

Regenerative Design Group

SPECIALTY SERVICES



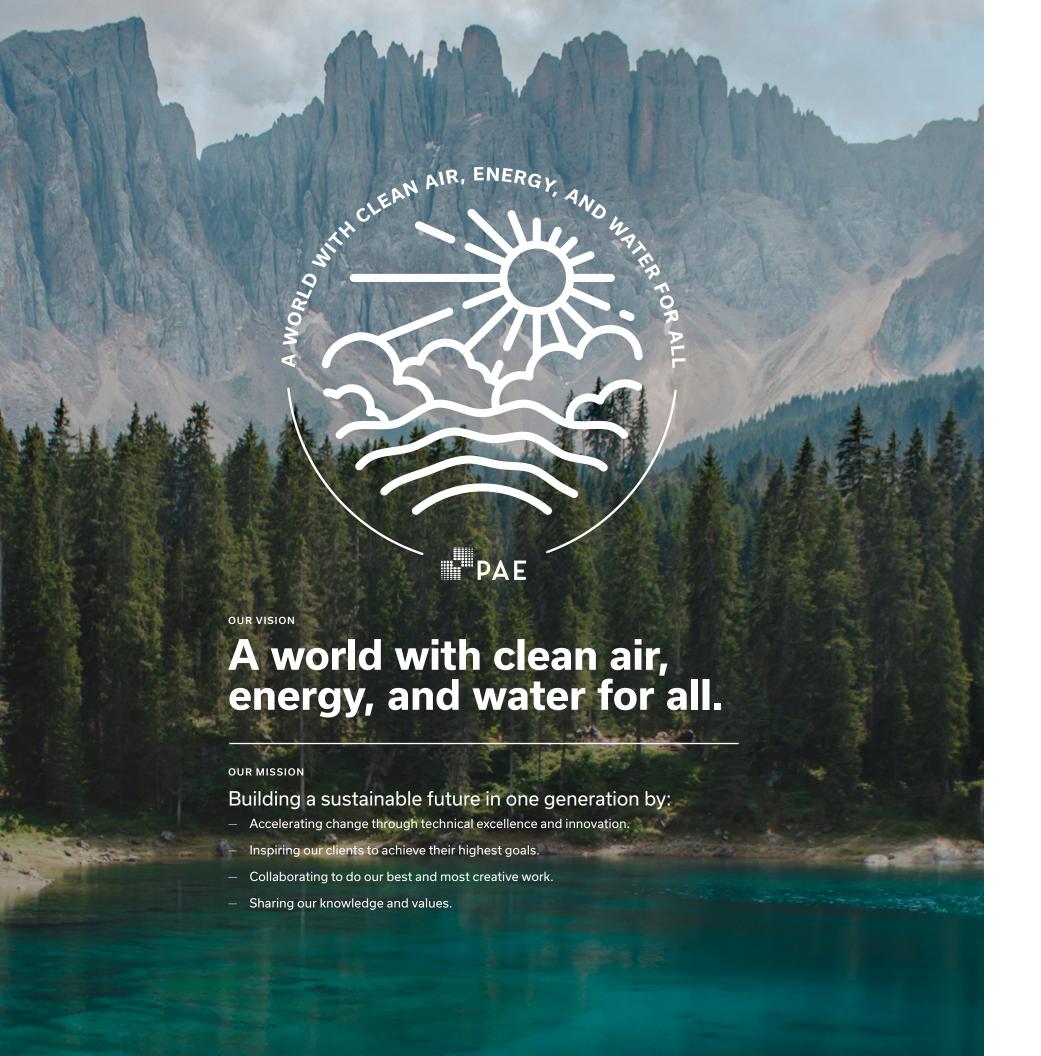


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Meet PAE

We design buildings that give more than they take.

Established in 1967, PAE is a 400-person firm providing services in mechanical, electrical, and plumbing engineering, building performance analysis, and technology and lighting design services via LUMA, our dedicated lighting design group within PAE. Our Regenerative Design Group adds a focus on systems thinking, deep carbon reduction, and solutions that

restore ecological and human health. As a multidisciplinary team with regenerative design and engineering under one roof, we carry the vision from concept through commissioning. This integrated approach means we're not only imagining what's possible—we're delivering buildings that perform, inspire, and regenerate.



