Bentley®
Advancing Infrastructure

Fast Facts

- PG&E's substation engineering department is responsible for more than 1,000 transmission and distribution substations spanning two-thirds of California.

- Accurate 3D reality models provided the basis for intelligent 3D design for retrofit projects and visualize the projects for community stakeholders.

- ContextCapture automated the production of 3D models for existing substations, eliminating manual 2D drawing conversion and field measurement.

ROI

- Automatically generating a 3D model with ContextCapture takes 80 less resource hours than manually converting 2D drawings into 3D models.

- Bentley Substation reduced the cost of recreating existing substation equipment in 3D by 50 percent.

3D Design and Modeling of PG&E Brownfield Substations Streamlines Electrical Grid

ContextCapture Automates 3D Modeling for Brownfield Projects, Resulting in a 50 Percent Reduction in Modeling Costs

Modeling Brownfield Substations

The San Francisco-based Pacific Gas & Electric Company (PG&E) owns and operates more than 1,000 transmission and distribution substations spanning two-thirds of California. The Substation Engineering Department has been struggling to keep up with the volume of projects, given the push to modernize the electric grid. About 95 percent of the utility's USD 1 billion substation budget goes to brownfield locations, where existing infrastructure is primarily documented by 2D drawings. The practice of manually converting 2D drawings to 3D models for use on retrofit projects was time consuming and inaccurate. PG&E replaced that process with reality modeling using Bentley's ContextCapture and shortened model production time by one-third. The highly accurate reality meshes are integrated into Bentley Substation for intelligent 3D design of upgrades, then shared among design teams through ProjectWise, which is used as the central repository.

Modernizing the Electric Grid

Incorporated in 1905, PG&E is now one of the largest combined natural gas and electric energy companies in the United States. The investor-owned electric utility provides energy services to approximately 16 million people throughout a 70,000-square-mile service area in northern and central California. As a subsidiary of PG&E Corporation, PG&E is part of California's massive electricity generation system, which produces more than 296,000 gigawatt hours each year.

The utility has experienced near constant growth in demand for energy recently. In the past 50 years, the number of California households has nearly doubled from 6.5 million in 1970 to 12.5 million today. While the number of consumers has grown, the way consumers use energy and electronics has dramatically changed. Keeping pace with these changing demand patterns has posed significant challenges for utilities across the country.

Model creation using ContextCapture took less than 40 resource hours with its advanced image capture and processing technology capabilities.

The current design of the energy grid has become ill-suited for efficiently managing demand. PG&E is part of a nationwide push to modernize the electric grid, transforming it into a "smart grid" that is more efficient, reliable, and responsive to consumer needs.

Substation Retrofit Challenges

Upgrading PG&E's electric grid requires advancements to existing equipment and infrastructure. Substations are a critical element of the electrical system because they connect high-voltage transmission lines with distribution lines that provide power to homes and businesses. PG&E spends about USD 950 million annually on projects at existing substations throughout its service area. The substation engineering department is responsible for a range of brownfield projects, such as expansions, upgrades, and retrofits.

Before utilizing Bentley Substation, the majority of the existing substations were designed in a 2D environment. The substation engineers were creating 3D models of these substations to be used as the basis for retrofit designs. The laborious process started with the engineers taking the existing 2D drawings of the facilities and filling in information gaps with field measurements. After about 120 hours of manual effort, the resulting models were frequently inaccurate due to errors in the legacy documentation and because the engineers were unable to go on-site to measure energized equipment.

Automating 3D Model Creation

PG&E had been previously successful in implementing Bentley Substation for the 3D design and modeling of new greenfield substations. The BIM solution switched the focus from 2D drafting and design to 3D design and modeling. The substation engineering department wanted to extend this success to brownfield projects and looked to Bentley for a time-saving solution for creating accurate 3D models of PG&E's existing substations.

Bentley's ContextCapture provided a cost-effective alternative. The software incorporates advanced image capture and processing technology to create engineering-ready reality meshes from high-resolution photography and laser-scan point clouds. By modeling existing conditions, ContextCapture provides context for new design, construction, and operations.

To capture the imagery of its brownfield substations, PG&E deploys a combination of photographic techniques using unmanned aerial vehicles, man lifts, and on-ground equipment. ContextCapture automatically identifies the relative position and orientation of each photo, reconstructs the images in 3D, and maps the appropriate textures. The software produces a reality mesh that is then referenced into Bentley Substation. ContextCapture produces an intelligent 3D reality mesh, which is referenced into Bentley Substation where engineers can complete the entire substation retrofit design that unite electrical and physical design.

Using ContextCapture, model creation takes less than 40 resource hours, including 16 resource hours for photo capture, 36 hours for automatic processing (no personnel required), and 16 resource hours for retouching.

One Source of Truth

The substation engineering department manages project information with ProjectWise, enabling the electrical and civil design teams to seamlessly share the 3D models and other data. By assigning geo-coordinates to the substation models, facility information can be incorporated into PG&E's geographic information system and also be accessible to other departments and disciplines.

Using ProjectWise, in conjunction with ContextCapture and Bentley Substation, provides one source of truth in a centralized location. The common data environment improves the accuracy and mobility of design and construction documents, and reduces the risk of redesign and rework. Having information and deliverables available on demand improves project performance and accelerates project delivery. These benefits have been instrumental in PG&E's ability to stay on track with the number of projects scheduled.

Real Time and Cost Savings

PG&E had already achieved remarkable results with the adoption of Bentley Substation. The software reduced project design time by 40 percent and saved an estimated USD 5.7 million across about 120 substation projects each year. Previously, the 3D design technology could only be applied effectively to new greenfield projects. Now, because of advances in image capture and processing, PG&E is able to implement 3D design more efficiently on existing brownfield projects at significant cost and time savings.

Using reality modeling with ContextCapture instead of manually converting 2D drawings, PG&E expects to reduce 3D modeling costs by 50 percent. Bentley's process took significantly less time to recreate an existing substation as a 3D model, compared to the previous manual method of creating a 3D model from 2D drawings. The automatically generated reality meshes are accurate within inches and completely eliminate the need to take field measurements. As a result, personnel have to travel to and from the substation facilities half as often.

PG&E also uses ContextCapture for tasks beyond the scope of modeling existing substations. The software can be used to generate a reality mesh of the terrain, producing a quick and low-cost digital terrain model without a full land survey. It can also process images of substation assets, which can be categorized, inventoried, and used to plan condition-based maintenance.

Stakeholder Engagement

Beyond the time and cost savings, reality meshes have proven to be powerful for visualizing projects and communicating with stakeholders. PG&E works collaboratively with surrounding communities to ensure that its facilities are safe, secure, environmentally responsible, and compatible with current and future development in the area. Up-to-date reality meshes allow stakeholders to clearly see the impact of projects. These real-time updates help avoid costly conflicts and changes in the field, as well as support long-term, sustainable planning.

In compliance matters, reality meshes provide realistic renderings of planned upgrades for existing substations and other facilities. Illustrating the visual impact of a new security wall, for example, helps gain community acceptance of features required by the Federal Energy Regulatory Commission. PG&E has found creative ways to maximize the value of Bentley's reality modeling software.