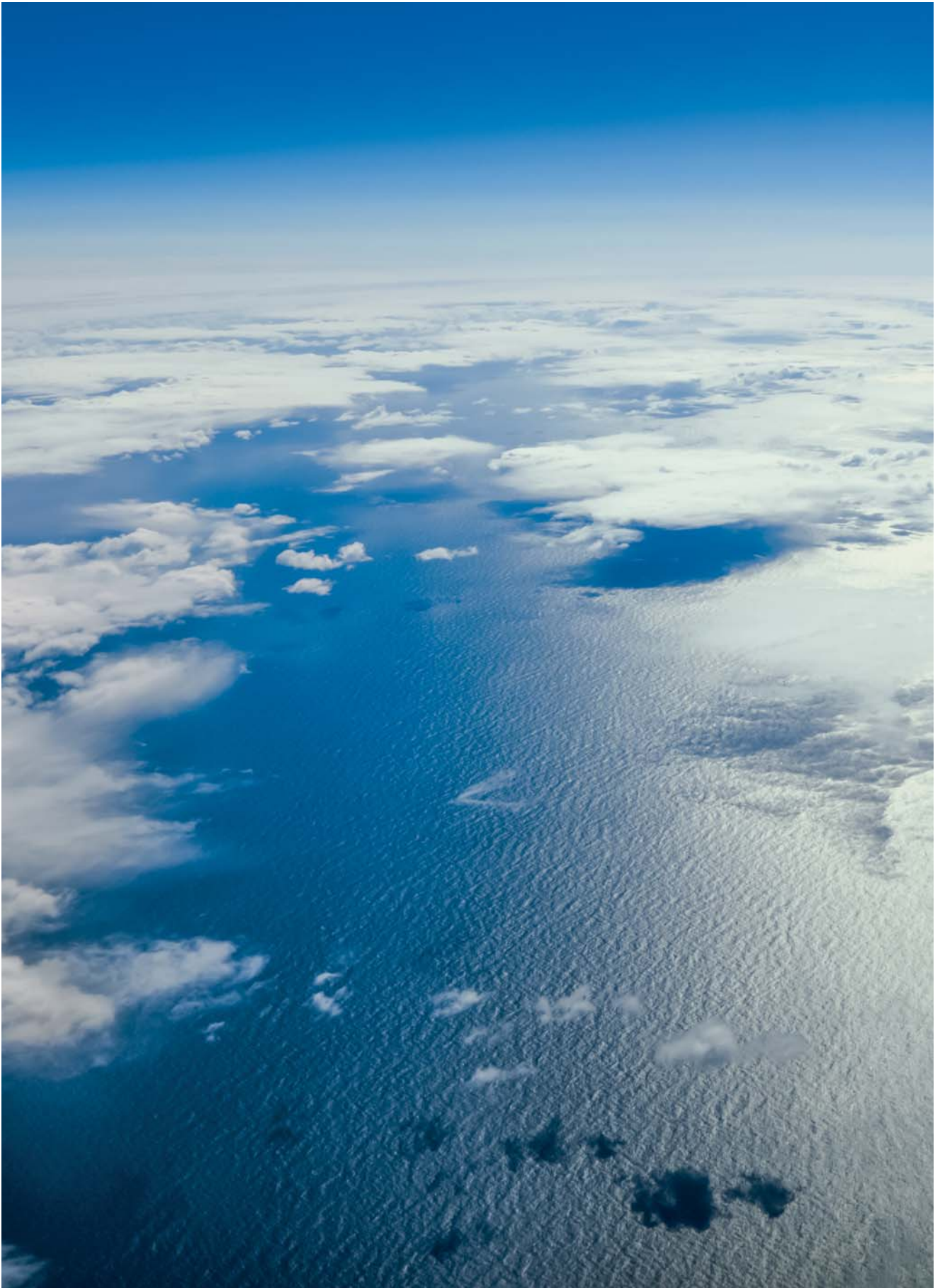




SIGNPOST BROCHURE

Technology of the future: Heating with hydrogen



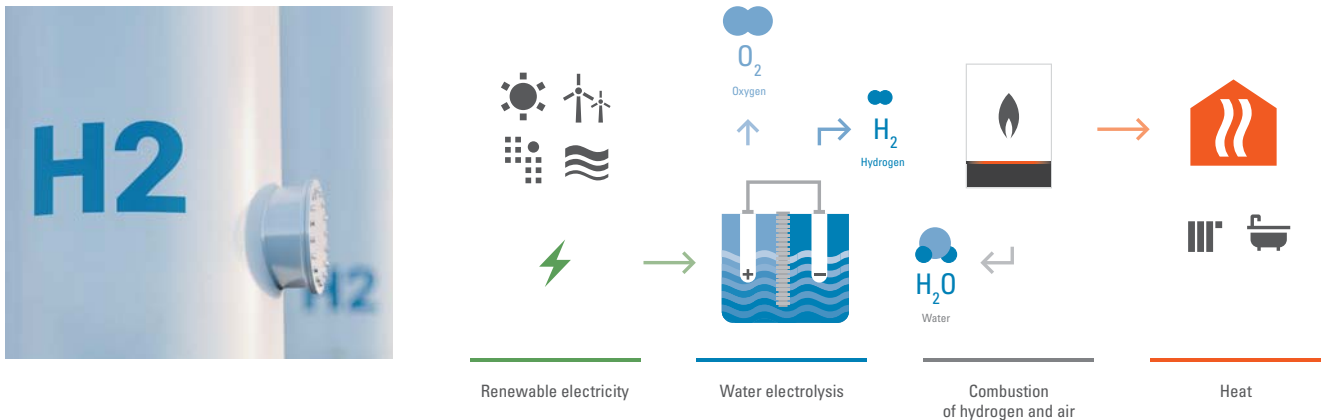


The increasing number of extreme weather phenomena worldwide in recent years makes it clearer than ever that CO₂ emissions must be reduced. Policymakers in Germany and the EU have therefore set themselves the objective of becoming climate-neutral by 2050 – in other words, reducing CO₂ emissions to zero. However, this can only be achieved if the burning of fossil fuels is avoided as far as possible. Oil and natural gas will continue to provide the necessary energy for our heating systems for some years to come, but we will have to look for alternative fuels to supply heat. One source of hope for achieving this ambitious plan of climate neutrality is a new, greenhouse gas-neutral energy source: hydrogen.

Viessmann is playing a key role in this energy transition, both in an advisory role for political decision-makers as well as in a formative capacity. With a comprehensive range of heating and air conditioning product and services, the Viessmann Group supplies cutting edge technology and sets benchmarks for using energy efficiently. Concrete products and services that help to reduce costs, conserve resources and protect the environment. We are also working on changing our energy supply sustainably as part of a cooperation with the German Federal Ministry for Economic Affairs and Energy (BMWi). One example is the development of solutions using hydrogen as the energy source. This enables us to create the conditions for a successful future for an entire industry and to create living spaces for generations to come.

Hydrogen – the greenhouse gas-neutral energy source with a future

Hydrogen is indispensable as an energy source of the future, not just because it burns with almost zero emissions. It is also available in large quantities and can be produced sustainably.



