acatech Annual Report 2016

Foreword

Dear readers,

Whether it be in the form of robotic assistants, new ways of producing energy or breakthroughs in biotechnology, technological innovations can significantly improve a society's productivity and living standards. But technology is not neutral – the way it is used must be shaped by policy. Technology can only help a country to modernise and remain competitive if the opportunities and challenges associated with innovative developments are subject to public debate and negotiation.

This was a running theme in the speeches and many of the discussions at the acatech Annual Meeting in autumn 2016. In a powerful address, Federal President and acatech patron Joachim Gauck stressed that it is particularly important to promote receptiveness to new technologies in Germany because of the nation's "deep-rooted tendency to lose confidence at the first sign of any risk".

He praised acatech's efforts to foster dialogue between academia, industry and government as an important contribution to the much-needed development of a better understanding of technology. Going forward, the Federal President encouraged the Academy to keep building bridges with the public and engaging in discussions to identify scientifically sound visions of how Germany can get fit for the future.

acatech continued to develop its dialogue with the public in 2016. On the first Tuesday of every month, we now invite interested parties to the acatech Forum in Munich to discuss topical technology themes with the experts. Advisory groups of actors from civil society form an integral part of our projects. Through its partnership with the recently established Science Media Center, acatech assists journalists with their research by providing them with science-based expertise. This year, we are also expanding our dialogue with the public through joint initiatives with the churches in Germany and adult education centres (Volkshochschulen) in Bavaria.

acatech's events and publications in 2016 also provided an important stimulus to the public policy debate on new technologies. How and to what extent do we wish to use learning machines in the future? Which skills will the workforce need in an increasingly digitalised workplace? How will automation change the road traffic? And do we need to place greater emphasis on joint transport and energy planning? Our focus was on these and other themes where policy decisions will need to be taken sooner rather than later. The digital transformation of our economy and society is happening faster and more radically than many people think.

The new year also brought in change at acatech. After two terms of office, Reinhard F. Hüttl's time as President came to an end in February 2017. We are deeply indebted to him for everything he did to develop the content of

the Academy's work and strengthen the international dimension of our organisation. We are delighted that he will continue to represent acatech on the global stage. The results of a status analysis carried out at the acatech Office in Munich in June 2016 provided a ringing endorsement of our work, which received an overall rating of "excellent" from a team of independent experts. The experts' praise and recommendations are spurring us on in our efforts to continue developing the Academy.

Munich and Berlin, May 2017

Prof. Dr.-Ing. Dieter Spath
acatech Präsident

Prof. Dr. Henning Kagermann
acatech Präsident

Thematic Fields

Technologies

Digital connectivity is bringing about a rapid and radical transformation of our economy. It promises efficient processes, new business models and user-friendly applications – the opportunities for German industry are huge. At the same time, it is transforming the workplace and demanding new skills of the workforce. So what changes do industrial and service companies in Germany need to make in order to maintain their global leadership in the face of this technological transformation?

Are partnerships more important now than ever before? Which new skills must the workforce acquire? And how should autonomous systems be designed to ensure their social acceptance? acatech is involved in several projects to analyse topical issues connected with the technological transformation of our economy and provide recommendations for policymakers.

Industrie 4.0: Developing the strengths of German industry

In the future, business processes such as supply, manufacturing, maintenance, delivery and customer service will all be connected via the Internet. Rigid value chains are being transformed into flexible global value networks. According to the findings of an international benchmarking study published by acatech and partner organisations in June 2016, Germany is well placed to implement the Industrie 4.0 transformation compared to other countries around the world and could even become a leading market and leading supplier by 2030. The strong points of German industry lie in its innovative manufacturing sector, its strengths in the field of business IT and its established know-how in the relevant key technologies. In order to remain competitive, it will need to build on these strengths, making use of venture capital, Internet technologies and innovative, data-driven business models.

Photo: Annegret Hultsch Fotografie

"We live in a time of unique opportunities. Our vision of networked production and production-related services can become a global standard. This will allow Germany to strengthen its position as a leading manufacturing nation and industrial equipment supplier."

Georg Schütte, State Secretary at the Federal Ministry of Education and Research (BMBF), receiving the Industrie 4.0 benchmarking study from acatech Executive Board member Günther Schuh at the BMBF manufacturing congress in Berlin in June.

But it is users' needs, not products and machines, that are at the centre of Industrie 4.0. This means that data will be critical to success and digital platforms will become key marketplaces. Customised solutions can be created by combining customer and product data. **In order to accelerate the development of digital platforms, companies must collaborate in digital ecosystems**. acatech published examples of successful implementations in its report *Smart Service Welt* that was launched at the Hannover Messe 2016.

New forms of cooperation and harmonised norms and standards are essential for value creation in global networks. Many companies, particularly specialised SMEs, are concerned about how data and intellectual property can be effectively protected in this context. The acatech STUDY *Industrie 4.0 in a Global Context*, which was launched in November at a Münchner Kreis symposium, provides them with country-specific background information to assist them in their negotiations with international partners.

European Commissioner for Digital Economy and Society Günther Oettinger with acatech President Henning Kagermann and Academy Member Michael Dowling at the presentation of the acatech STUDY Industrie 4.0 in a Global Context. Photo: acatech

Digitalisation will also bring about profound changes in industrial work processes. **Developing the workforce's skills and training them to perform new tasks will be key to the successful implementation of Industrie 4.0, especially in SMEs.** The acatech POSITION PAPER *Kompetenzen für Industrie 4.0* provides recommendations for all the relevant education partners about how to adapt training and professional development to the requirements of digitalisation.

Photo: Presse- und Informationsamt der Bundesregierung

"Managers need to stop micromanaging organisational processes, while employees must acquire new skills. In Germany, we have both the ideal conditions for this transformation and the right competencies in our companies. By delivering the appropriate training for the business environment and workplace of tomorrow, we can ensure that the transformation is a positive one."

Federal Minister of Education and Research Johanna Wanka at the presentation of the acatech POSITION PAPER *Kompetenzen für Industrie 4.0* at the National IT Summit in Saarbrücken in November 2016

INDUSTRIE 4.0 SCIENTIFIC ADVISORY COMMITTEE: At the 2015 Hannover Messe, the Plattform Industrie 4.0 was expanded to include a wider range of political and social actors. Since then, under the leadership of the Federal Ministry of Education and Research (BMBF) and the Federal Ministry for Economic Affairs and Energy (BMWi), it has broadened its remit to cover the security of networked systems, the regulatory framework and training and professional development. In support of the new structures, since January 2016 the Scientific Advisory Committee's 20 members have been working even more closely with the Plattform Industrie 4.0 and its working groups.

Autonomous systems: Valuable assistance governed by clear guidelines

Connected digital systems are also finding their way into other areas of our lives. In the field of healthcare, self-learning robots can provide support for patient treatment and care. Self-driving vehicles can make transport and logistics systems safer, more efficient and more sustainable, while smart buildings use autonomous systems to reduce their energy consumption. Under the chairmanship of acatech President Henning Kagermann, the Expert Panel Autonomous Systems investigates the opportunities, risks and societal impacts of autonomous systems and advises the German government on the implementation of its High-Tech Strategy.

At the 2016 Hannover Messe, Federal Minister of Education and Research Johanna Wanka learned about the autonomous robot prototypes developed by the Expert Panel Autonomous Systems. Photo: Svea Pietschmann

In its interim report published in April 2016, it concludes that, despite their capabilities, in many situations autonomous systems lack the common sense and intuition to replace human beings. Humans will continue to set the goals which the machines will then deliver by planning and executing the necessary steps increasingly autonomously within their own scope of action. The success of autonomous systems thus ultimately depends on their social acceptance.

Automobility of the future: Scenarios and roadmap

Mobility is one of the most exciting fields of application for autonomous systems. The acatech STUDY *Neue autoMobilität*, published in December 2016, contains concrete semi-automated and fully automated driving scenarios and an implementation roadmap that show how connectivity and automation can improve road traffic flows and road safety between now and 2030. In addition to investing in infrastructure and research, it will also be necessary to establish test sites in real road traffic settings. If (semi-)automated driving can be shown to work in this environment, public confidence in this technology is likely to grow. Regulations such as the Road Traffic Act and vehicle licensing laws will also need to be updated.

Target image of the automated road traffic of the future. Source: acatech

Personalised medicine: The theme of the acatech Academy Day

Digitalisation also promises huge advances in the field of medicine. The combination of modern technology and big data enables personalised diagnosis and treatment, increasing the options available to practitioners and thus improving the chances of successful outcomes. Participants in the acatech Academy Day held in Hannover in May 2016 discussed the key challenges, including data security, data privacy and patient control over their personal data.

Photo: David Ausserhofer

"Communication between experts from the widest possible range of disciplines and members of the business community and the public is absolutely key to innovation, particularly in the field of healthcare. Germany's scientific academies, especially acatech, help to promote this important dialogue."

Gabriele Heinen-Kljajić, Minister for Science and Culture of the Lower Saxony state government, at the acatech Academy Day in Hannover in May 2016

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acatech projects in the thematic field of Technologies in 2016

Completed projects	
Smart Maintenance for Smart Factories	Dec. 2014 - May 2016
Industrie 4.0 – International Benchmark	Jan. 2014 - June 2016
Industrie 4.0 in a Global Context – Strategies for Cooperating with International Partners	July 2015 - June 2016
Skills Development Study Industrie 4.0	June 2015 - Nov. 2016
Cooperation Opportunities for Development Cooperation & the Private Sector in the Field of Technology and Know-how Transfer in Emerging Economies (Brazil)	May 2016 - Nov. 2016
Workshop series: Industrie 4.0 – The Future of Industrial Work	Dec. 2014 - Nov. 2016
open.acatech.de (Massive Open Online Course “Industrie 4.0”)	June 2015 - Nov. 2016

Ongoing projects	
Additive Manufacturing (in partnership with Leopoldina and the Berlin-Brandenburg Academy of Sciences and Humanities; lead institution acatech)	Feb. 2014 - Jan. 2017
Industry 4.0 Maturity Index	April 2016 - April 2017
open.acatech.de (Massive Open Online Course “Machine Learning”)	Nov. 2016 - Apr. 2017
Expert Panel Autonomous Systems	Jan. 2016 - June 2017
Framework for the Future of Materials	March 2016 - Nov 2017
Digital Service Platforms	Nov. 2015 - July 2017
Medical Technology and Personalised Medicine	Jan. 2015 - Sep. 2017
InnoKey 4.0	Jan. 2016 - Sep. 2017
Industrie 4.0 Scientific Advisory Committee II	March 2016 - Feb. 2019

Energy, Resources and Sustainability

November 2016 had a strong claim to the title of "climate protection month of the year". This was the month when a new global climate agreement came into force, replacing the Kyoto Protocol. Shortly afterwards, the Federal Cabinet adopted a Climate Action Plan for Germany that was presented by Federal Environment Minister Barbara Hendricks at the Marrakech climate summit.

