WE ARE OPENING DOORS TO

ENERGY FUTURE

AUSTRIA AG
Renewables and Gas

ENGLISH

AUSTRIA AG
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Contents

RENEWABLES AND GAS

RAG Austria AG

RAG is Austria’s largest energy storage company, and one of Europe’s leading gas storage facility operators.

The business focus is market driven storage, conversion and conditioning of energy in gaseous forms. The company has gas storage capacity of over 6.3 billion cubic metres (bn cu m) of natural gas, or about 6% of total capacity in the EU.

A large part of RAG’s gas fields have already been converted into storage facilities, which can rapidly discharge stored energy in large quantities on-demand. In this way RAG is delivering on its vision of “sustainable energy mining”, and decisively reinforcing security of supply in Austria and Europe. RAG operates and continues to develop a total of 11 pore storage facilities. These include the storage facilities in Puchkirchen/Haag, Haidach, Haidach 5, Aigelsbrunn and the 7Fields interconnected gas storage as well as the hydrogen storage facilities in Pilsbach and Rubensdorf.

The company also develops leading edge energy technologies related to “green gas” that partner renewables. This is enabling RAG to play a vital role in attaining Austria’s ambitious climate goals, and in the sustainable stewardship of the country’s raw material and energy supplies.

RAG aims to provide its customers with safe, efficient and affordable energy and gas storage services – sustainably and responsibly.

Foreword

Efforts towards an energy transition have rapidly turned into a watershed in energy policy. Supply shortages and price rises due to the changed geopolitical situation and advancing climate change are bringing home to us just how vital crisis-proof, climate-neutral energy supplies and predictable energy costs are. The challenges are immense and can only be tackled by sharing the burden. Meeting them effectively requires joint action by the main players in the energy, industrial and transport sectors, as well as politicians, pressure groups and consumers. Room for innovation is also essential. Our future energy landscape must offer security of supply, and be climate-friendly, technologically open and interlinked.

As a company with a strong sense of responsibility, we will play an active part, bringing our expertise, practical experience and innovative capabilities to bear on the rapid realisation of the energy system of the future. Our core business is large-scale seasonal energy storage and supply. At the same time we are working flat-out to propel the energy sector and its technologies in the direction of carbon neutrality. Gaseous energy forms including natural gas, biogas, synthetic gas and hydrogen have a major role to play here. The central question is: how can we carry renewable solar and wind energy over into the winter, so we can use it whenever we need it, regardless of the weather and the season? Energy storage at RAG facilities is a large part of the solution, and is the precondition for reliable use of renewable energy; it is the key to future energy security of supply.

RAG Austria AG is committed to maximising quality and maintaining its strong long-term commercial performance by leveraging its longstanding subsurface gas storage expertise, wide-ranging technological expertise, high environmental and safety standards, and collaborative and transparent corporate culture. Besides its inventiveness and agility, RAG owes its success to a reliable and ambitious workforce.

Join us on a shared, energised and innovative journey to a secure, climate-neutral energy future!

Markus Mitteregger
CEO RAG Austria AG

Michael Längle
CFO RAG Austria AG

INTERVIEW

“We’re bringing the future of energy to life right now.”

RAG board members CEO Markus Mitteregger and CFO Michael Längle discuss the fuel of the future, hydrogen, the “RAG spirit” and the importance of bulk storage to the energy transformation.

“RAG’s main strengths are its ability to innovate, and to act in a responsible, far-sighted manner.”

The current geopolitical situation has immense implications for energy supply and energy prices in Europe. Does this mean that it poses a threat to the planned energy transformation?

Quite the contrary! It is accelerating the pace of change. It is giving a big push to the ramp-up of renewable energy production, and since the beginning of the war in February 2022 solar and wind power output have hit new records in the EU.
But that is aggravating the basic problem with renewables – their volatility and the fact that they are not available year round. How can green power be carried over into the winter? It’s not just clean energy we need, but the maximum possible security of supply. We need large volumes of energy, available flexibly, to meet demand throughout the year. The current situation shows yet again how essential that is for our economy and living standards. As such, it is not possible to store large amounts of wind and solar power, so the gaseous.

What role do gaseous energy forms have to play in a future sustainable energy system?

Gaseous energy forms are innate energy all-rounders – transformable and fit for all kinds of uses. They are clean, safe and reliable, they can also be “green”, and the necessary infrastructure is in place. Because of this they have long since ceased to be a mere bridging technology, and should be seen as a key element of tomorrow’s renewable energy system. Gas is in great demand, especially for power and heat generation to meet the needs of industry, power stations and households, because it can be stored in large volumes and withdrawn on-demand at high capacity. At present we mostly rely on conventional natural gas, but the future will see a great deal of green gas and clean hydrogen being consumed. It will then be possible to use methane wherever it is needed as feedstock – for instance, in the chemical industry. The future belongs to solar and wind powered green gas production, and to large-volume storage in gas reservoirs. Because of this, our corporate claim is: “RAG – renewables AND gas”. What is needed now are rapid strategic decisions – speed is of the essence.

As Europe’s fourth-largest storage operator you are ideally placed to profit from the future of energy. What’s the strategy behind this?

RAG’s main strengths is its ability to innovate, and to act in a responsible, far-sighted manner. Because of this we were very quick to see which way the wind was blowing and bet on the future of energy – despite some opposition. This brought us success, and enabled us to evolve from a conventional oil and gas producer into the largest Austrian energy storage operator and a highly promising European player. Our gas reservoirs have become commercial storage facilities. The long-term strategy behind this is “sustainable energy mining”. The idea is deceptively simple. The gas pore reservoirs we discover are amazing treasures. Natural gas was stored there safely for millions of years. That still holds good when we re-use them for gaseous energy forms – and it will do so in future for hydrogen and green gas.

“We see ourselves as enablers who are acting as a link between renewables and security of supply.“

RAG has recently gone through major changes, and now the initials stand for Renewables and Gas. What will be the main focus of your business activities over the next few years?

We have a wealth of expertise and experience at many levels – from the production of hydrocarbons and their underground storage through to geothermal energy and “green gas” technologies. Our focus is still on energy storage, as well as the efficient use of oil and gas resources in place. We believe the future lies in the use of these as raw materials instead of as heating or transportation fuels. There will be green gas and hydrogen for the latter, and they will be climate-neutral or completely emission-free.

RAG has patented “green gas” technologies, has launched international projects and partnerships in this area, and is operating ultra-modern energy storage facilities. How do you manage to be in the forefront of so many different lines of business?

We’re interested in technical success. That’s in our DNA. With our resources, our infrastructure and the know-how of our highly trained, experienced and ambitious workforce, we’re working on sustainable solutions for the production, storage, efficient use and top-quality processing of energy and raw materials. And that means we’re driving the future of energy. We see ourselves as enablers who are acting as a link between renewables and security of supply. Operating our ultra-modern energy storage facilities, which we have planned and built with investments from a variety of companies between 2005 and today, demands a great deal of expertise. This is the only way we can supply energy reliably and continuously, without maintenance outages. Our people are committed to the “RAG spirit”, not short-term profit maximisation. That’s the secret of our many years of success.

Energy supplies face severe challenges not just from the current insecure import situation but also from hybrid attacks on critical infrastructure, such as cybercrime. How are you responding?

With our storage capacity of more than 6.3 billion cubic metres of gas, we operate about 6% of all EU capacity, making us part of the critical energy infrastructure. Because of this we have long applied the toughest possible safety standards, and we take measures designed to prevent disruption of the availability and integrity of our assets by third parties, through cyber attacks or physical events. All of our assets, including our gas storage facilities, have their own safety concepts in place. In addition, we collaborate closely with experts and public agencies, and as a critical infrastructure operator under the Network and Information Systems Security Act (NIS) we’re subject to strict safety standards, and compliance is externally audited.

Like natural gas, hydrogen is an all-rounder. Both are storable energy forms, can generate heat, and can be used as transport fuels.

That tomorrow’s energy supplies must be sustainable goes without saying. But how do you manage that in practice, in an eco-friendly fashion, without CO_2 emissions, without import dependence, and with high levels of supply security?

We are convinced that the future belongs to sustainable, regional, carbon neutral energy cycles. All the elements come together at our Kremsmünster site, and it is the ideal place to create a showpiece for the new approach. In the RAG Energy Valley, in Krift, near Kremsmünster, Upper Austria, a model region is currently taking shape that may also offer an answer to the question of how to provide large conurbations with secure, year-round green energy supplies. CO_2 neutral energy is to be produced, stored and used there throughout the year to supply local industry and households with power, heat and transport fuel. Climate protection and security of supply are at the heart of the thinking behind the scheme. We are aiming for a perfect combination of green energy production, conversion, storage and consumption. Summer solar energy is made storable by converting it into hydrogen for use as green power, heat and transport fuel in winter. Another advantage of the RAG Energy Valley project in Krift is the fact that value creation remains in the region, and the business location is strengthened.

Hydrogen has an established reputation as a cornerstone of tomorrow’s climate-neutral energy mix. What makes hydrogen so special?

Hydrogen is a hot topic at present, and rightly so. You could almost talk of a hydrogen revolution. Hydrogen is a natural chemical element, and like natural gas it is highly versatile. Both are energy forms, highly storable, and ideal for power and heat generation, as well as for use in transportation and energy-intensive industrial processes. But the main point is the fact that hydrogen production can be climate-neutral, meaning it can make a major contribution to climate action. H_2 has long been used as a chemical feedstock – for instance to make ammonia, which is a base material for fertiliser. Hydrogen has immense potential as an energy form for electricity generation. As a production technology we rely not just on water electrolysis but also on methane electrolysis. The latter is an emission-free process that harnesses wind and solar energy to break methane down into hydrogen and carbon. This yields both hydrogen – a storable, climate-neutral energy form – and carbon, a valuable raw material. Solid carbon is a material of the future, and it plays an important role in agriculture as a soil conditioner. We find this very exciting because it opens up new prospects for us. And when it comes to technological breakthroughs, we like to be at the cutting edge.

“RAG is the first company in the world to have stored hydrogen in pore reservoirs.”

Why must green electricity be converted into gaseous energy forms like hydrogen when we already have batteries and pumped storage?

Pumped storage power stations and batteries will not be able to cope for long with the huge energy storage demand from industry and households, because they have only a fraction of the necessary capacity. They are ideal as add-on capacity and daily storage, and fulfil the function of stabilising the power grid by balancing out fluctuations, but they are no alternative to large-volume storage of gaseous energy forms. Only this can underpin security of supply, and even out seasonal swings. The figures make that clear: RAG’s storage facilities hold 500 times as much energy (72 TWh) as all of Austria’s pumped storage capacity together (0.14 TWh). The withdrawal capacity is also enormous, at 32 GW – equal to the output of about 27 nuclear power plants. Daily and seasonal storage facilities do not compete with each other; they have their own uses, so they’re both necessary.

How precisely does hydrogen storage work? Isn’t this still a long way off?

RAG is the world’s first company to have stored hydrogen in pore reservoirs. Why is that so important? It is only possible to store summer sunshine on a large scale and carry it over to the winter in the form of hydrogen, thereby decoupling energy production from consumption. The need for this will grow massively. RAG is currently operating its own pure-play hydrogen storage facility in Rubensdorf as a demonstration project. This is the 11th storage facility we have built and developed, alongside the nine natural gas storage facilities and the first hydrogen storage facility, in Pilsbach. We are pooling resources and exploiting synergies in these activities. We are collaborating with a number of large Austrian energy and industrial companies on this project. The only way to establish a future-proof, sustainable energy system is by cooperating with energy producers, storage and infrastructure operators, industrial companies, and regional governments and local authorities.

Domestic oil and gas output has long been in decline, but now you want to step it up again. Does that make sense?

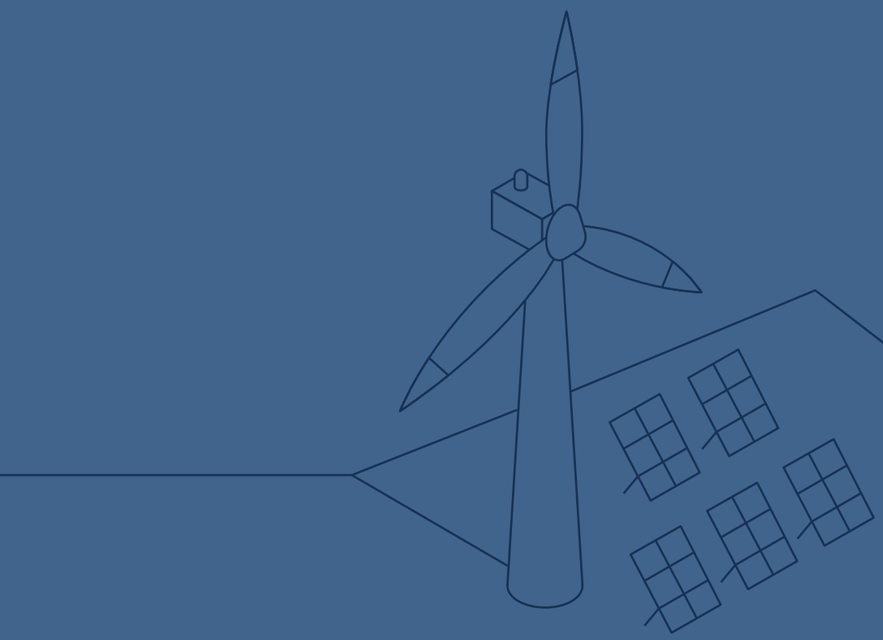
In the current energy and geopolitical situation, with the insecurity surrounding imports of primary products, domestic production has become particularly important. Responding to this problem is one of our responsibilities. Extracting and using our local underground natural wealth is the order of the day. RAG will therefore operate existing fields in Upper Austria and Salzburg more intensively, rather than investing in new exploration. This will apply both to optimisation of storage capacity and to increasing the efficiency of production. We produce, store and transport oil and gas in line with the strictest environmental and safety standards, to be used for direct, decentralised supplies that reduce import dependence. Making sufficient quantities of domestic oil and gas available to Austrian industry is our top priority. The exploitation of these resources can and will be emission and CO_2 neutral.

