ABSTRACT

Title of Thesis:	FUSION RE: ACTION Architecture's Role in Energy Transitions
	Stephanie Nicole Berg, Master of Architecture, 2026
Thesis Directed By:	Assistant Director of Graduate Architecture + Associate Clinical Professor, Michael Ezban, Architecture Program, School of Architecture, Planning & Preservation

Nuclear fusion promises clean, abundant energy, yet public understanding of it remains thin, abstract, and confused with nuclear fission. Fusion has had little public presence, limited cultural familiarity, and few spatial experiences that help people understand its meaning and relevance. As we accelerate toward this energy transition, with fusion approaching commercial deployment, architecture becomes a critical interface between science, energy infrastructure, and everyday life. This thesis asks what it means to make fusion energy urban and public.

Set on Baltimore's Canton waterfront, the project proposes a fusion energy campus with a science center, fusion power plant, and a harborfront park. This campus aims to educate the public on energy systems, bring energy autonomy to Baltimore residents, and improve the urban fabric through resilient landscapes and biophilic design. These elements work together as a single system to translate scientific complexity into legible civic experiences, positioning fusion not as distant infrastructure, but as a visible and integral part of urban public life.

FUSION RE:ACTION
Architecture's Role in Energy Transitions

by

Stephanie Nicole Berg

Thesis submitted to the Faculty of the Graduate School of the
University of Maryland, College Park, in partial fulfillment
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Advisory Committee:
Professor Michael Ezban, Chair
Professor Brittany L. Williams, Chair
Professor Michael Carlos Kleiss, Chair

Preface

I have always been drawn to the invisible systems that shape the world around us. The laws of physics, thermodynamics, energy, mass, and material behavior. These describe forces we cannot always see directly, but that still organize how we live. Architecture sits inside those forces. It mediates heat, light, water, air, technology, and comfort. For me, that is where this thesis began.

My interest in sustainability and regenerative architecture made me increasingly aware that the built environment cannot be separated from energy. Architecture is often asked to reduce harm, use less, consume less, and operate more efficiently. Those goals matter, but they also made me wonder what happens when the energy question changes. What if the future is not only about scarcity? What if part of the future is learning how to use abundance responsibly?

That question became more real as energy demand kept growing around me. Data centers, artificial intelligence, climate adaptation, and everyday utility costs are not distant issues. They are already here. Even my own electricity bill made the question feel less abstract. Energy is something we depend on completely, but rarely understand, rarely see, and rarely feel connected to until it becomes expensive or unreliable.

Fusion pulled all these interests together. It is technical, complex, powerful, and full of possibility. It forces architecture to think beyond the usual language of sustainability. If energy could become cleaner, denser, and more abundant, how should architecture respond?

This thesis grew out of that inquiry. It is not just about designing new energy technology. It is about imagining how the systems that power our lives could become more visible, more public, and more connected to the cities and landscapes they serve. It's about how architecture can help us understand a future that feels almost impossible to imagine but is increasingly necessary to consider. At its core, this thesis is my attempt to sit with that possibility long enough to begin to give it form.

Dedication

To Steven, for his unwavering love, patience, and endless support, and for helping me carry out this work, especially when it felt too heavy to bear alone.

And to Melvin, for his unconditional love and companionship, keeping me grounded through the long hours, and giving me a purpose greater than myself.

Acknowledgements

I would first like to thank my thesis chair, Michael Ezban, for his guidance, patience, and steady support throughout this process. His feedback helped me clarify the architectural stakes of the project and push the thesis beyond a technical proposal into a larger question about energy, landscape, and public life.

I would also like to thank Britt Williams, my committee chair, for her thoughtful criticism, encouragement, and perspective throughout this process. Her insight helped strengthen the project's relationship to site, experience, and architectural communication.

Thank you to Daniel Pantoja, my peer mentor, for his time, honesty, and support throughout the development of this work. His feedback helped me stay grounded through the design process and continue moving forward when the project felt overwhelming.

I am also grateful to Chris Penafiel, my research partner, for the conversations, shared research, and collaboration that helped shape my understanding of fusion, energy systems, and the broader questions surrounding this thesis.

I am also deeply grateful to my cohort and to the faculty at the University of Maryland who shaped my education over these past years. The conversations, critiques, late nights, shared deadlines, and constant exchange of ideas made this work stronger. This thesis carries pieces of many studios, reviews, lectures, and informal conversations that helped me grow as a designer, researcher, and thinker.

I want to thank my family and friends for their love, patience, and encouragement throughout this process. Their support gave me stability when the work felt overwhelming and reminded me that life existed beyond the thesis. I am grateful for every check-in, every meal, every moment of reassurance, and every bit of help that allowed me to keep going.

I am especially grateful to Thomas J. Dolan, Ph.D., Adjunct Professor in Nuclear, Plasma & Radiological Engineering at the University of Illinois Urbana-Champaign, for taking the time to correspond with me and share insight from his long career in fusion research. His work helped ground this thesis in the technical realities and long history of fusion power.

I would like to thank Dr. Ian Abel, Associate Research Scientist at the University of Maryland’s Institute for Research in Electronics and Applied Physics, for generously helping me connect with researchers who could answer technical questions about fusion and energy systems.

I would also like to thank Christopher Wilson for sharing his expertise in fusion power plant systems, neutronics, radiation effects, and facility integration. His insight helped me better understand the technical systems that surround fusion design and the spatial implications of bringing those systems into architecture.

Lastly, I would like to acknowledge Commonwealth Fusion Systems, whose publicly available materials on ARC, SPARC, and commercial fusion development were invaluable to my understanding of how fusion research is moving toward built infrastructure. Their openness made it possible to study fusion not only as a scientific process, but as an emerging architectural and urban condition.

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Chapter 1: Introduction

Energy Transitions

Energy transitions are not just technological milestones. They change the spaces and systems that organize everyday life. Coal and steam reshaped cities around rail, factories, and ports. Oil and electrification pushed energy production farther from daily experience, while nuclear fission concentrated it inside secured campuses. Fusion enters this lineage with a different spatial possibility: a compact, high-density energy source that could bring production closer to the city. That shift gives architecture a role in making the next energy transition visible, legible, and part of the urban fabric.

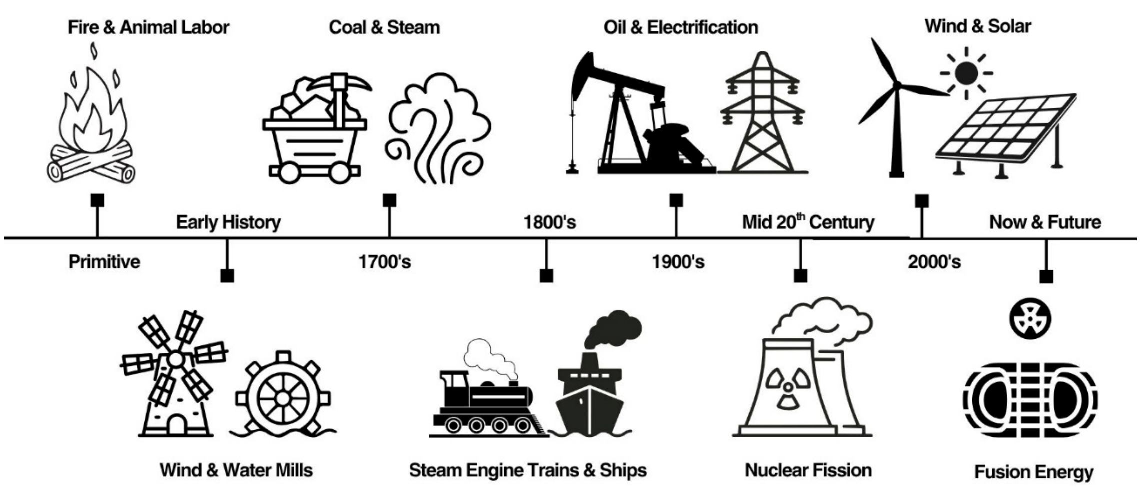


Figure 1. Timeline of energy production methods marking historic spatial shifts in the built environment

Making Fusion Energy Legible

Nuclear fusion is the process that powers the sun, releasing enormous amounts of energy when atoms fuse. Fusion has been tested through decades of research, and recent breakthroughs in net energy gain and reactor design suggest its commercial viability as early as the 2030s. Unlike conventional nuclear fission, in which atoms are split, fusion produces no long-lived radioactive waste and carries no risk of meltdown. Its fuels are abundant and extremely energy dense, meaning that relatively small quantities can generate tremendous amounts of power. For many researchers, policymakers, and energy planners, fusion represents a long-awaited, game-changing promise for a decarbonized energy future. As experimental and demonstration projects begin to point toward commercial-scale facilities, fusion is poised to remove the constraints of limited energy and usher in a new era of energy abundance.

The Perception Gap

Despite its promise, fusion remains largely unfamiliar to the public. For decades it has circulated almost exclusively within the scientific community, described in technical language and often dismissed with the refrain that it is "always fifty years away." Its progress has rarely been communicated in layman's terms, and little effort has been made to share its significance beyond specialist circles. Because fusion research occurs in controlled laboratory environments that the public cannot and should not access directly, most people have had no meaningful exposure to it at all. In this absence of approachable communication, the word "nuclear" becomes a stand-in, and fusion gets folded into the same mental category as fission. Images of meltdowns, waste, and weapons fill the gap left by a lack of education and visibility. As a result, fusion inherits an emotional landscape of fear and suspicion shaped by fission, reinforcing confusion, hesitation, and a default sense of mistrust toward nuclear technologies in general.

A Turning Point

This misunderstanding is not just a semantic or scientific problem; it has material consequences for how future energy systems may unfold. Fusion is emerging at a moment when decarbonization timelines are tightening and many existing energy sources carry significant environmental, spatial, or political costs. If confusion and inherited stigma prevent fusion from being understood or trusted, it risks being under-supported or excluded from the mix of tools available to address long-term energy demand. In that scenario, societies may be forced to lean more heavily on systems that are more land intensive, less reliable, or more damaging to the planet over time. The gap between what fusion can offer and what the public perceives it to be becomes, in this sense, an architectural and cultural problem as much as a technical one.

Architecture as Mediator

As fusion moves toward commercial-scale deployment, the public's first meaningful encounter with the technology will happen through buildings and landscapes rather than scientific reports. The architecture that surrounds fusion will shape how people interpret it and whether they feel cautious, curious, or confident. Design choices such as form, approach, material expression, and the way a site is organized can create a sense of openness and clarity, or they can reinforce distance and uncertainty. Architecture can mediate the threshold between advanced science and everyday civic life by offering experiences that are intuitive, inviting, and grounded in place. In this way, the challenge of public understanding becomes an architectural one: how can design help people see fusion as a knowable, safe, and shared part of our energy future?

Conceptual Framework

Understanding fusion in the public realm requires more than providing information. It relies on the quality of the experiences that architecture creates. This thesis organizes its approach around three interconnected themes: visibility, discovery, and education. Together, these themes form a framework for considering how the built environment can help people engage with a technology that is powerful, unfamiliar, and difficult to understand through information alone. Visibility considers what fusion can reveal about itself through form, material, and spatial clarity. Discovery focuses on how movement and sequence shape curiosity and invite gradual, intuitive understanding. Education refers to the ways architectural and landscape experiences can help people grasp how energy shapes the past, present, and future. These ideas work in concert to transform fusion from a distant scientific pursuit into an experience that is legible, grounded, and public facing. They provide the lens through which the design inquiry in this thesis is developed.

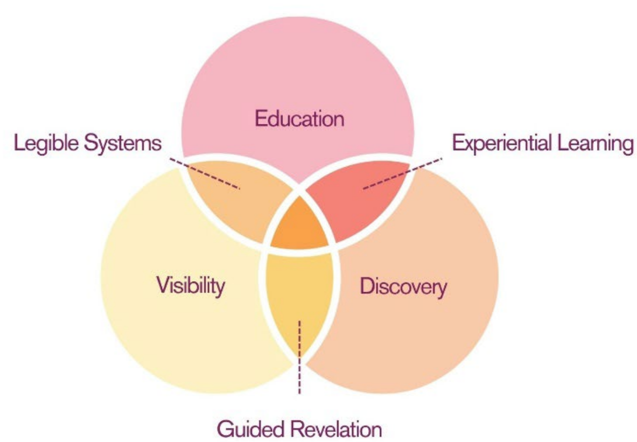


Figure 2. Conceptual framework diagram for public understanding of fusion energy systems

Visibility

In this thesis, visibility is treated as a design problem rather than a simple call for transparency. The question is not only whether fusion is visible, but what is visible, from where, and to whom. Visibility shapes which aspects of the project read as technical, which read as civic, and which remain abstract or symbolic. Architectural decisions about massing, openings, sectional cuts, and lighting become ways to register that something precise and carefully controlled is happening, without exposing sensitive equipment or overwhelming visitors with detail. Visibility also operates at different distances: from far away, the project can signal the presence of a new kind of energy infrastructure; up close, it can reveal enough structure and activity to support a sense of order, safety, and care. In this way, visibility becomes a tool for guiding how fusion is first pictured and understood in the public imagination.

Discovery

Discovery in this thesis refers to how architecture choreographs the encounter with fusion over time. Rather than presenting information all at once, the project uses movement, sequence, and changing spatial conditions to support gradual, intuitive understanding. Discovery begins before a visitor enters the building, through the alignment of paths, views, and thresholds that establish fusion as something to approach with curiosity rather than apprehension. As people move through the project, shifts in scale, light, material, and orientation reveal different layers of the facility, giving a sense of the system's complexity without overwhelming the visitor or exposing sensitive equipment. These orchestrated moments of revelation allow fusion to be understood experientially: not as a diagram or a technical argument, but as a spatial narrative that unfolds at the pace of the observer. By shaping how and when key elements become visible, discovery turns the unfamiliar into something that can be explored, interpreted, and understood as part of civic life.

Education

Education in this thesis is understood as something that emerges through experience rather than instruction. Because fusion is unfamiliar and cannot be directly accessed, the project uses the built environment to help visitors understand where fusion sits within a larger narrative of energy. Architectural and landscape elements can highlight how energy systems have shaped daily life in the past, how they structure the present, and how emerging technologies like fusion may influence shared futures. This educational dimension is not delivered through signage or technical explanation but through spatial relationships, material contrasts, environmental cues, and the pairing of visible and invisible processes. By prompting visitors to observe, compare, and situate fusion within a continuum of energy infrastructures, the project encourages comprehension that grows out of context rather than content. In this way, education becomes a quiet but powerful tool for expanding public understanding and grounding fusion within the civic imagination and the built environments that shape it.

Chapter 2: Literature Review

Introduction

This chapter establishes the conceptual and architectural foundations for the thesis by examining how energy systems shape space, perception, and public life. Rather than treating energy as a purely technical or policy-driven domain, the literature reviewed here is read through an architectural lens, foregrounding how different forms of energy production claim land, organize infrastructure, and signal risk or safety through the built environment. The chapter asks not only how energy systems work, but how they are encountered, understood, and trusted.

The review is organized around three intersecting lines of inquiry. First, it examines the spatial consequences of contemporary energy infrastructure, focusing on energy density, land use, environmental externalities, and systemic constraints that shape landscapes and cities. Second, it considers how nuclear technologies have been culturally framed through histories of secrecy, accident, and institutional mistrust, and how these narratives become attached to architectural form. Third, it articulates fusion energy as a distinct technological condition whose physical and safety characteristics generate specific architectural demands that cannot be adequately addressed through inherited fission typologies.

Together, these strands position architecture as a critical mediator between technical necessity and public comprehension. By grounding the discussion in spatial consequences rather than abstract evaluation, this chapter establishes the terms through which fusion can be understood as both an energy system and an architectural problem. The sections that follow do not advocate for a single energy solution but instead clarify the conditions under which architecture must operate if emerging technologies are to be integrated responsibly into civic and environmental contexts (Hughes, 1983; Jasanoff and Kim, 2015; Pidgeon et al., 2003).

Energy Infrastructure and Spatial Consequences

Energy systems do not simply power cities; they organize them. Across historical transitions, dominant fuels and prime movers have written themselves into land, water, and built form. Energy also shapes where settlements grow, how infrastructure is routed, and which landscapes are transformed into zones of production, exchange, or exclusion. These spatial effects are not secondary outcomes

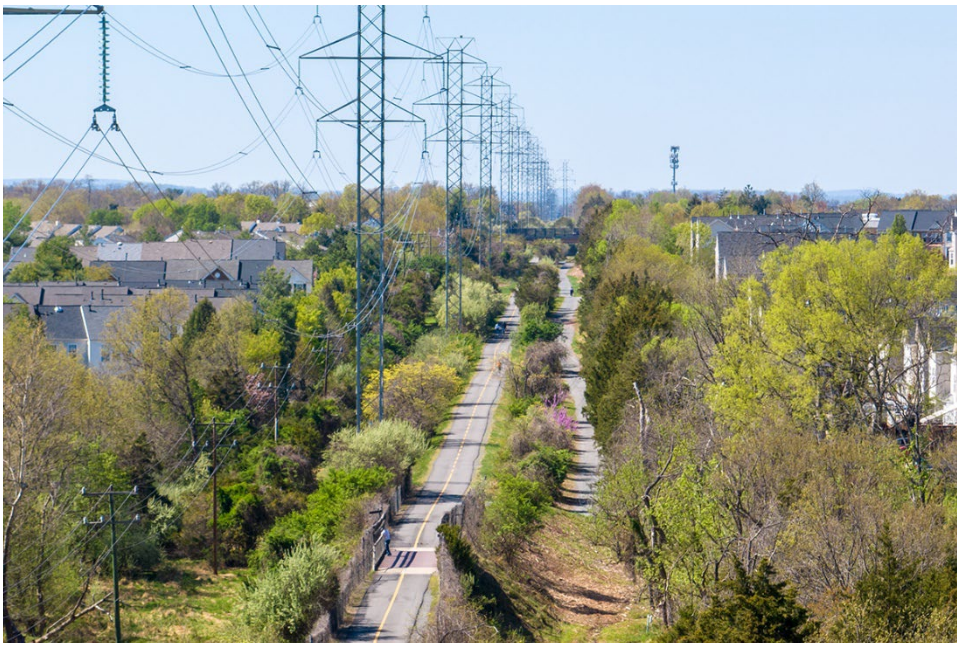


Figure 3. Transmission lines along the W&OD Trail in Loudoun County, Virginia (Kenny, 2023)

of energy choice but primary expressions of it. Architecture and planning inherit them whether they are acknowledged or not (Smil, 2017; Hughes, 1983).

Energy infrastructure operates simultaneously at multiple scales. At the territorial level, extraction zones, transmission corridors, and cooling-water access redraw regions. At the urban scale, substations, rights-of-way, and service yards harden edges and constrain adjacent development. At the architectural scale, machine halls, maintenance envelopes, and safety setbacks determine massing, circulation, and public interface. Together, these layers form what can be understood as an energy spatial grammar: a recurring set of forms and relationships that persist long after individual technologies evolve (Easterling, 2014; Banham, 2022).

This section frames energy critique through that grammar. Rather than ranking technologies by virtue or carbon intensity alone, it examines how different energy systems distribute space, claim land and water, and impose long-term stewardship obligations. The aim is not to dismiss any one approach, but to surface the spatial consequences that energy choices carry, particularly as decarbonization accelerates and new infrastructures are asked to coexist with civic and ecological life (Smil, 2017; Sovacool, 2016).

Energy Density, Land Use, and Territory

Energy density is one of the clearest predictors of how power systems shape land. Low power-density sources require extensive territorial coverage, dispersing generation across wide landscapes, while high power-density sources concentrate production within compact sites that rely on heavy interconnection and cooling infrastructure. These differences are not abstract. They determine whether energy appears as a field, a corridor, or a node, and whether its presence is felt as gradual occupation or as concentrated intervention (Smil, 2015; International Energy Agency, 2023).

Utility-scale renewable systems make this spatial logic explicit. Solar photovoltaic fields and wind farms convert large areas of land or sea into energy landscapes, often overlapping with agricultural, ecological, or recreational uses. This territorial spread is not inherently problematic, but it introduces conflicts that design and planning must resolve visual continuity versus fragmentation, habitat protection versus access, and long-term land stewardship versus rapid deployment. The assumption that renewables are "free" or "clean" in spatial terms obscures these trade-offs, particularly as scale increases (Ritchie et al., 2023; IEA-PVPS, 2021).

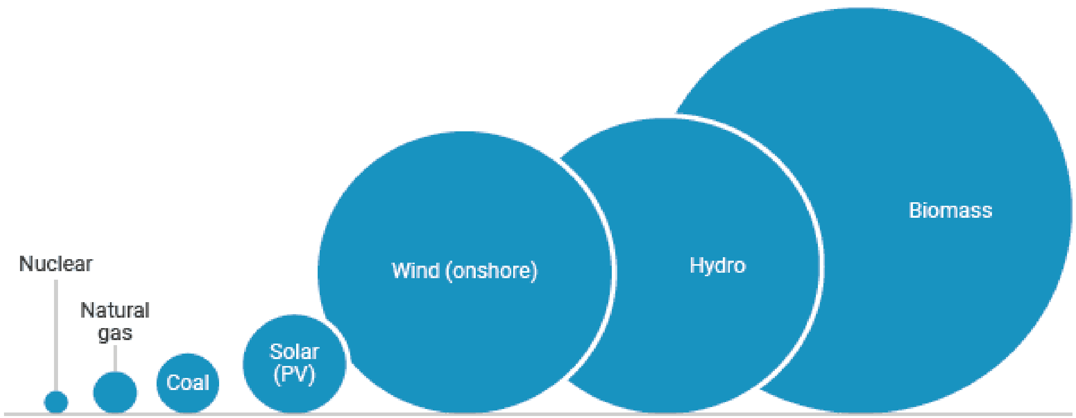


Figure 4. Relative land use of electricity generation options per unit of electricity (Brook & Bradshaw, 2015)

High-density thermal systems invert this relationship. Fossil fuel plants, nuclear fission facilities, and prospective fusion plants occupy relatively compact sites, but they extend their influence outward through cooling-water demands, transmission corridors, fuel logistics, and waste management zones. Their land footprint may be smaller at the fence line, yet their spatial consequences concentrate intensely at specific edges: shorelines shaped by intake and outfall structures, inland landscapes defined by cooling towers or heat-exchange fields, and corridors fixed by grid interconnection requirements (Hirsch and Rice, 1974; Sandri et al., 2020; Miyoshi et al., 2018).

The architectural implication is not that one model is preferable to another, but that territory is always being claimed, either diffusely or concentrically. Distributed systems trade local intensity for regional spread. Concentrated systems trade land economy for infrastructural thickness and long-term site commitment. In both cases, energy production becomes a form of spatial authorship that architecture must engage directly (Banham, 2022; Adam et al., 2004).

Understanding these dynamics is essential for evaluating emerging energy

Figure 5. Solar photovoltaic installation in Ruicheng County, Shanxi Province, China (McNeil, 2019)

technologies. As decarbonization timelines tighten, societies face pressure to deploy systems quickly, often without fully accounting for their spatial costs. An energy future that is both low-carbon and spatially responsible requires acknowledging how density, land use, and territorial reach interact — and designing accordingly. This question sets the stage for examining how different energy infrastructures externalize costs through water use, material flows, and stewardship obligations, and how those externalities can be made legible rather than hidden (Sovacool, 2016; Gupta et al., 2024; International Energy Agency, 2023).

Infrastructure, Water, and Environmental Externalities

Energy infrastructure does not end at the point of generation. Every system relies on extended networks of water, material extraction, waste handling, and long-term maintenance that shape landscapes far beyond the visible boundary of a plant or

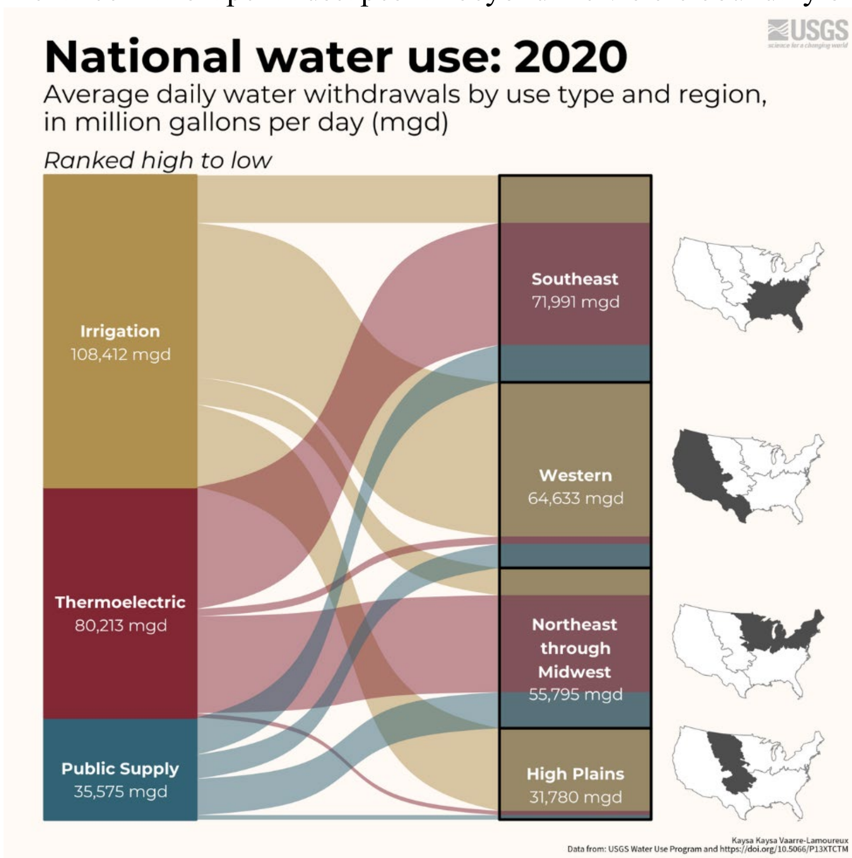


Figure 6. National water withdrawals by use type and region in the USA (USGS, 2020)

field. These externalities are often treated as technical or environmental concerns, yet they are also architectural and spatial in nature, producing durable forms, territories, and patterns of exclusion that persist over time (Easterling, 2014; Chertow, 2000).

Water is one of the most significant spatial drivers of energy infrastructure. Thermal systems, including fossil fuel plants and nuclear facilities, require large volumes of water for cooling, drawing energy production toward coastlines, rivers, and lakes. Intake and outfall structures, heat-exchange fields, and thermal discharge zones transform shorelines into engineered edges, often limiting public access and reshaping aquatic ecologies. Even systems framed as low-impact rely on water-intensive processes upstream, from mineral extraction to manufacturing, embedding hydrological consequences within broader supply chains (Harris and Diehl, 2019; DOE, 2010).

Material extraction and lifecycle impact further complicate the spatial footprint of energy systems. Renewable technologies depend on extensive mining for metals, rare earth elements, and concrete, while thermal systems require specialized

Figure 7. Open-pit cobalt mine in the Democratic Republic of Congo (Dubourthoumieu, 2018)

alloys, shielding materials, and long-lived structural components. These material flows generate landscapes of extraction, processing, and disposal that are rarely co-located with generation sites but remain integral to the system as a whole.

Architecture typically encounters these consequences indirectly, yet they shape the ethics and realities of the siting, scale, and longevity (Yoon et al., 2021; Chertow, 2000).

Waste and decommissioning introduce a temporal dimension to spatial responsibility. Energy infrastructures do not simply arrive and disappear; they leave behind altered ground conditions, residual contamination, and structures that must be dismantled, repurposed, or monitored. Decommissioning is itself a spatial project, involving access routes, staging areas, containment zones, and long-term land management strategies. Treating waste as an afterthought obscures architectural commitment embedded in energy production and defers responsibility across generations (Sandri et al., 2020; Perrault et al., 2019).

The architectural challenge is not to eliminate these externalities, but to refuse their invisibility. When water systems, material flows, and waste processes are hidden or displaced, their spatial consequences re-emerge elsewhere, often in less regulated or less visible contexts. A spatially responsible approach to energy infrastructure must therefore confront these externalities directly, acknowledging that sustainability is not only a matter of emissions, but of how systems occupy land, claim resources, and structure long-term stewardship. This recognition sets up the next question: how reliability, scale, and systemic constraints further complicate the spatial demands placed on energy infrastructure (Easterling, 2014; Schweizer-Ries, 2008).

Reliability, Scale, and Systemic Constraints

Beyond land use and environmental externalities, energy systems are shaped by demands for reliability and scale. Power infrastructures must operate continuously, respond to fluctuating demand, and integrate into regional and national grids that were often built around older technologies. These systemic requirements introduce spatial constraints that are as consequential as generation itself, determining where infrastructure can be placed, how it must be connected, and how much redundancy it requires (Hughes, 1983).

Intermittency is one of the most visible expressions of this condition. Renewable systems tied to solar and wind cycles depend on storage, backup generation, and overcapacity to meet peak demand. These compensatory systems carry their own spatial footprints, from battery installations and pumped storage reservoirs to expanded transmission corridors that balance generation across regions.

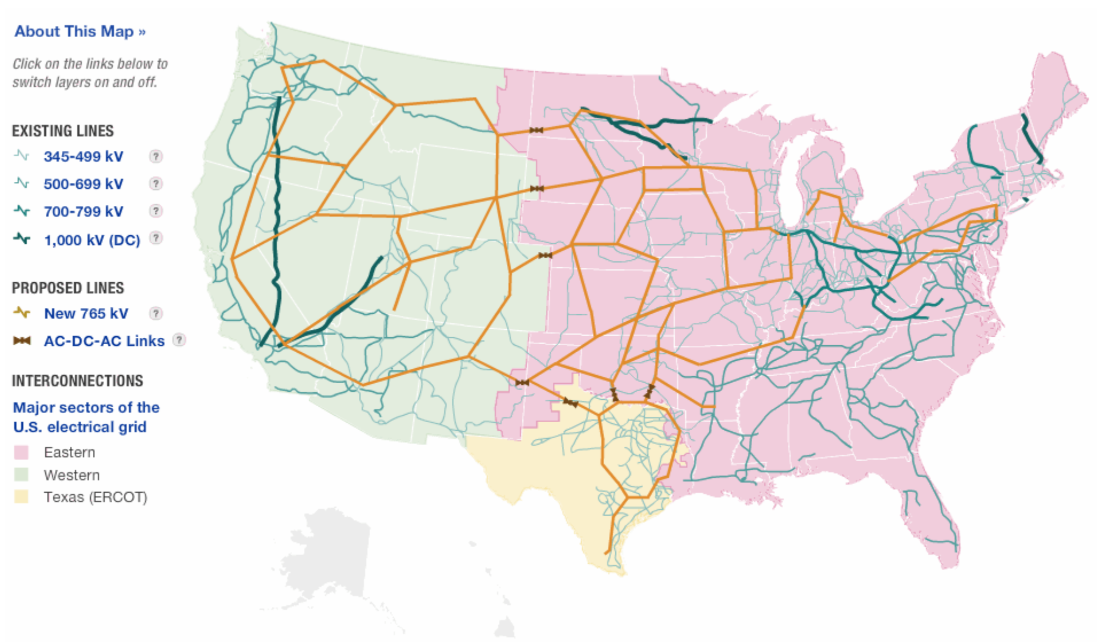


Figure 8. Major transmission corridors and interconnections of the U.S. electric grid (Infrastructure USA, 2011)

As scale increases, the spatial logic of reliability becomes increasingly complex, layering new infrastructures onto existing ones rather than replacing them outright (International Energy Agency, 2023; Sovacool, 2016).

Grid expansion further intensifies these pressures. High-voltage transmission lines, substations, and rights-of-way fix energy systems into the landscape through long-term easements and exclusion zones. While often treated as neutral technical necessities, these corridors shape patterns of development, fragment ecosystems, and constrain future land use. Architecture and planning typically engage these elements at their edges, yet they define the territorial reach and political visibility of energy infrastructure as much as generation sites themselves (Easterling, 2014; Boone, 2002). Reliability also carries political and institutional dimensions. Energy systems

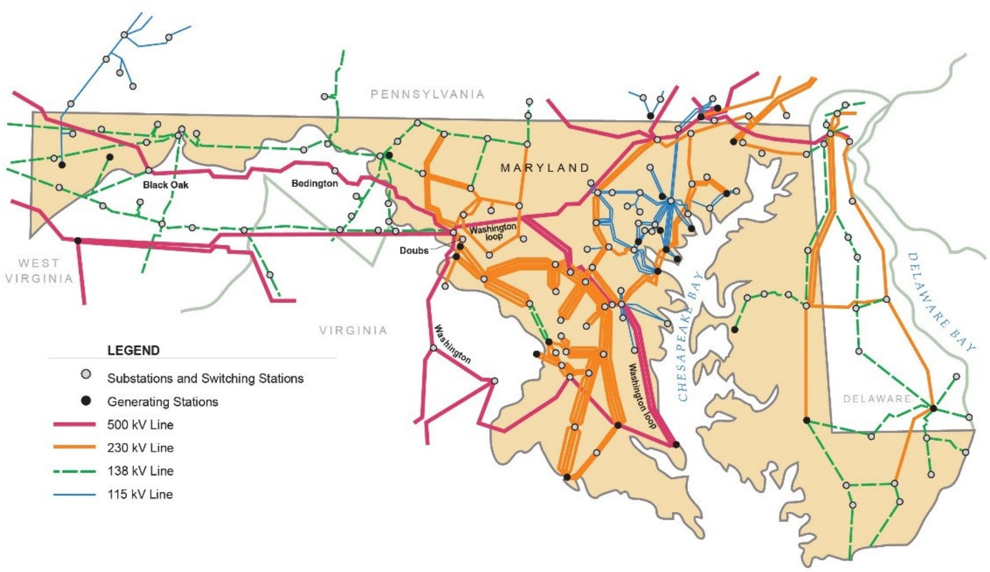


Figure 9. High-voltage transmission network in Maryland (PPRP, 2026)

are entangled with regulatory frameworks, jurisdictional boundaries, and public acceptance, all of which influence how infrastructure is permitted, maintained, and expanded. Large-scale projects often encounter resistance not because their goals are unclear, but because their spatial impacts are unevenly distributed or poorly communicated. In this context, reliability is not only a technical achievement but a negotiated condition that depends on trust, transparency, and long-term stewardship (Pidgeon et al., 2003; Ansolabehere & Konisky, 2009).

Together, these constraints underscore a central architectural question: what does it mean to design for an energy future that is both decarbonized and spatially responsible? Reliability cannot be separated from the landscapes, infrastructures, and civic relationships that support it. As energy systems grow more complex and interdependent, architecture is increasingly asked to mediate between technical

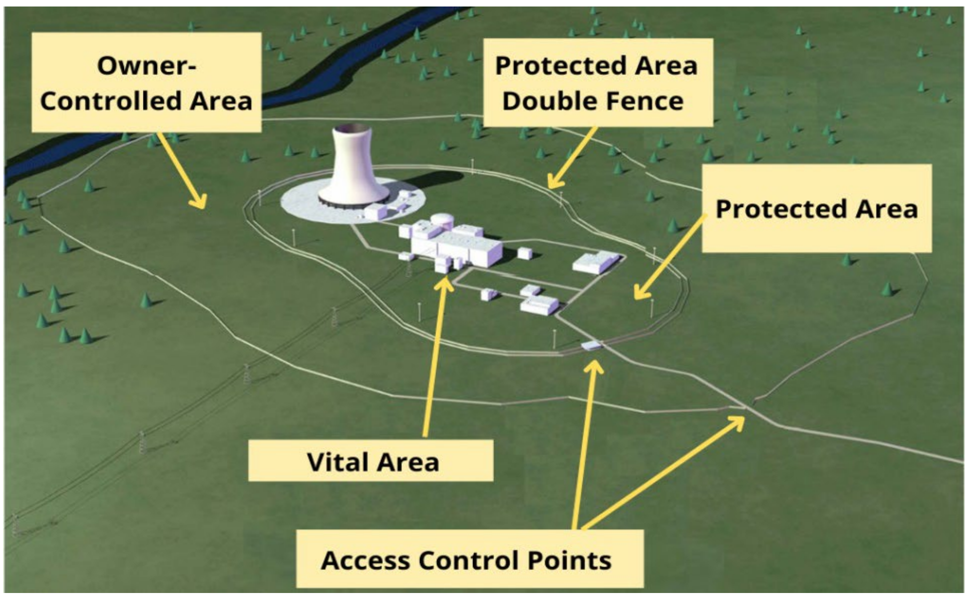


Figure 10. Typical organization of nuclear power plant security zones (Nuclear Energy Institute)

necessity and public consequence. This tension sets the stage for examining how perceptions of risk, visibility, and trust shape the reception of large-scale energy infrastructure, particularly when that infrastructure carries the cultural weight of the nuclear (Jasanoff & Kim, 2015; Schweizer-Ries, 2008).

