3/2019

energy innovation austria

Current developments and examples of sustainable energy technologies

Bundesministerium
Verkehr, Innovation
und Technologie

klima+ energie fonds

Technologies and concepts for low-carbon production

Decarbonisation of industry

The manufacturing industry is a key sector when it comes to meeting European and national climate goals. Austrian research institutions and corporations are developing and testing pioneering technologies and production processes for a low-carbon, competitive industry for the future.

Photo: stock.adobe.com

Ways to achieve a zero-emission industry

Innovation is the key for climate-friendly production

Photo: stock.adobe.com

The industrial sector is one of the sectors with the largest energy use and high CO_2 emissions worldwide.

In Austria, the final energy consumption of industry and manufacturing accounts with 94 TWh for about 30% of the total energy consumption.[1] Of this, 61% are used in the energy-intensive industrial sector, which includes iron and steel production, mineral industry, chemical industry as well as paper and pulp industries. The greenhouse gas emissions of the industrial sector amounted to 25.2 million tonnes of CO_2 equivalent in Austria in 2016, representing an increase of around 15% compared with 1990.[2]

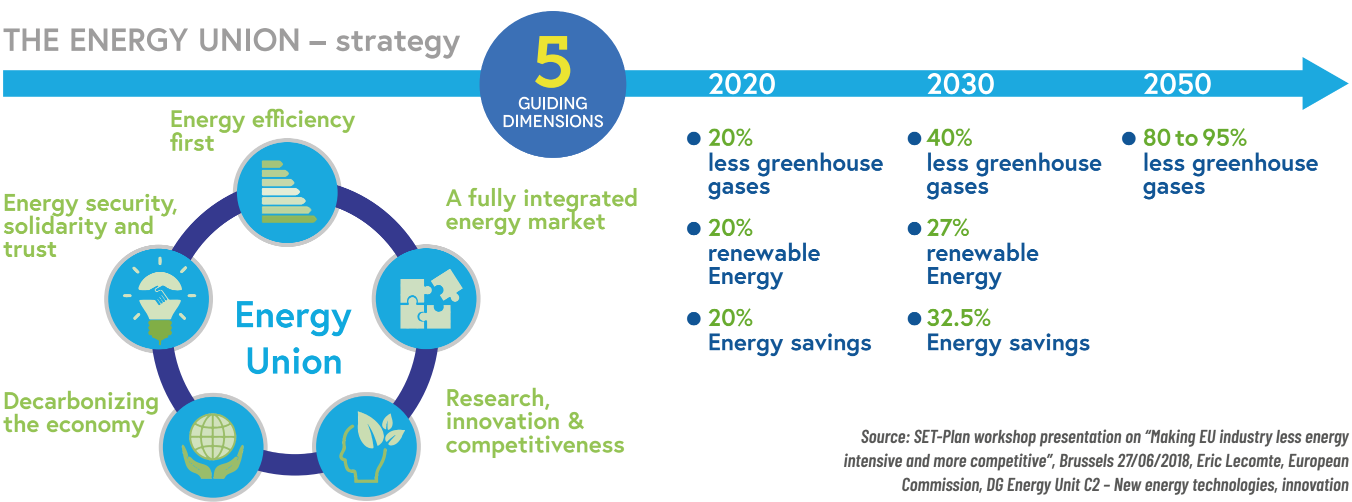
EUROPEAN CLIMATE PROTECTION GOALS

The aim of European climate policy is to achieve a competitive and climate-neutral economy by 2050. In November 2018, the EU Commission presented a long-term strategic vision which is in line with the objectives of the Paris agreement and covers almost all EU policies[3]. The strategy sets out the need to invest in technological solutions and coordinated measures in key areas such as industrial policy, finance and research.[4]