Given the current climate and energy situation, how can Europe achieve energy transformation and remain competitive?

The long-term goal of climate neutrality by 2040 has been displaced by particularly urgent needs. Suddenly the focus is on two other aspects of policy, besides climate protection: energy costs and security of supply. Reconciling these three considerations is a mammoth task that calls for rapid, decisive action – in the first place, of course, by government, which must create the necessary business environment and investment security. Beyond this, there will need to be a major effort from all concerned – from producers through to consumers. Strong international cooperation will also be essential, because energy knows no borders. It would be an illusion to think that these challenges can have national solutions. The hydrogen ramp-up programme is a case in point. Our international, cross-sectoral energy partnerships, such as the ongoing H2EU+Store and H2 cross border projects, show what can be done. We are creating an entire value chain, from production and transport, through to storage and withdrawal across borders. It is time to act, starting with measures that can be taken at once. That is exactly what RAG is doing. While others are still busy with studies, we are already creating facts. We’re not waiting for official targets, we’re already working on the future of energy. Our open-technology projects are pointing the way forward to emission-free use of raw materials which, besides the aim of a sustainable hydrocarbon and energy economy, hold the key to green and secure energy and raw material supplies.

Renewables and gas – with us

Secure, sustainable, competitive and affordable energy for all is one of the major challenges of our time, and is key to economic growth and prosperity in Europe.



The global energy business is in a ferment of change

We are on course for a sustainable energy system that will limit climate change. Emission reductions and greening measures are the overarching priorities.
At the same time, the current geopolitical situation presents us with major challenges in terms of sources of supply, security of supply and price. These challenges can only be overcome by a massive joint effort on the part of policymakers and every sector of the economy.. Austria and Europe not only require clean, affordable energy for power, heat and transportation: at the same time they need maximum security of supply, with large amounts of energy available flexibly and with high withdrawal capacities.

Taking responsibility
Thanks to our commitment to innovation, for years we have been working on promising solutions that respond to changes in terms of climate, policy and economic realities.

RAG is rethinking conventional energy production, reflecting its commitment to meeting its responsibilities as part of the sustainable energy sector of the future.
We call our sustainable energy concept “sustainable energy mining”. It centres on energy storage, and the interaction of renewables and gas. This is the key to a future of clean and completely reliable energy supplies.
Combining traditional gas storage with renewables unlocks the problems of energy storage and creating a needs-based structure on an industrial scale, while conserving the climate and the environment for future generations.
RAG has the resources, infrastructure and know-how to drive the development and roll-out of innovative, forward looking, carbon neutral energy solutions based on green gas technologies. Internationally registered patents are testament to RAG’s expertise in this field, as a company that invests about six million euros in research and development annually.

OUR FIELDS OF ACTIVITY

STORAGE

Increasing gas storage and withdrawal capacity: high-volume, seasonal storage of conventional natural gas, hydrogen and biomethane to strengthen security of supply in Austria and Europe, and support the expansion of renewable energy sources.

CONDITIONING

Treatment of the gas we produce, in order to provide marketable products. This includes gas processing, hydrogen purification and processing of methane into transportation fuels such as CNG, LNG or e-fuels.

CONVERSION

Applying cutting-edge technology such as power-to-gas to produce hydrogen or green gas. Conversion also means the synthesis of methane (CH_4) by combining carbon dioxide (CO_2) and hydrogen (H_2), and cracking methane to obtain hydrogen and carbon.

PRODUCTION

Production of natural gas and oil and their utilisation as valuable inputs in the chemical, pharmaceutical and other industries, without CO_2 emissions. Solar power generation and its utilisation to produce hydrogen.

Enabling security of supply

The major expansion of renewable energy generation required to meet climate protection targets represents a formidable challenge for security of supply and for existing energy infrastructure, which needs to be able to cope with the growth in erratic renewable power generation.

Power-to-gas makes it possible to convert renewable energy into green gas, so that a portion of the energy harvested from the sun and the wind in summer can be stored as gas, in underground pore reservoirs, to be used in winter and/or produce synthetic methane by means of natural processes. The stored energy can be withdrawn in large quantities at any time as required, and quickly delivered using existing infrastructure (plants and pipelines).

Using existing infrastructure

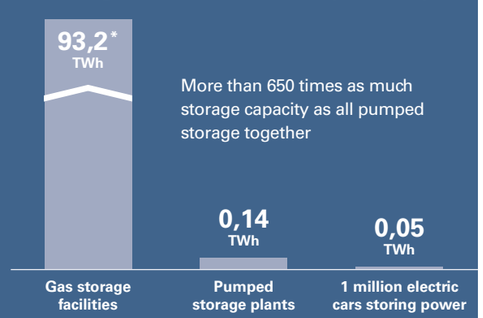
The energy transformation can only succeed if security of supply is guaranteed. Highly developed gas infrastructure, including storage facilities, means that enough energy is always available. The high capacity of Austria's storage facilities, at the heart of Europe's gas networks, provides security. With a total storage capacity of more than 6.3 billion cubic metres (bn cu m), RAG makes a major contribution to security of supply in Central Europe. Scarcely a single other EU member state has such high and such reliable storage capacity and to achieving climate goals.

Existing gas infrastructure, comprising storage, pipelines and wells, will form the backbone of an affordable renewable energy system in the future. We can use it to underpin the bulk storage and rapid, on-demand availability of renewable solar and wind power in the form of green gas.

Gas storage facilities

Industry and households still need power when renewables cannot produce it because the sun goes in or the wind stops blowing. Pumped storage power stations and batteries can only ride out demand for short periods (daily balancing and stabilization of the power grid), because they have a very small degree of storage capacity. To underpin supply security and balance seasonal demand swings, large gas storage facilities are a must. RAG's storage facilities hold 500 times as much energy (72 TWh) as all of Austria's pumped storage capacity together (0.14 TWh).
Withdrawal capacity is also enormous, at 32 GW – equal to the output of 27 nuclear power plants.

Gas storage facilities – the country's battery



* Of which 72 TWh are accounted for by the RAG gas storage facilities.

Innovation is our appeal

RAG has been working on groundbreaking projects for the seasonal storage of hydrogen and to develop green gas technologies for 10 years. Our innovative capabilities have enabled us to become one of the sustainable technology leaders in the European energy storage and supply sector.

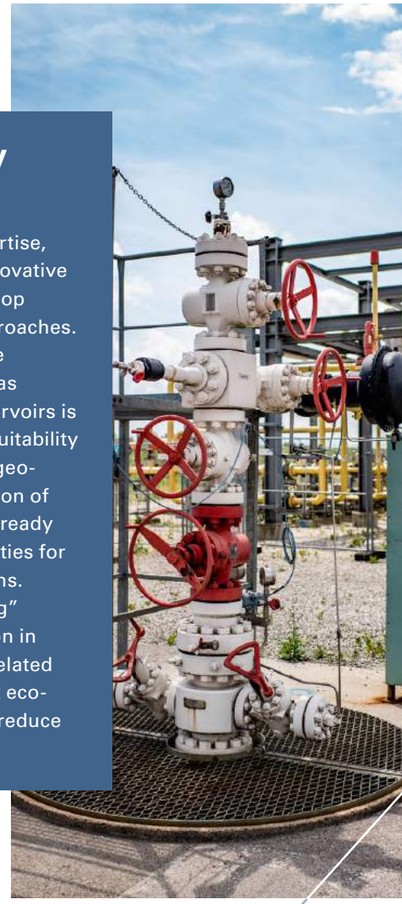
Sector coupling – joining forces for the energy future

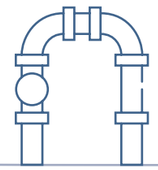
Cross-sectoral collaboration between energy production businesses, electricity and gas infrastructure, and industry is pivotal to the development of a sustainable energy system and to significant reductions in carbon dioxide emissions. Sector coupling refers to the networking of the power, gas, heating and industrial sectors to create the integrated energy system of the future.

"Our pore reservoirs are at the heart of the renewable energy future."

Sustainable Energy Mining

Our subsurface engineering expertise, technological capabilities and innovative capacity have allowed us to develop "sustainable energy mining" approaches. RAG is pursuing a strategy for the sustainable after-use of natural gas production sites. Each of our reservoirs is evaluated to assess its longterm suitability for energy storage, green gas or geothermal projects. A large proportion of our natural gas reservoirs have already been converted into storage facilities for natural gas and other energy forms. RAG's "sustainable energy mining" approach is set to spark innovation in Austrian industry, cut transport-related greenhouse gas emissions, boost economic growth in the regions and reduce dependence on energy imports.





32 GW of withdrawal capacity
working for security of supply

Gas – a talented all-rounder

The energy sources of the future come in the shape of gas: methane, biomethane and hydrogen. Gas is future fit. It is low-emission, innovative and supply-secure.

Gas is a talented all-rounder. The range of gaseous energy sources is broad.

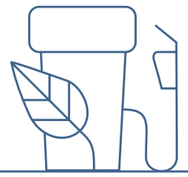
The spectrum of gaseous energy sources runs from conventional natural gas to green gas such as hydrogen and biomethane. Gas underpins the attainment of climate goals, is a partner for renewables and can even be produced renewably. Gas can be manufactured using wind or solar energy, or from biomass, and contributes directly to carbon dioxide emission reductions in transportation, in the form of LNG and bio-LNG, CNG and bio-CNG, with hydrogen waiting in the wings.
Energy in the form of gas can be transported out of sight underground, stored in huge quantities, made available quickly in large volumes, and used in a variety of applications to generate electricity or heat, or to fuel vehicles.

Natural gas – the universal raw material

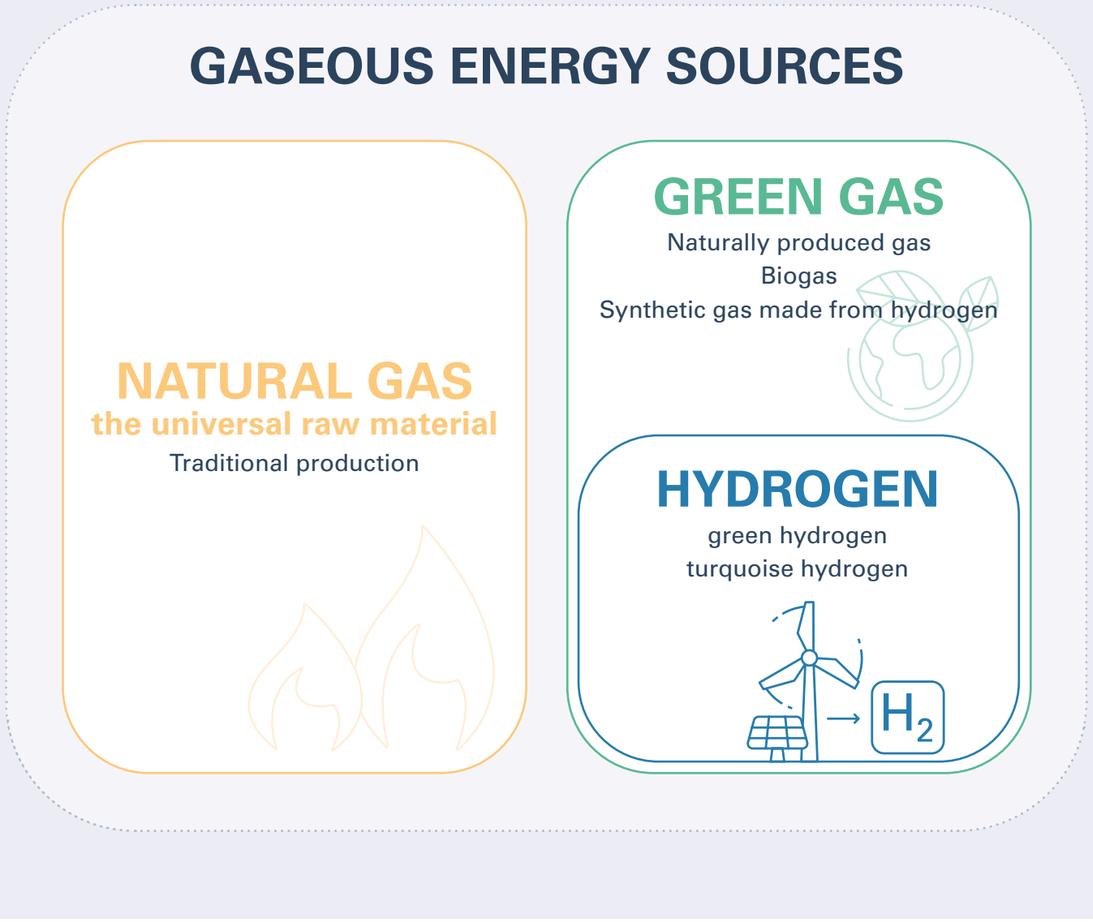
Natural gas is a raw material with universal applications. Natural gas deposits are principally composed of methane (CH_4) – a simple compound of carbon (C) und hydrogen (H), which can be bonded and separated synthetically.
Natural gas has a pivotal part to play in the progressive roll-out of a sustainable energy system, and will help us along the road to a renewable energy future.

