle funds.

Project Valuation

A clear problem statement makes it possible to define the NPV of risk, which combines the expected probability of asset failure with the consequences of failure. The present value of each project alternative's costs are offset by the NPV of risk, enabling calculation of an **overall project NPV.** Project champions develop the project NPV, and executives can use it as a quantitative financial basis for comparing and selecting project alternatives. This approach can be applied across projects of all kinds, from mechanical modifications to software changes.

Learn more about individual project valuation best practices by reading MCR's project business case development white paper.

Dynamic Portfolio Optimization

Once the facts are gathered and the capital budget is set, executives face the challenge of deciding which projects get funded. MCR facilitates a two-step ranking process that enables an executive review team to integrate both quantitative and qualitative factors for an optimized portfolio.

The first step identifies projects that deliver the greatest financial value. All candidates for the budget year are ranked by project NPV, strictly ordering projects by the value they create for the business. The annual capital budget serves as the cutoff, with projects falling above (go) or below (no-go) the line.

However, as every nuclear professional knows, plant decision-making is rarely driven by numbers alone. Many problems involve qualitative factors that are difficult to measure, such as regulatory considerations, occupational safety, human factors, or scheduling flexibility.

The second step brings these qualitative issues into focus, culminating with the executive review team determining whether a project is mandatory or discretionary, with an unbiased, experienced facilitator like MCR providing expert input and guidance to avoid error traps.

With these facts in hand, the executive review team gains a clear understanding of each project's value and necessity. Executives can then adjust projects above or below the line to ensure all mandatory and highest-

value discretionary projects are funded. The budget line can shift between years and, for multi-plant utilities, across units. Slack in one year or unit can be reallocated to finance priority projects elsewhere.

Portfolio optimization should not be a "one-and-done" exercise. Project NPV can shift as new risks appear and others are managed. Assuming the same year-over-year risk probability overlooks the impact of changing conditions and emerging threats. That's why a capital portfolio needs to stay flexible, evolving with the risk landscape to keep decisions relevant and effective. For example, asset failure probability can be updated as new work order data are obtained, driving an updated project NPV. MCR has successfully leveraged a variety of dynamic probabilistic tools, such as Monte Carlo simulation, to help clients appraise these uncertainties.

Understanding Obsolescence

Broad-based claims of obsolescence, often coupled with dubious assertions of severe consequences, can unintentionally pull the wool over nuclear executives' eyes, potentially inflating the capital portfolio with massive amounts of unneeded spending. True obsolescence must be defined as a point where the next failure would render an asset unable to be returned to service without substantial overhaul or modification. Furthermore, newer technologies are not always necessary; even if no longer cutting-edge, existing assets can continue to function effectively within design bases. Expected asset failure frequency and the availability of spares or repair parts must be evaluated to effectively forecast true obsolescence. For example, MCR evaluated a client's project and discovered the true forecasted obsolescence date fell after the plant's planned retirement, eliminating the need for the project entirely.

By applying MCR's balanced approach, leadership can confidently decide which projects to implement, when to implement them, and which to defer, all while ensuring alignment with company safety, reliability, and cost goals. Even large, complex portfolios across multiple units can be optimized with a reasonable level of effort using MCR's proven approach. Furthermore, this process provides assurance that all known or knowable threats have been accounted for, reducing the probability of emergent portfolio course corrections.

Results

In MCR's experience, optimizing the capital portfolio can uncover significant cost savings potential. MCR has saved clients billions of dollars in unnecessary capital project spending. For a single client alone, MCR identified over $100 million in capital project costs from an approximately $400 million budget that could be eliminated or shifted across a six-year portfolio. All project adjustments are performed with safety in mind, backed by reasonable failure probabilities and consequences. This is not a simple "trim off the top" exercise; indeed, MCR may recommend increasing cost estimates for some projects to capture their full scope and prevent future surprises. However, these cost increases are often offset by substantial savings identified in other projects.

Exhibit 2 illustrates an example of these cost adjustments, showing each budget year before and after MCR's analysis and recommendations. Cost adjustments are broken down by MCR's identified strategy. Only a rigorous project-based analysis can identify such variability in available cost reduction options from year to year, highlighting the gaps in simple blanket cost reduction approaches.

Exhibit 2: Example Yearly Capital Portfolio Adjustment Opportunities Identified for a Nuclear Plant

