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Improved electrolysis for distributed hydrogen production

GA No. 700008

# High Performance PEM Electrolyser for Cost-effective Grid Balancing Applications

# HPEM2GAS - Deliverable report

## D6.5 Publishable report on field test results

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## Summary

A 200 kW (75 cells, 415 $cm^2$) PEM electrolyser based on new type of MEAs and an advanced stack design was demonstrated at Emden (Germany) for power-to-gas applications. The activities includedthe production of electrolytic hydrogen from an electricity grid sharing a large fraction of renewable energy (from wind mills) and the injection of the produced hydrogen into the local gas grid. The field testing activity required a previous site analysis. The gas takeover station of SWE at Pfälzer-Straße in Emden (Germany) was considered as an appropriate location for the demonstration plant. Specific approval for the hydrogen gas injection directly into the natural gas grid was granted by the Technischer Überwachungsverein (Technical Inspection Association) authorities. After completing the site-building phase in Emden and electrolyser factory acceptance testing (FAT) at ITM (UK), the electrolysis plant was assessed during the field testing activity and generated hydrogen was fed into the gas feed station. The hydrogen pressure was reduced from 20 bar to 10 bar, as SWE's gas network operates at 8.5 bar. The hydrogen was fedinto a mixer to mix the feeding volume with the natural gas. SWE's electricity grid, usually sharing a large fraction of renewable energy, was used for the required electrical supply and a transformer ensured low voltage for the electrolyzer operation. The field testing activity was carried out with the aim of evaluating the power-to-gas process as a means to store the surplus of renewable energy and to provide grid balancing service. The proof-of-concept of power-to-gas was demonstrated for the new electrolysis system and significant knowledge was acquired about the operation of this type of advanced electrolyser at high current density. The operational period of the electrolyser was affected by the occurrence of a failure at the electrolyser plant essentially due to a mechanical damage of an MEA inside the stack, which was clearly identified by specific diagnostics of the 75-cell stack. Another issue that occurred during operation was contamination of the active components of the stack (MEAs). This was thought to have resulted from a temporary malfunctioning of the ion exchange resin cartridge of the water purification system. The system was subjected to the detailed analysis and specific solutions have been identified. Several communication activities were undertaken for the field testing site.

# Contents

# 1 Introduction

The activities carried out within the HPEM2GAS project involved the development of advanced electrolysis components e.g. catalysts, membrane, membrane-electrode assemblies and stack and their integration in to a PEM electrolysis system. The system was validated as proof-of-concept for a power-to-gas process.  The Emden Council in Germany was selected for the field testing site due to the large share of renewable energy by the local electricity grid.  In particular, Emden is an appropriate location for the field test due to the high share of wind power and the limited flexibility of the rather small grids of Stadtwerke Emden (SWE) in Emden. SWE is the local supplier for electricity, water and gas owning all these grids in Emden. SWE Emden has pursued the development of renewable energies due to its location close to the Nord Sea coast where wind energy plays a major role with a total capacity of more than 36 MW in wind energy plants installed (Fig. 6.1).

*Figure 6.1 Emden wind park*

The variation of wind power requires a high network utilization, which means additional efforts for the transmission system operator (TSO). Thus, SWE and University of Applied Sciences Emden/Leer (HS EL), have considered different solutions to cope with these fluctuations. Among the different approaches, Power-to-Gas appears to play a relevant role due to its possibility to store energy for prolonged periods.

In the HPEM2GAS project, SWE and HS EL have evaluated the technical feasibility and the economic potential of Power-to-Gas solutions within the SWE's grid and they have focused on different scenarios. In particular it has been evaluated the balance between the supply and demand of electricity in the SWE grids with regard to possible utilization rates of Power-to-Gas (hydrogen) plants. In this regard, the effect of utilising a power-to-gas process on the power and gas grid of SWE has been analysed quantitatively for different sizes of Power-to-Gas plants with regard to the technical feasibility of integrating advanced PEM electrolysers into the local electricity and gas grids. Even if there is no clear legal framework, currently, less than 5 % hydrogen may be fed into the natural gas grid in Germany. In Emden, a maximum of 2 % $H_2$ can be fed into the natural gas network since a natural gas filling station is present in the immediate vicinity of the field testing site. The quality of the natural gas from this filling station must be guaranteed in order to rule out possible damage to the refuelled cars. The proof-of-concept of power-to-gas process was assessed using the advanced PEM electrolyser developed in HPEM2GAS during the field testing activity in Emden and several communication activities were undertaken for the field testing site.