Green gas – standard bearer for the future of energy

Green gas stands for all gaseous energy forms that offer carbon free, low carbon or carbon neutral production and consumption. Whether in the shape of hydrogen produced by means of water or methane electrolysis, biomethane, or naturally produced green gas from our Underground Sun Conversion project – gaseous energy sources are the future. Green gas not only has vast potential, it is sustainable, affordable and storable. It is paving the way for a sustainable energy future.



Working in tandem, natural gas and green gas represent the only realistic prospect of reaching climate targets while safeguarding security of supply.



Naturally produced synthetic gas
First, hydrogen (H_2) is produced using solar or wind energy in a process known as power-to-gas. The hydrogen can be directly injected into RAG's storage facilities, to be withdrawn as needed. Or, in a second step, carbon dioxide (CO_2) can be added, and the hydrogen is converted into naturally produced natural gas (CH_4) underground, where it can be stored in large volumes to meet seasonal demand peaks. This creates a sustainable carbon cycle. The green gas produced in this way is carbon neutral.

Synthetic gas
Synthetic gas means gas that is produced by means of electrolysis or splitting, using green electricity and an abundant feedstock (water or methane). It includes green and turquoise hydrogen, as well as synthetic natural gas produced from hydrogen in an underground methanation process (Underground Sun Conversion project).

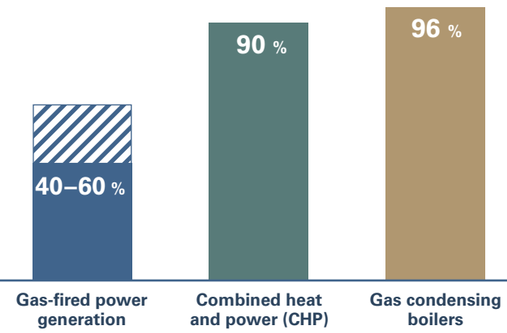
Clean hydrogen

Green hydrogen is produced by water electrolysis, exclusively using electricity generated from renewable sources.
Water electrolysis: H_2O + 1 energy = H_2 + O

Turquoise hydrogen is produced by electrical splitting of natural gas or biogas (methane electrolysis), where methane is broken down into hydrogen and solid carbon in an emission free process.
This means that carbon, a valuable raw material, can be obtained at the same time as storable, climate neutral hydrogen, using just a quarter of the renewable energy required by water electrolysis.
Methane splitting: CH_4 + ¼ energy = C + 2 H_2

Gas's high efficiency is a major argument in its favour.

Sensible use of gas is the key to efficiency.



Source: Association of gas and heat supply companies

GAS – A TALENTED ALL-ROUNDER

Using gas innovatively with us

Green gas is the standard bearer for sustainable energy supplies.

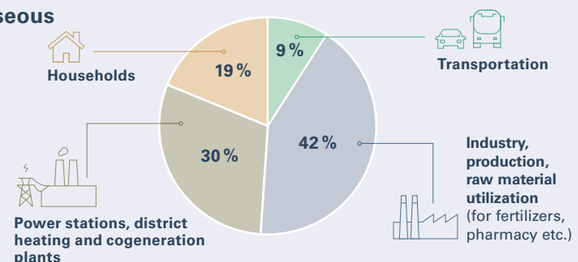
Green gas stands for all gaseous energy forms that offer carbon free, low carbon or carbon neutral production and consumption: hydrogen produced by means of water or methane electrolysis, biomethane, or naturally produced green gas from our Underground Sun Conversion project. Green gas not only has vast potential, it is sustainable, affordable and storable. And it is available on demand. It has the same excellent properties as the conventional natural gas that we have long relied on, and is renewable, too.

To meet Austria's ambitious climate targets, more use needs to be made of sustainable domestic resources, and energy imports must be made secure.

The infrastructure for green gas is already in place. The gas can be directly injected into Austria's 43,000-kilometre grid, and held in storage facilities which have a dual role as the enablers of a sustainable energy future, and as an essential backstop to volatile renewable energy.
Sustainable use of existing gas infrastructure together with green gas technology can significantly reduce the system costs associated with the energy transformation. It dispenses with the need to develop new supply systems such as high-voltage power lines, and saves consumers the cost of new appliances since they can continue to use existing efficient gas central heating systems.

Applications of gaseous energy sources

Gaseous energy sources are required in every area of life: to heat homes, to generate electricity safely, to fuel clean transportation, and to keep industrial production costs down.



Source: www.gruenes-gas.at

Green gas has a pivotal part to play in the progressive roll-out of a sustainable energy system.

Gas in industry: Raw material and energy source

In addition to its flexible use, especially in electricity and heat production, industry is particularly dependent on a secure gas supply. The main consumer of natural gas in Austria is the manufacturing sector, with 40.5%. Natural gas is thus the most important energy source for Austria's industrial base. Natural gas from the large storage facilities enables a secure supply around the clock, which is of great economic importance, especially in the industrial and commercial sectors. The high energy efficiency and the well-developed infrastructure are a further plus point. In the energy-intensive production of paper, iron and steel, but also glass, gas enables the necessary high temperatures for process heat. In the chemical industry, it is an important raw material and the starting material for countless everyday goods. Gas is, for example, the basis for the production of fertilizers for agriculture or of urea, which is used for the exhaust gas cleaning of diesel engines (AdBlue). Methane is also indispensable for numerous starting materials for plastics.

Efficient power and heat generation

Renewable sources account for 36,5% (2020) of total energy consumption in Austria, and the government's climate strategy targets an increase to 46-50% by 2030. This ambitious goal cannot be attained without efficiency measures – reducing consumption, and wind and solar power storage. Since storage on an industrial scale will not be possible for some time to come, conventional natural gas will be needed as an energy reserve for generating power on demand. Gas power stations are highly efficient and future fit. They can supply electricity exactly when and where it is needed at the shortest notice. In combined heat and power (CHP) plants, where thermal energy from gas is used to generate heat as well as electricity, efficiency is close to 90%. And if gas is used in a condensing boiler, efficiency of 96% can be achieved. In the future, green gas and hydrogen will also be used to fuel these power plants. In Kremsmünster RAG 2023 will build the first hydrogen-fueled cogeneration station and demonstrates how green heat and and power supply can succeed – with gas.

Storage

As Austria's biggest gas storage company – making it the country's biggest energy storage operator – RAG's natural pore reservoirs mean it has the capability to provide large-volume, flexible and seasonal storage of conventional natural gas, green gas, biogas and hydrogen. These energy sources are ready to be called on in large volumes precisely when and where they are needed, allowing us to underpin security of supply for Austria and Europe.

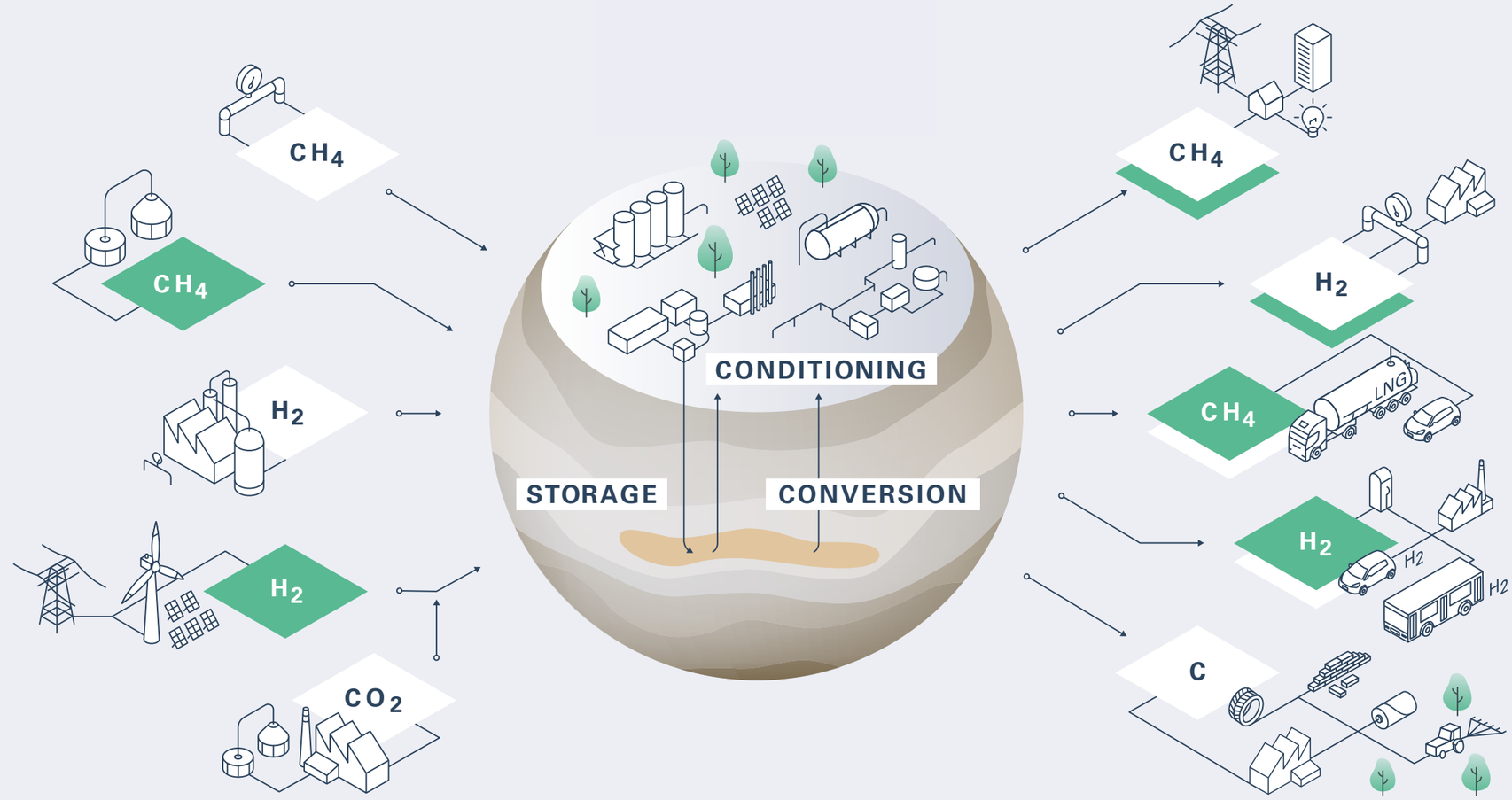
Conversion

Renewable electricity from solar and wind energy is converted into hydrogen by means of carbon-neutral electrolysis. This makes it possible to store a portion of the summer energy harvest as gas in our pore reservoirs for use in winter, or to combine the hydrogen with carbon dioxide (produced from biomass or industrial operations) and convert it into synthetic natural gas, in underground gas reservoirs, by means of a natural microbiological process. This creates a sustainable carbon cycle, and the naturally produced green gas is carbon neutral. By conversion we also mean the synthesis of CO_2 and H_2 to CH_4 and the splitting of CH_4 to hydrogen and carbon.

Conditioning

Stored energy can be withdrawn and used at any time as required. This green energy can then be delivered via existing pipeline networks for efficient power and heat generation. Treatment of gas and provision of marketable products is key. This includes gas processing, hydrogen purification and processing of methane into transportation fuels such as CNG, LNG or e-fuels. In addition, methane electrolysis is set to produce carbon that can be used as a valuable basic material for batteries, insulation materials, tyres, construction materials and steel, or in agriculture as a soil conditioner. The process also produces carbon neutral, climate friendly hydrogen for use in energy generation or industrial processes.

Tomorrow's energy world with RAG



Gaseous Energy Sources:

- CH_4 CH4 Natural Gas
- CH_4 Biogas / Bio-Methane
- H_2 Hydrogen from pyrolysis
- H_2 Hydrogen from electrolysis
- CO_2 Carbon Dioxide from biomass or industrial process

Applications:

- CH_4 CH_4 Use for electricity and heat
- H_2 H_2 Hydrogen in transport network and industry
- CH_4 Green Gas for mobility
- H_2 H_2 Hydrogen for industry, mobility and heat
- C Carbon from pyrolysis

STORAGE

Our speciality: energy storage

RAG's energy storage facilities are highly versatile. Their wide range of capabilities guarantees security of supply in Austria and Europe, and they hold the key to a green energy future.
They can hold large volumes of conventional natural gas and in future will also store green gas such as hydrogen, for withdrawal at high capacity and at any time.

≈50%

of RAG's gas reservoirs have been converted into gas storage facilities.

"RAG's energy storage facilities are essential for the step-by-step reduction of CO_2 emissions towards a sustainable energy system, the attainment of the climate targets and the use of renewable energy sources."

