energy innovation austria

1/2024

Current developments
and examples
of sustainable energy
technologies

klima+ energie fonds

Federal Ministry
Republic of Austria
Climate Action, Environment,
Energy, Mobility,
Innovation and Technology

50 Years International Energy Agency

Austria's contribution to global research collaboration

Founded in 1974 in response to the oil crisis, the International Energy Agency plays an important role today in shaping a clean, secure and sustainable energy future. As one of the founding members, Austria has been actively involved from the start in numerous technology programmes and projects, and benefits from exchanging knowledge at the international level.

Photo: stock.adobe.com

50 Years IEA Collaboration in Research

The technology network for a changing energy future

Photos: stock.adobe.com

Since it was first established in 1974, the International Energy Agency has played a crucial role in ensuring a more secure, efficient and sustainable global energy supply. In response to the oil crisis, a total of 16 countries belonging to the Organisation for Economic Cooperation and Development (OECD) joined forces 50 years ago in order to develop long-term strategies aimed at securing the energy supply. Austria was one of those founding countries. The IEA now has 31 member countries, 5 accession countries and 13 association countries.[1] The Agency is based in Paris. Dr Fatih Birol has been its Executive Director since 2015.

While the focus initially was on securing the supply of oil and successfully managing future energy crises, the range of areas covered has expanded over the years, with the development and distribution of renewable energy technologies and energy efficiency taking centre stage. The IEA's data and analyses now cover 80% of global energy consumption, 80% of global CO_2 emissions and 87% of global investments in clean energy.[2]

NEW CHALLENGES

At the Ministerial Meeting in March 2022, the member countries agreed to expand the Agency's mandate further. The focus today is on developing strategies and innovative solutions for emission-free energy systems in order to achieve the global climate protection objectives and create a clean, secure, sustainable and affordable energy future for all. The IEA will face some major challenges over the next 50 years, including the transition to a low-carbon economy, an energy transition based on renewables and successfully managing the consequences of climate change.

The IEA's work today covers many other important aspects, including a transition centred around people, affordability, as well as critical minerals and supply chains for clean energy technologies. Non-technical topics such as gender equality, inclusion and justice are also increasingly being made a higher priority.

The organisation provides insightful data, time series and trends in its analyses and publications. The most important of these are the annual World Energy Outlook, the Net-Zero by 2050 Roadmap and the progress review of all clean energy technologies and efficiency measures.

[1] **IEA member countries (31):** Australia, Austria, Belgium, Canada, Czechia, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Japan, Lithuania, Luxembourg, Mexico, Netherlands, New Zealand, Norway, Poland, Portugal, Slovakia, South Korea, Spain, Sweden, Switzerland, Türkiye, United Kingdom, United States
Association countries (13): Argentina, Brazil, Egypt, India, Indonesia, Kenya, Morocco, China, Senegal, Singapore, South Africa, Thailand, Ukraine
Accession countries (5): Chile, Costa Rica, Columbia, Latvia, Israel
www.iea.org/countries

[2] Source: www.iea.org/about

Photo: stock.adobe.com

WORLD ENERGY OUTLOOK

The World Energy Outlook is the central source for analyses and forecasts in the world of energy. The publication provides objective data, offers insights into the global energy supply and global energy demand in various scenarios and analyses the impact on energy security, climate targets and economic developments.

The impact of energy trends in key areas such as investment, flows of trade, electrification and energy access were also analysed in 2023. The IEA has seen signs of an acceleration in the switch to clean energies despite the current crises and major fluctuations on the energy markets. This can be seen among other things in the trends to introduce photovoltaics, electric vehicles, batteries and heat pumps. For every USD spent on fossil fuels today, USD 1.8 is spent on a range of clean energy technologies and the associated infrastructure: just five years ago this ratio was still 1:1.

The increased spending is, however, concentrated in the industrialised countries and China. The necessary investments in all other countries of the Global South are lagging behind in most areas involving final energy consumption.

www.iea.org/reports/world-energy-outlook-2023/executive-summary

TECHNOLOGY AND INNOVATION

The IEA recognised from the outset the crucial role that research and innovation play in shaping a sustainable energy future. Numerous pioneering projects have been initiated and energy innovations successfully launched by promoting co-operation between the member countries and bringing together expertise from different disciplines.

The first meeting of the Committee on Energy Research and Technology (CERT) was held in 1975. The first joint research programme in the field of solar energy was established two years later. The CERT coordinates and promotes the development, trial and introduction of clean energy technologies. The different topic areas of Renewable Energy, End-Use Technologies, Fossil Fuels, Fusion Power and Industrial Decarbonisation are grouped into five working parties. The Working Party for Industrial Decarbonisation was first established in 2023 to support the industrial transformation towards climate neutrality.

The research cooperation is carried out as part of the Technology Collaboration Programmes (TCPs). The TCPs address research and policy activities on a wide range of energy-related topics, including renewable energy sources, energy efficiency, system integration, security and diversification of the energy supply, carbon management and various interdisciplinary topics. The TCP network promotes the exchange of knowledge and at the same time offers the opportunity to showcase Austrian expertise to the rest of the world and for participants to learn from each other. Around 6,000 experts from 54 nations are currently working together in a total of 40 TCPs.

www.iea.org

”The importance of the IEA has changed fundamentally in the 50 years since it was first established. It provides information year after year on the global status of the energy transition and highlights the steps that need to be taken to ensure continued compliance with the Paris Agreement. Accelerating research and innovation and launching new technologies and system solutions on the market are key factors in this regard. The IEA’s global energy technology network supports these efforts. We are working together to ensure that in future we can look back with pride on the turning point in the global energy transformation.”