Nuclear Image, Risk, and Public Trust

Nuclear energy occupies a unique cultural position shaped as much by history and narrative as by technical performance. Unlike other large-scale infrastructures, nuclear facilities are often read through layers of inherited meaning that precede any direct encounter with the site. These meanings are not abstract. They are learned through historical events, media representation, institutional behavior, and the physical cues of the built environment. For architecture engaging in nuclear technology, public perception is therefore not an external constraint but a design condition (Jasanoff and Kim, 2015; Farahat, 2016; Pidgeon et al., 2003).

The public understanding of nuclear energy was forged during a period when scientific discovery, military secrecy, and geopolitical urgency were tightly coupled. Early nuclear facilities emerged within wartime and Cold War contexts that prioritized containment, restriction, and opacity. These conditions established a visual and spatial language—thick walls, distant siting, guarded perimeters—that continues to define what "nuclear" looks like today. While Leiss (2013) cautions against treating stigma as an inherent property of nuclear technologies or sites, his analysis nonetheless highlights how perceptions of place, risk, and institutional behavior become entangled through spatial experience and governance over time (Hughes, 1983; Leiss, 2013; University of Chicago, n.d.).

Accident narratives further solidified this association. Events such as Three Mile Island, Chernobyl, and Fukushima differ substantially in cause, consequence, and scale, yet they converge in public memory as evidence of catastrophic potential. Technical postmortems consistently show that measured health impacts and radiological exposure were often lower than public fear suggested, but perception does not follow dose-response curves. These events demonstrated that failure, however rare, could be systemic, poorly communicated, and socially disruptive. In this context, mistrust became durable not because of misunderstanding alone, but because institutions appeared unprepared to communicate clearly, proportionally, and transparently in moments of crisis (Edwards et al., 2019; NRC, n.d.; UNSCEAR, n.d.; IAEA, 2015).

Risk perception research helps explain why these narratives persist. Hazards that are invisible, unfamiliar, and associated with catastrophic outcomes are consistently weighted more heavily than everyday risks, regardless of statistical likelihood. Trust in operating institutions plays a decisive role: communities are more willing to accept risk when they believe operators are competent, accountable, and transparent. Where secrecy, inconsistency, or exclusion dominate, fear fills the interpretive gap. For nuclear energy, architecture often becomes the most visible proxy for institutional intent, signaling whether a facility is defensive, indifferent, or engaged (Kasperson et al., 1988; Renn et al., 2010; Ellin, 1997; Lees and Baxter, 2011).

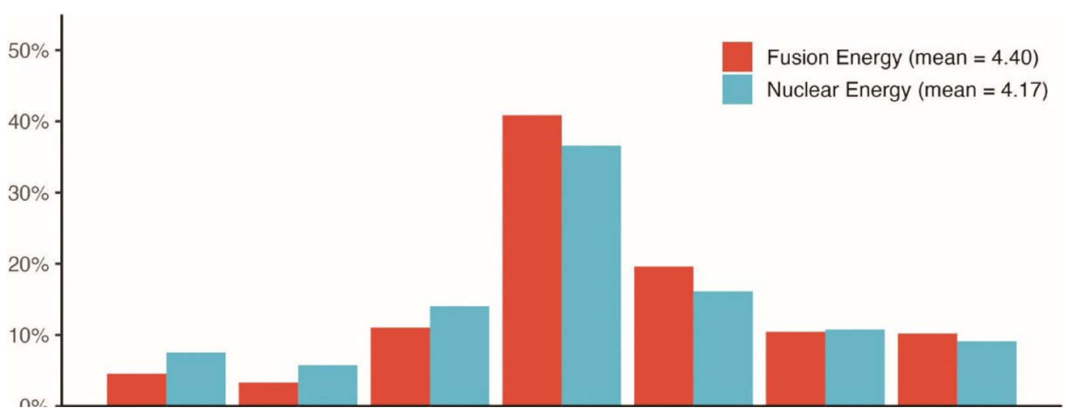


Figure 11. Public support for fusion energy by perceived association with nuclear fission (Gupta et al., 2024)

Fusion enters this landscape with a partial advantage and a significant burden. Surveys suggest that fusion is often perceived more favorably than fission, framed as clean, futuristic, and distant from weapons or long-lived waste. At the same time, confusion remains widespread. Because fusion facilities have not yet entered everyday civic life, the public frequently maps familiar fission risks directly onto fusion, collapsing distinct physics into a single cultural category labeled "nuclear." This conflation is reinforced when fusion facilities adopt architectural cues inherited from fission typologies without explanation or reinterpretation (Horlick-Jones et al., 2010; Turcanu et al., 2020; Jones et al., 2019; Gupta et al., 2024).

The gap between fusion's technical risk profile and its perceived danger is therefore not merely a communication problem; it is a spatial one. Fusion facilities must still appear protected, controlled, and serious, yet if that protection is expressed only through distance and opacity, it reinforces the very mistrust fusion seeks to overcome. Architecture becomes the medium through which this tension is negotiated. Thresholds, visibility, material choice, and circulation patterns do not simply organize movement; they shape how safety, care, and accountability are read by non-experts (Farahat, 2016; Ellin, 2003; Lees and Baxter, 2011).

This section establishes that public trust is not built through reassurance or exposure alone, but through legibility. Nuclear facilities earn credibility when their constraints are visible, their protections are proportional, and their operations appear routine rather than exceptional. These insights do not prescribe form, but they define the perceptual terrain in which fusion architecture must operate. The environmental psychology principles that follow translate this cultural and historical understanding into concrete spatial strategies, providing tools for designing environments that communicate safety and stewardship without sacrificing technical rigor (Schweizer-Ries, 2008; Passini and Arthur, 1992; Lynch, 1960).

Fusion Fundamentals as Architectural Specificity

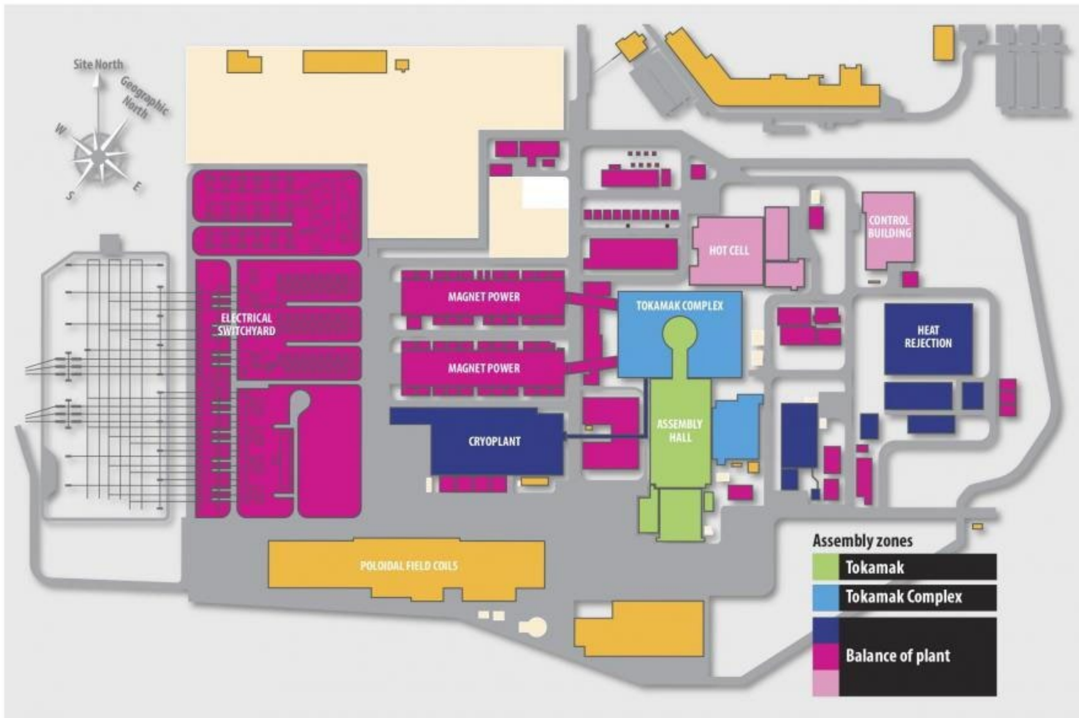


Figure 12. ITER campus floor plan diagram reflecting fusion's tight adjacency needs (ITER, 2026)

Fusion is often discussed in abstract scientific terms, yet its fundamentals carry direct and unavoidable spatial consequences. Like fission, fusion requires large machine halls, substantial cooling systems, electrical switchyards, and secure perimeters that separate technical operations from public life. At a distance, a fusion facility may therefore resemble a conventional nuclear power plant in scale and seriousness. At closer inspection, however, fusion introduces a set of spatial and programmatic conditions that differ fundamentally from those of fission and that operate as primary architectural drivers rather than secondary constraints. These differences establish fusion as an energy technology with its own architectural specificity (Dolan, 2013; ITER, 2019; Farahat, 2016).

Fusion as a High-Density Energy System

Fusion's defining characteristic is its extraordinary energy density. A relatively small quantity of fuel produces enormous power, allowing fusion facilities to achieve outputs comparable to large conventional plants within a far more compact physical footprint. This compactness distinguishes fusion from renewable systems that rely on extensive territorial deployment and from fossil fuel infrastructures that depend on distributed extraction and transport networks (Hirsch and Rice, 1974; Morris et al., 2022).

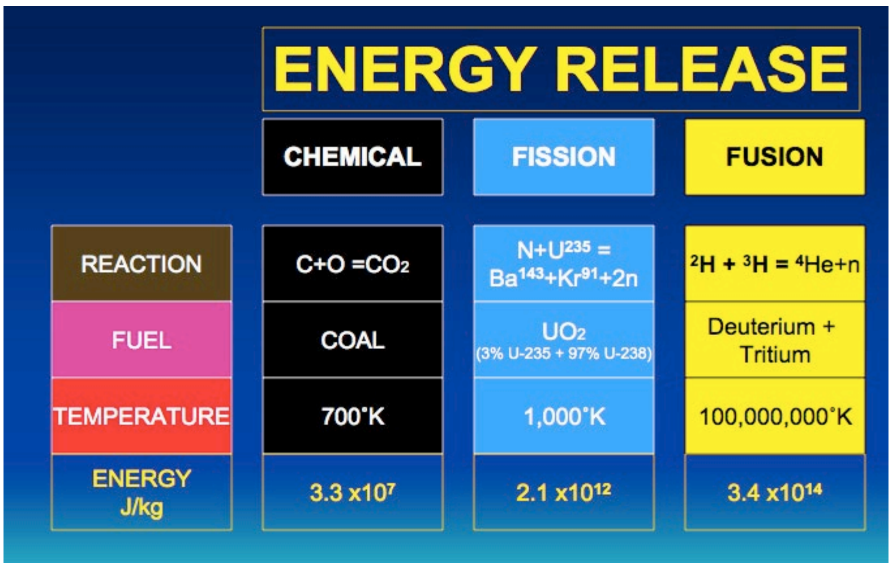


Figure 13. Comparison of energy per unit mass (Webber, 2007)

At the architectural scale, this density produces centralization as a spatial condition. Fusion facilities concentrate generation, control, cooling, and support systems within a single campus organized around the reactor device. This centralization is reinforced by device geometry, which dominates building massing in a way unique to fusion. Tokamak-based systems organize space radially around a toroidal vacuum vessel surrounded by blankets and shielding assemblies. Unlike fission reactors, typically housed within cylindrical containment structures optimized for pressure and redundancy, fusion devices require continuous circumferential access for remote handling and component replacement. The result is a 360-degree service envelope that structures both plan and section, transforming the reactor hall from a singular volume into a thickened ring of access, shielding, and technical circulation. Architecture must therefore respond to a machine that generates space outward from its geometry rather than fitting neatly within a generic enclosure (Chuyanov, 1999; Kim et al., 2013).

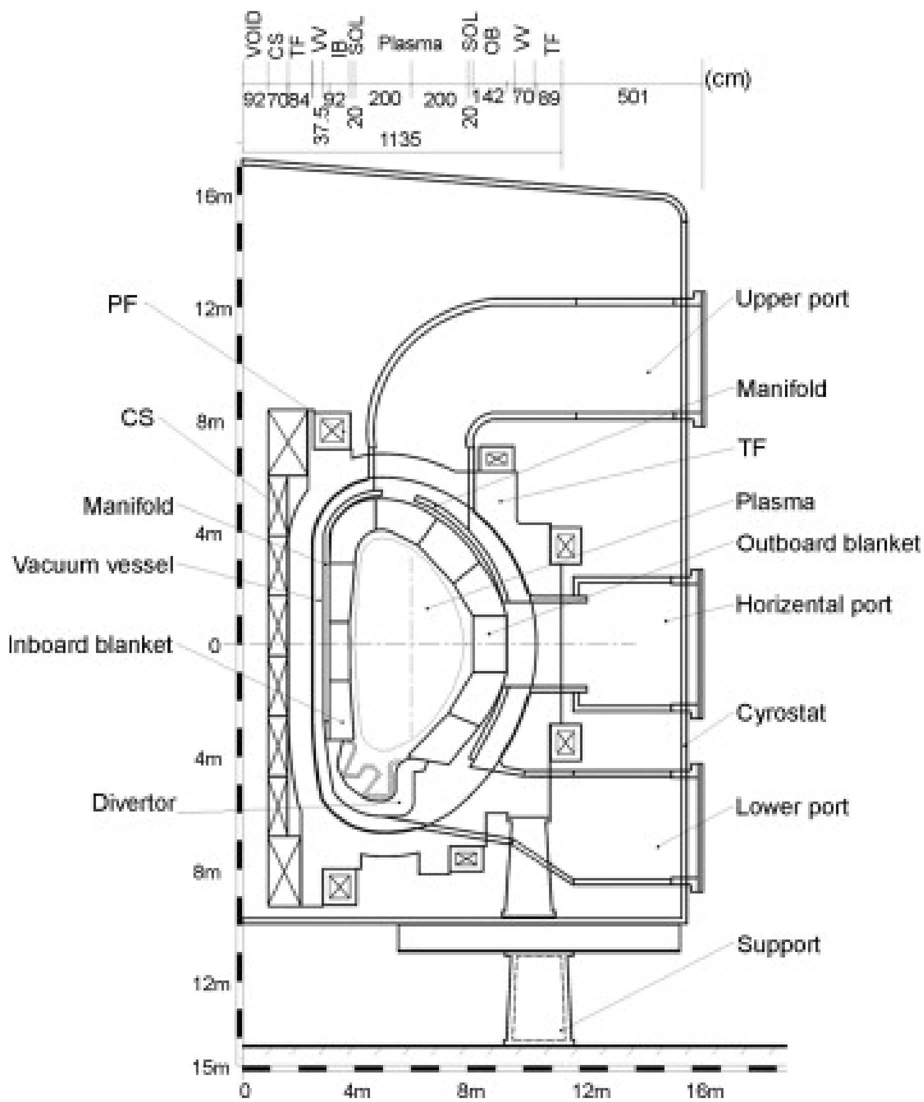


Figure 14. Tokamak section highlighting vacuum vessel, coils, blanket, and ports (Y. Wu, 2008)

Non-Negotiable Facility Requirements

Beyond geometry and density, fusion introduces operational requirements that fundamentally shape program and adjacency. Deuterium–tritium fusion depends on on-site tritium breeding from lithium blankets, along with continuous systems for fuel recovery, purification, storage, and reinjection. These processes demand close physical proximity between the reactor, hot cells, tritium laboratories, and the cryogenic infrastructure that supports superconducting magnets. Unlike fission's once-through fuel cycle, fusion produces a tightly coupled internal ecosystem in which programmatic elements must remain spatially adjacent to function safely and efficiently. The architecture that results is organized by interdependence rather than linear process flow (Chuyanov, 1999; Morris et al., 2022; Wu, 2008).

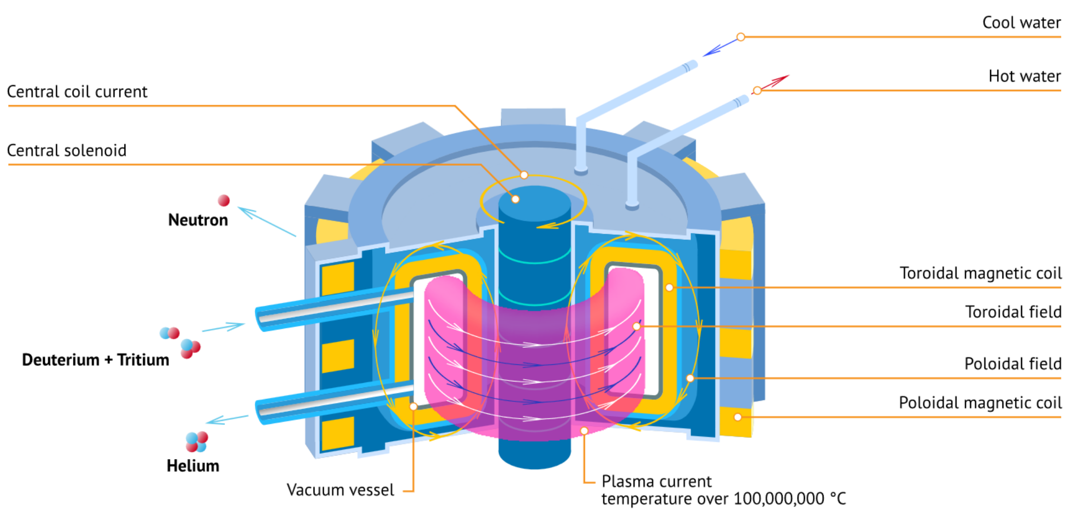


Figure 15. Schematic of layered systems a fusion reactor must house and separate (Nuclear Encyclopedia, 2025)

Fusion's activation profile further reshapes the choreography of stewardship and maintenance. First-wall and structural components become highly activated during operation and require robust remote handling from the outset. At the same time, this activation decays on much shorter timescales than fission waste, implying a different temporal horizon of care and responsibility. Architecturally, this distinction matters. Fusion facilities must accommodate heavy shielding and isolation during operation while also acknowledging that "radioactive" does not necessarily mean permanent exclusion. The challenge is not to downplay risk, but to spatially register the difference between short-lived activation and long-term contamination in ways that are intelligible rather than abstract (Commonwealth Fusion Systems, 2025; Sandri et al., 2020; Taylor, 2015).

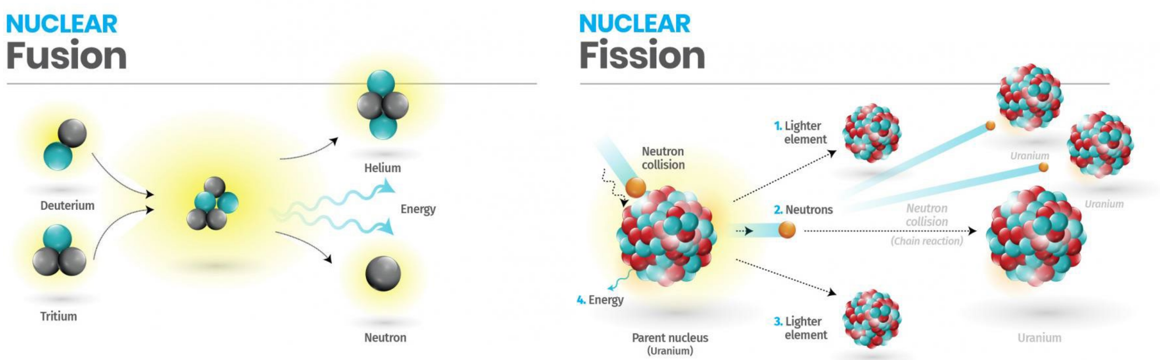


Figure 16. Fusion vs. Fission Atomic Scale Reaction Comparison (ANSTO, 2023).

Spatial Consequences of Safety and Care

Taken together, fusion's density, geometry, and operational requirements produce facilities that appear closed, fortified, and inward facing. Layers of shielding, separation, and controlled circulation translate protection into distance, reinforcing the perception that fusion is inaccessible or unknowable. This spatial distance is not accidental; it is the visible expression of care, precision, and responsibility. Yet without architectural mediation, the same signals of care can be read as signals of exclusion (Chuyanov, 1999; Kim et al., 2013).

This is where fusion's architectural challenge becomes unavoidable. Fusion's safety envelope differs from that of fission: loss of plasma confinement immediately terminates the reaction rather than escalating it into a runaway chain process. While this does not eliminate the need for rigorous safety systems, it permits different forms of public interface than those associated with conventional nuclear power plants. Graduated thresholds, controlled transparency, and selective visibility become possible where they would otherwise be inappropriate. Architecture becomes the medium through which this distinction can be communicated, not through explanation alone, but through carefully calibrated proximity, framed views, and the visible presence of protective systems (Hirsch and Rice, 1974; Taylor, 2015; Hirsch and Bezdek, 2021).

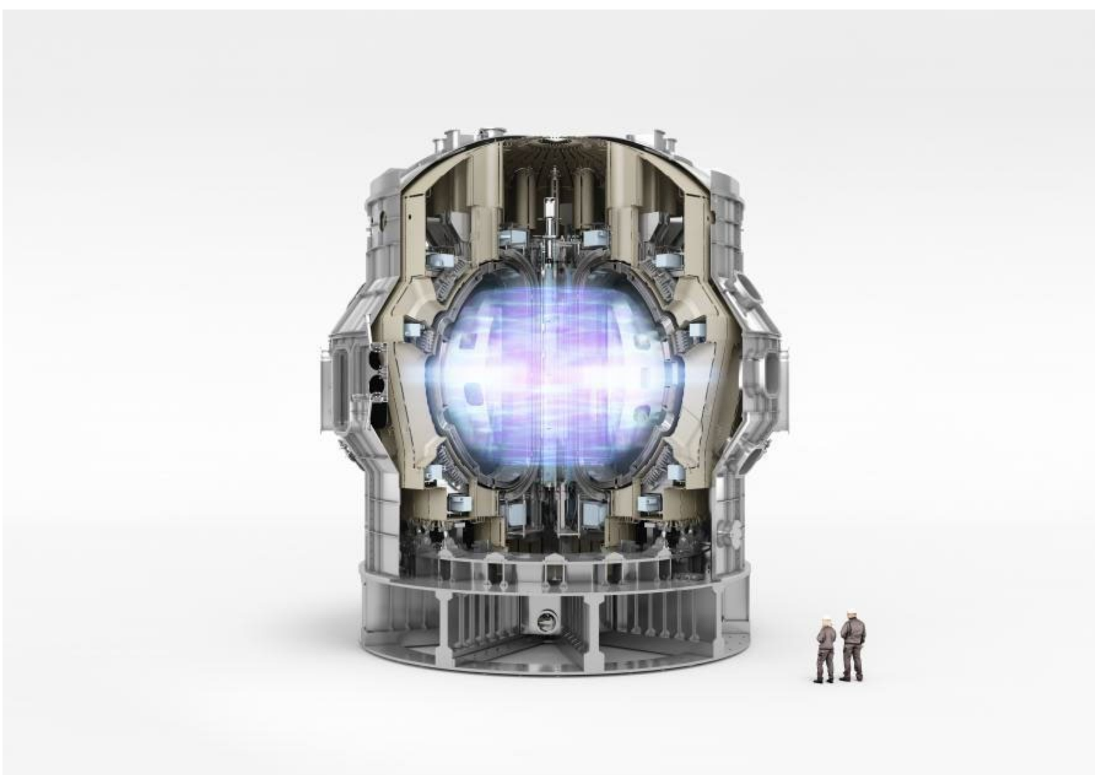


Figure 17. Cutaway rendering of JT-60SA with people for scale (F4E & EuroFusion, 2023)

In this sense, the distance produced by fusion's requirements is not merely a technical outcome but an architectural problem. How that distance is shaped, revealed, or bridged will determine whether fusion remains an abstract and mistrusted technology or becomes a comprehensible part of civic and industrial life. The chapters that follow build on this specificity, examining how architecture can negotiate the space between necessary protection and meaningful public encounter (Hoedl, 2022; Hoedl, 2023).

Architecture, Legibility, and Public Encounter

Public trust in complex energy infrastructure is shaped less by technical explanation than by spatial experience. Research on risk perception, cognition, and environmental behavior consistently shows that people judge unfamiliar technologies through cues they can see, touch, and navigate. In nuclear contexts especially, where hazards are invisible and histories are culturally charged, architecture becomes a primary medium through which safety, competence, and care are interpreted. This section reframes environmental psychology not as abstract theory, but as a set of spatial tools for making powerful systems legible without exposing what must remain protected (Pidgeon et al., 2003; Schweizer-Ries, 2008).

Legibility begins with thresholds. Facilities that jump abruptly from open public space to opaque restrictions tend to amplify anxiety, while those that stage access through visible gradients communicate proportional control. A sequence of plazas, lobbies, supervised paths, overlooks, and clearly marked boundaries allows visitors to understand why access changes and what lies beyond each limit. When architecture "shows the rule" through consistent materials, lighting shifts, and aligned circulation, security reads as intentional rather than arbitrary. In nuclear settings, this graduated approach is essential to maintaining trust while enforcing real constraints (Schweizer-Ries, 2008; Ellin et al., 1997; Lees and Baxter, 2011).

Material choice reinforces this legibility. Robust, high-mass materials signal containment and durability, while calibrated transparency—through glazing, cutaways, and controlled views—signals openness and accountability. The goal is not spectacle, but coherence: systems that are expressed cleanly and maintained visibly read as safe because they appear understood and cared for. Where shielding or proprietary equipment requires opacity, pairing mass with explanation prevents opacity from being misread as secrecy. Architecture that explains itself reduces cognitive load and allows visitors to form accurate mental models of how the facility works (Ellin et al., 1997; Lees and Baxter, 2011).

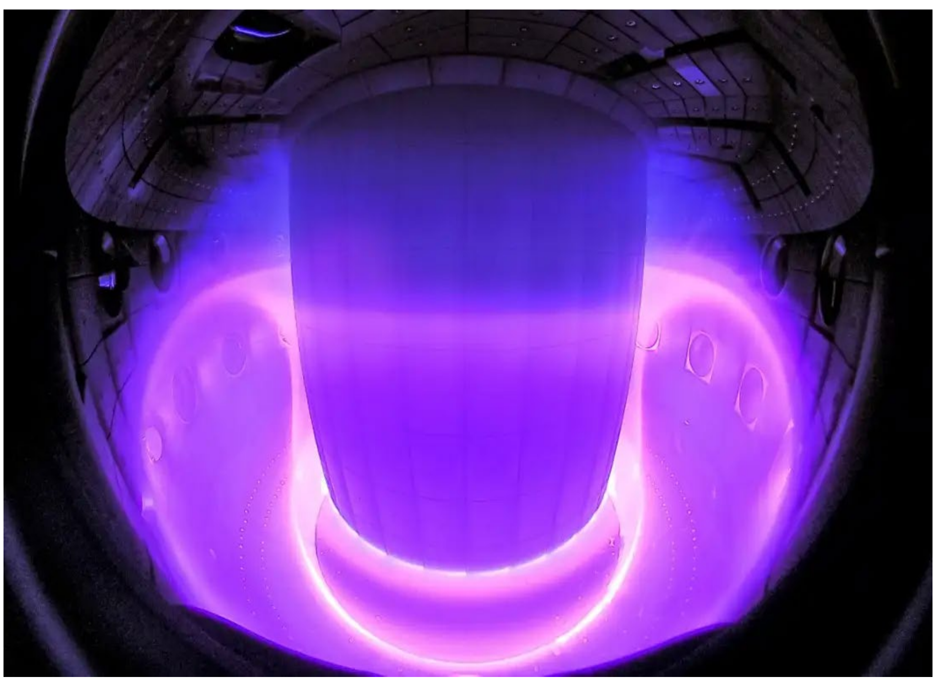


Figure 18. Image of a tokamak during plasma operation (Curdin Wüthrich, SPC/EPFL, 2022)

Human scale plays a parallel role. Even within large industrial volumes, people orient themselves through body-scale cues: predictable handrails, seating, ceiling heights, and pauses along circulation routes. Layering these elements along public paths keeps visitors grounded and oriented, preventing the disorientation common in oversized technical spaces. Compression and release in section—lower, quieter spaces before large volumes; protected overlooks instead of exposed edges—help visitors register complexity without feeling overwhelmed (Schweizer-Ries, 2008).

Light further organizes perception. Daylight along public routes and gathering spaces signals openness and normalcy, while even non-dramatic lighting in process zones emphasizes routine work over theatrical display. Carefully controlled "reveal bands" at key points allow glimpses into operation without turning the facility into a spectacle. At night, restrained lighting hierarchies reinforce civic presence while avoiding the glowing excess that can read as surveillance or danger (Schweizer-Ries, 2008).

Finally, transparency to process must be deliberate. Not everything can or should be seen, but what is visible should clearly relate to what is explained. Aligning diagrams, dashboards, and material samples with real systems helps visitors connect abstraction to reality. Where visibility stops, architecture should say so plainly, using physical proxies or labeled sections to maintain continuity of understanding. Consistency between what is shown, what is said, and what is experienced is critical; trust erodes quickly when those signals diverge (Pidgeon et al., 2003; Schweizer-Ries, 2008).

Taken together, these strategies position architecture as an active participant in public comprehension rather than a neutral container. Thresholds, materials, scale, light, and visibility become tools for translating safety physics into spatial experience. In the context of fusion energy—where the technical risk profile differs from fission, but public perception has not yet caught up—these tools are not optional. They form the basis for an architectural approach that can demonstrate difference through experience, allowing the public to see fusion not as an abstract promise or inherited fear, but as a knowable, governed, and civic technology (Pidgeon et al., 2003; Schweizer-Ries, 2008).

Conclusion

Taken together, the literature reviewed in this chapter demonstrates that energy infrastructure is never spatially neutral. Decisions about energy production shape territory, water systems, material flows, and long-term stewardship obligations, producing durable architectural and landscape consequences regardless of technology or intent. As decarbonization accelerates, these spatial effects become more visible and more contested, placing increasing pressure on architecture to engage energy systems not as background utilities, but as formative civic actors (Hughes, 1983; Sovacool, 2016).

Within this broader context, nuclear energy occupies a uniquely charged position. Its cultural associations with secrecy, catastrophe, and institutional distance have been reinforced through historical events and architectural conventions that privilege opacity and exclusion. Fusion enters this landscape with a different technical risk profile, yet it inherits many of the same perceptual burdens. As the chapter has shown, this gap between technical reality and public understanding is not merely communicative but spatial, embedded in how facilities are sited, structured, and encountered (Pidgeon et al., 2003; Jasanoff and Kim, 2015; Leiss, 2013; Horlick-Jones et al., 2010; Jones et al., 2019; Gupta et al., 2024).

The review ultimately establishes fusion as an energy technology with clear architectural specificity. Its high energy density, centralized geometry, non-negotiable operational requirements, and distinct safety envelope produce spatial conditions that demand a purpose-built architectural response. At the same time, research on legibility, thresholds, and environmental perception underscores that public trust is built through experience rather than explanation. Architecture therefore becomes the medium through which fusion's difference can be made tangible, allowing safety, care, and governance to be read directly through space (Chuyanov, 1999; Kim et al., 2013; Morris et al., 2022; Taylor, 2015; Sandri et al., 2020; Schweizer-Ries, 2008).

This chapter provides the conceptual groundwork for the design research that follows. Chapter 3 builds on these insights by outlining the methodological approach of the thesis, while subsequent chapters translate these spatial, cultural, and technical conditions into precedent analysis, site selection, and architectural propositions. In doing so, the thesis moves from understanding fusion as an abstract promise toward testing how it might operate as a visible, legible, and trusted part of the built environment.

Chapter 3: Methodologies

Introduction

Designing for nuclear fusion requires more than technical understanding; it calls for a research framework that can address how people perceive, interpret, and inhabit an unfamiliar energy technology. Following the approach outlined in the Lucas readings on research methods in architecture, this thesis treats methods as an integral part of design rather than a separate, preliminary phase. Because fusion sits at the intersection of science, public culture, and the built environment, its architectural representation must be informed by ways of knowing that bridge these domains. Research methods matter here because they allow the project to move beyond assumption, grounding design decisions in site observation, precedent analysis, environmental psychology, and interdisciplinary inquiry. Together, these methods structure how the thesis investigates visibility, discovery, and embodied understanding of fusion.

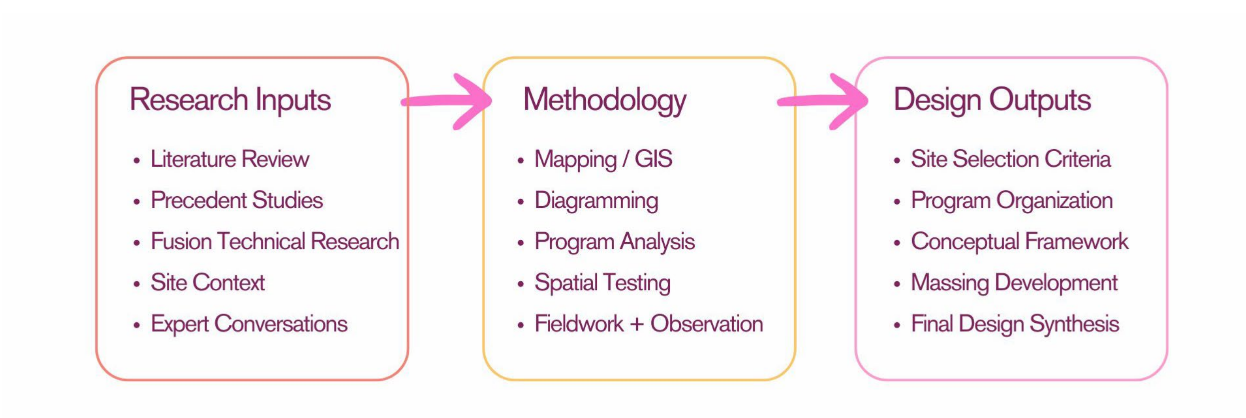


Figure 19. Linear methodology workflow chart.

Approach

This thesis uses a mixed-method, interdisciplinary research approach consistent with the framework outlined in the Lucas readings. Fusion occupies a unique cultural and scientific territory, so no single method can fully address how it is understood or how architecture might mediate that understanding. The project therefore integrates qualitative analysis, experiential observation, theoretical inquiry, and design-driven exploration. Site research, precedent study, environmental psychology, and drawing all contribute different kinds of knowledge, from spatial perception to behavioral tendencies to architectural strategies for communicating complexity. Together, these methods create a layered approach that links research and design, allowing the project to investigate how visibility, discovery, and embodied education can support public understanding of fusion.

Site Selection & Analysis

Site selection for this thesis was guided by methods that prioritize cultural resonance, spatial legibility, and public accessibility. The Canton waterfront was identified through mapping, historic research, and observational analysis as a landscape where industrial infrastructure and residential neighborhoods meet, creating a spatial seam that heightens questions of visibility, comfort, and perception. The site was studied through on-foot exploration, photographic documentation, and experiential mapping, allowing the research to record how people move, pause, and interpret this edge condition. GIS mapping and archival materials were used to understand the site's industrial past and its evolving identity within Baltimore's energy and maritime history. These combined methods revealed the site's potential as a meaningful civic setting for fusion: a place where energy production, public life, and landscape are already intertwined, and where architecture can actively shape how fusion is encountered and understood

Fieldwork and Observations

Fieldwork played a central role in understanding how the public already engages with industrial waterfront environments and how those environments shape perception. Walking the Canton shoreline allowed this thesis to document the site's sensory and atmospheric qualities, including changes in light, sound, scale, and texture across the transition from residential to industrial conditions. Observing how people use the waterfront, including where they walk, where they pause, and what they avoid, revealed patterns of comfort, curiosity, and unease that often accompany proximity to large-scale infrastructure and hard boundaries like fences. These on-site observations were recorded through notes, photographs, and experiential mapping, providing insight into how spatial cues influence behavior and emotional response. This method helped identify opportunities for architecture to introduce clarity, comfort, and orientation within a landscape that is otherwise defined by opacity and industrial abstraction.