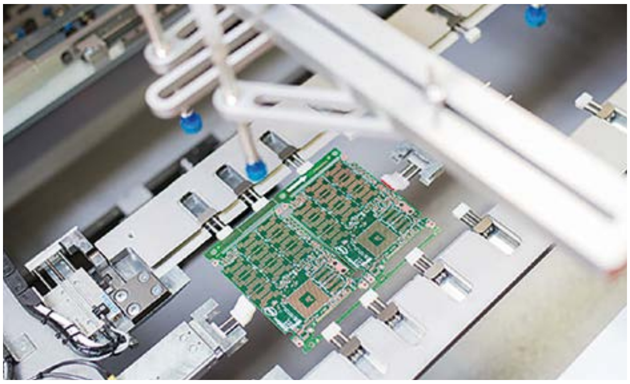
The European Strategic Energy Technology Plan (SET Plan) aims at developing and implementing low-CO_2 technologies and making them more competitive. Objectives, measures and actions for a low-carbon, competitive industrial sector are defined in the SET Plan Action 6: “Continue efforts to make EU industry less energy intensive and more competitive”[5].

A TECHNOLOGICAL EDGE THROUGH INNOVATION

Growth, prosperity and jobs can only be guaranteed in Europe if there is a strong industrial foundation. The aim of the European policy is therefore to drive forward the reindustrialisation of member



Source: SET-Plan workshop presentation on “Making EU industry less energy intensive and more competitive”, Brussels 27/06/2018, Eric Lecomte, European Commission, DG Energy Unit C2 – New energy technologies, innovation



High-tech production of circuit boards, photo: AT&S

states and to secure Europe's place as an industrial location for the long term. Green technologies for low-CO_2 production are increasingly in demand worldwide. Innovations in climate-friendly production methods help to increase the technological edge and competitiveness of European industry. At the same time, the use of renewable energies reduces the dependency of local companies from imports of fossil fuels.

RESEARCH AND DEVELOPMENT

In order to achieve the European climate protection goals, the industrial sector will need to greatly reduce its process-based greenhouse gas emissions. Although significant progress has been made in recent years, further innovations – also radical ones – and the development of new infrastructures are required for the extensive decarbonisation of industry. Research and industry in Austria are continuously developing and testing new concepts and breakthrough technologies for low-CO_2 production. In certain sectors (e.g. the iron and steel industry), Austrian companies are some of the trailblazers in climate-friendly production processes. The energy efficiency in industrial processes is constantly being improved. The aim is increasingly to integrate renewable energy sources and to match the energy requirements of industrial facilities with energy supplies available from fluctuating renewable sources.

This issue presents pioneering projects relating to the topic of "decarbonisation of industry", supported within the framework of the programmes by the Climate and Energy Fund and the Austrian Federal Ministry for Transport, Innovation and Technology. ●

[1] IndustRiES study – Energy infrastructure for 100% renewable energy in industry, AIT Austrian Institute of Technology on behalf of the Climate and Energy Fund, 2019
[2] Environment Agency Austria, climate protection report 2018, www.umweltbundesamt.at/aktuell/publikationen/publikationssuche/publikationsdetail/?pub_id=2258
[3] In the Paris Agreement of 2015, 195 countries agreed to keep the temperature increase to well below 2 °C and to pursue efforts to keep the increase to 1.5 °C.
[4] ec.europa.eu/clima/policies/strategies/2050_en
[5] setis.ec.europa.eu/system/files/set_plan_ee_in_industry_implementation_plan.pdf

STUDY

ENERGY INFRASTRUCTURE FOR 100% RENEWABLE ENERGY IN INDUSTRY

The **IndustRiES** study by the AIT Austrian Institute of Technology on behalf of the Climate and Energy Fund examined how Austrian industry could be supplied with 100% renewable energy and what the resultant requirements would be for the energy infrastructure (including storage systems for the provision of flexibilities). Numerous analyses were carried out for three different scenarios (basis, efficiency and radical change). The radical change scenario also includes the process conversion of the iron and steel sector to direct reduction with hydrogen.

Depending on the scenario, the final energy use of the industrial sector lies between 82 and 108 TWh. The results show that the industrial final energy use balance could be covered in all scenarios using the existing renewable energy potential available in Austria (231 TWh). However, the potential is not enough to cover the final energy use of the other sectors (traffic, public and private services, private households and agriculture), which amounts to a total of 220 TWh. Depending on the scenario, there is a gap in coverage of 71 to 97 TWh.