Photo: private

SABINE MITTER
IEA RESEARCH COOPERATION
FEDERAL MINISTRY FOR CLIMATE ACTION, ENVIRONMENT, ENERGY, MOBILITY, INNOVATION AND TECHNOLOGY

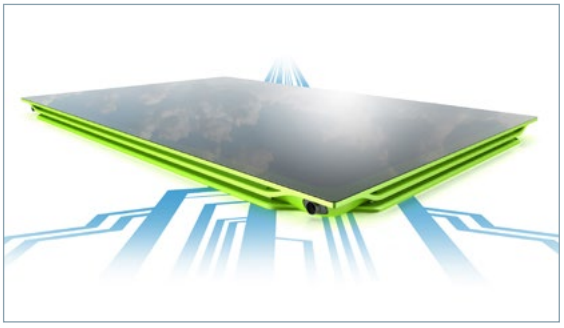
Austria's role in the International Energy Agency technology network

Austrian experts and companies are currently active in 23 out of 40 IEA technology programmes and in one expert group. Global networking within the framework of IEA research cooperation plays a crucial role in Austria's efforts to achieve a sustainable and secure energy future.

The country is making a valuable contribution towards the global energy transition through its active participation in international research projects, while at the same time benefiting from the advantages of international cooperation in the energy sector.

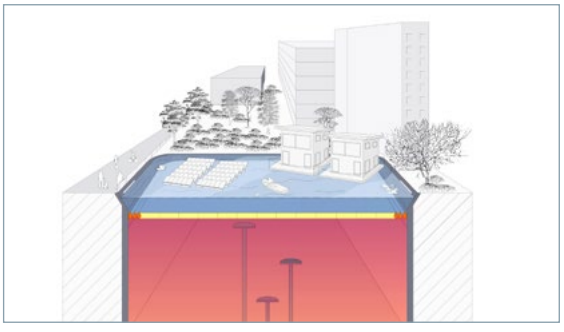
- **Access to international resources and expertise**
  Austria has access to a global research network through its cooperation with other IEA members and therefore to a broad spectrum of resources, knowledge and experience in the energy sector. Becoming aware of international developments at an early stage supports the strategic direction for Austrian RTI policy.
- **Promotion of innovation and the technology transfer**
  Participation in international research projects allows Austrian companies and research institutions to develop innovative technologies and showcase Austrian expertise internationally.
- **Reinforcing the national energy research landscape**
  Cooperation on international projects helps strengthen the national energy research landscape and consolidates Austria's position as an energy innovation country.
- **Contribution towards the global energy agenda**
  As a member of the IEA, Austria contributes towards the global energy agenda and helps to address international challenges in the energy sector. Networking supports the efforts to transfer research results into international norms and standards.

1 *Residential home heated 100% with solar energy (1997) – The Nader residence with 85 m² of collector area and 75 m³ of energy storage systems is heated 100% by solar energy and was one of Austria's contributions to IEA SHC Task 26 Solar Combisystems. (Photo: AEE INTEC)*



2 *First all-plastic collector (2010) – The Sunlumo "One World Collector" was developed as part of the Austrian SolPol project and was a contribution to IEA SHC Task 39 Polymetric Materials for Solar Thermal Applications. (Photo: SUNLUMO Technology GmbH)*

3 *Solar process heat at Göss brewery (2014) – The mashing process was converted and a 1,470 m² solar thermal collector now supplies hot water in a low-temperature process thanks to a new heat exchanger – an Austrian contribution to IEA SHC Task 49 Solar Heat Integration in Industrial Processes. (Photo: AEE INTEC)*



4 *The gigaTES project for the decarbonisation and increased flexibility of district heating (2022) – New concepts and materials for large-scale heat accumulators of between 50,000 m³ and 2 million m³ – an Austrian contribution to IEA Energy Storage Task 39. (Image: AEE INTEC)*

Milestones in energy research

www.iea.org/about/history

+ Austria's accession to IEA technology programmes
» Selected technological highlights and successful implementations
¤ Selected events

IEA established (1974)

1974 – 1979

¤ First CERT meeting (1975)
+ Solar Heating and Cooling (1977) – Austria is a founding member
+ Wind Power (1977)

1980 – 1989

+ Heat Pump Technologies (1980H
¤ District Heating and Cooling (established 1983)
+ Bioenergy (1983)
¤ IEA Heat Pump Conference in Graz (1984)

1990 – 1999

¤ IEA Photovoltaic Power Systems (PVPS) – Trend reports (1993)
+ Demand-side Management Energy Efficiency (started 1993)
» Residential house heated 100% through solar power (1997) 1
+ Fluidised Bed Conversion (1999)

2000 – 2009

IEA online (2002)

+ Advanced Fuel Cells (2004)
+ Energy in Buildings and Communities (2006)
+ Greenhouse Gases (2006)
+ Hybrid and Electric Vehicle (2007)
+ Advanced Motor Fuels (2008)
+ Energy-Efficient End-use Equipment (started 2008)
» IEA Wind energy in cold climates – Risk assessment of falling or thrown ice adopted in IEC61400 standard (2009)
¤ Equality in Energy Transitions Initiative (2009)
¤ PV global market leader China joins the PVPS programme (2010)

2010 – 2019

» First all-plastic collector (2010) 2
¤ International Smart Grid Action Network (established 2011)
¤ District heating and cooling: first task-shared annex (2012)
¤ IEA bioenergy conference in Vienna (2012)
» Solar process heat for the Göss brewery (2014) 3
+ Industrial Energy-related Technologies and Systems (2016)
+ District Heating and Cooling (2017)
+ Hydrogen (2018)
+ C3e Equality in Energy Transition (2018)
+ Energy Storage (2019)
+ User-centred Energy Systems (2019)

2020 – 2023

¤ Equality Initiative Ambassador programme launched in Austria
¤ Understanding and acceptance of hydrogen in the working plan
» New law and funding programme for regulatory sandboxes (2021)
¤ Equality initiative event series completed in Austria (2021)
¤ Launch of the first Industrial Energy Related Technologies and Systems (IETS) Task "Decarbonisation and Circular Economy" submitted by Austria (2021)
» gigaTES: key element for decarbonisation and increased flexibility in district heating 4
+ Decarbonisation of Cities and Communities (initiated and developed by Austria) (2022)
+ Advanced Materials for Transportation Applications (2022)
¤ Advanced Motor Fuels initiated and led by Austria – task for "Sustainable Aviation Fuels" (2022)

"From the security of oil supply to the energy transition"

High-temperature heat pumps

and their use in industrial processes and district heating networks

Heat pumps are used these days to heat rooms and produce hot water in many different types of buildings. They will play an increasingly important role in the energy system of the future, with the goal of reducing greenhouse gas emissions in the building sector.