The key to the energy future

With over 6.3 billion cubic metres (bn cu m) of gas storage capacity that can be drawn on rapidly around the clock, RAG Austria AG is Austria's largest energy storage company and one of Europe's leading storage operators. RAG operates around 6% of total gas storage capacity in the EU.

Sustainable Energy Mining

RAG has been using underground gas reservoirs to store energy for over 35 years. Expansion of gas storage in Upper Austria and Salzburg over the past 20 years has made these facilities a cornerstone of security of supply in Austria and Central Europe. Along the way, RAG has added a key link to its value chain and developed a sustainable form of energy mining. RAG has converted a large part of the gas reservoirs discovered over its 85-year history into storage facilities with long useful lives: today mainly for natural gas, and in the future for green gas and hydrogen. This is an outstanding track record by international comparison. The company is making a major contribution to tackling one of the biggest challenges faced by the energy sector: energy storability.
RAG's energy storage facilities serve customers in Austria and abroad, and include joint ventures with multinational energy companies. Storage capacity at RAG's facilities is marketed by the company's subsidiary RAG Energy Storage. RAG has the necessary resources, infrastructure and know-how to actively drive forward development and the expansion of cutting edge, carbon neutral energy solutions based on green gas. In addition, our storage facilities make a significant contribution to blackout prevention.
Gas can be withdrawn from them at any time, even in the event of a power outage.

6.3 bn cu m

After starting out over 35 years ago with 50 million (mn) cu m of storage in Puchkirchen, today RAG is Austria's leading storage company, and one of Europe's biggest storage operators, with a total capacity of over 6.3bn cu m. This corresponds to more than a hundred-fold increase in capacity.

Strengthening security of supply

Security of supply is the core issue for the energy sector. It is our mission, and we are committed to it unreservedly.

Austria's gas storage facilities shoulder the responsibility for long term, large volume energy storage, ensuring that seasonal imbalances can be evened out. As energy generation from renewable sources grows, the need for large volume, seasonal storage capacity also increases, since it is required to balance out the seasonal swings from energy surplus (excess solar energy in summer) to deficit (increased demand due to low temperatures in winter). Storage enables established supply security to be maintained at all times.
Industry and households still need energy supplies when the sun goes in or the wind stops blowing. Already, today's demand can only be met thanks to large volume, high performance energy storage facilities. Pumped storage and batteries play a useful part in in balancing hourly and daily demand. But to guarantee security of supply and compensate for seasonal fluctuations, gas storage is essential. RAG's storage facilities have 500 times the capacity (72 TWh) of all of Austria's pumped storage installations combined (0.14 TWh). This capacity can be drawn upon flexibly, at any time and rapidly to provide gas energy for power, heat and transportation – security of supply in action.

"Security of supply has a name: Energy storage. Our facilities MUST work under all circumstances and be ready to perform at all times. This is our daily business, backed by the highest technical know-how."

Efficient power generation and heat supply

Gas storage facilities can develop their full effect particularly in combination with gas-fired power plants and cogeneration. They are efficient, fast, flexible and have high efficiencies of up to 96% - in the future they can also be operated with green gas and hydrogen. Within a very short time, they respond to fluctuations from wind or solar electricity.

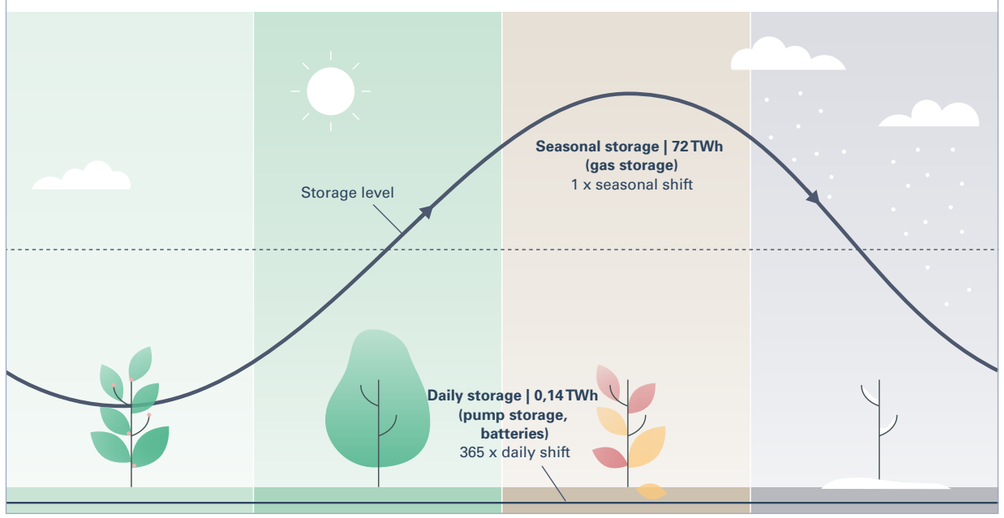
Energy storage over the year

Natural gas is produced throughout the year, at roughly constant rates. Austria's imports are transported along pipelines from Russia and Norway, and as LNG cargoes from all over the world. The amount of gas consumed by industry, power stations and households varies according to the season and time of day. Demand is much higher in winter than in summer, and more gas is used during the day than at night. Gas must be stored to ensure that it is available when needed. Storage injections and withdrawals in recent years have shown that withdrawal periods are lengthening, and that in future RAG's storage facilities will be required to provide even more flexibility – also in order to compensate politically or technically unpredictable situations.

Energy storage facilities for green gas

As well as holding conventional natural gas, RAG's facilities will soon be required for storage of green gas. The necessary reduction in carbon dioxide emissions and transformation of energy systems will only succeed if electricity generated by wind and solar farms can be stored. One solution is power-to-gas. This key technology of the energy future produces emission-free energy forms using electricity from renewable energy sources such as wind and sun. Starting from a raw material that is available in large quantities, such as water or (bio)methane, hydrogen and oxygen can be produced on the one hand by means of water electrolysis or, on the other hand, the future material carbon and hydrogen can be produced by means of methane electrolysis. The hydrogen can be stored in gas reservoirs (in underground natural gas reservoirs) to be taken out when it is needed.

Balancing out daily and seasonal demand swings



Efficient, sustainable and safe

Use of underground natural gas reservoirs is the safest and most efficient way of stockpiling energy. Austria has geological structures that are ideal for gas storage.

Millions of years
New supplies can be stored in these formations, where gas accumulated naturally over millions of years, at depths of more than 1,000 metres. These former gas fields originated over 20 mn years ago, when organic matter in the primeval ocean that occupied today's Prealps was trapped by sandstone sediments.

Sandstone reservoirs
Over time, gas built up in the pores of the sandstone, forming gas reservoirs that can cover an area of several square kilometres. Clay strata several hundred metres thick overlie the gas reservoirs, and this natural insulating layer makes them an extremely safe means of underground storage.
The proof of this comes from nature itself, since the original gas reserves were held there for millions of years.

Our energy storages

With a working gas volume of more than 6.3 billion cubic meters, RAG is one of the largest storage operators in Europe. RAG's storage facilities include the Puchkirchen/Haag, Haidach, Haidach 5 and Aigelsbrunn storage facilities and the 7Fields storage network.

RAG’s energy storage facilities

RAG operates its storage facilities in the provinces of Salzburg and Upper Austria. These facilities are porous sandstone reservoirs of large volume, which are connected to the Austrian and German pipeline network.

Puchkirchen/Haag

RAG made its first gas discovery in Puchkirchen in 1956. Conversion of the gas formation into a storage reservoir began in 1982 and was completed in 2009 after a number of expansions. During the summer of the latter year the Puchkirchen facility was linked with the Haag reservoir.
At present the facility has a maximum working gas volume of some 1.1 bn cu m (equivalent to 12.5 TWh), and injection and withdrawal capacity of 520,000 cu m/hour (6 gigawatts, GW).

Haidach 5

The repurposing of this depleted gas formation as a storage reservoir began in 2005.
Haidach 5 has a maximum working gas volume of around 16m cu m (equivalent to 185 GWh), and injection and withdrawal capacity of approx. 20,000 cu m/hour (231 megawatts, MW).

Aigelsbrunn

Gas production at this field started in 2001. Development of the gas storage facility began in 2008, and it was commissioned on 1 April 2011. Aigelsbrunn has a maximum working gas volume of approx. 130m cu m, and injection and withdrawal capacity of 50,000 cu m/hour (577 MW).

71,8 TWh

Key figures: RAG gas storage facilities, 2023
(TWh, GW and MW thermal)

Working gas volume:	**71,8 TWh**	**6.226 mn cu m**
Withdrawal capacity:	32,1 GW	2.783.900 mn cu m
Injection capacity:	26,9 GW	2.329.300 mn cu m

Haidach gas storage facility

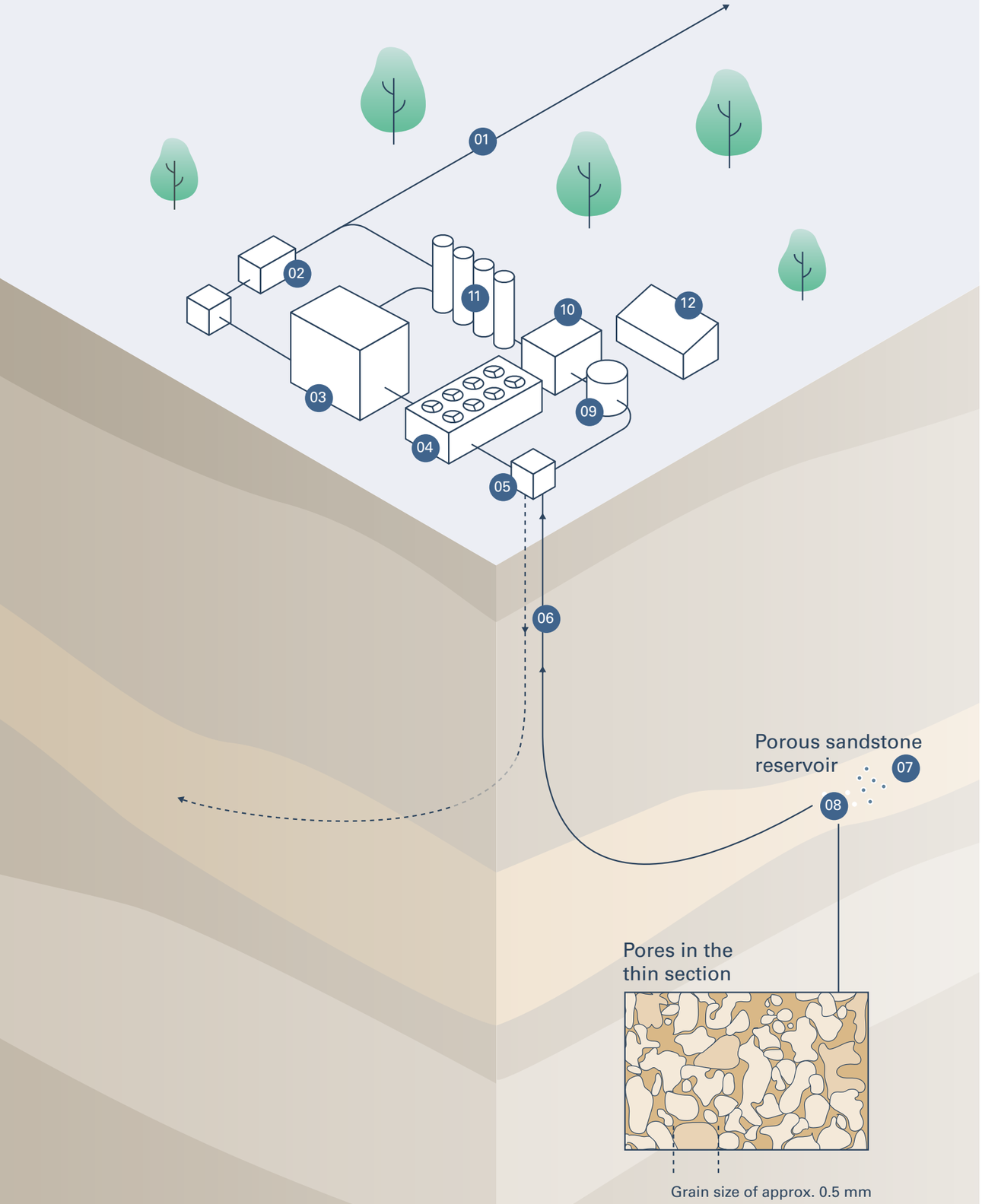
7 Fields gas storage facility (Oberkling)

Haidach

The Haidach natural gas storage facility was planned and constructed by RAG under its concession. Since then, RAG has been technical storage operator. the German SEFE (Securing Energy for Europe) now holds a share of around 56% of the Haidach storage facility.
The first development phase was completed in 2007, and the second in 2011. The total storage capacity of 2.9 bn cu m of natural gas (33,5 TWh) is equivalent to a quarter of annual gas consumption in Austria. Haidach is the second-largest storage facility in Central Europe.
It has an injection capacity of 1,050,000 cu m/hour (12.1 GW) and withdrawal capacity of 1,160,000 cu m/hour (13.4 GW). The capacities of the Haidach storage are operated by SEFE Storage and by RAG Energy Storage.

