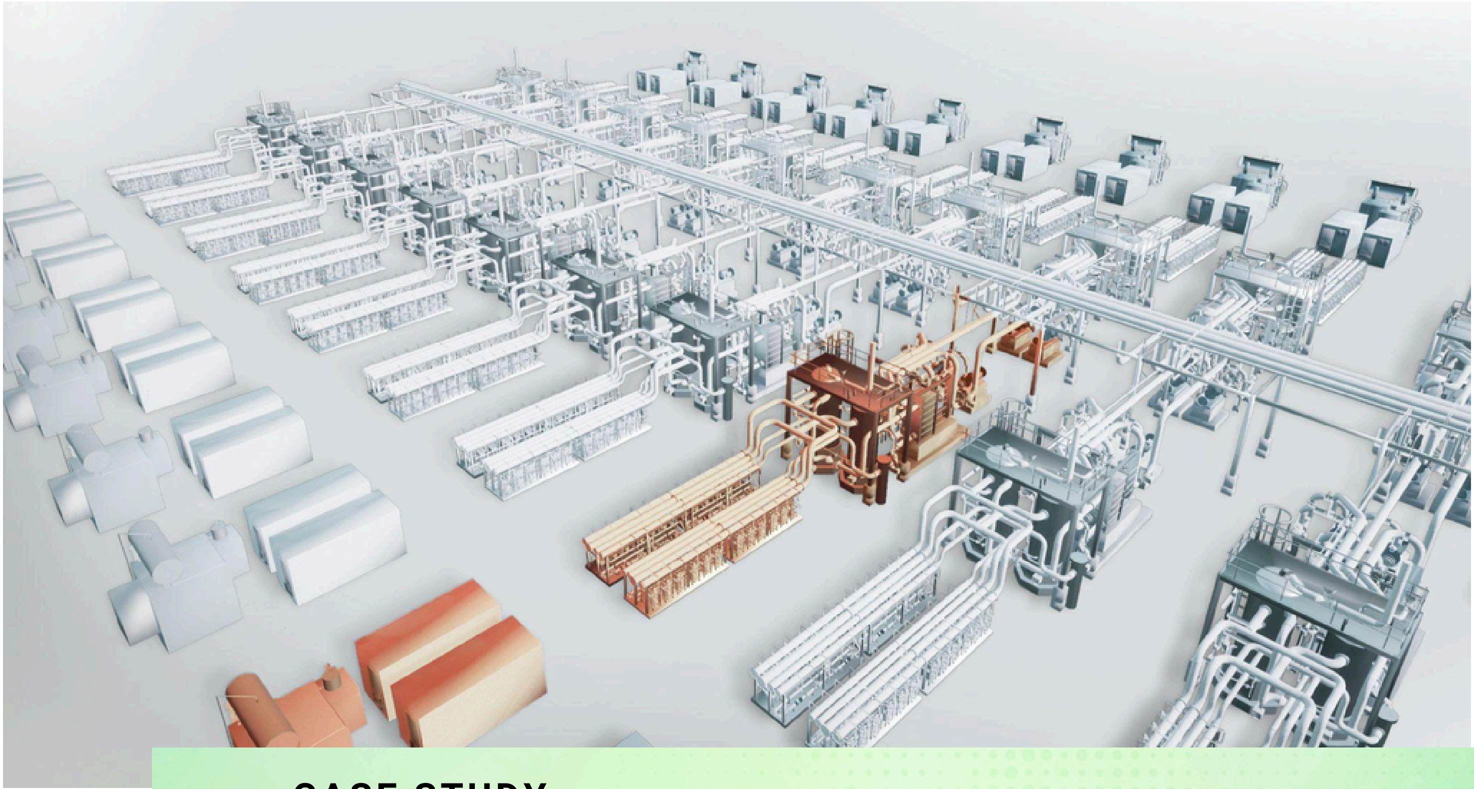
PlantStream



CASE STUDY

PlantStream Implementation in Decarbonization and Hydrogen Businesses

Summary

Decarbonization businesses are rapidly expanding in the new energy era. Projects related to new energies, including hydrogen, require more efficient approaches from the design phase. This article presents a case study demonstrating how PlantStream facilitated the creation of high-precision 3D model designs in a shorter period compared to traditional methods, specifically in the water electrolysis business developed by Toyota Motor Corporation and Chiyoda Corporation. It details the benefits of implementing PlantStream in new energy projects from the perspective of improving design efficiency and accuracy and explains how it contributed to reducing costs and shortening project durations.

