Bentley®
Advancing Infrastructure

Electrical Design Projects E-book

Powering Electrical Designs with Intelligent Modeling

Bentley's electrical and instrumentation design applications allow you to consolidate and automate your electrical designs while transcending the limits of unintelligent CAD graphics. With these integrated physical and electrical design applications, you can complete substation designs faster. Quickly conquer the most complex cabling projects with 3D raceway design and automatic cable routing. Save time and reduce errors with intelligent electrical design for machine controls, plants, mining equipment, and more.

The following innovative examples were selected from Bentley's *Year in Infrastructure* Awards program.

The program annually recognizes the world's most outstanding infrastructure projects. The projects are submitted by Bentley's software users and are judged by a jury of independent experts who adhere to the highest standards in determining which of the projects exemplify innovation, superior vision, and an unwavering commitment to exceptional quality and productivity. They showcase how users, just like you, have successfully employed Bentley's electrical and instrumentation design applications to save time and costs on utilities, manufacturing, power generation, and mining projects.

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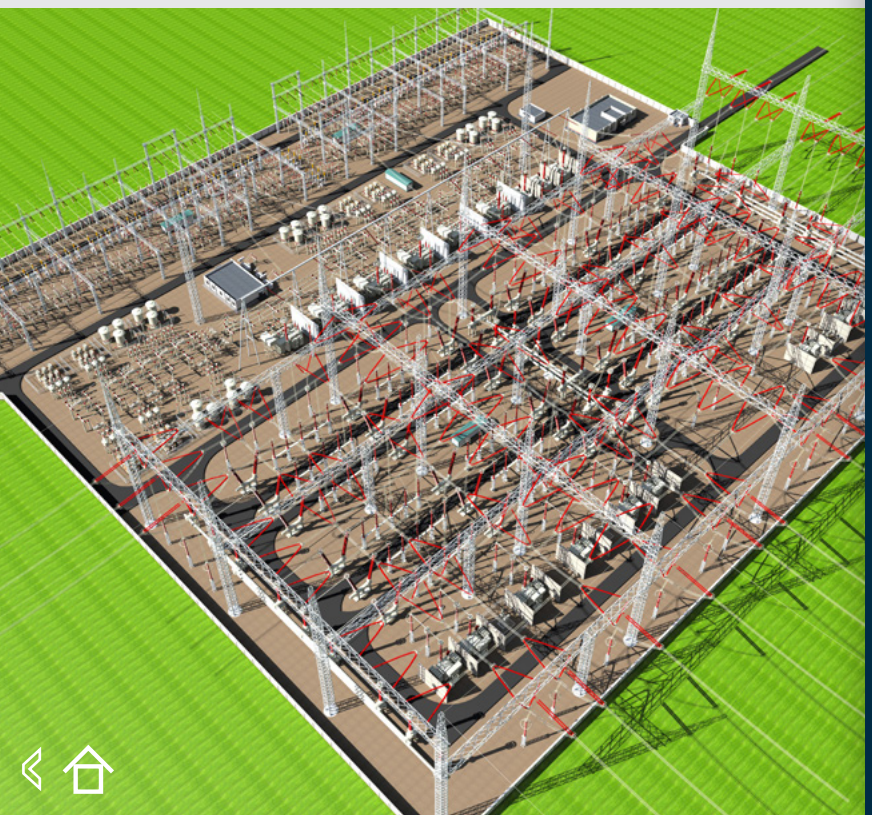
Pestech International Berhad

Substation Design and Automation for Olak Lempit Substation Project
Banting, Selangor, Malaysia

To improve power supply within the district of Banting in Selangor, Malaysia Tenaga Nasional Berhad is expanding the Olak Lempit Substation from a 275/132-kilovolt facility to a 500-kilovolt substation. Pestech International Berhad was awarded the MYR 79.5 million power system installation project to supply, erect, and commission the main intake substation.

Bentley Substation served as the main design application, incorporating cable routes from Bentley Raceway and Cable Management, electrical schematics from Promis.e, and equipment models from MicroStation. The team used Navigator to perform clash detection and ProjectWise for design collaboration and content management. Working in a comprehensive modeling environment using Bentley's automated and interoperable software minimized rework, reduced design time by 50 percent, and saved an estimated MYR 200,000.

Project Playbook: OpenBuildings Designer, Bentley Raceway and Cable Management, Bentley Substation, ContextCapture, LumenRT, MicroStation, Navigator, ProjectWise, Promis.e



Northeast Electric Power Design Institute Co., Ltd. of China Power Engineering Consulting Group

New Project of a 750-kV Substation in the Bortala Mongol Autonomous Prefecture

Bortala Mongol, Xinjiang Uyghur, China

The new Xinjiang 750-kilovolt substation will contribute to the strong grid support and high-voltage, large-capacity outbound transmission channels required to meet the demands of new energy initiatives in the Bortala Mongol Autonomous Region. The CNY 500 million project is a collaborative 3D BIM design pilot for the State Grid Corporation of China that is being designed by Northeast Electric Power Design Institute Co., Ltd. of China Power Engineering Consulting Group. The substation will improve the power supply capacity of the grid and increase the safety and reliability of power in the region.

The project team used Bentley Substation to shorten design time by 15 hours, saving CNY 200,000 in design costs. Publishing the BIM designs as iModels facilitated construction, and the reapplication of the 3D models for construction schedule simulation and operations enabled the team to realize a full lifecycle 3D BIM strategy.

Project Playbook: OpenBuildings Designer, Bentley Substation, LumenRT, MicroStation, Navigator, ProjectWise, ProSteel, ProStructures, STAAD