The study also shows that electrification based on renewable power will play a key role in the future. Depending on the scenario, the electrical energy requirement in industry lies between 32 TWh (efficiency) and 68 TWh (radical change). In the radical change scenario, the industry's demand for electricity more than doubles in comparison with the status quo (30 TWh).

Important energy policy measures on the path to gradual decarbonisation of the industrial sector include an intensified and immediate expansion of renewable energies, the creation of an integrated European energy infrastructure and the use of new options to link the energy sectors.

Link to the study: bit.ly/2lWW2Ng

IndustRiES study – Energy infrastructure for 100% renewable energy in industry, AIT Austrian Institute of Technology on behalf of the Climate and Energy Fund, 2019

SolarAutomotive

Renewable energy for the automotive industry

Photo: stock.adobe.com

The automotive and automotive supply industries are amongst the most important economic sectors in the European Union, accounting for more than 10% of manufacturing jobs in the EU and around 4% of the European gross domestic product.
Source: ACEA, (2017), The Automobile Industry Pocket Guide 2017-2018

To reduce CO_2 emissions in industry and small-scale manufacturing over the long term, energy requirements must fall and the use of renewable energies must increase. Solar process heat offers many opportunities for supporting industrial processes with renewable energy and for reducing the need for fossil energy sources. An economical implementation is particularly viable in situations when temperatures below 100 °C are needed, no waste heat can be used and where there is a constant heat demand, at least in the sunny months. Integrating solar heat is an option for heating networks, heated pools, machines and tanks, drying processes as well as for supplying hot water and for building ventilation systems, for example. Solar heat is CO_2-free and can be combined with other heat sources such as heat pumps, combined heat and power units or gas, oil and biomass boilers. Despite its high potential, the market for this technology has only developed slowly to date.

* **PROJECT PARTNERS:** S.O.L.I.D. GmbH, KPV Solar GmbH, Stiftung für Ressourceneffizienz und Klimaschutz (STREKS - Foundation for Resource Efficiency and Climate Protection), Fachbereich Umweltgerechte Produkte und Prozesse (UPP- Department of Environmentally Friendly Products and Processes) at the University of Kassel

INTERNATIONAL RESEARCH COOPERATION

Within the scope of the D-A-CH initiative, the German-Austrian cooperative project SolarAutomotive was launched in 2016 under the management of AEE INTEC and the University of Kassel (Department of Solar and Systems Engineering)*. The aim of this transnational cooperation is to drive forward the integration of solar process heat in the automotive industry as well as in the upstream supply chain. Application examples and the implementation of flagship projects will provide innovative impulses and demonstrate the potential for CO_2-free production. As the industry comprises a wide variety of production branches and processes, knowledge can be transferred to other industrial sectors (e.g. food and beverages, textiles, printed circuit boards, metalworking). To begin with, twelve sub-branches in the automotive and automotive supply industries were identified and the processes suited to a solar thermal energy supply due to their process requirements were determined. These key processes include, for example, electroplating processes in metal finishing, air conditioning measures in the automotive industry and washing and drying processes in the textile industry.

Potential for solar process heat

Based on the final energy usage of European industry and on the assumption that the entire industrial requirement for heat below 200 °C can be supplied via solar thermal energy, the potential CO_2 savings are 25 million tonnes per year. In the automotive industry alone (excluding the automotive supply industry), this means 4.2 million m^2 of installed collector surface and an output of 2.4 gigawatts SHIP (Solar Heat for Industrial Processes).