Heat pump technology also enables numerous other applications, such as providing heat to district heating networks and for industrial processes. Improving energy efficiency is a key topic in manufacturing plants. Many companies also generate significant amounts of waste heat from different areas and processes, with much of this remaining unused up to now. However, in industry and commerce heat pumps are still rarely used at the present time. Of the 61,677 heat pumps installed in Austria in 2022, only 131 of these were industrial heat pumps.[1]

The **IEA Heat Pumping Technologies Programme** includes a project specifically dedicated to the topic of **High-temperature Heat Pumps (Annex 58)**[2]. This is focused on heat pumps with supply temperatures above 100°C.

Expertise from the member countries is processed in a structured manner in order to gain an overview of the technological options available with high-temperature heat pumps. Integration of heat pump systems into different industrial processes is a key topic.

Descriptions are being developed of high-temperature heat pump concepts for selected industrial processes (e.g. brick drying or steam generation) in order to help potential end users and answer their questions on the applicability of the technology in their processes. Examples are also collected and published showing the large variety of heat pump technologies available on the market as well as demonstration projects in the high-temperature range.

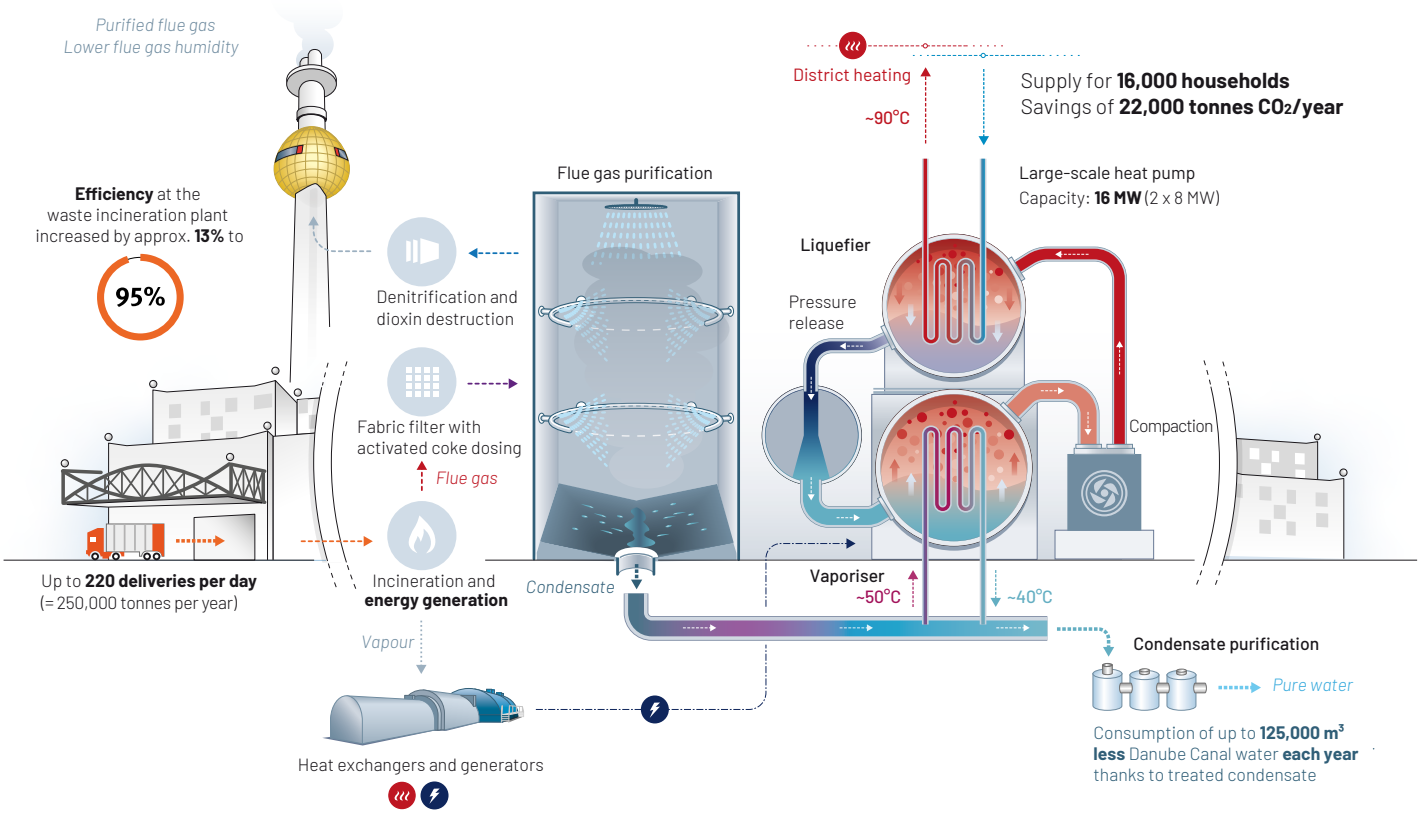
Guidance is also being developed to support companies in developing their decarbonisation strategy. Heat pumps have major potential here, as the technology is both a way to increase efficiency as well as a measure for electrification.

