



Nel Hydrogen relies on PC-based control for environmentally friendly hydrogen filling stations

Michael Stefan, Senior Director Product Management, Nel Hydrogen Fueling, shows the hydrogen filling station from Nel Hydrogen. Soon, the company plans to produce 300 units per year.

Sustainable mobility

Hydrogen is considered to be the energy source of the future. It is a component of water and of almost all organic compounds. Therefore, molecules containing hydrogen are found in every living organism. As an energy source, it does not produce carbon dioxide if it is collected using renewable energy sources such as wind or solar power. The Danish company Nel Hydrogen is a long-standing pioneer in the field of hydrogen technology. With its hydrogen production concepts, Nel aims to make a key contribution to environmentally friendly mobility. Nel Hydrogen develops fueling stations and dispensers for cars, buses, and trucks. Fast, real time control and monitoring of every single station component is crucial for securing high reliability and low maintenance. The sophisticated software solutions are based on Beckhoff technologies.

Based in Herning, Denmark, the technology company Nel Hydrogen has been consistently focused on developing hydrogen filling stations. Business, science and politicians expect this market to grow rapidly in the coming years. This is due to increased efforts to achieve sustainability in all areas of life. Hydrogen is a gas that can easily be stored and transformed from electricity. The energy conversion of hydrogen to create a fuel source is two to three times more efficient than conventional engines. This means that hydrogen-powered vehicles have a longer range while using less fuel than conventionally powered vehicles. In the process, they do not emit any CO₂ or other pollutants such as carbon monoxide or nitrogen oxides. The only waste product is water. Today, Nel Hydrogen produces and sells more than

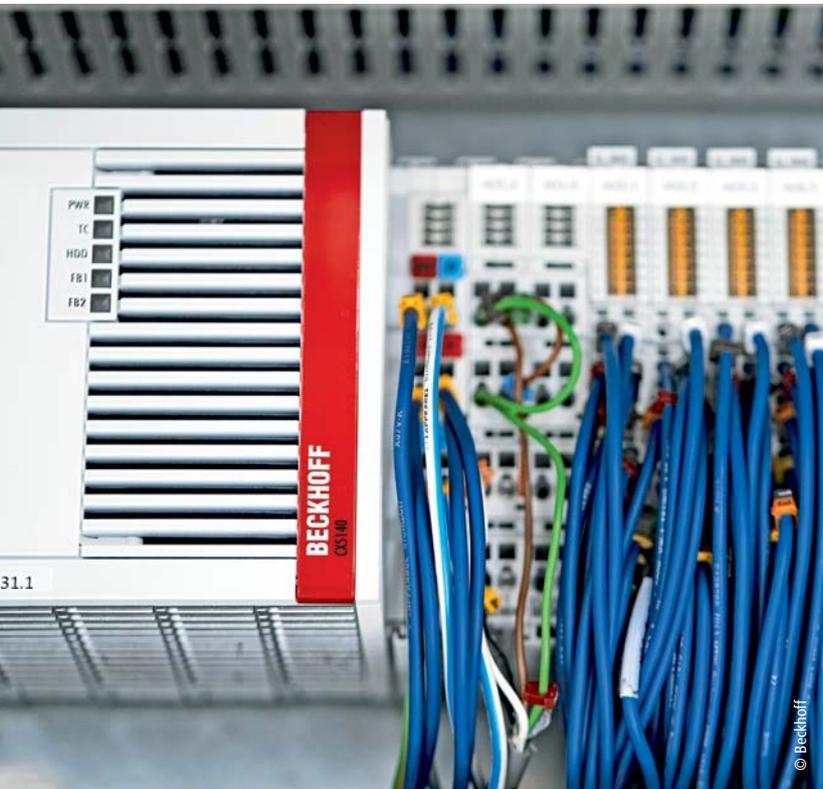
30 stations per year. This number will soon rise to 300. Filling the tank of a hydrogen car may take only three minutes and keep it driving as far as 600 km – and 1,000 km in the near future.

The automotive industry is rethinking

"We see a shift in strategy among the world's automobile producers. A significant share of our stations is sold to Korea. Asian car producers have an aggressive strategy when it comes to zero emission vehicles. In the USA, especially in California, there are attractive leasing offers for hydrogen cars. The USA has the world's largest car







A CX5140 embedded PC from Beckhoff ensures fast signal processing and makes the hydrogen filling station as convenient as a gasoline pump.

market and there is a high demand for zero-emission cars. We have prepared for a rapid expansion in our production facility so we can meet market demands. According to market prognoses, there will be a need of 20,000 to 30,000 hydrogen dispensers world-wide by 2030," says Michael Stefan, Senior Director of Product Management at Nel Hydrogen.