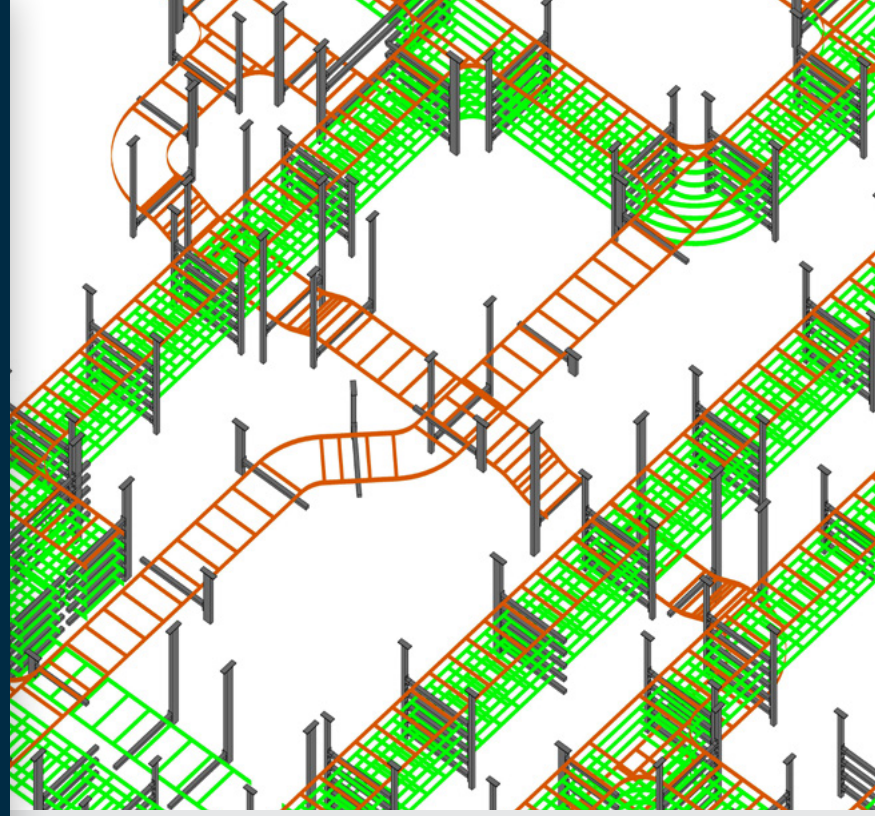
Siemens LLC

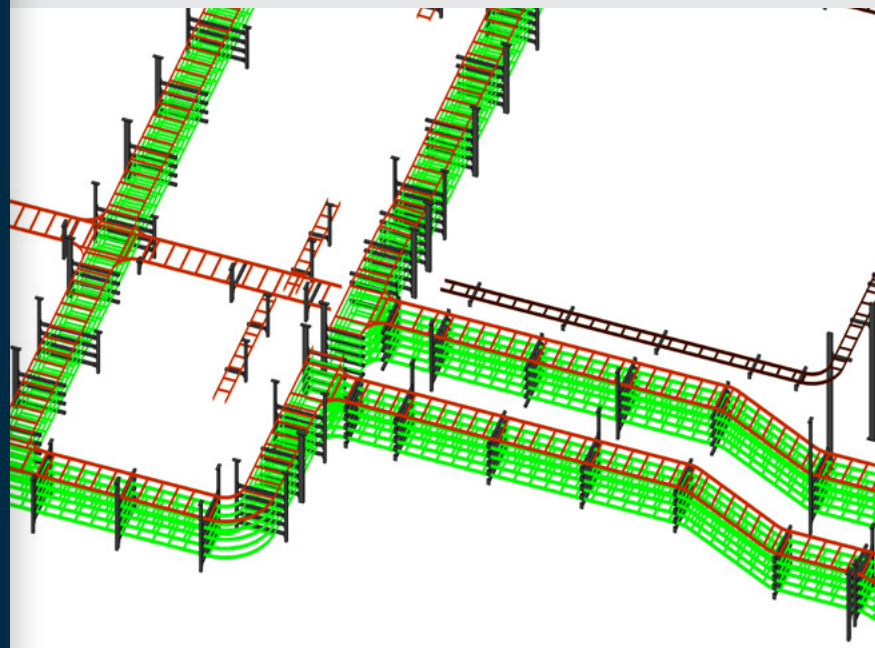
Supply and Installation of 400/132/11-kV Wafra "Z" Substation
Al Wafrah, Ahmadi Governorate, Kuwait

Wafra-Z substation is one of the largest in Kuwait, consisting of two separate buildings that house transformers and other equipment. Kuwait Ministry of Electricity and Water awarded Siemens the contract to supply all primary and secondary electrical equipment and carry out associated electrical design and engineering, installation, and commissioning. The USD 64.5 million project required proper arrangement, routing, and pulling numerous cables within basement and tunnel-space constraints.

The project team used Bentley Raceway and Cable Management to design the cable layout and produce a 3D model of the cableway system, enabling clash detection performance and reducing rework during installation. Based on the 3D model, precise bills of quantities and material were automatically calculated, improving ordering estimates. The design margin mark was reduced to less than 3 percent, compared to 10 to 15 percent on similar projects. The 3D model was exported as an iModel to use at the construction site.

Project Playbook: Bentley Raceway and Cable Management, Promis.e





THANH DAT Power Construction Designing Consulting Co., Ltd.

110-kV Bau Bang Substation

Bau Bang, Binh Duong, Vietnam

Constructed and put into operation in 2015, the 110-kilovolt Bau Bang transmission line supplies power to the Bau Bang district in the Binh Duong province of Vietnam. It is a core transmission line route creating a ring-circuit connection with the Binh Duong power center. To strengthen transmission capacity and ensure power supply to the district, the 17.5-kilometer line is being upgraded from one circuit to include two circuits. THANH DAT Power Construction Designing Consulting is responsible for designing this USD 2 million project.

The project team used Bentley Substation for 3D modeling and collaborative design. The flexibility and interoperability of the application facilitated seamless information sharing among the multiple disciplines, and intelligent modeling enabled the generation of accurate bills of material and improved design productivity. The plant design software provided a comprehensive solution to optimize design and engineering of all substation components.

Project Playbook: Bentley Substation

Pacific Gas and Electric Company

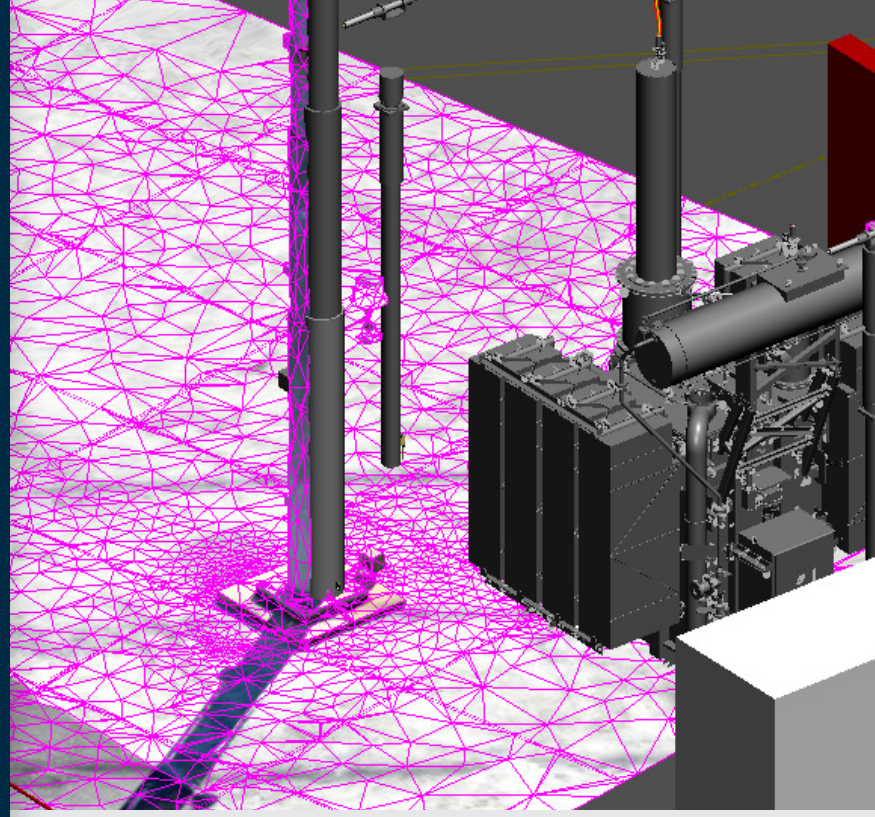
Reality Modeling in Bentley Substation

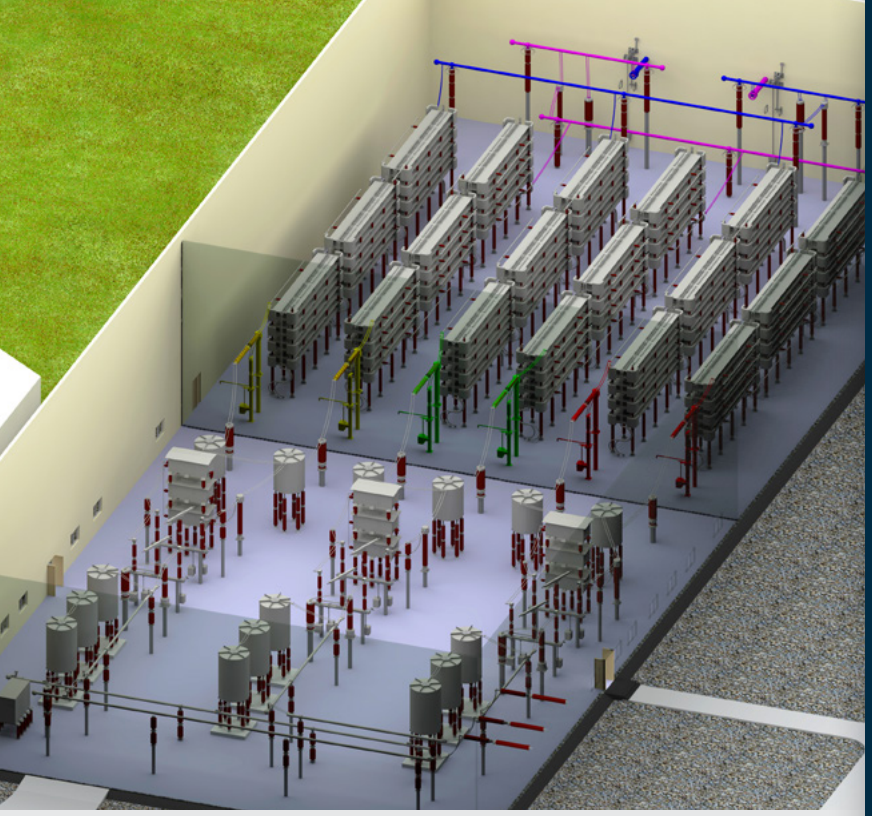
San Francisco, California, United States

Pacific Gas and Electric Company (PG&E) owns and operates more than 1,000 transmission and distribution substations, spanning two-thirds of California. With 95 percent of its USD 1 billion substation budget spent on brownfield locations, PG&E had been manually converting existing 2D drawings to 3D models for use on retrofit projects. That time-consuming process has been replaced by reality modeling based on image capture and processing.