## 2 Electrolysis Plant

The electrolysis plant, demonstrated in Emden in the framework of the HPEM2GAS project, was based on one PEM electrolyser stack (75 cells) installed in a 16 foot ISO container with a ground mounted refrigerant chiller. The plant required specifically mains electricity and tap water to generate self-pressurized hydrogen. The system was integrated into the control centre of SWE. A separate control system for the electrolyzer was installed in the SWE control room with the operator in the SWE control centre that was located about 6 km from the electrolyzer's location. In addition, remote access by ITM was planned. The plant control system was located in the main control panel. The panels were divided into Programmable Logic Controller (PLC), incomer, essential and non-essential compartments. The control panel was allocated with the power supply unit (PSU) in the control compartment. The plant control software operated on an S7-1500 failsafe PLC. Safety-critical and process instrumentation were interfaced through the PLC IO (input-output) modules in the control panel. A touch screen, Human Machine Interface (HMI) was provided for plant visualisation and control. The HMI was mounted upon the front of the main control panel. Password protection was used to ensure only users with sufficient privileges that could stop/start the plant. The plant was operated remotely, by the Distributed Control System (DCS) of SWE. Table 1 provides details about the electrolysis plant characteristics.

*Table 6.1 HPEM2Gas electrolysis plant specifications*

| Parameter | Value |
|---|---|
| Hydrogen flow rate (kg/24 hrs) | 80 |
| Hydrogen purity | < 5ppm $O_2$ & < 5ppm $H_2O$ |
| Maximum hydrogen output pressure (bar) | 20 |
| Oxygen pressure (bar) | Atmospheric |
| Water Requirement | Potable mains drinking water @ 2 ... 6 bar pressure |
| Electrical Power Supply | 400VAC, 3 Phase + neutral, 50Hz |
| Operating range (%) | 25 ... 100 |
| User Interface | Touch screen HMI / Remote interface |
| Monitoring | ITM IP access and data logging option |
| Dimensions (H x L x W) | 16 ft ISO container (2.90m x 4.89m x 2.44m) |
| Packaging | Containerised plug and play unit |
| Operating Conditions | Outdoors well ventilated |
| Environmental Temperature (°C) | -20 ... +40 |

Beside the hydrogen produced and injected into the gas grid, the other outputs of the plant were the heat rejected during the electrolyser operation, also as consequence of the water and hydrogen purification processes and venting of oxygen, vapour water and small amounts of hydrogen gas (to safe location). The produced electrolytic hydrogen was transferred to the natural gas takeover station from SWE which was located just a few meters away from the electrolysis plant. Hydrogen was thus injected into the natural gas grid operated by SWE. The gas station at Pfälzer-Straße in Emden is owned by the public authorities and is directly adjacent to a building that is already operated and maintained by SWE (Fig. 6.2).

The site was prepared to receive the installation of the electrolyser. The connections between the electrolyser and the feed-in point were coordinated between ITM and SWE. These were mainly tap water and a suitable power supply, a cable from the protection pipe to the transformer station, a low-voltage cable route laid from the transformer station to the electrolyser etc. For the system connection, the pipelines were mainly located under the ground with the main line being the hydrogen line from the electrolyser to the regulation station close to the main natural gas feed-in station for the city of Emden.