"Green hydrogen cycle: using renewable electricity, the electrolyser produces hydrogen (H_2) and oxygen (O_2) from water (H_2O). H_2 ready heating appliances burn hydrogen highly efficiently, producing water again in addition to heat for heating, and completing the cycle."

There is no doubt that hydrogen will play a crucial role in supplying energy in the 21st century. Its positive properties, such as producing virtually no exhaust gases when burned, make it an ideal substitute for fossil fuels such as coal, oil or natural gas.

A top position for Germany in the hydrogen technology rankings

The considerable importance attached to hydrogen as an energy source can be seen in the world of politics. The German government has announced a nine billion euro strategy focusing on accelerating the development of a hydrogen infrastructure. Together with 21 other EU countries and Norway, it has made hydrogen a "Project of common European interest". By 2024,

European hydrogen production with renewable energies is expected to reach one million tonnes, and ten million tonnes by 2030.

Breaking new ground in collaboration with the BMWi

Germany's grand coalition wants the country to become a global pioneer in the use of hydrogen energy. This is because hydrogen as an energy source can make significant inroads into lowering CO_2 emissions over the short term. The Viessmann Group is well represented in the national hydrogen strategy developed for this purpose. For example, in the "SmartQuart" pilot project funded by the Federal Ministry for Economic Affairs and Energy (BMWi), the first living lab for the energy transition.

An energy source that occurs practically everywhere

Despite hydrogen being the most abundant chemical element in our universe, it rarely occurs on Earth in a pure form as an unmixed gas.

On our planet, hydrogen is found practically only in chemical compounds, for example as water. It covers over two-thirds of the Earth's surface in this form. This represents huge potential, as the world's total water reserves amount to almost 1.4 billion cubic kilometres. Natural gases, e.g. methane, and crude oil are also important hydrogenous compounds.