7Fields

7Fields was planned and built by RAG under its concession. Since then, RAG has been technical storage operator. The German Uniper Energy Storage has a holds a share of 50% of 7Fields.
The first expansion phase began in 2009 and was completed in 2011. Following completion of the second expansion stage in 2014 and a capacity adjustment in 2019, around 2.1 bn cu m (24,2 TWh) of natural gas can now be stored at 7Fields. It has an injection capacity of 689,300 cu m/hour (11.9 GW) and a withdrawal capacity of 1,033,900 cu m/hour (11.9 GW).
7Fields is made up of former gas fields in Upper Austria and Salzburg. Integration of several storage reservoirs into an interconnected storage facility is particularly resource efficient. The site is unique in Europe, with five storage stations connected via pipelines to three metering stations and to the Austrian and international gas grids.
Uniper and RAG Energy Storage market the capacity of this interconnected storage network.



STORAGE

How does a gas storage facility work?

When gas arrives at a storage facility via a pipeline network it first enters a metering station where it is filtered, and the quantity and quality are measured. Injection to and withdrawal from the reservoir take place via a number of wells. Where necessary, compressors bring the incoming gas (working gas) up to the right injection pressure. Since compression raises the temperature, the gas must then be cooled before being conveyed to the wellhead and injected into the natural rock formations. Care must be taken not to exceed the original reservoir pressure. Working gas is injected and withdrawn as required. This cuts operating costs and helps maintain high environmental standards. Whenever the gas is withdrawn it must be reprocessed. It must be dried as it will have absorbed moisture in the reservoir. Once it is on-specification it enters the grid and is transported to the consumer.

01 Public grid
02 Metering station
03 Compressor station
04 Cooling unit
05 Wellhead
06 Well
07 Porous sandstone reservoir
08 Working/cushion gas
09 Preheater
10 Pressure reduction station
11 Drying units
12 Control room and stores

Conserving resources and the environment

Husbanding natural resources and good environmental stewardship play a vital role in gas storage, and all the processes at storage facilities operated by RAG are carefully designed for maximum environmental soundness. Minimising energy use and emissions, utilising waste prevention technology, and employing new technology to monitor and test the plant and pipelines are particularly vital. This is ensured by internal controls and an energy management system certified according to the ÖNORM EN ISO 50001:2018 standard.

NEW TECHNOLOGY

Our future is innovation

The future belongs to green gas. RAG has a long track record of close involvement with new technologies that will make it possible to store and utilise large volumes of renewable energy efficiently.
Conversion by means of power-to-gas technology enables us to store a portion of the energy harvested in summer from the sun and the wind in the form of gas, in pore reservoirs, for use in winter or for methane production directly within the reservoir. Together with natural gas, green gas is the key to the success of the energy transformation. It means that large amounts of solar and wind power can be efficiently transported and stored, making climate-friendly energy available on demand.

Capacity for innovation

RAG has decades of experience of producing, utilising and storing gas, and since 2013 the company has been working on cutting edge projects aimed at seasonal storage of hydrogen and the development of green gas technologies. RAG's innovative capacity has enabled it to become a sustainable technology leader in the European energy storage and supply sector. Besides conventional natural gas, RAG is focusing on novel green gas production technologies such as power-to-gas and methane splitting. The Underground Sun Storage and Underground Sun Conversion projects offer a unique opportunity to store large volumes of gas produced from renewable sources, such as solar and wind power, seasonally and carbon neutrally underground, for withdrawal as and when it is needed. Green gas not only has vast potential, it is sustainable, affordable and storable.
It is the standard bearer of a sustainable energy future.
RAG has been a pioneer in the field of hydrogen production since 2015, when it brought Austria's first megawatt-scale water electrolysis plant online. In addition to this, in collaboration with a variety of industrial partners, research institutions and universities, RAG is investigating the viability of a range of methane splitting approaches (pyrolysis, plasmolysis and photolysis).

Innovative solutions

International patents registered for green gas technologies underline RAG's expertise in this field. For example, hydrogenotrophic methanogenesis is a natural process for the production of synthetic natural gas underground using hydrogen, carbon dioxide and microorganisms, developed in the Underground Sun Conversion project. RAG invests about seven million euros in research and development annually.

NEW TECHNOLOGY

Underground Sun Storage

Producing, storing and supplying green hydrogen made from wind and solar energy

Underground Sun Storage is the brand name for RAG's groundbreaking approach to energy production and storage. At our demonstration plants in Pilsbach and Rubensdorf (near Gampern), we are making tomorrow's energy systems a reality – storing summer power for the winter, and dispensing it to customers during the winter months.

Storing up summer sunshine for the winter

Scenarios for the future overall energy system show that, especially in Central Europe, the expansion of renewable power generation will result in a large renewable energy surplus in summer. In contrast, in winter months fewer hours of sunshine and low water flows, combined with the markedly higher energy demand – accentuated by the growing use of heat pumps and electric vehicles – will lead to a huge supply shortfall, which cannot be made up for by energy imports. Energy will therefore have to be stored in summer, in the form of large quantities of gas (adding up to several TWh) so that in winter sufficient green energy is available to generate electricity and heat, and to meet transportation needs.

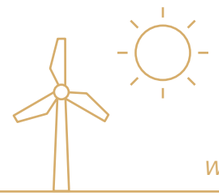
Hydrogen storage

This is precisely what we are already doing today at our demonstration plants, with the aid of power-to-gas technology. Surplus energy or fractions of output generated from renewables are used to produce hydrogen by way of water or methane electrolysis, so they can be stored in the natural gas system.

Finding an answer to the question of how to store renewable energy is key to maximising its contribution to the energy mix, and thereby achieving a substantial reduction in carbon emissions. In terms of the strategic development of energy systems, RAG's pioneering work is hugely significant for business, political decision-makers and public authorities. The results have opened the way to repositioning natural gas storage facilities, with their enormous storage capacity, as hydrogen stores in the energy system of the future. They will play the role of large-scale, seasonal storage facilities for renewable energy, just as RAG's gas storage facilities do today.

Hydrogen economy

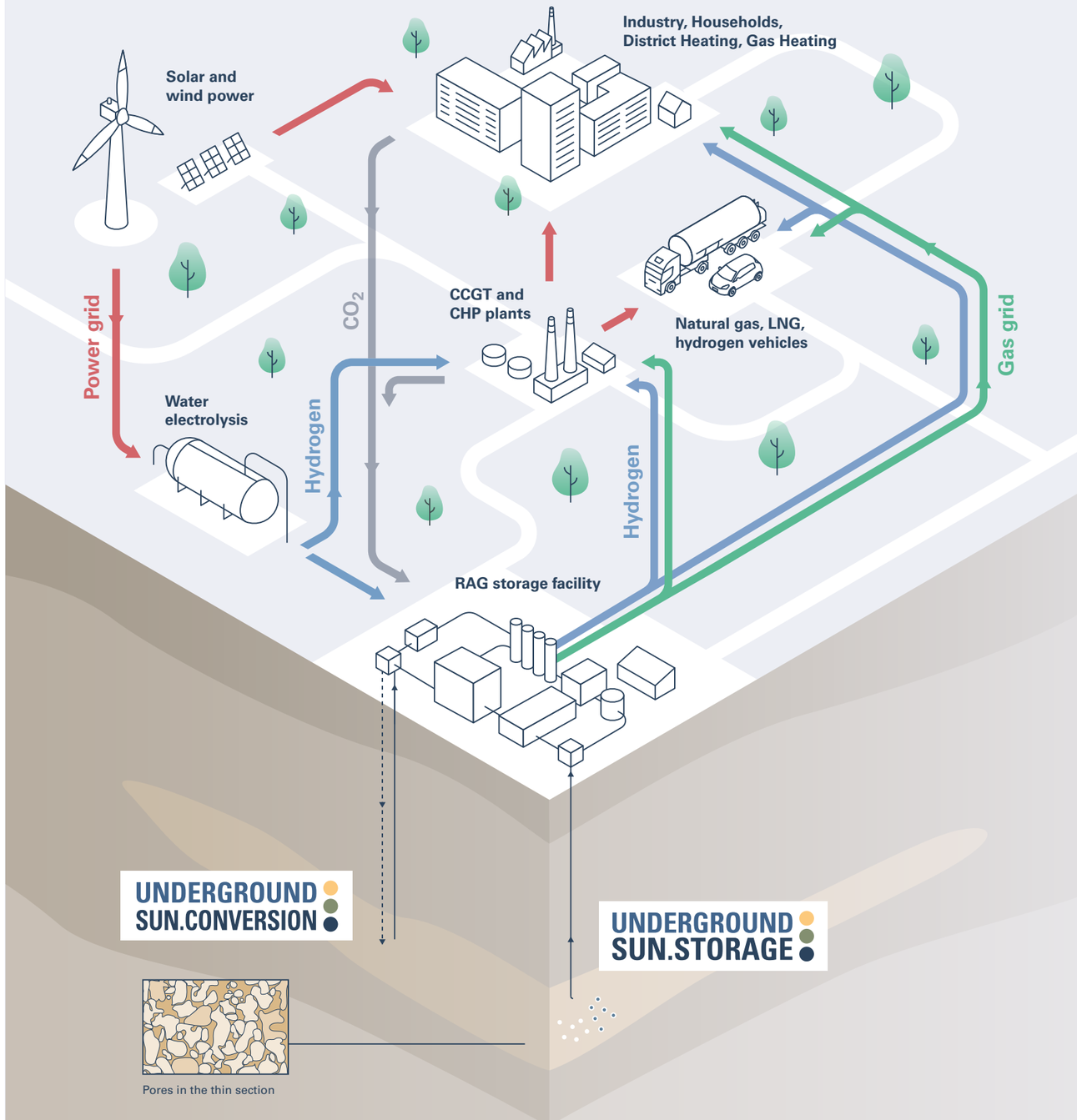
The Underground Sun Storage project is one of a kind worldwide, and is providing valuable insights into the seasonal storability of renewable energy in the form of pure hydrogen. It is part of the WIVA P&G model energy region, and is laying the groundwork for a stable hydrogen economy. Use of sandstone pore storage facilities to store hydrogen is included in Austria's Long-Term Strategy 2050 in accordance with Regulation (EU) 2018/1999 of the European Parliament and of the Council on the Governance of the Energy Union and Climate Action. The project is being financed by Austria's Climate and Energy Fund as part of its energy research programme.



Wind + sun = green gas

Power-to-gas

Wind + sun = green gas
Power-to-gas comes down to this simple formula. This key technology of tomorrow's energy systems involves producing emission-free energy using power generated from renewable sources. Using inputs such as water or biomethane which are available in abundance, water electrolysis can produce hydrogen and oxygen, and methane electrolysis or pyrolysis can yield hydrogen and carbon, another key raw material for the future.



Underground Sun Conversion

Producing, storing and supplying green hydrogen made from wind and solar energy.

USC Technology: Geological history on fast forward

Over 1,000 metres below ground, where natural gas formed millions of years ago, a unique, highly innovative method is recreating the process by which it originated. Hydrogen and carbon dioxide are injected into suitable depleted natural gas reservoirs, where they are converted into methane (green gas) by a microbiological process. Converting the energy, densifying it and storing it all take place out of sight, in porous rock formations at depths of over 1,000 metres.

Natural production of green gas

RAG holds an international patent for this process, which is called hydrogenotrophic methanogenesis. Both methanation and storage take place naturally. The project's huge potential lies in the fact that it can provide the urgently needed flexibility which renewable energy currently lacks, heralding the creation of a sustainable carbon cycle.
The multidisciplinary, international follow-up project entitled Underground Sun Conversion – Flexible Storage (USC-FlexStore), is further developing the technology tested in the Underground Sun Conversion project and designing green gas storage and production services based on the research findings. Field tests were carried out at RAG's hydrogen facility in Pilsbach, Upper Austria. This flagship project is being financed by Austria's Climate and Energy Fund as part of its energy research programme.

Benefits at a glance

Carbon neutral
Green Gas is carbon neutral when carbon dioxide that is already present, e.g. as a result of biomass combustion, is captured by the production process. This creates a sustainable carbon cycle.