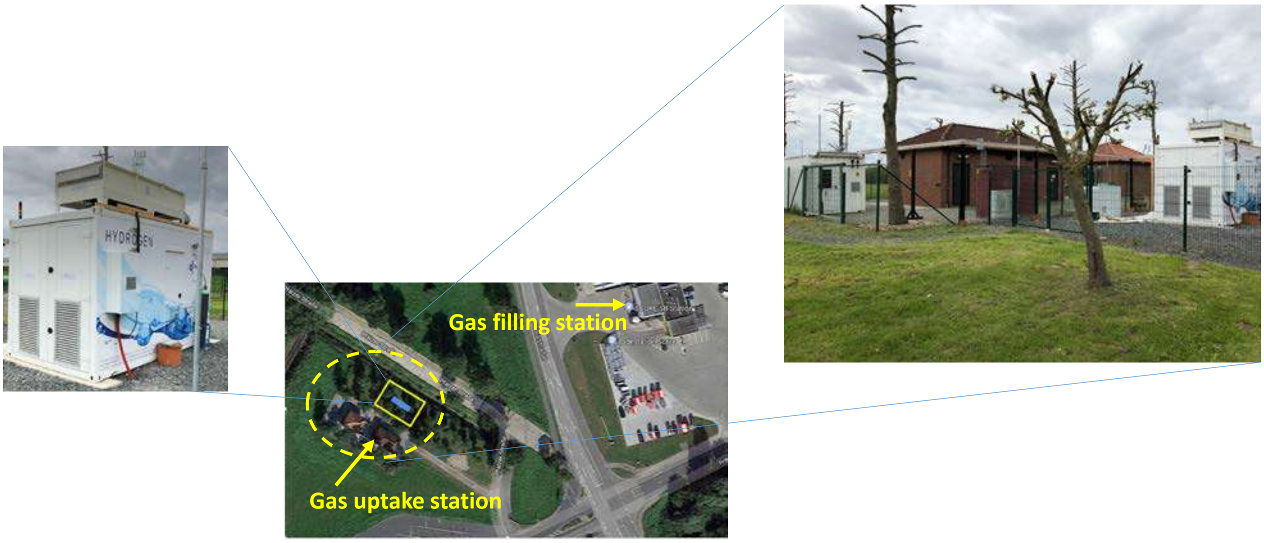


*Figure 6.2 HPEM2GAS field testing site at  Pfälzer-Straße, Emden, Germany*

# 3 Field testing

A specific procedure was undertaken for the approval of the electrolysis plant and related hydrogen injection into the gas grid being this regulated in Germany by the Federal Immission Control Act. The authority providing this approval was the trade supervisory office. The TÜV (Technischer Überwachungsverein) certification was provided by an inspector of this agency after a positive SAT (site acceptance test) was carried out. The outlet hydrogen pressure was adapted to the natural gas grid operating pressure and the hydrogen was fed into a mixer to homogenize with the natural gas. The installation of the mixer required a shutdown of the entire feeding station that was carried out before acquiring the TÜV (Technischer Überwachungsverein) certification. Fig. 6.3 shows the HPEM2GAS plant used for field testing activities.

*Figure 6.3 HPEM2GAS electrolysis plant for field testing in Emden Germany*

The initial field testing activities consisted of the automated running of the system with operator training and system handover.

Electrolyser stack assessment essentially regarded the complete differential pressure test, a complete common pressure test on stack, the switch of the hydraulic system to automatic, the procedures enabling piston pressure and record gauge reading, circulation of water through stack and recording quality after specific times.

These procedures were followed by powering up the system and engage breakers for operation with a check of vent lines. These were properly connected and well supported by ensuring that output lines were connected to vent. By using an automatic mode on the control system the plant was operated according to a logic flow diagram. Automatic operation was performed with the possibility to change operating parameters according to specific HMI-settable values. The automated operation included any outstanding tests required in the Alarms and Warnings checklist.

Polarisation tests were initially carried out by using a manual operation mode where the system was set up to run at normal pressures until the process water temperatures were roughly stable at operating levels. The polarisations were carried out by starting at 100% capacity and reducing the power into the stack in 10% increments while recording the current, $H_2$ pressure of the system, the individual stack voltages, piston pressures, and hydraulic pressures.

The system was thus assessed for automatic operation to run the plant at full capacity noting operating temperatures and chiller activity with check for any system shut downs (SDs). While operating the plant in automatic mode, the loading was progressively decreased from 100% --> 10% and it was confirmed that the changes did not create any shutdown. However, most of the automatic operation was carried out by running the plant at normal working gas generation levels.

The generated hydrogen was dried and purified with pressure and temperature sensors ensuring safe monitoring of the apparatus.