Sustainable and economical in the long term

Forecasts indicate falling production costs achieved through the reduced costs for electrolyzers and renewable energies for electricity generation, and through the introduction of carbon capture and storage (e.g. in the North Sea). According to the international market research institute Bloomberg NEF, green hydrogen could be able to compete with natural gas in terms of cost by 2050.

Combustion relevant properties compared with natural gas

The combustion of hydrogen differs significantly from that of natural gas, for example. The energy density of gaseous hydrogen in relation to volume under normal pressure and at normal temperatures is approx. 3.0 kWh/m³ – only about one third of that of natural gas (9.97 kWh/m³). These properties of hydrogen have practical effects on almost all combustion parameters of a gas heating appliance. These include:

- Output
- Air ratio
- Emissions
- Efficiency

GREEN, GREY, BLUE, TURQUOISE HYDROGEN – WHAT CAUSES THIS?

Hydrogen must first be produced in order to be used as an energy source and raw material. There are essentially four processes for this:



Green hydrogen

is made by electrolyzing water. The electricity used for this process comes from renewable energy technologies. As a result, this type of hydrogen production is CO₂ free.



Grey hydrogen

is produced by steam reforming, mostly from natural gas. The resulting CO₂ escapes into the atmosphere, which increases the greenhouse effect.



Blue hydrogen

is obtained in the same way as grey hydrogen. However, the CO₂ produced is captured and stored, so it is not released into the atmosphere. This method of hydrogen production can therefore also be considered CO₂ neutral.



Turquoise hydrogen

is obtained through methane pyrolysis. This produces solid carbon. It is CO₂ neutral only if the heat required comes from renewable energies and the resulting carbon is permanently bound.

The benefits of hydrogen as an energy source

The most common element in the universe has numerous positive properties.

- + Hydrogen is not toxic, corrosive or radioactive
- + Hydrogen does not contaminate water, and does not cause damage to nature or the environment
- + Hydrogen has the highest energy density per kilogram compared to natural gas and fuel oil (hydrogen 33.3 kWh/kg, natural gas 13.9 kWh/kg, fuel oil 11.4 kWh/kg).
- + Hydrogen can be produced and burnt in a CO₂ neutral way and is therefore absolutely eco-friendly



Viessmann: pioneering in production, groundbreaking in development

Viessmann develops and produces integrated climate and energy solutions for people, businesses and local authorities worldwide. It is only natural that we "think in generations".

Viessmann's history has always been a story of innovation. We are curious about real progress and use all our skills, technical resources and experience to keep finding new and improved solutions. That's why research and development has always been given high priority at Viessmann. Simply because we believe that there is no future without innovation. And because we want to make a significant contribution to ensuring that our society uses energy efficiently and sustainably. For example, with new ideas such as the use of hydrogen as an energy source for heating systems.

"We create living spaces for generations to come"

This motto reflects the responsibility we take for the living spaces of future generations. That motivates us to constantly keep improving. After all, this motto also reflects our responsibility and our drive to make a difference with holistic technological progress – from comfortable homes to coexistence in neighbourhoods and cities, to the preservation of our planet.

Solutions that significantly lower CO₂ emissions

The heating/DHW sector has the most to benefit from the energy transition as it accounts for up to 50 percent of CO₂ emissions. Up to 20 percent hydrogen could already be added to the natural gas in the existing grid. This would reduce emissions by around 7 percent per year. The latest gas condensing boilers from Viessmann can in principle already be operated with 20 to 30 percent hydrogen. Opting for these boilers is an excellent way to equip yourself for the future.

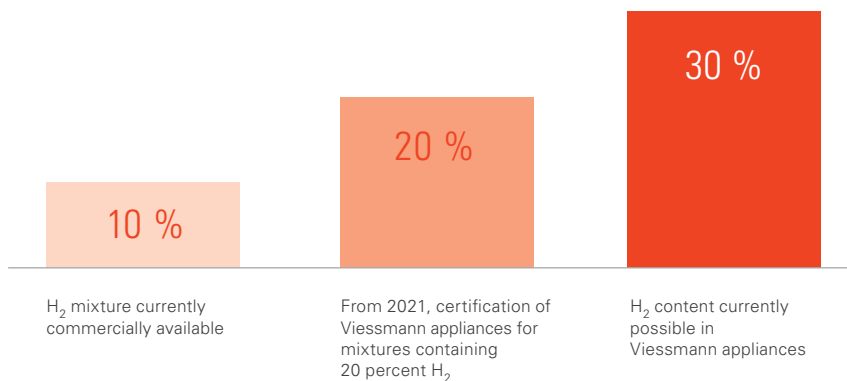
Viessmann: always at the cutting edge of development