Since climate protection is not possible without a sustainable, secure and affordable energy policy, acatech is engaging in the debate through a series of projects and events. In March 2016, for example, we began the second phase of the Energy Systems of the Future (ESYS) project, a joint initiative of acatech, the German National Academy of Sciences Leopoldina and the Union of the German Academies of Sciences and Humanities.

Making energy scenarios more transparent

Scenarios often provide the basis for energy policy decisions. The validity of these scenarios can only be evaluated if their outcomes are subject to scrutiny by third parties. However, many institutes do not disclose their data and models. In March 2016, the joint academy project ESYS published guidelines for improved transparency in a document entitled Consulting with energy scenarios which concludes that freely available open-source models would be the best solution. Even if the data forms part of the institute's proprietary assets, it should at least still be disclosed to a panel of independent experts. Public institutions could also provide access to standard reference data so that different scenarios can be compared.

Photo: David Ausserhofer

"Raw material and CO_2 prices are difficult to predict, but assumptions about them can have a major influence on scenario outcomes. These assumptions should therefore be thoroughly documented."

acatech Executive Board member Armin Grunwald, co-chair of the ESYS "Scenarios" working group, on the publication of the position paper *Consulting with energy scenarios*

No energy transition without metals

The success of the energy transition hinges not only on energy policy decisions but also on the availability of raw materials. **Growing quantities of metals and minerals are required for wind farms, solar plants and storage systems.** Published in August 2016, the study *Rohstoffe für die Energieversorgung der Zukunft* describes the interactions between Germany's energy transition, the global raw materials markets and the social and environmental landscape of the mining industry.

Engaging with the public

Both mining projects and projects to upgrade the energy infrastructure can be scuppered by public protests. To what extent does giving the public a say increase acceptance of the energy transition and at what point does it hamper decision-making? And how can individuals contribute to a successful energy transition in their role as consumers? These were some of the questions addressed during the discussion forum "Energie.System.Wende." held in Berlin in September 2016.

ESYS members also engage in regular discussions with experts from government, industry and NGOs at the “trialogues” hosted by the HUMBOLDT-VIADRINA Governance Platform. In July, acatech Executive Board member Eberhard Umbach presented the interim results of a project on “integrated energy” that looks at how best to create linkages between the electricity, heating and transport sectors in order to minimise greenhouse gas emissions.

Different stakeholders in society also want to have their say about the direction of energy research. In order to bring these diverse voices together, the “Energiewende Research Forum” dialogue platform organised a participation process that ran from 2013 to 2015. Its results were fed into the Kopernikus Projects for the Energy Transition research initiative. Federal Minister of Education and Research Johanna Wanka announced the selected consortia at the Energiewende Research Forum before unveiling them to the press in April 2016. A total of 230 research institutions, companies and civil society organisations are developing solutions for new power grid structures, ways of using surplus renewable energy, flexible industrial processes and systems integration.

Moderator Jörg Thadeusz chairing a discussion on public participation in energy issues with Gesine Schwan (Humboldt-Viadrina), Holger Lösch (BDI) and Karl-Eugen Huthmacher (BMBF) at the “Energie.System.Wende.” event. Photo: David Ausserhofer

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Photo: David Ausserhofer

“We will show that a secure, affordable and clean energy supply is possible without sacrificing prosperity and jobs. Between now and 2025, we will be bringing new energy concepts online that can be used on an industrial scale but are also acceptable to society.“

Federal Minister of Education and Research Johanna Wanka announces the Kopernikus projects at the Energiewende Research Forum in April 2016.

Reusing CO_2

It is clear from the above that ideas and research initiatives for achieving a more sustainable energy supply are already well advanced. However, preventing CO_2 from industrial processes – e.g. in cement and steel production – from escaping into the atmosphere is a far greater challenge. Since June 2016, acatech has been investigating Carbon Capture and Storage (CSS) and Carbon Capture and Utilisation (CCU) technologies in a project funded by the European Climate Foundation entitled Technical Decarbonisation Solutions: Methods of Reducing CO_2 in Industrial Processes.

After all, CO_2 contains carbon, which is a fundamental building block of many chemical products. The working group is analysing the **role that Industrial Carbon Capture, Utilisation and Storage (iCCUS) can play in a long-term climate protection strategy for Germany**, with a view to maintaining the competitiveness of German industry in an era of stringent emissions targets.

Left to right: Ulrich Glotzbach (acatech), Jonas Helseth (Bellona Foundation), Alfons Kather (Hamburg University of Technology) and Jürgen-Friedrich Hake (FZ Jülich). Photo: acatech

acatech projects in the thematic field of Energy, Resources and Sustainability in 2016

Completed projects	
Energy Systems of the Future (Phase I)	March 2013 - Feb. 2016

Ongoing projects	
Technical Decarbonisation Solutions: Methods of Reducing CO2 in Industrial Processes	June 2016 - Jan. 2017
Energy Systems of the Future (Phase II)	March 2016 - Feb. 2019
Geothermal Technologies in Metropolitan Areas	Jan. 2017 - June 2018

Education and Skilled Professionals

What will work be like in an increasingly digitalised world? Which skills will we require in the future? The digital transformation of our economy and society was a key theme of the employment and education policy debate in 2016. Following on from the publication of a Green Paper on the subject, the Federal Ministry of Labour and Social Affairs (BMAS) organised a dialogue process with associations and institutions on the topic of "Work 4.0". The outcomes are outlined in a White Paper published in February 2017.

One of the key calls to action formulated with Federal Chancellor Angela Merkel at the 4th National STEM Summit in June was to ensure that digital education forms an integral part of teaching and teacher training. In October, Federal Minister of Education and Research Johanna Wanka launched the Educational Offensive for the Digital Knowledge-Based Society, a strategy for driving the digital transformation right across the education system, from early childhood and school education to vocational training, higher education and continuing professional development. Finally, the Standing Conference of the Ministers of Education and Cultural Affairs unveiled its Education in the Digital World Strategy in December. acatech participated at various different levels in all of these debates.

Education in the digital transformation

Today, the ability to use digital media confidently and an understanding of the forces driving the digital transformation are key requirements for digital literacy and participation in the changes taking place in our economy and society. While schools have an important role to play in helping people to acquire the relevant skills, it is not necessary to teach "digitalisation" as a separate subject in its own right. Instead, it is crucial to provide students with a solid grounding in the STEM subjects that can be applied in practice to the digital world, as well as to ensure that all subjects are given a "digital spin". It is especially important for teaching methods to incorporate basic ways of using digital technology.

acatech Member Kristina Reiss discusses suggestions about digital education with young people at the 4th National STEM Summit. Photo: acatech

As well as basic IT literacy, skills such as entrepreneurial thinking, willingness to embrace change, collaboration and agile working methods are all becoming more and more important. Accordingly, it is necessary for schools and teacher training institutions to forge even closer links with industry and science. acatech made the case for this approach at the 4th National STEM Summit in Berlin in June 2016.

DIGITAL ASSISTANCE SYSTEMS IN THE SMART FACTORY: In the joint project "APPsist – Intelligent Knowledge Services for Smart Production", partners from academia, industry and civil society developed prototypes to demonstrate how smart assistants will be able to help workers keep pace with the digital transformation by providing them with needs-based knowledge on the job. Federal Chancellor Angela Merkel was among those to receive a demonstration during the National IT Summit. In this project, which was funded by the Federal Ministry for Economic Affairs and Energy (BMWi), acatech was responsible for coordinating the advisory board which advised the project partners on strategic issues and formulated recommendations for implementing the project's findings.

The future of work: Providing the freedom to shape change

The digital transformation will bring about huge changes in the value structures of industry and the service sector within a very short space of time. This will include new forms of corporate and work organisation. acatech envisages a positive future for work in which all types of work are equally accepted. Empowered freelancers in particular are becoming increasingly important to employers in the digital world of work. **There is also a need for progressive governance that provides the freedom to experiment and allows a flexible approach to change.** These were the conclusions drawn by the HR directors of several large enterprises during in-depth discussions about the future of work with acatech and the Jacobs Foundation. The results were published in an acatech IMPULSE report that members of the acatech HR Working Group presented to the Minister of State to the Federal Chancellor, Helge Braun, at the Federal Chancellery in April 2016.

Immanuel Hermreck (Bertelsmann), Henning Kagermann (acatech), Helge Braun (Minister of State), Johann C. Jacobs (Jacobs Foundation), Thomas Sattelberger (MINT Zukunft schaffen), Christian P. Illek (Deutsche Telekom). Photo: Bundesregierung, Jochen Eckel

"Against the backdrop of demographic change, digitalisation provides us with an opportunity to compensate for future labour shortages through productivity gains. Getting to grips with digitalisation is therefore critical to securing our competitiveness and the fabric of our society. I would like to thank acatech and the Jacobs Foundation for their thought-provoking insights."

Minister of State to the Federal Chancellor, Helge Braun (3rd from left), receiving the acatech IMPULSE report *Die digitale Transformation gestalten – Was Personalvorstände zur Zukunft der Arbeit sagen*

In order to shape the new world of work, businesses need the chance to trial and experiment with new ways of working. The social partners must work together to identify how good working conditions might be viably regulated in the future. A platform for discussing these issues is provided by the workshop series The Future of Industrial Work that acatech has been running with the Hans Böckler Foundation since 2014. At a workshop on SMEs in the mechanical engineering industry held in June 2016, the managing directors of two companies from North Rhine-Westphalia presented practical examples of how Industrie 4.0 processes had been introduced in their organisations. This was followed by a discussion of digital assistants with representatives of academia, the private sector and the trade unions.

The need to rapidly drive forward the transformation process within companies was also very much to the fore at the annual meeting of the acatech Senate in Munich, where over 70 leading decision-makers discussed "The Future of Work and Management". They concluded that the key to a successful digital transformation is rapid upskilling allied with a management culture that promotes flexible collaboration, decentralised decision-making and entrepreneurship at every level, as well as allowing employees the freedom to develop their creative and innovative potential.