Regarding the injection of hydrogen into the gas grid, it was necessary to install a pressure reduction valve. The operating pressure of the electrolyser was 20 bar; the specific pressure reduction valve allowed to decrease the pressure to 10 bar before the outlet. SWE was operating the gas network at 8.5 bar. Thus, feeding hydrogen at 10 bar into the gas grid provided a slight overpressure as required also for efficient mixing.

Multiple measurements were taken in the control station such as pressure, temperature and flow using specific sensors.

During the field-testing activity, with the electrolysis system subjected to different electric loads, the hydrogen was leaving the control station and it was entering the gas transfer station through a specific pipeline.

To facilitate the mixing of hydrogen with natural gas, a specific mixer with built-in lamellas allowing a turbulent flow for the gas mixture. This allowed good gas homogeneity to be achieved.

As above mentioned the system was equipped with an automatic and remote-control. SWE was in charge of operating the unit on a day-to-day basis while ITM assured that the system was operating properly.

The proof-of-concept of power-to-gas was demonstrated for the new electrolysis system and useful knowledge was acquired about the operation of this type of advanced electrolyser at high current density. The operational period of the electrolyser was affected by the occurrence of a failure at the electrolyser plant essentially due to a mechanical damage of an MEA inside the stack. This problem was clearly identified by a post-operation analysis of the 75-cell stack. Another that  occurred during operation was the contamination of the active components of the stack (MEAs). This was thought to have resulted from a temporary malfunctioning of the ion exchange resin cartridge of the water purification system. The system was subjected to diagnostic analysis and specific solutions have been identified relating to the main issues.

# 4 Communication activities for the field testing

Several communication activities were undertaken for the field testing site.

On the 12th of February 2019, the HPEM2GAS project workshop took place in Emden, Germany involving more than 50 participants with a visit to the field testing site.


Some articles were published about the HPEM2GAS power-to-gas process in Emden in divulgative journals in Germany and in Italy (Emder Zeitung Article , Ostfriesen Zeitung Article, Stadt+Werk Article, Platinum Article).

# Elektrolyse: Emder Anlage weckt internationales Interesse

**ENERGIE** Forscher und Entwickler informierten sich über Prototyp für Power-to-Gas-Station

In Emden wird mit Windenergie Wasserstoff gewonnen. Die Testanlage weckt großes Interesse.

**EMDEN** / GO - Der 2,5 Millionen Euro teure Prototyp ist unscheinbar und befindet sich abgelegen im Emder Stadtwesten. An der Einfahrt in den Sicherheitsbereich steht hinter einem dürren grünen Zaun ein Container. In ihm wird mit Hilfe von Windenergie Wasserstoff erzeugt – Power to Gas. Die Idee: Wo Wind und damit Energie im Überfluss vorhanden sind, sollen Wege gefunden werden, diesen Überschuss zu speichern und nutzbar zu machen. Das begehbare Versuchslabor in Emden zeigt, wie es funktionieren kann. Auf Einladung der Hochschule Emden/Leer und der örtlichen Stadtwerke, die das ostfriesische Vorzeige-Projekt gemeinsam mit einem internationalen Konsortium planen, informierte sich am Dienstag eine Forscher- und Entwicklergruppe über das Elektrolyseverfahren in Emden.

Einer, der die Gäste aus Dänemark, England und anderen europäischen Ländern über das Gelände führte, war Gunnar Kielmann. Er ist technischer Leiter bei den Stadtwerken und erläuterte, was in dem weißen Container passiert: „Wir spalten Wasser in Wasserstoff und Sauerstoff", so Kielmann. Der Sauerstoff wird in die Luft geblasen. Der Wasserstoff landet im Emder Gasnetz.

**Power to Gas**

**Die Technologie** basiert darauf, dass Wasser mithilfe von Energie in seine Bestandteile Wasserstoff und Sauerstoff zerlegt wird. Das Wasserstoffgas kann beispielsweise in das Gasnetz eingespeist oder später in einem Gaskraftwerk wieder in Strom umgewandelt werden. In diesem Fall wird von einer Rückverstromung gesprochen.