> **„Our vision at AT&S is to implement a sustainable energy supply at all our locations. And what could be more natural than using solar power to turn this vision into reality? The 'SolarAutomotive' project has identified a number of technically interesting possibilities for the use of solar process heat which we are currently evaluating and we hope to be able to integrate them into our energy concept.“**
>
> HEINZ MOITZI
> CHIEF OPERATIONS OFFICER (COO) AT&S

Photo: AT&S

CASE STUDIES

Within the framework of SolarAutomotive, 25 detailed case studies have been carried out in different countries identifying possible points of integration for supplying various production processes with solar thermal energy. The detailed simulations take into account numerous process parameters (temperature level, spreading, heating rates, etc.) as well as process engineering characteristics and product quality. This results in the choice of suitable collector technology and surface, storage, installation site and orientation of the system.

The case studies confirmed the great potential of solar process heat in the automotive and automotive supply industries. The analyses show technically and economically practical system concepts of various sizes (solar thermal energy surface areas ranging from 50 m^2 to 3,200 m^2). After a positive internal evaluation, the concepts are set to be implemented as the next step.

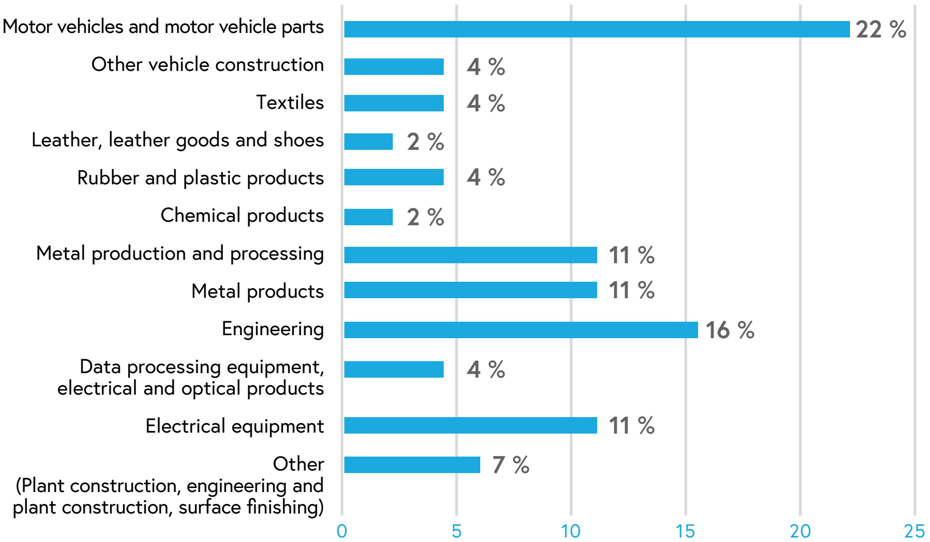
High-tech-Production, photo: AT&S

SOLARAUTOMOTIVE GUIDELINE

Based on the results, a guideline was created with the aim of helping to make the use of solar process heat in the automotive and automotive supply industries more widespread. Alongside information on potential usage options and integration concepts, simple, tailored tools were made available for the design and economic valuation of a system. A preliminary design tool and a detailed simulation tool (SolarSOCO) enable rapid or in-depth calculations. ●

www.energieforschung.at/projekte/847/solare-prozesswaerme-fuer-die-automobil-und-zulieferindustrie (in german)

SolarAutomotive case studies – distribution of sectors



Source: AEE INTEC

OXYSTEEL

Energy efficiency and Demand Side Management in the steel industry

With a final energy usage of 2,140 PJ, the iron and steel industry is one of the biggest energy users in the European Union*. As well as the energy-intensive and high-emission blast furnace method used in steel production, electric furnace steelmaking is used worldwide. Scrap steel is melted down in electric arc furnaces and then processed into high-quality steel products. The melting of recycled scrap steel requires the use of less energy and results in lower CO_2 emissions compared with the conversion of iron ore to iron in a blast furnace. The electric arc furnaces can also be operated using power from renewable energy sources. However, the heating of some auxiliary components takes place both in the blast furnace and in the electric arc furnace route with gas firing.