The Substation Engineering Department has reduced the cost of substation modeling by 50 percent with the use of UAV imagery and processing with ContextCapture. Taking one-third less time than previously used methods to create, the highly accurate 3D reality models are referenced into Bentley Substation to model the existing substation in 3D for use in substation design. Using ProjectWise to share the models among design teams, PG&E now has one source of information in a centralized location.

Project Playbook: Descartes, Bentley Substation, ContextCapture, MicroStation, ProjectWise





China Energy Engineering Group Zhejiang Electric Power Design Institute Co., Ltd.

Daishan Convertor Station

Zhoushan, Zhejiang, China

Part of the island power supply network for Zhoushan, Zhejiang, China, the 300-megawatt Daishan Converter Station is the hub of the Zhoushan multiterminal, flexible, DC power transmission demonstration project. China Energy Engineering Group Zhejiang Electric Power Design Institute Co., Ltd. (CEEC-ZEPDI) designed the CNY 641.18 million station for State Grid Zhejiang Electric Power Company as part of a project to interconnect island grids and improve offshore wind power utilization.

With Bentley Substation, CEEC-ZEPDI achieved a collaborative process that shortened the design cycle to 30 days for this project. STAAD.Pro was used to create a simulation model where wind resistance design of a large-span steel roof truss structure could be researched to pinpoint the optimum design solution. Additionally, 3D design in Bentley Substation solved complex design questions for the engineering team. Accurate 3D simulations saved CNY 2.2 million in live tests.

Project Playbook: OpenBuildings Designer, Bentley Substation, MicroStation, Pointools, ProjectWise, STAAD.Pro

TRC

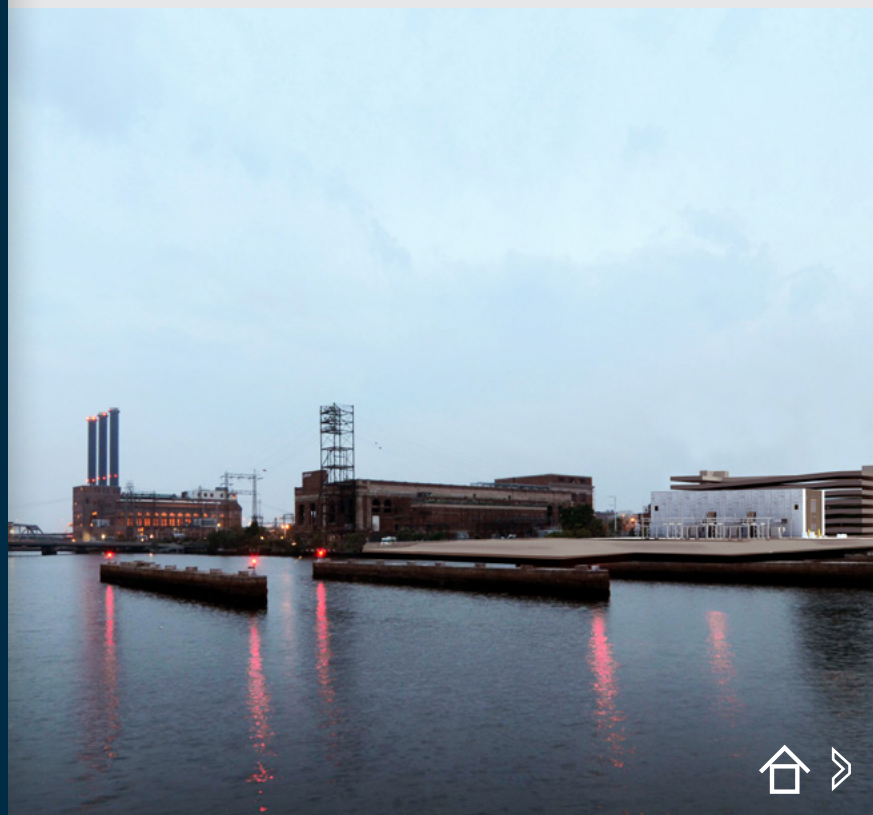
South Street Substation

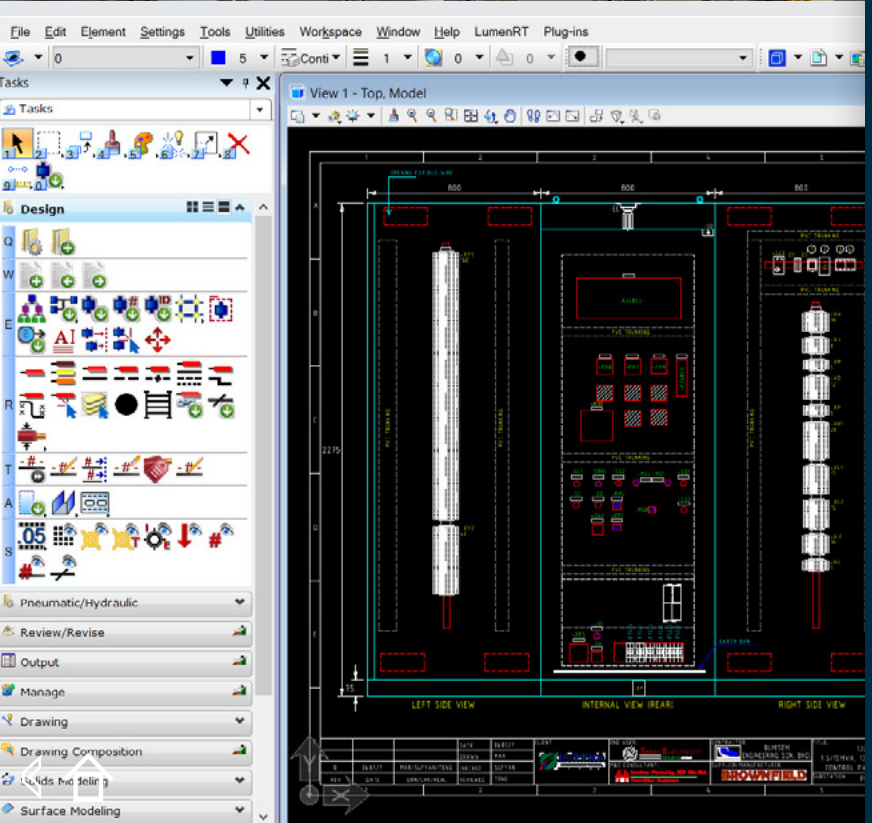
Providence, Rhode Island, United States

TRC won the USD 50 million EPC contract to rebuild and replace National Grid's South Street Substation in Providence, Rhode Island. The project included rebuilding the 115/11.5/23 kilovolt indoor substation, converting supply circuits, rerouting feeder getaways, modifying remote terminals, and installing fiber optic cable. TRC was required to integrate the new construction with existing facilities so the substation would remain in continuous operation.

TRC used Bentley solutions to achieve a design that incorporated contributions from multiple subcontractors, using various 3D design platforms. Bentley Substation integrated the different formats into a single master design model that was used for cross-discipline checking. This checking eliminated issues that would have led to construction delays and cost overruns. A full 3D walkthrough of the station's interior and exterior helped the client visualize the design.

Project Playbook: Descartes, Bentley Substation, MicroStation, ProjectWise





Brownfield Engineering Sdn. Bhd.

Propose 48-MW Large-scale Solar (LSS) Project
Kudat, Sabah, Malaysia

Kudat will soon become a renewable energy hub for the state. Solar energy is popular in the area because the region receives maximum sun exposure. Brownfield Engineering was tasked with the design, manufacture, supply, factory test, and delivery of the secondary electrical equipment, which will sit between the solar panels and substation on this project.