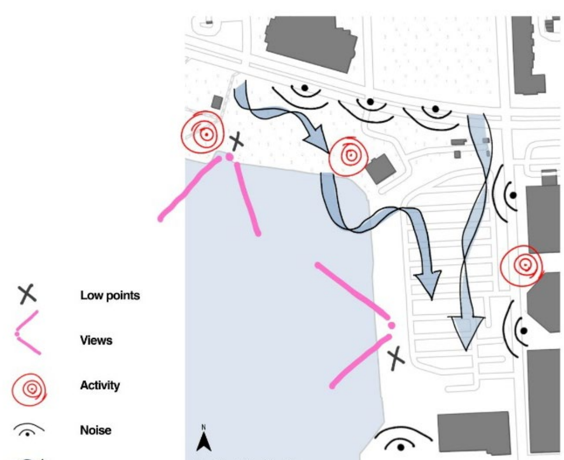


Figure 20. Early observation and phenomenology fieldwork map

Precedent Analysis

Precedent analysis for this thesis focused on projects that make complex or hidden systems publicly legible through architecture. Examples include civic-scaled infrastructure and public science buildings such as CERN's Science Gateway, Copenhill, the Whitney Water Purification Facility, the VW Transparent Factory, and the Beinecke Library. These were studied through drawings, diagrams, photographs, and written analysis to understand how they organize public and restricted zones, choreograph movement, and express technical programs through form and material. Attention was given to how each precedent handles visibility, frames moments of discovery, and embeds education into spatial experience rather than treating it as an add-on. Plans, sections, and circulation diagrams were traced and simplified to reveal underlying patterns, such as protected cores with more open perimeters or hybrid landscapes that blend infrastructure with public use. This method clarified which architectural strategies are most effective for communicating complexity to non-expert audiences and directly informed how fusion might be framed as both advanced technology and civic presence.

Diagramming & Drawing

Diagramming and drawing served as primary research tools in this thesis, functioning not only as representational techniques but as methods for generating knowledge. Analytical diagrams were used to clarify program relationships, visibility conditions, circulation paths, and spatial thresholds. Sectional studies tested how the protected fusion core could be surrounded by public zones that support discovery and orientation. Sequential drawings explored how visitors might move through the project and what they would encounter at each stage, allowing the spatial narrative of fusion to be developed through iteration. Atmospheric sketches and material studies helped evaluate how light, scale, and enclosure influence comfort and perception. These drawing-based methods made it possible to test hypotheses about visibility, discovery, and embodied education in ways that written analysis could not, and they played an essential role in shaping the architectural strategies that guide the design proposal.

Figure 21. Neighborhood context drawing, early sketching study

Cross-Discipline Engagement

Cross-disciplinary engagement has been essential to this thesis, particularly because fusion is a scientific and technological field that extends far beyond traditional architectural knowledge. Throughout the research process, I consulted experts working in fusion physics and energy systems to understand current technical trajectories, operational constraints, and the emerging realities of commercial-scale fusion facilities. Conversations with researchers and practitioners helped clarify what aspects of fusion must remain secure, what processes might be safely expressed through architecture, and how public perception influences the adoption of unfamiliar technologies. In parallel, methods from science communication, museum studies, and environmental psychology informed strategies for translating complex scientific ideas into spatial experience. Landscape architecture and urban research contributed tools for interpreting industrial edges, environmental context, and civic identity. Bringing these disciplines together allowed the project to bridge scientific understanding with architectural intention, ensuring that design decisions remain grounded in both technical accuracy and human experience. This collaborative, cross-disciplinary approach anchors the thesis in the realities of fusion while expanding architecture's role in shaping how technology enters public life.

Conclusion

Together, these methods create a research framework that supports the goals of the thesis and the complexity of its subject. Site analysis, field observation, and precedent study establish a grounded understanding of how people relate to unfamiliar infrastructures and how architecture can mediate those encounters. Literature review and environmental psychology provide insight into perception, legibility, and trust; while drawing and diagramming translate these insights into spatial strategies that can be tested and refined. Cross-disciplinary engagement, particularly conversations with experts in fusion physics, ensures that the project remains technically informed while staying focused on public experience. In combination, these methods shape a design process that is both rigorous and imaginative, capable of addressing the scientific realities of fusion and the cultural work required for its acceptance. They form the foundation through which the thesis explores how architecture can support visibility, discovery, and experiential education of fusion within civic life.

Chapter 4: Case Studies

Introduction

Precedent studies are especially important for this thesis because fusion energy does not yet have an established civic architectural typology. While fusion facilities are beginning to emerge as technical campuses and research environments, there are few built examples that show how fusion might operate as public-facing architecture. Because of this, the case studies in this chapter are drawn from adjacent architectural problems: energy infrastructure, public science education, protected technical cores, and buildings that make complex systems visible without fully exposing them.

Rather than treating these precedents as models to copy, this chapter reads them for spatial strategies. Each project offers a different way of negotiating the relationship between public access and controlled systems, whether through promenade, landscape, transparency, sectional reveal, or the careful staging of movement. Together, these examples help establish a set of architectural tools for approaching fusion as both a technical facility and a civic experience.

Design Precedents

The first group consists of design precedents that operate at the boundary between infrastructure and civic space, technical core and promenade, education and spectacle. Projects such as CERN Science Gateway, CopenHill, the Whitney Water Purification Facility and Park, the Volkswagen Transparent Factory, the Beinecke Library, and the Centre Pompidou demonstrate how normally hidden systems can be made spatially and socially legible through calibrated visibility, choreographed movement, and experiential learning.

Across these examples, I examine how discovery is staged through sequence, how education is embedded in form and section rather than isolated as exhibit, and how public access is negotiated alongside controlled or fragile cores. Together, these projects offer a toolkit of spatial strategies for making powerful technologies visible, legible, and even inviting.

BUILDING TYPE	NAME & ARCHITECT	LOCATION & DATE	THEMES & KEY CONCEPTS	
Science Center	CERN Science Gateway Renzo Piano Building Workshop	Geneva, Switzerland 2023	Scientific Communication – Translates complex physics into spatial narrative – Demonstrates how architectural form can teach and symbolize scientific process – Aligns with the goal of demystifying plasma and fusion.	
Power Plant / Recreation	CopenHill Power Plant BIG (Bjarke Ingels Group)	Copenhagen, Denmark 2019	Hybrid Civic-Industrial Typology – Combines energy production with public recreation – Reimagines industrial function as cultural attraction – Suggests how industrial and public program can coexist and change perception.	
Water Treatment Facility / Park	Whitney Water Purification Facility and Park Steven Holl Architects	Hamden, Connecticut 2005	Infrastructure as Civic Landscape – Integrates working utility into public landscape – Promenade reveals process and ecology – Illustrates infrastructure as education – Parallels how fusion could merge science and experience.	
Factory / Exhibition Hall	VW Transparent Factory (Gläserne Manufaktur) Henn Architekten	Dresden, Germany 2002	Industrial Transparency and Processional Experience – Choreographs visitors through the act of manufacturing, turning production into performance – Shows how to guide visitors through making process an experiential narrative.	
Museum / Cultural Center	Centre Pompidou Renzo Piano & Richard Rogers	Paris, France 1977	Urban Technological Icon – Externalizes systems to make technology visible and accessible – Demonstrates how exposing function can generate civic identity – Offers a model for an educational landmark.	
Library	Beinecke Rare Book and Manuscript Library Gordon Bunshaft (SOM)	New Haven, Connecticut 1963	Containment and Reverence – Protects a delicate core and makes preservation visible and sacred – Demonstrates a controlled environment as both civic and monumental – Informs how to safely reveal fusion energy at its center.	

Figure 22. Design precedents matrix

CERN Science Gateway

CERN Science Gateway is a new public portal to the European Organization for Nuclear Research outside Geneva, designed by Renzo Piano Building Workshop as an architectural threshold between one of the world's most advanced physics campuses and a general audience. The project is organized as a cluster of pavilions and tubular bridges that evoke the geometry of the Large Hadron Collider while spanning over existing roads and landscape, stitching together different parts of the site. It brings exhibitions, education spaces, an auditorium, and a public foyer into direct proximity with working research facilities, with the explicit goal of demystifying particle physics and making CERN feel permeable rather than remote. As such, it becomes an important reference for how Fusion RE:Action might frame a fusion campus as a civic gateway rather than a sealed compound.

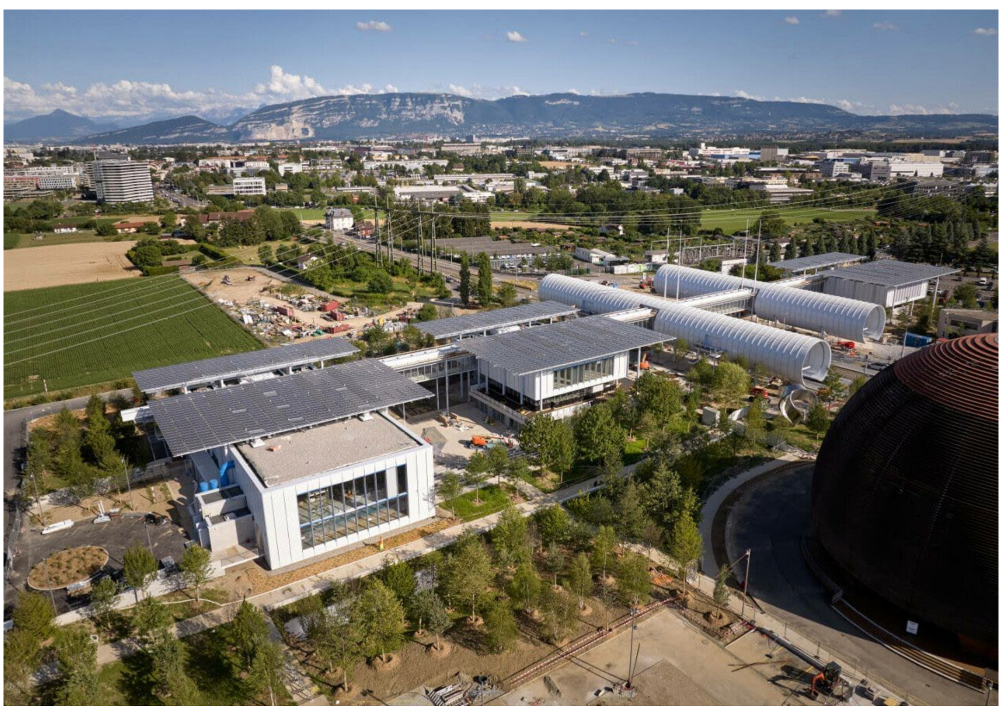


Figure 23. CERN Science Gateway aerial image (RBPW, 2024)

Architecturally, Science Gateway turns circulation itself into a didactic device: the elevated tubes and bridges register as over scaled "particles" moving through space, and visitors inhabit these trajectories as they move between pavilions. The ensemble of low, pavilion-like volumes keeps the campus visually porous while still allowing clear distinctions between public and restricted zones, often using glazing, screens, and level changes rather than heavy walls to mark thresholds. Inside, large-span exhibition halls and flexible education spaces are treated as neutral, almost infrastructural interiors that can host changing displays, workshops, and events tied to ongoing research. Landscape, plazas, and bridges are woven together so that the experience is less about entering a singular building and more about moving through a network that mirrors the distributed nature of the collider itself. Through these strategies, the project constructs a legible relationship between the abstract scale of high-energy physics and the human-scaled paths, rooms, and vistas of everyday public life.

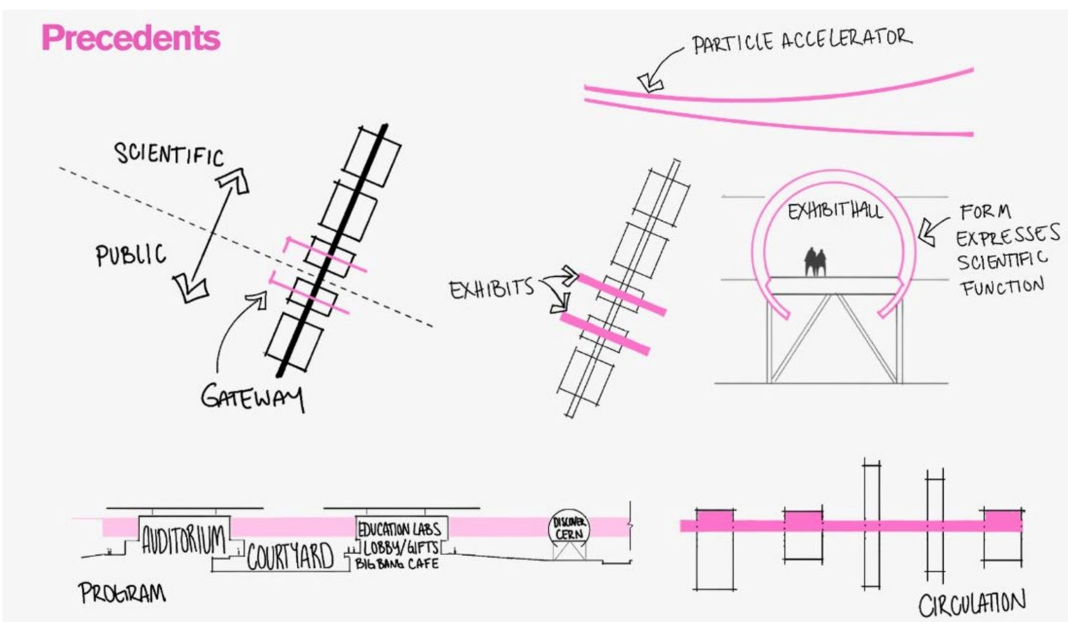


Figure 24. CERN Science Gateway study diagrams

For Fusion RE:Action, Science Gateway suggests how a fusion research campus on the Baltimore waterfront might be organized around a clear architectural "armature" that both references science and structures public movement. Instead of hiding the reactor complex behind a single perimeter, the project points toward a more distributed field of pavilions, bridges, and landscape elements that collectively choreograph encounters with the technical core. It reinforces the value of treating circulation as an interpretive medium, where sequences of ramps, tubes, and overlooks can gradually build understanding and comfort rather than relying solely on didactic displays. It also highlights the importance of designing thresholds that feel transparent and inviting while still defending secure zones, something that will be critical in balancing access, safety, and trust for a nuclear program in a city shaped by waterfront industry and environmental injustice.

CopenHill Waste to Energy Plant

CopenHill, or Amager Bakke, is a waste-to-energy plant in Copenhagen designed by BIG that fuses an emissions control facility with an artificial mountain for skiing, hiking, and climbing, effectively turning critical urban infrastructure into a recreational landmark. The building houses a high-efficiency incinerator and energy plant at its core while its sloping roof and faceted envelope are treated as an inhabitable terrain, complete with a ski slope, walking paths, and a climbing wall that rises up the smokestack. Located on the city's industrial waterfront, it was conceived as both a technical upgrade to the region's energy system and a public symbol of Copenhagen's climate ambitions, rebranding waste processing as part of an active, everyday landscape rather than a remote or stigmatized utility. This hybrid of plant and park makes it a key precedent for Fusion RE:Action, offering a built example of how an energy facility can become a civic destination without concealing its infrastructural role.

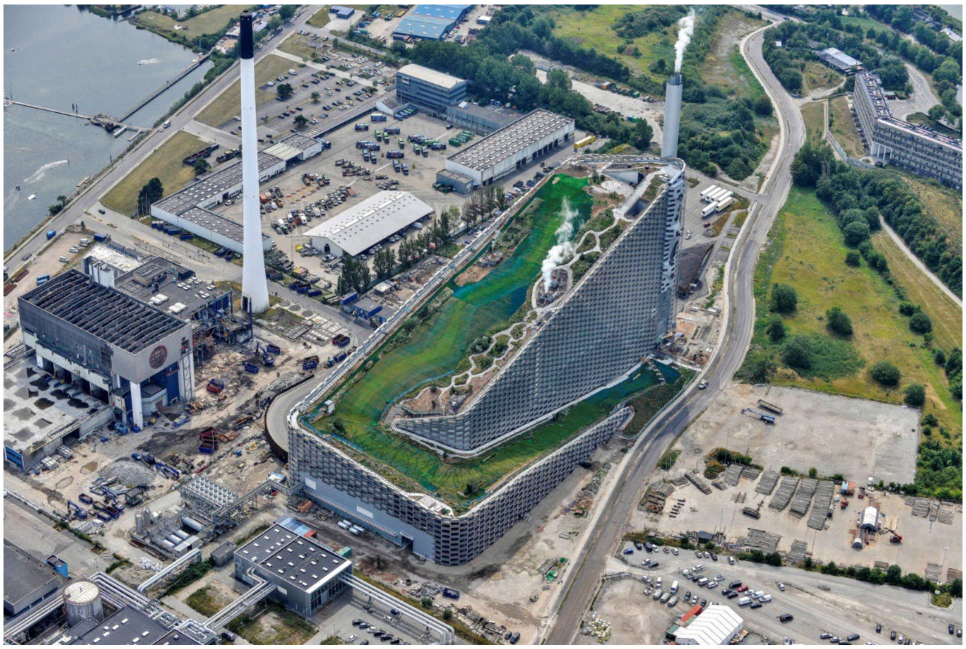


Figure 25. Aerial image of CopenHill by BIG (Google Earth, 2025)

The building's power lies in the way it exploits section and surface. A relatively straightforward box contains the plant, while the inclined roof folds up from the ground to create a continuous topographic ramp that visitors can occupy without ever entering the industrial volume. Along this ramp, different speeds and uses overlaps: slow walkers, skiers, and spectators share terraces, paths, and edges that periodically open to framed views of the harbor or down into glimpses of the machinery inside. The facade is treated as a thickened skin of perforated metal panels, guardrails, and planting, so the outer face reads as both envelope and landscape, supporting vegetation in some areas and filtering light in others. At night, the glowing interior and lit roof reinforce its presence as a landmark, keeping the energy plant legible within the city's skyline while softening its bulk.

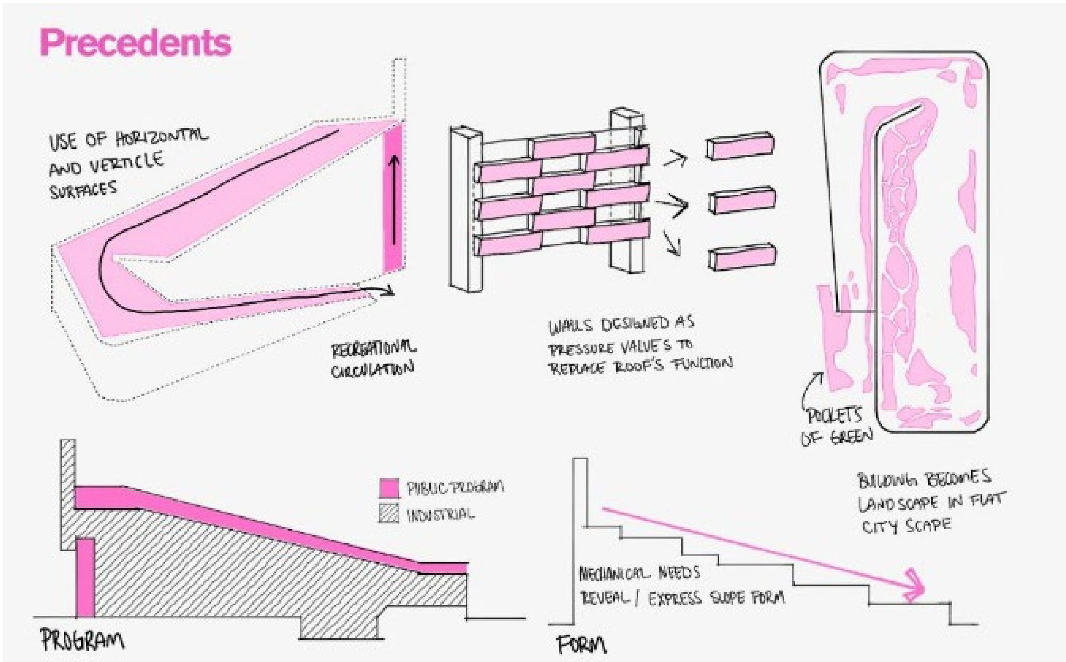


Figure 26. CopenHill precedent study diagrams

Read against the ambitions of Fusion RE:Action, CopenHill provides a clear argument for treating the fusion facility not as an isolated industrial object but as an inhabitable terrain on the Baltimore waterfront. Its handling of roof and section suggests ways a secure reactor hall could be wrapped in occupiable ramps, terraces, and overlooks that normalize proximity to energy production while preserving strict safety thresholds. At the same time, the project's reliance on spectacle has drawn criticism related to cost, carbon, and long-term relevance, which serves as an important caution. For this thesis, the lesson is to borrow the idea of a shared civic landscape and everyday use, while prioritizing educational sequences and environmental performance over singular attractions. In that sense, CopenHill becomes less a model to replicate and more a reference for how public movement and terrain can recalibrate the image of an energy plant within a harbor city.

Whitney Water Purification Facility and Park

Whitney Water Purification Facility and Park in New Haven, designed by Steven Holl, is a municipal water treatment plant that deliberately hides much of its industrial volume below grade while offering a continuous public park above. The project sits at the edge of the city, where infrastructural uses often become fenced-off service zones, yet here the plant is paired with a landscape of walking paths, grasses, and light wells that invite everyday use. The facility's six treatment stages are echoed in the park's organization, so that the surface becomes a quiet diagram of what is happening underneath. This coupling of buried utility and accessible terrain positions Whitney as a key precedent for Fusion RE:Action, suggesting how a technically demanding, safety-sensitive program can coexist with an open civic landscape.

Figure 27. Aerial image of Whitney Water Purification Facility (Steven Holl Architects, 2005)

Rather than relying on a singular object-building, the complex works through calibrated absences and sectional reveals. The bulk of the treatment plant is sunk into the ground, allowing the park surface to remain largely continuous while gentle berms and cuts hint at the volumes below. A sequence of paths crosses these shifts in grade, occasionally aligning with skylights, glass prisms, and apertures that bring daylight into the plant and offer oblique views back down, reminding visitors that the pastoral surface is underpinned by an active utility. The geometric ordering of the park—its linear elements, basin-like depressions, and framed views toward the reservoir—quietly maps onto the logic of the treatment process without turning it into a didactic theme park. Materials such as concrete, gravel, grasses, and water are handled in a restrained palette, so the landscape feels contemplative and civic rather than merely decorative open space on top of infrastructure.

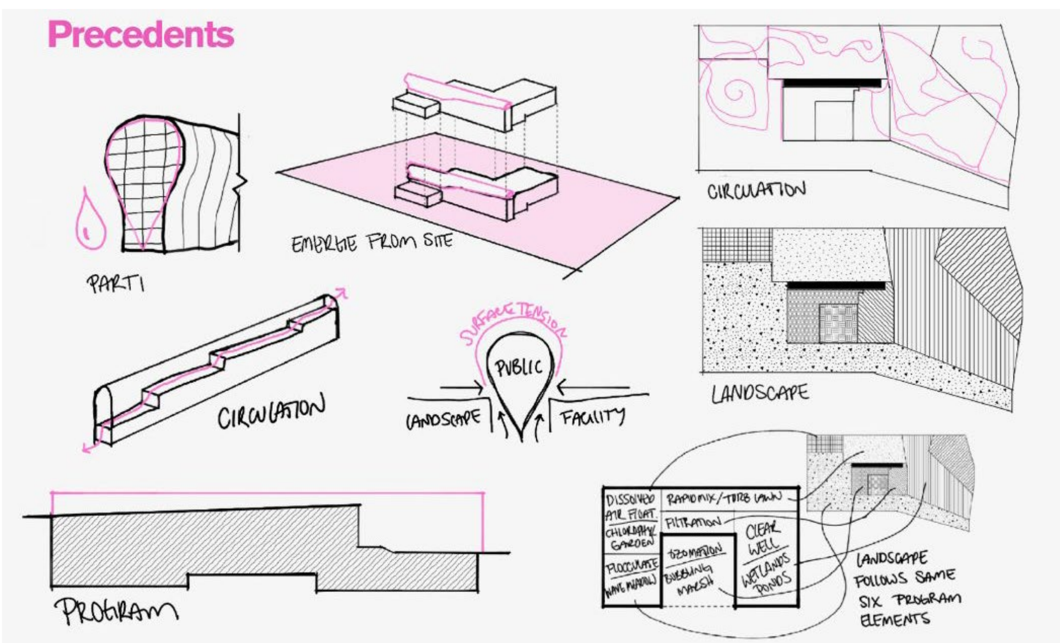


Figure 28. Whitney water purification facility precedent study diagrams

Translating these moves to Fusion RE:Action shifts the focus toward how a fusion core and its supporting systems might be partially buried or otherwise visually reduced while their presence remains legible in the landscape. Whitney's strategy of using topography, light wells, and carefully placed openings points to ways the reactor's volume and processes can be signaled without exposing sensitive equipment directly. The project also reinforces the value of aligning public circulation with an abstracted version of the technical sequence, where a walk along the waterfront or through a park subtly traces cooling loops, containment shells, or energy flows. In the context of Baltimore's harbor, this suggests a fusion facility that doubles as green infrastructure and public open space, allowing the site to participate in stormwater management, habitat, and recreation while also housing a highly specialized scientific program.

Volkswagen Transparent Factory

In Dresden, the Volkswagen Transparent Factory stages car production in the middle of the city, turning what is typically hidden at the edge of town into a glassy urban performance. Designed as both an assembly plant and showroom, the building brings finely tuned manufacturing lines, customer handover spaces, and visitor tours under one continuous, light-filled envelope. Cars move slowly along elevated tracks, workers operate in full view, and visitors enter through a generous forecourt that feels closer to a cultural venue than an industrial shed. Rather than masking the mechanics of production, the project leans into visibility as part of the brand narrative, inviting the public to observe and, to some extent, participate in the life of the factory.

Figure 29. VW Transparent Factory by HENN architects; aerial image (Google Earth, 2025)

The spatial organization is carefully choreographed to sustain that visibility without collapsing necessary boundaries. Public circulation is separated but intertwined with the paths of vehicles and workers, using changes in level, glazed partitions, and controlled overlaps to maintain safety while preserving sightlines. A clear structural grid and modular floor plates support flexible assembly lines, but they also produce a calm, legible interior where movement is easy to read. Materials—glass, polished concrete, warm wood—reinforce the sense that this is a civic interior as much as an industrial one, and the building's transparency extends out to the surrounding park and tram stop, tying the factory into the everyday routines of Dresden residents. The architecture, in other words, gives the production process enough distance to be understood as a sequence, but not so much distance that it feels abstract or opaque.

For the ambitions of Fusion RE:Action, the Dresden factory offers a script for how a highly technical and potentially intimidating process can be made observable without feeling either voyeuristic or unsafe. The layered circulations, calibrated proximities, and use of glass as both barrier and medium suggest concrete ways to structure public paths around a reactor hall or control room, allowing visitors to trace sequences of operation through views, alignments, and repeated encounters.

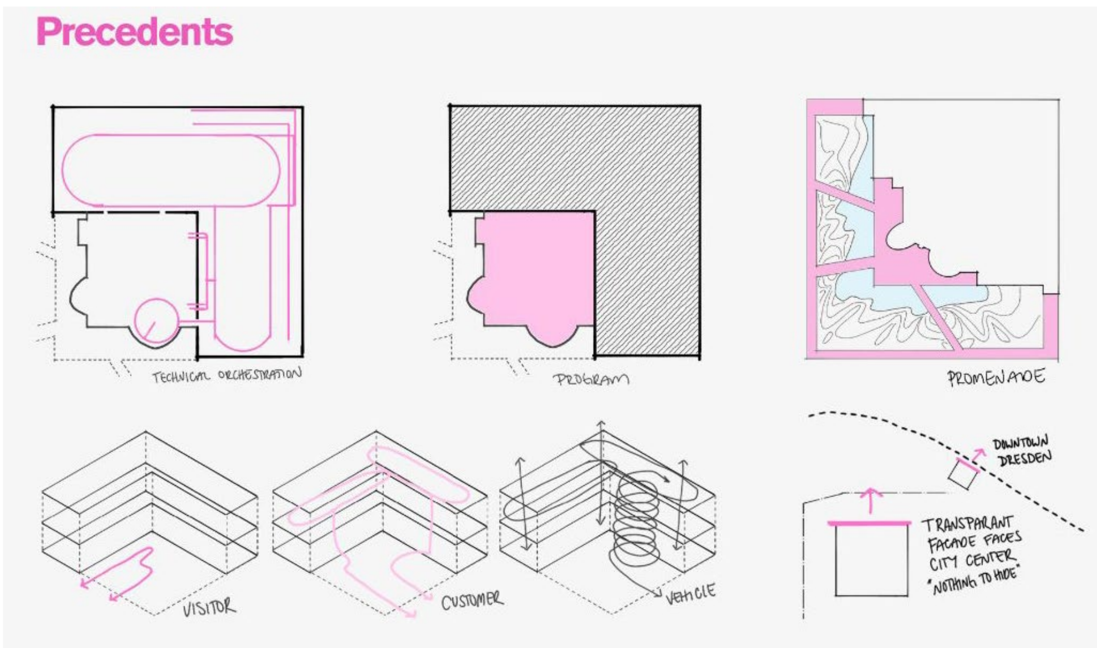


Figure 30. Precedent study diagrams of the VW Transparent Factory by HENN

It also raises productive questions about authenticity and spectacle: to what extent is visibility serving understanding, and when does it become a curated performance? On the Baltimore waterfront, where trust in industrial actors is shaped by histories of pollution and exclusion, this precedent pushes the project to design forms of transparency that go beyond branding, using spatial access, sightlines, and shared interiors to support genuine legibility of the fusion process.

Beinecke Rare Book and Manuscript Library

Beinecke Rare Book and Manuscript Library take the problem of protecting fragile material and turns it into a single, memorable spatial idea: a glowing tower of books held at the center of a dark, stone lined hall. Gordon Bunshaft's design at Yale places the main collection inside a glass core, lifts that core slightly above the floor, and surrounds it with reading rooms and exhibition spaces wrapped in translucent marble skin. From the plaza, the building appears as a heavy, almost mute volume hovering over a sunken court, while inside the marble admits a soft, diffuse light that keeps the books safe and gives the entire room an otherworldly glow. The emphasis is on a clear hierarchy of nested enclosures that makes the most sensitive contents feel both secure and visibly present, rather than hidden away back-of-house house storage.

Figure 31. Beinecke Library at Yale by SOM, aerial image (Google Earth, 2025)

The project communicates this hierarchy through a carefully staged sequence of thresholds and changes in atmosphere. Visitors move from bright exterior courts into a cooler, dimmer interior where the marble panels filter daylight so that the perimeter reads as continuous, luminous surface instead of conventional windows. Within this hall, the book tower stands as a second enclosure, transparent but sealed, so the core is always in view without ever feeling casually accessible. Below, additional stacks and reading spaces occupy a sunken level, which reinforces the impression that the collection extends into the ground as well as up into the tower. Material choices remain restrained, with stone, bronze, and glass carrying most of the weight, so that attention rests on spatial relationships and light rather than decorative detail.

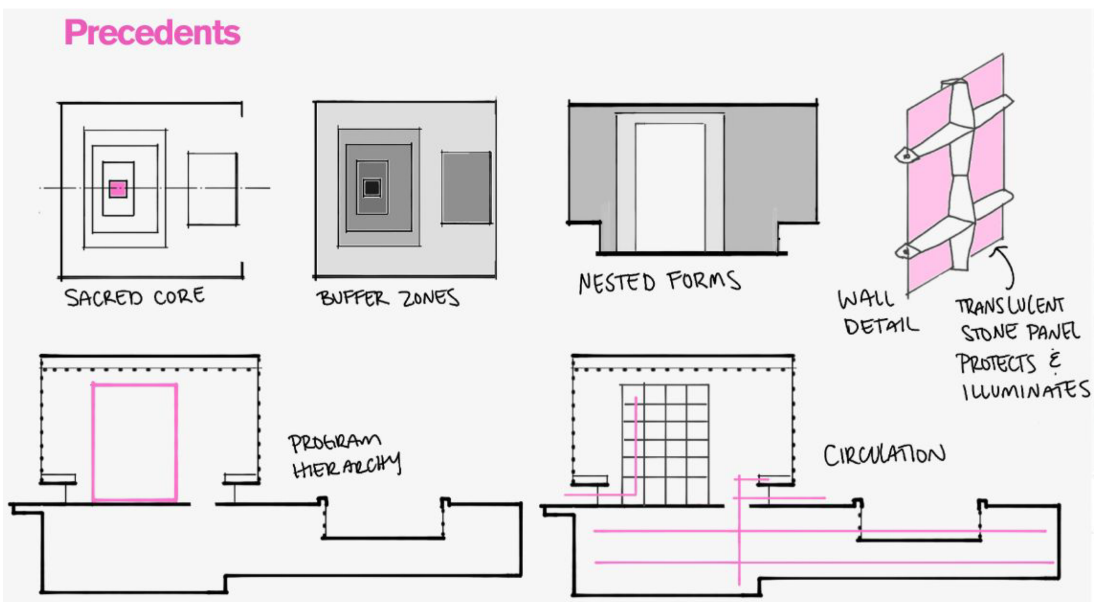


Figure 32. Beinecke Library precedent study diagrams

Looked at through the lens of Fusion RE:Action, Beinecke suggests a different approach to visibility than the more extroverted infrastructural precedents. It implies that making a reactor core legible does not require full exposure and that a sense of care or reverence can be as powerful as spectacle in shaping public perception. The image of a luminous, nested object surrounded by calibrated thresholds aligns with the need to keep certain spaces highly protected while still acknowledging their presence. On the Baltimore waterfront, this precedent opens up the possibility of treating the fusion core as a central, glowing volume around which promenades, research spaces, or galleries orbit, using light, distance, and vertical layering to frame the technology as a shared resource rather than a hidden danger.

Centre Pompidou

Few buildings make their own pipes, ducts, and beams as memorable as their galleries, but the Centre Pompidou does exactly that. Conceived for central Paris as a new kind of cultural engine, it gathers a museum, library, performance spaces, and public services into a deep, flexible volume that faces a broad urban square. Renzo Piano and Richard Rogers chose to make the mechanics of the building visible rather

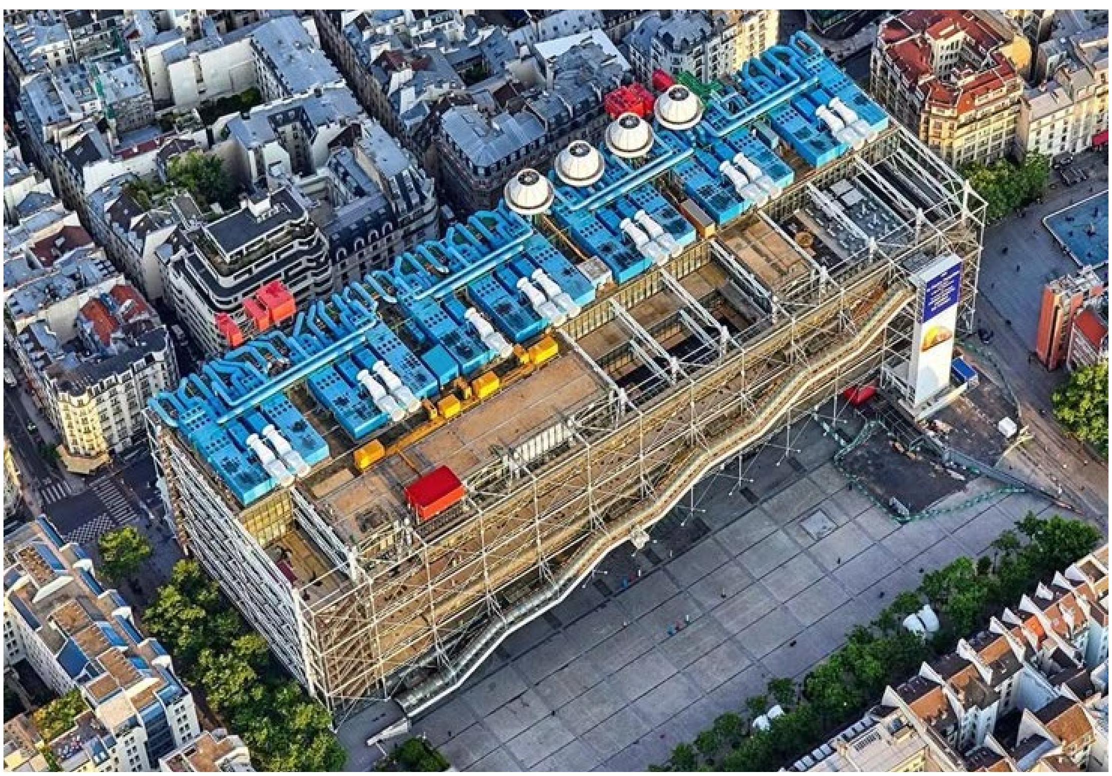


Figure 33. Centre Pompidou by Renzo Piano & Richard Rogers, aerial image (Google Earth, 2025)

than neutral, treating structure, circulation, and environmental systems as the primary architectural expression. The image that results is both technological and civic, a large machine that belongs as much to the life of the plaza as to the institutional programs inside.