Henning Kagermann (acatech), Joachim Wenning (Munich RE), Ann-Kristin Achleitner (TU of Munich), Christin Eisenschmid (Intel), Christian P. Illek (Deutsche Telekom) and Christian Schlögel (KUKA). Photo: David Ausserh

acatech projects in the thematic field of Education and Skilled Professionals in 2016

Completed projects	
The Laboratory within Engineering Education	July 2012 - Sep. 2016
Advisory board for the project APPsist – Intelligent Knowledge Services for Smart Production	June 2014 - Dec. 2016

Ongoing projects	
Barometer of Young Talents in the STEM Subjects	July 2013 - June 2017
Workshop series: Industrie 4.0 – The Future of Industrial Work	Dec. 2014 - June 2017
Drop-out Rates in the Engineering Sciences	Aug. 2015 - Dec. 2017
National Skills Monitoring (NKM) – Pilot Phase	Feb. 2016 - Dec. 2017
HR Working Group – Forum for HR Directors on the Future of Work	May 2014 - Dec. 2017
Innovation Indicator	July 2015 - Dec. 2017

Technology Communication

Innovations in fields such as artificial intelligence, mobility and medicine promise major improvements for individuals and society as a whole. However, their implementation in the form of products, services or processes requires people to have a receptive attitude towards technology. This is not something that can be imposed on society from above. Instead, it is necessary to provide easy-to-understand and objective information about new technologies, address people's fears – regardless of whether or not they are justified – and carefully analyse their risks, areas of application and limits.

Genome editing is one new technology that has been a source of public controversy during the past year – while it undoubtedly has the potential to revolutionise molecular biology research, its critics see it as meddling with evolution on a massive scale. Another question that was in the spotlight was the extent to which an informed public can and should participate in science and science policy. Through its expert studies and a variety of dialogue formats, acatech works to promote constructive engagement between science and the public on topical technology issues.

Social media: Opportunities and risks for science communication

Science and journalism are two of the pillars of a democratic society. However, the way that science is communicated is changing due to the growing popularity of social media. Social media make it easier for the public to access research results and communicate directly with scientists. However, they also entail risks such as inadequate quality control of publicly available scientific information or even deliberate misinformation. The ongoing second phase of the **joint academy project "Science, the Public and the Media"** has been analysing the importance of social media in science communication. The scientific reports commissioned by the working group were discussed at a public workshop with guests from science, the media and government. The working group used its blog, the workshop and Livestream to invite comments from anyone with an interest in science communication. The final project report will be published in the summer of 2017.

Continuous communication: Innovative formats

acatech is experimenting with a variety of innovative, interactive dialogue formats in order to ensure that different target groups engage as continuously as possible in the debate about technological developments. Together with the Bavarian Academy of Sciences and Humanities, acatech ran a Science Slam at Munich's "Münchner Wissenschaftstage" science festival in November 2016. Each scientist had ten minutes to give a brief presentation of their research and visionary ideas on the topic of water. In September, acatech also hosted two Science & Technology Cafés at the congress of the German Association for the Advancement of Science and Medicine in Greifswald. Visitors had the chance to discuss artificial photosynthesis and nitrogen fixation with the experts.

Another opportunity for face-to-face discussion was provided by the fishbowl event in Munich organised by acatech, the Bavarian Academy of Sciences and Humanities and Leopoldina in October 2016. In this format, guest experts are seated in the middle of the room, as if in a goldfish bowl. Two empty chairs are provided next to them for any participants who wish to come forward and engage them in a public discussion. On this occasion, the topic was the medical opportunities and ethical limits of genome editing.

In June 2016, the Academy launched a new event format called the acatech am Dienstag (acatech on Tuesday) series. Once a month, interested members of the public are invited to the acatech Forum on Munich's Karolinenplatz to discuss topical technology issues with guests from government, academia and industry. The themes covered included everything from big data and human-machine interaction to nanotechnology and the role of art in communicating about new technologies.

Sami Haddadin of Leibniz-Universität Hannover provides participants in the November 2016 "acatech am Dienstag" (acatech on Tuesday) event with a demonstration of the highly autonomous robotic arm Franka that he developed. Photo: acatech

Early engagement with the public: The example of artificial photosynthesis

acatech places particular emphasis on the development of discussion-based communication formats that facilitate early public information and participation. This issue was analysed using the example of experiences in the research field of artificial photosynthesis, with the findings being documented in a report published in 2016. To wrap up the project, students and other interested parties attended a workshop organised by acatech and the Evangelische Akademie Tutzing where they discussed future scenarios for technologies such as algal biotechnology, catalytic fixation of CO_2 and alternative photovoltaics. Experts from academia and industry had the opportunity to present their research initiatives. Following on from this public discussion of the opportunities and risks, acatech is participating in a new joint academy project on the current state of research into artificial photosynthesis and the specific scientific and technological challenges.

Photo: Vandenhoeck & Ruprecht

"Early engagement with the public is very important with new technological developments. As we all found out with GM crops, trying to create acceptance after a technology has already been introduced simply doesn't work. Consequently, we very much welcome the approach that acatech is taking towards artificial photosynthesis by ensuring public involvement from very early on in the technology's development."

Dr. Stephan Schleissing, head of Ethics in Technology and the Natural Sciences at LMU Munich's Institute Technology-Theology-Natural Sciences and freelance associate of the Evangelische Akademie Tutzing.

Making technology communication exciting: Initiatives for the young generation

acatech and Wissenschaft im Dialog (Science in Dialogue – WiD) ran their third three-day training workshop on technology communication at the Deutsches Museum in Munich in July 2016. 18 young professionals from the fields of journalism, PR and science communication worked with experts to produce new technology communication concepts. The workshops addressed how to communicate information about technology in a way that can be easily understood and how to involve the public in the development of new technologies.

During the 2015/16 school year, acatech and the Zeidler-Forschungs-Stiftung ran the first TECHNIKENTDECKER **schools competition**. Pupils from years 5 to 10 in Bavaria were asked to make a short film about a technological device or piece of equipment, a location that played an important part in the history of technology or an example of modern technology in the area where they live. Prizes were awarded to the ten entries that tackled their subject in a particularly creative manner. The competition is designed to promote STEM education and media skills in children and young adults. The 2016/17 competition is currently underway.

In Munich in July 2016, pupils from Schweinfurt Frieden-Mittelschule were awarded first prize in acatech's schools competition for their video about the world's oldest roller dam. Photo: Thomas Effinger

AN INTERDISCIPLINARY APPROACH: acatech has its own working group on basic questions in science and engineering. This interdisciplinary group brings together the expertise of engineers, scientists, technology and science philosophers, technology sociologists, technology historians and economists. It is currently working on a project investigating assessment criteria for the technological sciences and appointments in the technological sciences.

acatech projects in the thematic field of Technology Communication in 2016

Completed projects	
Symposium Industry – Infrastructure – Society	June 2015 - Feb. 2016

Ongoing projects	
Communication between Science, the Public and the Media (Phase 2): Importance, Chances and Risks of Social Media (with the Berlin-Brandenburg Academy of Sciences and the German National Academy of Sciences Leopoldina)	April 2015 - June 2017
Artificial Photosynthesis: Current State of Research, Scientific and Technological Challenges and Technology Futures	Jan. 2016 - Sep. 2017
Assessment Criteria for the Technological Sciences and Appointments in the Technological Sciences	July 2016 - Dec. 2017
Technology Communication – Activities in Bavaria	Jan. 2014 - Dec. 2018
Training Workshop on Technology Communication	Jan. 2014 - Dec. 2018

Work and Results

Innovation policy advice

Technological developments can provide solutions to global challenges such as climate change, demographic change and urbanisation whilst at the same time generating growth, value added and employment at a national level. Innovation is thus key to a country's long-term global competitiveness. Since 2010, acatech has coordinated a dialogue process between government, science, industry and civil society aimed at continuing to strengthen innovation in Germany.

The Innovation Dialogue: Providing expert policy advice to the Federal Government

acatech provides independent expert advice on innovation policy issues through the Innovation Dialogue between the Federal Government, industry and science. The dialogue comprises twice-yearly technical discussions between the German Chancellor, the Federal Minister for Economic Affairs and Energy, the Federal Minister of Education and Research and the head of the Federal Chancellery and 16 representatives of science, industry and civil society. Each meeting focuses on one particular strategic innovation policy issue.

The basis for the discussions is provided by a policy paper that brings together the results of a broad-based stakeholder dialogue with experts from acatech's network and other organisations. The Innovation Dialogue is organised by the acatech Office under the guidance of acatech President Henning Kagermann.

Knowledge transfer: The changing face of a cross-cutting innovation policy challenge

The theme of the Innovation Dialogue held at the Federal Chancellery in May 2016 was modern forms of knowledge, technology and information transfer. Transferring knowledge and technology is a challenge that must be addressed collectively by science, industry and government. Traditionally, it has been understood to involve translating new ideas and developments from science and research into marketable products, for example through patents, collaborative research and spin-offs.

Today, however, the transfer process also operates recursively – **different actors from the fields of basic and applied research as well as industry and civil society all influence each other reciprocally.** This can potentially result in disruptive changes. For instance, the blurring of the boundaries between traditional industries and the IT sector is leading to new partnerships and forms of cooperation between science and industry. The public increasingly sees itself as an active participant in scientific developments rather than a passive recipient of them. This is changing the nature of science communication and resulting in the emergence of concepts such as citizen science. The transfer relationships must therefore be adapted to reflect this changing reality.

Biotechnology: One of the key technologies of the 21st century

Our ability to control biological processes is growing at a spectacular rate. Biotechnology is a key technology that, over the next few years, has the potential to transform many industries and areas of our lives in a manner akin to digitalisation. This was one of the main findings of the Innovation Dialogue with the Federal Government in November 2016. New genome analysis and modification techniques (especially genome editing) will help us find replacements for fossil fuels and develop new medicines e.g. for treating cancer.

Although Germany is very strong in the field of biotechnology research, it needs to get better at translating this strength into commercial and medical applications. Moreover, a number of policy, regulatory and ethical questions still need to be resolved. In order to take full advantage of biotechnology's huge innovative potential for Germany, it will be necessary to engage in a comprehensive debate and address the regulatory, ethical and social implications of different applications.

Human-machine interaction: In the public spotlight

Through the Innovation Dialogue, acatech provides the Federal Government with timely expertise and recommendations on issues that are likely to come onto the policy agenda in the near future. One such theme concerns the technological and social aspects of human-machine interaction. This topic was addressed by the Innovation Dialogue in November 2015 and was the subject of widespread public debate during 2016. The ARD network looked at the issues from various different angles in a special week of programmes on the "Future of Work". The relationship between humans and robots also attracted a lot of attention from the other major media and was the topic of a podium discussion at the acatech Annual Meeting in October 2016.

Federal President Joachim Gauck called for courage and responsibility in our approach to autonomous systems at the acatech Annual Meeting in Berlin in October 2016. Photo: David Ausserhofer

In his official address, Federal President Joachim Gauck called for us to have the courage to innovate and to be less afraid of the risks. He argued that autonomous systems can provide people with valuable assistance in all kinds of different areas. However, he also warned that people should always “be the masters of technology, not its slaves”.