The team implemented Promis.e to standardize and automate its design of the secondary equipment. The system automatically generated reports and checked engineering designs, which were exported as various files to downstream manufacturing and installation processes. By using Bentley applications, cross-references occurred automatically instead of five days later, and bills of material were produced in five minutes instead of one day. Brownfield Engineering realized a 60 percent time savings by automating drawings and reports. Reducing the cost of staff, printings, and materials waste saved an estimated MYR 20,000 on the project.

Project Playbook: MicroStation, Navigator, Promis.e

Toshiba Transmission and Distribution Systems Asia Sdn. Bhd.

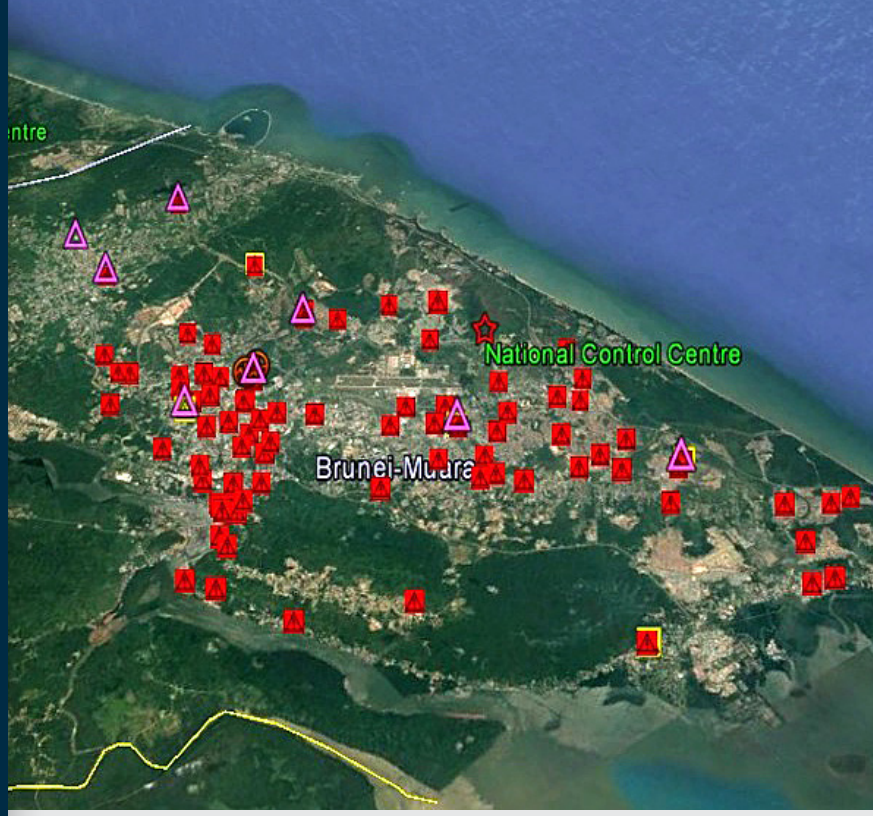
Integration of SCADA System with Electrical Panels for Brunei National Control Center

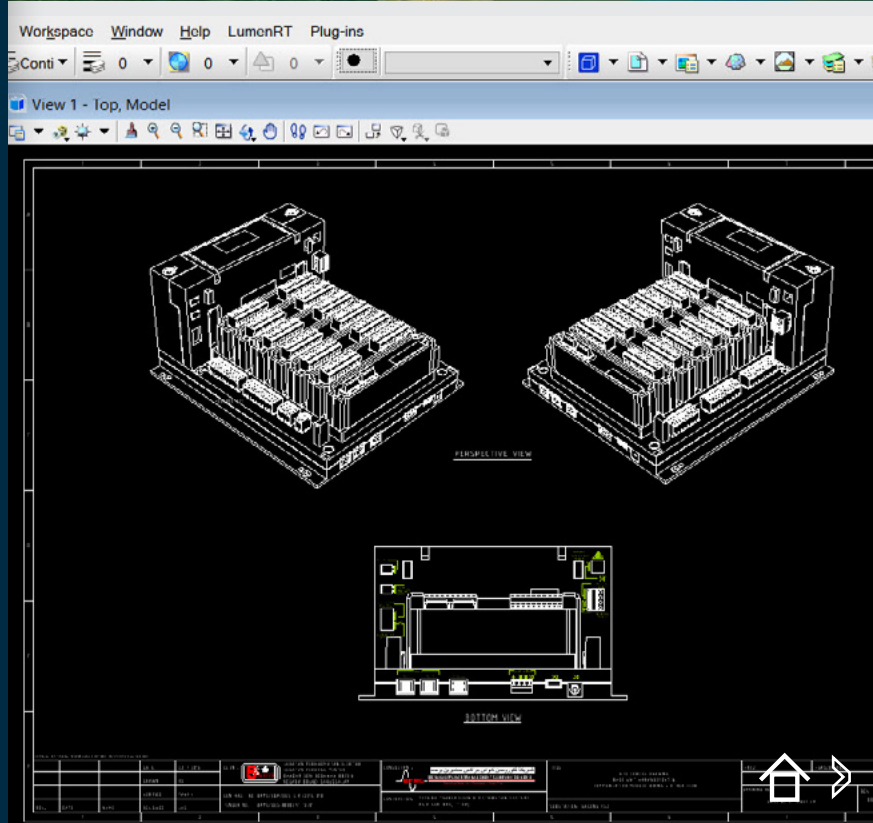
Brunei

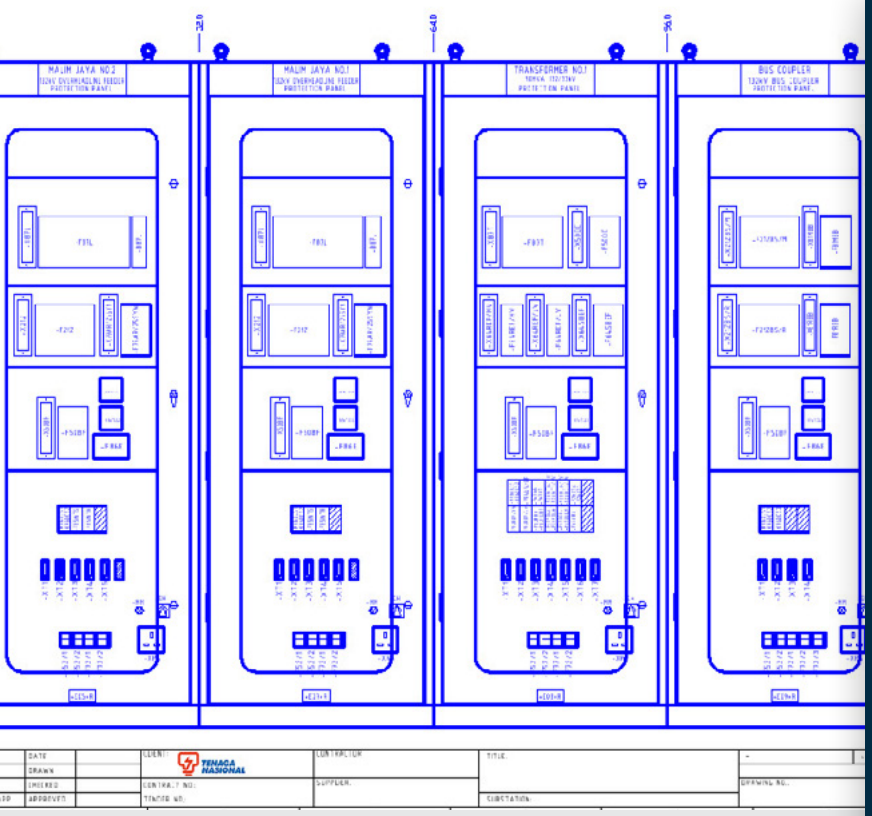
The Brunei Department of Electricity Services (DES) contracted Toshiba Transmission and Distribution Systems Asia to implement a supervisory control and data acquisition (SCADA) system in the national power grid to improve reliability of the nation's power supply. Toshiba provided equipment, engineering, and technical services for the SCADA system's supply, installation, testing, and commissioning on this USD 23 million project. This system comprises a central control center together with remote control units across the network that monitor, gather, and process real-time data.