On the outside, the building reads as a thick serviced frame wrapped with color coded elements that clarify what each system does. Primary trusses and braces line the perimeter, large ducts and pipes are grouped by function and color, and glazed circulation tubes snake along the facade to carry people up through the section. Inside, the floor plates remain relatively open, allowing curators and staff to reconfigure galleries and public areas over time without disturbing the overall skeleton. The long escalator along the street front turns vertical movement into an urban experience, lifting visitors slowly above the square and roofscape while giving intermittent views into the interior. Meanwhile, the plaza at ground level operates as an everyday stage for street performance, casual gathering, and protest, so that the institution engages people whether they pass through the doors.

In the context of this thesis, Pompidou reads as a study in how complexity can be made explicit without becoming alienating. The clear articulation of systems suggests that portions of the fusion plant’s support infrastructure, such as cooling equipment or data handling, could be expressed in ways that are legible and teachable rather than buried in anonymous back of house spaces. Its reliance on a generous forecourt reinforces the importance of creating a civic foreground on the Baltimore waterfront, a place where people can occupy the project without always entering controlled technical areas. Taken together, these strategies support an image of the fusion facility as both a working piece of energy infrastructure and a recognizable urban platform for public life, integrating new technology into the familiar rhythms of the harbor.

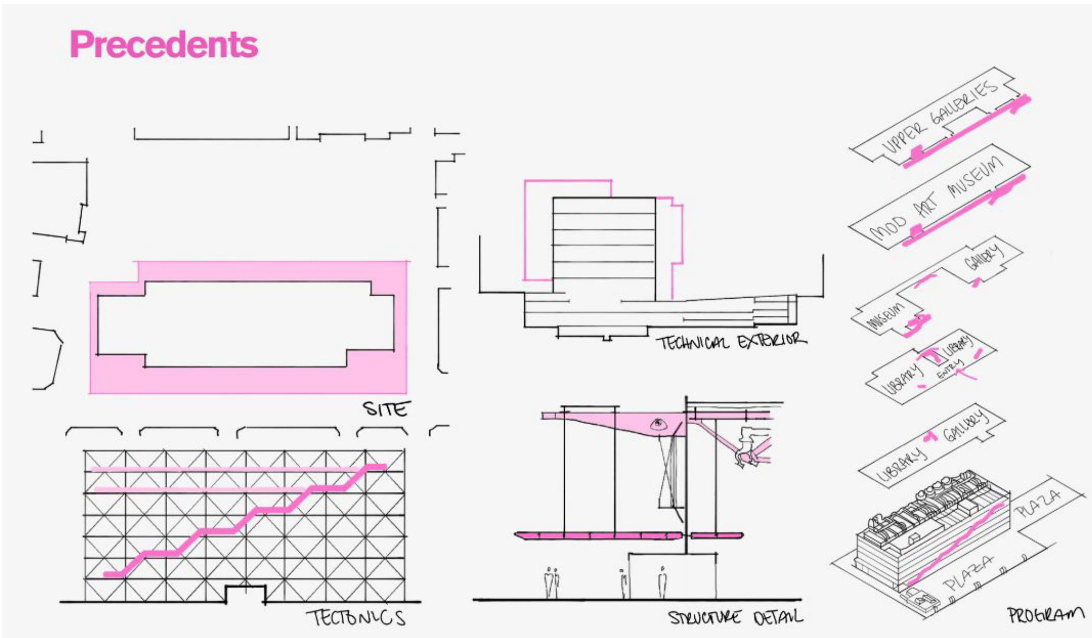


Figure 34. Precedent study diagrams of Centre Pompidou

Technical Precedents

Because fusion facilities introduce non-negotiable operational and safety requirements, this chapter also includes a set of fusion-specific technical precedents: the International Thermonuclear Experimental Reactor (ITER) in Saint-Paul-lès-Durance, France, Commonwealth Fusion Systems' SPARC (Smallest Possible ARC) tokamak and development campus in Devens, Massachusetts, and JT-60SA (Japan Torus-60 Super Advanced) in Naka, Ibaraki, Japan. These examples are not treated as formal models to emulate. Instead, they establish the spatial realities that any fusion-centered architecture must accommodate, including typical facility components, service and shielding needs, access control, maintenance logistics, and the organizational separation between public-facing areas and protected core systems.

Read alongside the design precedents, they help distinguish what must remain controlled from what can become legible. This grounding allows Fusion RE:Action to translate technical necessities into an architectural framework that supports visibility, discovery, and education without compromising safety.

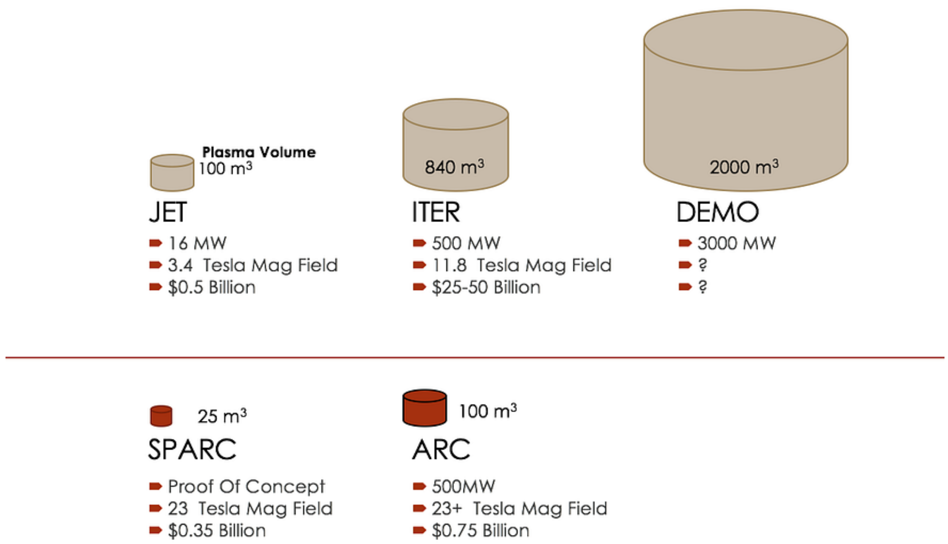


Figure 35. Size comparison of commercial and international public fusion projects (MIT, 2022)

ITER (International Thermonuclear Experimental Reactor)

As the world's largest and most publicly visible fusion experiment, the International Thermonuclear Experimental Reactor (ITER) represents the upper limit of scale and ambition for contemporary tokamak facilities. Located in southern France and funded by a multinational consortium, ITER has been widely publicized as a flagship project for fusion research, generating an unusually rich archive of drawings, diagrams, construction photography, and public-facing explanatory material. This level of documentation makes ITER an essential technical reference, even though it was never conceived as civic architecture. Its prominence, visibility, and sheer physical scale position it as a global point of comparison for any discussion of fusion's future.

Spatially, ITER operates as a vast, highly controlled industrial campus embedded within a semi-rural landscape. The tokamak complex is housed within a monumental reinforced concrete bio shield, surrounded by auxiliary buildings for cryogenics, power conversion, cooling, diagnostics, and remote handling. Circulation is almost entirely segregated, with clear separations between operational zones, maintenance zones, and limited visitor access areas. The architecture emphasizes containment, redundancy, and protection, resulting in an inward-facing composition that prioritizes technical performance over spatial legibility. While ITER includes a visitor center and outreach facilities, these remain largely detached from the reactor core, reinforcing the sense that fusion occurs elsewhere, behind layers of enclosure and security.

Figure 36. 445-acre ITER campus, in Saint-Paul-lès-Durance, France, aerial image (ITER, 2025)

For this thesis, ITER is useful precisely because of these qualities. It establishes the extreme end of fusion infrastructure, clarifying which aspects of the system must remain inaccessible, shielded, or spatially isolated. At the same time, its separation between public education spaces and the reactor core highlights the missed opportunity for architectural mediation. Reading ITER through the lens of visibility, discovery, and education allows the project to identify where architectural design might operate differently at smaller scales, maintaining safety while reducing distance. ITER thus functions not as a model to replicate, but as a boundary condition against which more civic, legible fusion architecture can be imagined.

SPARC (Smallest Possible Arc) Commonwealth Fusion Systems Campus

The SPARC tokamak and its associated campus in Devens, Massachusetts, represent a contrasting fusion trajectory: private, compact, and explicitly oriented toward near-term commercial viability. Developed by Commonwealth Fusion Systems (CFS), SPARC is heavily publicized through renderings, technical summaries, and press releases that frame fusion as an imminent and scalable energy solution. While access to detailed architectural documentation is more limited than at ITER, the project's visibility within public discourse and its positioning within an American suburban-industrial context make it a valuable precedent for understanding how fusion is being communicated outside of state-led megaprojects.

At a much smaller scale than ITER, SPARC relies on high-field superconducting magnets to reduce reactor size while maintaining performance. This technological choice has direct spatial consequences, compressing the reactor hall and concentrating support systems into a tighter footprint. The Devens campus reads as a hybrid research and light-industrial environment, with secure buildings set within a landscape shaped by access roads, parking, and service infrastructure. Public access is minimal, and architecture prioritizes efficiency, speed of construction, and operational flexibility over civic presence. The site reflects a model in which fusion is treated as proprietary and transitional, something to be perfected before it is shared.

Figure 37. SPARC 50-acre campus in Devens MA, aerial image (Commonwealth Fusion Systems, 2025)

Within the context of this thesis, SPARC is useful as a mid-scale reference that bridges experimental research and future deployment. Its compactness suggests that fusion facilities need not dominate their surroundings physically, even if they remain highly controlled. At the same time, its limited public interface underscores the risk that fusion could emerge as an invisible or exclusive technology if architectural engagement is deferred. SPARC therefore helps frame the challenge of how a demonstration-scale facility might retain technical rigor while beginning to establish a public relationship earlier in the fusion timeline.

ARC (Affordable Robust Compact) Commonwealth Fusion Systems Campus

ARC, CFS's planned commercial power plant in Chesterfield County, Virginia, extends this precedent from demonstration-scale research into grid-scale deployment. Unlike SPARC, which is primarily a research and validation facility, ARC is framed as a power plant intended to produce approximately 400 megawatts of electricity. It's situated near Richmond, on an industrial energy site in collaboration with Dominion Energy, signals a shift from fusion as laboratory infrastructure toward fusion as utility infrastructure.

Figure 38. Rendering of ARC 25-acre campus in Richmond, VA (Commonwealth Fusion Systems, 2026)

For this thesis, ARC is important less as a completed architectural model than as evidence that fusion is beginning to enter real questions of siting, public visibility, grid connection, and civic impact. It reinforces the central gap this thesis addresses: even as fusion approaches commercial deployment, its architectural and public-facing identity remains unresolved.

JT-60SA (Japan Torus–60 Super Advanced)

JT-60SA occupies an intermediate position between ITER and SPARC/ARC, both in scale and institutional character. Developed through a collaboration between Japan and the European Union, the facility functions as an advanced research tokamak intended to support ITER operations and future DEMO-class reactors. JT-60SA is notable for the breadth of published technical material available, including facility layouts, system diagrams, and construction documentation, making it one of the most accessible fusion facilities for architectural analysis. Its location within a research campus in Naka, Japan, situates it within a controlled but established scientific environment rather than an isolated megasite.

Figure 39. JT-60SA ~35-acre Campus at Naka Fusion Institute in Ibaraki, Japan (Google Earth, 2026)

Architecturally, JT-60SA is organized around a central tokamak hall surrounded by a constellation of support spaces for power supply, cooling, diagnostics, and maintenance. While still highly secured, the facility exhibits a more legible organizational clarity than ITER, with clearer adjacencies and a more compact overall composition. The buildings read as purpose-built research infrastructure, restrained in expression and closely tied to their technical function. Limited visitor circulation exists, but, as with most fusion facilities, it remains peripheral, reinforcing a hierarchy between observation and operation.

For this thesis, JT-60SA is valuable as a well-documented, mid-scale example that demonstrates how fusion facilities are typically organized when not operating at extreme scale or commercial urgency. It provides a clear baseline for understanding spatial relationships between reactor core, service zones, and circulation without the overwhelming monumentality of ITER. By studying JT-60SA alongside SPARC and ITER, the thesis can compare how scale, institutional context, and technological ambition influence architectural outcomes. Together, these precedents help define the envelope of what fusion facilities are today, creating space for Fusion RE:Action to argue for what they could become when architecture actively engages visibility, discovery, and education.

Conclusion

Across the design precedents, a set of recurring architectural strategies emerges for reconciling powerful, often opaque systems with the spaces of everyday life. CERN Science Gateway and the Volkswagen Transparent Factory demonstrate how circulation, transparency, and controlled views can choreograph carefully framed encounters with complex processes. CopenHill and the Whitney Water Purification Facility show how section, topography, and landscape can host public occupation while housing large-scale infrastructure beneath or alongside it. The Beinecke Library and the Centre Pompidou, in very different ways, treat fragile or technical cores as generators of architectural identity, either by nesting them within layers of protection or by externalizing their supporting systems. Together, these projects suggest that the relationship between core and context is not fixed, but can be tuned through light, distance, material, and movement to balance access, legibility, and control.

Read alongside these architectural examples, the fusion-specific technical precedents sharpen the stakes of this negotiation. ITER, SPARC, and JT-60SA clarify the non-negotiable spatial realities of fusion research, including shielding, maintenance access, security zoning, and the separation between operational and public domains. At the same time, they reveal a consistent architectural pattern: fusion facilities are typically organized to minimize exposure and maximize containment, with public engagement occurring, if at all, at a distance from the reactor core. When viewed through the lens of Fusion RE:Action, these facilities highlight not only what must remain protected, but also how current architectural responses reinforce fusion's invisibility and cultural remoteness. Their inclusion establishes a critical baseline against which alternative spatial strategies can be measured.

Together, the design and technical precedents refine the thesis themes of visibility, discovery, and education. Visibility is not understood as full exposure, but as a calibrated condition shaped by vantage point, layering, and selective revelation.

Discovery emerges through sequence and movement, allowing understanding to build gradually rather than through singular didactic moments. Education is embedded in form, section, and landscape, where spatial relationships and material cues reinforce what interpretive content may explain. Looking ahead to the design work, these lessons translate into a set of ambitions and open questions: how to construct a clear spatial armature that organizes technical and public programs, how to calibrate proximity to the fusion core, and how to shape a harbor landscape that operates simultaneously as civic ground and resilient infrastructure. Chapter 5 takes up these questions directly, testing how the strategies distilled here can be adapted to the specific conditions of the Baltimore waterfront and translated into an architectural proposal that makes fusion both legible and trusted without reducing it to spectacle or sealing it away as a black box.

Chapter 5: Program Development

Abstract

This chapter translates the research developed in earlier chapters into a programmatic framework for a fusion science campus on Baltimore's harbor. The proposal combines fusion energy production, public education, and waterfront infrastructure within a single interconnected site, positioning fusion as a visible and accessible part of urban life rather than remote industrial infrastructure. Guided by the thesis themes of visibility, discovery, and education, the chapter establishes the organizational relationships between public, ecological, and technical systems that shape the architectural proposal developed in later chapters.

The program emerges from research into fusion infrastructure, public perception, environmental psychology, and Baltimore's industrial waterfront conditions. Technical requirements associated with reactor systems, maintenance, cooling, and operational security are developed alongside public-facing programs focused on exhibitions, education, gathering, and environmental restoration. Together, these requirements establish the operational and spatial framework for the fusion campus.

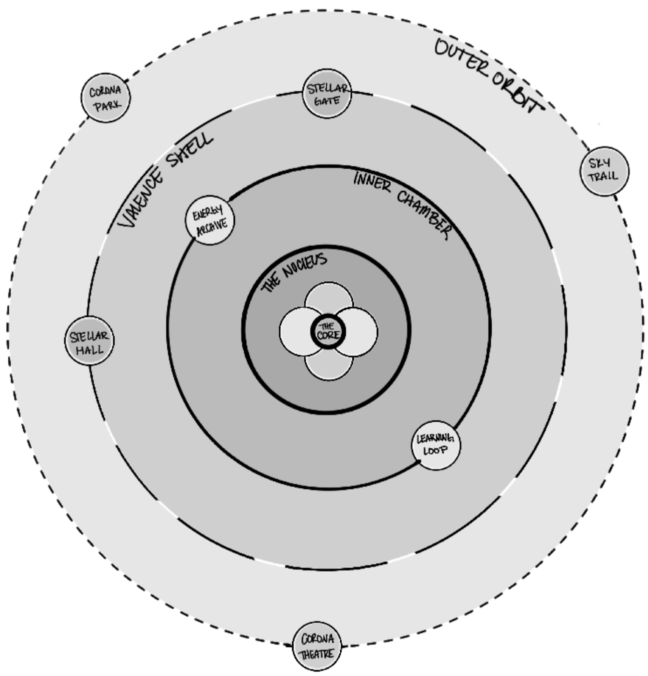


Figure 40. Early program organization concept

Programmatic Drivers

Among the precedents studied, CERN Science Gateway and the SPARC tokamak represent two extremes of the same architectural problem: how advanced scientific infrastructure negotiates its relationship to the public realm. Rather than treating either project as a formal model to replicate, this thesis studies them as organizational frameworks that reveal different approaches to access, movement, visibility, and control. The goal is not to reproduce their architecture, but to understand how each project positions public experience relative to protected technical systems, and how those relationships shift depending on institutional priorities. Read together, CERN and SPARC establish the spatial and operational tensions that ultimately shape the program of Fusion RE:Action.

CERN Science Gateway

CERN Science Gateway is especially relevant because its central challenge closely parallels that of this thesis: how to position a public-facing educational environment at the threshold of an advanced physics campus without compromising security, clarity, or institutional legitimacy. Rather than operating as a singular object or isolated visitor center, Science Gateway organizes exhibitions, classrooms, an auditorium, and gathering spaces along a clear circulation armature that gradually transitions between public and research environments. In simplified form, it contains many of the same conditions required for a civic fusion facility: a protected scientific

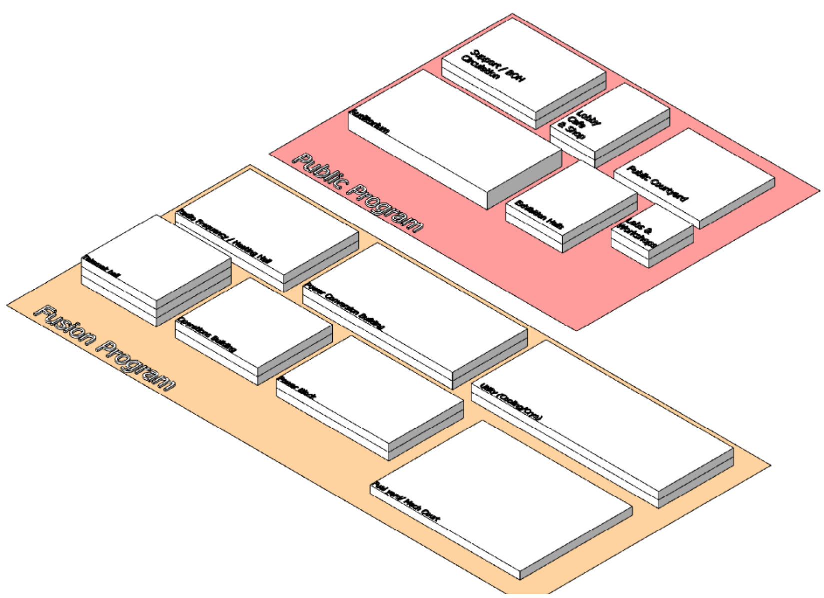


Figure 41. Program scale comparison SPARC vs. CERN Science Gateway

hinterland, a sequence of interpretive spaces, and an arrival condition that belongs as much to the city as to the institution itself.

At CERN, this relationship is organized through a linear didactic spine punctuated by a series of threshold spaces that mediate between public and scientific worlds. Bridges, foyers, exhibition halls, classrooms, and auditoriums widen and compress along the circulation sequence, allowing visitors to pause, orient themselves, and gradually absorb increasingly complex layers of information. Movement itself becomes an educational device, building familiarity and comfort over time while maintaining clear separation from sensitive research zones. The project demonstrates how architecture can transform restricted scientific infrastructure into a spatial narrative without dissolving the operational boundaries that protect it.

SPARC Fusion Campus

In contrast, the SPARC tokamak and Commonwealth Fusion Systems campus in Devens, Massachusetts, define the opposite end of this relationship. SPARC is organized primarily around operational efficiency, compactness, speed of deployment, and technical control, with little meaningful public interface beyond institutional communication and media representation. Its spatial logic is inward-facing, tightly coupling the reactor, maintenance systems, diagnostics, and service infrastructure while minimizing circulation overlap and unnecessary exposure. As a technical precedent, SPARC clarifies the non-negotiable realities of fusion infrastructure at a smaller and more commercially driven scale, including shielding requirements, access separation, tightly integrated support systems, and the spatial consequences of high-field superconducting reactor technology.

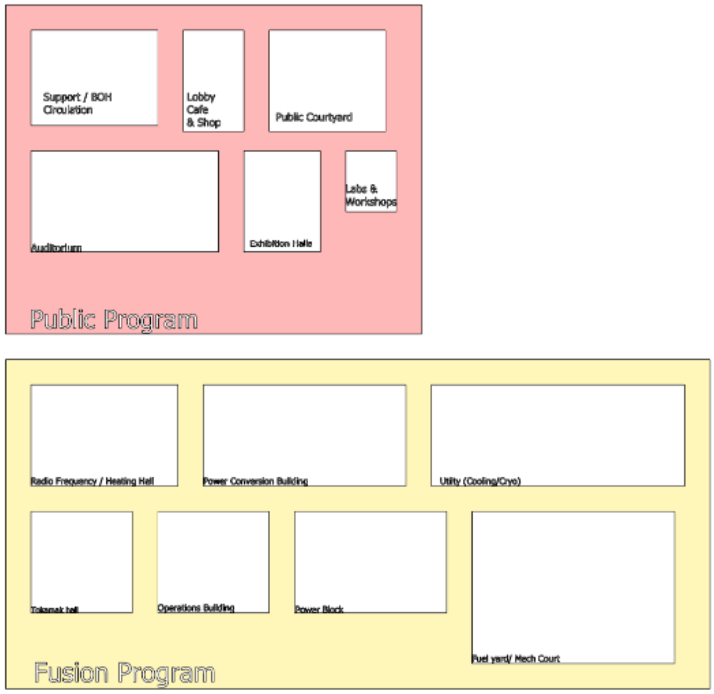


Figure 42. Program scale comparison SPARC vs. CERN Science Gateway

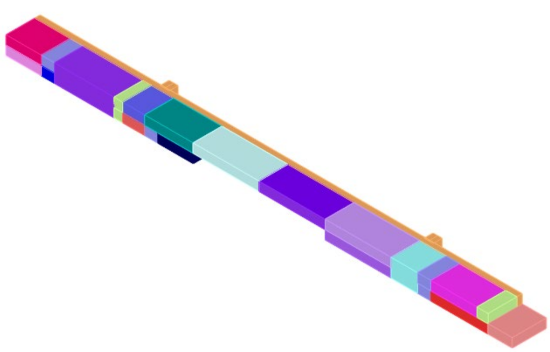
Within this thesis, SPARC functions less as a civic model than as a boundary condition that defines what fusion architecture cannot ignore. Where CERN externalizes and choreographs the threshold between public and research, SPARC reinforces it through compactness, security, and operational focus. Fusion RE:Action emerges in the tension between these two organizational logics. The project adopts CERN's strategy of progressive encounter and public orientation while grounding it within the technical and spatial constraints revealed by SPARC.

Program Organization

The proposal organizes the site as a fusion science campus composed of three primary systems: the Science Center, the Landscape, and the Fusion Power Plant. Together, these systems structure relationships between public education, environmental infrastructure, and fusion energy production across the waterfront site. Rather than concentrating all functions within a singular building, the campus distributes public, ecological, and technical programs across the harbor edge while maintaining controlled relationships between access, visibility, and operational infrastructure. This organization supports the broader thesis themes of visibility, discovery, and education by allowing visitors to encounter fusion gradually through architecture, landscape, and proximity to working energy infrastructure.

Science Center

The Science Center contains the primary public and educational programs for the fusion campus. The building occupies approximately 67,200 square feet at the ground plane and contains roughly 144,000 square feet of usable interior space. Program elements include permanent and rotating exhibition galleries, classrooms, workshop spaces, research outreach laboratories, administrative offices, cafés, lounges, event spaces, and assembly areas for school groups, lectures, conferences, and public events.



Program Space	Target Area (sq ft)	LxW Option A (Rectangular)	LxW Option B (Square/Other)
Research Labs & Hub	10,000	100' x 100' (Open floor)	50' x 200' (Linear wing)
STEM Classrooms	6,500	65' x 100'	130' x 50'
o	8,000	80' x 100'	70' x 115'
Interactive Exhibits	18,500	100' x 185'	135' x 135'
Reception & Lobby	4,000	50' x 80'	60' x 65'
Science Center Cafe	2,500	40' x 62.5'	50' x 50'
Science Center Shop	1,500	30' x 50'	38' x 40'
Main Public Restrooms	2,500	30' x 42' (ea. Gender)	40' x 60' (Shared core)
Permanent Energy Galleries	18,000	90' x 200'	120' x 150'
Immersive Theater	5,500	70' x 80'	75' diameter (Circular)
Temp Exhibit Hall	6,000	60' x 100'	75' x 80'
Museum Lobby/Entry	2,000	25' x 80'	45' x 45'
Museum Bistro/Cafe	1,500	30' x 50'	35' x 43'
Museum Gift Shop	1,000	20' x 50'	32' x 32'
Collection Storage	4,000	50' x 80'	60' x 65'
Museum Restrooms	1,500	25' x 30' (ea. Gender)	30' x 50' (Shared core)
Loading Dock & Staging	3,500	50' x 60'	40' x 75'
Exhibit Repair Workshop	3,000	50' x 60'	40' x 75'
Main Mechanical/Elec	4,500	80' x 150'	100' x 120'
Staff Admin Offices	3,000	50' x 60'	40' x 75'
Circulation	18000	24' x 750'	150' x 120'

Figure 43. Science center program chart and early massing diagram

A large tokamak exhibit serves as the central educational feature within the exhibition program. Additional galleries focus on plasma physics, fusion energy, climate change, energy infrastructure, and related scientific topics through physical exhibits, digital media, and interactive displays.

Educational spaces include classrooms, laboratories, and workshop areas intended for school partnerships, university outreach, hands-on learning, and public science programming. The building also contains a 250-seat dome theater for educational screenings, scientific presentations, and immersive media related to fusion research, astronomy, and climate science.

Additional program elements include a large auditorium, public gathering spaces, cafés, lounges, administrative offices, storage, support spaces, restrooms, circulation, and building services required for daily operation and public occupancy.

Landscape

Immediately The landscape contains the primary exterior public and ecological programs for the fusion campus. Program elements include waterfront promenades, plazas, outdoor classrooms, gathering spaces, pedestrian circulation paths, ecological restoration zones, wetlands, stormwater retention systems, flood mitigation infrastructure, and public open space distributed across the harbor edge.

Additional landscape programs include restored shoreline conditions, biodiversity zones, planted buffer areas, thermal park spaces, event lawns, overlook areas, and outdoor educational spaces intended to support informal public use, recreation, environmental education, and waterfront access.

Repurposed industrial oil tanks are incorporated into the landscape as stormwater retention and ecological infrastructure supporting flood control, habitat restoration, and environmental programming. Portions of the site are designed to accommodate periodic inundation during major storm events as part of the larger flood mitigation strategy for the waterfront.

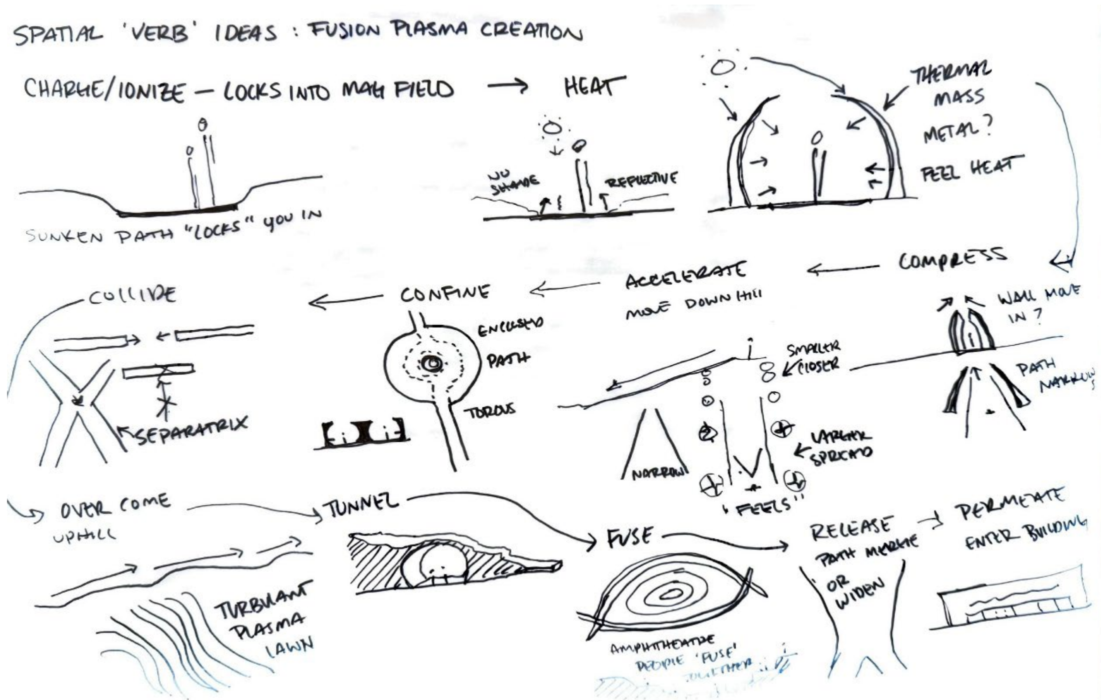


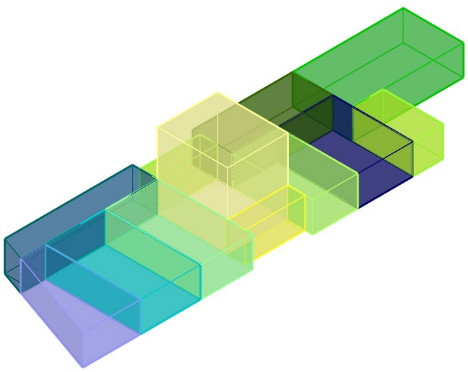
Figure 44. Early landscape exploration diagrams

The landscape also contains staff parking, service access, loading areas, emergency access routes, and circulation infrastructure required to support the operation of both the Science Center and Fusion Power Plant. Together, these landscape systems occupy approximately 25 acres across the site.

Power Plant

The Fusion Power Plant contains the operational infrastructure required for fusion research and energy production. Primary program elements include the reactor hall, control rooms, diagnostics spaces, maintenance facilities, cooling infrastructure, cryogenic systems, mechanical and electrical support spaces, energy conversion equipment, secured service areas, and technical administration spaces.

The reactor hall houses the tokamak and associated shielding systems required for reactor operation and maintenance. Control rooms support reactor monitoring, systems management, and operational oversight. Diagnostics spaces support plasma analysis, testing, and performance monitoring during reactor operation.



Program	SQFT	LxW	Floor #
Hot Cell	4800	120 x 40	4
Toamak Hall	16800	120 x 140	8
Circulation	4800	120 x 40	4
cryo	12600	140 x 90	4
cooling	30000	150 x 200	4
GIS/GSU	13000	200 x 65	4
Operations	20000	100 x 200	4
Storage/maintanance	33000	100 x 330	4
turbine	17200	215 x 80	4
rf heating	3570	140 x 150	4
power supply	46500	80 x 280	4

Figure 45. Program chart and massing for power plant layout

Cooling systems, cryogenic infrastructure, and mechanical support spaces are required to sustain reactor operation, temperature regulation, superconducting systems, and power conversion processes. Maintenance facilities, workshops, staging areas, and equipment handling spaces support repair, servicing, replacement, and long-term operational flexibility.

Additional program elements include storage, loading areas, secured circulation, emergency systems, staff support spaces, and utility infrastructure necessary for continuous plant operation and site management. Public access to the facility remains restricted due to operational, safety, and security requirements associated with fusion infrastructure.

Program Summary

The program organizes the site through three interconnected systems: the Science Center, the Landscape, and the Fusion Power Plant. Together, these systems combine public education, environmental infrastructure, and fusion energy production within a single waterfront campus occupying approximately 25 acres along Baltimore's harbor.

The Science Center contains the primary educational, exhibition, and public gathering programs for the campus. The building contains roughly 144,000 square feet of usable interior space dedicated to exhibitions, classrooms, laboratories, theaters, workshops, event spaces, and public amenities.

The Landscape supports circulation, ecological restoration, stormwater management, flood mitigation, thermal park infrastructure, and public waterfront access across approximately 482,000 square feet of exterior site area. Program elements include promenades, plazas, outdoor classrooms, wetlands, retention systems, gathering spaces, restored shoreline conditions, and supporting site infrastructure.

System	Role	Main Components	Access
Science Center	Public education	Exhibits, dome theater, auditorium, classrooms, workshops, café	Public
Landscape	Public and ecological infrastructure	Promenade, wetlands, stormwater, thermal park, oil tank landscapes	Public
Fusion Power Plant	Technical energy production	Reactor hall, cooling, cryogenics, control rooms, maintenance, grid connection	Guided

Figure 46. Table summary of program zones

The Fusion Power Plant contains the reactor and supporting infrastructure required for fusion research and energy production, totaling roughly 768,000 square feet of interior space dedicated to reactor operations, diagnostics, maintenance, cooling infrastructure, energy conversion systems, control rooms, and secured operational support spaces.

System	Area	Purpose
Science Center	144,000 sf interior	Public education and interpretation
Landscape	25 acres	Public waterfront, ecological restoration, stormwater, flood adaptation
Fusion Power Plant	768,000 sf interior	Fusion operation, support systems, energy production
Total Interior	912,000 sf	Combined public and operational building area

Figure 47. Program area summary

Together, the project contains approximately 912,000 square feet of interior building area distributed between public educational programs and operational fusion infrastructure. Combined with the surrounding landscape systems, the campus establishes a framework that integrates technical infrastructure, public education, and environmental performance within a single interconnected waterfront site.

Chapter 6: Site Selection and Analysis

Introduction

The success of this thesis depends not only on the design of the fusion campus, but on where that campus is placed and what existing conditions it engages. The site is not treated as a neutral container. It operates as part of the thesis argument, testing how fusion energy infrastructure might exist within a real urban waterfront shaped by industrial history, ecological vulnerability, energy demand, public perception, and everyday civic life.

Baltimore makes this question especially relevant. Maryland consumes far more energy than it produces, and Baltimore depends heavily on electricity generated outside the city. At the same time, the harbor already contains the physical legacy of older energy systems through fuel storage infrastructure, utility corridors, industrial parcels, and working waterfront uses. This overlap between energy dependence and visible industrial history makes the Canton waterfront a strong site for asking how future energy infrastructure could become more local, legible, and public.

This chapter documents the selection and analysis of the Canton waterfront as the primary site for the thesis. The following sections examine the programmatic, environmental, social, and infrastructural conditions that shaped the development of the project.