• Introduction

We develop and provide PlantStream, a 3D CAD software equipped with automated spatial design functions for plant engineering, including layout planning, piping, civil and architectural, and electrical and instrumentation design. PlantStream features pre-templated functionalities for equipment and piping layouts, enabling users to quickly and easily create high-precision 3D models through simple operations like drag-and-drop and parameter adjustment. Utilizing its automatic routing feature facilitates easy redesign of piping, allowing for rapid responses to design changes and enabling the creation of multiple layouts in a short time. This improves the quality of preliminary designs and allows for the comparison of layouts from multiple perspectives—material quantity, safety, and maintainability—right from the early design stages, thus enhancing the overall 3D design process by selecting the optimal layout.

• Utilization of PlantStream in the New Energy Sector

PlantStream finds applications across various industries, including oil and gas, chemicals, water treatment, electricity generation, and FPSOs. In this article, however, we will introduce a new application of PlantStream in a water electrolysis plant, showcasing its versatility and effectiveness in this emerging area.

On February 5, 2024, a press release announced a collaboration between Toyota Motor Corporation and Chiyoda Corporation in the water electrolysis business. Under a Memorandum of Understanding (MOU) for joint development, the entry into the rapidly expanding water electrolysis market was announced globally, capturing the attention of hydrogen business operators both domestically and internationally.

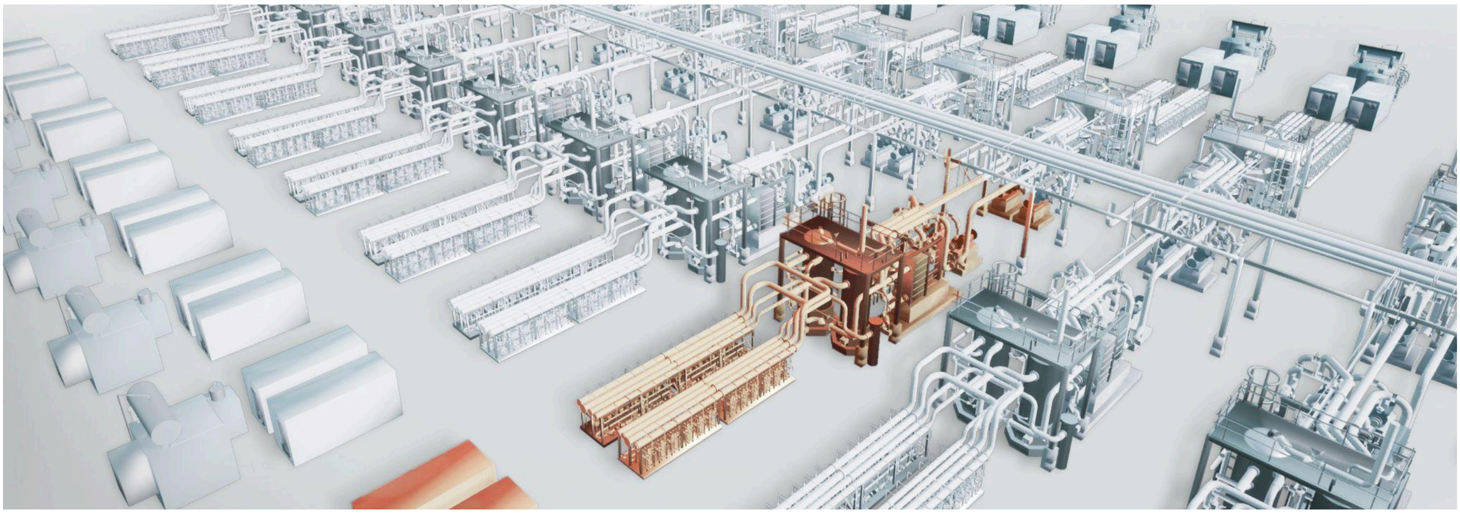


Figure 1: Water Electrolysis System Jointly Developed by Toyota Motor Corporation and Chiyoda Corporation

PlantStream was utilized during the initial design phase of this water electrolysis device. Using PlantStream, it was possible to meet the needs of the rapidly growing hydrogen production market and achieve high-precision 3D model designs in a significantly shorter period than traditional methods. This article will further discuss the benefits and contributions of implementing PlantStream in new energy projects.