The project team reduced design time by almost 50 percent and saved more than USD 12,000 on the resource-hour rate using Promis.e. The team completed remote terminal unit panel drawings in half the time. The System Average Interruption Duration Index (SAIDI) was considerably reduced from 167 times to 80 times a year.

Project Playbook: Bentley Substation, MicroStation, Navigator, Promis.e







ETD T&D Sdn. Bhd.

Supply of 132/33-Kilovolt Protection and Control Panel for Pulau Gadong

Pulau Gadong, Melaka, Malaysia

ETD T&D is one of the few producers of control relay panels in Malaysia. The organization was contracted by Tenaga Nasional Berhad to supply and install protection control panels for the PMU 132/33-kilovolt substation at Pulau Gadong. The estimated MYR 2 million project will prevent flashovers of circuit breakers, which can cause explosions and are dangerous for maintenance or control personnel inside the substations.

Using Promis.e's intelligent functions, the project team created and built the catalog, time block, symbols, parts information, and report template in accordance with guidelines. The process allowed the team to properly organize the project and drawings, as well as automate many of the processes. The automation reduced the required time to produce electrical drawings for the customer's approval and to change or modify reports. ETD T&D saved 65 percent on production and design time and could automatically generate reports in seconds instead of days.

Project Playbook: MicroStation, Promis.e

Tamco Switchgear Sdn. Bhd. (Larsen & Toubro Group)

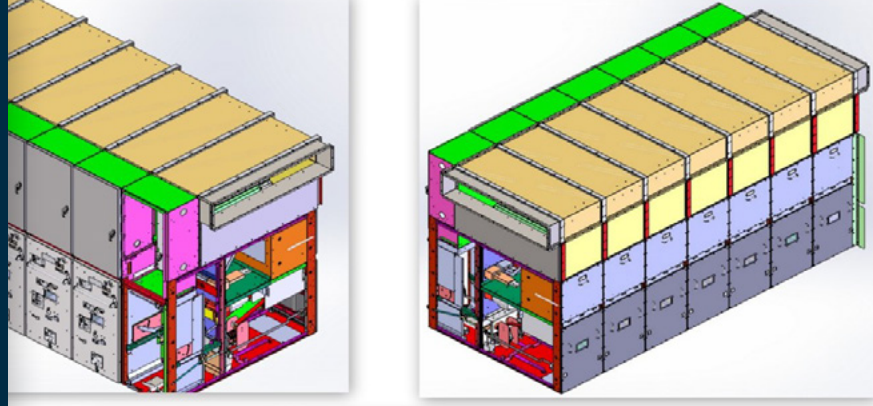
Modernization of Engineering in Control Systems

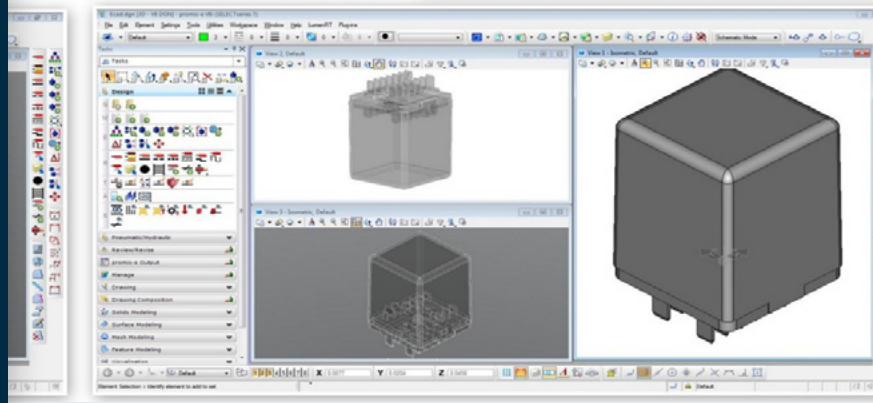
Doha, Qatar and Kuala Lumpur, Malaysia

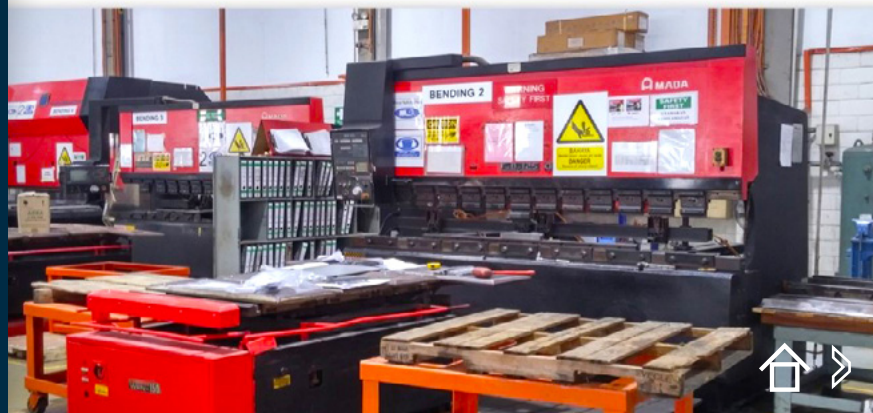
Tamco Switchgear, a leading switchgear manufacturer in Southeast Asia, was awarded the task of delivering low- and medium-voltage switchgear and protection relay panels. The USD 110 million project included the engineering, manual procurement, fabrication assembly, and mechanical design of an 11-kilovolt switchboard and remote-control panels, and associated equipment meeting the necessary requirements and standards. The team had to deliver 12,856 panels during a short delivery time while still maintaining the highest quality.

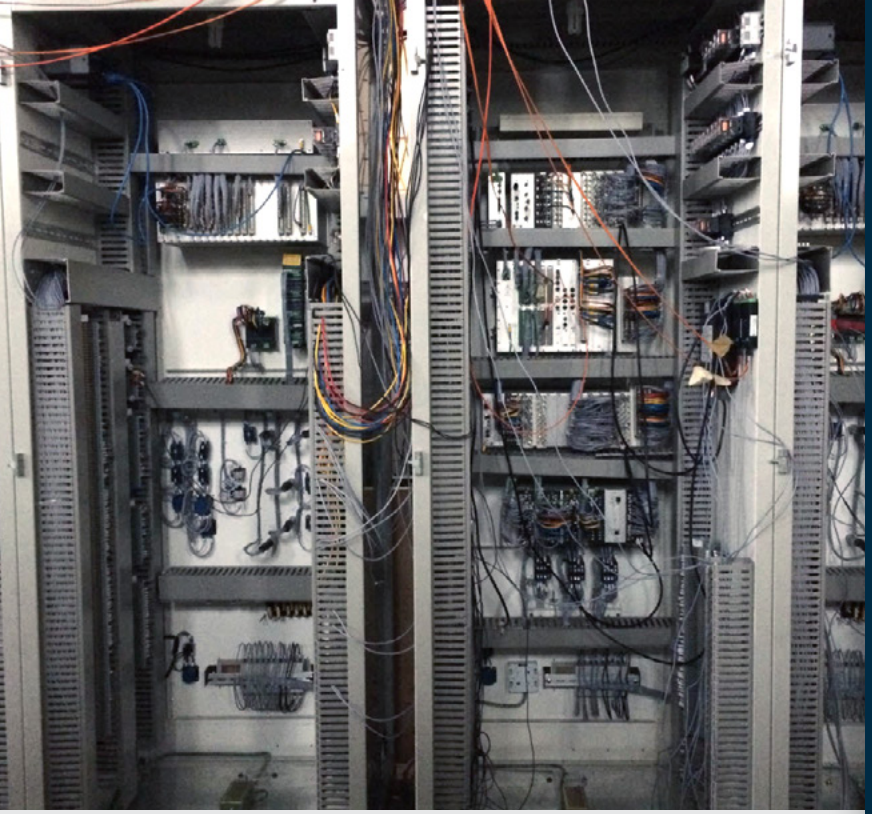
Promis.e's 3D capabilities allowed the team to design the mechanical structure and directly upload it into the CNC machines for automatic fabrication, reducing mechanical component mismatch and manufacturing line work. Promis.e also automated many capabilities to reduce errors and save time. The application's interoperability with third-party software streamlined the process, lessening production time by 50 percent and leading to a potential savings of USD 5 million in materials and project costs.