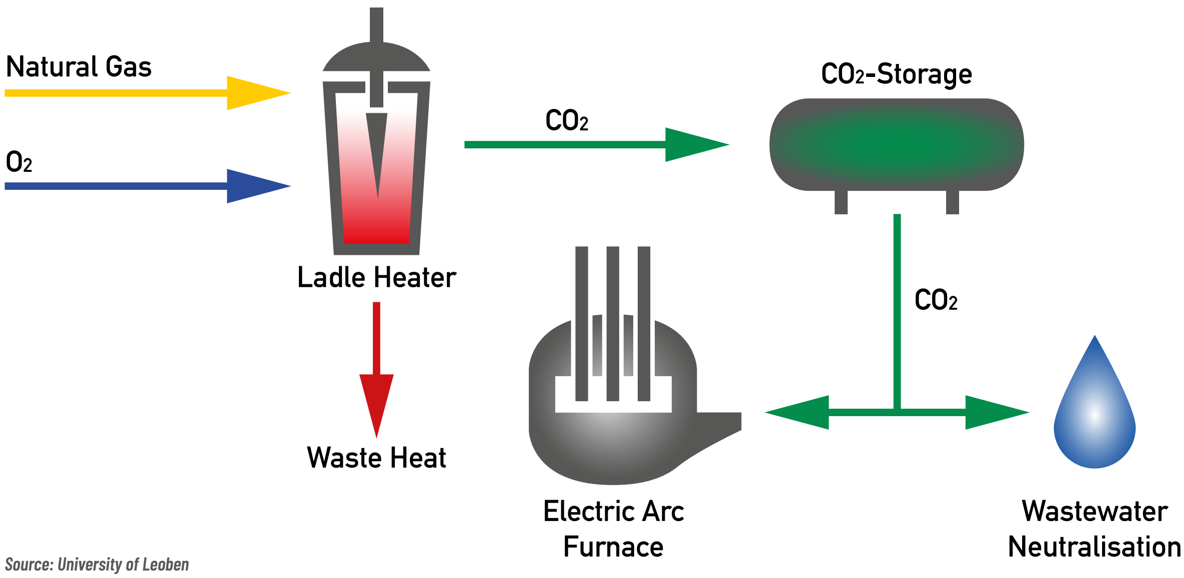
The OxySteel project, managed by the University of Leoben – Chair of Energy Network Technology in cooperation with Breitenfeld Edelstahl AG and Messer Austria GmbH, is researching and testing ways of increasing energy efficiency and reducing CO_2 emissions in electro-steel plants. The project team is developing an innovative process design integrating oxygen combustion and CO_2-separation (CCU/Carbon Capture and Utilisation) into the production process. In addition, the potential for Demand Side Management in steel production is analysed.

ENERGY-EFFICIENT PROCESSES

Oxygen combustion can be used in electro-steel plants to pre-heat ladle heaters as well as in heat treatment. Replacing the combustion air with pure oxygen leads to a higher flame temperature, lower exhaust gas losses and reduced nitrogen emissions. As part of the project, the Messer Oxipyr oxygen burner is being fitted with a special measurement sensor to achieve optimal control of the combustion process. Oxygen burners are up to 50% more energy efficient and produce a waste gas with a higher concentration of CO_2.

* SOURCE: Energy Balance Sheets, 2014 data 2016.

Photo: Breitenfeld Edelstahl AG, Stefan Nadrag



Source: University of Leoben

Some of the CO_2 produced in the process is used for environmentally friendly wastewater neutralisation in the plant. The use of carbon dioxide instead of other chemicals to treat wastewater means that the salt content of the wastewater is lower. Research is also being conducted to ascertain whether some of the CO_2 could be used for refining purposes in the electric arc furnace. The introduction of an O_2/CO_2-mix for iron refining should improve the melting behaviour and increase the iron yield for the same volume of scrap.

Photo: stock.adobe.com

TRIAL RUNS IN STEEL PLANTS

The technologies developed as part of the project are being integrated into the production process in the Breitenfeld Edelstahl AG steel plant in Styria. Five conventional ladle heaters are being replaced by three new furnaces with oxygen burners. This is expected to significantly reduce natural gas consumption and, consequently, CO_2 emissions. The internal plant usage of CO_2 also has a positive effect on the energy and CO_2 balances. The researchers expect annual energy savings of 12 GWh due to the implementation of OxySteel. This is the equivalent of around 10% of the annual natural gas requirement of a small town in Styria.