Site Selection Criteria

Site selection was guided by four primary criteria: energy burden, infrastructural capacity, civic visibility, and environmental repair. The site needed to connect fusion to a real urban energy problem rather than treating it as an abstract future technology.

First, the project required a city where energy demand, imported power, and household energy burden make the question of future energy infrastructure socially relevant. Maryland consumes far more energy than it produces, and Baltimore depends heavily on electricity generated outside the city. This creates a condition where energy is economically present but spatially distant. Residents experience energy through cost, reliability concerns, and utility burden, but rarely through direct public understanding of where power comes from or how it is produced. For this reason, Baltimore became an important test site for asking whether future energy infrastructure could become more visible, local, and civic.

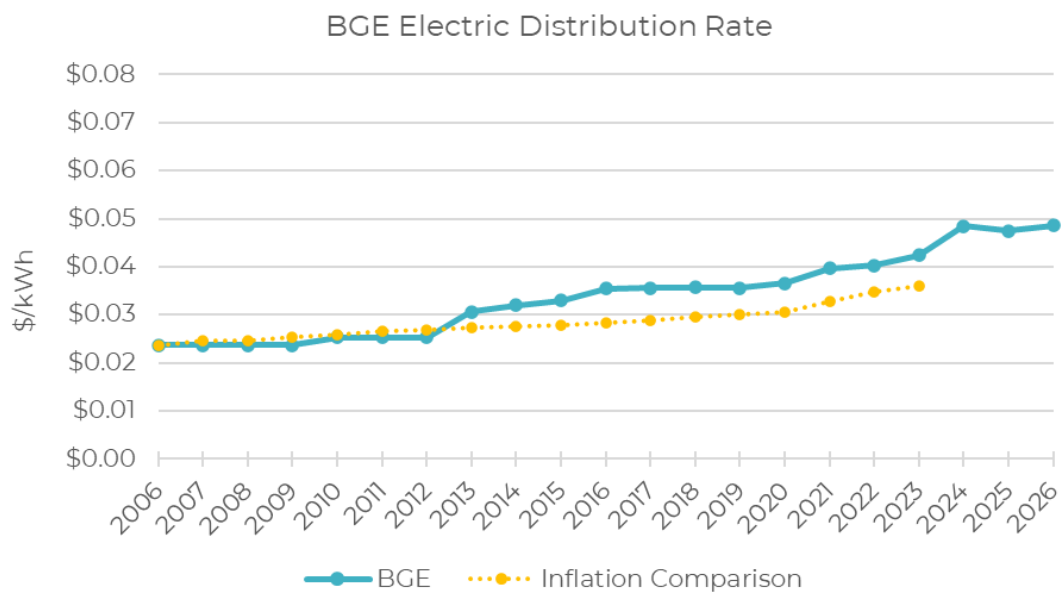


Figure 48. Baltimore's rate increase compared to inflation, shows higher burden (Maryland.gov, 2026)

Second, the site needed to support the physical requirements of a fusion campus. This included enough area for a Fusion Power Plant, Science Center, public landscape, secured operational zones, service access, and future grid connection. Proximity to existing industrial and utility infrastructure was important because the thesis investigates fusion as part of an existing energy landscape, not as an isolated object placed on empty land.

Third, the site needed to be visible and accessible to the public. The thesis depends on the relationship between technical infrastructure and civic life, so the site had to engage surrounding neighborhoods, waterfront circulation, road networks, and public edges. A working waterfront condition was especially valuable because it allows energy production, industry, ecology, and public space to exist in close proximity.

Finally, the site needed to offer opportunities for environmental repair. Because the project links energy transition to waterfront adaptation, the selected site needed to engage flood risk, hardened shoreline conditions, industrial remnants, and underused land. The Canton waterfront meets these criteria because it combines Baltimore's energy burden, industrial history, visible waterfront infrastructure, neighborhood proximity, and ecological vulnerability within a single site.

Baltimore and Canton Waterfront Site Analysis

The thesis is situated along the Canton waterfront in Baltimore, Maryland, within a portion of the harbor shaped by overlapping industrial, logistical, ecological, and residential conditions. The site occupies a transitional edge between active maritime infrastructure and rapidly changing urban neighborhoods, making it uniquely suited to the project's investigation into how future energy systems might operate within visible civic environments rather than isolated industrial enclaves.

Regional context

At the regional scale, Baltimore's harbor has historically functioned as a major center of shipping, manufacturing, petroleum storage, rail infrastructure, and energy distribution along the eastern seaboard. Large industrial parcels, port facilities, fuel terminals, warehouses, and transportation corridors continue to define significant portions of the waterfront landscape. At the same time, many former industrial areas throughout the harbor have undergone substantial redevelopment into residential, commercial, recreational, and mixed-use districts.

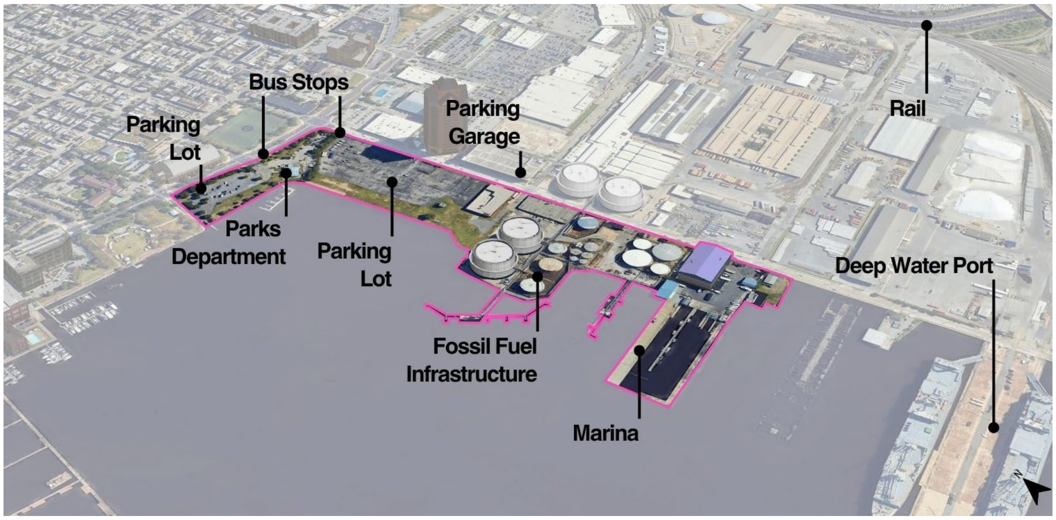


Figure 49. Regional industrial importance and legacy infrastructure on/near the site

This coexistence of active industry and urban redevelopment creates a broader regional condition in which older forms of energy infrastructure remain physically embedded within the contemporary city. The thesis positions fusion within this evolving landscape, treating the harbor not only as a site of industrial history, but as an active testing ground for future relationships between energy production, public access, and environmental adaptation.

Inner harbor context

Within the harbor itself, the Canton waterfront occupies a highly visible edge between industrial operations, public waterfront spaces, and emerging mixed-use development. The site remains closely tied to working maritime infrastructure, including fuel storage, shipping activity, distribution facilities, and utility systems that continue to support the larger metropolitan region.

At the same time, nearby portions of the harbor contain parks, promenades, marinas, commercial corridors, and residential developments that bring large numbers of people into direct proximity with these infrastructural landscapes. This overlap between public life and industrial infrastructure became central to the thesis, since it already reflects many of the spatial tensions explored throughout the project: openness versus security, environmental vulnerability versus redevelopment, and visible infrastructure versus hidden systems.

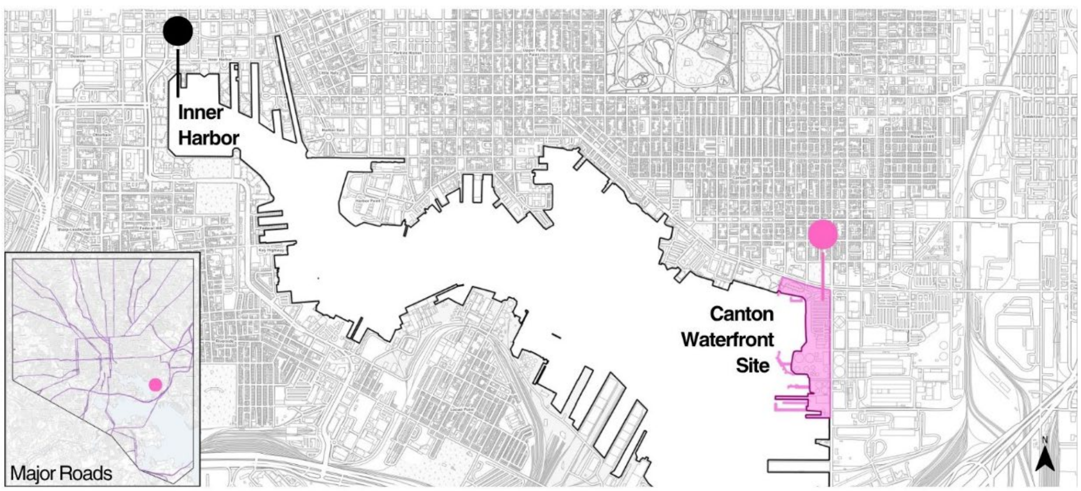


Figure 50. Site's relationship to the Inner Harbor

The harbor also introduces significant environmental pressures associated with sea level rise, storm surge, flooding, and shoreline erosion. These conditions directly influenced the development of landscape systems and broader resilience strategies integrated into the project.

Neighborhood context

At the neighborhood scale, the site sits between residential areas, commercial districts, industrial parcels, and public waterfront destinations within Canton and the surrounding harbor communities. Nearby neighborhoods contain a mixture of rowhouse residential fabric, newer mixed-use development, commercial corridors, parks, and active industrial uses that collectively produce a highly layered urban condition.

The site's proximity to existing neighborhoods was important to the thesis because it positions fusion infrastructure within everyday urban experience rather than separating it from public life. Pedestrian access, waterfront circulation, nearby commercial activity, and visual exposure from surrounding streets and public spaces all contribute to the site's role as a visible civic edge within the city.

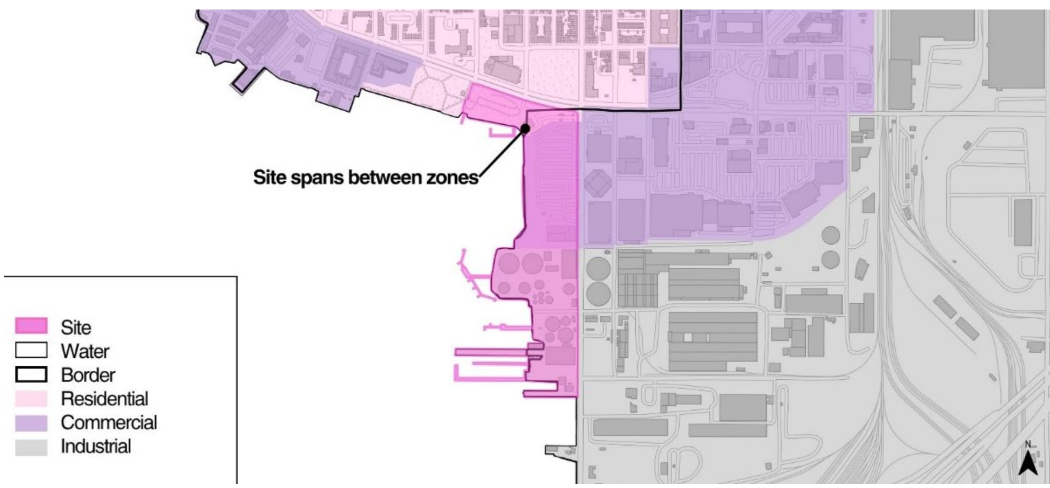


Figure 51. Site's relationship to adjacent zones

Rather than operating as an isolated research campus, the project uses these surrounding neighborhood relationships to explore how energy infrastructure might participate more directly in public education, recreation, and waterfront life within Baltimore's evolving harbor landscape.

Elevation and Topography

The Canton waterfront is defined by low, relatively flat ground shaped by industrial fill and harbor modification. Rather than a natural shoreline with gradual elevation change, the site is organized through constructed surfaces, paved edges, and abrupt transitions between land and water. This limited topographic variation became important to the project because it left few existing buffers between public space, industrial infrastructure, and the harbor itself.

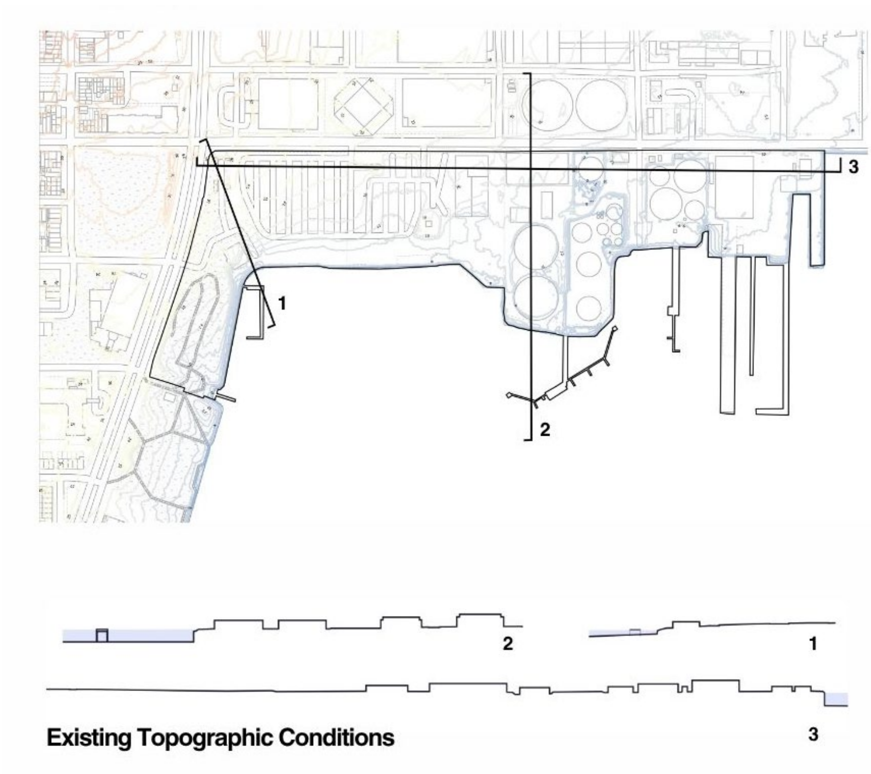


Figure 52. Existing topographic conditions and site sections

Topography therefore became a design constraint rather than a background condition. The project needed to create new sectional relationships across the site: raised circulation where access must remain reliable, lower floodable areas where water can be temporarily held, and transformed ground planes that connect the

Science Center, landscape, and power plant. These elevation changes support the larger thesis by turning the ground itself into part of the public and environmental infrastructure.

Flooding and Sea Level Rise

The site's position along Baltimore's harbor creates exposure to tidal fluctuation, storm surge, sea level rise, and periodic flooding. These risks are not separate from the thesis. They directly shape how a future energy campus can operate on a vulnerable waterfront. A fusion facility requires secure, reliable infrastructure, but the public landscape around it must also respond to changing water conditions over time.

Figure 53. Diagrammatic maps of potential flooded zones

For this reason, the project treats flooding as an organizational force. Floodable landscapes, stormwater retention, planned inundation areas, and shoreline modification allow the site to absorb water while maintaining public access and protecting critical infrastructure. Rather than defending the entire edge as a hard barrier, the proposal uses landscape and topography to create a more adaptive relationship between the harbor, public space, and energy infrastructure.

Synthesis

The selection and analysis of the Canton waterfront reinforced the central thesis argument that fusion infrastructure should not remain isolated from public life, environmental systems, or contemporary city. Existing conditions along the harbor already contain many of the tensions explored throughout the project, including the relationship between industrial infrastructure and civic space, environmental vulnerability and redevelopment, and visible systems that remain publicly inaccessible or poorly understood.

These conditions also connect the project to Baltimore's larger energy burden. The proposal assumes a 400 MW fusion power plant, not as a total solution to the city's energy needs, but as a way to test how compact energy production could operate at an urban scale. When mapped against residential demand, this capacity suggests that fusion infrastructure could have a meaningful local relationship to the communities it serves rather than functioning as distant, anonymous utility infrastructure.

These conditions directly shaped the development of the program and the organizational structure of the campus. The proximity of active infrastructure, residential neighborhoods, public waterfronts, and post-industrial landscapes required the project to negotiate competing demands between openness and security, education and operation, environmental repair and continued industrial use.

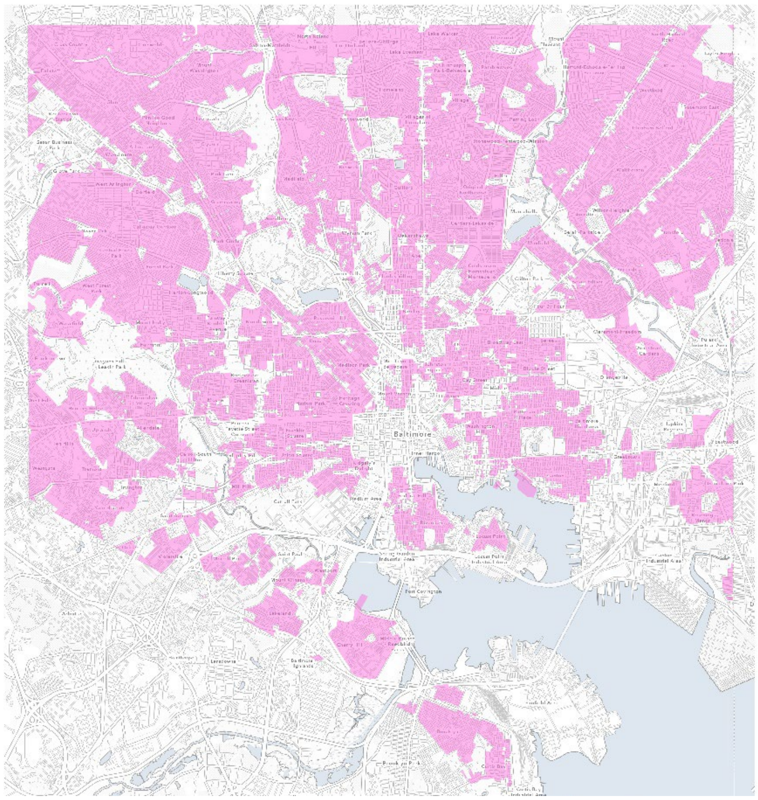


Figure 54. 1 400 MW fusion power plant covers 100% of residential with ~0.30 million MWh/yr left over

Three major tensions emerged repeatedly throughout the site analysis. The first is the relationship between secured technical infrastructure and publicly accessible waterfront space. The second is the contrast between older fossil fuel infrastructure and emerging forms of clean energy production. The third is the condition of underutilized or inaccessible industrial land existing alongside highly active public waterfront districts.

Rather than attempting to eliminate these tensions, the thesis uses them as generative conditions for the project. Together, they establish the conceptual and spatial framework that guides the architectural testing and design development explored in Chapter 7.

Chapter 7: Conceptual Testing of the Thesis

Introduction

This chapter documents the conceptual development of Fusion RE:Action as the project evolved from research, program, and site analysis into architectural form. Rather than emerging through multiple unrelated schemes, the proposal developed continuously as new technical information, site conditions, and organizational priorities reshaped the project over time.

Earlier chapters established visibility, discovery, and education as central thesis objectives alongside questions surrounding public trust, energy infrastructure, and waterfront adaptation. Chapter 7 traces how these ideas began translating into spatial and organizational strategies across the site. In doing so, the project shifted away from a singular building centered entirely around the reactor and toward a distributed campus composed of the Science Center, Landscape, and Fusion Power Plant.

Massing and Spatial Logics

The following sections document the project as an evolving architectural process shaped through conceptual testing, technical feedback, program refinement, and site response. Rather than presenting isolated iterations or formally distinct proposals, the chapter traces how specific pressures and discoveries gradually reshaped the organization of the project over time. Diagrams, massing studies, and conceptual models are used throughout the chapter to illustrate how earlier thesis ideas related to visibility, infrastructure, public access, ecology, and energy transition were translated into spatial relationships across the campus.

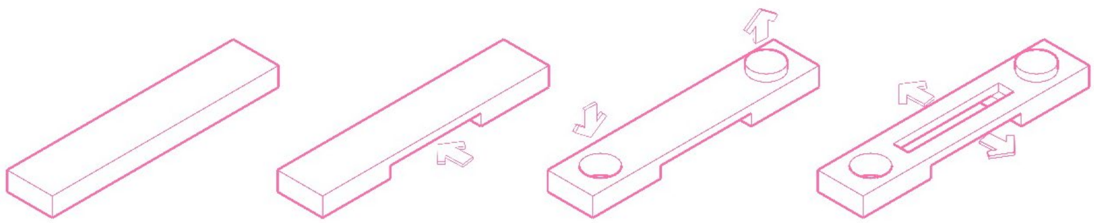


Figure 55. Massing Evolution Diagram

Reactor as Initial Driver

The earliest stages of the project focused almost entirely on the tokamak and fusion power plant as the central architectural problem. Initial studies assumed that the reactor itself could operate as a visible public object around which educational and civic programs could be organized. This produced a singular-building logic in which public exhibitions, gathering spaces, circulation systems, and observation areas clustered closely around the reactor core.

This approach emerged directly from earlier thesis arguments surrounding energy visibility and public perception discussed in Chapters 2 and 4. If fusion was to become publicly understood as a civic and environmental technology rather than hidden industrial infrastructure, the architecture initially attempted to place energy production and public life in proximity.

Fusion's compactness and energy density also influenced these early studies. Unlike conventional power plants that often require significant territorial separation, fusion suggested the possibility of integrating large-scale energy infrastructure directly within the city. This reinforced the thesis interest in positioning energy production within everyday urban experience rather than isolating it from public life.

At this stage, the reactor operated as both the symbolic and organizational center of the project, shaping circulation, visibility, and program relationships across the site.

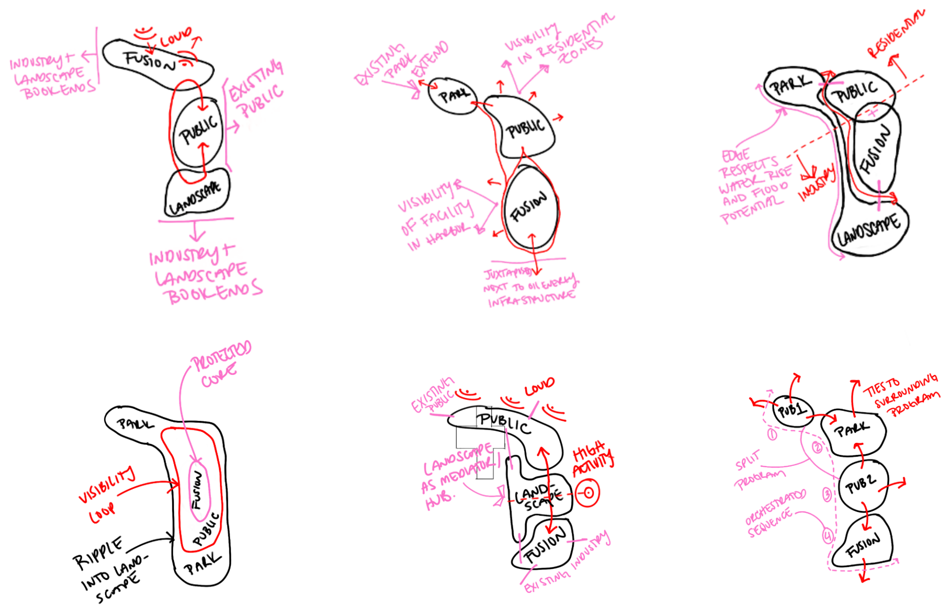


Figure 56. Early program organization diagrams

Technical Reality and Program Separation

As the project developed, discussions with fusion researchers Ian Abel and Christopher Wilson introduced operational realities that challenged many of the project's early assumptions. Shielding requirements, maintenance access, servicing operations, and restricted technical zones made it increasingly clear that the tokamak could not realistically function as a continuously exposed public object.

This became a major turning point in the development of the thesis. Earlier conceptual studies depended heavily on direct public visibility into the reactor itself, but the technical realities of fusion infrastructure required a different architectural approach. Rather than organizing the project around direct exposure, the architecture shifted toward questions of legibility, framing, and controlled visibility.

As a result, the singular-building organization gradually separated into two distinct but related systems: the Science Center and the Fusion Power Plant. This shift allowed the public and operational programs to develop according to their own spatial and technical requirements while remaining visually and conceptually connected across the site.

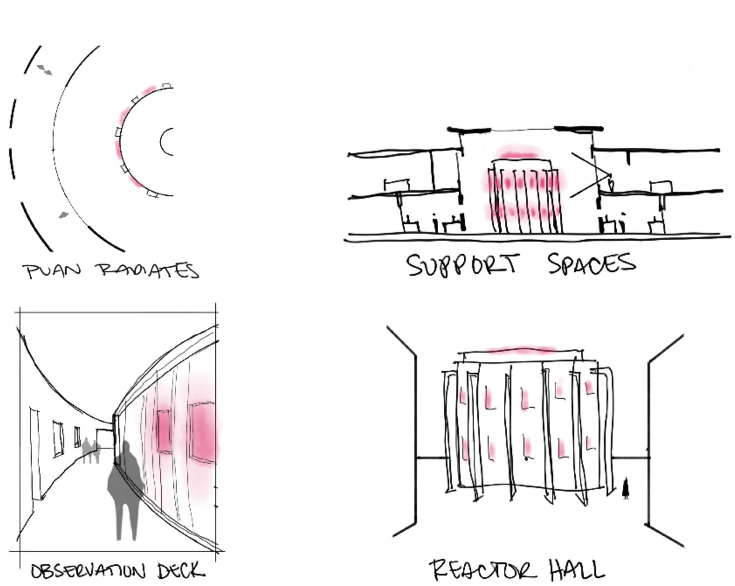


Figure 57. Early vignettes illustrating reactor visibility

This transition also clarified architecture's role within the thesis. Public understanding no longer depends on unrestricted access to the reactor itself. Instead, the project focused on how orientation, proximity, circulation, and framing could communicate the presence of fusion infrastructure without compromising operational requirements. The architecture therefore shifted from exposing the reactor to constructing relationships between the public and systems that largely remain inaccessible.

Landscape as Organizational Field

As the project moved away from a singular-building strategy, the landscape became increasingly important to the organization of the campus. Rather than operating as residual open space, the landscape evolved into the primary connective system between the Science Center and Fusion Power Plant.

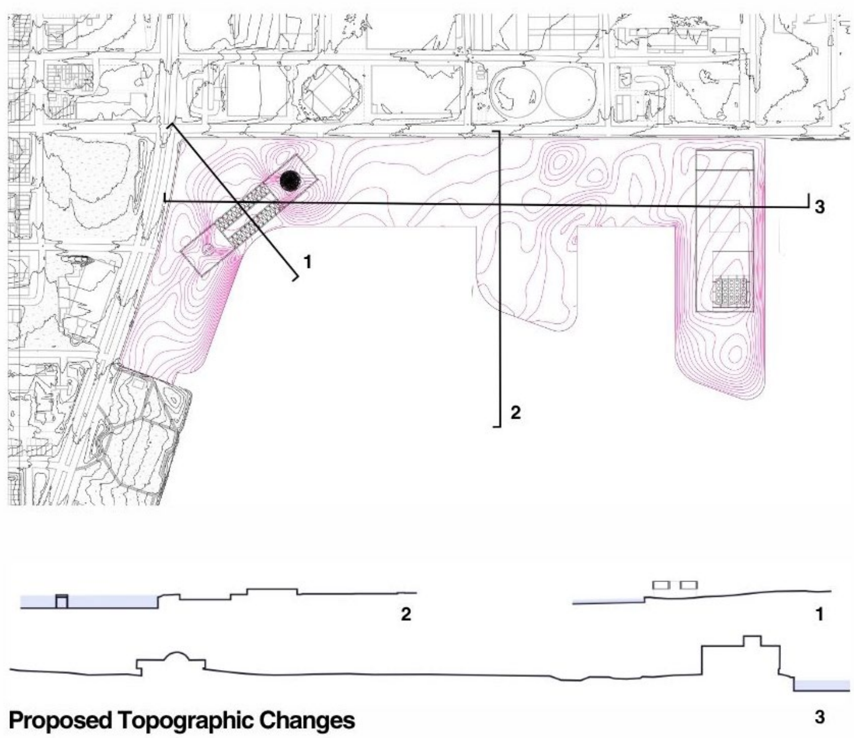


Figure 58. Proposed topographic conditions and site sections

This shift was reinforced through collaboration and discussion with landscape architect Michael Ezban, whose perspective emphasized the potential for the landscape to operate simultaneously as public space, environmental infrastructure, and organizational framework. Existing harbor conditions including flood risk, fragmented shoreline ecology, and industrial remnants further strengthened the role of the landscape throughout the project.

The landscape also became a medium through which concepts explored in earlier research and precedent studies could be translated spatially across the site. Ideas related to flow, attraction, threshold, and field behavior informed circulation systems, planting strategies, topographic manipulation, and public gathering spaces without relying on literal representation.

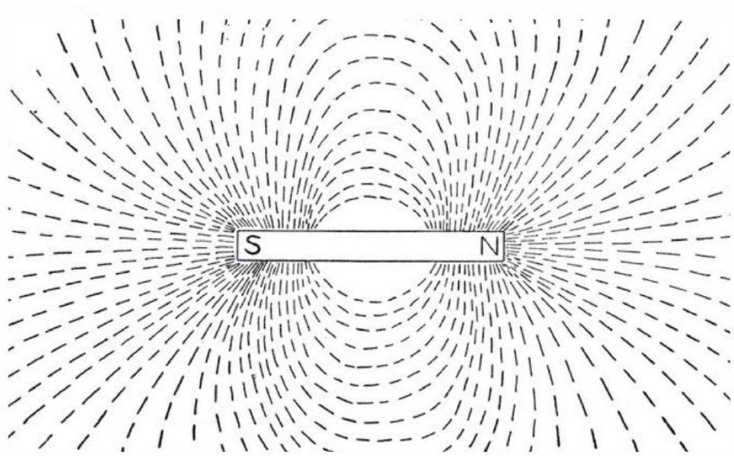


Figure 59. Magnetic field diagram inspired topographic changes

As a result, ecological performance, public occupation, and conceptual organization became increasingly intertwined. Flood mitigation systems, wetlands, circulation paths, stormwater infrastructure, and gathering spaces began operating as overlapping systems rather than isolated site elements. The landscape ultimately became the field within which the public and technical components of the project could coexist while maintaining distinct operational identities.

Harbor Transformation and Site Organization

The development of the project required substantial modification of the harbor edge to accommodate the scale of the Fusion Power Plant while preserving public waterfront access. Rather than treating the power plant as a hidden back-of-house condition, the project extended the existing rectilinear logic of Baltimore's industrial shoreline outward into the harbor itself.

This move positioned the power plant directly within the visual field of the waterfront rather than behind it. The plant became visible from the harbor, surrounding neighborhoods, the landscape, and the Science Center, reinforcing earlier thesis arguments surrounding the visibility of energy infrastructure within civic life.

Figure 60. Harbor reconfiguration maps

At the same time, the Science Center rotated away from the strict alignment of the power plant, creating a spatial divergence between public and operational systems across the site. The bridge became the primary organizational threshold linking these conditions together. More than circulation infrastructure, it functioned as an armature that framed views toward the power plant while controlling movement between public and secured areas.

Earlier separatrix and axial concepts also continued to influence the project during this stage of development. While these ideas became less formally literal over time, they persisted as organizational strategies related to threshold, crossing, and spatial transition across the campus.

Infrastructure, Structure, and Legibility

As the project developed, infrastructural and structural requirements increasingly shaped the organization of the architecture. Large-span conditions associated with the reactor hall, maintenance systems, and operational infrastructure reinforced the industrial scale of the Fusion Power Plant and distinguished it from the lighter public character of the Science Center and bridge systems.

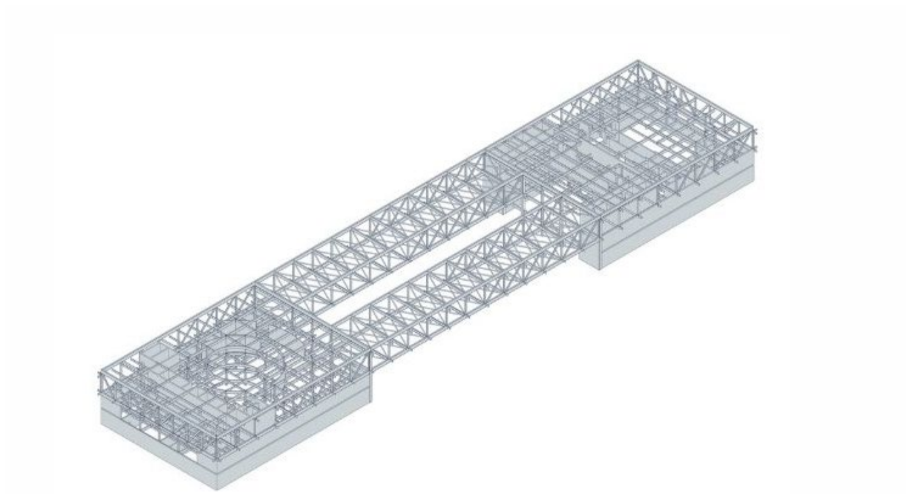


Figure 61. Science center steel truss and concrete structure

Rather than concealing these infrastructural requirements, the project embraced clarity and legibility as organizational principles. Structural systems, circulation armatures, and operational separation remained visible within the architecture, reinforcing the thesis interest in making energy infrastructure more publicly understandable without compromising technical performance or security requirements.

Industrial Memory and Energy Transition

The existing oil tanks along the harbor initially emerged as important visual remnants of Baltimore's industrial waterfront. Over time, however, they became increasingly integrated into the organizational and environmental logic of the project itself.

Rather than removing the tanks, the project repurposed them as components of the larger landscape system supporting stormwater retention, ecological restoration, biodiversity, and public occupation across the site. Through this transformation,

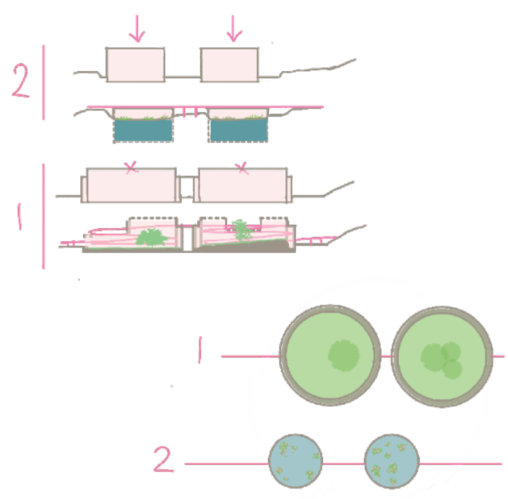


Figure 62. Process diagrams of oil tank adaptation

former fossil fuel infrastructure became part of the environmental and public systems supporting the fusion campus.

This relationship reinforced the broader thesis interest in energy transition and infrastructural continuity. Fusion RE:Action positions fusion within a waterfront already shaped by extraction, storage, shipping, and industrial energy systems rather than presenting it as an isolated technological object disconnected from the city's industrial history.

Emerging Architectural Direction

Through this process, the project evolved from a singular reactor-centered building into a distributed campus composed of interconnected public, ecological, and technical systems. The Science Center, Landscape, and Fusion Power Plant emerged as distinct but interdependent components operating together across the waterfront.

This organizational shift allowed the project to address many of the tensions identified throughout earlier chapters, including relationships between public access and secured infrastructure, industrial history and environmental adaptation, and visibility and restriction. Rather than relying on direct exposure to the reactor itself, the project increasingly focused on controlled visibility, framing, proximity, and gradual discovery as organizational principles.

Together, these conceptual developments established the framework for the final architectural proposal presented in Chapter 8.