Hydrogen being used as a new, additional energy source will increase incrementally, e.g. through increased injection into the gas grid. Innovative manufacturers such as Viessmann already offer solutions with advanced gas condensing boilers and fuel cells that convert natural gas/hydrogen mixtures easily and efficiently into heat and electricity. Viessmann therefore puts maximum futureproofing and investment security at its customers' disposal.

Gas condensing boilers from Viessmann are already hydrogen compatible

As a pioneer in the field of heating technology, Viessmann is making it possible today to use an energy source with a high hydrogen content. All Viessmann gas heating appliances can run on 10 percent hydrogen. Lab tests have shown that up to 30 percent is possible without any problems. However, Europe still lacks a statutory framework for approving the use of such mixtures. And Viessmann is already thinking beyond this: gas heating appliances and fuel cells are being developed and tested for operation with 100 percent hydrogen.

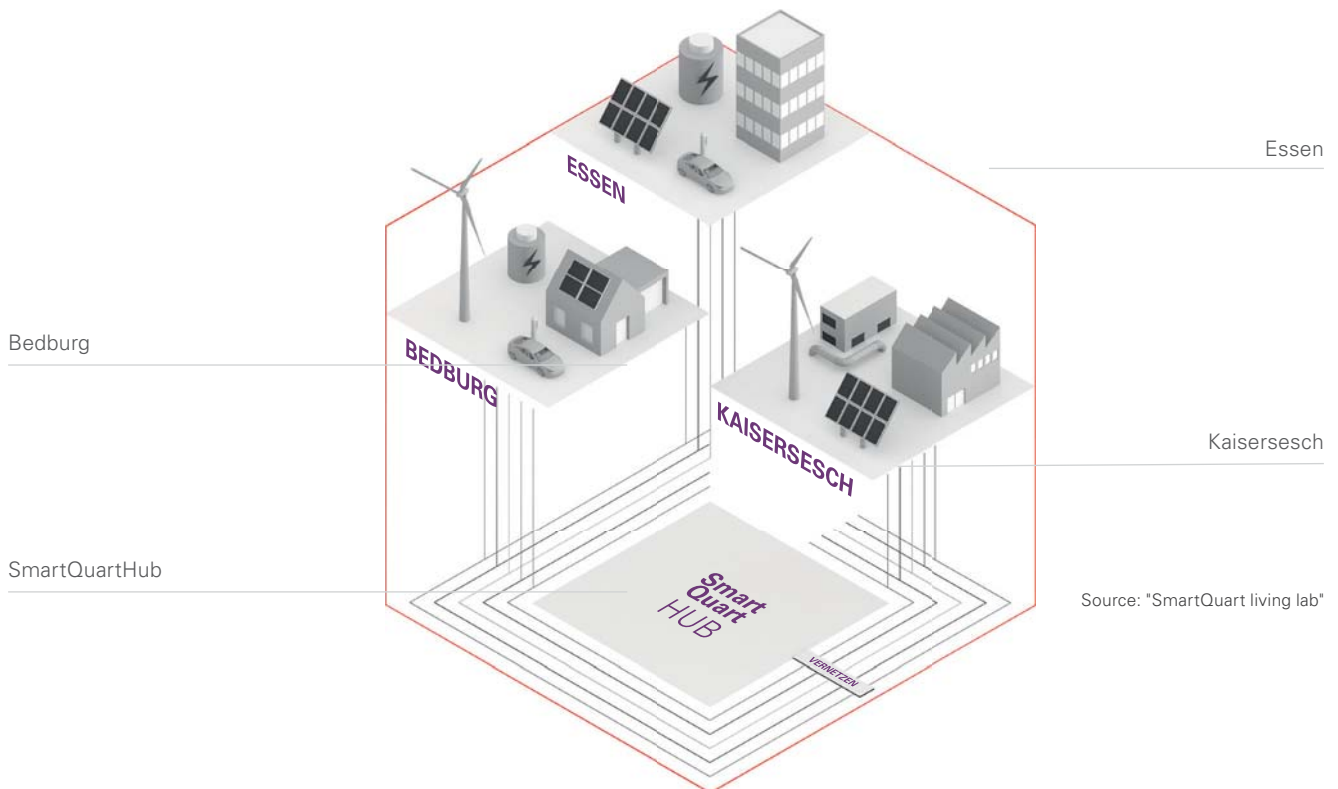
H₂ MIXTURE



The first prototypes are currently being tested in the Viessmann Technology Centre for compatibility with mixtures containing 100 percent hydrogen.