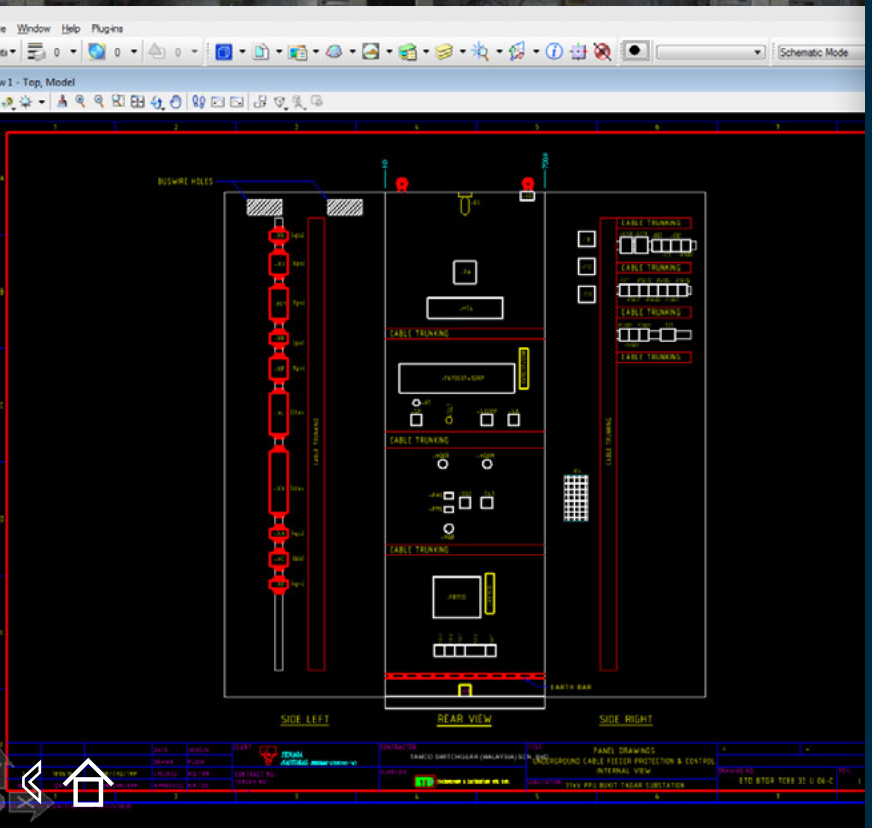
Project Playbook: MicroStation, Navigator, ProjectWise, Promis.e











ETD Transmission & Distribution Sdn. Bhd.

Supply of Control and Protection Panels for Landfill Renewable Energy System
Bukit Tagar, Perak, Malaysia

The Bukit Tagar Sanitary Landfill (BTSL) in Perak, Malaysia is targeted as a source of renewable energy for the country. ETD Transmission serves as a technology partner, providing design and manufacturing of control and protection relay panels for BTSL's waste-to-energy plant. For this project, ETD Transmission was tasked with supplying the site with 10 panels, delivered with comprehensive design drawings that comply with Malaysian standards. The panels will be capable of reusing waste to meet the increasing demands for electricity in nearby areas.

The project team used Promis.e to automate its electrical design drawings, creating intelligent symbols and device categories to facilitate engineering, calculations, reporting, and cross-referencing. Bentley applications allowed for a consistent, standardized design process that eliminated design errors to produce accurate drawings. The automated functions in Bentley's comprehensive schematic layout and design technology saved up to 50 percent in design and production time, enabling the team to deliver the 10 panels in 11 days, compared to 30 days with traditional CAD software.

Project Playbook: Navigator, Promis.e

Rosatom State Nuclear Energy Corporation

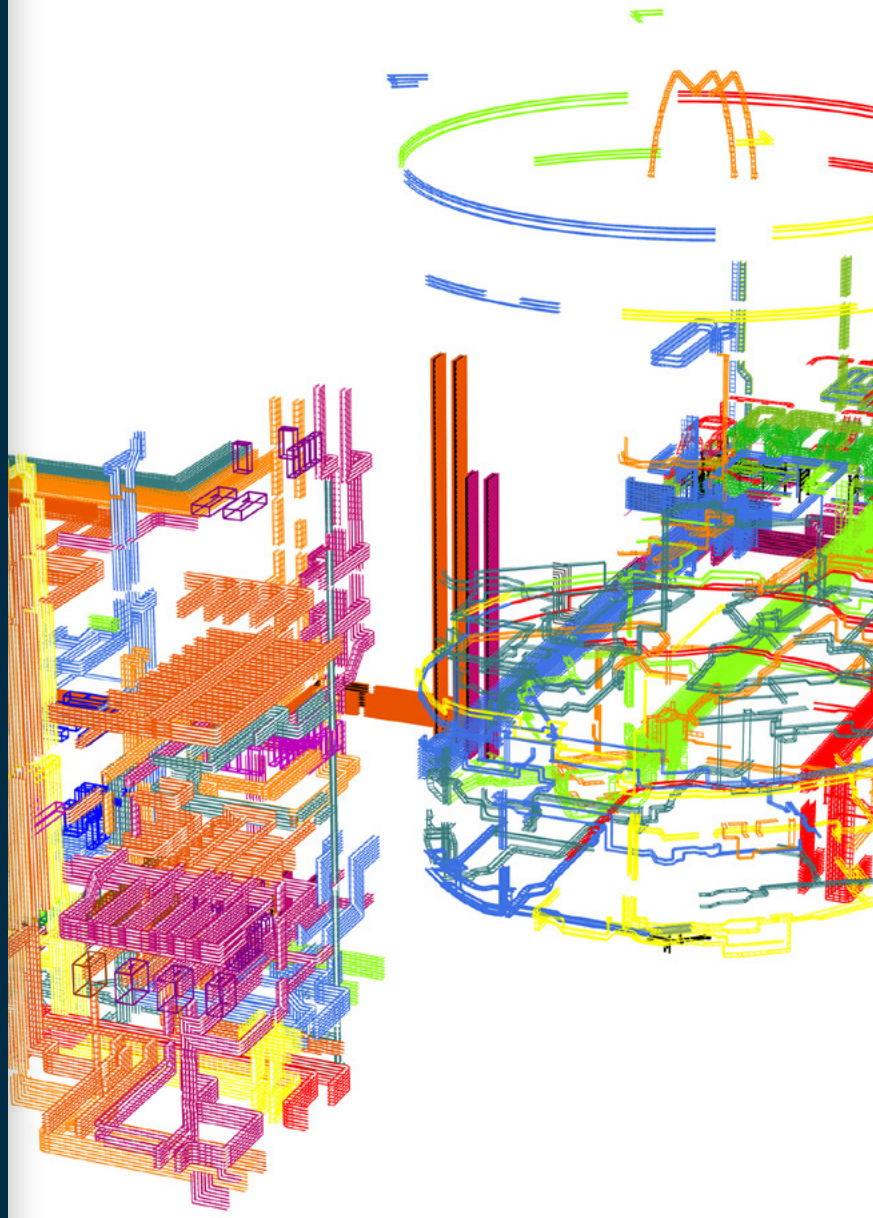
Electrical Design in Russian-Finnish Project on the Construction of Nuclear Power Plants Hanhikivi-1