PAE is an engineering and design firm that turns complex challenges into reality. By leveraging the latest technologies we solve problems in unique ways and our designs enable buildings and communities to be more resilient and efficient. PAE is trusted by our clients in every aspect of a project's lifespan, from idea to occupancy. We set ambitious goals backed by analysis to significantly conserve water and energy while balancing costs and long-term operational needs.

As a B Corp, we measure success by the benefits our projects provide to our clients, our communities, and our planet. We embrace innovation, transparency, sustainability, and lifelong curiosity.







SERVICES



Regenerative **Design Services**

Our Regenerative Design services help clients solve complex problems and make informed decisions through modeling and analysis for their buildings and districts. Through our deep understanding of the built environment, we can show predictive performance and the value of goals over time, bridging the gap between architectural design and various building and district systems. Our services inform the vision, implement details, and track performance.



Technology Design

Our technology design team works in partnership with our clients to provide tailored solutions that are reliable and robust. We design systems which enable occupants of the built environment to connect, collaborate, and innovate. We listen to each client user group and design intuitive audiovisual systems, powerful wired and wireless communications infrastructure, and dynamic physical security solutions.



Architectural Lighting Design

LUMA is a dedicated lighting design service within PAE. We collaborate with our clients to decide on a common vision through light. We listen and probe. We question and clarify, exploring all options. We then use light to organize and reinforce the architectural vision.



Mechanical Engineering

PAE's mechanical engineering services are focused on building performance, comfort, controllability, energy use, maintainability, and the elegant integration of mechanical and plumbing systems with architectural design. We also offer related services such as fire-protection systems design, commissioning, comfort analysis, envelope optimization, water-cycle analysis, and energy modeling.



Electrical Engineering

PAE provides engineered electrical systems, including designs for metering and renewable-energy systems, that are tailored to each client's project criteria and malleable enough to meet future goals. We work collaboratively to develop innovative ideas for lighting, control, power, and technology systems that are integrated and work in concert with the building and its occupants.

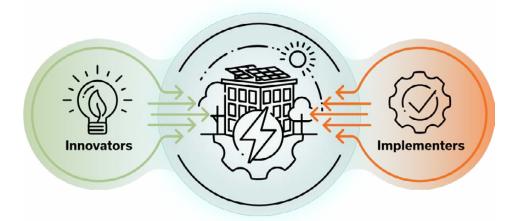


Plumbing Engineering

We work early on with project teams to analyze the use of water to find healthy, innovative, and simple designs that elegantly integrate with the building's mechanical systems and architectural designs. Our Regenerative solutions for water and waste include: water use reduction and energy-saving design strategies, specialty piping systems, onsite treatment, and more.

Regenerative Design At PAE

PAE's Regenerative Design Team is a multidisciplinary group driving high-performance, low-impact, and climate-positive outcomes across all building types and scales. We collaborate with architects, developers, and communities to embed sustainability, resilience, and equity from concept through post-occupancy. Rooted in rigorous technical analysis, our approach is intentionally holistic; it addresses energy, water, materials, embodied and whole life carbon, passive design strategies, ecological integration, occupant health, and future climate readiness.

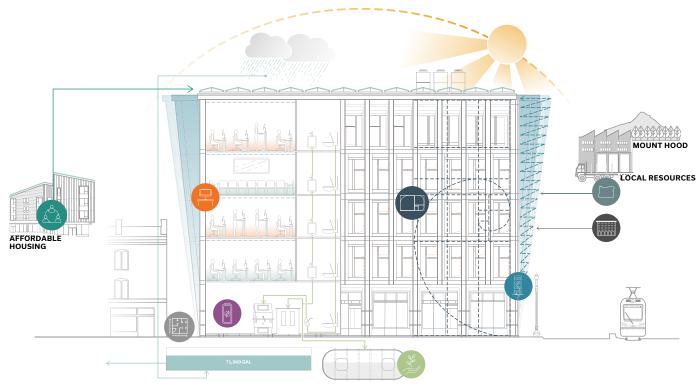


We act as translators between performance data and design intent, helping teams articulate the value of sustainability strategies in ways that are both technically sound and emotionally resonant. We believe every project has a story to tell, including the people it serves, the systems it transforms, and the future it imagines. We shape those narratives to support design alignment, stakeholder engagement, and long-term impact.

More than just meeting certifications like LEED, Passive House, or Living Building Challenge, our work aims to push past compliance toward regenerative outcomes that restore ecological balance, improve human wellbeing, and inspire meaningful change.