Comprehensive testing in the Viessmann Technology Centre

In the Technology Centre, the Viessmann Group's hub of research and development, the suitability of conventional gas condensing boilers for natural gas/hydrogen mixtures containing up to 30 percent hydrogen is already being intensively investigated. The results from the test rig speak for themselves. All test criteria were fulfilled with a mixture containing 30 percent hydrogen. The particularly important criteria of appliance safety and robustness were not impacted in any way by this high hydrogen concentration. The ignition behaviour actually improved.



SmartQuart: smart neighbourhoods are being built at three locations that are supplied with energy in an almost completely climate-neutral way.

Ambitious pilot projects: SmartQuart Kaisersesch relies 100 percent on hydrogen

Hydrogen as an energy source – the new fuel will be tested in real life as part of the SmartQuart project funded by the BMWi. Hydrogen powered condensing boilers from Viessmann play a key role here.

Around one third of the total energy consumption in Germany, i.e. approx. 800 TWh/a, is used for space heating and domestic hot water heating. It is therefore essential to develop climate-neutral heat generators and use them in the building sector. Paving the way to a greenhouse gas-neutral future, the Viessmann Group is developing hydrogen heating appliances that are 100 percent hydrogen compatible and can be easily converted from natural gas to hydrogen operation. Highly efficient and zero CO₂/CO emissions in H₂ operation.

Viessmann: pacemaker for innovative technologies

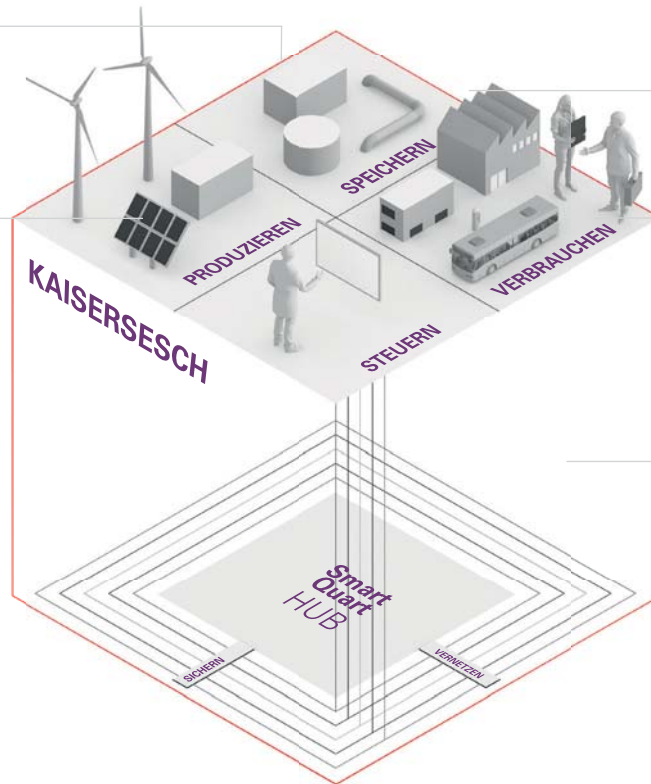
Viessmann is currently developing "H₂ ready" condensing boilers to be run on 100 percent hydrogen, as will be installed for real-life operation in Kaisersesch, and is using test rigs to test these comprehensively. From 2023, Viessmann will be one of the first H₂ ready manufacturers to enter the market with a complete hydrogen-based portfolio.



Condensing boilers from Viessmann – ready for the energy source of the future.

Hydrogen-based micro grids

Wind turbines
Photovoltaic systems
Electrolyser



LOHC surplus energy
Hydrogen storage system
H₂ users, industrial building
Heat recovery
Hydrogen mobility
H₂ CHP unit

SmartQuart control centre

Source: *SmartQuart living lab*

In the town of Kaisersesch, in Rhineland-Palatinate in Germany, an entire infrastructure for supplying pure hydrogen will be built by 2023.