nachhaltigwirtschaften.at/en/iea/technologyprogrammes/hpp
nachhaltigwirtschaften.at/en/iea/technologyprogrammes/hpp/iea-hpt-annex-58.php

[1] Innovative energy technologies in Austria: Market development in 2022, Federal Ministry for Climate Action, Environment, Energy, Mobility, Innovation and Technology (BMK)
[2] **Participating countries:** Austria, Belgium, China, Canada, Denmark, France, Finland, Germany, Netherlands, Japan, Norway, South Korea, Switzerland, USA

Construction of a large-scale heat pump at the Spittelau waste incineration plant in Vienna, photos: Wien Energie/Johannes Zinner

Large-scale heat pump in Spittelau - decarbonisation of district heating



Source: Wien Energie/APA-Grafik on demand

National project: Large-scale heat pump – Spittelau waste incineration plant

Vienna's district heating system is already considered to be a pioneering model for environmentally friendly heating. The plan is for 56% of heating requirements in Vienna to be covered by district heating by 2040. Wien Energie's aim is for 100% of the heat that it produces to be climate-neutral by then, using resources that include large-scale heat pumps and geothermal energy. The third large-scale heat pump with a capacity of over 10 megawatts is currently being built at the Spittelau waste incineration plant. The state-of-the-art 16 megawatt plant will supply 16,000 households with climate-friendly district heating from spring 2025, thereby saving around 22,000 tonnes of CO_2 per year.

Waste heat from flue gas purification

Wien Energie uses the Spittelau waste incineration plant to generate electricity and heat for households in Vienna. The incineration process produces flue gases that are filtered and purified as part of a multi-stage process. The pollutants from the flue gas are bound in water, then the water is purified, cooled and discharged back into the Danube Canal. The waste heat remaining in the flue gas is released into the air via the chimney. Starting in 2025, Wien Energie will use heat pumps to utilise this waste heat for the district heating system. With the help of heat exchangers, the energy will be extracted from the condensate (water) produced when the flue gas is cooled and then utilised in the highly complex system to generate heat at around 90 degrees Celsius for Vienna's district heating network.

A highly efficient process

Wien Energie is increasing the efficiency of the entire waste incineration plant by around 13% to over 95% through use of the heat pumps. This means that almost all of the necessary energy for the process is also utilised efficiently. Once the heat energy has been extracted, the cooled water from the flue gas condensation is treated and fed back into the waste incineration plant process. This saves water resources, as Wien Energie needs up to 125,000 cubic metres less water per year from the Danube Canal for the waste incineration process as a result.

www.wienenergie.at/blog/fernwaerme-zukunft

The project is part of the "Thermaflex" lead project and is being implemented as part of the Green Energy Lab research initiative.
greenenergylab.at

KEY DATA FROM THE SPITTELAU LARGE-SCALE HEAT PUMP

- Construction started in the spring of 2023
  commissioning scheduled for early 2025
- Plant capacity: 16 megawatts thermal
  (two heat pumps at 8 MW each)
- It will supply around 16,000 households in Vienna
- Savings of around 22,000 tonnes of CO_2 per year
- EUR 40 million investment

Photos: HELLA Sonnen- und Wetterschutztechnik GmbH

Cooling buildings

Energy-efficient and climate-neutral technologies

Space heating, cooling, lighting and hot water in buildings account for around 30% of total energy consumption in the IEA countries. The **IEA Energy in Buildings and Communities Technology Collaboration Programme (EBC)** is aimed at using research and innovation for integration of energy-efficient and sustainable technologies in the building sector. Austria has been represented in the EBC programme since 2006 and collaborates in research in the following topic areas:

> Energy efficiency and sustainable technologies for energy supply in buildings
> Ventilation and indoor air quality in buildings
> Impact of energy use on indoor air quality and health
> Development and comparison of building simulation programmes
> Energy management systems for buildings and communities
> Community and regional energy supply concepts

nachhaltigwirtschaften.at/en/iea/technologyprogrammes/ebc

The **Resilient Cooling of Buildings project (IEA EBC Annex 80)** is concerned with sustainable, affordable and energy-efficient air conditioning for buildings. One important aspect involves increasing the resilience of buildings to extreme weather events such as heatwaves and power outages and ensuring healthy conditions for building users. There are already numerous innovative solutions in this sector, such as solar control coatings (cool materials), shading, ventilative and adiabatic cooling, thermally activated building systems, phase change materials (PCMs) and geothermal probe fields. However, the broad-based application of these concepts often fails due to real-life and economic obstacles. Awareness of policy makers need to be raised and suitable performance indicators implemented in norms and standards.

Various other technologies with potential for future cooling of buildings are currently still in development. These include advanced glazing technologies, micro-cooling, individual comfort controls, electrostatic air purification, combinations of comfort ventilation and ventilative cooling as well as high-efficiency vapour compression machines and absorption chillers. The systematic collection and pooling of international research expertise and transfer of knowledge among the participating countries[1] are aimed at supporting and promoting the further development, widespread distribution and implementation of the various cooling strategies. Austria is leading the research project. Participation in such international collaborations plays a role in developing Austrian expertise further in the sustainable building cooling sector, raising its profile internationally and opening up new markets.