Regenerative Design in Action

The PAE Living Building isn't just a structure — it's proof that regenerative design is achievable today. As the world's first developerdriven Living Building, it produces more energy and water than it consumes, demonstrating how sustainable buildings can restore ecological balance and provide long-term community value.





NET ZERO

The building rethinks the concept of net-zero in an urban context to deliver best-in-class energy efficiency and maximum onsite production. The 133 kW onsite photovoltaic (PV) system and a 195 kW off-site PV array, in collaboration with a nearby affordable housing project, produce more energy annually than needed to operate the building.



BATTERY

Net-metering in urban centers has often been seen as impractical due to technological limitations in electrical networks, hindering solar energy integration. The building challenges this notion by using a 380 kWh onsite battery, which stores solar energy during the day and releases it back to the grid at night. This arrangement allows for a major downtown PV installation and creates an opportunity for a gridfriendly building that helps deliver clean energy at night when other solar renewable power is unavailable.



THERMAL COMFORT

A high-performance envelope, operable windows, and radiant heating and cooling throughout reduce cooling and heating energy use to less than 50% of what a typical building would need. In lieu of a geothermal heat pump system often used in ultra high-performance HVAC systems, the building is designed around air-source heat pumps.



RESILIENCY

Engineered to have a lifespan of half a millennium, this building is built to withstand Category IV earthquakes, a synonymous standard with hospitals and emergency facilities.



100% of building's water needs are collected, treated, and used onsite with the help of a 71,000 gallon underground cistern, including drinking water. The building only uses municipal water for the fire protection systems.



COMMUNITY BENEFIT

The project includes a 195kW photovoltaic system on a nearby affordable housing project. The energy will be provided to the organization at below market rate. The total present value of the reduced electrical costs over 15 years is anticipated to be nearly \$200,000.



NUTRIENTS

The nutrients from the building's toilet systems are fed to the 18 composters using a vacuum flush system, a first of its kind for a multistory living building. The innovative waste treatment systems reduce water use and create valuable plant-nutrient streams, closing the loop between agriculture, food, and what used to be considered waste.

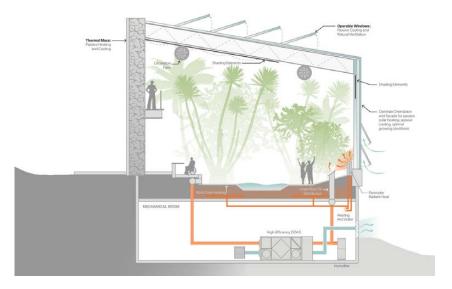
What Makes Us **Different**

At PAE, we believe that great design is both visionary and verifiable.

We achieve this with a data-driven approach that takes large data sets to simulate performance for both current and future location-specific weather conditions. Data analytics are used to probe results and identify optimal solutions to complex problems. This approach allows project teams to test ideas confidently, ensuring that a design will work once it is built.

This rigorous analysis allows us not only to confirm performance but also to explore new ideas, compare options, and discover solutions that might otherwise be overlooked. The process clarifies complex challenges, ensuring that our systems are as simple as possible while meeting ambitious goals.

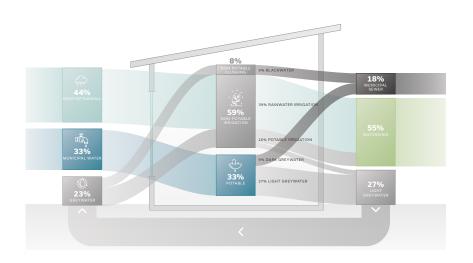
By grounding each project in real-world data, we provide owners and design teams with confidence that strategies will succeed, budgets will remain balanced, and performance targets will be met. This philosophy influences everything we do and forms the foundation of what sets PAE Regenerative Design Services apart: an integrated approach, clear communication, meaningful innovation, and proven results.



Integrated Approach

As part of PAE, our Regenerative Design Services integrate seamlessly with our MEP engineers. This close collaboration breaks down silos, enhances efficiency, and unlocks new opportunities for performance across disciplines. By working together from the start, we align analysis and design to deliver outcomes that are more resilient, efficient, and regenerative.

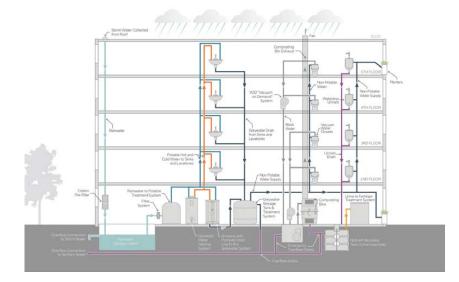
← Conservatory Concept Appalachian State University Conservatory for Biodiversity Education & Research | BOONE, NC



Clear Communications

We turn complex data into clear, actionable insights. By making analysis understandable to owners, contractors, and design partners, we create transparency that drives confident decisions and keeps projects on track.