[Learn more](#)

More information about the pilot project with hydrogen as an energy source can be found at viessmann.family/wasserstoff viessmann.family/hydrogen

First living lab for hydrogen: SmartQuart in Kaisersesch

While the SmartQuart locations in Essen and Bedburg will mainly use electricity-based solutions (local wind power and photovoltaic systems, decentralised and centrally installed heat pumps), a complete hydrogen infrastructure will be created in Kaisersesch by 2023. This involves setting up the entire value chain – from the generation of renewable electricity for the operation of the electrolysers, the storage of hydrogen and its distribution, up to its use in heat and power supply as well as for industry and transport.

Viessmann appliances: successful testing in real-life conditions

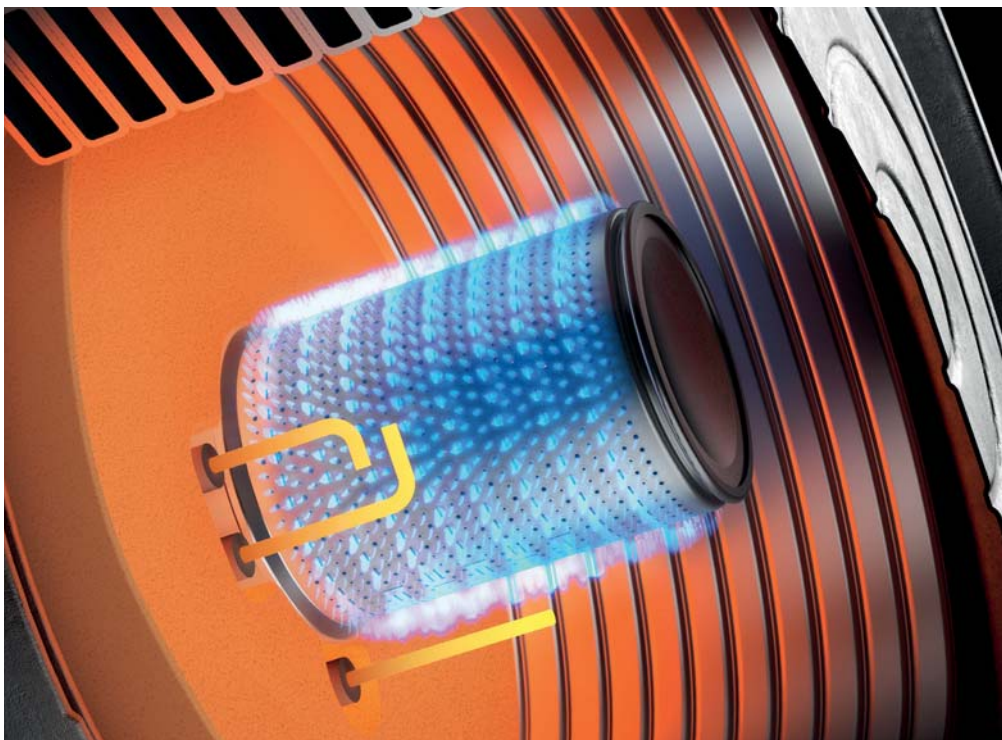
For space heating and domestic hot water heating, the Viessmann Group will provide hydrogen-powered condensing boilers in the Kaisersesch SmartQuart. In addition, fuel cell systems will be used to supply electricity and heat, which are also designed to run on pure hydrogen. Field testing in Kaisersesch will commence in 2023. The condensing boilers will be able to run on pure hydrogen, natural gas or natural gas/hydrogen mixtures. This means that they can also be used later in real life in a transition phase from natural gas to a pure, futureproof hydrogen supply without any problems.



Advanced gas condensing boilers, such as the Vitodens 300-W, can be operated easily with at least 20 percent hydrogen in the natural gas. Tests have shown that up to 30 percent is actually possible.

Technology that considers the future: Lambda Pro Plus gas-adaptive combustion control

Specially developed by Viessmann, the Lambda Pro Plus combustion controller plays a key role in using hydrogen efficiently as an energy source.



The efficiency of using gas as a fuel is causally related to the air ratio (lambda), i.e. the ratio of air and gas. It determines the energy efficiency resulting from combustion, as well as the pollutant emissions. The measurement of the air ratio and the corresponding adjustment is carried out via the gas-adaptive Lambda Pro Control combustion controller.

Ionisation signal: the basis of information for efficiency

It has long been known that a gas combustion flame emits an ionisation signal. This was initially used to monitor and protect the heating system among other things. The Lambda Pro Plus process builds on this concept and has been enhanced by Viessmann for advanced, fully modulating boilers with a high power density. To get the ratio of hydrogen to natural gas right, the gas-adaptive Lambda Pro Plus combustion controller plays a decisive role: it provides exact values by constantly measuring and evaluating the ionisation current in the flame.