Große Mengen liefert die kleine Anlage in Emden nicht: Nach Stadtwerke-Angaben sind es pro Tag 80 Kilogramm. Zum Vergleich: Eine Tankfüllung für ein wasserstoffbetriebenes Auto liegt etwa bei 6 bis 8 Kilogramm. Vollgetankt hätte so ein Fahrzeug eine Reichweite von rund 600 Kilometern. Ein Vorteil der Testanlage in Emden ist laut Kielmann, dass dort ein Einspeisepunkt für Gas und eine Stromleitung in unmittelbarer Nähe zueinander liegen. Die Energie wird benötigt, um Wasser in seine beiden Bestandteile zu zerlegen. In diesem Fall stammt der Strom aus einer 20-Kilovolt-Leitung, die Windenergie aus den Polderflächen nach Emden führt.

Die Power-to-Gas-Anlage ist erst seit Kurzem in Betrieb. Eigentlich hätte der Test bereits im September beginnen sollen, „aber die Entwicklung hat ein bisschen länger gedauert", sagt Kielmann. Nun soll der Testlauf bis Juni Aufschlüsse zur verwendeten Technik und zur Wirtschaftlichkeit.

Um Firmen wie Volkswagen und Investoren für das Verfahren zu interessieren, seien „eine hohe Effizienz und niedrige Kosten" entscheidend, sagte Dr. Sven Steinigeweg. Der Professor und Dekan des Fachbereichs Technik an der Hochschule Emden/Leer betreut das Projekt. Gunnar Kielmann ist von Wasserstoff als Energieträger bereits überzeugt: Für ihn steht fest: „Wasserstoff wird für die Elektromobilität interessant."

# Energie wird gespeichert

## Internationale Fachtagung zur Power-to-Gas-Anlage / Prototyp in Emden besichtigt

Von Jens Tammen
☏ 0 49 21 / 89 00-419

**Emden.** Wasserstoff kann als Energiespeichermedium für Windstrom eine große Rolle spielen. Wie groß diese Rolle letztlich ist, wird demnächst auf der Power-to-Gas-Anlage (Strom oder elektrische Energie zu Gas) in der Pfälzer Straße getestet (wir berichteten). Den Anfang Januar errichteten Prototypen haben gestern rund 50 Fachleute aus dem europäischen Raum besichtigt.

Die Hochschule Emden/Leer und die Stadtwerke Emden hatten dazu zu einer internationalen Fachtagung in die Räume der Hochschule eingeladen. Beide sind Partner des Projekts HPEM2GAS, das mit 2,5 Millionen Euro von der Europäischen Union gefördert wird. Auf dem Tagungsprogramm stand schließlich auch die Besichtigung und - soweit möglich - Vorführung der neuen Power-to-Gas-Anlage.

Ben Green von der Herstellerfirma ITM Power war dazu aus Großbritannien angereist. Er erklärte die Funktion und den Aufbau der neuen Anlage. Bei der Anlage handelt es sich demnach um einen Elektrolyseur, der die Bestandteile von Wasser (H2O) voneinander trennt. Wasser wird somit in Wasserstoff (H2) und Sauerstoff (O) gespalten. Der Wasserstoff kann im Anschluss für wasserstoffbetriebene Autos genutzt werden. Mit dem Prototyp sollen zunächst 80 Kilogramm pro Tag erzeugt werden. Mehr gibt die doch recht kleine Anlage nicht her. Damit können die Tanks von bis zu zehn Fahrzeugen einmal komplett gefüllt werden. Die Reichweite dieser Füllung liegt bei rund 600 Kilometern, wie sich die Experten gestern einig waren.

### Wasserstoff wird ins Erdgasnetz gespeist

Eine weitere Möglichkeit ist, und diese soll in Emden umgesetzt werden, den Wasserstoff durch die Methanisierung in Methangas umzuwandeln und dieses in das Erdgasnetz einzuspeisen. „Bis zu zwei Prozent dürfen dem reinen Erdgas beigemischt werden", sagte gestern Sven Steinigeweg, Dekan im Fachbereich Technik. Steinigeweg ist Mitorganisator der Fachtagung in Emden. Dass der internationale Zuspruch so groß war, freute ihn gestern. Das Forschungsprojekt betreibt europaweit derzeit sieben solcher Anlagen. Sie befinden sich in Dänemark, Großbritannien, Italien und den Niederlanden. Sie alle haben das Ziel, die Umwandlung des Ökostroms rentabel zu machen. Und entsprechend groß war das Interesse der Teilnehmer.