International Affairs

Sustainable development will only be possible if industry, science and civil society work together as partners. Concrete solutions to global challenges can only be developed by collaborating across national borders. acatech's statutes give it a mandate as Germany's voice on science and engineering both at home and abroad. Accordingly, the Academy raises national issues at both European and international level. Its membership of academy networks, its cooperation with sister academies and other organisations in industrialised and emerging economies and its continuously expanding network of strategic partners ensure that the Academy's national and international work is informed by specific expertise.

European Academies: SAPEA – providing policy advice to the European Commission

SAPEA – Science Advice for Policy by European Academies – was launched in December 2016. Five European academy networks bring together more than 100 science academies from across Europe. **The consortium, which is coordinated by acatech, jointly provides the European Commission with independent, interdisciplinary, science-based policy advice.** SAPEA works within the European Commission's Scientific Advice Mechanism (SAM) that was established by Commission President Jean-Claude Juncker and the EU's Research Commissioner Carlos Moedas in 2015.

Its aim is to ensure the improved and timely incorporation of scientific knowledge into the policymaking process at European level. The consortium partners include the European Council of Academies of Applied Sciences, Technologies and Engineering (Euro-CASE). In December 2016, acatech President Reinhard F. Hüttl was re-elected for a new three-year term as Euro-CASE Chairman. Euro-CASE's work is spread across four platforms on the themes of innovation policy, bio-economy, climate and energy policy and engineering education.

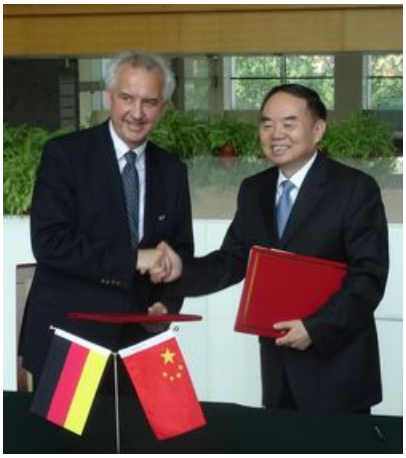
Photo: European Union, 2016, Reference: P-031230/00-10

Launch event with the presidents of the five European academy networks at the European Commission in Brussels in March 2016. Front row (left to right): Reinhard F. Hüttl (Chairman of Euro-CASE), Rolf-Dieter Heuer (HLG), Françoise Meunier (Vice-President of FEAM), European Commissioner Carlos Moedas, Elvira Fortunato (HLG), Julya Slingo (HLG) and Pearl Dykstra (HLG); back row: Sierd Cloetingh (President of Academia Europaea), Günter Stock (President of ALLEA), Janusz Bujnicki (HLG), Jos van der Meer (President of EASAC), Cédric Villani (HLG) and Henrik C. Wegener (Chair of the HLG).

Academies around the world: Technology for social progress

acatech is also active at a global level through its membership of the worldwide Council of Academies of Engineering and Technological Sciences (CAETS). The Academy is a member of the CAETS Energy Working Group which has already produced three reports, the most recent of which is titled *Transitioning to Lower Carbon Economy*. acatech was also involved in the organisation of the CAETS Annual Meeting which was held in London in September 2016. Under the conference theme of "Engineering a Better World", representatives of Government, Academia and Industry explored the role that the technological sciences should play in tackling global challenges.

Strategic network: Cooperation with China, Sweden and Israel



acatech President Reinhard F. Hüttl and the President of our Chinese sister academy CAE, Zhou Ji, agreed to extend the partnership between the two academies. Photo: CAE

acatech also cultivates bilateral relationships with individual science and engineering academies, foundations and think tanks in Europe and the rest of the world. **In 2016, we agreed a three-year extension to our partnership with the Chinese Academy of Engineering (CAE) that began back in 2012.**

Together with the CAE and the Münchner Kreis, acatech organised the symposium “The Digital Transformation of Manufacturing Industries” which was held in Munich in November 2016. This event brought together international experts from industry, academia and government to discuss the latest developments in intelligent production networking, as well as potential directions for international cooperation.

In August 2016, acatech hosted an evening event with the German Chamber of Commerce in China, Shanghai. Representatives of German and Chinese businesses exchanged their views on how Industrie 4.0, smart services, innovative products and data-driven business models can help to conserve global resources, create new jobs and secure their nations’ competitiveness.

The German-Swedish Dialogue in Berlin in October 2016 provided representatives of academia and industry from both countries with an opportunity to discuss their innovation models. The event – which acatech helped to organise – was attended by the Swedish Minister for Enterprise and Innovation, Mikael Damberg. As part of a delegation that travelled to Israel in April 2016, acatech President Reinhard F. Hüttl gave a commitment to assist the Israel Institute of Technology (TECHNION) with the development of an academy of science and engineering based on the acatech model. The kick-off symposium in Berlin in February 2018 will be attended by representatives of academia, industry and government from both countries.

Dialogue with the political sphere and the public

acatech provides a space for dialogue that brings together some of the top minds not only from academia and industry but also from government, the trade unions, foundations, the media and civil society organisations. This dialogue allows them to conceive technology futures and formulate recommendations for policymakers and society. Through its events, competitions, PR work and wide range of partnerships, acatech was able to communicate important ideas about strategic engineering and technology policy issues during 2016.

In so doing, the Academy contributes to thematically complex public debates and policymaking processes. It is conducted in this work by its guidelines for policy advice to government and society which call for excellence and interdisciplinarity in its project work and transparent communication of the results in a way that can be easily understood by a wide audience.

Policy advice: Expertise for evidence-based decision-making

In 2016, acatech once again initiated and supported dialogues on technology policy issues through various events for deputies of the German Bundestag and the Bavarian State Parliament. The “acatech am Mittag” (Lunch with acatech) discussions addressed flexibility concepts for the German power supply up to 2050, successful ways of promoting innovation in SMEs and how to tackle the risks that technology can pose to society. A technical discussion with the Committee on Education, Research and Technology Assessment in December 2016 addressed the impacts of social media on science communication. Meanwhile, in June 2016, acatech discussed how mobility is changing and the associated challenges with members of the Bavarian State Parliament. acatech Members also participated in numerous bilateral discussions, providing scientific expertise to deputies and parliamentary parties.

Engaging with the public: Creating platforms for dialogue

A nation’s capacity for innovation is influenced by public perceptions of technology, industry and infrastructure. Using the examples of fracking, genetic engineering and the chemical industry, representatives of academia, government, industry and the media discussed how public acceptance and opposition are formed and how to ensure an evidence-based debate at a symposium chaired by acatech Executive Board member Ortwin Renn.

Public receptiveness towards technological developments was discussed at the acatech symposium “Industry – Infrastructure – Society” in Potsdam in January 2016. Photo: David Ausserhofer

The European Commission’s Circular Economy Package provided the theme for a stakeholder conference in Berlin in January 2016 organised by acatech, the Ellen MacArthur Foundation, SUN Institute Environment & Sustainability and McKinsey & Company. Experts from industry, academia and government discussed how Germany can benefit from the circular economy principle.

Transparency: Communicating our results as widely as possible

acatech shares the results of its main projects through freely available publications and invites discussion of them at the leading industry fairs, symposia and its own events. At the Hannover Messe in April 2016, the Academy showcased examples of concrete applications for autonomous systems, as well as organising events on its projects Digital Service Platforms and New autoMobility. Other recent project findings were presented to audiences including senior politicians at the 4th National STEM Summit in June and the National IT Summit in November.

The main focus of the Academy Day held in Hannover in May 2016 was on the digitalisation and personalisation of medicine, while human-machine interaction and robotics provided the theme for the acatech Annual Meeting in October 2016, which was attended by Federal President Joachim Gauck.

Photo: David Ausserhofer

"In a society that continues to depend on highly advanced technology, we need a deeper understanding of science. That is why I particularly commend the work of your Academy, all its leaders and all the people and institutions that support it. You promote collaboration between different disciplines, you strengthen cooperation with industry and you provide invaluable input to the policy debate. I urge you to build even more bridges with the world of machines. Open up your laboratories and workshops, share your latest findings with everyone, not just the chosen few. We all need your ideas and visions – we need science fiction, in the best, most serious sense of the word."

Federal President Joachim Gauck in his official address to the acatech Annual Meeting in Berlin in October 2016.

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acatech's studies on skills development for Industrie 4.0, the global context of the strategic initiative Industrie 4.0, flexibility options for the energy systems of the future and the debate surrounding the future of science communication all received particular attention from the media. acatech's Presidents Henning Kagermann and Reinhard F. Hüttl and several of the experts involved in the Academy's projects contributed to these debates through guest appearances and interviews in the leading media.

A diverse range of formats: Reaching new target groups

In the MOOC "Hands on Industrie 4.0" Günther Schuh explains how to introduce Industrie 4.0 into business practise. Photo: acatech

acatech is using new formats and partnerships to expand its current range of dialogue platforms. In April and May 2016, the Academy ran its first Massive Open Online Course (MOOC) entitled Hands on Industrie 4.0 in conjunction with the Hasso Plattner Institute. Over 8,000 people enrolled on this five-week online course on the principles of Industrie 4.0. Our next MOOC in March 2017 took an in-depth look at machine learning.

Under the patronage of the Bavarian State Minister of Education, Science and the Arts, Ludwig Spaenle, 2016 saw acatech and the Zeidler-Forschungs-Stiftung announce a new edition of the TECHNIKENTDECKER schools competition, which awards prizes for creative pieces of work about technology. In 2016, the Academy's PUNKT prize for technology journalism and technology photography was awarded for the written text category. The winners were the journalists Reto U. Schneider (NZZ Folio) for a piece on artificial intelligence and Michael Spehr and Lukas Weber (FAZ) for their entry on smart home technologies.

Journalist Reto U. Schneider (2nd from left) was awarded the PUNKT journalism prize at the acatech Annual Meeting in October 2016 for his self-experiment "Mensch gegen Maschine" (Man vs. Machine). Photo: David Ausserhofer

Launched in the summer of 2016, the acatech am Dienstag (acatech on Tuesday) event series provides a platform for representatives of the scientific community to engage in an open and self-critical dialogue with the public. Once a month, the Academy invites interested members of the public and guests from government, academia, industry and the media to the acatech Forum on Munich's Karolinenplatz. The **topics discussed in 2016 included big data, human-machine interaction, nanotechnology and the role of art in communicating about new technologies.**

Projects

acatech's Members collaborate with other experts from academia and industry on projects addressing cutting-edge issues in the fields of Energy, Resources and Sustainability, Technologies, Education and Skilled Professionals and Technology Communication. They also contribute their expertise to joint projects between acatech and other institutions or academies. The project results are presented in publications prepared with the assistance of the acatech Office.