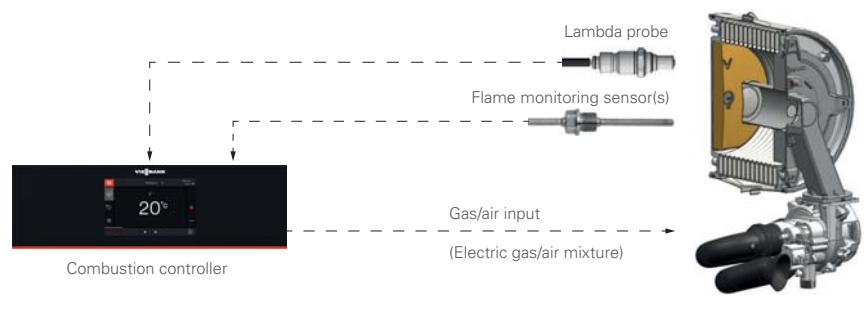
Hydrogen and natural gas: differing properties

Hydrogen and natural gas have different combustion properties. Especially with its higher combustion speeds and temperatures, hydrogen causes a shift in the reaction zones and conductivity zones for recording the ionisation signal for the Lambda Pro Plus gas-adaptive combustion controller.

A new concept: fired with pure hydrogen

The addition of hydrogen to natural gas is only an intermediate step. The objective is to fire heating systems with pure hydrogen. One of the challenges here is the lack of an ionisation signal, which is required by the Lambda Pro Plus gas-adaptive combustion control system. This means a new concept for flame monitoring is necessary for pure hydrogen operation. The basis for this is a modern, gas-adaptive condensing boiler for natural gas, which is modified to suit the requirements of pure hydrogen combustion.

Hydrogen combustion properties differ significantly from those of natural gas, which necessitates the development of a new combustion, flame monitoring and control system, as well as modifications to the components. The technical concept developed by the Viessmann Group is based on sensor-guided electronic combustion control with a lambda probe. This concept makes it easy to convert from natural gas to hydrogen, thus ensuring the future viability of appliances in the transition phase.



Sensor-guided electronic combustion control with lambda probe

BENEFITS OF SENSOR-GUIDED ELECTRONIC COMBUSTION CONTROL

- + Newly developed, hydrogen compatible, fully premixing surface gas burner with wide operating field and NO_x reduction
- + Sensor-based electronic combustion control system with lambda probe for optimal operation and high efficiency
- + Innovative flame monitoring, suitable for hydrogen and natural gas
- + Modular burner design; can be converted from natural gas to hydrogen

	Gross calorific value H _s	Wobbe value W _s	Specific air requirement	Ignition limits	Flame temperature	Flame speed	Ignition delay time
Unit	[kWh/m ³]	[kWh/m ³]	[kWh/m ³]	[%]	[°C]	[cm/s]	[s]
Natural gas (CH₄)	11.09	14.98	0.96	5 – 14	1970	43	0.3
Hydrogen	3.54	13.42	0.80	4 – 77	2130	346	0.0001

A direct comparison of the properties of hydrogen and natural gas

Hydrogen: An ideal energy source for modernisation and new build projects

There are many possible uses for hydrogen. The clean all-rounder can show its strengths especially in generating heat for residential and commercial buildings.

In existing buildings in particular, building owners rarely think about switching to a different energy source when modernising. The investments for adapting the supply, storage and use of a new fuel are usually far too high. Not the case with hydrogen. This makes it an energy source with excellent prospects for the future. Here are some solutions that show typical real-life examples of modernisation and new build projects.

Detached house modernisation

Conventional detached house with four-person household, built in 1982, 150 m² living space, to be modernised on a limited budget. The regional gas grid is currently operated with 10 % hydrogen. The plan is to switch to 100 % H₂ in a few years.



It is important to the owners to install a futureproof heating system that will not have to be replaced or expensively retrofitted in just a few years. This requires the old gas condensing boiler to be replaced with a new one.

Solution

Minimal investment is all it takes to replace the old gas condensing boiler. The rest of the heating system remains in place. The new gas condensing boiler offers a high degree of futureproofing as it automatically adapts to increasing H₂ content in the gas.