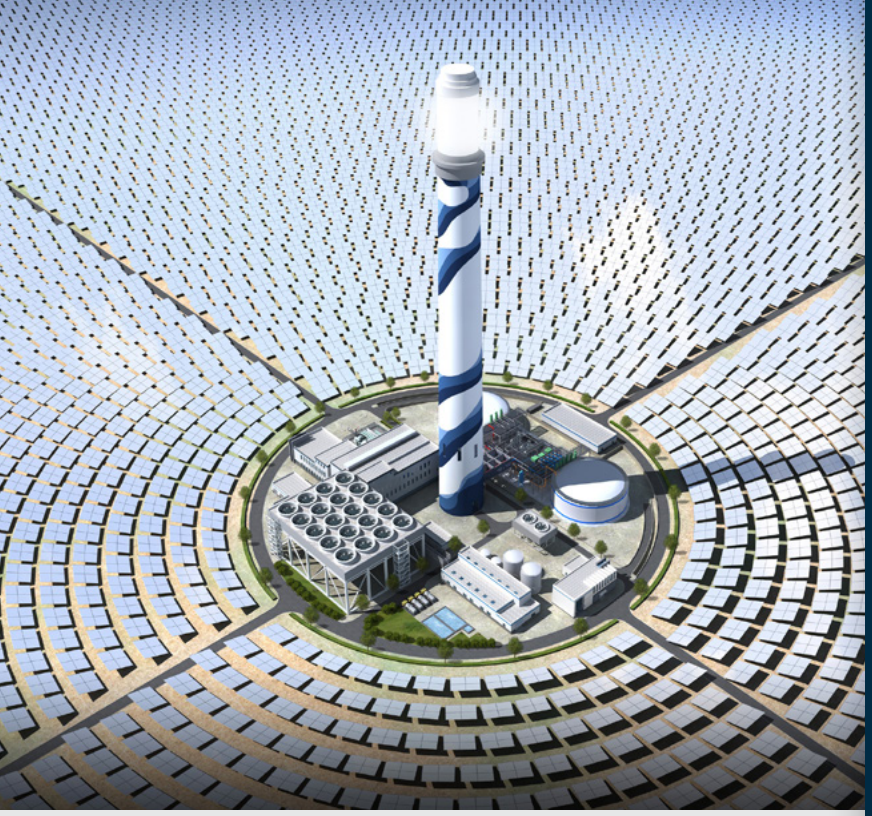
Pyhajoki, Northern Ostrobotnia, Finland

Russian organization Rosatom State Nuclear Energy Corporation (Rosatom) and Finnish company Fennovima Oy are partnering to construct the USD 8.2 billion Hanhikivi 1 nuclear power plant (NPP) in Pyhajoki, Northern Finland. Structural designs for the buildings were completed last year using OpenBuildings Designer. Rosatom is designing the electrical structures, supports, and equipment for the facility, which is scheduled to commence operations in 2024.

Faced with Finland's unique NPP safety standards and a short time frame to meet client deadlines for the electrical construction of the plant, Rosatom used Bentley applications to develop accurate designs in accordance with the strict regulations. Working in an open, connected data environment (CDE) enhanced decision making, accelerated design time by 50 percent, and improved documentation quality by 70 percent. Leveraging Bentley Raceway and Cable Management with OpenBuildings Designer to design 13 electrical structures of the nuclear island reduced design costs.

Project Playbook: OpenBuildings Designer, Bentley Raceway and Cable Management, MicroStation, Navigator, ProjectWise





Northwest Electric Power Design Institute Co., Ltd. of China Power Engineering Consulting Group

Huaneng Ningxia Dam Power Plant Stage IV Project

Qingtongxia, Ningxia Hui Autonomous Region, China

The Ningdong-Zhejiang ±800-kilovolt power transmission project will guarantee supply to the western and northern regions of China. Northwest Electric Power Design Institute Co., Ltd. of China Power Engineering Consulting Group was contracted to build the Huaneng Ningxia Dam Power Plant Stage IV Project. The power plant features two 660-megawatt coal firing intercooling units and flue gas sulfurization and denitrification facilities to support the main transmission project.

Northwest Electric Power Design Institute and Bentley cooperated on an eight-year research and development project to complete a collaborative design and data management solution. OpenPlant and Bentley Substation greatly improved collaboration among the multidiscipline design team and played a critical role in transferring data throughout the project. The applications helped reduce design modifications by 70 percent and resource hours by 40 percent.

Project Playbook: OpenBuildings Designer, Bentley Raceway and Cable Management, Bentley Substation, ContextCapture, LumenRT, MicroStation, Navigator, OpenPlant, OpenRoads, Promis.e, ProStructures, STAAD

Shenzhen Zhirun New Energy Electric Power Survey and Design Institute Co., Ltd.

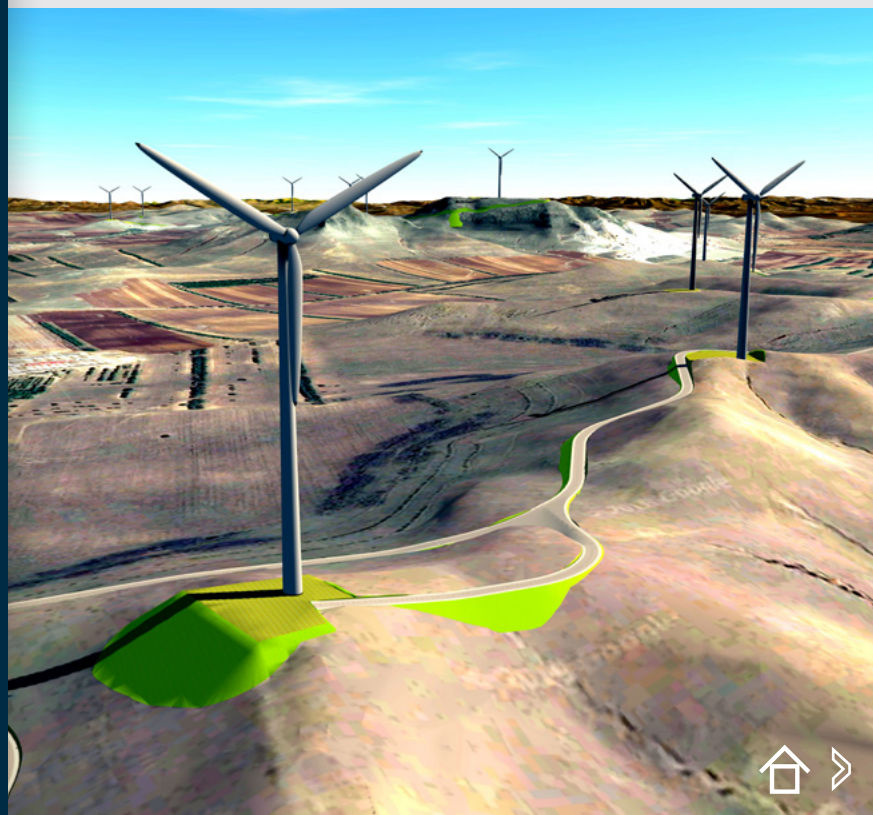
1 Million-kilowatt Wind Farm Project in Inner Mongolia