← Water Flow Diagram Confidential Client | WASHINGTON



Meaningful Innovation

For us, innovation isn't about chasing novelty—it's about impact. By simulating and testing ideas, Regenerative Design Services identifies strategies that are bold, practical, and proven to perform in the real world.

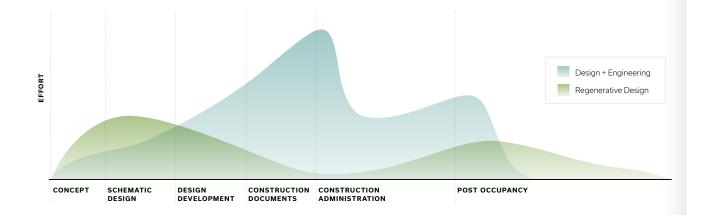
← Water Systems Diagram PAE Living Building | PORTLAND, OR

How Our Insights Multiply

Project Timing and Integration

Smart project timing is essential to achieve high-performance goals. This is especially critical where integrated designs are needed crossing boundaries between disciplines.

Our best projects integrate our analysis with the entire team early so there is a clear vision. With this vision, the entire team can work together to find solutions that previously were considered too hard, too expensive, or too unconventional. It is very common that projects that achieve higher goals have minimal cost premiums and inspire change through the entire team and, potentially, the entire building industry.



Systems Modeling INFORMS ONSITE ENERGY ARCHITECTURAL RESOURCES **DESIGN** OCCUPANT CODE COMFORT COMPLIANCE **STUDIES** BUILDING **ENERGY MEP DESIGN PERFORMANCE STANDARDS** GREEN **EMBODIED AND** BUILDING **OPERATIONAL RATING EMISSIONS ENERGY RESILIENCE** SOLUTIONS RESULTING IN **Optimized Building Outcomes**

Regenerative Design

Build beyond our most audacious sustainability goals.

PAE relies on our Regenerative Design services to help clients make informed decisions in everything from sustainability goals for their projects to building performance and occupant satisfaction. This is done through careful analysis and our deep understanding of building science to show predictive performance and the value of the goals over time. It also enables us to advise against any mishaps before they happen. Quantitative analysis makes qualitative visions a reality and allows us to envision even more for the project.







Energy Modeling and Analysis

Natural

Daylight

Analysis

Ventilation



Thermal Comfort **Analysis**



Facade Optimization



Passive House



Water Balance Analysis





Whole Site Carbon Analysis

Energy Analysis

Whole Site Water

Whole Site

Analysis

Site Ecology

Potentials



Strategic Visioning



Regenerative Potentials



Resiliency



Planning





Microgrids



Full System Design



Battery Energy Storage System



Grid-Interactive **Building Design**



Solar PV



Energy Resilience



Distributed Energy Resource Analysis



Life Cycle Cost Analysis





Whole Life Carbon



Gap Analysis



Operational Carbon



Embodied Carbon



MEP Life Cost Analysis



Time-of-Use **Emissions**

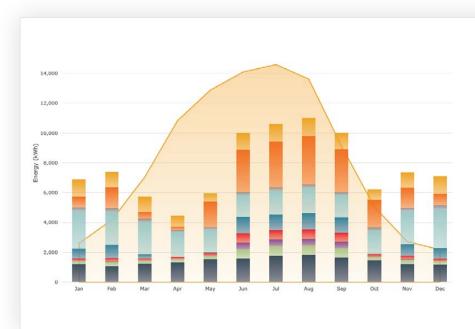


Climate Change Analysis

Resource Efficiency

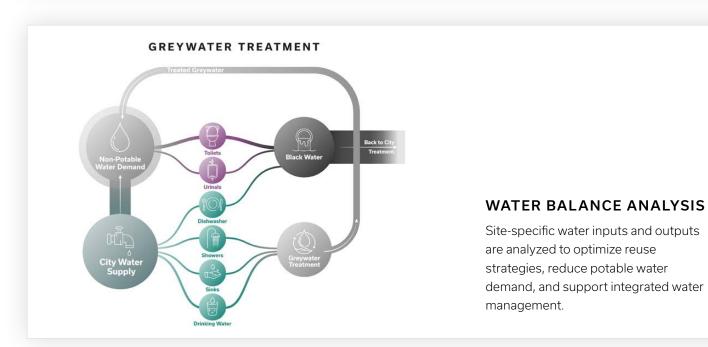
Integrated buildings with best-in-class performance