USING FLEXIBILITIES

The process design also makes it possible to provide the necessary flexibility for integrating the power from fluctuating renewable energy sources such as wind power and photovoltaics, for example. The operational flexibilities will be assessed in the project and the potential for network services calculated from this. Due to its existing connection to the 110 kV high-voltage network and the possibility of connecting it to the 220 kV network, the location of the steel plant is suitable for making use of the internal operational flexibility of the plant as a regional or transregional flexibility option. ●

NEFI
NEW ENERGY FOR INDUSTRY

OxySteel and SANBA (see page 8) are projects of the flagship region NEFI – New Energy for Industry, an innovative network made up of scientific institutes, technology providers and companies for the development and demonstration of key technologies for the decarbonisation of industry.
www.nefi.at

SANBA

Industrial waste heat for the energy supply of a future urban district

NÖM dairy in Baden near Vienna, photo: NÖM, Mario Pampel

With the Smart Anergy Quarter Baden (SANBA) project which was started in 2018, the AIT Austrian Institute of Technology* is developing a concept for a low-temperature heating and cooling grid, also known as an anergy grid, for the Martinek military camp in Baden, near Vienna, which were abandoned in 2014. The 40-hectare site owned by the Austrian Ministry of Defence has been the subject of numerous development plans over the last few years. A new multi-use urban district with residential, commercial and office buildings could be constructed there. The listed buildings of the former military camp would need to be renovated regardless of their future use. The central idea for the refurbishment is to provide the district with industrial low-temperature waste heat produced by processes at the nearby NÖM dairy. Further sources of energy available locally such as geothermal energy, photovoltaics and solar thermal energy could be used to supply energy to the buildings.

Local anergy grids are pipeline networks that distribute low-temperature water (from 4 to 30° C) between individual buildings or groups of buildings. The water can be used for direct cooling ("free cooling") as well as for heating and cooling using heat pumps. Anergy networks present new opportunities for decentralised energy supply. By forming local energy communities, the integration of locally available renewable energy sources becomes possible and flexibility is increased. As both energy producers and consumers, the buildings in a district become active network participants.

FEASIBILITY STUDY

A multi-layered, interdisciplinary simulation algorithm is being developed for the efficient planning of a local low-temperature heating and cooling network. Simulations for three different usage scenarios (exclusive use of the historic buildings or the use of additional buildings, too) are being carried out. The user and load profiles of the buildings are assumed to be mixed. The results of the project will show whether the concept is technically and economically feasible and whether it should be pursued. As a first step, the waste heat potential from the wastewater at the NÖM dairy was analysed and a hydrogeological model for the use of geothermal energy at the site was created. A technical draft for the components of the anergy network was also developed and the first cost-effectiveness calculations were performed.

To date, there has been little research into local anergy networks, but these could become more important in the future, especially in urban areas. SANBA should deliver important insights to support the implementation of such networks in Austria and to enable the screening of suitable locations and planning, in particular within the framework of renovation projects. ●

www.nefi.at

* **PROJECT PARTNERS:** NÖM AG, TU Wien (Vienna University of Technology) – Institute of Energy Systems and Thermodynamics, ENFOS. e.U. – Energy and Forest, Research and Service, Institute of Building Research and Innovation ZT-GmbH, City of Baden Energy Department, University of Leoben – Chair of Energy Network Technology, geothermal GmbH, BauConsult Energy GmbH
PROJECT ADVISORS: The Austrian Ministry of Defence, represented by the Military Real Estate Management Centre (MIMZ), Austrian Federal Monuments Office

UNIV. PROF. RENÉ HOFMANN

Head of the "Industrial energy systems" research group, TU Wien – Institute for Energy Systems and Thermodynamics; Thematic Coordinator of the Efficiency in Industrial Processes and Systems research field, AIT Austrian Institute of Technology, Center for Energy

In your opinion, what are the greatest challenges for the energy-intensive industry in the transition to low-carbon production?