• Current State of the Green Hydrogen Market

Generally, an electrolysis plant refers to a device that extracts hydrogen by electrolyzing pure water using renewable energies such as wind and solar power. The hydrogen produced through this process is referred to as "green hydrogen." A significant issue with green hydrogen is its production cost, which is higher than other fuels like LNG. To address this issue, a system known as "value difference support" has been implemented by Japan's Ministry of Economy, Trade and Industry (METI). This scheme uses government grants to subsidize the price gap between hydrogen and existing fuels like LNG. For businesses, receiving this value difference support is crucial for ensuring viability. However, to receive this support, businesses must apply to METI, and not all projects are eligible. The decision to provide support depends on factors such as the domestic benefits of the manufacturing process and the cost competitiveness of hydrogen production.

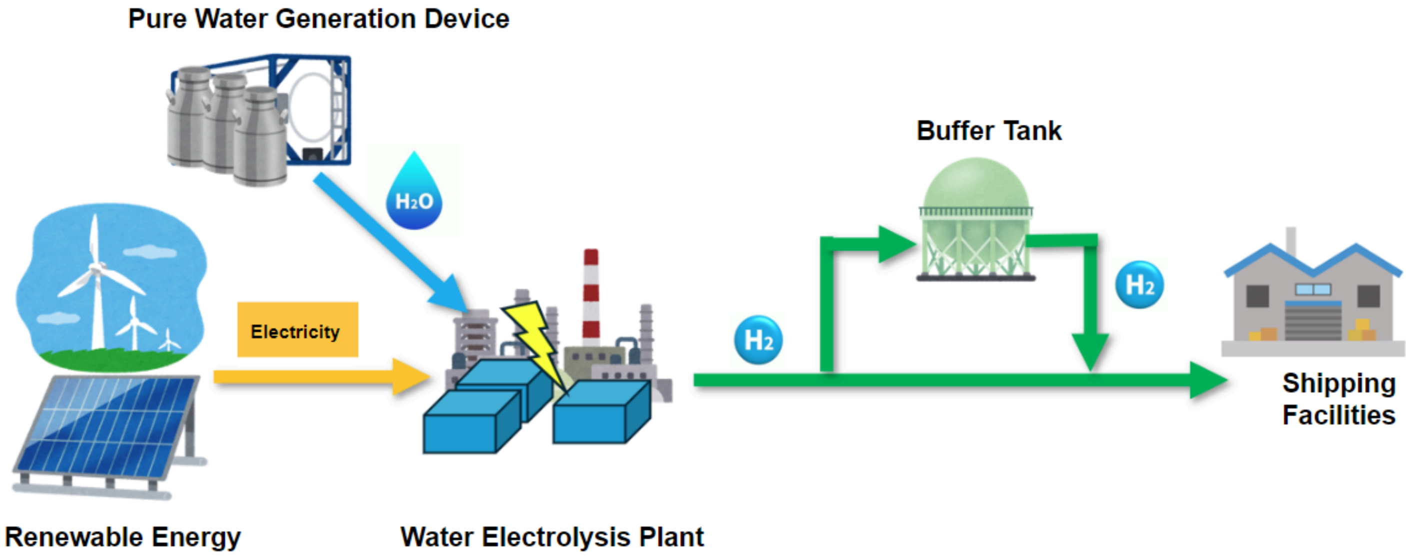


Figure 2: Image of Green Hydrogen

• Enhancing Project Feasibility through 3D Design Concepts

To enhance the competitiveness of hydrogen production, particularly in the heart of hydrogen production, the electrolysis plant, it is crucial to increase the hydrogen production efficiency per unit footprint. In other words, the key to improving competitiveness lies in how to pack various equipment related to the electrolysis system into a limited footprint. As the demand in the rapidly growing hydrogen market increases, manufacturers of water electrolysis devices are competing to minimize the occupied area to develop more attractive products.