- acatech Projects

- Joint projects

- Coordinating Committee projects

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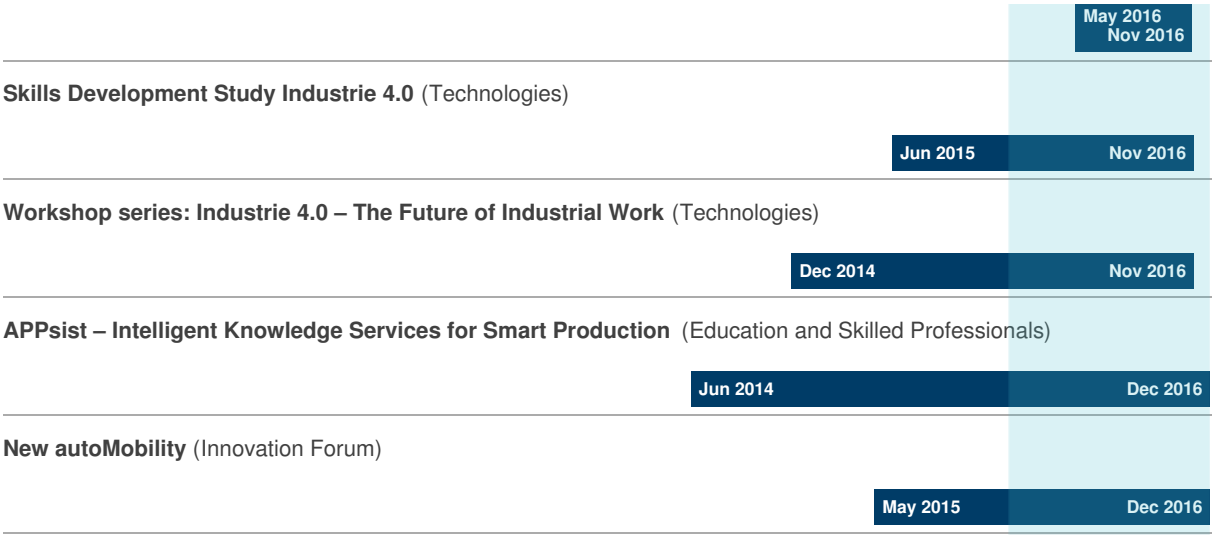
acatech Projects

In acatech projects, acatech's Members combine their own expertise with that of other experts from academia and industry to address topical issues in the fields of Energy, Resources and Sustainability, Technologies, Education and Skilled Professionals and Technology Communication.

Projects completed in 2016



Ongoing projects

Coordination of the German National Platform for Electric Mobility (Innovation Forum)

Jan 2015 – Dec 2017

Innovation Award of the State of North Rhine-Westphalia (Innovation Forum)

Jan 2012 – Dec 2017

Innovation Dialogue between the Federal Government, Industry and Science (Innovation Forum)

Dec 2009 – Dec 2017

Geothermal Technologies in Metropolitan Areas (Energy, Resources and Sustainability)

Jan 2017 – Jun 2018

Joint projects

In its joint projects, acatech collaborates closely with scientific and allied institutions on socially and economically important technology themes.

Projects completed in 2016

2016

Energiewende Research Forum (Partner: Institute for Advanced Sustainability Studies (IASS) and Max Planck Society)

Apr 2013 – Feb 2016

Hands-on: Industrie 4.0 – a Massive Open Online Course for the fourth industrial revolution (Partner: Hasso Plattner Institute)

Jun 2015 – Nov 2016

Euro-CASE Energy Platform (Partner: European Council of Applied Sciences, Technologies and Engineering (Euro-CASE))

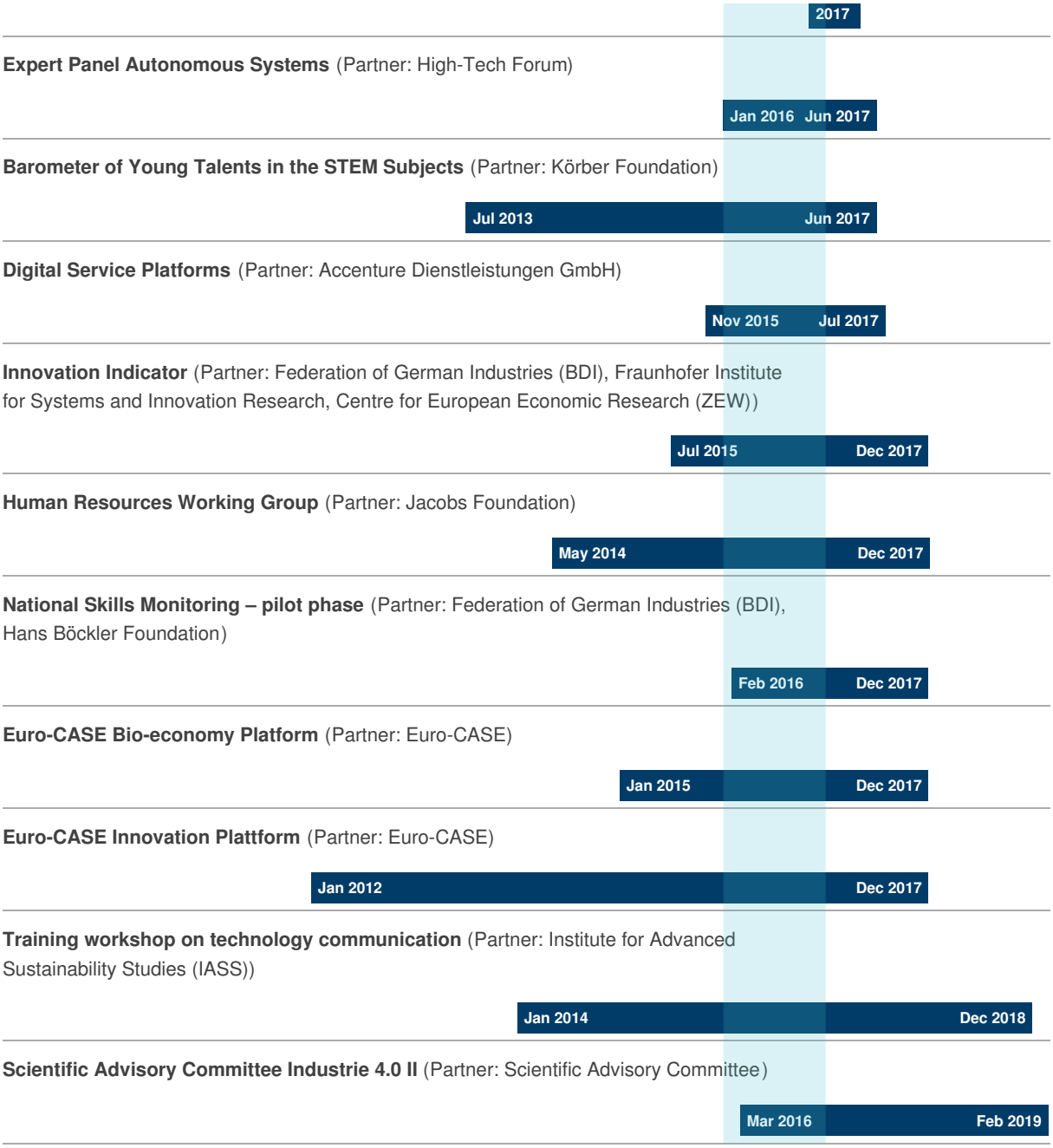
Jan 2013 – Dec 2016

Ongoing joint projects

2016

Machine Learning – acatech's second Massive Open Online Course (Partner: DFKI)

Nov 2016 – Apr

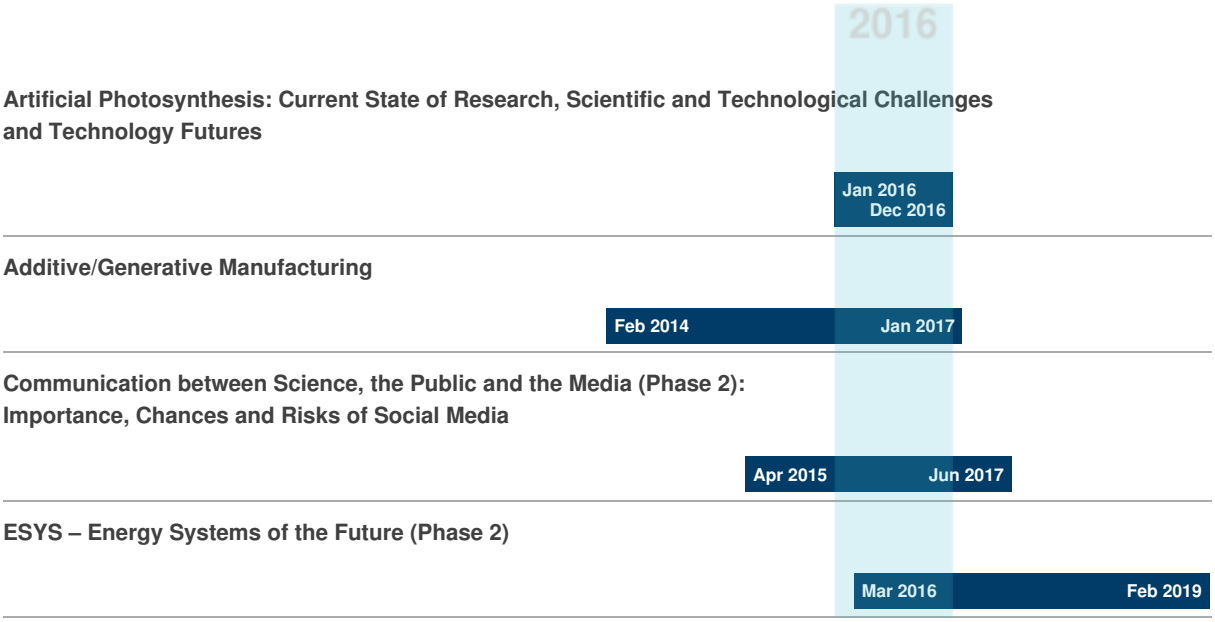

2017
Expert Panel Autonomous Systems (Partner: High-Tech Forum)
Jan 2016
Jun 2017
Barometer of Young Talents in the STEM Subjects (Partner: Körber Foundation)
Jul 2013
Jun 2017
Digital Service Platforms (Partner: Accenture Dienstleistungen GmbH)
Nov 2015
Jul 2017
Innovation Indicator (Partner: Federation of German Industries (BDI), Fraunhofer Institute for Systems and Innovation Research, Centre for European Economic Research (ZEW))
Jul 2015
Dec 2017
Human Resources Working Group (Partner: Jacobs Foundation)
May 2014
Dec 2017
National Skills Monitoring – pilot phase (Partner: Federation of German Industries (BDI), Hans Böckler Foundation)
Feb 2016
Dec 2017
Euro-CASE Bio-economy Platform (Partner: Euro-CASE)
Jan 2015
Dec 2017
Euro-CASE Innovation Plattform (Partner: Euro-CASE)
Jan 2012
Dec 2017
Training workshop on technology communication (Partner: Institute for Advanced Sustainability Studies (IASS))
Jan 2014
Dec 2018
Scientific Advisory Committee Industrie 4.0 II (Partner: Scientific Advisory Committee)
Mar 2016
Feb 2019

Coordinating Committee projects

In the Coordinating Committee of the National Academy of Sciences, acatech collaborates with the German National Academy of Sciences Leopoldina and the Union of the German Academies of Sciences and Humanities on projects aimed at providing policy advice to government and society. Only those projects in which acatech was/is the lead institution are listed below.