The decarbonisation of industry must always be considered from two viewpoints: on the one hand, the energy supply for industrial processes as a cross-sectoral substitute for fossil energy sources and, on the other hand, the production processes themselves. The key factors here are the cascading and efficient use of high-quality raw materials and energy sources, and increased rates of recycling, but also the complete substitution of some production processes such as the use of direct reduction with hydrogen in steel production. It is also possible to make captured CO_2 available to other industrial processes as a high-quality raw material, by applying carbon capture and usage approaches in the cement industry, for example. To be able to achieve the decarbonisation of industry, however, the use of electrical energy has to be significantly higher than today's level. This presents new challenges for the storage and electrical infrastructure in order for the increasing proportion of volatile, renewable energies to be optimally used and integrated.

A switch to low-carbon production is currently still afflicted by major economic, regulatory and technical uncertainties. A transformation in this direction requires significant investment and this can only be made on the basis of clear and reliable framework conditions.

Which innovations and key technologies will drive forward the decarbonisation of industry?

The digitalisation and automation of the industrial sector has a major influence on the decarbonisation of industry. It enables cross-location efficient usage and provision of resources including the associated energy supply. In this way, raw-material cycles can be completed and cascading usage pathways can be optimised. Digital energy management allows for a flexible response to the availability of resources and the development of new business segments through the provision of flexibility. There are further key topics relating to the use of waste heat to increase efficiency. The coupling of high-temperature processes, e.g. in industrial furnaces, with the further development of heat pumps plays a significant role here. The use of hydrogen as both an energy source and a raw material in the chemical industry and iron and steel production also has the potential to make a considerable contribution to the decarbonisation of industry.

What does the development of climate-friendly production methods mean for Austria as a location for industry?

There is an opportunity for Austria to take a pioneering role internationally in the decarbonisation of industry with the development of climate-friendly production methods. The industrial location can be sustainably secured, strengthening Austria's competitiveness in a globalised world through the export of these products and technologies.

You represent Austria in the "Industrial Energy-Related Technologies and Systems" technology programme by the International Energy Agency. How do Austrian research institutes and companies benefit from international cooperation?

The Technology Collaboration Programme "Industrial Energy-Related Technologies and Systems" focuses on the topic of energy use in industry. The goal is intensified research and development of industrial energy technologies and systems in the context of international cooperation between OECD and non-OECD countries. The focus is on the collaboration of industry-relevant research disciplines, networking within industrial sectors and on cross-sectional technologies, as well as the transfer of information and knowledge between experts from industry, science and politics. Participating in IETS allows Austrian stakeholders to network at an international level, provide R&D output for industrial energy technologies and systems and to implement projects abroad using Austrian technologies.

IEA TCP – INDUSTRIAL ENERGY-RELATED TECHNOLOGIES AND SYSTEMS (IETS)

Annex 15 – Industrial Excess Heat Recovery
Annex 17 – Membrane Processes in Biorefineries
Annex 18 – Digitalization, Artificial Intelligence and Related Technologies for Energy Efficiency and GHG Emissions Reduction in Industry
Annex 19 – Electrification in Industry

nachhaltigwirtschaften.at/de/iea/ (in german)
iea-industry.org

TOREtech

Energy efficiency in brick production

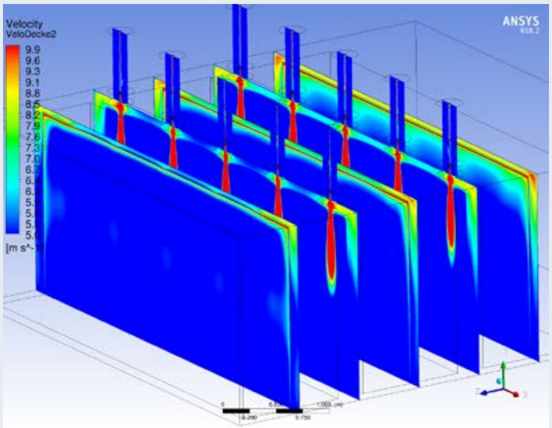
Substantial energy savings have been made in brick production in recent years through the use of new technologies. The Austrian company Wienerberger is an innovative leader and is continually improving its offering of energy-efficient, highly insulating bricks and sustainable system solutions. With TOREtech, a new concept is being developed that will further optimise the manufacturing process.