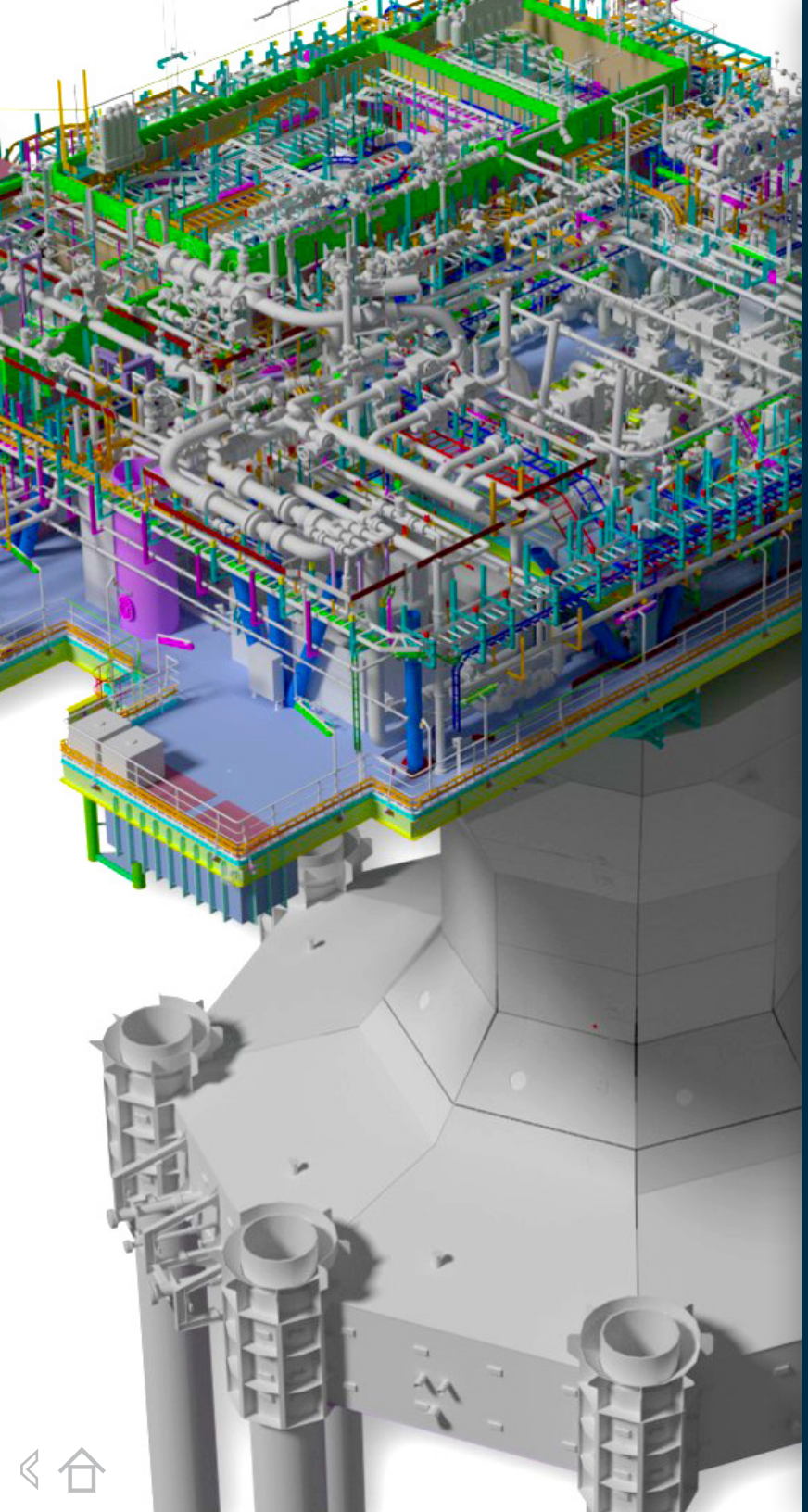
Xilin Gol League, Inner Mongolia Autonomous Region, China

The CNY 5 billion China Inner Mongolia wind power plant involves constructing three 220-kilovolt booster stations and 290 sets of wind turbine generator systems. The project is situated on a low mountain hill steppe at an elevation of about 1,000 to 1,500 meters. The vast terrain and complex topography posed design challenges for the team, who also had to implement a design that would reduce carbon emissions.

Shenzhen Zhirun implemented a 3D design workflow using Bentley applications and generated the model in LumenRT. The design team used Bentley Substation to establish an electrical equipment library and LumenRT to visualize the project and avoid impacting farming and mining areas. The wind farm project will significantly reduce carbon emissions. Bentley applications helped reduce design time by 25 percent and overall costs by 10 percent.

Project Playbook: OpenBuildings Designer, Bentley Raceway and Cable Management, Bentley Substation, LumenRT, OpenRoads





Volgogradnefteproekt, LLC

Design of Electro-Technical Solutions and Systems for the Conductor Supported Platform of Filanovsky Field

Caspian Sea, Astrakhan Region, Russia

As part of developing the Filanovsky Field, Volgogradnefteproekt LLC provided detailed design services and technical support for building an offshore, ice-resistant, stationary satellite platform that can operate autonomously via remote control. Consisting of energy systems and power grids, the design had to consider structural positioning and environmental susceptibility and meet industry standards for mass load that required complex calculations. Using 3D modeling to design the satellite platform enabled the multiple engineering disciplines to work within a single model simultaneously, optimizing coordination and project workflows.

Using Bentley applications, the team reduced time spent correcting errors by 40 percent and delivered the design documentation three months ahead of the deadline. Bentley Raceway and Cable Management automated the cumbersome process of calculating mass load in compliance with regulations, saving 70 percent in time and reducing the risk of errors.

Project Playbook: OpenBuildings Designer, AssetWise, Bentley Raceway and Cable Management, MicroStation, Navigator, OpenPlant, Promis.e, ProStructures

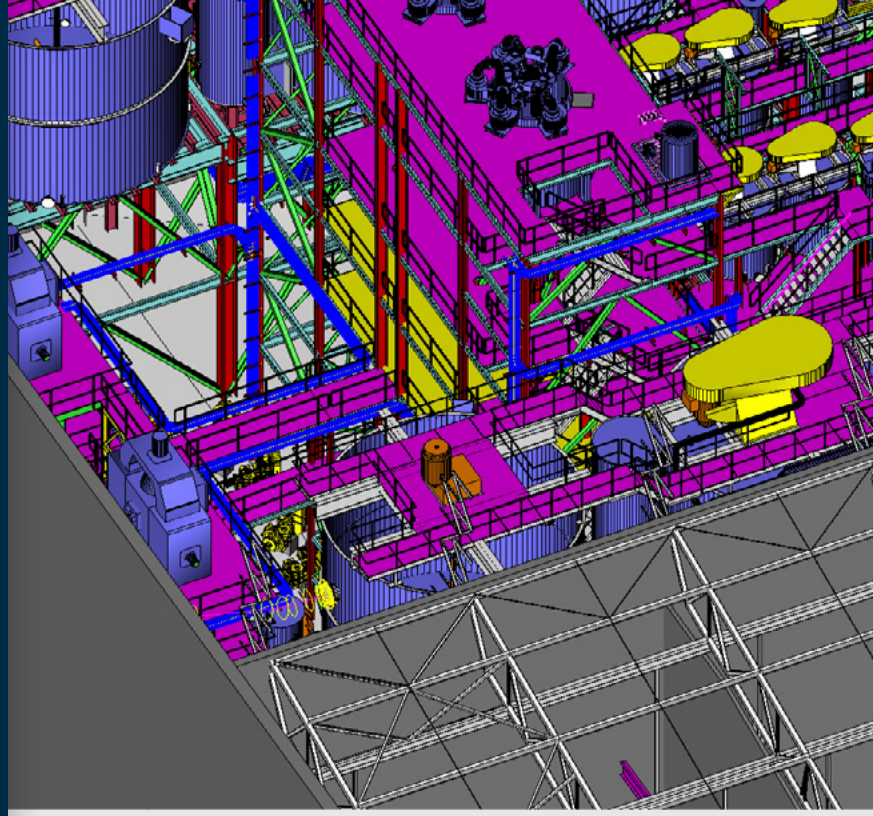
Kazgiprotsvetmet Ltd.

Bystrinsky Ore Mining and Processing Plant—Dressing Works for Processing and Dressing Gold, Iron, and Copper Ores
Bystrinskoye Field, Zabaykalsky Krai, Kazakhstan

As Kazakhstan's main institute in mining and metallurgy, Kazgiprotsvetmet Ltd. provided detailed design for the USD 1.1 billion Bystrinsky Ore Mining and Processing Plant at Bystrinskoye Field in Zabaykalsky Krai. This priority project is being developed by Norilsk Nornickel, a leader in the metals and mining industry in Russia, for annual production of copper (65.8 thousand metric tons), iron (2.1 million metric tons), gold (6.9 metric tons), and silver (35.9 metric tons).

The institute used Bentley Raceway and Cable Management (BRCM) to create 3D models of the cable support systems, supports, and equipment. BRCM integrated with other software solutions to deliver the client's required format. BRCM allowed the institute to divide electrical design among users and have the latest information available to all team members in a single database. BRCM's 3D design capabilities accelerated design by 30 percent.

Project Playbook: Bentley Raceway and Cable Management, Promis.e



About Bentley Systems

Bentley Systems is the leading global provider of software solutions to engineers, architects, geospatial professionals, constructors, and owner-operators for the design, construction, and operations of infrastructure. Bentley's MicroStation-based engineering and BIM applications, and its digital twin cloud services, advance the project delivery (ProjectWise) and the asset performance (AssetWise) of transportation and other public works, utilities, industrial and resources plants, and commercial and institutional facilities.

Bentley Systems employs more than 3,500 colleagues, generates annual revenues of $700 million in 170 countries, and has invested more than $1 billion in research, development, and acquisitions since 2014. From inception in 1984, the company has remained majority-owned by its five founding Bentley brothers. Bentley shares transact by invitation on the NASDAQ Private Market.

For additional information, visit **www.bentley.com**.

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