Projects completed in 2016

Ongoing Coordinating Committee projects



Events

acatech's mission is to promote knowledge transfer and foster a lively personal dialogue between representatives of academia, industry, government and civil society. One important means of doing so is via the events that acatech organises itself or participates in through its Members. The following list provides an overview of the key events in 2016.

Berlin, 15 January 2016

Discussion: "The Importance of Data to Future Mobility" with the CDU/CSU parliamentary group in the German Bundestag

Potsdam, 18 January 2016

Symposium: "Industry – Transport – Society"

Berlin, 25 January 2016

Discussion: "The Circular Economy: Creating Value, Closing the Loop"

Berlin, 26 January 2016

acatech am Mittag (Lunch with acatech): "Flexibility Concepts for the German Power Supply 2050"

Tutzing, 10 February 2016

Debating Workshop: "Artificial Photosynthesis"

Berlin, 25 February 2016

Technical discussion: "Energy Systems of the Future"

Berlin, 16 March 2016

Meeting of acatech Executive Board with research policymakers

Brussels, 17 March 2016

Launch of European academy networks with EU Commissioner Carlos Moedas and High Level Group of Scientific Advisors

Berlin, 12 April 2016

acatech am Mittag (Lunch with acatech): Presentation of Innovation Indicator 2015

Hannover, 25 April 2016

Presentation of Skills Development Study Industrie 4.0 to Federal Minister Johanna Wanka

Munich, 29 April 2016

Official opening of the new acatech Office in Munich by Bavarian Minister-President Horst Seehofer

Munich, 9-10 May 2016

Workshop: "Artificial Photosynthesis"

Hannover, 23 May 2016

Academy Day: "Technology for People and Patients – the Digitalisation and Personalisation of Medicine"

Munich, 2 June 2016

acatech am Morgen (Breakfast with acatech): "Mobility in Bavaria"

Munich, 14 June 2016

acatech am Dienstag (acatech on Tuesday) (launch): “We need to talk”

Düsseldorf, 20 June 2016

Workshop on the Future of Industrial Work

Berlin, 23 June 2016

Presentation of the study “International Benchmark, Options for the Future and Recommendations for Manufacturing Research (INBENZHAP)” to Georg Schütte, State Secretary at the Federal Ministry of Education and Research

Munich, 5 July 2016

acatech am Dienstag (acatech on Tuesday): “Digital Transformation – The Future of Work”

Munich, 8 July 2016

acatech Senate Annual Meeting: “How can management and employees shape the future of work?”

Stuttgart, 13-14 July 2016

acatech Communications and Sponsor Group: Connected Industry and Mobility

Berlin, 21 July 2016

Training Workshop on Technology Communication

Munich, 26 July 2016

Training Workshop on Technology Communication

Munich, 26 July 2016

acatech am Dienstag (acatech on Tuesday): “Fuel and Raw Materials from Light and Air”

Munich, 27 July 2016

Schools competition prize-giving ceremony

Munich, 1 August 2016

Energiewende holiday seminar for schoolchildren

Greifswald, 11 September 2016

Science Café on “Artificial Photosynthesis”

Potsdam, 12 September 2016

Expert workshop on “Energy Storage” in conjunction with the Ministry for Economic Affairs and Energy of the State of Brandenburg (MWE)

Munich, 13 September 2016

acatech am Dienstag (acatech on Tuesday): “Opportunities and Challenges of Genome Editing“

Berlin, 23 September 2016

Conference: “Drop-out Rates in the Engineering Sciences”

Berlin, 29-30 September 2016

ESYS Annual Conference

Munich, 4 Oktober 2016

acatech am Dienstag (acatech on Tuesday): “Are you Ready for Big Data?”

Berlin, 12 Oktober 2016

acatech Annual Meeting

Munich, 24 Oktober 2016

Workshop with the Nationale Institut für Wissenschaftskommunikation (NaWik): “Communicating Critical Topics”

Munich, 8 November 2016

acatech am Dienstag (acatech on Tuesday): “Man and Machine – Hand in Hand?”

Munich, 23-24 November 2016

Conference with Münchner Kreis: “The Digital Transformation of Manufacturing Industries”

Berlin, 1 Dezember 2016

Discussion with research policymakers on the importance, opportunities and risks of social media in science communication

Munich, 6 Dezember 2016

acatech am Dienstag (acatech on Tuesday): “Nanomachines – Visions, Art and Creativity Galore”

Brussels, 13 Dezember 2016

Meeting of the Presidents of the European academy networks with Director-General Robert-Jan Smits at the official launch of the EU’s SAPEA project

Berlin, 7 Oktober 2016

German-Swedish Dialogue: “How to foster Innovation”

Berlin, 13 Oktober 2016

Workshops: “Circular Economy” and “Communication between Science, the Public and the Media”

Munich, 7 November 2016

Fishbowl event: “Opportunities and Limits of Genome Editing”

Saarbrücken, 16 November 2016

Presentation of acatech POSITION PAPER Kompetenzen für Industrie 4.0 to Federal Minister Johanna Wanka

Berlin, 1 Dezember 2016

acatech am Mittag (Lunch with acatech): “The Principles of Evidence-Based Assessment and How to Tackle Risks and Dangers”

Berlin, 5 Dezember 2016

Presentation of acatech STUDY Neue autoMobilität to State Secretary Rainer Bomba

Leipzig, 9 Dezember 2016

Workshop with the Saxon Academy of Sciences (SAW): “Bioeconomy Wood 2030”

Publications

acatech disseminates the key findings of its projects through publications aimed at policymakers, industry, academia and the public. The majority are published in the Academy's own series. All the publications are freely available online on the acatech web site. In the autumn of 2016, acatech redesigned its various publication series and gave them a new look. The Academy was involved in a total of 17 publications on socially and economically important technology themes during 2016.

- acatech series

- Joint publications

- Publication series of the Coordinating Committee

- Publication series of the joint academy project "Energy Systems of the Future"

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acatech series

acatech POSITION PAPER

In this series, acatech publishes position papers on strategic engineering and technology policy issues. They contain specific recommendations and are aimed at decision-makers in government, academia and industry, as well as interested members of the general public. The publications are produced by acatech Members and other experts and are authorised and published by acatech's Executive Board. The following publications were published in the acatech POSITION PAPER series in 2016:

acatech (Hrsg.)
Kompetenzen für Industrie 4.0 – Qualifizierungsbedarfe und Lösungsansätze

acatech (Ed.)
Hydraulic Fracturing – A technology under debate
(the German version was published in 2015)

acatech IMPULSE

In this series, we publish analyses and ideas on principles of science and engineering and science-based advice for policymakers and the public. The acatech IMPULSE reports are produced by acatech Members and other experts and are authorised and published by acatech's Executive Board. The following publications were published in the acatech IMPULSE series in 2016:

acatech (Hrsg.)
Innovationspotenziale der Mensch-Maschine-Interaktion

acatech (Hrsg.)
Die digitale Transformation gestalten – Was Personalvorstände zur Zukunft der Arbeit sagen. Ein Stimmungsbild aus dem Human-Resources-Kreis von acatech und Jacobs Foundation.

acatech (Hrsg.)
Technik gemeinsam gestalten – Frühzeitige Einbindung der Öffentlichkeit am Beispiel der Künstlichen Fotosynthese

acatech MATERIALS

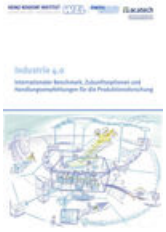
In this series, we publish discussion papers, presentations and preliminary studies produced during the course of acatech's project work. Responsibility for the content of the publications in this series lies with the respective editors and authors. The following publications were published in the acatech MATERIALS series in 2016:

Nickolaus, R./Mokhonko, S. (Hrsg.)
In fünf Schritten zum zielführenden Evaluationsdesign – Eine Handreichung für Bildungsinitiativen im MINT-Bereich

Umbach, E. (Hrsg.)
Zellproduktion in Deutschland – Eine Betrachtung aus Sicht der Wissenschaft

Joint publications

These publications include the interim and final reports of joint projects carried out by acatech in cooperation with other partners. Responsibility for their content lies with the respective editors and authors. acatech was involved in the following joint publications in 2016:



Heinz Nixdorf Institut, Universität Paderborn/WZL der Rheinisch-Westfälischen Technischen Hochschule Aachen/acatech (Hrsg.)
Industrie 4.0 – Internationaler Benchmark, Zukunftsoptionen und Handlungsempfehlungen für die Produktionsforschung

Heinz Nixdorf Institut, Universität Paderborn/WZL der Rheinisch-Westfälischen Technischen Hochschule Aachen/acatech (Eds.)
Industrie 4.0 – International Benchmark, Options for the Future and Recommendations for Manufacturing Research

acatech (Hrsg.)
Smart Service Welt: Digitale Serviceplattformen – Praxiserfahrungen aus der Industrie. Best Practices.

acatech (Hrsg.)
Kompetenzentwicklungsstudie Industrie 4.0 – Erste Ergebnisse und Schlussfolgerungen

Fachforum Autonome Systeme/acatech (Hrsg.)
Das Fachforum Autonome Systeme im Hightech-Forum der Bundesregierung – Chancen und Risiken für Wirtschaft, Wissenschaft und Gesellschaft (Zwischenbericht)

acatech (Hrsg.)
Science Finance. Analysen – Beispiele – Meinungen
Ausgabe 1/2016

Publication series of the Coordinating Committee

This series publishes the findings of projects aimed at providing advice to policymakers and the public in which acatech collaborates with the German National Academy of Sciences Leopoldina and the Union of the German Academies of Sciences and Humanities as part of the Coordinating Committee of the National Academy of Sciences. acatech was involved in the following publications in 2016:

Leopoldina/acatech/Union der deutschen Akademien der Wissenschaften (Hrsg.)
Wissenschaftliche und gesellschaftspolitische Bedeutung bevölkerungsweiter Längsschnittstudien (position paper)

acatech/Leopoldina/Union der deutschen Akademien der Wissenschaften (Eds.)
Consulting with Energy Scenarios (Series on Science-Based Policy Advice)
(the German version was published in 2015)

acatech/Leopoldina/Union der deutschen Akademien der Wissenschaften (Eds.)
Flexibility Concepts for the German Power Supply 2050. Ensuring Stability in the Age of Renewable Energies (Series on Science-Based Policy Advice)
(the German version was published in 2015)

Publication series of the joint academy project “Energy Systems of the Future”

This series publishes the position papers and analyses produced by the working groups of the joint academy project “Energy Systems of the Future”. Through this joint project, acatech, the German National Academy of Sciences Leopoldina and the Union of the German Academies of Sciences and Humanities endeavour to promote a fact-based debate on the implementation of the energy transition. The following publication was published in this series in 2016:

Angerer, G. et al.
Rohstoffe für die Energieversorgung der Zukunft: Geologie – Märkte – Umwelteinflüsse

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Voices

"In a society that continues to depend on highly advanced technology, we need a deeper understanding of science. That is why I particularly commend the work of your Academy, all its leaders and all the people and institutions that support it. (…) We all need your ideas and visions – we need science fiction, in the best, most serious sense of the word."