As well as making technical improvements to its products, Wienerberger has also succeeded in substantially reducing specific energy consumption in production: a reduction of 23% in bricks and 16% in roof tiles were achieved by 2018, in comparison with the 2010 figures. The manufacture of heavy clay products continues to be energy intensive and there is additional potential for optimisation here. Besides crushing raw materials, the drying and firing of bricks requires a relevant use of energy.

Within TOREtech, Wienerberger is currently focusing on furnace optimisation. In cooperation with the TU Wien (Vienna University of Technology) – Institute for Process Engineering and the engineering office DrS³ *, an innovative tunnel furnace energy concept is being worked on, with an innovative gas burner especially developed for tunnel furnaces and energy-efficient process technology. The aim is to further reduce the primary energy requirement for brick production.

INNOVATIVE COMBUSTION TECHNOLOGY

With TOREtech, a jet pump pure gas burner concept is being developed that functions without an external supply of combustion air. Pure gas burners only work with the hot furnace atmosphere already contained in the combustion chamber of the tunnel furnace and avoid the insertion of air, thus reducing the energy requirement. However, the pure gas burners currently available on the market do not have the required flame jet speed to achieve a homogeneous temperature distribution in the furnace, which means that burners with externally supplied combustion air have been used for tunnel furnaces up until now.



CFD simulations (Computational Fluid Dynamics)

- Detailed analysis of the burner and nozzle geometries (including the combustion calculation, analysing the mixing behaviour and the flame structure)
- Optimisation of the burner geometry
- Combustion calculation regarding potential pollutant emissions
- Analysing the ignition characteristics for various conditions

Source: DrS³

TOREtech hot test stand, photo: Wienerberger AG

TOREtech cold test stand, photo: TU Wien (Vienna University of Technology)

This innovative concept combines the pure gas burner with a jet pump using natural gas. This approach has not yet appeared on the market and should increase the energy efficiency of the process.

TEST STANDS FOR ANALYSIS

The development of the new technology is supported by numerical flow simulations and is currently being analysed at two test stands. The "cold test stand" is being used to test the flow mechanics of the jet pump in the new burner concept and to validate and calibrate the CFD (Computation Fluid Dynamics) analyses. The "hot test stand" constitutes a section of a tunnel furnace. Here, the concept can be tested in a real, practical environment.

ENERGY-SAVING POTENTIAL

The new technology has the potential to reduce energy usage in tunnel furnaces in the medium term, thus securing cost benefits and competitive advantages. Wienerberger expects this gas burner innovation to demonstrate at least 10% more thermal efficiency and that it will therefore be possible to further reduce gas consumption and CO_2 emissions from the brick furnaces in a sustainable way. ●

„We have been taking responsibility for generations and our environment for 200 years. Our aim is to manufacture products of the highest quality and drive forward the decarbonisation of our industry. In order to achieve this, we are investing in research and development, continually improving our production processes and working in close cooperation with external research institutes. Our goal is to further reduce the CO_2 emissions from our production continuously over the next few years. Using the TOREtech technology will make a significant contribution to this."

HEIMO SCHEUCH
CEO WIENERBERGER AG

*** PROJECT PARTNERS:** TU Wien (Vienna University of Technology) – Institutes for Process Engineering / Thermal Process Engineering and Simulation / Chemical Process Engineering and Energy Technology, DrS3 - Current Calculation and Simulation e.U.

You can also visit us at:

www.energy-innovation-austria.at

INFORMATION

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STUDY IndustRiES
Energy infrastructure for 100% renewable energy in industry
AIT Austrian Institute of Technology
on behalf of the Climate and Energy Fund
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