- + New hydrogen compatible gas condensing boiler with the option of later conversion to 100 % hydrogen operation
- + Possibility of supplementing with solar thermal
- + Use of ViCare and Vitoguide

Apartment building modernisation

Apartment building with twelve rented residential units of 80 m² each, built in 1982. The heat supply is currently decentralised with fairly old wall mounted gas condensing boilers in each apartment.



The gas supplier in the region wants to pioneer the use of hydrogen and switch to 100 % water investments in H₂.

Solution

With minimal investment, the existing infrastructure in the building can be adapted to hydrogen use. Since the existing heating system remains in place, a straightforward appliance replacement takes place.

- + Replacement of the old wall mounted appliances with new gas condensing boilers, suitable for 100 % hydrogen operation
- + Use of ViCare and Vitoguide

Tailor-made: system solutions for modernisation and new build

New detached house

Detached house with 170 m² living space, located in a pilot region with 100 % hydrogen supply. The owners are aiming for a holistic solution that offers the greatest possible autonomy from the electricity supplier, including a wall box for electric vehicles.



All the advantages of new, environmentally friendly technology are to be combined in the house. The owners are happy to invest the necessary budget, as they want a long term sustainable solution.

Solution

For the greatest possible autonomy from the electricity supplier, a high efficiency, futureproof solution is created with coordinated system components for heat and electricity from a single source. Including all the benefits of an energy community.

- + Vitovator PT2 for pure hydrogen operation
- + Supplemented with photovoltaics and a power storage unit
- + Use of ViCare, Vitoguide, GridBox and ViShare

Commerce and local authorities

The existing town hall of a medium sized local authority in Europe needs to be modernised to become energy efficient. The building's heating centre (old gas boiler) dating back to 1980 urgently needs to be modernised to supply office space of approx. 800 m².

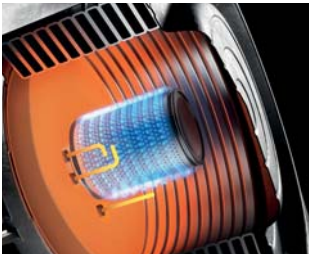


The budget and the existing heating system do not stretch to heat pumps. The local authority wants to set an example of sustainable energy use and is therefore subsidising the expansion of the regional H₂ infrastructure to initially 20 %, increasing later to 30 % H₂ in the gas grid.

Solution

With a tailor-made system, Viessmann not only supplies coordinated system components for heat and electricity – the comprehensive engineering support includes all services and guarantees a solution from a single source.

- + Medium sized boiler and small combined heat and power unit for gas mixtures of up to 30 % H₂
- + Use of ViCare, Vitoguide/ Vitoscada



A milestone in heating technology: the Matrix-Plus burner

VIESSMANN'S INTEGRATED RANGE OF SOLUTIONS	
Value added services	VIESSMANN WÄRME VIESSMANN VISHARE FörderProfi ...
Digital services	ViCare VitoGuide ...
Connectivity/ platforms	Connectivity Inside Vitoconnect @wbutler GridBox ...
Products/ systems	[Icons representing various heating and climate control products and systems] ...

Seamless integration of products and systems with digital services and value added services for system users and trade partners

Viessmann is the leading provider of climate solutions for all living spaces. The "Integrated Viessmann Solutions Offering" enables users to connect products and systems seamlessly via digital platforms and services for climate (heating, cooling, air quality) and refrigeration solutions.

All solutions are based on renewable energy and maximum efficiency. All the activities of our family company, founded in 1917, are based on the following mission statement: "We create living spaces for generations to come" – that is the responsibility of the global Viessmann family with 12,300 members.



We create living spaces for generations to come.



Number 1 Trade Partner – for the 15th consecutive time

Practical partnership

As part of its comprehensive range, Viessmann also offers a wide selection of value added services. These include an extensive training and further development programme for trade partners at the well equipped training facilities of the Viessmann Academy.

With its new digital services, Viessmann offers innovative solutions such as the operation and monitoring of heating systems by smartphone. Users benefit from greater reassurance and convenience, whilst contractors can keep a constant eye on the systems for which they are responsible.



As a family company in its fourth generation, we take a long term view: we create living spaces for generations to come. This mission statement guides the actions of all employees in the large Viessmann family.

VISSMANN GROUP IN FIGURES

1917

— Viessmann was founded

12 300

— employees

2.65

— Group turnover in billions of euros

56

— export share in percent

22

— manufacturing sites in
12 countries

68

— sales companies in
31 countries

120

— sales offices worldwide

Your trade partner

02/2021 GB

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