Joachim Gauck, Federal president, in his Official address to the acatech Annual Meeting in Berlin in October 2016

Photo: David Ausserhofer

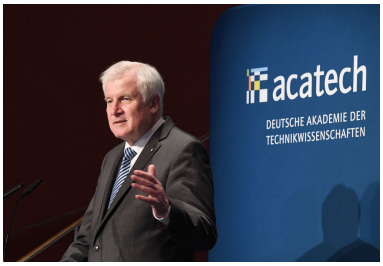

Photo: David Ausserhofer

"You provide us with help and advice on all kinds of strategic issues, you have a wealth of practical experience and you foster young talent. Every member of acatech has done a great job. For this, you deserve our respect and our thanks!"

Horst Seehofer, Minister-President of the Free State of Bavaria, in his speech at the official opening of the acatech Forum on Munich's Karolinenplatz in April 2016

"acatech fills a gap in the essential activities of the science and engineering communities, government and the public."

Jürgen Zöllner, Executive Board member of Stiftung Charité, speaking on behalf of the team of independent experts that carried out a status analysis of the Academy under his leadership in the summer of 2016

Photo: David Ausserhofer

Photo: European Union

"Reinhard Hüttl has made acatech into an international player whose voice is heard throughout Europe and beyond."

Robert Jan Smits, EU Director-General for Research and Innovation, speaking at an event held in Berlin in February 2017 to mark Reinhard F. Hüttl's retirement as acatech President

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“Communication between experts from the widest possible range of disciplines and members of the business community and the public is absolutely key to innovation, particularly in the field of healthcare. Germany’s scientific academies, especially acatech, help to promote this important dialogue.”

Gabriele Heinen-Kljajić, Minister for Science and Culture of the Lower Saxony state government, at the acatech Academy Day in Hannover in May 2016

Photo: David Ausserhofer

Photo: Federal Employment Agency

“The digital transformation will be accompanied by highly dynamic changes in occupational profiles. If jobs are lost as a result of the productivity gains achieved through automation, it will be even more important to stimulate growth through innovation and to realise the resulting employment opportunities. Industrie 4.0 and the Smart Service Welt will be key to the creation of more and better jobs in Germany.“

Detlef Scheele, Chairman of the Executive Board of the Federal Employment Agency

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“acatech is increasingly taking the interests of works councils, staff councils and the trade unions into account, particularly in Industrie 4.0 projects. It does so by discussing worker participation opportunities and requirements with an advisory group comprising representatives of the social partners and civil society organisations. The Hans Böckler Foundation is delighted to contribute insights from all of its research areas to acatech’s ongoing work.”

Michael Guggemos, Management spokesman of the Hans Böckler Foundation

Photo: Hans-Böckler-Stiftung

Photo: Presse- und Informationsamt der Bundesregierung

"Digitalisation is changing the world of work. New and flexible manufacturing processes are emerging. (…) In Germany, we have both the ideal conditions for this transformation and the right competencies in our companies. By delivering the appropriate training for the business environment and workplace of tomorrow, we can ensure that the transformation is a positive one."

Johanna Wanka, Federal Minister of Education and Research, at the presentation of the acatech POSITION PAPER Kompetenzen für Industrie 4.0 at the National IT Summit in Saarbrücken in November 2016

"German industry and SMEs need data-based business models enabled by digital platforms in order to remain competitive. The practical examples collected by acatech show what the digitalisation of our economy could look like. To make it happen, cooperation on digital services between different institutions will be essential."

Matthias Machnig, State Secretary at the Federal Ministry for Economic Affairs and Energy (BMWi), at the presentation of the acatech publication Digitale Service Plattformen during the 2016 Hannover Messe

Photo: Michael Voigt

Photo: David Ausserhofer

"Against the backdrop of demographic change, digitalisation provides us with an opportunity to compensate for future labour shortages through productivity gains. Getting to grips with digitalisation is therefore critical to securing our competitiveness and the fabric of our society. I would like to thank acatech and the Jacobs Foundation for their thought-provoking insights."

Helge Braun, Minister of State to the Federal Chancellor at the presentation of the acatech IMPULSE Die digitale Transformation gestalten – Was Personalvorstände zur Zukunft der Arbeit sagen in Berlin in April 2016

Structure

Organisation

Photo: acatech

Members

acatech's Members are leading experts from the fields of engineering, the applied sciences, the humanities, economics and the social sciences. They are responsible for the content of the Academy's work. In acatech projects, they work in interdisciplinary teams with representatives of other organisations from academia, industry and civil society.

Photo: acatech

Senate

acatech's Senate forms the second pillar of the Academy, alongside the Members. The Senate includes members of technology companies, associations, societies and government, as well as the presidents of the major science organisations. The members of the Senate advise the Academy on strategic issues and channel proposals from industry. They facilitate communication with the corporate world in acatech's projects.

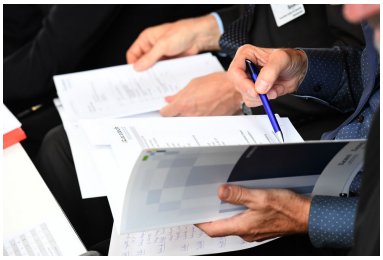

Photo: acatech

Executive Board

acatech's Executive Board represents the Academy externally and is responsible for its management. Its members are elected from the members of the General Assembly and the Senate Committee, ensuring that the Executive Board represents both pillars of the Academy. The Executive Board includes acatech's Presidents and Vice-Presidents plus its Secretary General and Managing Director who both serve as non-voting members.

Photo: acatech

Förderverein

acatech is a non-profit organisation that relies on a mix of private funding and public funding from the Federal Government and the Länder. The private funding is raised by the acatech Förderverein in the form of donations that are used to help finance scientifically important programmes, projects, initiatives and dialogue formats. The work carried out by the Förderverein thus plays an important part in making the Academy's projects possible.

Photo: acatech

Board of Trustees

The acatech Board of Trustees comprises members from academia, industry, government and civil society. Its primary role is to help the Executive Board decide on the Academy's strategic direction. The Board of Trustees meets at least once a year.

Photo: acatech/David Ausserhofer

acatech Office

The acatech Office is headquartered in Munich, with additional offices in Berlin and Brussels. Its staff of approximately 80 employees support the work of the Academy's organs, coordinate the implementation of its projects and communicate its work to interested members of the public. They also support acatech's international networking with other science organisations around the world.

Members

acatech's Members are invited to join the Academy because of their outstanding scientific achievements and high reputation. acatech had a total of 498 Members as of December 2016. This included 15 newly-elected female and 20 newly-elected male experts from the fields of engineering, the natural sciences, the humanities, economics and the social sciences. A complete list of all acatech's Members is available here.

New acatech Members in 2016

Nachname	Vorname	Titel	Institution
Amunts	Katrin	Prof. Dr. med.	Heinrich Heine University Düsseldorf
Beck	Susanne	Prof. Dr.	Leibniz Universität Hannover
Blind	Knut	Prof. Dr.	Technische Universität Berlin
Boll	Susanne	Prof. Dr.	Carl von Ossietzky University of Oldenburg
Charpentier	Emmanuelle	Prof. Dr.	Max Planck Institute for Infection Biology
Christ	Hans-Jürgen	Prof. Dr.-Ing.	University of Siegen
De Doncker	Rik W.	Prof. Dr. ir.	RWTH Aachen University
Górak	Andrzej	Prof. Dr.-Ing.	TU Dortmund University
Hell	Stefan	Prof. Dr.	Max Planck Institute for Biophysical Chemistry

Nachname	Vorname	Titel	Institution
Heuberger	Albert	Prof. Dr.-Ing.	Fraunhofer Institute for Integrated Circuits IIS; Friedrich-Alexander-Universität Erlangen-Nürnberg
Hornegger	Joachim	Prof. Dr.-Ing.	Friedrich-Alexander-Universität Erlangen-Nürnberg
Janich	Nina	Prof. Dr.	German Academic Scholarship Foundation; TU Darmstadt
Köller	Olaf	Prof. Dr.	Leibniz Institute for Science and Mathematics Education
Krawczyk	Charlotte	Prof. Dr.	German Research Centre for Geosciences
Kutter	Christoph	Prof. Dr.	Fraunhofer Research Institution for Microsystems and Solid State Technologies EMFT; University of the Federal Armed Forces Munich
Löschel	Andreas	Prof. Dr.	University of Münster
Marotzke	Jochem	Prof. Dr.	Max Planck Institute for Meteorology
Mezini	Mira	Prof. Dr.-Ing.	TU Darmstadt
Müller-Quade	Jörn	Prof. Dr.	Karlsruhe Institute of Technology
Patzelt	Holger	Prof. Dr. Dr.	Technical University of Munich
Roßmann	Jürgen	Prof. Dr.-Ing.	RWTH Aachen University
Rudolf	Petra	Prof. Dr.	University of Groningen
Spiecker, known as Döhmann	Indra	Prof. Dr.	Goethe University Frankfurt
Sternberg	Katrin	Prof. Dr.-Ing.	Front End of Innovation and Materials at Aesculap AG
Teutsch	Georg	Prof. Dr.	Helmholtz Centre for Environmental Research UFZ
Thomsen	Christian	Prof. Dr.	TU Berlin
van Rienen	Ursula	Prof. Dr.	University of Rostock