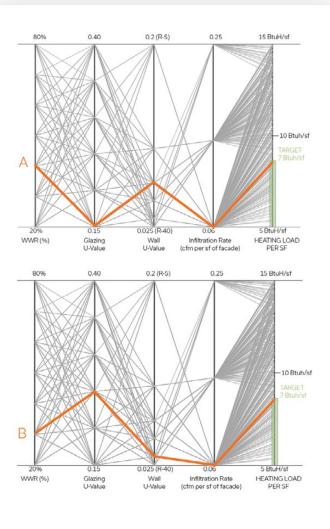
By using building performance analysis, we can take a deeper look at the way a building will exist in its environment both today and in the future. We work with the entire design team to create systems to maximize the value of buildings while also respecting resource use. This offers benefits for clients by lowering costs while achieving optimal performance outcomes.



ENERGY ANALYSIS

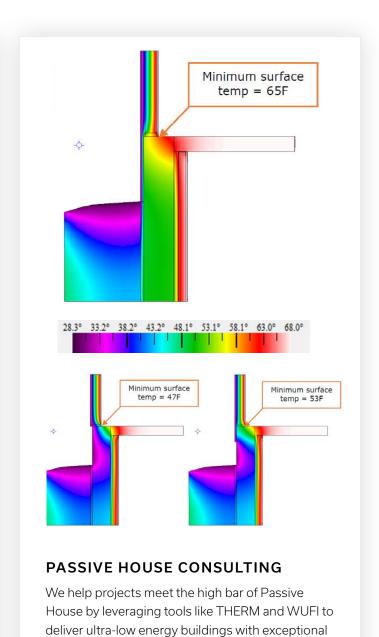
Energy performance is modeled and evaluated for each project to identify targeted strategies that reduce consumption, lower emissions, and improve long-term operating costs. We consider monthly end-use breakdowns and hourly profiles to uncover specific energy trends.





FAÇADE OPTIMIZATION

Facade systems are optimized using parametric analysis to balance aesthetics, energy performance, daylight access, and thermal comfort.

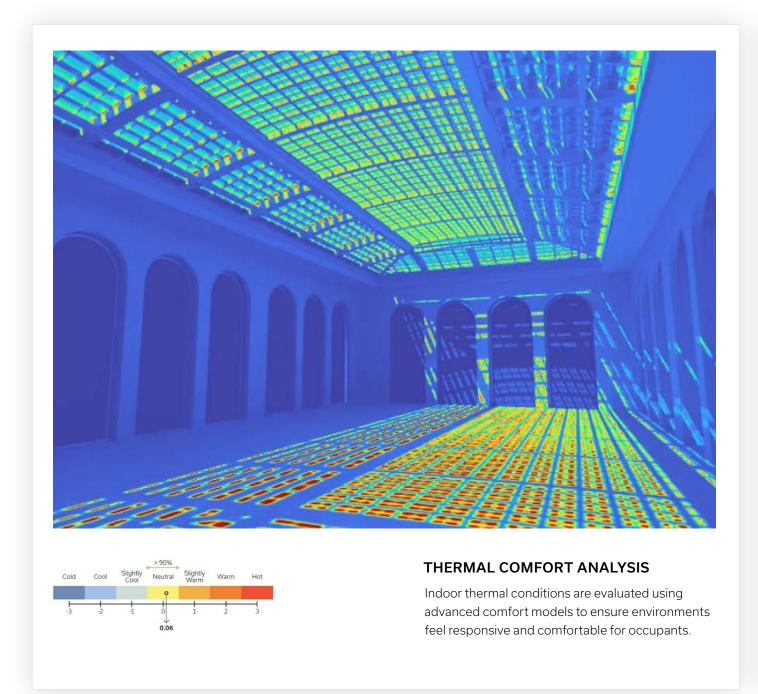


indoor air quality and thermal comfort.

Experiential

Great buildings don't just perform well, they feel right.