Chapter 8: Design Synthesis

Introduction

Fusion RE:Action proposes a fusion research and demonstration campus on Baltimore’s harbor edge where public education, environmental infrastructure, and energy production operate as one civic system. The project brings fusion into an urban waterfront setting without treating it as fully open or unrestricted. Instead, it uses controlled visibility, gradual discovery, and public programming to make fusion legible while maintaining the operational separation required by the power plant.

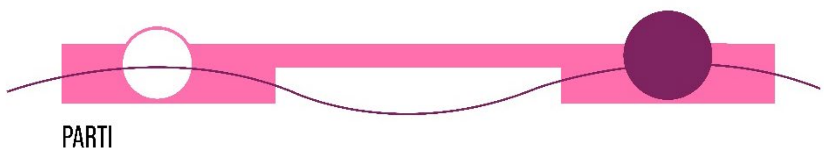


Figure 63. Science center parti

The final proposal is organized through three interconnected systems: the Science Center, the Landscape, and the Fusion Power Plant. The Science Center serves as the public educational interface, the Landscape connects ecological repair with public waterfront use, and the Fusion Power Plant operates as the technical core of the campus. Together, these systems test how architecture can mediate between advanced energy infrastructure and everyday civic life.

Master Plan and Site Strategy

The campus occupies approximately twenty-five acres along the Canton waterfront. Rather than consolidating the program into one building, the proposal distributes it across the site according to public, ecological, and operational needs.

The Science Center is positioned as the primary point of arrival and public orientation. It connects visitors to exhibitions, educational programs, gathering spaces, and views toward the larger campus. The Fusion Power Plant extends into the harbor along a modified industrial shoreline, allowing the plant to remain visible from

Figure 64. Site master plan

the harbor, landscape, Science Center, and surrounding waterfront. Between them, the landscape acts as connective infrastructure, organizing circulation, stormwater, flood adaptation, ecological restoration, and public space.

The harbor edge is reshaped to accommodate the scale of the power plant while maintaining public access across the waterfront. Wetlands, retention basins, planted terraces, promenades, and floodable landscapes allow the site to respond to water risk while supporting public occupation and biodiversity.

Science Center

The Science Center contains approximately 144,000 square feet of usable interior space within a 67,200 square foot footprint. It includes exhibitions, classrooms, workshops, gathering spaces, a café, an auditorium, and a 250-seat dome theater. These programs introduce visitors to fusion science, plasma physics, magnetic confinement, energy systems, and the larger environmental and industrial histories connected to Baltimore's waterfront.

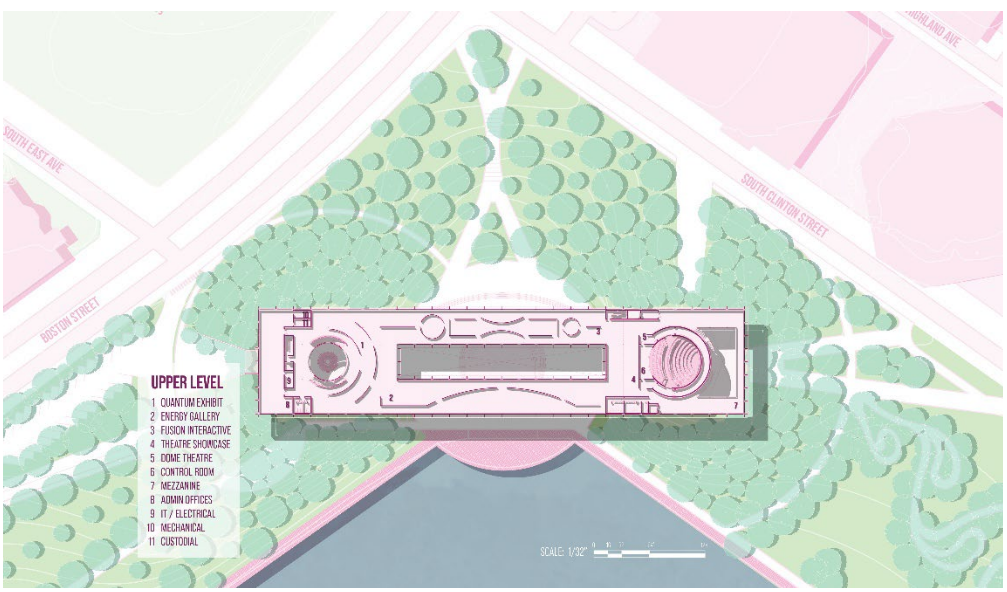


Figure 65. Upper-level floor plan

The dome theater supports immersive science programming, public lectures, and fusion-related screenings. Classrooms and workshops support school visits, hands-on learning, research demonstrations, and partnerships with educational institutions. Together, these programs make the Science Center both an educational building and a civic destination.

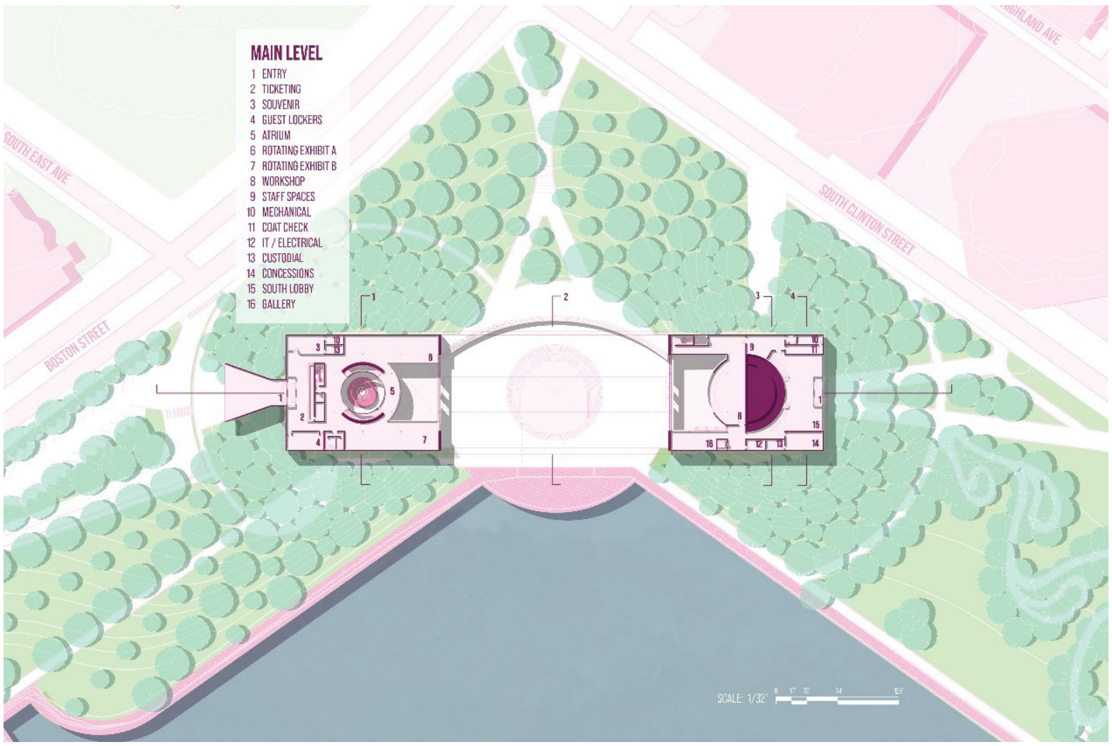


Figure 66. Science center entry level plan

The Science Center is organized around a central atrium that connects major public programs across multiple levels. Circulation moves through loops, bridges, overlooks, galleries, and gathering spaces rather than a single linear route. This organization allows visitors to move gradually between introductory exhibits, immersive spaces, and views toward the landscape and Fusion Power Plant.

The Science Center uses light, transparency, exposed structure, and framed views to interpret fusion through space rather than signage alone. Glazing, translucent enclosure systems, and layered circulation create changing relationships between the interior, harbor, landscape, and power plant. Scientific ideas are communicated through movement, proximity, scale, and visual relationships, allowing visitors to understand fusion as part of a larger civic and environmental system.

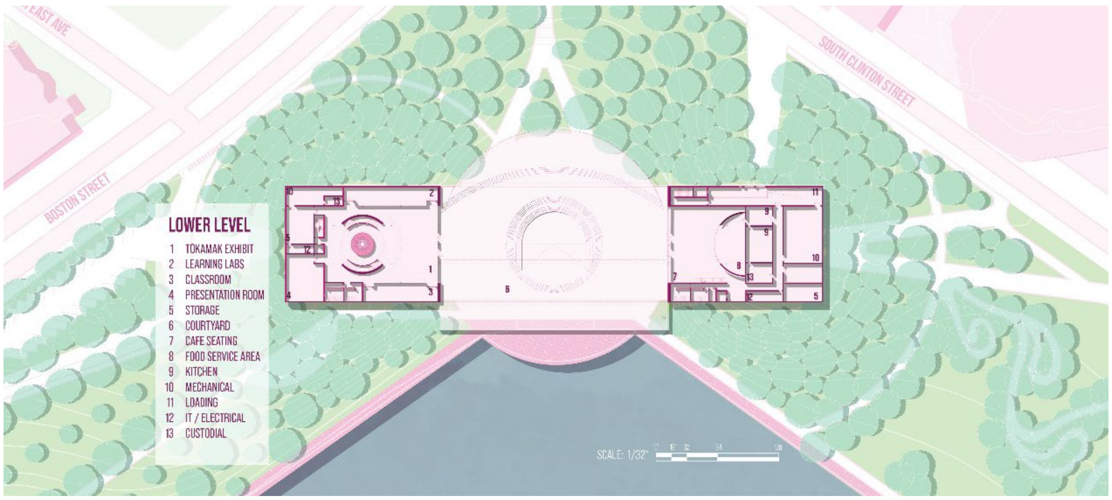


Figure 67. Science center ground level plan

Landscape

The landscape operates as both public waterfront and environmental infrastructure. Wetlands, retention zones, planted berms, floodable ground, and restored shoreline areas support stormwater management, flood adaptation, biodiversity, and ecological repair. Rather than treating landscape as leftover open space, the project uses it as the connective field between the Science Center and Fusion Power Plant.

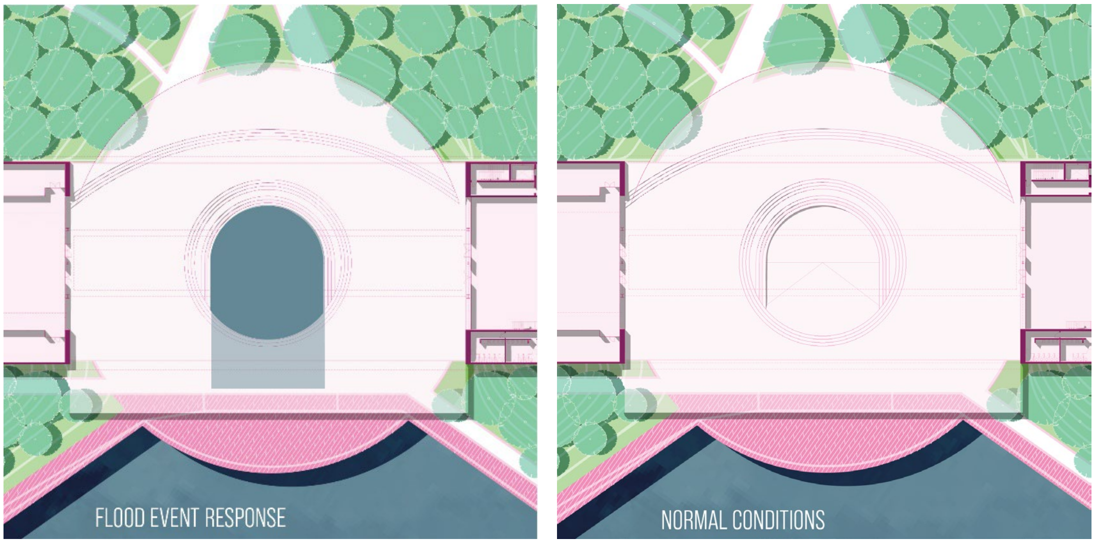


Figure 68. Stormwater retention multipurpose courtyard

Promenades, overlooks, gathering areas, outdoor classrooms, and waterfront paths allow visitors to move through the site while maintaining views toward the harbor and power plant. The thermal park creates a major public gathering area that links recreation, environmental systems, and energy interpretation.

The existing oil tanks are preserved and repurposed as part of the landscape system. Some operate as stormwater retention basins, while others become

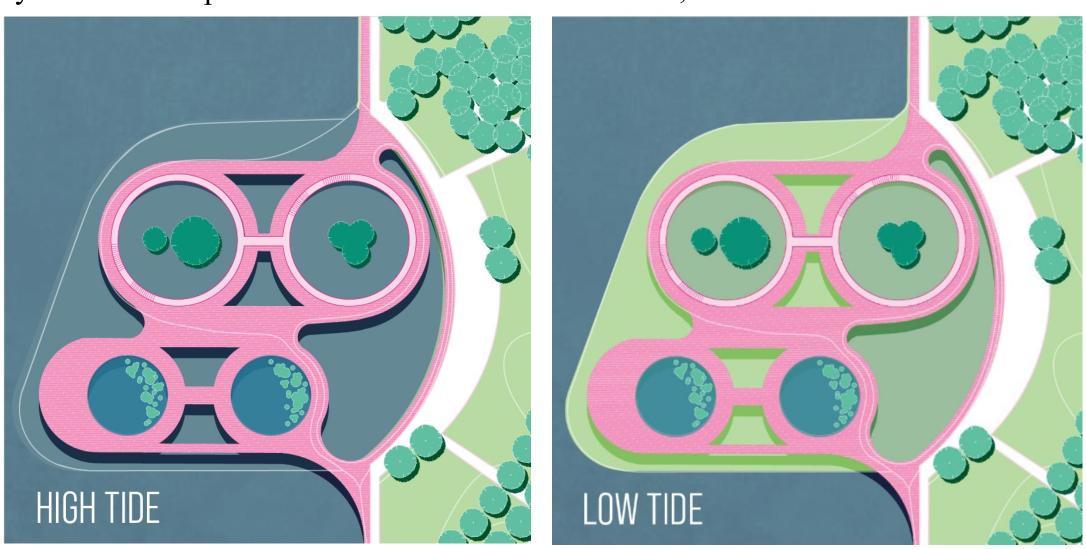


Figure 69. Repurposed oil tanks as flood zones and biodiversity tanks

biodiversity zones, gathering areas, or ecological landscapes. This transformation keeps the site's industrial memory visible while shifting former fossil fuel infrastructure toward public and environmental use.

Fusion Power Plant

The Fusion Power Plant is the operational core of the campus. It is organized as a long linear structure extending into the harbor and contains the tokamak hall, cooling systems, cryogenics, energy conversion systems, maintenance areas, control rooms, service circulation, and secured operational spaces.

The tokamak hall occupies the protected center of the building. Surrounding technical spaces support reactor operation, equipment servicing, cooling, monitoring, and long-term maintenance. The building prioritizes clear separation between public, guided, service, and restricted zones.

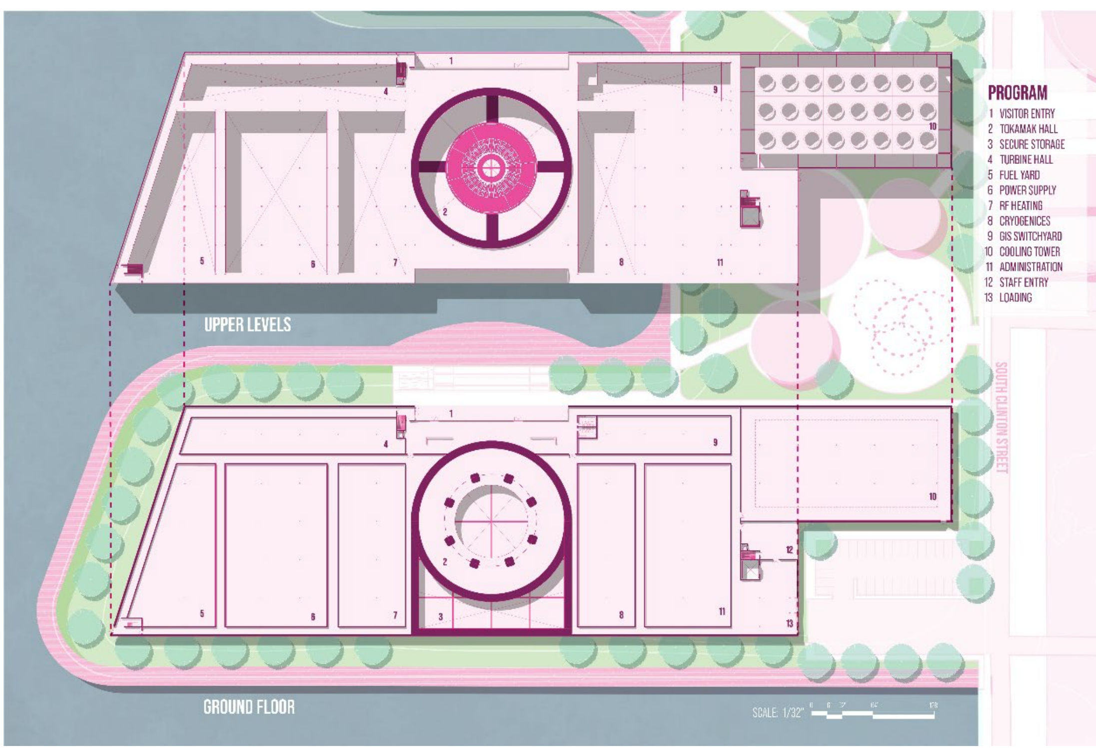


Figure 70. Power plant floor plans

The organization of the building prioritizes clarity, circulation separation, servicing access, and infrastructural efficiency while maintaining visual legibility throughout the visitor-accessible portions of the facility.

Although the reactor itself remains inaccessible, visitors can enter controlled portions of the power plant through guided tours. A secured public lobby connects to the landscape and leads visitors through designated paths overlooking visible infrastructure. Cooling systems, structural systems, circulation networks, and portions of the energy conversion systems remain visible, while the tokamak hall, hot cell, operations spaces, and lower service levels remain restricted.

This organization allows the public to experience the scale and complexity of fusion infrastructure without compromising safety or operation. The plant remains visible across the campus through bridges, courtyards, landscape paths, and framed views from the Science Center.

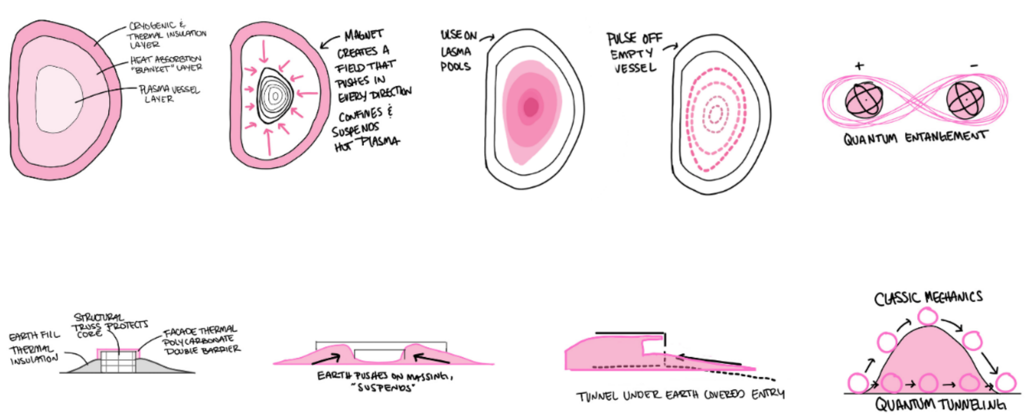


Figure 71. Spatial interpretation diagrams of fusion concepts

The power plant's scale reflects the demands of fusion energy production. Long-span structural systems support the reactor hall, maintenance zones, and technical systems. Industrial circulation, service routes, overhead infrastructure, and maintenance paths remain legible rather than hidden, allowing the building to communicate its operation through structure, scale, and organization.

Structure, Material, and Tectonics

The project uses distinct structural and material systems to clarify the relationship between public space, landscape, and energy infrastructure. The Science Center uses a lighter steel frame, glazed surfaces, and translucent enclosure systems to support openness and public visibility. The Fusion Power Plant uses a heavier industrial language tied to containment, servicing, and operational infrastructure.

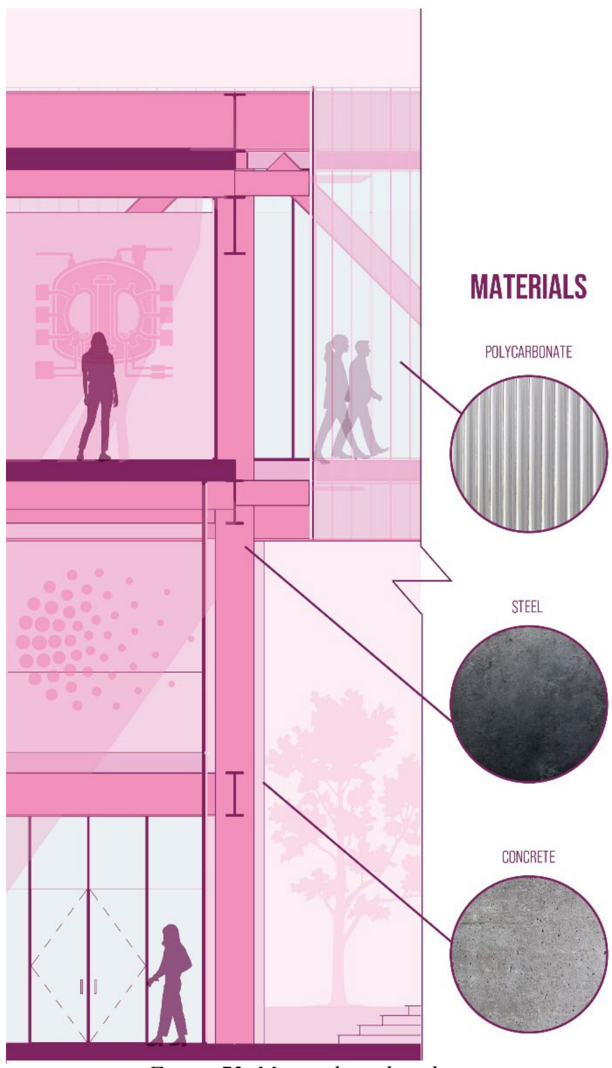


Figure 72. Materials and enclosure

The bridge acts as a major structural and experiential threshold. Its exposed truss system supports the span between the Science Center and the landscape while framing views toward the power plant. Across the campus, polycarbonate screens, glazing, exposed steel, concrete, weathering steel, planted surfaces, and floodable ground create a material language tied to both working waterfront infrastructure and public civic space.

Sectional Relationships

Sectional relationships clarify how the campus connects ground, water, circulation, structure, and infrastructure. The project does not operate as separate buildings placed on a flat site, but as a layered sequence of public spaces, floodable landscapes, bridges, and secured technical zones.

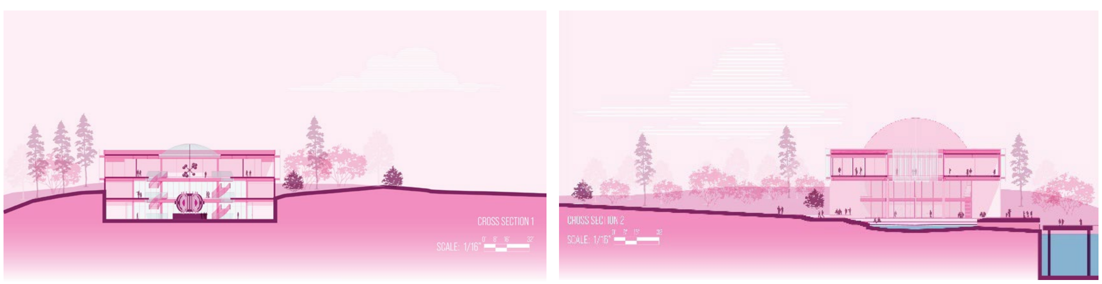


Figure 73. Cross sections through science center

In the Science Center, the atrium, galleries, bridges, and lower exhibition levels create vertical relationships between public programs and views toward the harbor, landscape, and Fusion Power Plant. The courtyard basin extends this sectional logic into the landscape by operating as both outdoor gathering space and stormwater infrastructure.

The bridge creates the clearest sectional threshold in the project. It suspends visitors between the Science Center and the infrastructural landscape while framing the power plant ahead. In the Fusion Power Plant, public circulation remains separated from secured operational zones while still allowing controlled views toward major systems. Together, these sectional relationships support the thesis by making technical, ecological, and public systems visible without collapsing them into one unrestricted space.

Figure 74. Cross sections through science center

Visitor Experience

The visitor sequence begins at the Science Center entry level, where ticketing, lockers, and support spaces are organized around the lobby. Entry is compressed within the ground, referencing quantum tunneling, before opening into the main atrium. From this point, the building expands vertically and visually, revealing the volume below and establishing the atrium as the primary orientation space. A double spiral stair sits at the center, connecting levels and organizing movement through the building.

Figure 75. Site section through science center

Around the atrium, rotating exhibits are arranged as mezzanines overlooking the space below. These introductory exhibits establish the basic concepts of fusion before visitors descend toward the main tokamak exhibit. The tokamak exhibit anchors the main hall as a double-height space organized around a scale model for hands-on learning. Classrooms, labs, and presentation spaces surround it, reinforcing the exhibit as the educational center of the Science Center. Above, a suspended fusion diagram occupies the upper volume, making the fusion process legible in space.

Figure 76. Exhibit space on upper level

The dome theater and its lobby form a second major public sequence within the building. The lobby includes information, coat check, concessions, and lounge seating, and can expand during larger events. In section, the dome emerges into the lobby volume, with skylights casting light across its surface. Stairs rise along both sides of the dome, leading to the theater entry, mezzanine galleries, and upper exhibit spaces. The dome theater seats up to 250 people and supports immersive fusion screenings, public lectures, and science programming.

The visitor route then opens into the courtyard, where the educational program extends outside. Under normal conditions, the courtyard functions as an outdoor classroom and gathering space, connecting visitors to the landscape and harbor. During major storm events, it becomes part of the water retention system, temporarily holding and managing floodwater. The café is positioned along the courtyard edge, with seating oriented toward the space. The dome intersects this area, with food service located at its base and support spaces behind it. Above, a workshop occupies the upper level of the dome, allowing visitors to see fabrication and exhibit repair from below.

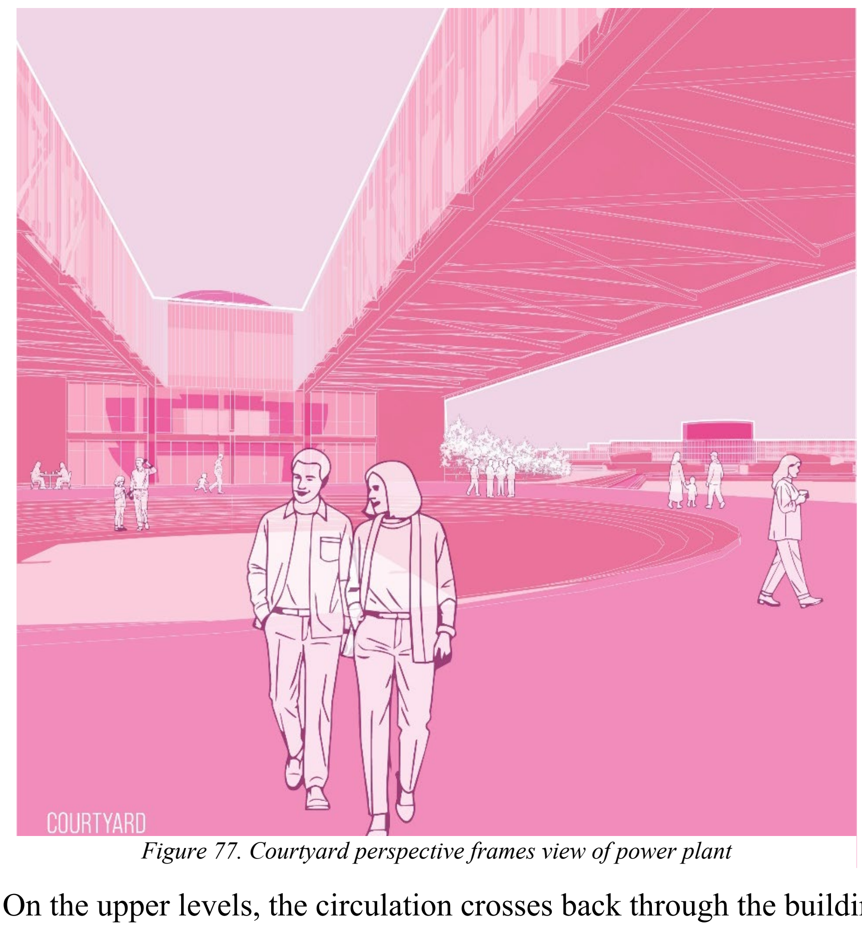


Figure 77. Courtyard perspective frames view of power plant

On the upper levels, the circulation crosses back through the building along the main bridge. Larger exhibits focus on atomic processes, quantum mechanics, and the fundamentals of fusion, moving from physical models toward more abstract scientific concepts. The split into two bars creates a looped circulation path that slows movement and encourages visitors to move intentionally through the galleries. These elevated paths frame exhibits, views into the dome lobby, and views outward toward the energy infrastructure beyond.

The sequence then extends into the landscape. A primary axial path cuts through the site as an extension of the separatrix, organizing movement between program zones and connecting the city to the harbor edge. Former oil tanks are repurposed as ecological and public landscapes, supporting gathering, retention, biodiversity, and education. The thermal park uses heat, water, and landscape as an experiential public environment tied to the project's energy systems, while the tokamak pavilion operates as an overlook and educational destination embedded within the waterfront landscape.

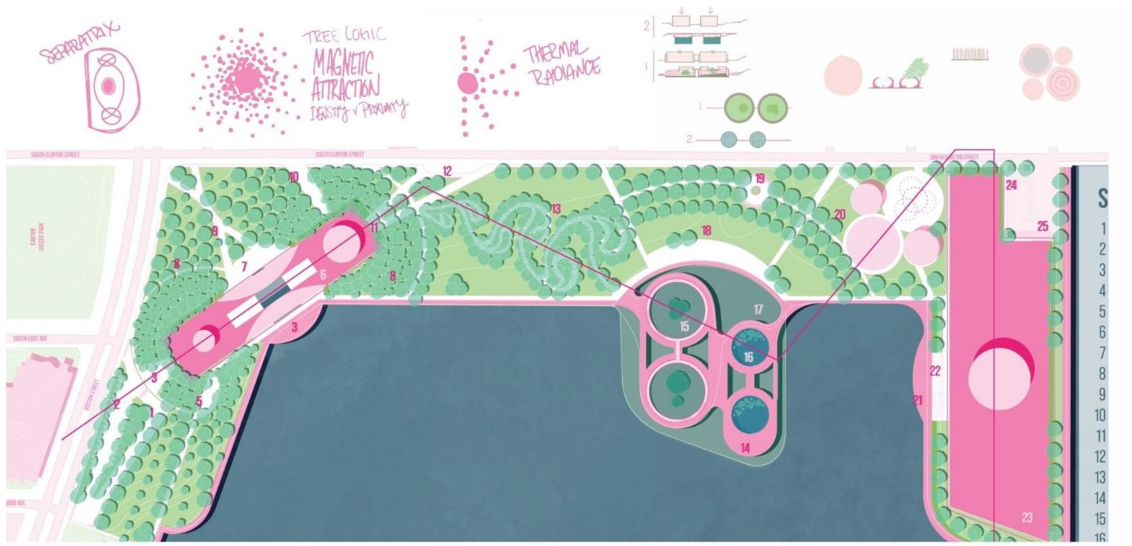


Figure 78. Landscape details

The boardwalk becomes the major connection between the public Science Center, landscape, and the Fusion Power Plant. As visitors move across it, the power plant is framed directly ahead, shifting the experience from scientific interpretation toward infrastructural encounters. This lowered crossing makes the relationship between public circulation, landscape systems, and secured technical infrastructure physically legible.

Guided tours continue into the Fusion Power Plant through a secured lobby and controlled circulation path. The plant is organized around the tokamak hall, with support systems for cooling, fuel handling, power distribution, cryogenics, maintenance, and secure service spaces arranged around it. Public circulation remains separated from industrial operations, allowing visitors to observe the facility without entering restricted areas. At the end of the sequence, the power plant becomes both the technical and symbolic heart of the project: a source of energy, education, and civic infrastructure for Baltimore.

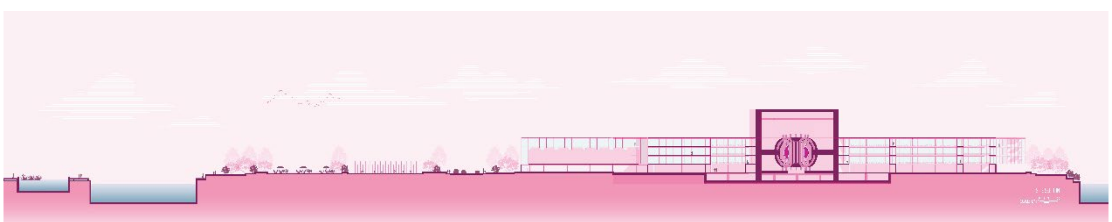


Figure 79. Site section through power plant building

Conclusion

Fusion RE:Action proposes a new relationship between energy infrastructure, public life, and the city. By combining a Science Center, adaptive harbor landscape, and Fusion Power Plant, the project tests how fusion can become visible, educational, and civic without sacrificing operational control.

The thesis positions fusion not only as a technical energy problem, but as an architectural and cultural one. Through controlled visibility, public programming, ecological adaptation, and spatial sequence, Fusion RE:Action offers a prototype for future urban energy campuses where energy production, public space, and environmental infrastructure operate as interconnected civic systems.

Figure 80. Aerial rendering of final project site and buildings

Glossary

Activation

The process by which materials exposed to neutron radiation become radioactive over time.

ARC

(Affordable Robust Compact) A commercial fusion power plant planned by Commonwealth Fusion Systems. In this thesis, ARC represents fusion's shift from research infrastructure toward grid-scale utility infrastructure.

Atomic Energy

Energy released through reactions involving the nucleus of an atom, including both nuclear fission and nuclear fusion.

Auxiliary Systems

Supporting infrastructural systems required for reactor operation, including cooling, cryogenics, diagnostics, and power conversion.

Bio Shield

A thick protective enclosure surrounding portions of a nuclear reactor designed to reduce radiation exposure.

Black Box

A system or technology whose internal processes remain hidden or inaccessible to public understanding.

Blanket

A layer surrounding the plasma chamber within a fusion reactor that absorbs neutrons, captures heat, and may breed tritium fuel.

Bulkhead

A retaining wall or edge condition used to stabilize waterfronts and industrial shorelines.

Calibrated Visibility

A controlled relationship between public access and infrastructural exposure in which systems remain visible without unrestricted access.

Carbon Emissions

Greenhouse gases released into the atmosphere through industrial processes and energy production, primarily carbon dioxide.

Catastrophic Failure

A sudden and uncontrolled system breakdown resulting in large-scale damage or danger.

Chain Reaction

A self-sustaining nuclear reaction in which released particles trigger additional reactions, commonly associated with nuclear fission.

Civic Infrastructure

Infrastructure that simultaneously supports technical performance and public or social functions within the city.

Climate Mitigation

Strategies intended to reduce the severity or long-term impacts of climate change.

Confinement

The containment and control of plasma using magnetic fields in order to sustain fusion reactions.

Containment

Protective systems and spatial separations used to isolate hazardous materials, radiation, or reactor operations from occupied environments.

Controlled Access

Restricted circulation systems regulating movement into secured or operational environments.

Cryogenic Cooling

Extremely low-temperature cooling systems used to maintain superconducting reactor components.

Cryogenics

Systems and technologies used to produce and maintain extremely low temperatures, often required for superconducting magnets in fusion reactors.

Deuterium

A hydrogen isotope commonly used as fusion fuel. Deuterium contains one proton and one neutron.

Diagnostics

Systems and instruments used to monitor, measure, and analyze reactor and plasma performance.

Divertor

A reactor component that removes excess heat and waste particles from plasma within a tokamak.

Electrification

The replacement of fossil fuel-dependent systems with electrically powered alternatives such as electric vehicles, heat pumps, and electric infrastructure.