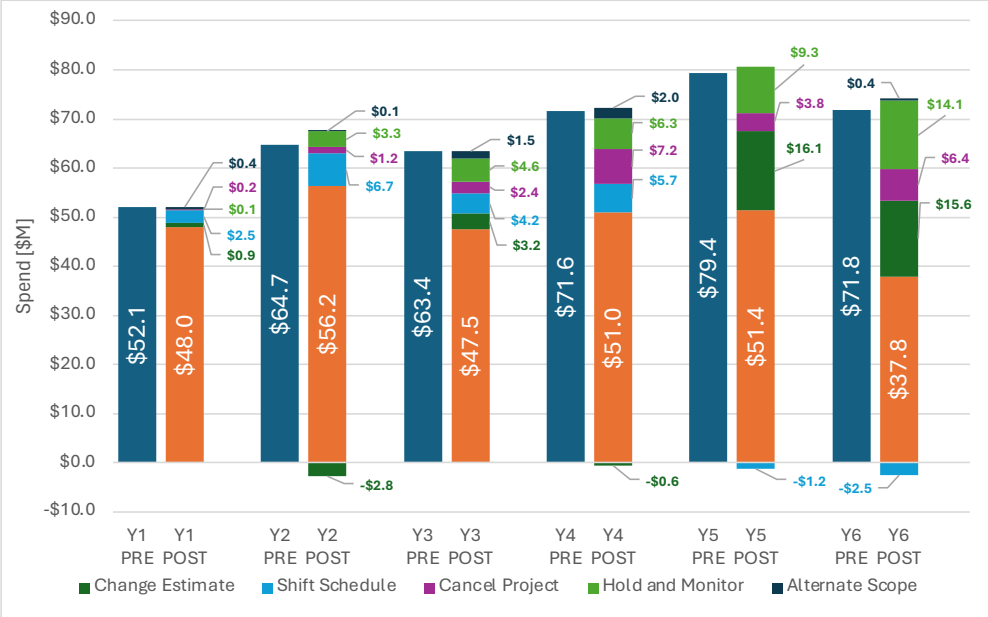
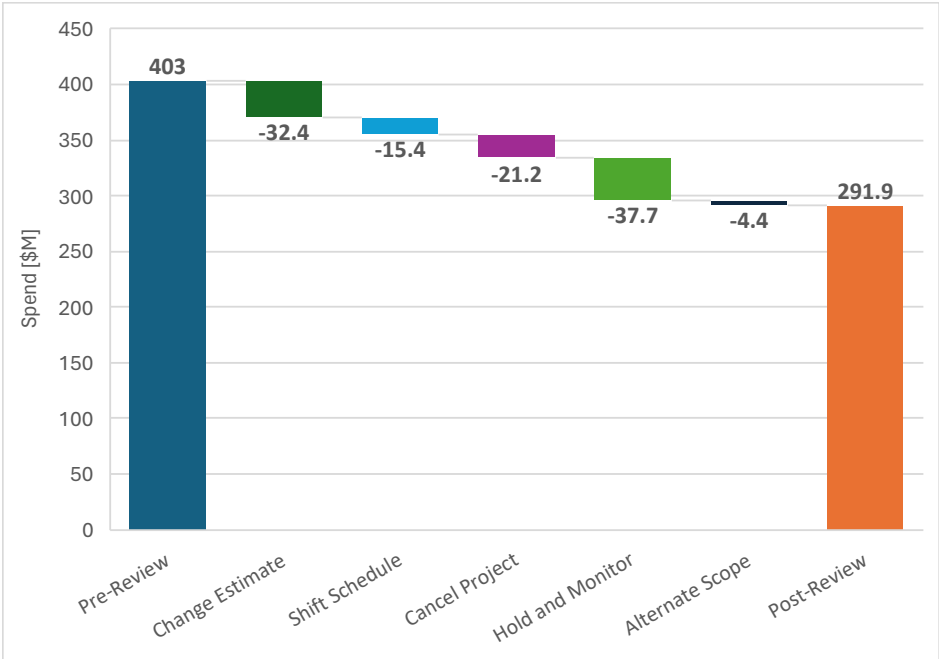


Exhibit 3 shows a waterfall chart of the same example six-year capital portfolio, with net savings grouped by MCR's identified strategy.

Exhibit 3: Example Nuclear Plant 6-Year Capital Portfolio Reduction Waterfall



Process Improvement

After the capital portfolio is initially optimized, the long-term challenge becomes maintaining strong plant performance and capital cost discipline. Executives must understand the underlying reasons why their capital portfolio was inconsistent and misaligned with business objectives. By interviewing key stakeholders and auditing how business processes support portfolio development, MCR can identify opportunities and threats and recommend corrective actions to establish strong process performance going forward.

The first stage is to address the process issues initially uncovered during the portfolio optimization effort. After this, a more expansive process improvement effort for the entire organization can be performed to root out deeper process issues. This prevents issues from recurring and positions the organization for long-term success, especially if there are plans to implement an enterprise resource planning (ERP) system. Before investing in advanced ERP software, it's essential to "get the house in order" by strengthening base capital planning practices.

Millions of Dollars in Capital Cost Optimization Could Be Possible—Why Wait?

Without judicious oversight, an unchecked capital portfolio can yield significant consequences for a nuclear station, with the worst outcome being financial insolvency and premature plant decommissioning. Plant executives need to ensure their capital portfolio is well maintained, accounted for, and within their control. Uncontrolled capital portfolio growth is a recipe for financial disaster, but haphazardly trimming the portfolio is equally problematic, potentially impacting projects critical to safety and reliability. Especially in a production environment, frequent tactical challenges can distract from strategic plans. Executives cannot assume their capital portfolios will simply sort themselves out, but rather must be active participants in a culture of rigorous inquiry.

To achieve this objective, it is advantageous to retain a team with expertise evaluating an entire portfolio's worth of capital projects to ensure every dollar is allocated to the right project at the right time. Simply implementing an ERP system alone as a tool will not address the issue of inadequate capital project portfolio optimization; a deep dive into culture and process is also required. MCR has been referred to as the preeminent experts in nuclear asset management and project evaluation. Indeed, we have significant experience supporting the nuclear power industry and have saved clients billions of dollars in capital costs while remaining cognizant of high safety and reliability standards. No other consultancy can match our decades of industry experience, proprietary analytical approaches, and ability to seamlessly bridge the gap between the power plant and the boardroom.

About the Authors

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Tim is a Vice President at MCR and leads the Nuclear Generation practice. He has more than 30 years of utility industry experience in nuclear power plant operations, maintenance, work control, business operations, process improvement, and technology solutions, and he has achieved significant performance improvements for his clients. Tim provides the often-elusive connection between corporate strategy, long-range planning/budgeting, work management, and technology through industry-leading life cycle management practices.

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