At PAE, we use experiential analysis to ensure that design decisions support comfort, wellness, and delight for the people who occupy them. From thermal comfort and daylight access to natural ventilation and visual quality, we simulate how spaces will actually be experienced across seasons, orientations, and uses. These analyses translate technical metrics into human-centered insights, empowering design teams to balance aesthetics, performance, and lived experience. Whether you're shaping a healing environment, a learning space, or a workplace, we help ensure that every square foot supports comfort, health, and emotional connection.







DAYLIGHT ANALYSIS

Daylight conditions are simulated to inform design strategies that enhance visual comfort, reduce glare, and decrease reliance on artificial lighting.



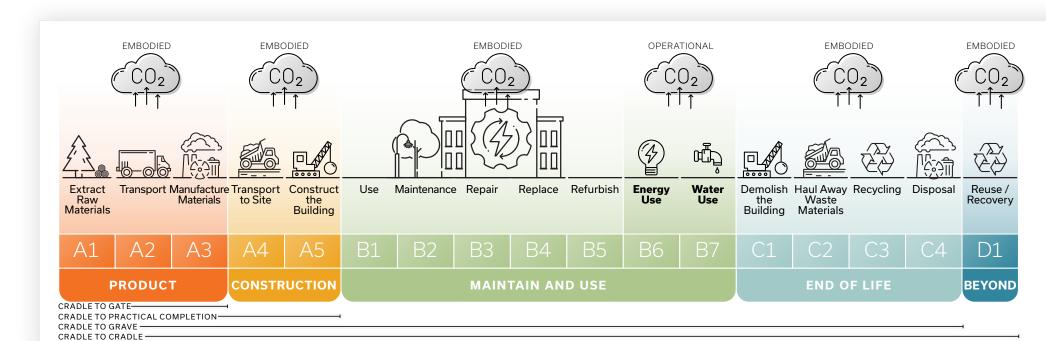
NATURAL VENTILATION CONCEPTS AND ANALYSIS

Natural ventilation strategies are developed and integrated into architectural designs to improve indoor air quality, reduce cooling loads, and support passive design goals.

Whole Life Carbon

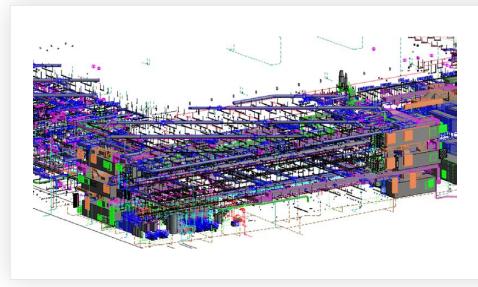
If regenerative architecture is the goal, we must focus on the metrics that capture a building's total climatic impact.

By using net-zero carbon as a benchmark, we can evaluate projects from cradle to grave. This includes operational energy use, refrigerant leakage, and embodied greenhouse gas (GHG) emissions. Comparative life cycle assessments help us weigh design options and identify strategies that minimize whole life carbon. Treating carbon as the key performance metric shifts how we understand regenerative design. It means recognizing both the sources of emissions and the potential for carbon sinks. Even Net-Zero Energy buildings can have high GHG emissions if they ignore embodied carbon, refrigerants, or grid emissions.



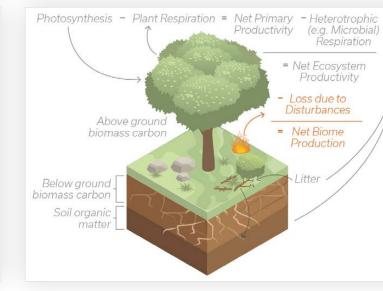
WHOLE LIFE CARBON ANALYSIS INTEGRATOR

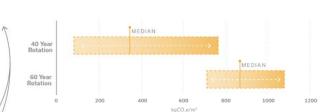
Whole life carbon analysis quantifies both embodied and operational carbon across a building's entire life cycle to support low-carbon decision-making. As the Whole Life Carbon Integrator, PAE will be the central point of coordination to unify embodied and operational carbon data into a clear, actionable framework. By aligning project goals with ASHRAE 240-2024 and providing targeted insights, we help teams stay focused on what matters most: reducing total carbon impact.



MEP EMBODIED CARBON

Embodied carbon in mechanical, electrical, and plumbing systems is the next frontier to reduce whole-building emissions. As an early signatory of MEP 2040, PAE has developed our own modeling tool as part of our commitment to pushing the industry toward greater accountability.