Die Anlage in Emden soll in Kürze offiziell in Betrieb genommen werden. „Es fehlt noch eine endgültige technologische Abnahme, auch der TÜV schaut sich alles noch einmal an", sagte Steinigeweg gestern zur *Emder Zeitung*. Die Testphase läuft dann über die kommenden sechs Monate. Im Idealfall gibt es danach eine größere Anlage, die mehr Windstrom speichern und Wasserstoff in das Erdgasnetz einspeisen kann. Sollten die Ergebnisse wider Erwarten nicht so positiv ausfallen, könnte die Anlage auch wieder abgebaut werden, betonte der Dekan.

Künftig könnte für die weitere Nutzung des Wasserstoffs auch eine Wasserstofftankstelle bei der gegenüberliegenden Tankstelle errichtet werden, erklärte Stadtwerke-Geschäftsführer Manfred Ackermann während der Vorführung der Anlage.

Ben Green von der Firma ITM Power aus Großbritannien erklärte den rund 50 Fachleuten gestern die Power-to-Gas Anlage in der Pfälzer Straße. EZ-Bild: Tammen

stadt+werk



**Nähere Informationen zum Bild**


**Über das bei den Stadtwerken Emden eingesetzte neuartige Elektrolyse-Verfahren informierte sich vor Kurzem Niedersachsens Umweltminister Olaf Lies (SPD).**

v.l.: Rolf Kramer, Alexander Flat und Gunnar Kielmann von den Stadtwerken Emden; Matthias Arends, MdL aus Emden; Niedersachsens Umweltminister Olaf Lies; Professor Dr. Gerhard Kreutz, Hochschule Emden/Leer; Dr. Nicola Briguglio, CNR

(Bildquelle: Hochschule Emden/Leer)

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**Stadtwerke Emden**

# Elektrolyse in großem Stil

**[24.7.2019] Im Rahmen des Projekts HPEM2GAS haben die Stadtwerke Emden vor rund einem halben Jahr einen neuartigen Elektrolyseur in Betrieb genommen und können damit künftig in großem Umfang Wasserstoff erzeugen.**


Wasserstoff wird für die Bewältigung der Energiewende eine immer größere Rolle zugeschrieben. Die Stadtwerke Emden (SWE) haben daher vor rund einem halben Jahr den Prototyp eines neuartigen, kostengünstigen Elektrolyseurs installiert. Damit werden nach Angaben der Stadtwerke Emden nach dem Power-to-Gas-Prinzip aus überschüssigem Windstrom täglich etwa 80 Kilogramm Wasserstoff erzeugt, die direkt ins Gas- und Stromnetz der SWE fließen.

An dem von der EU geförderten 2,5-Millionen-Projekt HPEM2GAS (High Performance PEM Electrolyzer for Cost-effective Grid Balancing Applications) ist neben den SWE und der Hochschule Emden/Leer ein internationales Konsortium beteiligt. Das Projekt läuft seit April 2016 und endet im September dieses Jahres.

„Wir haben in der Region die Möglichkeit, in großem Stil Wasserstoff beziehungsweise synthetisches Erdgas zu erzeugen. Die kleine Forschungsanlage ist für uns ein erster Schritt", erklärt Stadtwerke-Chef Manfred Ackermann. „Die tägliche Wasserstoffproduktion des Emder Prototypen entspricht etwa acht Tankfüllungen", so Alexander Flat, bei den Stadtwerken zuständig für Power to Gas. Gunnar Kielmann, technischer Leiter der SWE, ergänzt, die Wirtschaftlichkeitsprüfung der Anlage sei neben der technischen Analyse ein wichtiger Bestandteil des Projekts HPEM2GAS. Um verlässliche Daten zu erhalten, würden in der Praxis unterschiedliche Szenarien durchgespielt. „Wir stressen die Anlage sozusagen – von Kaltstarts über längere Ruhephasen bis hin zu häufigem An- und Ausschalten", so Kielmann. „Als Betreiber brauchen wir diese Informationen."