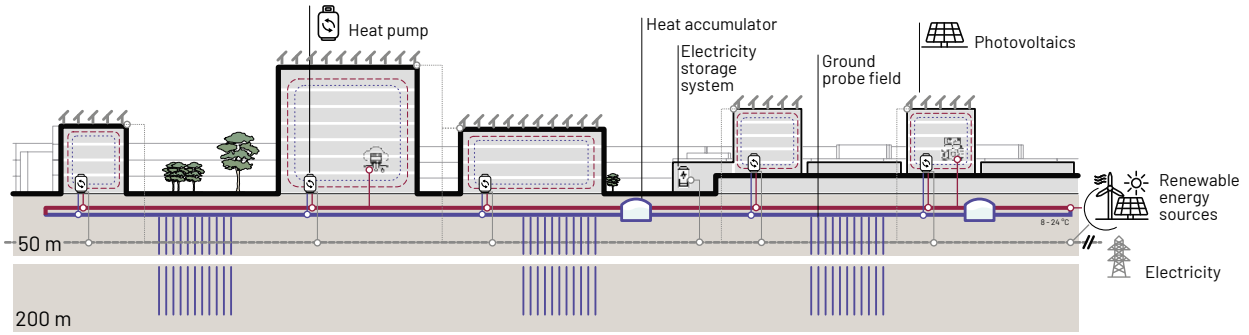
The following results have been achieved so far:

> The current state of the art of a large number of building-related cooling technologies was ascertained and published in the State of the Art Review (SOTAR).[2]
> The resilience of these cooling technologies was analysed using defined key performance indicators and summarised in technology profile sheets. A design guideline has been written for resilient cooling of buildings and this will be published in the spring of 2024 in cooperation with REHVA.
> The performance of selected technologies in practice was surveyed based on national and international case studies and summarised in the Field Studies Report.[3]

The international consortium under Austria's leadership is seeking a follow-up project on cooling in cities and urban neighbourhoods. The Executive Committee has already approved the plans to prepare a project proposal.

nachhaltigwirtschaften.at/en/iea/technologyprogrammes/ebc/iea-ebc-annex-80.php

[1] **Participating countries:** Australia, Austria, Belgium, Brazil, Canada, China, Denmark, France, Italy, Norway, Singapore, Sweden, Switzerland, Türkiye, USA, United Kingdom
[2] www.building-research.at/10.52776/COXK4763
[3] www.building-research.at/10.52776/JIIT7246



Supply of cooling and heating scenario based on an anergy network, Illustration: Graz University of Technology, Institute of Thermal Engineering

National project: COOL-QUARTER-PLUS

Greenhouse gas-neutral cooling for office and research quarters

Rapid city growth and the impact of climate change are resulting in a global increase in cooling requirements in the building sector. Decentralised individual air-conditioning units require a lot of energy and often have poor efficiency levels. They also cause considerable noise pollution and spoil the appearance of building façades. The COOL-QUARTER-PLUS project[1] involves the development of new solutions and concepts for the centralised cooling of buildings and entire urban quarters. The project is focused on office and research quarters, as it is easier to implement measures controlled centrally here than is the case in residential buildings and mixed-use quarters due to the ownership structure and operational management.

Emissions-free operations

The new cooling concepts are intended to be operated without greenhouse gases wherever possible. The cooling is produced primarily based on electricity that is generated on site from photovoltaics. The spectrum of cooling systems ranges from centralised building solutions to semi-centralised pooling of photovoltaics or cooling generation, to systems that are fully centralised in the respective neighbourhoods. The concepts are reproduced as a dynamic model and analysed with regard to their energy-related system behaviour. Based on this, the simulation results are compared with long-term measurement data from a real-life example neighbourhood.

Adaptation to user requirements

The system must be adapted to closely reflect user requirements so that the cooling systems can be operated as efficiently and effectively as possible. Information from existing systems is analysed for this purpose using machine learning. The plan is to enable direct feedback from users in the newly developed systems via a mobile app.

Life-cycle assessments

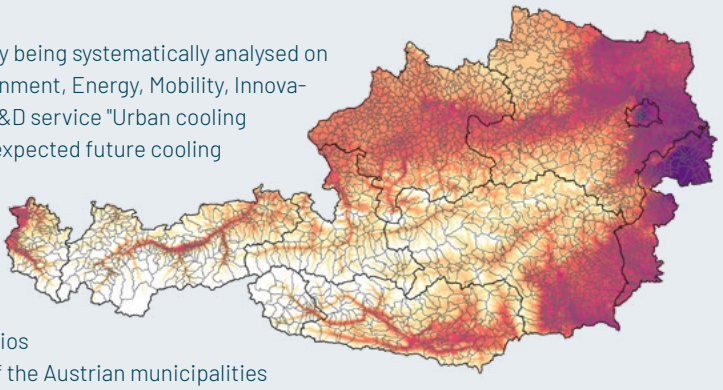
A comparative and dynamic life-cycle cost calculation of the cooling systems is also being done as part of the project. The life-cycle assessment and the differentiation between grey and operational greenhouse gas emissions form the basis for a holistic evaluation of the concepts and the associated building-related measures.

nachhaltigwirtschaften.at/en/sdz/projekte/cool-quarter-plus.php

[1] **Project partners:** Graz University of Technology - Institute of Thermal Engineering (project management), Graz University of Technology - Institute of Software Technology/Institute of Electrical Power Systems/Institute of Structural Design, EQUA Solutions AG, simulation services technical solutions GmbH, TB-Starchel Ingenieurbüro GmbH

URBAN COOLING DEMAND IN AUSTRIA 2030/2050

The increasing demand for cooling in Austria is currently being systematically analysed on behalf of the Federal Ministry for Climate Action, Environment, Energy, Mobility, Innovation and Technology (BMK) within the framwork of the R&D service "Urban cooling Demand in Austria 2030/2050" (UKÖ 2030/2050)[2]. The expected future cooling demand in the residential and office building stock is being quantified for the years 2030, 2040 and 2050 against a background of different regional climatic conditions, the typological building and settlement structures in Austria and the different comfort requirements. In addition, the cooling demand from the scenarios developed is being located geographically at the level of the Austrian municipalities in cooling-demand maps. Target group-specific conclusions and recommendations for action will be developed for decision-makers based on these findings in order to support the development and implementation of climate protection measures and climate change adaptation strategies.