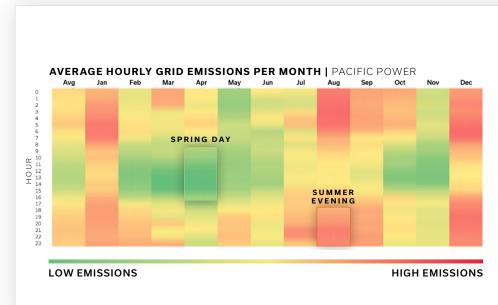
BIOGENIC CARBON ANALYSIS

Carbon storage in plant-based materials is evaluated to support regenerative material strategies and reduce net project emissions. PAE developed a new method for accounting for biogenic carbon, revealing the nuance in wood selection across projects.

Emissions Analysis

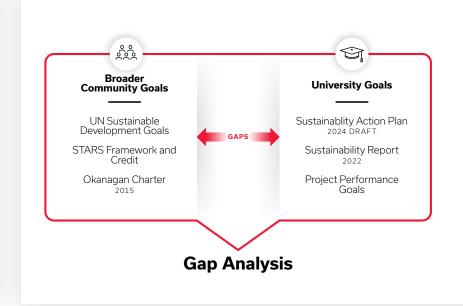
Reaching zero carbon.

A holistic view of emissions in the built environment is essential to achieving meaningful carbon reductions and addressing the climate crisis. As a leader in carbon emissions consulting, PAE analyzes all three GHG Protocol scopes (1, 2, and 3) while also conducting deep assessments of operational, refrigerant, and embodied carbon. We look beyond the buildings of today to the systems of tomorrow, accounting for factors such as regional grid emissions, time-of-use energy impacts, and future climate conditions. This comprehensive approach enables organizations, developers, and policymakers to set and achieve effective strategies for decarbonization and carbon neutrality.



TIME-OF-USE EMISSIONS

Emissions are assessed based on when energy is consumed to align building operations with cleaner grid hours and capture the complexity of the operational carbon story.



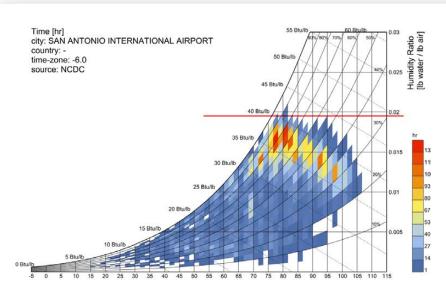
GAP ANALYSIS

A new way of thinking is needed to overcome traditional project barriers in achieving net positive energy, carbon, and water. Gap analysis is done early in the project to convene key project stakeholders and our team to confirm areas of research, collect known barriers, and set the project success criteria.



MEP LIFE CYCLE ANALYSIS

MEP systems are assessed across their full life cycle to guide decisions around durability, cost, carbon impact, and long-term performance.



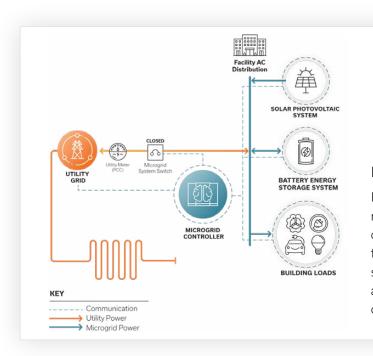
CLIMATE CHANGE ANALYSIS

Future climate scenarios are projected to inform design strategies that ensure comfort, performance, and compliance over time, even in a changing climate.

Microgrids and Energy Resilience

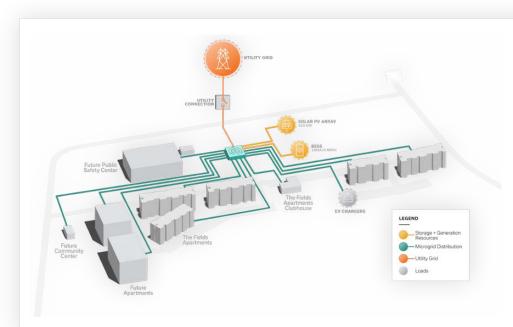
Microgrids sit at the intersection of sustainability and resiliency

PAE has established itself as a leader in sustainable and resilient microgrid design. With designs that integrate photovoltaic (PV) and battery energy storage systems with the microgrid brains, our projects are able to achieve reduced operating emissions and energy resiliency. We work with owners who value minimizing operating costs, maximizing resilience, and advancing a sustainable energy future. Together we create solutions that show what is possible with future energy systems.