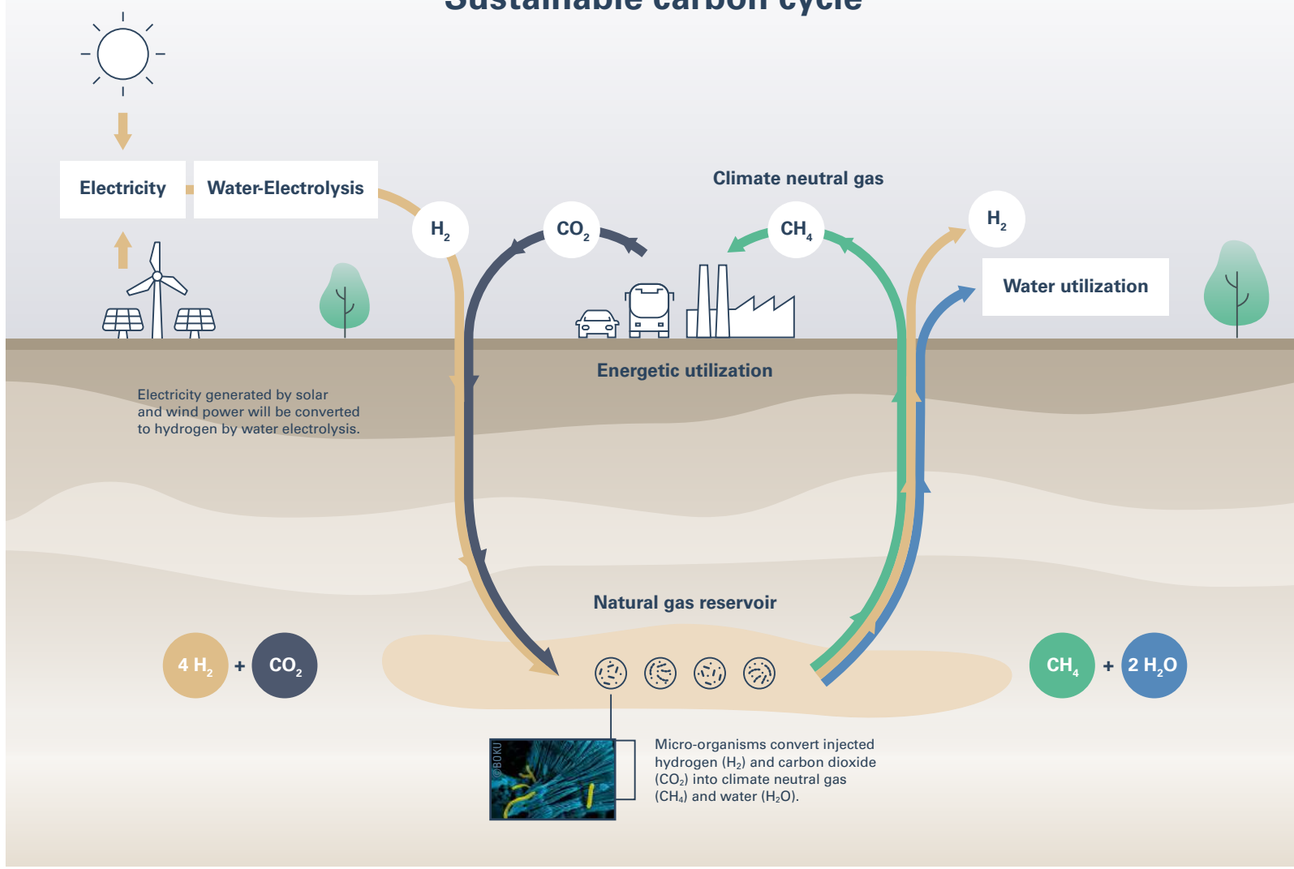
Renewable energy becomes storable
Solar and wind power output fluctuates due to changing weather conditions, meaning that production cannot be adjusted to demand. The quandary of how to store renewable energy is solved by converting it into renewable natural gas.

Use of existing infrastructure
Infrastructure already in place can be used for the natural production process, as well as for underground storage in natural gas reservoirs, and environmentally friendly transportation to consumers.

A continuation of the investigations can be found in the Carcon Cycle Economy Demonstration project.
The „C-CED" combines various CO_2 capture and utilization technologies. For example, CO_2 is to be extracted on a pilot scale from various sources such as the air, exhaust gases from the steel industry or biogas and subsequently made storable by converting it into valuable, renewable methane (methanation).

"RAG's constant ability to innovate and commitment to research and development are among its key success factors."

Sustainable carbon cycle

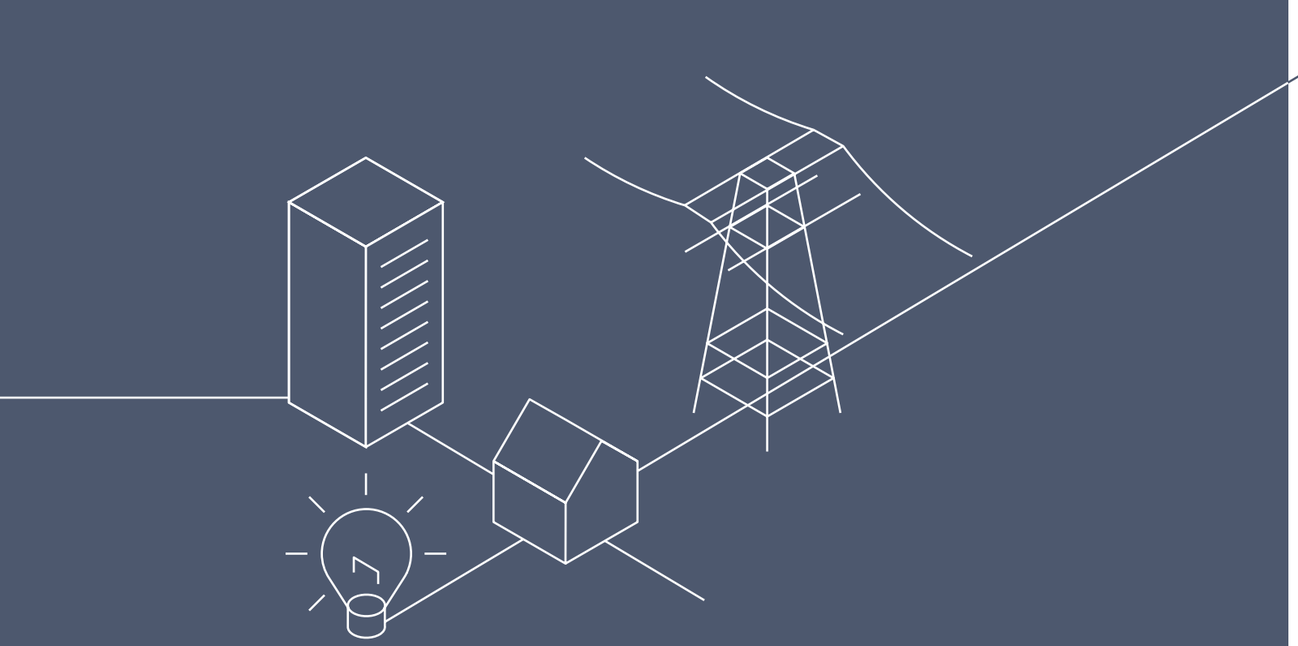


"Archaea are the stars of the energy transition. We feed these microorganisms in our pore reservoirs with hydrogen and carbon dioxide – and they make them into natural, climate-neutral green gas."

CONDITIONING

Gas treatment on demand

We process our customers' energy, providing gas for power, heating, industry and transportation. Gas is also an important raw material in the chemical industry for countless everyday goods.



"Conditioning – so we always have green energy in the form needed."

The energy held in our storage facilities can be withdrawn and made ready for use on demand. It can then be delivered via existing pipeline networks for power generation at gas-fired power stations, heat generation by local cogeneration stations or central heating systems, and clean transportation. Before the gas can be fed into the supply network it has to be processed.

When it emerges from the reservoirs it is too "wet" for use – it contains reservoir water. Treatment is needed because final consumers require "dry" gas. First, the produced reservoir water, liquid hydrocarbons and solids are separated out by our dehydration units. Then the gas is dried, and injected into the pipeline network at marketable quality and appropriate pressure.
In future our storage facilities will also hold large volumes of green gas such as hydrogen. This will make it even more important to supply end users with consumer-grade gas conforming to a variety of quality specifications, as bio-CNG, bio-LNG and hydrogen.

RAG has extensive experience of handling differing gas grades and purities – vital when dealing with all gaseous energy forms.

The green path to hydrogen

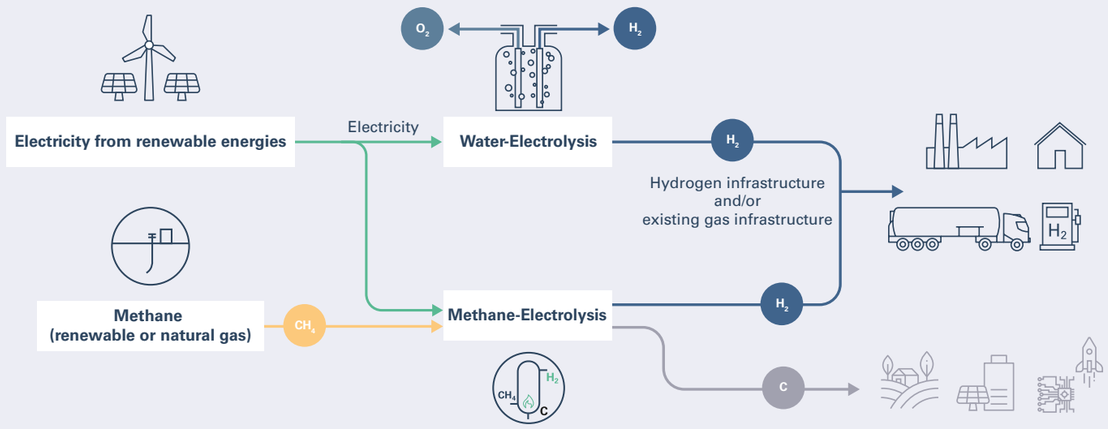
Like natural gas, hydrogen is an all-rounder: both are energy forms with excellent storage characteristics, and can be used as transport fuels. Green hydrogen plays a central role in the transformation of the industry, the transportation sector, and the energy industry towards sustainability and climate neutrality.

Hydrogen has a big future; it is set to play a key role in hitting the world's climate goals and enhancing security of supply. Its production is climate-neutral, relying on renewable solar and wind power, and it is suitable for industrial, heat and power generation, as well as transportation applications. Hydrogen can be seasonally stored in large quantities, in existaing facilities, carried in unseen, environmentally friendly gas pipelines, and then cleanly and flexibly used across every sector of the economy.
There are two carbon neutral pathways to the production of hydrogen: via water or methane electrolysis.

Storing hydrogen directly in depleted gas reservoirs or converting it into methane
For more than ten years, RAG Austria AG has been working with hydrogen as an energy source in order to store renewable energy on a large scale and seasonally. In the projects of RAG - Renewables And Gas, electricity of summer is stored in the form of hydrogen and thus made available at any time.

14 x
lighter than air

How is hydrogen produced?



"RAG is concentrating on carbon and hydrogen made in Austria."

Efficient production

"Methane electrolysis requires less than a fifth of the renewable power consumed by other emission free hydrogen production methods."
Markus Mitteregger
CEO RAG Austria AG

Climate neutral production of hydrogen and carbon from methane

To reach agreed climate targets and reduce carbon emissions, a great deal more green gas will be needed than can be produced by current methods. RAG is therefore already committed to a wider perspective, and to carbon dioxide reduction across the entire energy market. It is looking at the potential of several cutting edge green gas technologies as replacements for fossil fuels in the molecule-based energy sector.

RAG is a hydrogen pioneer, and can draw on six years' experience of water electrolysis. It is also involved in the highly promising climate and carbon neutral production of hydrogen by means of methane splitting/electrolysis. Both processes are free from carbon dioxide emissions. Methane splitting to produce hydrogen calls for just under one-fifth of the energy use as compared to water electrolysis, whilst yielding valuable resource carbon that can be used to make steel, batteries, carbon fibre, and numerous structures and materials, including fuel cells and electrical equipment. Carbon can also serve as a valuable soil conditioner that promotes plant growth. As methane splitting runs on renewable energy, the process is carbon dioxide neutral. Where methane from binding processes such as biogas production or Underground Sun Conversion technology is employed, carbon dioxide is actually permanently recycled and bonded.

This innovative technology will make a significant contribution to Austria's energy transformation whilst triggering a burst of innovation in industry, strengthening regional economies, and benefiting security of supply.

The share of hydrogen will increase from around 1 % today to around 10 % of global energy consumption by 2050.
Source: Fraunhofer Institute 2022

Green hydrogen – made by RAG

The green hydrogen produced by RAG at its site in Pilsbach by means of water electrolysis is certified in accordance with the TÜV Süd CMS 70 standard. This proves that the production is exclusively based on electricity from renewable energy sources. We see this certification as an essential prerequisite for the market ramp-up and commercialization of hydrogen and the associated storage services.

The facts speak for themselves

Carbon is lighter and stronger than steel. It is exceptionally durable, and tear and tension resistant, has excellent springing and damping properties, is highly resistant to acids and alkaline solutions, is highly electrically and thermally conductive, heat and cold resistant, and does not corrode.

PROCESSING

The climate neutral pathway to carbon

Aircraft, wind turbines, bicycle components, drones and medical equipment: solid carbon is one of the world's most valuable and versatile materials. Initially developed for space travel, it is now encountering rapidly growing global demand and applications. Thanks to methane electrolysis, in future carbon manufacturing will be climate neutral.

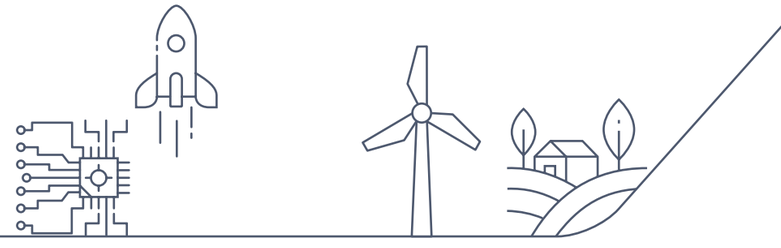
Carbon in industry

Solid carbon is a prized industrial raw material for the sustainable production of construction components, batteries, computer chips, tyres and carbon fibre. It goes into carbon based structures and materials at work in many different industries, including medical technology, aerospace, sports and leisure equipment, and high tech. For example, an increasingly important allotrope of carbon is graphene – a structurally two-dimensional material with a big future.