Cooling degree days on a 1 km x 1 km grid in 2030, Image: BOKU IRUB/Lore Abart-Heriszt

nachhaltigwirtschaften.at/en/sdz/projekte/urbaner-kaeltebedarf-in-oesterreich-2030-2050.php

[2] **Project partners:** Institute of Building Research & Innovation ZT GmbH (project management), Vasko + Partner ZT-GmbH, BOKU Institute of Chemical and Energy Engineering, BOKU Institute of Spatial Planning, Environmental Planning and Land Rearrangement

Hybrid energy networks

New concepts for energy storage systems

The **IEA District Heating and Cooling Technology Collaboration Programme** was founded as far back as 1983 in order to generate expertise on the efficient operation of heating networks and combined heat and power (CHP) systems and disseminate this internationally. The heating sector currently faces some major challenges. The heating networks need to be developed further and made more flexible so that they can integrate large quantities of renewable energy from different sources and at different temperature levels in the future.

nachhaltigwirtschaften.at/en/iea/technologyprogrammes/dhc

The **Hybrid Energy Networks project (Annex TS3)**[1] involves research into new concepts for district heating and cooling networks, such as the incorporation of high-efficiency heat pumps and storage systems. Sector coupling, i.e. linking the electricity, district heating/cooling and gas grids, is a key element in decarbonising the energy system. Energy is transferred with this from one sector to another via various coupling points (combined heat and power, power-to-heat and power-to-gas). This makes it possible to exploit synergies and optimise the entire energy system. Intelligent control and regulation strategies as well as flexible storage system capacities play a key role here. The potentials and challenges of hybrid energy networks are being analysed as part of the IEA project from the perspective of the district heating and cooling system, with tools and methods also being developed and evaluated. Case studies are also being collected while appropriate business models and framework conditions are being developed.

nachhaltigwirtschaften.at/en/iea/technologyprogrammes/dhc/iea-dhc-annex-ts3.php

[1] **Participating countries:** Austria (lead), Belgium, Denmark, France, Germany, Sweden, United Kingdom

National project: SEKOHS Theiss

Powerful hybrid energy storage system

An innovative energy storage approach is combining different storage technologies in a hybrid system. The SEKOHS Theiss project aims to develop and demonstrate such a storage system – combining thermal and electrical storage – in the field for the first time.

The project combines a large thermal storage system, which is fed by a 5 MW electric heating system and a 5 MW battery storage system with a capacity of 6 MWh. A photovoltaic system connected to the battery storage system will be installed at the location. This system makes it possible to use synergy effects from the provision of ancillary services and the district heating supply. The innovative concept is currently validated by the project partner EVN Wärmekraftwerke GmbH in extensive field tests at the Theiss power plant in Lower Austria. Artificial intelligence methods are used to achieve an optimized system operation. The optimization measures include extended photovoltaic generation forecasts and intelligent storage system monitoring concepts.

This project will provide essential insights into the technical, economic and regulatory aspects of hybrid storage systems, enable an evaluation of the concept and identify potential for the transfer to other areas.

50,000 m³ thermal energy district heating storage in Theiss, photo: C.Stadler/Bwag

greenenergylab.at/en/projects/sekohs-theiss

[2] **Project partners:** TU Wien, Energy Economics Group (project management), AIT Austrian Institute of Technology GmbH, EVN AG, EVN Wärmekraftwerke GmbH (demo project management)

The project is being implemented as part of the Green Energy Lab research initiative. greenenergylab.at

Photo: stock.adobe.com

Social acceptance

The users' perspective

To really decarbonise the energy systems we will need more than just new technologies and far-reaching organisational changes. Social acceptance and people's participation in the energy transition also play a key role. Technical and social innovations must work together to bring about long-term and sustainable changes. Limited research has been done to date on how the transformation process will affect society and how the new technologies will be accepted and utilised by people.

The **IEA User-Centred Energy Systems Technology Collaboration Programme (UsersTCP)** was launched in 2019. Its aim is to provide insights from socio-technical research on the design, social acceptance and usability of clean energy technologies. Knowledge concerning users' needs and behaviour is essential in order to develop successful strategies for a clean, efficient and safe energy transition. In the 2020-2025 period, the UsersTCP is focused on topics centring around user behaviour and where it plays a key role in determining energy consumption and flexibility in energy systems.

nachhaltigwirtschaften.at/en/iea/technologyprogrammes/users

"Social License to Automate"

Smart home applications enable energy to be used more efficiently and energy consumption to be reduced through smart control. Automated load shifting (demand side management) can be used to offset fluctuations in the power grid and improve grid flexibility. The IEA "Social Licence to Automate" project was focused on the conditions under which households and municipalities are prepared to allow this automated control. The **follow-up project SLA 2.0**[1] now involves experts examining how consent for automation can be supported with inclusive and community-based approaches. It focuses on three aspects:

> Gender and diversity factors: what role do they play in increasing the flexibility of energy consumption?
> Community effects: how can energy communities help promote a social licence to automate?
> Focus on data: analysis of consumer load profiles to derive flexibility markers and data quality criteria from them.

nachhaltigwirtschaften.at/en/iea/technologyprogrammes/users/iea-users-annex-sla2.0.php

[1] **Austrian project partners:** AIT Austrian Institute of Technology, Energy Institute at the Johannes Kepler University Linz, University of Applied Sciences Technikum Vienna
International partners: University College Cork (Ireland), Delft University of Technology (Netherlands), NTNU Norges teknisk-naturvitenskapelige universitet (Norway), Chalmers University of Technology (Sweden), UIG Université de Genève (Switzerland), Western Sydney University (Australia)