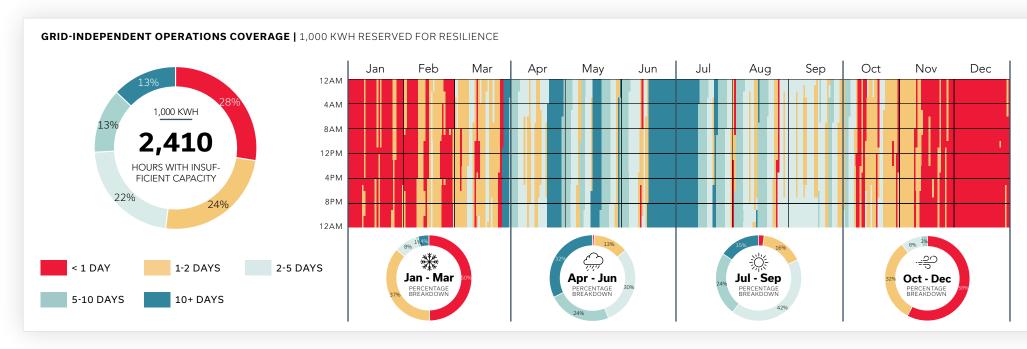
BUILDING MICROGRIDS

Building-scale microgrids integrate on-site renewable energy, storage, and smart controls to improve resilience and energy flexibility. These systems are tailored to support critical loads, enable load shifting, and operate independently during grid disruptions.



DISTRICT MICROGRIDS

District microgrids are shared energy systems that integrate generation, storage, and smart controls to serve multiple buildings. These systems enable coordinated energy management, optimize performance across diverse loads, and enhance resilience at the community scale.



ENERGY RESILIENCE ANALYSIS

System vulnerabilities are assessed to identify risks to energy performance and reliability. PAE uses its expertise in building energy modeling and electrical design to evaluate battery energy storage systems (BESS) and other generation sources as part of resilient energy strategies. With an in-house developed energy resilience modeling tool, PAE can help projects fully understand the benefits - and limits - of their energy systems.

Strategic Planning

Interconnected Strategy for Resilient Communities

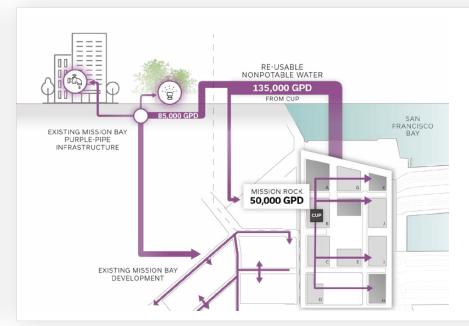
PAE's sustainable district planning begins with early, strategic conversations about climate, resources, and community needs. We identify potential challenges and opportunities to create plans that are practical, resilient, and beneficial for generations to come. Our early visioning and calculations look at how energy, water, and emissions balance out across the site based on the demands of the buildings and site elements.

By applying our analysis expertise in building performance analysis, greenhouse gas consulting, energy system and design expertise in mechanical, electrical, plumbing, and technology engineering design, these ideas become reality.



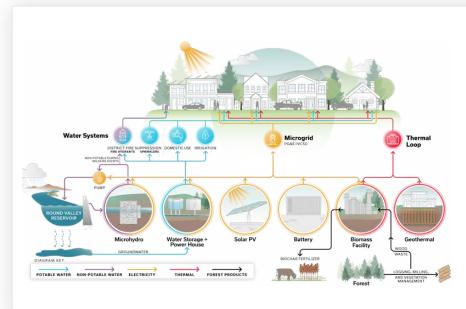
DISTRICT ENERGY SYSTEMS

District energy systems provide centralized heating, cooling, or power to multiple buildings through a shared thermal infrastructure. By aggregating demand, they improve efficiency, reduce emissions, and simplify the integration of renewable and lowcarbon energy sources.



DISTRICT WATER SYSTEMS

District water systems manage supply, reuse, and discharge across multiple buildings or campuses through an integrated approach. These systems enhance water resilience, reduce consumption, and enable more effective resource planning at scale.



STRATEGIC VISIONING

Strategic visioning aligns early project decisions with long-term goals for sustainability, resilience, and performance. This process helps set priorities, guide design direction, and ensure stakeholder alignment from the outset.



RESILIENCY PLANNING

Resiliency planning identifies risks related to climate, energy, and operations and develops strategies to mitigate them. This includes buildingand district-scale solutions to ensure continuity, adaptability, and long-term performance.





OFFICES

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