It is ultra-thin, light, stable and conductive, and its applications are virtually unlimited. Carbon is also used in fuel cells and hydrogen storage systems, and is a key material for water, soil and air purification equipment.

Carbon in agriculture

Solid carbon is also a major basic component of the soil. Thanks to the admixture of carbon more water and nutrients are stored, and they are available to plants when needed, thereby promoting growth. Carbon is also an ideal habitat for useful microorganisms, forming humus and enhancing soil fertility. It improves the absorption of water during heavy rain, thus reducing the danger of flooding. Adding carbon can also cut nitrogen emissions, thereby limiting greenhouse gas emissions. As an additive to fertiliser, carbon minimises odour nuisance.



Our contribution: clean transport

Gas on the road

Transportation and logistics are crucial to a functioning economy. But at a time of climate change it is equally essential for transport fuel to be low-emission, affordable and safe. Gas fits the bill on all counts. It is the cheapest and safest way to slash road traffic pollution.
With a share of about 45% of all emissions, the transport sector as such, and heavy goods traffic in particular, could play an important part in achieving national and European climate goals.
All medium and long term forecasts predict growth in the volume of road traffic, especially heavy goods traffic.
In recent years the effects of improvements in the efficiency of drive systems and fuels have been cancelled out by the steep increases in goods traffic. This has led to regular rises greenhouse gas emissions from road traffic. Especially in urban areas, air quality suffers from vehicle emissions. A raft of EU initiatives are therefore promoting greater use of natural gas and liquefied natural gas (LNG) as transport fuels.

The fuel of the future

The use of green gas as a fuel can make a major contribution to meeting ambitious climate targets. In the future, it will also be possible to use green transportation gas produced from renewable sources, in the form of CNG or LNG, in addition to conventional natural gas. RAG's ongoing research and development activities are opening up new horizons.

The advantages are obvious:

- ✔ Lower CO_2 emissions
- ✔ Little or no fine particulate emissions
- ✔ Greatly reduced noise pollution

600

The advantage of liquefaction: The volume of natural gas is reduced by a factor of 600, while the energy capacity is compressed.

LNG – an ideal alternative fuel

Liquefied natural gas (LNG) is the ideal alternative fuel for heavy goods vehicles (HGVs).

LNG is ideal for long-haul routes, and hence for HGVs. LNG trucks have long been available as standard models, and are enjoying rapidly growing popularity due to the fact that they boast significantly lower emissions than diesel vehicles.
Another advantage the exemption from toll charges in Germany. Their range is another attractive feature: one tankful is enough for distances for over 1,500 kilometres with a 40-tonne load. In economic terms, LNG is already the best available alternative to diesel, and it is therefore used by many environmentally aware hauliers.

What are LNG and LBG?

Liquefied natural gas (LNG) is natural gas that has been converted to a fluid aggregate state by cooling it to a temperature of around -163°C. Liquefaction makes it possible to transport and store 600 times as much energy in the same space. The gas can be produced in Austria or transported to customers here in specially designed road, barge and sea-going tankers. LNG has other big advantages: it is very economical and efficient. Chemically speaking, liquefied biogas (LBG) is liquid methane, and thus identical to LNG and open to exactly the same uses; the difference is that it comes from renewable sources.

The future belongs to green LNG

Opting for biogas means that truck operation is carbon neutral, as the gas is renewable, and is locally produced in Austria. RAG has a long track record as a pioneer in the use of LNG in transportation.
Since 2017 the company has been employing ultra low temperature compression (ULTC) technology to manufacture low-emission LNG fuel, which is marketed via filling stations in Upper Austria (Ennshafen) and Styria (Graz) in cooperation with petrol station operator Leitner.
LNG already offers the possibility of low-emission mobility and there is also a case to be made, for it in terms of operating costs. Running costs are an important factor for road hauliers and other fleet operators, and with LNG vehicles fuel costs undercut conventional fuels such as diesel. A number of EU initiatives are therefore promoting increased use of natural gas and LNG as transport fuels.
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Filling station infrastructure

RAG opened Austria's first LNG filling station at Ennshafen port, near Linz, in 2017. The Enns outlet has a capacity of 12 tonnes of LNG – enough to refuel 60–90 trucks. RAG delivers the gas using its own LNG tankers. It goes without saying that these run on the same low-emission fuel.

280.000

40 % Bio-LNG
55% reduction in CO_2 emissions

Source: Natural & bio Gas Vehicle Association

12.000

LNG trucks on Europe's roads

"LNG is a competitive and low-emission alternative to conventional road haulage fuels."

FLAGSHIP REGION

RAG Energy Valley

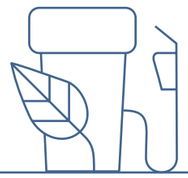
The RAG Energy Valley in Krift, near Kremsmünster, Upper Austria, is centred on sustainable energy management. In this ambitious demonstration project, energy will be generated, stored and used to supply households and businesses with power and heat, and to power vehicles, with no CO_2 emissions – all year round.

Combining climate friendliness with security of supply, the RAG Energy Valley project in Krift aims to demonstrate carbon-neutral energy supplies for rural districts and built-up areas. This will be made possible by finely-tuned coordination of generation, conversion, storage and use of green energy and key raw materials. Summer solar energy will be made storable by converting it into hydrogen, for use in winter to provide power and heat for industry and households, as well as transport fuel. This means that a carbon-neutral energy hub is taking shape in Upper Austria that may offer an answer to the question of how to provide large conurbations with secure, year-round green energy supplies. Another advantage of the RAG Energy Valley project in Krift is the fact that value creation will remain in the region, and the business location will be strengthened.

Making a reality of the future of energy, today

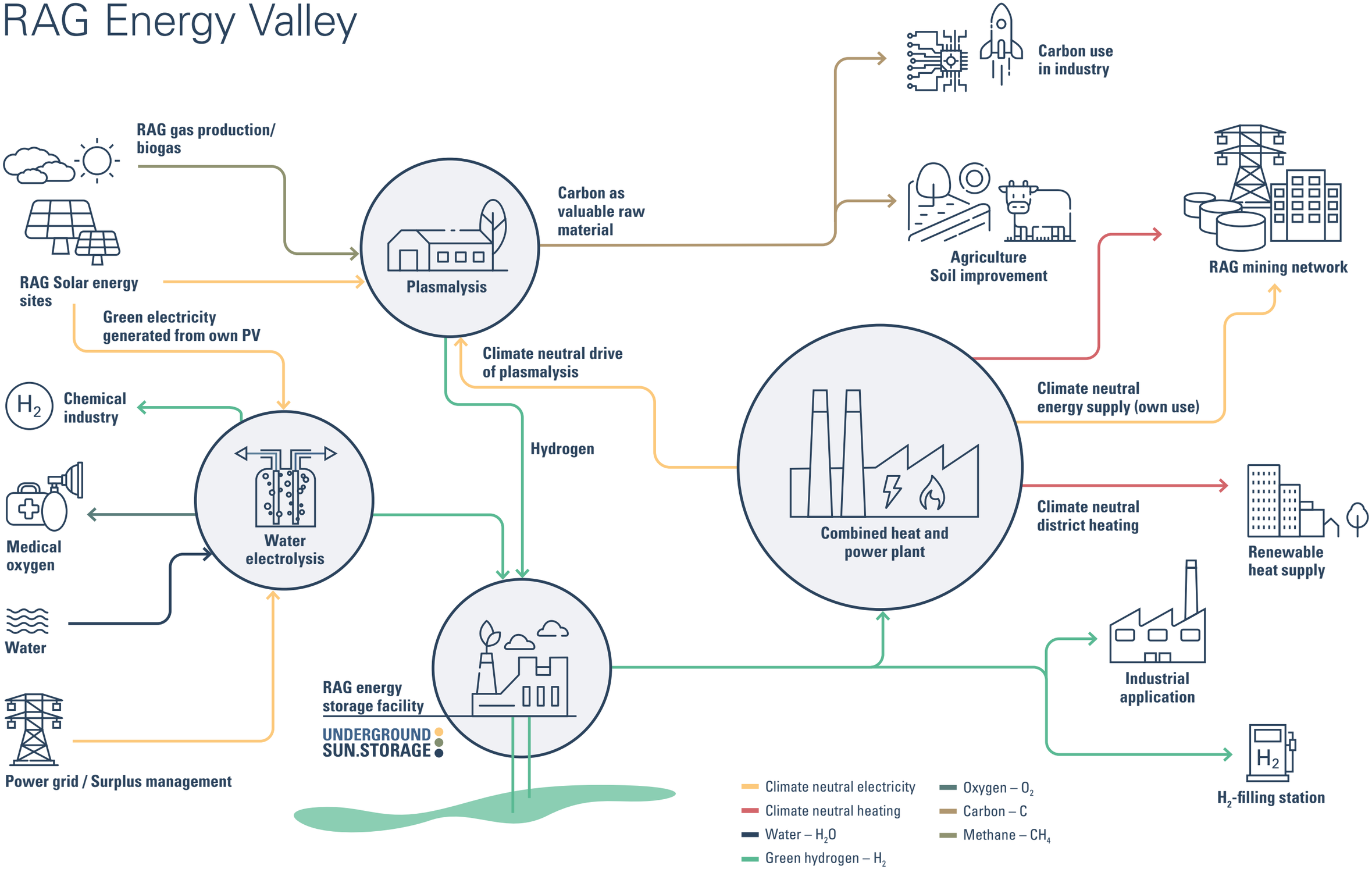
Just as the Kremsmünster area has already been in the forefront of energy innovation, value creation and security of supply in the past, we want to work with others to set standards for the future of energy and drive the development of advanced technology – from idea to production readiness.

Carbon-neutral, local, year-round energy supplies
In our regional energy hub, green energy will be produced, converted, stored and consumed so that industry and households will have a secure supply of sustainable energy for power, heat and transportation all year round.



We are convinced that the future belongs to sustainable, regional, carbon neutral energy cycles.

RAG Energy Valley



Production and use of domestic raw materials oil and gas

In the current energy and geopolitical situation, with the insecurity surrounding imports of primary products, domestic production of oil and gas has again become a big issue. It is our responsibility to extract and exploit local mineral resources.

“We produce, store and transport oil and gas according to the strictest environmental and safety standards, to be used for decentralised supplies that reduce import dependence.”

“Crude oil is far too valuable to be used for transportation or heating.”

Careful and frugal management of oil

RAG has produced crude oil efficiently and carefully for many years, giving a major boost to the economy and contributing to the supply-secure local production and supply of this mineral resource. The high-grade oil produced in Upper Austria is marketed exclusively in Austria, safeguarding high-quality industrial processing in sectors where it is indispensable. RAG has a wealth of experience in careful domestic oil exploration and production. Proprietary technology plays a key part in boosting efficiency and optimising oil production.

Oil is the base material for countless products and technologies that currently play a dominant role in our everyday lives and will continue to do so in future. Because of this, the sustainable use of reservoirs, conservation and efficiency are the watchwords in its production and use. Crude oil should be used carefully and only for applications where it has no substitute. The focus needs to be on recycling, not disposal. Expert plastic recycling reduces import dependence, protects the environment and is a key element in the closed-loop economy.

Krift tank farm bolstering security of supply

Around 240,000 tonnes of crude oil are stored at RAG’s Krift tank farm, near Kremsmünster in Upper Austria. The site has eco-friendly connections to pipeline and rail networks. The tanks are used not just to store oil produced by RAG but also to offer capacity to customers in RAG’s role as an approved stockholder. Importers of oil are legally obliged to keep a quarter of the previous year’s imports in storage. RAG provides this service for customers, maintaining legally mandated short and long-term storage of minimum reserves (compulsory emergency reserves). This enhances security of supply in Austria by creating buffer stocks to maintain oil supplies in an emergency – particularly important in today’s a testing energy and geopolitical environment.

Austria can currently cover about 7% of domestic demand for crude oil through its own production.

Natural gas – a vital resource

Natural gas plays a key role in Austrian energy supplies. It is required in large quantities for heat and power generation. The three most important uses of natural gas in Austria are generation of process heat in industry (40.5%), power and district heat generation (29.6%), and heating and hot water provision in buildings (21.9%). In addition, gas is a major and indispensable raw material for the chemical industry. For example, it is the base product for fertilisers used in agriculture, and for the urea used to treat emissions from diesel vehicles (AdBlue). Methane is also essential as the feedstock for numerous plastics. Another vital use of natural gas is in carbon-neutral production of hydrogen by means of methane electrolysis.

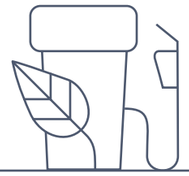
Using domestic resources

Local supplies of oil and gas play an important part in economic and industrial policy, as they maintain employment and generate growth. Because of this there is a legal obligation to produce these materials. According to the terms of its national concessions, RAG is both entitled and obliged to produce raw materials efficiently from the discovered resources in place. The Austrian Federal Government's "Masterplan Raw Materials 2030" (published in October 2021) explicitly provides for raw materials at existing fields to be extracted as fully as possible.

„Gas is versatile and can also be green: it is therefore an important enabler of a sustainable energy supply."