National project: Producing & sharing energy in solidarity

The "Energy with Spirit" flagship project brings together partners from business, science, research and the evangelical diaconal sector in order to implement a renewable energy community based on solidarity. The Bad Goisern evangelical boarding school (Upper Austria) and Donaustadt evangelical secondary school in Vienna are fixed starters and front runners. They both produce and consume clean energy. As well as benefiting the organisations that are taking part, the energy produced will also be passed on to socially disadvantaged and poverty-stricken households as well as people receiving basic care services and working poor people in the spirit of solidarity. In specific terms, this means that 10% of the energy produced in kilowatt hours or 10% of the profit generated in euros is earmarked for this purpose. The project aims to raise awareness of energy issues among all participants and demonstrate through co-creation and energy-related education how socially disadvantaged user groups can be integrated into the energy transition.

energywithspirit.at

Photo: energywithspirit.at

Bioenergy

Environmentally-friendly use of biogenic raw materials



Photos from L to R: WoodK+/Hartwig Zögl, Waldhör KG, Christof Industries

Bioenergy technologies are an important pillar of renewable energy supply. Biomass is obtained in this process from organic material (crops, plant waste and biowaste as well as animal waste products) and used to generate green electricity, heat or fuels. Bioenergy currently accounts for 55% of renewable energy sources in Austria.[1]

It must be remembered with the use and further expansion of bioenergy that biomass as a raw material is not available in unlimited quantities. Biomass resources must be utilised in an environmentally friendly way and with maximum efficiency in order to ensure sustainable usage.

The **IEA Bioenergy Technology Collaboration Programme** brings together experts from research, administration and business from 25 countries and the EU who work to support the dissemination of environmentally friendly, socially accepted and competitive bioenergy systems in all energy markets.

It is focused on initiating, coordinating and promoting research, development and trial projects and the targeted exchange of information on the topic of bioenergy. The topic areas addressed include biomass resources, supply systems, conversion, end products, as well as interdisciplinary topics along the entire value chain. The latest topics to be added include the production and conversion of microalgae and macroalgae as well as artificial photosynthesis.

nachhaltigwirtschaften.at/en/iea/technologyprogrammes/bioenergy

[1] www.biomasseverband.at

[2] **Participating countries:** Austria, Belgium, Canada, China, France, Germany, India, Italy, Netherlands, Sweden, United Kingdom, USA

The **Gasification of Biomass and Waste project (Task 33)**[2] involves collecting information on the production and utilisation of renewable heating and synthesis gases from biomass and waste and sharing this between the participating countries. The gasification of biomass means the production of combustible gases through the thermochemical processing of biomass. Solid biogenic substances are broken down thermally in this process using thermal energy and a gasification agent before being converted into a product gas. The product gas can be directly combusted in gas engines for production of power and heat or it can be cleaned and conditioned to result in syngas, which is used for production of renewable gaseous and liquid fuels and chemicals.

The project is focused on information exchange on production of power, heat, biofuels, biochemicals, SNG and hydrogen through biomass and waste gasification. Combined heat and power remains a relevant topic in the biomass gasification sector, especially in the low capacity range (500 kW). The high capacity range from 5 MW is now more heavily focused on the production of biofuels and biochemicals. Biochar is also relevant. It is produced as a by-product of gasification and has potential applications that are also being examined. The working period until 2024 covers the following priority areas:

> Gasification for combined heat and power
> Synthetic natural gas via gasification
> Production of biofuels
> Production of biochemicals
> Hydrogen production
> Gasification as CO_2 storage technology

Informational data sheets have been compiled for the topics of synthesis gases, biofuels, biochemicals, hydrogen and combined heat and power. These can be found on the project website. The website also includes a database with a list and description of 160 systems at the present time (globally).

task33.ieabioenergy.com/database

The new technology is currently being evaluated and optimised as part of test runs on a prototype.

Biochar from the test runs at the test facility, photo: BIOS BIOENERGIESYSTEME GmbH

National project: BC4I – Biochar for industry

The metallurgical industry is responsible for a significant proportion of global CO_2 emissions. One possible option for reducing emissions is to replace the fossil carbon used to date with CO_2-neutral biochar. This approach is being examined in the BC4I project[1], with a new process being developed for combining decentralised biochar production with high-efficiency generation of green electricity and heat from the pyrolysis gases released during the process. The core components of the innovative concept are a pyrolysis gas reactor based on the counterflow principle, which provides virtually dust-free pyrolysis gas, and a multi-stage pyrolysis gas reforming system for efficient break down of the tars contained in the gas.

High level of efficiency

The aim in developing the new process is to generate green electricity and heat from low-cost biomass with an energy conversion efficiency higher than previously achieved (>90%). Around 30 per cent by weight of the dry matter of the biomass used is converted into biochar in the pyrolysis reactor (this corresponds to around 52% of the fuel energy input), with the remainder leaving the reactor as pyrolysis gas. Part of the pyrolysis gas is then burned in an ultra-low-emission gas burner in order to provide the heat required for the thermal tar conversion and pyrolysis process. The main share of the pyrolysis gas is converted into heat and electricity in a gas engine. Following, around 29% of the fuel energy input can be utilized as district or process heat and 10% as electricity. Together with the energy content of the biochar, this results in an overall efficiency level of more than 90%.

Gas purification

The pyrolysis gas released from the fuel bed has a high tar content of between 200 and 300 g/Nm^3. The tars in the gas are removed by a novel reforming process covering a thermal and catalytic cracking step. The aim is to reduce the tar content by more than 99% so the pyrolysis gas can then be used in a gas engine without requiring any further purification.

