Self-sustainable Campus Project Wins Judge's Choice Award in Bentley Education's Inaugural Future Infrastructure Star Challenge

Using 3D Modeling and Digitalization to Design Mini-Modular Plant Transforms Energy Performance at Izmir Institute of Technology, Turkey

Transforming Energy Performance

As part of the Bentley Education program that inspires young minds to advance infrastructure and develop digital skills, Bentley Systems launched its first Future Infrastructure Star Challenge, asking students to conceptualize a world-changing infrastructure project addressing a global environmental issue using Bentley applications. The program received 144 entries from over 60 countries, and 10 finalists were selected to design and present their conceptual idea to the public and a judging panel of experts. Elif Gungormus Deliismail, studying for her Ph.D. in chemical engineering at the University - Izmir Institute of Technology in Turkey, won the Judges' Choice Award – which includes a USD 5,000 prize – for her project: Mini-Modular Plant for Digitized Campus.

Her innovative project shows how a mini-modular plant, coupled with smart centralized energy management and low-carbon fuel sources, can transform energy performance across a rural academic campus. She selected a rural university campus to pilot her idea, given these facilities' intensive energy consumption and remote location from the main energy grid often result in inefficiencies in the existing energy distribution infrastructure. Her infrastructure concept demonstrates how we must consider the reality of climate change and the delivery that is needed to tackle it and transform our energy use.

Addressing Sustainability in Campus Infrastructure

"Sustainability seems to be the most plausible solution to expand and achieve energy security. It is impossible to ignore the importance of sustainability," Deliismail said. The main concept for her project is to design a mini-modular plant for a digitally sustainable campus, making university buildings self-sustainable so that electricity, water, and fuels could be properly utilized, minimizing the supply infrastructure. The major challenge that she faced was constructing a safe, flexible, and easy-to-operate modular plant system that takes up minimal space and can be easily scaled to achieve or increase capacity by integrating additional modules with existing ones. The ultimate goal is to distribute and adapt these modular systems, or mini plants, to improve the circular economy.

She selected her own Izmir Institute of Technology campus, consisting of 32 buildings with a population of 7,655, to pilot her modular energy solution. The mini plant will produce methane for heating, as well as water, hydrogen, and oxygen, using hydrogen to generate electricity. In addition to relying on renewable resources, the system integrates carbon dioxide and biogas as

feedstock to produce dimethyl ether as an alternative to diesel fuel for generators and transportation. With the ability to simultaneously generate electricity, heat, water, and clean fuel through digitalization, this futuristic system delivers self-sustaining buildings to achieve sustainable campus life.

Designing a Mini-modular Plant

Each mini-modular plant includes both internal and external equipment, ranging from reactors, and piping and control instruments, to a carbon dioxide capture system and storage tanks. To design the plant, Deliismail first needed to define the campus boundaries. “The first step is to define the campus boundaries, take measurements using drones, and create a 3D reality campus model with ContextCapture,” Deliismail said. Using ContextCapture, she processed 689 drone-captured campus images into a 3D reality model. She used MicroStation to model the plant design. “The 3D campus model and digital modular plant were combined using LumenRT for animated visualization,” said Deliismail. The application enabled her to deliver a dynamic presentation of her proposed energy concept. Using the models to perform detailed chemical engineering design calculations, Deliismail confirmed the modules’ viability for energy distribution using renewable resources and biogas production from garden waste and animal manure.

The total energy requirement for the campus buildings, including transportation fuel, uses 1,429.6 tons of oil equivalent annually. Through digital modeling and analysis, Deliismail determined that her proposed plant design could achieve self-sustainable buildings by installing 60 modules that would fulfill campus energy demands for heating, electricity, and transportation fuel. Using Bentley applications not only helped design this innovative energy solution, but they also facilitated digital asset management, as well as tracking and locating of assets, which are critical to ensuring reliable operations of the 60 campus mini modules. “One of the main benefits of using Bentley applications is asset management,” Deliismail said. The software improved efficiencies, organizational sustainability, decision-making, and financial performance. At a unit cost of USD 28,015 per module, after taking biogas capital expenditures and natural gas sale costs into account, the payback period for all 60 modules would be less than seven years. The sustainable energy supply is expected to save the school USD 120,000 in one year.

Advancing Digitalization for Smart Energy Management

Deliismail used ContextCapture to generate a reality model not only of the original existing campus, but also of the campus with all the modular plants operating in its vicinity. By then integrating Industrial IoT, artificial intelligence, and sensors, she transformed modular energy plant into a smart energy system through the creation of a digital twin. The digital twin optimizes energy usage on campus, enabling the monitoring and scheduling of energy supply based on activity levels. Through digital intelligence, operations and management can observe and

identify asset risk, implementing predictive maintenance processes to ensure asset reliability for each of the mini-modular units.

As an alternative to installing an individual mini-modular system per building, Ms. Deliismail also determined that a vertical centralized energy system could be organized to save space, creating a smart centralized energy plant on campus. Regardless of which smart energy solution is used, however, both ensure self-sustainable buildings and a greener alternative to traditional electricity, fuel, and water supplies. “What I focused on in my project is sustainability in the infrastructure framework. Self-sustainable buildings are the next generation that can improve the quality of our lives, protect our ecosystem, and preserve natural resources,” commented Deliismail.

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Image:

Caption: Elif Gungormus Deliismail is pursuing her Ph.D. in chemical engineering at the University - Izmir Institute of Technology in Turkey. She won the Judges’ Choice Award in the Bentley Education Future Infrastructure Star program for her project: Mini-Modular Plant for Digitized Campus.