The water electrolysis reaction occurs within a device called a "cell stack," but around it, numerous auxiliary devices are needed to generate the pure water used as raw material for electrolysis. These include transformers, rectifiers, and other electrical equipment, as well as a variety of equipment such as pumps, vessels, and heat exchangers connected by multiple pipes. If the goal is to eliminate excess space and achieve the densest possible packing of equipment, a three-dimensional model that considers vertical as well as horizontal space is necessary for layout planning. Moreover, creating a 3D model is not a one-time task; it involves continuous detailed discussions and revisions to refine the optimal layout gradually. Thus, in new sectors like hydrogen, the impact of 3D visualization on project feasibility is even more pronounced than in other types of plants.

For this particular water electrolysis project, the model included hundreds of pipes and dozens of pieces of equipment. Normally, such a project would take several months, but with the use of PlantStream, a 3D model was created in less than a month. Even in the early stages of the project, the 3D model allowed for the selection of the best design from multiple perspectives, including material quantity, safety, and maintainability of the equipment, which also enabled cost reductions.

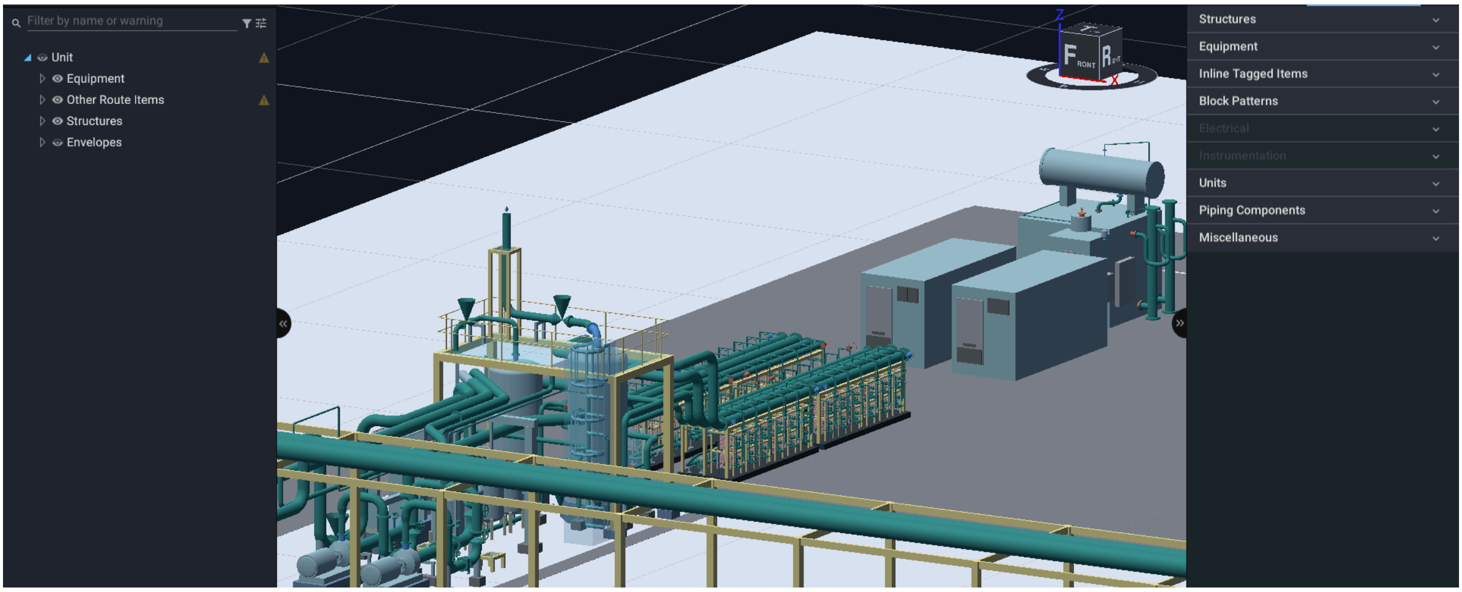


Figure 3: 3D Model of a Water Electrolysis System Created with PlantStream

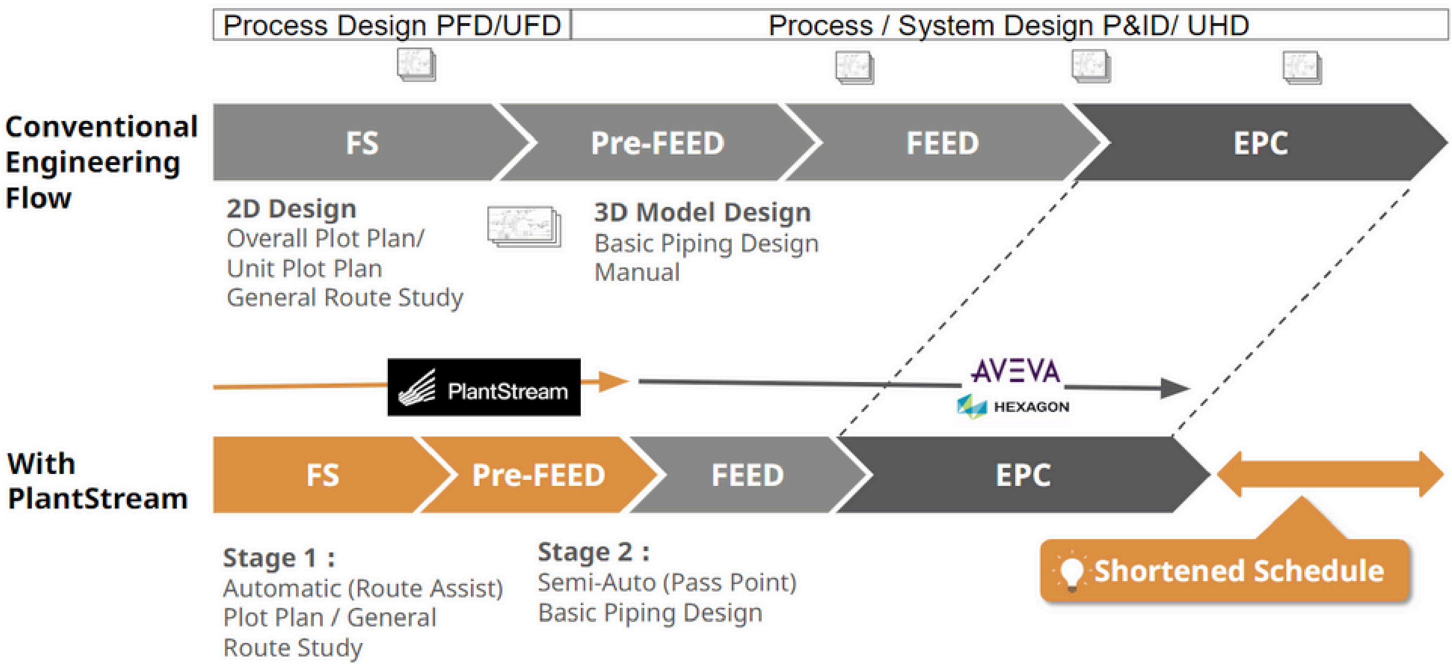
Unit Operation + Shared Piping Model Overview

- **Number of devices: Approximately 20**
- **Man-hours: Two weeks**
- **Man-hours: Two weeks**
- **Number of operators: Two**

This chapter discusses the effectiveness of utilizing PlantStream in the new energy sector and provides detailed insights into the software's features.

■ Creating 3D Models from the Early Design Phase

In plants where there are few EPC achievements, especially in emerging fields like new energy, evaluating spatial layout studies and sharing visual concepts using only 2D drawings can be challenging. This increases the likelihood of making early design phase changes more frequently. By using PlantStream to create 3D models right from the early design phase, the visual appeal is enhanced, facilitating shared understanding among designers and construction supervisors. As a result, the frequency of design changes is reduced, contributing to shorter construction timelines.