Electromagnetic Field

A physical field produced by electrically charged particles and magnetic forces.

Energy Conversion

The process of transforming thermal or mechanical energy into usable electricity.

Energy Density

The amount of energy stored or produced relative to mass or volume. Fusion possesses significantly higher energy density than fossil fuels or fission.

Energy Grid

The interconnected network responsible for transmitting and distributing electricity from power generation facilities to users.

Environmental Justice

The equitable distribution of environmental benefits and burdens across communities, particularly regarding pollution, infrastructure, and public health impacts.

Environmental Psychology

The study of how physical environments influence human behavior, perception, and emotional response.

Fission

A nuclear reaction in which a heavy atomic nucleus splits into smaller nuclei, releasing energy and radioactive byproducts.

Fissile Material

Material capable of sustaining a nuclear fission chain reaction.

Flood Mitigation

Design strategies intended to reduce the impacts of flooding through retention, absorption, grading, and adaptive infrastructure.

Fuel Cycle

The complete process of producing, using, recovering, and managing nuclear fuel materials.

Fusion

A nuclear reaction in which light atomic nuclei combine to form heavier nuclei, releasing large amounts of energy.

Fusion Campus

Within this thesis, a spatial framework integrating fusion infrastructure, public education, landscape systems, and civic space into a unified urban environment.

Fusion Energy

Energy generated through nuclear fusion reactions, typically involving hydrogen isotopes such as deuterium and tritium.

GIS Substation

Gas-insulated switchgear electrical infrastructure used for compact, high-voltage power transmission and grid connection.

Gradient of Access

A sequence of spatial conditions ranging from fully public to fully secured environments.

Grid Connection

The physical and electrical relationship between a power generation facility and the regional electrical grid.

Harbor Edge

The transitional boundary between land and water along the waterfront, shaped by ecological, industrial, and infrastructural systems.

Hot Cell

A shielded and remotely operated maintenance space used for handling radioactive or activated materials.

Hydrogen Isotope

Variations of hydrogen atoms containing different numbers of neutrons, including protium, deuterium, and tritium.

Industrial Memory

The retention and reinterpretation of existing industrial infrastructure and histories within contemporary architectural and landscape interventions.

Industrial Waterfront

A harbor or shoreline condition shaped primarily by shipping, manufacturing, storage, logistics, and utility infrastructure.

Infrastructure

The physical systems and networks that support societal functions such as transportation, energy production, water management, and communication.

Infrastructure Legibility

The ability of infrastructural systems to be visually and spatially understood by the public.

Intermittency

The inconsistency of energy production associated with renewable systems such as wind and solar power.

ITER

The International Thermonuclear Experimental Reactor, a large-scale international fusion research project located in southern France.

JT-60SA

An experimental tokamak reactor in Japan developed collaboratively by Japan and the European Union to support fusion research.

Legibility

The ability of architecture and infrastructure to communicate their organization, purpose, and operation to occupants and visitors.

Magnetic Coil

An electrically charged coil used to generate magnetic fields for plasma confinement within a tokamak.

Magnetic Confinement

The use of magnetic fields to contain plasma within a controlled fusion reactor environment.

Maintenance Logistics

The spatial organization and circulation systems required for servicing, repairing, replacing, and operating technical infrastructure.

Mega-Project

A large-scale infrastructural or architectural development involving substantial technical, financial, and organizational complexity.

Neutron

An electrically neutral particle located within the nucleus of an atom.

Neutron Activation

The process through which materials absorb neutrons and become radioactive.

Nuclear Culture

The social, political, and cultural perceptions surrounding nuclear technologies and infrastructure.

Nuclear Energy

Energy produced through reactions involving atomic nuclei, including both fission and fusion processes.

Operational Core

The secured technical and infrastructural systems necessary for fusion energy production and plant operation.

Operational Separation

The physical distinction between public circulation and secured technical systems within infrastructure projects.

Perception

The way individuals interpret and emotionally respond to environments, systems, or technologies.

Plasma

A high-energy state of matter consisting of charged particles capable of sustaining fusion reactions.

Plasma Physics

The scientific study of plasma behavior, electromagnetic interactions, and high-energy particle systems.

Polycarbonate

A lightweight translucent material used in the project's enclosure systems to filter light and soften infrastructural scale.

Power Conversion

The transformation of thermal reactor energy into usable electrical energy.

Power Plant

An industrial facility that generates electrical energy through mechanical, thermal, or nuclear processes.

Primary Containment

The innermost protected enclosure surrounding a reactor or hazardous operational system.

Public Interface

Architectural and spatial systems that mediate relationships between visitors and secured technical infrastructure.

Public Trust

Public confidence in the safety, transparency, and reliability of institutions or infrastructure.

Quantum

A term describing the behavior of matter and energy at atomic and subatomic scales. Within this thesis, quantum ideas inform some spatial and conceptual references, including tunneling, entanglement, and uncertainty.

Radiation

The emission and transmission of energy through particles or electromagnetic waves.

Reactor Core

The central operational area of a reactor where nuclear reactions occur.

Remote Handling

The use of robotic or indirect systems to manipulate radioactive or hazardous materials from protected environments.

Renewable Energy

Energy derived from naturally replenishing resources such as solar, wind, hydroelectric, and geothermal systems.

Resilience

The capacity of environmental, infrastructural, or urban systems to adapt to disruption and recover from environmental stress.

Runoff

Water from precipitation or flooding that flows across surfaces toward drainage or retention systems.

Science Center

The primary public educational building within Fusion RE:Action containing exhibitions, classrooms, theaters, workshops, gathering spaces, and interpretive programs related to fusion energy and environmental systems.

Separatrix

In plasma physics, the boundary separating confined plasma from surrounding magnetic conditions. Within the thesis, the term also informs organizational and circulation logic across the site.

Shielding

Protective systems designed to reduce exposure to radiation and high-energy particles generated during fusion reactions.

Social Acceptance

Public willingness to support, occupy, or coexist with infrastructure and technological systems.

Social License

Informal public approval or legitimacy granted to institutions, infrastructure, or development projects.

SPARC

A compact experimental tokamak developed by Commonwealth Fusion Systems in Devens, Massachusetts. In this thesis, SPARC serves as a technical precedent for understanding fusion infrastructure, compactness, operational control, and limited public access.

Spatial Armature

An organizing circulation or structural framework that coordinates movement and relationships across a project.

Spatial Legibility

The clarity through which users can understand organization, circulation, and relationships within architecture.

Stormwater Retention

Landscape systems designed to collect, slow, and manage runoff during rainfall and flood events.

Superconducting Magnet

A magnet capable of conducting electricity without resistance at extremely low temperatures, commonly used in tokamak reactors.

Superconductivity

A condition in which electrical resistance disappears within certain materials at extremely low temperatures.

Technical Core

The secured operational center containing primary infrastructural and reactor systems.

Thermal Gradient

The rate of temperature change across a space, material, or environmental condition.

Thermal Insulation

Materials or systems used to reduce heat transfer between environments.

Thermal Park

A public landscape zone within the project integrating recreation, environmental systems, and energy-related interpretation.

Threshold

A spatial or experiential transition between distinct architectural, environmental, or operational conditions.

Threshold Condition

A transitional spatial moment between different environmental, programmatic, or operational zones.

Tokamak

A toroidal fusion reactor that uses magnetic fields to confine plasma for sustained fusion reactions.

Toroidal

A donut-shaped geometric condition associated with tokamak reactor geometry.

Transparency

Within the thesis, both physical visibility and institutional openness associated with public understanding of infrastructure.

Tritium

A radioactive hydrogen isotope used alongside deuterium as fusion fuel.

Urban Energy Landscape

A built and environmental condition in which energy infrastructure, public space, ecological systems, and urban development operate together.

Vacuum Vessel

The sealed chamber within a tokamak that contains plasma during fusion reactions.

Visibility

Within the thesis, the controlled public perception and spatial awareness of energy infrastructure through architecture, circulation, and framing rather than unrestricted access.

Waterfront Infrastructure

Industrial, ecological, and public systems positioned along the edge between land and water.

Waterfront Resilience

Adaptive environmental and infrastructural strategies intended to support long-term waterfront occupation under changing climate conditions.

Wetland Restoration

The ecological rehabilitation of degraded waterfront environments to improve biodiversity, flood mitigation, and environmental performance.

Bibliography

A & V Monografías. "Planta de Tratamiento / CopenHill = Amager Resource Center / CopenHill, 2010–2018, Copenhagen, Denmark: BIG – Bjarke Ingels Group." *A & V Monografías* 211–212 (2019): 56–65.

This source documents CopenHill as both an industrial facility and a public architectural project. It is useful for understanding how BIG transforms a waste-to-energy plant into an inhabitable terrain, combining technical infrastructure with recreation, circulation, and civic visibility. For this thesis, it supports the idea that energy infrastructure can operate as public space without hiding its industrial function. **Keywords: CopenHill, Amager Bakke, waste-to-energy, public recreation, infrastructure, civic landscape.**

Alain Becoulet. "Progress on ITER Construction and Engineering." *Fusion Engineering and Design* 188 (January 11, 2023): 113424–24. https://doi.org/10.1016/j.fusengdes.2023.113424

This article provides a detailed account of construction and engineering milestones on the ITER site, including infrastructure readiness, component assembly, and technical progress toward First Plasma. The authors grapple with the problem of coordinating vast civil engineering projects with precision reactor systems, highlighting strategies for integrating the tokamak structure, cryogenic facilities, and service buildings within a challenging site. The paper serves as a rare scholarly bridge between architectural-scale construction and highly technical systems development. For your thesis, it offers concrete evidence of how fusion infrastructure becomes a built environment in real time, revealing the evolving architectural and programmatic frameworks at the monumental scale of ITER. **Keywords: ITER, construction progress, plant assembly,**

infrastructure, engineering, site, architecture.

Ansolabehere, S., and D. M. Konisky. "Public Attitudes toward Construction of New Power Plants." *Public Opinion Quarterly* 73, no. 3 (July 21, 2009): 566–77. https://doi.org/10.1093/poq/nfp041

Ansolabehere and Konisky use national survey data to examine public acceptance of new power plants across the United States. They find that support is conditional, depending on proximity, environmental risk, and perceived necessity. Nuclear facilities, in particular, face heightened opposition when sited near communities, reflecting deep-seated concerns about safety and equity. The study demonstrates that attitudes toward infrastructure are shaped as much by social and spatial context as by technical performance. For this thesis, the article clarifies why fusion's siting cannot rely solely on scientific assurances. Architecture and design must mediate these concerns, transforming facilities into transparent, trusted presences that align with public values. **Keywords: public attitudes, siting, nuclear facilities, risk perception, equity, fusion architecture.**

Architectural Record. Branch, Mark Alden. "Water Shed: A Water Purification Plant and Park by Steven Holl and Michael Van Valkenburgh Is a Model of Sustainable Infrastructure." *Architectural Record* 193, no. 10 (October 2005): 134–141.

Branch examines the Whitney Water Purification Facility and Park as a model for integrating working infrastructure with landscape and public experience. The article is useful because it addresses the project's architectural form, environmental function, and public presence together rather than treating the utility as hidden background infrastructure. For this thesis, it supports the use of landscape, procession, and spatial atmosphere as tools for making technical systems visible and understandable. **Keywords: Whitney Water**

Purification Facility, water infrastructure, Steven Holl, MVVA, landscape, public utility.

Archeyes. "Beinecke Rare Book and Manuscript Library by SOM at Yale." *Archeyes*. https://archeyes.com/beinecke-rare-book-and-manuscript-library-by-som-at-yale/

This source provides an overview of the Beinecke Library's spatial organization, material strategy, and protected glass book tower. It is useful for understanding the building as a precedent for containment, reverence, and controlled visibility. For this thesis, Beinecke supports the idea that a fragile or protected core can be made publicly legible without being fully exposed or physically accessible. **Keywords: Beinecke Library, protected core, SOM, visibility, preservation, containment.**

Archeyes. "The Centre Georges Pompidou by Richard Rogers and Renzo Piano." *Archeyes*. https://archeyes.com/the-centre-georges-pompidou-by-richard-rogers-renzo-piano/

This source presents the Centre Pompidou as a landmark of exposed systems, structural expression, and public urban life. It is useful for understanding how mechanical, circulation, and structural elements can become part of a building's public identity. For this thesis, Pompidou supports the idea that technical systems can be made visible in ways that create civic presence rather than fear or distance. **Keywords: Centre Pompidou, exposed systems, civic architecture, technology, public plaza, legibility.**

Arquitectura Viva. "Acelerador lineal — CERN Science Gateway, Geneva: Renzo Piano Building Workshop." *Arquitectura Viva*, no. 259 (2023): 66–71.

This source documents CERN Science Gateway as an architectural project tied to scientific communication and public education. It is useful for understanding how Renzo Piano Building Workshop translates the language of particle physics into public form, circulation, and exhibition space. For this thesis, it supports the use of architecture as a gateway between advanced research and non-expert audiences. **Keywords: CERN Science Gateway, Renzo Piano, science education, physics, public interface, architectural communication.**

Arquitectura Viva. “Planta de energía CopenHill = CopenHill Power Plant, Copenhagen, Denmark: BIG Bjarke Ingels Group.” *Arquitectura Viva* 230 (2020): 34–41.

This source presents CopenHill as an energy facility that has been reimagined as a public landmark. It is useful because it frames the building’s technical and recreational programs together, showing how a power plant can become part of the city’s cultural and environmental identity. For this thesis, it supports the argument that infrastructure can become visible, accessible, and socially active. **Keywords: CopenHill, BIG, power plant, recreation, public infrastructure, Copenhagen.**

Baba, Ece Ceylan, Cansu Aktaş, Ceren Balioğlu, and Taylan Kaba. “Fear and Architecture: Learning from Mega-Projects and Canal Istanbul as a Case.” *Journal of Contemporary Urban Affairs* 7, no. 1 (May 29, 2023): 19–37. https://doi.org/10.25034/ijcua.2023.v7n1-2

Baba and colleagues explore how fear shapes both the design and reception of mega-projects, using Canal Istanbul as a case study. They argue that architecture and urban interventions can amplify social anxieties when they are perceived as opaque, disruptive, or imposed. The study emphasizes that fear is not only a psychological response but also a spatial and cultural condition embedded in built form. For this thesis, the article highlights how nuclear fusion facilities risk reproducing similar anxieties if designed as inscrutable industrial enclosures. It reinforces the importance of architectural strategies that counteract fear by foregrounding legibility, transparency, and public engagement.**Keywords: fear, mega-projects, public perception, cultural anxiety, transparency, fusion architecture.**

Banham, Reyner. *Architecture of the Well-Tempered Environment*. University of Chicago Press, 2022

Banham examines how mechanical systems for heating, cooling, and climate control have reshaped architecture in the modern era. He identifies the paradox that these systems are crucial to performance yet are often overlooked in architectural discourse because of their invisibility. Through historical case studies, Banham shows how environmental technologies silently reorganize design, sometimes becoming legible in form, other times hidden. For this thesis, Banham establishes a precedent for considering fusion's magnetic fields, heat, and shielding as not only engineering challenges but also architectural forces that demand representation. **Keywords: environmental systems, invisibility, architecture, technology, performance, fusion, infrastructure.**

BIG – Bjarke Ingels Group. "CopenHill." *BIG.dk*. https://big.dk/projects/copenhill-2391

BIG's project page provides direct information about CopenHill's design concept, program, and architectural strategy. It is useful as a primary source for understanding the project's intention to combine waste-to-energy infrastructure with skiing, hiking, climbing, and public overlook spaces. For this thesis, it helps establish CopenHill as a precedent for turning energy production into a civic and experiential landscape. **Keywords: CopenHill, BIG, waste-to-energy, hybrid program, public landscape, infrastructure.**

Boone, Christopher G. "An Assessment and Explanation of Environmental Inequity in Baltimore." *Urban Geography* 23, no. 6 (September 2002): 581–95. https://doi.org/10.2747/0272-3638.23.6.581

Boone examines patterns of environmental inequity in Baltimore, showing how low-income and minority neighborhoods are disproportionately exposed to industrial hazards and poor environmental quality. Using spatial analysis, he demonstrates that inequities are embedded in the city's geography and persist through zoning, land use, and political neglect. The study frames environmental justice as inseparable from urban planning and infrastructure. For this thesis, Boone's work underscores the importance of addressing Baltimore's industrial legacy at Sparrows Point. A fusion facility must not reproduce inequities but instead present itself as an agent of ecological repair and community benefit, reshaping perceptions of industry through design and siting.

Keywords: environmental justice, inequity, Baltimore, industrial legacy, siting, fusion architecture.

Carayannis, Elias G., John Draper, and Ion A. Iftimie. "Nuclear Fusion Diffusion: Theory, Policy, Practice, and Politics Perspectives." *IEEE Transactions on Engineering Management* 69, no. 4 (2020): 1–15. https://doi.org/10.1109/tem.2020.2982101

Carayannis and colleagues analyze fusion's development through the lens of innovation diffusion theory. They argue that technological success alone will not guarantee adoption; instead, policy frameworks, market forces, and politics will shape how fusion spreads. The article identifies barriers such as high capital cost, slow timelines, and weak public awareness, while suggesting strategies to accelerate acceptance, including international collaboration and consistent policy signals. For this thesis, the study highlights fusion as both a technical and socio-political project, where architecture can play a role in communicating stability and legitimacy. It underscores the importance of situating fusion design within narratives of progress and governance.**Keywords: fusion diffusion, innovation, policy, politics, adoption, architecture.**

Centre Pompidou. "An Iconic Architecture." *Centre Pompidou*. https://www.centrepompidou.fr/en/the-centre-pompidou-is-transforming-itself/an-iconic-architecture

This official source describes the Centre Pompidou's architectural identity, including its exposed systems, structural expression, and role as a cultural landmark. It is useful as a primary source for the building's public-facing architectural logic. For this thesis, it supports the study of how visible systems and civic gathering space can turn technical expression into public identity**. Keywords: Centre Pompidou, exposed infrastructure, public culture, Renzo Piano, Richard Rogers, systems.**

Chadwick, James. 1932. "The Existence of a Neutron." *Proceedings of the Royal Society A* 136 (830): 692–708. https://royalsocietypublishing.org/doi/10.1098/rspa.1932.0112.

Chertow, Marian R. "INDUSTRIAL SYMBIOSIS: Literature and Taxonomy." *Annual Review of Energy and the Environment* 25, no. 1 (November 2000): 313–37. https://doi.org/10.1146/annurev.energy.25.1.313

Chertow surveys the development of industrial symbiosis, the practice of linking waste streams from one industry as resources for another within shared infrastructures. She identifies the central challenge as inefficiency in resource flows and environmental externalities, and shows how clustering industries can generate mutual ecological and economic benefits. The taxonomy she develops, direct exchanges, utility sharing, and eco-industrial parks, offers a framework for thinking about infrastructure as ecologically productive rather than extractive. For this thesis, the article demonstrates how fusion could be integrated into larger energy and urban systems, where its thermal waste, materials, or spatial footprint might catalyze new forms of ecological and civic symbiosis. **Keywords: industrial symbiosis, waste heat, ecology, infrastructure, fusion, energy systems, architecture.**

Commonwealth Fusion Systems. "ARC: Putting Fusion Energy on the Grid." *Commonwealth Fusion Systems*. Accessed May 21, 2026. https://cfs.energy/technology/arc/

Commonwealth Fusion Systems presents ARC as the company's first grid-scale fusion power plant and the commercial successor to SPARC. The source describes ARC as a compact fusion facility intended to provide about 400 megawatts of clean power to the electrical grid in the early 2030s. It is especially useful because it connects fusion's technical promise to siting, grid integration, land use, energy demand, and commercial deployment. For this thesis, ARC helps establish that fusion is no longer only a laboratory or research-campus condition, but an emerging utility-scale infrastructure with unresolved architectural and civic implications. **Keywords: ARC, grid-scale fusion, commercial deployment, compact footprint, energy infrastructure, siting.**

Commonwealth Fusion Systems. "Publications." Cfs.energy. cfs, 2024. https://cfs.energy/technology/publications

The Commonwealth Fusion Systems (CFS) website presents the company's vision, technical progress, and research outputs, including a robust list of peer-reviewed publications related to its SPARC tokamak and HTS magnet technology. Beyond technical content, the site outlines commercialization goals, facility development in the United States, and CFS's strategy for delivering grid-connected fusion faster than ITER. As an industry voice, it provides a unique perspective on fusion's trajectory from laboratory science to market-ready energy infrastructure. While not peer-reviewed, the site is valuable as a primary source that illustrates how fusion is being framed for investors, policymakers, and the public. For this thesis, it offers insight into how architectural design can anticipate and mediate the narratives of speed, scale, and national identity that CFS promotes. **Keywords: Commonwealth Fusion Systems, SPARC, commercialization, U.S. facilities, primary source, scale, fusion architecture.**

Commonwealth Fusion Systems. "We Will Bring Clean Fusion Energy to the Grid from Our Campus in Chesterfield County, Virginia." *Commonwealth Fusion Systems*. Accessed May 21, 2026. https://cfs.energy/chesterfield/overview/

This source documents CFS's planned Fall Line Fusion Power Station in Chesterfield County, Virginia, near Richmond. It states that the facility will be financed, built, owned, and operated by CFS and is intended to produce about 400 megawatts of clean power, enough to serve major industrial and commercial demand or roughly 150,000 homes. For this thesis, the Chesterfield project is important because it gives ARC a real site, public-facing identity, and regional energy context. It reinforces the argument that fusion's next architectural problem will not only be technical performance, but how these facilities meet cities, landscapes, utilities, and publics**. Keywords: Fall Line Fusion Power Station, Chesterfield County, Richmond, ARC, grid connection, public energy infrastructure.**

Corner, Adam, Dan Venables, Alexa Spence, Wouter Poortinga, Christina Demski, and Nick Pidgeon. "Nuclear Power, Climate Change and Energy Security: Exploring British Public Attitudes." *Energy Policy* 39, no. 9 (September 2011): 4823–33. https://doi.org/10.1016/j.enpol.2011.06.037

According to this national British survey, public support for nuclear power is highly conditional, people were only likely to accept it if they believed it addressed climate change and energy security. The research problem targets ambivalent public attitudes shaped by competing narratives of risk and necessity, and shows that framing nuclear as a "reluctant acceptance" solution can shift opinion. The findings emphasize that how fusion or nuclear is narratively positioned, rather than its technical merits, is critical to building public trust. For this thesis, the article offers a powerful evidence base for architecture's rhetorical role in reframing fusion, not merely as an engineering infrastructure but as a situationally contextualized civic promise. **Keywords: nuclear power, public attitudes, climate change, energy security, risk perception, rebranding, architectural narrative.**

DBPIA / Nurimedia. "CopenHill." *DBPIA Architecture Journal* (Korea) (2020): 34–45.

Dima Stouhi. "AL_A Reveals Design of World's First Magnetized Fusion Power Station." ArchDaily, August 5, 2021. https://www.archdaily.com/966274/al-a-reveals-design-of-worlds-first-magnetized-fusion-power-station?utm_source=chatgpt.com

This article reports on AL_A's architectural proposal for a magnetized fusion power station, positioning it as the first attempt to frame fusion infrastructure through deliberate architectural design. While ArchDaily is not a peer-reviewed source, it serves here as a primary record of a unique architectural precedent that is not documented in scholarly literature. The article provides renderings, conceptual language, and design intentions that help envision how fusion might evolve beyond its purely technical enclosures. For this thesis, the AL_A proposal functions as a counterpoint to ITER, offering an architectural imaginary that illustrates both the opportunities and limitations of translating fusion technology into civic typology. **Keywords: fusion**

architecture, AL_A, precedent, infrastructure, typology, ArchDaily, primary source.

Ding, Eric L. "Brownfield Remediation for Urban Health: A Systematic Review and Case Assessment of Baltimore, Maryland." *Biochemistry and Molecular Biology Education*, February 1, 2006

Ding conducts a systematic review (1965–2003) of literature, EPA archives, media accounts, and interviews to assess how abandoned industrial sites (brownfields) in Baltimore contribute to public health and urban decline. He finds associations between brownfield contamination and higher infant and adult mortality rates in certain neighborhoods as well as lost economic productivity. He also discusses the tradeoffs in remediation choices, whether to prioritize housing, green space, or industrial reuse. The paper emphasizes that remediation is not just an environmental act but a social and planning decision about community futures. For your thesis, this source connects directly to Sparrows Point's industrial legacy and public health narratives. It helps ground your design argument in local urban conditions: a fusion facility must not only avoid harm but reverse stigma by participating in remediation, symbolic renewal, and health-forward design. **Keywords: brownfield, public health, Baltimore, remediation, urban redevelopment, stigma, industrial legacy.**

Di Pietro, Enrico, Pietro Barabaschi, Yutaka Kamada, Shinichi Ishida, and the JT-60SA Team. "Overview of Engineering Design, Manufacturing and Assembly of JT-60SA Machine." *Fusion Engineering and Design* 89, nos. 9–10 (October 2014): 2128–2135. https://doi.org/10.1016/j.fusengdes.2013.11.015

Di Pietro and colleagues provide a technical overview of the JT-60SA machine, including its engineering design, manufacturing, assembly process, and role within the broader Japan-Europe fusion research effort. The article describes JT-60SA as a superconducting tokamak intended to support ITER and future DEMO development through advanced plasma operation and long-pulse research. For this thesis, the source is useful because it grounds JT-60SA as a technical precedent rather than an architectural model. It helps clarify how fusion facilities are shaped by machine assembly, superconducting systems, operational constraints, and the need for highly coordinated technical spaces. **Keywords: JT-60SA, tokamak, superconducting coils, ITER, DEMO, engineering design, assembly.**

Edwards, Michael W., Robert D. Schweitzer, Jane Shakespeare-Finch, Aidan Byrne, and Keely Gordon-King. "Living with Nuclear Energy: A Systematic Review of the Psychological Consequences of Nuclear Power." *Energy Research & Social Science* 47 (January 2019): 1–15. https://doi.org/10.1016/j.erss.2018.08.016

Edwards and colleagues synthesize international research on the psychological impacts of living near or engaging with nuclear power. The review finds consistent evidence of elevated anxiety, stress, and distrust in communities adjacent to nuclear plants, regardless of actual exposure to radiation risk. Perceptions of invisibility, uncontrollability, and association with past disasters exacerbate these effects, influencing both individual well-being and community cohesion. The study argues that psychological and social dimensions must be considered alongside technical safety when evaluating nuclear energy. For this thesis, the article highlights the cultural and emotional burdens inherited by fusion from fission. It underscores that architecture can serve as a mitigating force, shaping perception through transparency, ecological integration, and visible commitment to safety. **Keywords: nuclear energy, psychology, anxiety, stigma, perception, trust, fusion architecture.**

Ellin, Nan, Edward J Blakely, and Et Al. *Architecture of Fear*. New York: Princeton

Architectural Press, 1997

This edited volume brings together essays that explore the ways architecture and urban design manifest societal fears, from gated communities and defensive landscapes to surveillance and securitized public spaces. Contributors argue that environments designed around fear often reinforce alienation, exclusion, and distrust, shaping collective psychology as much as physical space. The book situates these tendencies in the broader context of cultural anxieties about crime, terrorism, and social change. For this thesis, the text provides a critical framework for considering how nuclear fusion facilities might unintentionally embody fear if designed as isolated or fortified compounds. It suggests the importance of creating forms that counteract defensive postures, instead projecting openness, ecological responsibility, and civic participation. **Keywords: fear, defensive architecture, exclusion, security, stigma, fusion facilities, civic design.**

Farahat, Mohamed . "Analytical Architectural Study on Nuclear Power Plants." *Journal of Environmental Science and Engineering B* 5, no. 4 (April 28, 2016). https://doi.org/10.17265/2162-5263/2016.04.005

Farahat examines nuclear power plants from an architectural perspective, analyzing their planning, spatial organization, and symbolic presence. He argues that although these facilities are primarily designed around engineering imperatives, their forms also communicate cultural meanings tied to power, risk, and national identity. The study highlights how the exclusion of architectural thinking has reinforced public alienation from nuclear sites. For this thesis, the article provides a useful precedent for considering fusion facilities as architectural projects in their own right. It suggests that by deliberately engaging form, transparency, and materiality, fusion can avoid repeating the alienating legacy of fission plant design.

Keywords: nuclear power plants, architectural analysis, infrastructure, symbolism, risk perception, fusion design.

Ferm, Jessica, Dimitrios Panayotopoulos-Tsiros, and Sam Griffiths. "Planning Urban Manufacturing, Industrial Building Typologies, and Built Environments: Lessons from Inner London." *Urban Planning* 6, no. 3 (September 23, 2021): 350–67. https://doi.org/10.17645/up.v6i3.4357

Ferm and colleagues investigate how industrial land use and building typologies adapt within dense urban settings. Through case studies in London, they show how manufacturing can coexist with housing and civic life when planned with attention to form, access, and integration. The article highlights typologies that minimize disruption while contributing to local economies and communities. For this thesis, the study offers precedents for how fusion facilities might be sited closer to cities, challenging the tradition of isolating nuclear infrastructure. It suggests that design can reframe fusion as a neighborly, civic asset rather than an excluded risk. **Keywords: industrial typologies, urban planning, manufacturing, siting, coexistence, fusion architecture.**

Fondazione Renzo Piano. "Centre Georges Pompidou." *Fondazione Renzo Piano*. https://www.fondazionerenzopiano.org/en/project/centre-georges-pompidou/

Fraker, Joseph. "Census Tract Boundaries and PlaceBased Development Programs." *Cityscape* 24, no. 1 (2022): 217–30. https://doi.org/10.2307/48657947

Goetz and Chapple examine how census tract boundaries influence the outcomes of place-based development initiatives, highlighting the spatial politics of redevelopment and equity. The article argues that boundaries are not neutral but actively shape who benefits from, and who is excluded from, economic renewal projects. For Sparrows Point, this study is useful in understanding how brownfield redevelopment intersects with governance, financing, and community inclusion. It provides a critical framework for situating the rebranding of an industrial site within larger questions of justice and policy. **Keywords: redevelopment, place-based policy, spatial boundaries, equity, governance, Sparrows Point, brownfield.**

GA Document. "Gunter Henn: Transparent Factory, Dresden, Germany." *GA Document* 69 (2002): 14–29.

gooood. "CERN Science Gateway Building by Renzo Piano Building Workshop + Brodbeck Roulet Architectes Associés, Geneva." *gooood.cn*. https://www.gooood.cn/cern-science-gateway-building-by-renzo-piano-building-workshop-brodbeck-roulet-architectes-associes-geneva.htm

This source provides visual and descriptive coverage of CERN Science Gateway, including its pavilions, bridges, exhibition spaces, and relationship to the CERN campus. It is useful for studying the project's formal language and public circulation strategy. For this thesis, it supports CERN as a precedent for translating hidden scientific infrastructure into an accessible spatial narrative. **Keywords: CERN Science Gateway, Renzo Piano, science center, circulation, public education, physics.**

Gupta, Kuhika, Hank Jenkins-Smith, Joseph Ripberger, Carol Silva, Andrew Fox, and Will Livingston. "Americans' Views of Fusion Energy: Implications for Sustainable Public Support." *Fusion Science and Technology* 81, no. 1 (March 27, 2024): 1–17. https://doi.org/10.1080/15361055.2024.2328457

Gupta and colleagues analyze survey data on U.S. perceptions of fusion, identifying both optimism and hesitation. Respondents often viewed fusion as a promising clean energy source, yet many linked it to fission, revealing knowledge gaps and persistent stigma. The study highlights that technical safety alone does not guarantee acceptance; trust, transparency, and framing within climate solutions are crucial.

For this thesis, the article establishes an empirical foundation for understanding how architectural strategies must address perception as much as performance, suggesting that design can serve as a tool for building cultural legitimacy and public confidence. **Keywords: fusion energy, public attitudes, risk perception, trust, nuclear stigma, climate narrative, architecture.**

Henn Architekten. “Volkswagen Transparent Factory.” *Henn.com*. https://www.henn.com/en/project/vw-transparent-factory

Hirsch, Robert L., and William L. R. Rice. “Nuclear Fusion Power and the Environment.” *Environmental Conservation* 1, no. 4 (1974): 251–62. https://doi.org/10.1017/s0376892900004823

Hirsch and Rice provide an early assessment of fusion’s potential environmental impacts, contrasting it with fossil fuels and nuclear fission. They argue that while fusion largely avoids issues of long-lived waste and catastrophic accidents, it still presents challenges related to tritium handling, neutron activation, and large-scale energy infrastructure. The article is valuable as a historical baseline, revealing how optimism about fusion’s ecological promise has long been tempered by recognition of its risks. For this thesis, it highlights how environmental concerns have been integral to fusion’s narrative from the start, reinforcing the importance of addressing them transparently through architectural design. **Keywords: fusion power, environment, tritium, neutron activation, ecological impact, architecture.**

Hirsch, Robert, and Roger H Bezdek. “Public Acceptance of ITER-Tokamak Fusion Power.” *European Journal of Energy Research* 1, no. 4 (October 8, 2021): 8–12. https://doi.org/10.24018/ejenergy.2021.1.4.18

Hirsch and Bezdek examine the prospects for public acceptance of ITER and tokamak-based fusion power. They argue that while fusion offers clear safety and environmental advantages over fission, its association with the broader "nuclear" category complicates public perception. The article emphasizes that communication, transparency, and demonstrable benefits are essential for building legitimacy. By situating fusion's future within the politics of trust, the study reinforces the idea that technical progress alone will not ensure adoption. For this thesis, it underscores the need for architecture to mediate stigma by projecting openness and reliability, transforming a technical enclosure into a civic symbol. **Keywords: ITER, public acceptance, nuclear stigma, legitimacy, perception, architecture.**

Hoedl, S. "Achieving a Social License for Fusion Energy." *Physics of Plasmas* 29, no. 9 (September 1, 2022). https://doi.org/10.1063/5.0091054

Hoedl argues that social acceptance is as critical to the success of fusion energy as economic feasibility and technical performance. Drawing from energy justice and climate policy, he shows that without public trust and equitable participation, fusion may fail to deliver its promised benefits. The article highlights the importance of community engagement, transparent communication, and visible alignment with social goals such as climate mitigation and energy access. For this thesis, the study reinforces the idea that architecture must embody not just technical systems but also social values, projecting fusion as a trustworthy and inclusive civic infrastructure. **Keywords: fusion energy, social acceptance, energy justice, trust, climate mitigation, civic infrastructure.**

Hoedl, Seth. "Social Acceptance Is as Important as Low Costs and Net Energy Production for Climate and Energy Poverty Impact." *Journal of Fusion Energy* 42, no. 1 (May 22, 2023). https://doi.org/10.1007/s10894-023-00355-x

Hoedl introduces the concept of "social license" as essential for the future of fusion energy, arguing that technical success alone will not ensure adoption. Drawing from energy sociology, he shows how industries gain legitimacy through trust, transparency, and community engagement. Fusion is presented as particularly vulnerable to skepticism due to its nuclear associations, making proactive strategies crucial. For this thesis, the article highlights how architectural presence can function as part of this social license, signaling openness and accountability. It suggests that design strategies, public interfaces, visible environmental systems, and integration into civic life, are critical to achieving acceptance. **Keywords: fusion energy, social license, legitimacy, trust, transparency, civic architecture.**

Horlick-Jones, Tom, Ana Prades, and Josep Espluga. "Investigating the Degree of 'Stigma' Associated with Nuclear Energy Technologies: A Cross-Cultural Examination of the Case of Fusion Power." *Public Understanding of Science* 21, no. 5 (July 22, 2010): 514–33. https://doi.org/10.1177/0963662510371630

Horlick-Jones and colleagues explore whether fusion inherits the stigma of nuclear fission through surveys in Spain and the UK. They find that although fusion is technically distinct, public perception remains tied to broader fears of "nuclear," demonstrating that cultural narratives outweigh scientific explanation. The study shows how risk associations persist even when hazards differ, and that institutional trust strongly shapes acceptance. For this thesis, the article highlights the communicative burden on architecture: fusion plants must be designed to project transparency, safety, and civic value if they are to overcome inherited distrust. **Keywords: nuclear stigma, fusion perception, public trust, cultural narrative, risk communication, architecture.**

Infegy. "Social Listening Reveals Public Perception of Nuclear Energy and Fusion Research." Infegy Insight Brief, 2023. https://www.infegy.com/insight-brief/social-listening-reveals-public-perception-of-nuclear-energy-and-fusion-research

This industry insight brief uses social listening tools to analyze online discourse about nuclear energy and fusion. It identifies themes of risk, climate urgency, and technological optimism, while noting that fusion often benefits from a more hopeful narrative compared to nuclear fission. As a non-peer-reviewed report, its value lies in capturing real-time public conversations and sentiment analysis that complement academic surveys. For this thesis, the source provides evidence of how fusion is positioned in digital culture and underscores the need for architectural strategies that amplify transparency and trust in both physical and symbolic registers. **Keywords: social listening, public perception, nuclear energy, fusion research, online discourse, stigma.**

International Atomic Energy Agency (IAEA). 2004. "From Obninsk Beyond: Nuclear Power Conference Looks to Future." News article, June 2004. https://www.iaea.org/newscenter/news/obninsk-beyond-nuclear-power-conference-looks-future.