Optimization and increase efficiency

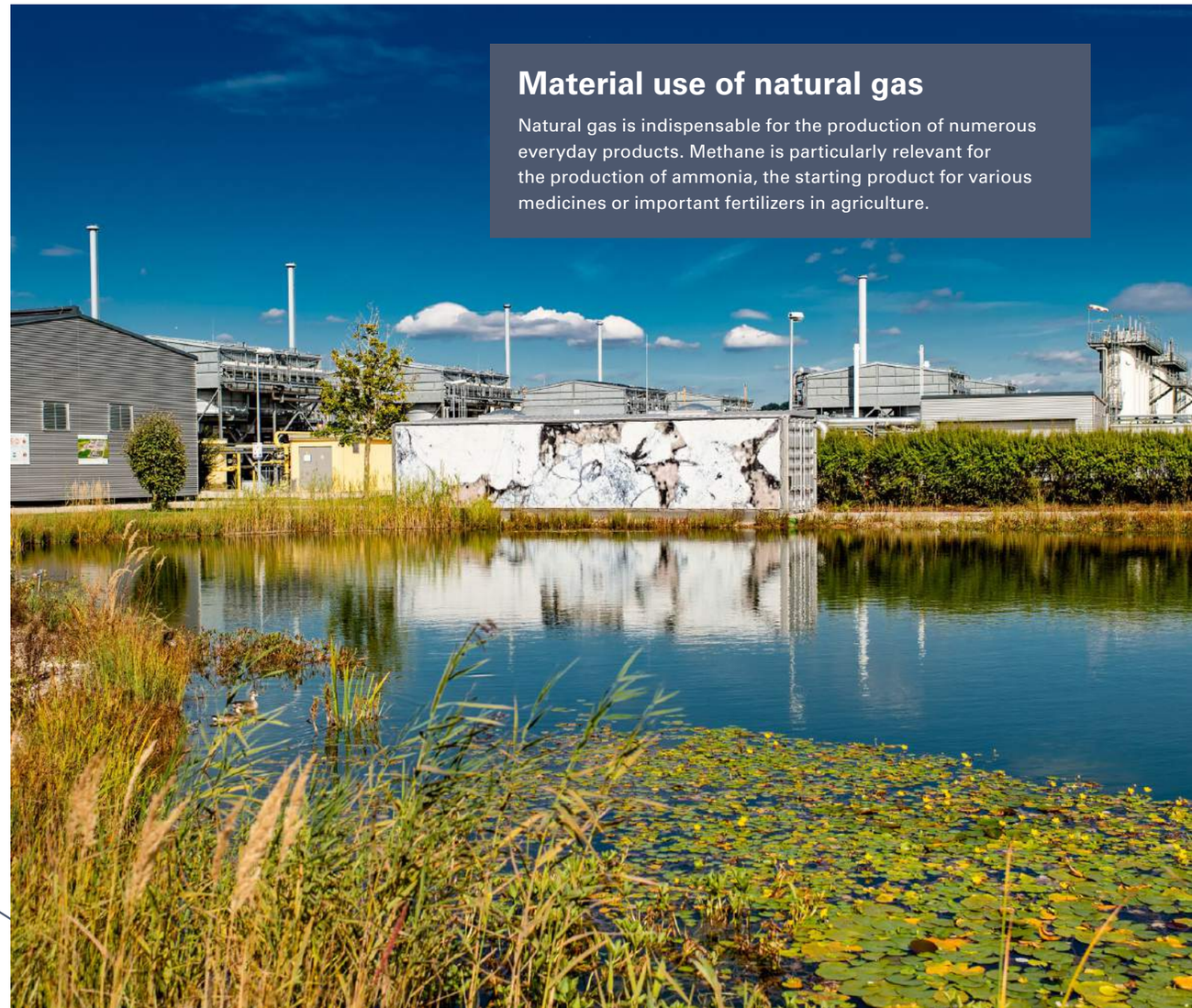
Our primary objective is to have sufficient quantities of domestic oil and gas available in Austria as an important raw material for our industry. In addition, we are working on the subsequent utilization of underground oil and gas reservoirs in order to use them for storage in a sustainable manner. RAG will therefore manage the existing reservoirs in Upper Austria and Salzburg more intensively in the future; this applies both to optimizing storage capacities and to increasing the efficiency of production.



654 million cu m of natural gas were produced in Austria in 2022.

Material use of natural gas

Natural gas is indispensable for the production of numerous everyday products. Methane is particularly relevant for the production of ammonia, the starting product for various medicines or important fertilizers in agriculture.



Committed to meeting our responsibilities

A responsible approach to business is vital to securing tomorrow's energy supplies. Careful stewardship of valuable energy resources, protecting the environment and the climate, and good relations with our neighbours are more important to RAG's commercial success than ever.

Responsible management

Our corporate philosophy, and corporate governance, compliance and integrity regulations are at the heart of everything we do. At RAG, corporate social responsibility (CSR) means carefully considering the financial, ecological and social aspects of our activities when making decisions. Our responsibilities to our employees, customers and suppliers, as well as to society, the environment and the climate are integral to our decision-making processes.

All of these considerations are embedded in our policies and underpin RAG's success.

Responsible approach to the environment

Together with safety, environmental protection and responsible stewardship of Austria's natural resources are paramount in everything we do. We pay particularly close attention to maximising environmental sustainability, optimising energy use, cutting emissions, use of waste avoidance technology, new methods for continuous surveillance and testing of plant and pipelines, as well as IT security and integrity management.

Research into innovative technologies

Working for a future with secure, sustainable and affordable energy supplies – while reducing greenhouse gas emissions and improving energy efficiency – comprises one of the biggest challenges facing the world today. As Austria's largest energy storage company, we began focusing on approaches aimed at reducing carbon dioxide emissions and the sustainable transformation of the energy system some years ago. In cooperation with various partners, RAG has initiated and conducts research into the production of climate and carbon neutral green gas, and into storing it in natural gas reservoirs in an environmentally friendly way.

This means that in future it may be possible for large quantities of renewable energy, such as wind and solar power, to be converted into gas, and transported and stored using existing gas infrastructure.

"Our focus is on securing energy supplies for future generations – through sustainability, environmental safeguards, careful use of resources and good relations with local residents."

Sustainable energy centres

RAG is pursuing a strategy for the sustainable after-use of underground natural gas reservoirs. Under the banner of “sustainable energy mining”, it centres on the use of natural reservoirs in porous geological strata (which are called pore reservoirs). Each of our reservoirs is evaluated to assess its long-term suitability for energy storage, green gas production or geothermal projects.
A large proportion of our natural gas reservoirs have already been converted into storage facilities for natural gas and other energy forms. The reservoirs are valuable and sustainable resources which ensure security of supply for Austria and Central Europe, and are a key component of a sustainable energy future. They enable significant volumes of conventional natural gas to be stored, and in future they will form the basis for seasonal storage of green gas and hydrogen, so that they can be supplied in large quantities whenever they are needed. This is security of supply in action.
RAG’s sustainable energy mining concept also means that existing production infrastructure – pore reservoirs, above-ground facilities and pipeline systems – can be put to efficient use as sustainable regional energy centres, and expanded. At the same time, operations will be climate neutral.

„The aim is to sustainably power 100% of our facilities with green energy by 2040, which translates into zero emission and carbon neutral operations.”

Efficient use of energy and resources

Where we can, we produce the energy required to operate our facilities ourselves, and we use it as efficiently as possible. We are also reducing vehicle emissions by operating a gas-driven (CNG) fleet, and rolling out the necessary refuelling infrastructure (CNG, LNG).

This can slash emissions significantly compared to conventional fuel types.

Nature conservation

When constructing facilities, RAG takes preservation of the natural environment into account at the planning stage, as part of the environmental analysis. The amount of land used, emissions and damage to the landscape are kept to an absolute minimum. Land is restored to its previous, greenfield state once a project has been completed. When constructing permanent facilities, RAG is committed to creating environmental compensation areas.

Cooperation with public authorities, environmental protection experts, planners, local authorities and landowners is especially important.

“For decades now, RAG has pursued a sustainable energy mining strategy, focused on the sustainable re-use and managing of mining facilites.”

Climate neutral operations by 2040

A core aspect of RAG’s sustainable energy mining concept is using production sites to produce renewable energy (such as photovoltaic power). RAG is converting well sites (a total of up to 220) into solar energy plants equipped with photovoltaic systems. This will enable us to generate up to 60,000 MWh of climate neutral energy a year, which will be used to power RAG’s facilities.

The electricity generated during the summer is converted into hydrogen, stored in our gas reservoirs and used in winter for the carbon neutral operation of drive units at our storage facilities. We aim to use this sustainable, eco-friendly approach to produce all of the energy required for our operations by 2040.

Safety

Safety is one of RAG's top priorities. We ensure safe places to work for all of our employees, as well as safe living environments for local residents and the local authorities where we operate by meeting the very highest safety standards.

Use of the latest technology, outstanding continuous training for our team, and forward-looking maintenance of our facilities are reflected in the highest standards of quality, workplace safety and environmental protection. Health, safety and the environment are the pillars of our management system, which plays a key role at our company.
On the basis of clear processes, precisely defined guidelines and instructions, and efficient communication we go one step further, setting ourselves a target of zero accidents in all of our activities.
Besides the health and safety measures designed to protect our own workforce, we integrate contractors closely into our safety activities.

Respectful employee relations

Equal opportunities, integration and diversity are central to our corporate philosophy. RAG's workforce brings together people from many different countries, and all are treated absolutely equally in terms of pay and career opportunities, regardless of their ethnicity, gender, cultural background or religion.

An inspirational environment

We are committed to providing our employees with excellent, flexible and safe working conditions, and an environment that supports them in making the best use of their abilities and promotes their development. RAG invests in staff development programmes and training including health education courses. An in-house health promotion scheme offers employees a selection of free courses, such as nutrition, exercise and relaxation programmes, as well as initiatives that reflect the latest health-related trends. The company also works closely with healthcare facilities and doctors. RAG has received the Austrian health ministry's quality seal for workplace health promotion; the current seal was awarded for the 2019–2021 period. The company offers individual working and working time models, and employees can take advantage of various types of sabbaticals and pre-retirement part-time working arrangements. These options give staff the space they need to develop, as well as boosting motivation.

A fair partner and a good neighbour

A reliable neighbour

Being a good neighbour will be critical to maintaining sustainable energy supplies in the future. Responsible treatment of all stakeholders, especially residents and local authorities in the areas where we operate, is not just a vital consideration but an article of faith for RAG. Because of this, we constantly seek detailed discussions with stakeholders in order to minimise the environmental and social impact of our activities.

Open communication and information

Ongoing communication with local authorities, public agencies and important local institutions is crucial to solid partnerships, as is providing comprehensive information and maintaining open dialogue with local residents and stakeholder groups, which are leading priorities for us.
We look to involve all of the relevant parties in administrative procedures to the greatest possible extent, with the goal of fostering acceptance of and trust in our operations and capabilities.

Dedicated to local communities

For decades, RAG's activities have promoted regional economic growth, and as a major employer and purchaser, the company makes an important contribution to the Austrian and the Central European economy. Numerous guided tours of facilities, open days and partnerships demonstrate the strength of our commitment to the regions where we operate. We carry out regular training and drills with local volunteer fire brigades, and offer paid internships and supervision of master's theses for students. RAG also supports regional social projects.

Continuity through change

1935
Foundation of Rohöl-Aufsuchungs Gesellschaft

1956
First discovery well, in Puchkirchen

1963
Beginning of natural gas production in Upper Austria

1992
Conversion of Rohöl-Aufsuchungs Ges.m.b.H. into an Aktiengesellschaft
Acquisition by EVN Energie Versorgung Niederösterreich of 50% of shares, with Mobil Oil Austria and Shell Austria AG each taking 25% stakes

1995
Construction of first commercial gas storage facility

1997
RAG's largest gas discovery to date, in Haidach

2007
Opening of the Haidach I storage facility

2008
Completion of final Puchkirchen expansion and construction of the 7Fields storage facility

2010
Commissioning of final expansion phase of the Puchkirchen storage facility, bringing capacity to 1.1 bn cu m

2011
Completion of Haidach II, 7Fields I and Aigelsbrunn gas storage facilities, with combined capacity of approx. 5 bn cu m

2013
Foundation of RAG Energy Storage GmbH

2014
Phase two expansion of 7Fields facility, taking capacity to approx. 5.8 bn cu m
Commissioning of natural gas filling station

2015
Launch of the Underground Sun Storage project

2017
LNG filling station opened

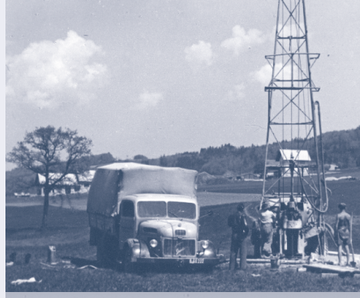
2018
Company renamed as RAG Austria AG
Commissioning of the Underground Sun Conversion project

2020
Initiation of the Underground Sun Conversion – Flexible Storage research project

2021
Construction of first PV array (own use)
Launch of the Underground Sun Storage 2030 research project, aimed at creating the first pure hydrogen storage facility

2023
Opening of the world's first hydrogen storage facility in a porous sandstone storage facility, Underground Sun Storage - Rubensdorf

2023
Start of implementation of RAG Energy Valley in Krift near Krems-münster (Upper Austria)



Executive Board

Markus Mitteregger (CEO)
Michael Längle (CFO)

Subsidiaries

RAG Energy Storage GmbH
REP GmbH
Silenos Energy GmbH

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