Stadtwerke-Chef Ackermann sieht in der vermehrten Wasserstoffproduktion an der Küste nicht nur eine Chance für die Region – auch für die Einspeisung ins Ferngasnetz könne dies interessant werden. *(bs)*

**https://hpem2gas.eu**
**https://stadtwerke-emden.de**

Stichwörter: **Energiespeicher, Power to Gas, Stadtwerke Emden**

*Bildquelle: Hochschule Emden/Leer*

**Suchen...**

Suchen





**Aktuelle Meldungen**

VW/VKU
**Systemwechsel zur E-Mobilität**

Bremerhaven
**Start für Wasserstoff-Modellprojekt**

Volvo
**157 E-Busse für Göteborg**

SAP / Accenture
**Cloud-Lösung für Versorger**

Windpark Borkum II
**Letzte Gondel von Senvion**

Rheinland-Pfalz
**Influencer erklären Energiewende**

Netze BW
**Vogelschutz unter Hochspannung**

Verteilnetzbetreiber Ost
**Broschüre zu Energiewende-Region**

Kongress Straßenbeleuchtung 2020
**Umfrage zum Status quo**

# L'idrogeno a salvaguardia dell'uso sostenibile dell'energia

*Un progetto europeo appena concluso punta alla decarbonizzazione del sistema energetico*

Gli effetti congiunti del riscaldamento globale e dei cambiamenti climatici potrebbero essere drammatici, per il futuro del pianeta. Sarà dunque importantissimo realizzare una transizione a livello energetico: basandosi non più su combustibili fossili, bensì su fonti rinnovabili: fino a raggiungere il 100%, obiettivo della UE entro il 2050. L'H2020 "HPEM2GAS" – coordinato dal CNR-ITAE di Messina e appena concluso – si è sviluppato in quest'ambito, puntando sull'idrogeno. "L'obiettivo è la decarbonizzazione del sistema energetico, usando l'idrogeno come vettore energetico preferenziale — spiega Antonino Salvatore Aricò, coordinatore del progetto -. Per farlo serve un sistema di elettrolisi estremamente efficiente, e occorre ridurre il costo dell'energia elettrica da fonte rinnovabile. Così abbiamo realizzato una componentistica avanzata in termini di catalizzatori, membrane e celle, e abbiamo integrato queste tecnologie in un sistema da 200 kW, che costituisce un proof of concept della nuova tecnologia di elettrolisi". Il prototipo di impianto, sperimentato in nella cittadina tedesca di Emden, ha dato buoni risultati, con un'efficienza da rinnovabili superiore al 70%. "Ora seguirà un follow-up plan per realizzare impianti su scala multi-megawatt: che utilizzino l'idrogeno come accumulo di energia, come refueling di veicoli elettrici e per applicazioni industriali". ■

SISTEMA REALIZZATO AD EMDEN

# 6 Conclusions

In the field testing activity carried out in Emden (Germany) of an advanced 75-cell, 200 kW PEM electrolyser developed in HPEM2GAS, the proof-of-concept of power-to-gas for the injection of the produced electrolytic hydrogen into the local gas grid was demonstrated. Specific approval (TÜV certification) for the hydrogen gas injection directly into the natural gas grid was granted by the Technischer Überwachungsverein (Technical Inspection Association). The produced electrolytic hydrogen passed through a regulator section in which the pressure was reduced from 20 bar to 10 bar before being injected into the natural gas grid. This reduction of the gas pressure was necessary because the SWE's NG gas network operates at 8.5 bar.

During this activity useful knowledge was acquired about the operation of this type of advanced electrolyser at high current density (3 A $cm^{-2}$). The operational period of the electrolyser was affected by the occurrence of a failure at the electrolyser plant essentially due to a mechanical damage of an MEA inside the stack. This problem was clearly identified by specific diagnostic analysis of the stack. Another issue occurring during the field testing was regarding contamination of the active components of the stack (MEAs) possibly by effect of a malfunctioning in the ion exchange resin cartridge of the water purification system. The system was subjected to the post-operation analysis and specific solutions identified for the main issues. Several communication activities were undertaken for the field testing site.