■ Rapid Response to Design Changes and Multiple Layout Studies

PlantStream allows for quick incorporation of changes in process design and equipment placement into the model. By moving equipment and using the automatic routing function, new layouts with connected piping can be created instantly. This capability enables multiple layout studies to be performed quickly and easily, allowing for quantitative comparisons of piping, steel, and cable materials. Consequently, this leads to the realization of economically optimized initial designs, enhancing overall project efficiency and cost-effectiveness.

Cost Factors	Pipe Weight (ton)	69,940	Pipe Weight (ton)	68,740	Pipe Weight (ton)	59,617
	Pipe Rack Weight (ton)	55,657	Pipe Rack Weight (ton)	52,430	Pipe Rack Weight (ton)	50,586
	Total (ton)	125,597	Total (ton)	121,170	Total (ton)	110,203

Reduction of 15,394 tons

■ Intuitive User Interface Accessible to Anyone Immediately

In the early stages of a project, layout studies often need to be made quickly by small teams. In such scenarios, the primary workforce may not consist of specialized piping engineers but rather project engineers whose main task is execution. Often, there may not be enough time to hire or find CAD operators. Considering this, the use of PlantStream, which requires minimal time from software implementation to the start of modeling, offers significant advantages. Its user-friendly interface allows even those without extensive CAD experience to begin work immediately, streamlining project initiation and facilitating quicker decision-making.

■Templated Block Pattern Models

As mentioned earlier, a variety of equipment types are used within water electrolysis plants. Traditional CAD software typically provides only basic model templates like cylinders and tetrahedrons, requiring users to combine these primitives to create equipment models. This process can be challenging without substantial training due to the high customizability and numerous input fields in traditional CAD software. In contrast, PlantStream includes templated block patterns for essential equipment such as pumps, heat exchangers, and drums, as well as for designing pipe and structural steel. These templates only require minimal input to specify necessary information, enabling even project engineers with limited CAD experience to perform modeling. This templating significantly improves time efficiency, making it possible to develop complex models more quickly and accurately, which is particularly beneficial in fast-paced project environments.

■ Importing FBX Models

In scenarios such as those involving cell stacks, where spatial constraints are stringent and high-precision considerations are necessary, it may not suffice to rely solely on templated block patterns. In such cases, detailed models created with traditional CAD software may need to be imported for further layout studies. PlantStream is equipped with an FBX file import feature, allowing for seamless integration of detailed equipment models developed by licensors. This capability enables detailed layout studies using both the block pattern models and imported FBX models, ensuring that the final layout meets the precision requirements.

■ Compatibility with Third-Party Software (such as 3D Viewers and Navisworks)

After model creation in PlantStream, it is possible to export the model as a .rvm file, which can then be imported into Navisworks and converted into a .nwd file. This feature allows for quick sharing with project members who do not have a PlantStream license. In addition to the .rvm format, the software also supports exporting in FBX and other file formats. This functionality enhances the efficiency of the design cycle from modeling to review, improving the productivity of the team significantly.

• Feedback on the Utilization of PlantStream

In the initial phases of projects like large-scale water electrolysis systems and dehydrogenation plants, where examples are scarce and extensive layout studies are required, the use of PlantStream has enabled rapid and easy optimization of 3D model layouts. This has garnered high praise from Toyota Motor Corporation and Chiyoda Corporation. By contributing to the minimization of the occupied area of devices, considering maintenance and transportability, and facilitating cost reductions, the strengths of PlantStream in early 3D model design and layout examination have been effectively demonstrated. This has resulted in significant project efficiencies and benefits, showcasing PlantStream's capabilities in streamlining complex engineering projects.

• Conclusion

Looking ahead at the expanding decarbonization market, there is anticipated to be a global increase in FS / Pre-FEED activities related to new energies, including hydrogen. This trend suggests that there will be increasing opportunities to leverage PlantStream, particularly during the conceptual design phases where its strengths are most pronounced. The utilization of PlantStream in decarbonization-related plant projects enables rapid, high-precision design and facilitates flexible layout study. This capability significantly aids in advancing new business initiatives, allowing for more efficient and effective project execution in the growing field of new energy solutions.