Maturing the market

Nel Hydrogen relies on Beckhoff technology to stay ahead of competition. The challenge is to navigate in a relatively immature market and choose technologies and solutions that can give end-customers the same experience with hydrogen fueling as with gasoline fueling. It has to be easy, and with typically only one hydrogen dispenser at each station, it has to work 24/7.

"We have taken a leading position in maturing this market with the goal of making hydrogen a successful alternative to gasoline and diesel. Not only from an environmental perspective, but also in practice. We apply Beckhoff Automation control solutions, and we can clearly say that Beckhoff's open platform strategy supports our business model," says Michael Stefan.

Real time is key

Beckhoff's TwinCAT PLCs and EtherCAT fieldbus control the entire fueling process. Component data is being collected, such as pressure, temperature, flow, gas detection, and the condition of the vehicle tank, and all data are distributed to the cloud. All processes and parameters are closely monitored in real time which enables predictive maintenance and fast reaction if required.

Applied PC Control

CX5140 Embedded PC with Intel® Atom™ processor:

- TwinCAT 3 PLC controls the entire system and refueling process.
- TwinCAT 3 HMI is applied as a user interface for end-users and service employees via external PC based on web browser (HTML5).
- TwinCAT 3 Modbus RTU is used for sensor and periphery equipment.
- TwinCAT 3 Modbus TCP interfaces are used for communication between devices.
- TwinCAT 3 IoT Communication is used for data handling, typically for local message broker.

EtherCAT I/O system:

- digital input and output terminals EL1809, EL2809
- analog input and output terminals EL3058, EL3064, EL3208, EL4004, EL4024
- serial interface EL6021

"We need powerful PLCs and fast signal processing to ensure that our equipment is just as sophisticated as petrol stations. Since the first fueling station was developed in 2003, the stations have become more complex. Therefore, we need solutions that give us the best options in the market. Real-time data is extremely important. It's a question of milliseconds from the data is being captured and distributed to the cloud – till the global monitoring system is able to react. This is the strength of Beckhoff components. There are very few limitations when it comes to speed, and with open standards you can connect to everything. Open standards, real time speed, and flexibility are key for us," says Jacob Svendsen, Head of Technology & Development, Nel Hydrogen.

Nel Hydrogen is one of the few filling station manufacturers that develops its own software. The company believes that more software-oriented, rather than hardware-based, solutions will emerge as the company's unique selling point.

"We gain valuable insight and experience by building the software solutions ourselves. Beckhoff supports us with this. Programming is made easy with the TwinCAT environment implemented in Visual Studio and the ability to use object-oriented programming. We can reuse codes from different PLCs as well as reuse codes to scale with different CPUs, thereby saving time and resources. We benefit from fast scan rates to better control regulation, diagnostics, reporting, and safe shutdowns in case of leaks. At the same time, we can reduce the energy consumption of each individual component. We are able to optimize both functionality and energy consumption of each component for the benefit of end consumers as well as the environment," says Jacob Svendsen.

Jacob Svendsen, Vice President, Technology & Development, Nel Hydrogen Fueling, is responsible for the development of hydrogen filling stations at Nel Hydrogen, alongside Michael Stefan.



About Nel Hydrogen

Nel Hydrogen has its origins in 1927 and is today a world leading pure-play hydrogen technology company with a market capitalization of \$ 3.4 billion. Originally, Nel Hydrogen was exclusively involved in the field of water electrolysis. Today, the company is the largest supplier of electrolyzers and sells both alkali and PEM electrolyzers. Through the take-over of the Danish company H2 Logic in 2015, Nel Hydrogen acquired the expertise to produce turnkey, standardized hydrogen filling stations with dispensers for cars, buses, trucks and forklifts. The company now employs more than 300 people and has been listed on the Oslo Stock Exchange since 2014. So far, Nel Hydrogen has sold 80 fueling stations in Europe, the USA and Korea.

Why hydrogen for mobility?

The world needs a new energy source to replace oil and gas to slow climate change and global warming. Hydrogen is the element with the highest energy density and can be produced from water by electrolysis using renewable energies. Another advantage of hydrogen is that it can be easily stored and converted into electricity or can be produced from electricity. Renewable irregular energy sources like wind and solar alone would bring the energy grids to their limits if there is no way of also storing the energy.

"Today, a dispenser is able to serve 40-80 cars per day, but in near future our stations should serve at least ten times that number per day. We need solutions that not only keep us up to date with market developments, but which help us develop the market," says Michael Stefan and continues: "For us, Beckhoff is the right partner because they keep focus on innovative solutions. We depend on that in our industry. Fortunately, the paths between

Beckhoff's development department in Germany and the support in Denmark are very short."

More information:

www.nelhydrogen.com

www.beckhoff.com/cx5140

www.beckhoff.com/ethercat