Nachname	Vorname	Titel	Institution
Wagner	Dorothea	Prof. Dr.	Karlsruhe Institute of Technology
Wallacher	Johannes	Prof. Dr. Dr.	Munich School of Philosophy
Waser	Rainer	Prof. Dr.-Ing.	RWTH Aachen University
Welpe	Isabell	Prof. Dr.	Technical University of Munich
Wulfsberg	Jens Peter	Prof.Dr.-Ing.	Helmut Schmidt University, University of the Federal Armed Forces Hamburg
Wuttig	Matthias	Prof. Dr.	RWTH Aachen University
Zlatkin-Troitschanskaia	Olga	Prof. Dr.	Johannes Gutenberg University Mainz

New associate Member of acatech in 2016

Nachname	Vorname	Titel	Institution
Wellmer	Friedrich-Wilhelm	Prof. Dr.-Ing. Dr. h. c. mult.	Federal Institute for Geosciences and Natural Resources

acatech Members who passed away in 2016

Nachname	Vorname	Titel	Institution
Appelrath	Hans-Jürgen	Prof. Dr. Dr. h. c.	Carl von Ossietzky University of Oldenburg
Geßner	Thomas	Prof. Dr.	Chemnitz University of Technology
Kallenbach	Eberhard	Prof. Dr.-Ing. Prof. h. c.	Ilmenau University of Technology
Knoche	Karl-Friedrich	Prof. Dr.-Ing. em.	RWTH Aachen University
Neumann	Manfred J.M.	Prof. Dr.	University of Bonn
Staufenbiel	Rolf	Prof. Dr.-Ing. em.	RWTH Aachen University
Wilke	Günther	Prof. Dr. Dr. h. c. mult.	Max-Planck-Institut für Kohlenforschung

They are fondly remembered by all at acatech.

Senate

New members of acatech's Senate are proposed by the Executive Board and elected by the Senate's existing members. As of December 2016, acatech's Senate comprised a total of 112 members from industry, associations, societies, government and science organisations. This figure includes the 17 new members minus the nine members who left the Senate. A complete list of all acatech's Senate members is available here.

New Senate members in 2016

Nachname	Vorname	Titel	Institution
Bachem	Thomas		German Startups Association
Barth	Andreas		Dassault Systèmes Deutschland GmbH
Baumann	Werner		Bayer AG
Dirks	Thorsten		Bitkom e.V.
Eichhorn	Ulrich	Dr.	Volkswagen AG
Jenner	Hartmut		Alfred Kärcher GmbH & Co. KG
Kolmsee	Ines		EWE AG
Mählmann	Hinrich	Dr.	Otto Fuchs KG
Müller	Herbert	Dr.	Surteco SE
Neumann	Karl-Thomas	Dr.	Adam Opel AG
Oschmann	Stefan	Dr.	Merck KGaA
Quante-Brandt	Eva	Prof. Dr.	Joint Science Conference
Richter	Klaus	Dr.	Airbus Deutschland GmbH
Schürmann	Franz-Josef		Adecco Germany Holding SA & Co. KG
Süß	Michael	Prof. Dr.	Georgsmarienhütte Holding GmbH
Wittenstein	Anna-Katharina	Dr.	Wittenstein SE
Zachert	Matthias		Lanxess AG

Members who left the Senate in 2016

Nachname	Vorname	Titel	Institution
Botti	Jean		Airbus Deutschland GmbH
Breuers	Werner		Lanxess AG
Brinker	Werner		EWE AG
Dekkers	Marjin		Bayer AG
Kempf	Dieter		Bitkom e.V.
Päfgen	Friedhelm		Surteco SE
Reiß	Vera		Joint Science Conference
Spath	Dieter	Prof. Dr.-Ing. Dr.-Ing. E.h. Dr. h.c.	Wittenstein SE
van Hüllen	Peter		Georgsmarienhütte Holding GmbH

Executive Board

Two new members joined acatech's Executive Board in 2016, bringing the total number of members up to 18. A complete list of all acatech's Executive Board members is available here.

New Executive Board members in 2016

Nachname	Vorname	Titel	Institution
Kley	Karl-Ludwig	Dr.	E.ON SE
Spath	Dieter	Prof. Dr.	Fraunhofer IAO

Förderverein

The acatech Förderverein comprises members from industry, academia, government and civil society, representing a current total of 71 companies and institutions. In 2016, they once more helped to raise donations towards the implementation of the Academy's projects. acatech would like to thank them for their hard work and support.

Board of the Förderverein

Prof. Dr.-Ing. Dr.-Ing. E. h. Dr. h. c. Ekkehard Schulz

Dr.-Ing. E. h. Bernd Pischetsrieder

Secretary of the Förderverein

Manfred Rauhmeier

Board of Trustees

In 2016, the acatech Board of Trustees had twelve members. There were no changes of personnel compared to 2015. A complete list of the members of the Board of Trustees is available here.

Office

www.acatech.de/de/ueber-uns/organisation/geschaeftsstelle.html

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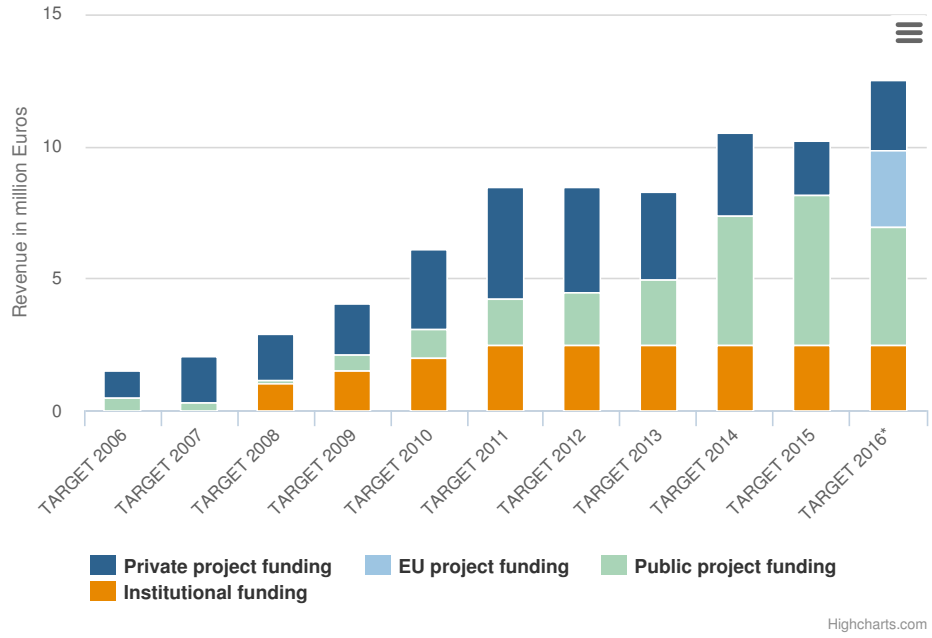
Finances

acatech is a non-profit organisation. Its institutional funding is shared equally between the Federal Government and the Länder. This is supplemented by public and private project funding.

Total revenue



* Provisional figures

Private project funding

Donations/Membership fees Förderverein

A.T. Kearney GmbH
ABB AG
Accenture GmbH
Atos IT Solutions and Services GmbH
BASF SE
Bayer AG
Beckhoff Automation GmbH & Co. KG
Bertelsmann SE & Co. KGaA
BITKOM e.V.
BMW AG
Brose Fahrzeugteile GmbH & Co. KG
BSH Hausgeräte GmbH
Carl Zeiss AG
Clariant SE
Daimler AG
Deutsche Börse AG
Deutsche Post AG
Deutscher Sparkassen- und Giroverband e.V.
Duisburger Hafen AG
EARN + INVEST GmbH
Egon Zehnder International GmbH
eurodata AG
Evonik Industries AG
EWE AG
ExxonMobil Central Europe Holding GmbH
Festo AG & Co. KG
Georgsmarienhütte GmbH
Google Germany GmbH
Grillo-Werke AG
Harting AG & Co. KG

Herrenknecht AG
Hitach Europe Ltd.
Huawei Technologies Deutschland GmbH
IBM Deutschland GmbH
Infosys Ltd.
Intel Deutschland GmbH
Jacobs Stiftung
Jopp Holding GmbH
Klöckner & Co SE
Lanxess AG
Linde AG
MAN SE
Merck KGaA
Muhr und Bender KG
Münchener Rückversicherungs-Gesellschaft AG
Opel Group GmbH
Otto Fuchs KG
Quandt, Stefan
Robert Bosch GmbH
RWE AG
SAP SE
SEW-EURODRIVE GmbH & Co KG
Sick AG
Siemens AG
SMS GmbH
Software AG
Stahlinstitut VDEh
Stifterverband für die Deutsche Wissenschaft e.V.
Surteco SE
ThyssenKrupp AG
TRUMPF GmbH + Co. KG
TÜV Rheinland Berlin Brandenburg Pfalz e.V.
TÜV SÜD AG
UNITY AG
Volkswagen AG
WAGO Kontakttechnik GmbH & Co. KG
Weidmüller Interface GmbH & Co. KG
Wittenstein SE
ZF Friedrichshafen AG

Private project donations

Accenture GmbH
Adam Opel AG
AUDI AG
Atos IT Solutions and Services GmbH
BASF SE
Bayer AG
Beckhoff Automation GmbH & Co. KG
Bertelsmann SE & Co. KGaA
BMW AG
Bundesverband der Deutschen Industrie e.V.
Daimler AG
DEKRA Automobil GmbH
Deutsche Bahn AG
Deutsche Post AG
E.ON SE
Ericsson GmbH
Harting AG & Co. KG
intelligence AG
Jacobs Stiftung
Körber-Stiftung
Münchener Rückversicherungs-Gesellschaft
Nokia Corporation/li>
Parametric Technology GmbH

Robert Bosch GmbH
RWE AG
Siemens AG
TRUMPF GmbH + Co. KG
TÜV SÜD AG
UNITY AG
Verband der Automobilindustrie e.V.
Volkswagen AG
Weidmüller Interface GmbH & Co. KG
Zeidler-Forschungs-Stiftung

Payments in kind

BMW AG
Deutsche Telekom AG

Locations

Photo: David Ausserhofer

Munich

acatech's Munich Office is the Academy's headquarter. It relocated to Karolinenplatz at the beginning of 2016. It is home to the Academy's senior management and the majority of its staff in the support, organisation and administration functions, as well as those responsible for specific priority themes.

Photo: acatech

Berlin

acatech has two offices in Berlin: its main Berlin Office and a project office that is home to the coordinating office of the joint Academy project Energy Systems of the Future (ESYS) and the office of the Energiewende Research Forum.

Photo: acatech

Brussels

acatech's Brussels office coordinates the Academy's networking activities at EU level.