Potential for industry

The biochar produced can be used in the metallurgical industry directly or after further processing. Biochar is primarily of interest for medium-sized metallurgical companies where switching to H_2 as a reducing agent and/or alternative processes are not possible or are too cost-intensive. This includes operators of electric arc furnaces, rolling processes, shaft furnaces and related processes. A complete switch from fossil carbon carriers to biochar could save up to 71,000 tonnes of CO_2 per year in this sector in Austria.

www.nefi.at/en/project/bc4i-biochar-for-industry

[1] **Project partners:** BIOS BIOENERGIESYSTEME GmbH (project coordinator), Catator AB, The University of Leoben – Chair of Nonferrous Metallurgy, Polytechnik Luft- und Feuertungstechnik GmbH

The project is part of the NEFI (New Energy for Industry) model region, which is promoting the decarbonisation of industrial companies driven by innovation and technology development. nefi.at

Pyrolysis reactor with thermal-catalytic tar reforming, photo: BIOS BIOENERGIESYSTEME GmbH

Pyrolysis gas cooler and gas burner at the test facility, photo: BIOS BIOENERGIESYSTEME GmbH

Photo: stock.adobe.com

Areas of flexibility in the energy system

Potentials and market mechanisms

The switch to renewable energy sources, the increase in decentralised electricity generation and storage and the growing demand for energy services based on electricity represent major challenges for the grids. Smart grid solutions are an important component in the integrated energy system of the future. A "smart power grid" enables the generation, distribution and consumption of electricity to be coordinated in an ideal way in order to ensure a flexible and secure energy supply. Smart grid technologies provide solutions for these types of intelligent networks that connect all stakeholders in the energy system and achieve efficient interaction through smart control. Many individual solutions for intelligent energy systems have been developed in recent years. These now need to be incorporated into an integrated overall energy management system that combines market, customer and grid-related requirements.

The **International Smart Grid Action Network (ISGAN TCP)** is an important tool in terms of developing and sharing expertise on smart, clean, flexible and resilient power grids. The aim is to develop smart grid technologies even further and broaden their use regionally, nationally and globally. The programme provides a platform for linking stakeholders from administration, research institutions and companies. Policy recommendations are also developed in this context on a regular basis. Austria is represented in various working groups.

nachhaltigwirtschaften.at/en/iea/technologyprogrammes/isgan

The **ISGAN Working Group 9**[1] addresses "flexibility in the electricity supply system" and the associated market mechanisms. Flexibility in the context of electricity supply refers to the option of changing the feed-in or withdrawal at a defined grid node of the electricity system via a prompt change in response to external signals. Flexibility is required in order to maintain or restore stability in the electricity system, e.g. in the event of fluctuating electricity generation from renewable energy sources, through flexible responses to conditions that are changing constantly.

The following topics are just some of those addressed in the project: identification and definition of flexibilities, issues regarding the integration of the trade in flexibilities, requirements of different market participants, as well as the development and scaling of interoperable flexibility markets. The Task 4 "Operational Planning" is led by Austria.

[1] **Participating countries:** Austria, Belgium, Canada, India, Japan, Republic of Korea, Sweden, United Kingdom

Project goals:

> Cross-country definitions and characterisations of flexibility markets
> Definition and understanding of local flexibility markets
> Comparison of the methods between different approaches
> Understanding of the interaction between different flex markets (redispatch, balancing energy, spot markets)
> Potential for local flexibility markets to support the distribution network
> Identification of best practices and contributions towards standardising flexibilities

nachhaltigwirtschaften.at/en/iea/technologyprogrammes/isgan/iea-isgan-working-group-9-workingperiod-2021-2023.php

Photos: stock.adobe.com

National project: Industry4Redispatch

The power grid will need digitalised and interconnected systems that enable the optimal use of flexibility in order for renewable energy to be used to a greater extent. The Industry4Redispatch project is a key project of the NEFI model region that focuses on the control of industrial energy supply systems.[1]

The primary goal is to allow industrial plants to respond flexibly to redispatch needs. In electricity trading, "redispatch" refers to interventions made to adjust the power feed-in of power plants at the request of the transmission system operator. The aim is to avoid or eliminate regional congestions for individual operational assets in the transmission system.

All necessary technical, regulatory, economic and organisational requirements for provision of redispatch, the necessary interaction as well as the optimisation and control between transmission system operators (TSOs) and distribution system operators (DSOs) are being investigated as part of the project.

Innovative solutions to support the grid are being developed that enable trials of an online, predictive and holistic control concept for industrial energy supply systems. The new technologies are intended to optimise participation in the market by companies and at the same time secure their energy supply.

Redispatch module

All relevant stakeholders are working closely together in the project to find an integrated solution for the automation and optimisation of the industry. The innovative redispatch module will be developed based on standardised requirements and trialled in a proof of concept. The module is aimed at utilising unused flexibility for industrial customers to provide redispatch in compliance with the requirements from the DSOs. The redispatch concept will be trialled and tested at various industrial plants in order to address the needs of industrial customers with differing levels of maturity in their automation systems.

Transformation guidelines

The final deliverables will be a step-by-step guide to transforming a conventional industrial energy supply system into a more flexible and more highly decarbonised system with optimum operations as well as the guidelines for the TSO-DSO coordination process.

nefi.at/en/project/industry4redispatch

[1] **Project partners:** AIT Austrian Institute of Technology (project management), Ankerbrot GmbH, APG Austrian Power Grid, Energie Kompass GmbH, Energienetze Steiermark GmbH, EVN AG, evon GmbH, kleinkraft OG, Mondi AG, Netz Burgenland GmbH, Netz Niederösterreich GmbH, Netz Oberösterreich GmbH, Siemens AG, TU Wien - Institute for Energy Systems and Thermodynamics/Institute of Mechanics and Mechatronics, Control and Process Automation, voestalpine Stahl GmbH, Wiesbauer Holding AG

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INFORMATION

IEA COLLABORATION IN RESEARCH
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