International Atomic Energy Agency (IAEA). 2015. The Fukushima Daiichi Accident: Report by the Director General. Vienna: IAEA. https://www-pub.iaea.org/mtcd/publications/pdf/pub1710-reportbythedg-web.pdf.

ITER Organization. n.d.-a. "Assembly Overview." Accessed October 2, 2025. https://www.iter.org/project/assembly-overview.

ITER Organization. n.d.-b. "Cryogenics." Accessed October 2, 2025. https://www.iter.org/machine/supporting-systems/cryogenics.

ITER. "ITER - the Way to New Energy." ITER, 2019. https://www.iter.org/

As the official site of the ITER project, this source provides technical specifications, site layouts, and detailed explanations of reactor systems that are not readily available in peer-reviewed literature.

While it is not an academic source, it functions as a primary document, offering authoritative and up-to-date information directly from the international consortium responsible for the facility. For this thesis, ITER.org is indispensable for understanding the scale, materials, and spatial organization of the world's largest experimental fusion plant. To balance its non-peer-reviewed status, its data are read alongside scholarly articles in Fusion Engineering and Design and Nuclear Fusion that contextualize and critique ITER's approach.**Keywords: ITER, fusion, infrastructure, site planning, scale, materials, primary source.**

Jasanoff, Sheila, and Sang-Hyun Kim. *Dreamscapes of Modernity: Sociotechnical Imaginaries and the Fabrication of Power*. Chicago ; London: The University of Chicago Press, 2015

This edited volume introduces the concept of sociotechnical imaginaries, collectively held visions of desirable futures shaped by science and technology. The essays demonstrate how nations and institutions embed technologies within narratives of progress, identity, and power, often with effects that reach beyond technical function. The central problem identified is that technologies do not emerge in neutral form but carry with them cultural expectations and anxieties that must be negotiated. For this thesis, the book provides a theoretical framework for understanding nuclear fusion not just as an energy system but as an unarticulated imaginary in need of architectural expression, where design could mediate between technical reality and public perception. **Keywords: sociotechnical imaginaries, cultural narratives, technology, power, nuclear fusion, architecture.**

Jones, Christopher R., Sophie Yardley, and Sarah Medley. "The Social Acceptance of Fusion: Critically Examining Public Perceptions of Uranium-Based Fuel Storage for Nuclear Fusion in Europe." *Energy Research & Social Science* 52

(June 2019): 192–203. https://doi.org/10.1016/j.erss.2019.02.015

Jones, Yardley, and Medley investigate how nuclear fusion is understood and perceived by the public, drawing on interviews, surveys, and discourse analysis. The authors identify a gap between expert framings of fusion as safe and sustainable, and public uncertainties that connect it with the stigma of nuclear fission. Their findings show that perceptions are shaped less by technical facts than by cultural narratives, trust in institutions, and the framing of communication strategies. For this thesis, the article underscores the importance of rebranding fusion not only as an engineering achievement but as a socially legible and trustworthy civic infrastructure, opening a space where architecture can mediate between science and public acceptance. **Keywords: fusion perception, public attitudes, nuclear stigma, trust, social acceptance, rebranding, architecture.**

JT-60SA. "JT-60SA." *JT-60SA*. Accessed May 21, 2026. https://www.jt60sa.org/wp/

The official JT-60SA project website introduces JT-60SA as a joint international fusion experiment built and operated by Japan and Europe in Naka, Japan. It explains the project's relationship to ITER and its role in investigating how future fusion power plants after ITER might operate more effectively. For this thesis, this source provides basic project framing, location, institutional context, and technical purpose. It supports the use of JT-60SA as a precedent for understanding fusion as an evolving research infrastructure with direct implications for later power plant design. **Keywords: JT-60SA, Japan, Europe, ITER, fusion research, DEMO, advanced plasma operation.**

Jürgen Adam, Katharina Hausmann, JüttnerFrank, Klaus Daniels, and Et Al. *Industrial Buildings : A Design Manual*. Basel ; Boston: Birkhäuser-

Publishers For Architecture, 2004

This design manual systematically addresses the architectural challenges tied to industrial buildings, particularly in logistics, manufacturing, storage, and distribution. The authors first present typologies and principles of technical and spatial organization, then analyze approximately seventy existing industrial projects to illustrate how functional flows influence form. Emphasis lies on modularity, process logic, and how a building's utility dictates strategy. For a thesis on fusion infrastructure, this manual offers foundational insight into how industrial systems translate into architecture. Even though it isn't about nuclear or energy facilities per se, its approach to organizing functional processes—flow, modularity, systems integration—provides a vocabulary for translating fusion's internal systems into external form. It helps me think through how a fusion plant might adopt industrial clarity rather than obfuscation. **Keywords: industrial typology, logistics, modularity, systems architecture, process flow, functional design.**

Keller Easterling. *Extrastatecraft: The Power of Infrastructure Space*. London: Verso, 2014

Easterling reframes infrastructure as a potent spatial agent rather than a neutral backdrop. She argues that systems like fiber optic cables, highways, and free trade zones exert political and cultural influence precisely through their invisibility. The book identifies "infrastructure space" as both the problem (its hidden power) and the method by which global organizations shape territory. For this thesis, Easterling provides a critical lens to interpret fusion facilities as more than technical enclosures, positioning them instead as infrastructures whose architectural presence could either remain concealed or be articulated as civic and ecological actors. **Keywords: infrastructure space, invisibility, politics, architecture, fusion, typology, culture.**

Kim, Hyuck Jong, Changwoo Park, Yong-su Kim, Gyunyoung Heo, Jong Kyung Kim, and Chang-ho Shin. “A Study on the Site Plot Plan and Building Schematics of a Fusion DEMO Plant.” *Fusion Science & Technology* 64, no. 3 (September 1, 2013): 473–82. https://doi.org/10.13182/fst13-a19138

Kim and colleagues explore the site planning and schematic building layout for a proposed DEMO fusion power plant, extending lessons learned from ITER toward a commercial-scale facility. The problem addressed is how to integrate complex reactor systems, tritium processing, cooling towers, and auxiliary services into a coherent and safe site plan. Using ITER as a reference, the study develops zoning strategies that separate hazardous areas from support and maintenance functions while accommodating remote handling and safety margins. For this thesis, the article provides rare insight into how fusion infrastructure translates into spatial organization at the campus scale, making it a valuable precedent for imagining fusion as an architectural typology. **Keywords: DEMO, site planning, building schematics, ITER, fusion infrastructure, safety, architecture.**

Koo, Bonjun, Kazuhiko Noguchi, Fumitaka Watanabe, Kotaro Kubo, and Tadahiro Shibutani. “Advanced Nuclear Technologies in Modern Energy Systems: A Comparative Risk Assessment in Japan.” *Energy Strategy Reviews* 57 (January 2025): 101632. https://doi.org/10.1016/j.esr.2024.101632

This study presents a comparative evaluation of risk profiles across advanced nuclear technologies, including fusion, within the Japanese energy context. It employs a multi-factor analysis that weighs actual operational risk against public acceptance for each technology. Through site-based scenarios, the authors highlight how fusion can offer lower accident and proliferation risks, but face perception challenges tied to nuclear associations. For this thesis, the article is invaluable: it blends technical risk assessment with the cultural framing of various nuclear options, reinforcing the need for architectural mediation to reframe fusion as safer and more legible to the public. **Keywords: nuclear risk, fusion, risk perception, comparative analysis, energy systems, architecture, public trust.**

L'Arca International. "CERN Science Gateway." *L'Arca International* 176 (2024): 24–33.

Landezine. "Lake Whitney Water Treatment Facility by MVVA." *Landezine Landscape Architecture Platform*. https://landezine.com/lake-whitney-water-treatment-facility-by-mvva/

L'Architecture d'Aujourd'hui. Pontoizeau, Yvette. "Centre Georges Pompidou, Paris – Piano, Renzo, and Rogers, Richard." *L'Architecture d'Aujourd'hui* 213 (February 1981): 92–95.

Pontoizeau's article provides architectural coverage of Centre Pompidou after its completion, situating the building within debates about technology, culture, and the modern city. It is useful as a historical source for understanding the project's early reception and architectural significance. For this thesis, it supports Pompidou as a precedent for using exposed systems and public circulation to create a legible technological landmark. **Keywords: Centre Pompidou, Renzo Piano, Richard Rogers, technology, urban culture, exposed systems.**

Lees, Loretta, and Richard Baxter. "A 'Building Event' of Fear: Thinking through the Geography of Architecture." *Social & Cultural Geography* 12, no. 2 (March 2011): 107–22. https://doi.org/10.1080/14649365.2011.545138

Lees and Baxter examine how architecture can become a "building event" that generates or amplifies fear within its social and geographic context. They argue that buildings are not neutral backdrops but active participants in shaping cultural emotions. Using case studies, they show how form, scale, and symbolism influence public comfort or anxiety. For this thesis, the article extends the discussion of fear from mega-projects to everyday encounters with architecture. It suggests that fusion facilities must be designed with awareness of their psychological impact, using form and spatial strategies to transform potential anxiety into trust and civic pride. **Keywords: architecture, fear, geography, public perception, symbolism, fusion design.**

Lux, Hanni, Dan Wolff, and Jack Foster. "Commercialization of Fusion Power Plants." *IEEE Transactions on Plasma Science*, 2022, 1–5. https://doi.org/10.1109/tps.2022.3194143

Lux and colleagues assess the challenges of moving fusion from experimental facilities to commercial power plants. They outline barriers including cost, scalability, regulation, and public acceptance, while emphasizing the need for standardized designs to accelerate deployment. The article situates fusion within broader energy markets, noting that its success depends as much on public trust and political will as on technical progress. For this thesis, the study underscores the urgency of framing fusion plants as legible civic infrastructure rather than inscrutable research complexes. It highlights architecture's role in easing commercialization by creating facilities that embody reliability, accessibility, and public value. **Keywords: commercialization, fusion power plants, scalability, public trust, infrastructure, architecture.**

Malafouris, Lambros. "Understanding the Effects of Materiality on Mental Health." *BJPsych Bulletin* 43, no. 5 (March 6, 2019): 195–200. https://doi.org/10.1192/bjb.2019.7

Malafouris explores how material environments influence human psychology and well-being, drawing on cognitive archaeology and design theory. He argues that materials are not passive but actively shape emotional and mental states through their sensory and symbolic qualities. The article connects materiality with mental health outcomes, emphasizing that design choices carry psychological consequences. For this thesis, the study reinforces the idea that the materials used in fusion facilities, concrete, steel, glass, or composites, are more than structural necessities. They also mediate perception, potentially transforming public anxiety into reassurance. Visible material strategies can communicate safety, openness, and ecological responsibility. **Keywords: materiality, mental health, perception, sensory design, architecture, fusion facilities.**

Metalocus. "Paris Architectural Masterpiece: Centre Pompidou by Renzo Piano and Richard Rogers." *Metalocus*. https://www.metalocus.es/en/news/paris-architectural-masterpiece-center-pompidou-renzo-piano-and-richard-rogers

Miyoshi, Yuya, Akira Aoki, Ryoji Hiwatari, Youji Someya, Yoshiteru Sakamoto, and Kenji Tobita. "Cooling Water System Design of Japan's DEMO for Fusion Power Production." *Fusion Engineering and Design* 126 (January 2018): 110–15. https://doi.org/10.1016/j.fusengdes.2017.11.013

Miyoshi presents the conceptual design of the cooling water system for Japan's DEMO fusion power plant, focusing on the spatial distribution of heat exchangers, piping networks, and auxiliary buildings. The article addresses the central challenge of removing massive thermal loads while maintaining safety, efficiency, and reliability under fusion operating conditions. By situating the cooling water system within the larger plant layout, the study shows how technical constraints dictate site organization and programmatic relationships across the campus. For this thesis, the paper is valuable because it demonstrates how ecological and thermal requirements become formative forces in the design of fusion infrastructure, linking engineering systems directly to architectural scale and environmental integration. **Keywords: DEMO,**

cooling systems, site planning, thermal management, fusion infrastructure, programmatic design, architecture.

Morris, A W, R J Akers, M Cox, F Militello, E Surrey, C W Waldon, H R Wilson, and H Zohm. "Towards a Fusion Power Plant: Integration of Physics and Technology." *Plasma Physics and Controlled Fusion* 64, no. 6 (May 5, 2022): 064002. https://doi.org/10.1088/1361-6587/ac6694

Morris and colleagues examine the integration of physics research with technological development in the path toward commercial fusion plants. They argue that success requires balancing plasma performance with engineering constraints such as heat exhaust, tritium breeding, and maintainability. The article emphasizes that plant design is an iterative negotiation, where scientific breakthroughs only matter if supported by workable systems. For this thesis, the study highlights how fusion architecture must respond to interdependent technical demands, not as abstract form-making but as a framework shaped by physics and engineering. It reinforces the need for designs that make these constraints legible and publicly meaningful. **Keywords: fusion power plant, physics integration, engineering constraints, tritium, maintainability, architecture.**

Mulligan, William H. "The Corporation Community: Life in Sparrows' Point, Maryland." *Business and Economic History* 9 (1980): 136–38. https://doi.org/10.2307/23702678

Brody examines Sparrows Point as a company town, exploring how Bethlehem Steel shaped not only the site's industrial output but also the daily lives, housing, and social fabric of its workers. The article provides insight into the community structures that grew up around the plant and the ways corporate power extended beyond the factory floor. For this thesis, it adds a social and cultural dimension to Sparrows Point's legacy, revealing how the identity of place is entangled with labor, class, and corporate image. This history of corporate paternalism and community-building enriches the parallels between Sparrows Point's industrial memory and nuclear fusion's need for public acceptance. **Keywords: Sparrows Point, Bethlehem Steel, company town, labor history, corporate power, industrial community, cultural identity.**

National Ignition Facility (NIF). n.d. "Achieving Fusion Ignition." Accessed October 2, 2025. https://lasers.llnl.gov/science/achieving-fusion-ignition.

Olgyay, Victor. *Design with Climate : Bioclimatic Approach to Architectural Regionalism*. Princeton: Princeton University Press, 2015

Olgyay establishes the principles of bioclimatic design, arguing that architecture must adapt to regional climate conditions to achieve environmental balance. He identifies the problem of climate-insensitive modernism and demonstrates how design strategies tied to solar orientation, wind, and thermal comfort can generate new architectural forms. The book offers a conceptual toolkit for understanding siting as a critical design variable. For this thesis, Olgyay provides the theoretical grounding to imagine fusion facilities situated in extreme climates, such as deserts, tundra, or coastal sites, where bioclimatic strategies could transform infrastructure into ecologically responsive architecture. **Keywords: bioclimatic design, regionalism, climate, siting, architecture, ecology, fusion.**

Our World in Data. "Energy." Accessed September 26, 2025. https://ourworldindata.org/energy

This dataset provides a comprehensive overview of global energy systems, covering historical and contemporary consumption by source. It contextualizes nuclear and potential fusion energy within the broader transitions from coal, oil, and natural gas to renewables. For this thesis, the source is valuable for situating fusion in the cultural and infrastructural history of energy transitions, supporting claims about fusion's potential to redefine industrial and architectural typologies. **Keywords: energy, Our World in Data, energy transitions, fossil fuels, renewables, fusion.**

Our World in Data. "Nuclear Energy." Accessed September 26, 2025. https://ourworldindata.org/nuclear-energy

Our World in Data aggregates global datasets on nuclear energy, including electricity generation, share of total energy, accident records, and long-term trends. The platform is widely used in academic and public discourse for accessible visualizations and open data. For this thesis, it situated fusion within the broader historical trajectory of nuclear energy, enabling global comparisons of production and perception. Its emphasis on long-term patterns strengthens arguments about energy transitions and the need for new typologies. **Keywords: nuclear energy, Our World in Data, electricity generation, global energy mix, transitions, fusion.**

Patterson, Eann A., Sally Purdie, Richard J. Taylor, and Chris Waldon. "An Integrated Digital Framework for the Design, Build and Operation of Fusion Power Plants." *Royal Society Open Science*, vol. 6, no. 10, 2019, article 181847. Royal Society, https://doi.org/10.1098/rsos.181847

This paper proposes a full-lifecycle "integrated digital framework" for fusion plants that links research, testing, design, construction, and operations through a shared data environment—essentially a domain-specific digital twin. The authors argue that orchestrating models, plant scheduling, and feedback loops across disciplines can shorten design cycles, improve safety/maintainability, and make operational assumptions transparent. For an architectural thesis on making fusion legible to the public, the framework offers two takeaways: (1) a technical basis for visible, real-time status displays (performance, safety margins, maintenance) in public-facing areas; and (2) a rationale for spatial adjacencies between test labs, control rooms, and educational spaces, since the plant's "single source of truth" data can ethically support interpretation without exposing sensitive zones. Use this as a methodological precedent for how information design and building organization can foreground safety and reliability. **Keywords: digital twin for fusion, integrated digital framework, lifecycle data management, safety case transparency, operations & maintainability.**

Piazza, Alessandro, and Fabrizio Perretti. "Categorical Stigma and Firm Disengagement: Nuclear Power Generation in the United States." *Organization Science* 26, no. 3 (2015): 724–42. https://doi.org/10.2307/43661017

Piazza and Perretti examine how categorical stigma affects organizational behavior, focusing on U.S. firms' disengagement from nuclear power between 1970 and 2000. Through quantitative analysis, they show that firms withdrew not only for technical or financial reasons but also because nuclear power became stigmatized as a category, producing reputational risk. The study demonstrates that stigma can have structural effects on industries, reshaping investment patterns and technological trajectories. For this thesis, the article is significant in framing fusion's challenge: even if technically superior to fission, it may inherit nuclear stigma as a category. This reinforces the importance of architecture as a tool to rebrand fusion visibly and symbolically, helping shift perception from stigmatized to desirable energy infrastructure. **Keywords: stigma, nuclear power, disengagement, reputation, fusion perception, architecture.**

Pidgeon, Nick F, Roger E Kasperson, and Paul Slovic. *The Social Amplification of*

Risk. Cambridge ; New York: Cambridge University Press, 2003

Pidgeon, Kasperson, and Slovic present a foundational framework for understanding how risks are amplified or minimized through social and cultural processes. They show that public responses to technological hazards are not determined solely by technical data but by communication, trust, media narratives, and institutional credibility. The book compiles case studies demonstrating how risk perception can escalate beyond measurable danger, shaping policy and public opinion. For this thesis, the framework explains why fusion, despite its safety advantages over fission, may still inherit public fear. It highlights the need for architecture to function as a communicative tool, making safety and transparency visible and credible. **Keywords: risk perception, social amplification, communication, trust, nuclear stigma, architecture.**

Presti, Paolo, Gaia Maria Galasso, Davide Ruzzon, Pietro Avanzini, Fausto Caruana, Giacomo Rizzolatti, and Giovanni Vecchiato. "Architectural Experience Influences the Processing of Others' Body Expressions." *BioRxiv (Cold Spring Harbor Laboratory)*, February 27, 2023. https://doi.org/10.1101/2023.02.24.529649

Presti and colleagues use neuroscience methods to show how architectural environments affect the way people perceive and interpret others' body language. Their findings indicate that spatial qualities such as openness, enclosure, and proportion can modulate emotional processing and social interaction. The study demonstrates that architecture does not merely house activity but actively shapes human cognition and relationships. For this thesis, the article supports the claim that fusion facilities can either amplify anxiety or foster trust depending on their design. It highlights the potential of architectural form to influence public perception at the embodied, psychological level. **Keywords: architecture, neuroscience, perception,**

embodiment, trust, fusion facilities.

Renzo Piano Building Workshop. "CERN Science Gateway Building." *RPBW Architects*. https://www.rpbw.com/project/cern-science-gateway-building

Renzo Piano Building Workshop. "Centre Georges Pompidou." *RPBW Architects*. https://www.rpbw.com/project/centre-georges-pompidou

Roth, Mareike, and Oliver Saiz. *Designing Emotion*. Birkhäuser, 2022

Roth and Saiz investigate how architecture and design deliberately engage with human emotion, drawing on psychology, neuroscience, and design case studies. The book argues that spatial qualities such as proportion, light, materiality, and sequence evoke specific affective responses that shape how environments are experienced and remembered. Rather than treating emotion as incidental, the authors frame it as a central design objective that influences well-being, perception, and meaning. For this thesis, the text provides a critical framework for considering how fusion facilities can move beyond neutral or defensive enclosures. It suggests that architectural strategies can be intentionally crafted to elicit trust, curiosity, and optimism, counteracting the fear and stigma historically tied to nuclear technologies. **Keywords: architecture, emotion, affect, perception, materiality, trust, fusion facilities.**

Rumpf, Peter. "Gläserne Manufaktur: VW-Montagewerk in Dresden." *Bauwelt* 93, no. 8 (2002): 18–25.

SAH Archipedia. "Whitney Water Purification Facility and Park." *Society of Architectural Historians Archipedia*. https://sah-archipedia.org/buildings/CT-01-009-0098

Sandra Karina Löschke. *Materiality and Architecture*. London ; New York: Routledge, 2016

Löschke explores materiality as a central dimension of architectural design, emphasizing how matter, surface, and texture mediate human perception and cultural meaning. She draws on theory and case studies to argue that materials are not neutral components but active conveyors of values and narratives. The book situates material choices within broader debates about sustainability, authenticity, and technological change. For this thesis, Löschke's work highlights how fusion facilities can use material expression to shift perception from secrecy and fear toward openness and ecological responsibility. It reinforces that material articulation, concrete, steel, glass, composites, is not only technical but also symbolic, shaping how nuclear technologies are culturally received. **Keywords: materiality, architecture, perception, sustainability, cultural meaning, fusion facilities.**

Sandri, Sandro, Gian Marco Contessa, Marco D'Arienzo, Manuela Guardati, Maurizio Guarracino, Claudio Poggi, and Rosaria Villari. "A Review of Radioactive Wastes Production and Potential Environmental Releases at Experimental Nuclear Fusion Facilities." *Environments* 7, no. 1 (January 1, 2020): 6. https://doi.org/10.3390/environments7010006

Sandri and colleagues review the types and quantities of radioactive byproducts generated in experimental fusion facilities. While fusion avoids high-level long-lived waste typical of fission, the authors note that activated structural materials and tritium management remain key concerns. They evaluate potential release pathways and argue that effective containment and recycling strategies can minimize risks. For this thesis, the article provides concrete evidence to counter exaggerated fears of catastrophic fallout, while acknowledging real material challenges. It suggests that architectural design must not hide waste-handling systems but integrate them visibly, reinforcing transparency and credibility in the public eye. **Keywords: fusion waste, radioactive materials, tritium, containment, transparency, architecture.**

Schweizer-Ries, Petra. "Energy Sustainable Communities: Environmental Psychological Investigations." *Energy Policy* 36, no. 11 (November 2008): 4126–35. https://doi.org/10.1016/j.enpol.2008.06.021

Schweizer-Ries applies environmental psychology to the study of energy-sustainable communities, examining how attitudes, behaviors, and built environments interact to support or hinder transitions to renewable energy. She emphasizes that technology adoption is inseparable from social acceptance, local identity, and everyday practices. The article demonstrates that visible and participatory design strategies strengthen community support for new energy systems. For this thesis, the study reinforces the idea that fusion facilities cannot remain isolated technological enclaves. Instead, their architecture must integrate ecological systems and community interfaces, presenting fusion as a shared civic resource rather than a remote industrial hazard. **Keywords: energy communities, environmental psychology, social acceptance, participation, identity, fusion architecture.**

Skidmore, Owings & Merrill. *SOM: Architecture of Skidmore, Owings & Merrill, 1963–1973*. New York: Monacelli Press, 2009.

Skidmore, Owings & Merrill. "Yale University Beinecke Rare Book and Manuscript Library." *SOM.com*. https://www.som.com/projects/yale-university-beinecke-rare-book-and-manuscript-library/

Sovacool, Benjamin K. "How Long Will It Take? Conceptualizing the Temporal Dynamics of Energy Transitions." *Energy Research & Social Science* 13 (March 2016): 202–15. https://doi.org/10.1016/j.erss.2015.12.020

Sovacool analyzes historical energy transitions, such as the shifts from coal to oil and from wood to coal, to evaluate the pace at which societies adopt new energy regimes. He challenges assumptions of rapid technological adoption, showing that transitions often take decades or centuries due to infrastructural inertia, political interests, and cultural resistance. He concludes that fusion, even if technically viable, will likely face long adoption timelines. For this thesis, the article sharpens the problem of urgency: fusion may hold promise as clean energy, but its slow rollout underscores why architecture must mediate both technical feasibility and cultural acceptance. **Keywords: energy transitions, adoption timelines, fusion, infrastructure, politics, culture, architecture.**

Steven Holl Architects. "Whitney Water Purification Facility." *Steven Holl Architects*. https://www.stevenholl.com/project/whitney-water-facility/

Stoneham, A M, J R Matthews, and I J Ford. "Innovative Materials for Fusion Power Plant Structures: Separating Functions." *Journal of Physics Condensed Matter* 16, no. 27 (June 26, 2004): S2597–2621. https://doi.org/10.1088/0953-8984/16/27/001

Stoneham and colleagues analyze the material challenges of fusion power plants, focusing on how different structural functions, such as load-bearing, shielding, and heat resistance, can be separated and optimized through novel materials. They highlight the potential of composites and alloys to address neutron damage and thermal stress while extending component lifetimes. The article underscores that material science is central to the viability of fusion infrastructure. For this thesis, the study suggests that material choices are not only technical but also architectural, influencing form, detailing, and perception. Visible use of innovative materials could communicate resilience and transparency, reframing fusion plants as forward-looking civic structures rather than inscrutable machines. **Keywords: fusion materials, structural design, composites, shielding, durability, architecture.**

Strandbygaard, SK. "Fear Follows Form: A Study of the Relationship between Neighborhood Type, Income and Fear of Crime at Train Stations a Study of the Relationship between Neighborhood Type, Income and Fear of Crime at Train Stations on JSTOR." *Jstor.org*, 2020. https://doi.org/10.2307/26967260

This study examines how built environments intersect with socioeconomic factors to influence fear of crime in public spaces, focusing on train stations. It demonstrates that architectural form, neighborhood context, and income levels combine to shape perceptions of safety. The findings emphasize that fear is not purely psychological but spatially and socially constructed. For this thesis, the article is valuable in linking architectural form directly to emotional response. It suggests that fusion facilities, if designed as forbidding or disconnected, may amplify fear regardless of technical safety. Conversely, forms that integrate openness, visibility, and contextual sensitivity can reduce anxiety and foster trust. **Keywords: fear, architecture, perception, public space, safety, fusion facilities.**

Taylor, Neill P. "Safety and Licensing of Nuclear Facilities for Fusion," May 1, 2015. https://doi.org/10.1109/sofe.2015.7482293

Taylor outlines the evolving framework for licensing fusion facilities, focusing on how safety principles developed for fission are being adapted to fusion's distinct risks. He emphasizes issues of tritium handling, radiation shielding, and regulatory uncertainty, noting that public confidence depends on rigorous oversight. The paper shows that safety is not only a technical challenge but also a communicative one, as licensing processes shape perception. For this thesis, the study highlights how architecture can embody regulatory clarity by making safety features legible. Design has the potential to translate abstract safeguards into visible spatial cues, strengthening public trust in fusion infrastructure. **Keywords: fusion energy, safety, licensing, regulation, tritium, public trust, architecture.**

The Architect's Newspaper. "BIG Completes Skiable CopenHill Power Plant in Copenhagen." *The Architect's Newspaper*, October 8, 2019. https://www.archpaper.com/2019/10/big-skiable-copenhill-powerplant-crit/

Thomas James Dolan. *Fusion Research*. Elsevier, 2013

Dolan's book offers a comprehensive overview of nuclear fusion research during its formative decades, covering both the scientific principles of plasma confinement and the engineering of experimental devices. It synthesizes technical knowledge from magnetic and inertial confinement approaches while also addressing reactor design, diagnostics, and international research programs. As one of the few single-volume surveys of fusion at the time, it serves as both a reference and a historical record of how the field defined its challenges and ambitions. For this thesis, the book is valuable not only for its technical explanations but also for situating fusion within a longer trajectory of scientific aspiration. It frames fusion as a project that has always combined technological experimentation with cultural and political imagination, reinforcing the need for architectural strategies that can give form to these ambitions in the present. **Keywords: fusion research, plasma confinement, reactor design, history, experimentation, technology, architecture.**

Turcanu, Catrinel, Ana Prades, Roser Sala, Tanja Perko, and Christian Oltra. "Fusion Energy: A Deeper Look into Attitudes among the General Public." *Fusion Engineering and Design* 161 (December 2020): 111891. https://doi.org/10.1016/j.fusengdes.2020.111891

Turcanu and colleagues analyze European public attitudes toward fusion, focusing on knowledge, trust, and perceived risk. Their surveys reveal cautious optimism but also confusion, as many respondents associate fusion with nuclear accidents and long-lived waste. The findings emphasize that public support depends on transparent communication and visible benefits, not just technical assurances. For this thesis, the article reinforces that architecture must act as a medium of communication, making fusion facilities legible, approachable, and situated within broader narratives of sustainability. It underscores the role of design in bridging the gap between expert confidence and public uncertainty. **Keywords: fusion energy, public attitudes, risk perception, trust, sustainability, architecture.**

UBM Development. "Where Hilltop Sports Meet Clean Energy: CopenHill by BIG." *UBM Development Magazine*. https://www.ubm-development.com/magazin/en/where-hilltop-sports-meet-clean-energy/

U.S. Department of Energy. 2022. "DOE National Laboratory Makes History by Achieving Fusion Ignition." Press release, December 13, 2022. https://www.energy.gov/articles/doe-national-laboratory-makes-history-achieving-fusion-ignition

U.S. Department of Energy. n.d. "The Manhattan Project: An Interactive History." Office of Scientific and Technical Information (OSTI). Accessed October 2, 2025. https://www.osti.gov/opennet/manhattan-project-history/index.htm.

U.S. Energy Information Administration (EIA). "Nuclear Explained: Data and Statistics." Last modified 2023. https://www.eia.gov/energyexplained/nuclear/data-and-statistics.php

This EIA page provides statistical data on U.S. nuclear reactors, including generating capacity, electricity share, and capacity factors. The data serve as a benchmark for understanding nuclear's current role in the U.S. energy mix. For this thesis, the statistics are critical to contextualizing fusion's potential scale, helping measure the impact of a facility like ARC or ITER against existing infrastructure. The resource is especially useful for comparative framing in visual materials such as posters and timelines. **Keywords: EIA, nuclear power, statistics, U.S. energy mix, capacity, infrastructure.**

U.S. Energy Information Administration (EIA). "Nuclear Power and the Environment." Last modified 2023. https://www.eia.gov/energyexplained/nuclear/nuclear-power-and-the-environment.php

This EIA explainer summarizes the environmental dimensions of nuclear energy in the United States, including waste handling, land use, and emissions comparisons. While not peer-reviewed, the source is authoritative as a U.S. government agency publication, providing baseline facts for policy and public discourse. For this thesis, the entry is valuable as context for fusion's differentiation from fission, especially around waste and safety narratives. It offers concise, accessible data that can inform design communication and public engagement strategies. **Keywords: EIA, nuclear power, environment, waste, safety, energy systems.**

U.S. Nuclear Regulatory Commission (NRC). n.d. "Backgrounder on the Three Mile Island Accident." Accessed October 2, 2025. https://www.nrc.gov/reading-rm/doc-collections/fact-sheets/3mile-isle.

United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR). n.d. "The Fukushima-Daiichi Nuclear Power Station Accident: An Overview." Accessed October 2, 2025. https://www.unscear.org/unscear/en/fukushima.html.

University of Chicago. n.d. "The First Nuclear Reactor, Explained." Accessed October 2, 2025. https://news.uchicago.edu/explainer/first-nuclear-reactor-explained.

V. Chuyanov. "International Thermonuclear Experimental Reactor (ITER) Plant Layout and Site Services," January 1, 1999

Chuyanov details the overall programmatic layout of the ITER facility, including the tokamak complex, auxiliary buildings, cooling systems, and service infrastructure. The paper highlights how technical imperatives (such as safety zones, tritium handling, and seismic resilience) translate into spatial zoning and building organization. More than a technical report, it establishes the foundational program that defines how a fusion plant operates as a campus, separating hazardous areas from support and service functions. For this thesis, the article is valuable not only as documentation of ITER's design but also as a model of how fusion demands generate programmatic frameworks that could evolve into an architectural typology. **Keywords: ITER, programmatic layout, site planning, plant design, infrastructure, architecture, campus organization.**

Vaclav Smil. *Energy and Civilization : A History*. Cambridge, Ma ; London the Mit Press, 2017

Smil presents a comprehensive history of how successive energy systems, from prehistory through fossil fuels, electricity, and nuclear power, have shaped human civilization. He identifies energy transitions as not just technological changes but as cultural and infrastructural reorganizations that leave lasting imprints on landscapes, settlements, and architecture. By tracing how coal, oil, and electricity produced distinct infrastructures and cultural meanings, Smil provides a framework to situate nuclear fusion as the next potential transition whose architectural form remains undefined. For this thesis, the book establishes the precedent that all major energy systems have produced new typologies, reinforcing the need to interrogate what typology fusion might generate. **Keywords: energy transitions, infrastructure, fossil fuels, electricity, nuclear power, civilization, architecture.**

Valentine, Cleo. "The Impact of Architectural Form on Physiological Stress: A Systematic Review." *Frontiers in Computer Science* 5 (January 4, 2024). https://doi.org/10.3389/fcomp.2023.1237531

Valentine reviews empirical studies on how architectural form influences human physiological stress responses, drawing on biometric data such as heart rate and cortisol levels. The article finds that certain spatial configurations, scales, and geometries can either heighten or alleviate stress. Importantly, it argues that design decisions have measurable effects on well-being and public comfort. For this thesis, the review strengthens the case for architecture's role in shaping trust in fusion facilities. If forms associated with control, openness, and natural reference can reduce stress, these strategies could be applied to fusion plants to counteract public anxiety and stigma. **Keywords: architectural form, stress, physiology, well-being, perception, fusion facilities.**

WikiArquitectura. "Beinecke Library." *WikiArquitectura*. https://fr.wikiarquitectura.com/beinecke-library-sec-3-2/

World Nuclear Association. n.d.-a. "Chernobyl Accident 1986." Accessed October 2, 2025. https://world-nuclear.org/information-library/safety-and-security/safety-of-plants/chernobyl-accident.

World Nuclear Association. n.d.-b. "Fukushima Daiichi Accident." Accessed October 2, 2025. https://world-nuclear.org/information-library/safety-and-security/safety-of-plants/fukushima-daiichi-accident.

Wu, Y. "Conceptual Design of the China Fusion Power Plant FDS-II." *Fusion Engineering and Design* 83, no. 10-12 (December 2008): 1683–89.

https://doi.org/10.1016/j.fusengdes.2008.06.048

Wu presents the conceptual design of the China Fusion Design Study II (FDS-II), outlining its reactor systems, safety provisions, and site organization. The study highlights how engineering requirements such as tritium handling, neutron shielding, and thermal management dictate spatial and programmatic decisions. By integrating lessons from ITER, the design aims to adapt experimental research into a more commercially oriented plant. For this thesis, the article expands the global precedent base beyond European and Japanese models, demonstrating how cultural and national contexts shape fusion architecture. It reinforces the idea that technical demands and civic identity must be negotiated together in facility design. **Keywords: fusion power plant, FDS-II, conceptual design, site planning, safety, architecture.**