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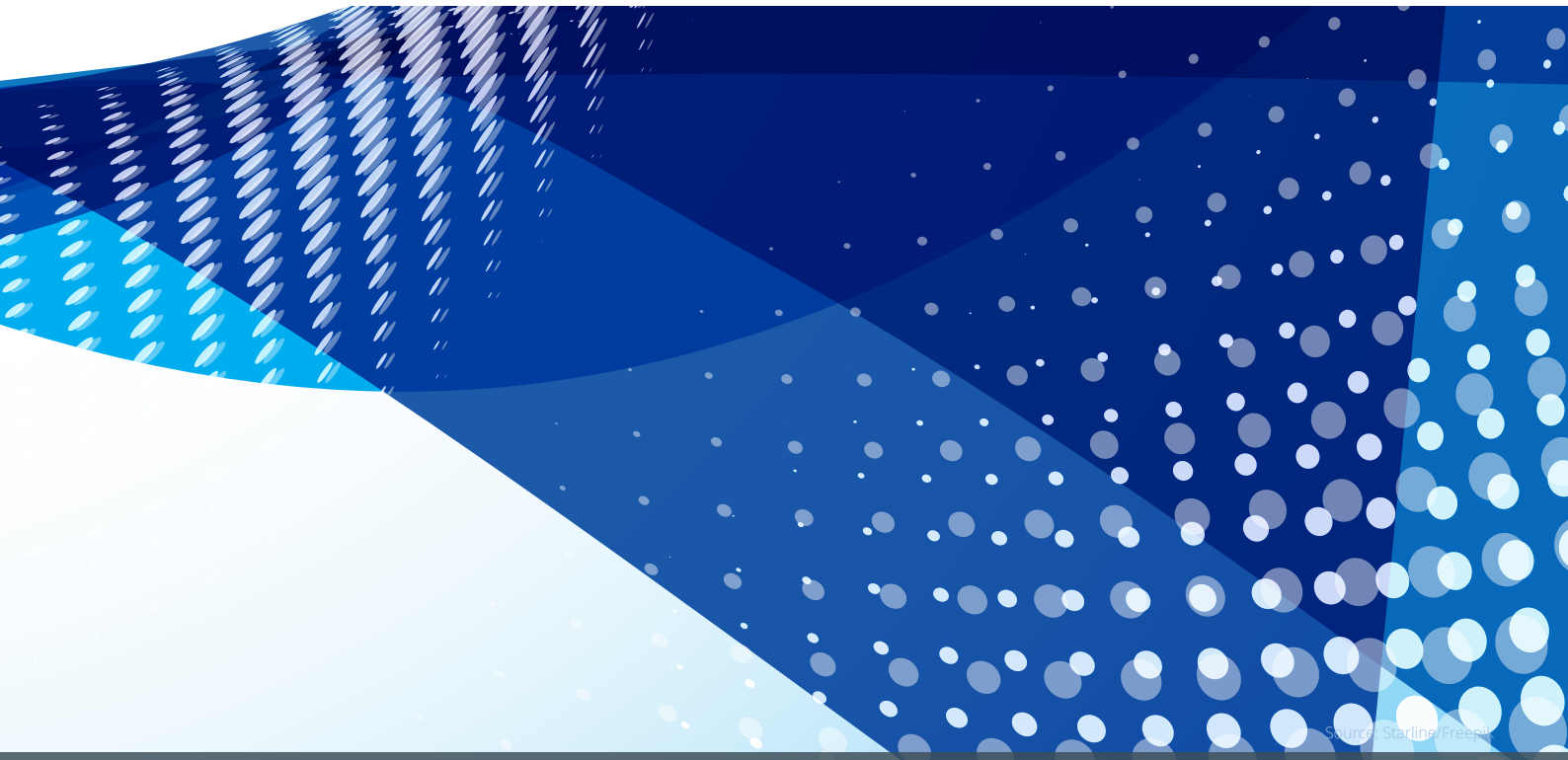
STRATEGY FOR AUSTRIA



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FUTURE OF ENERGY **DIALOGUE 2050**

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ENERGY
Research and Innovation Strategy for Austria

Summary

CONTENTS

Vienna, March 2017

From vision to strategy – via an intensive public consultation process

Following on from the 2010 Energy Research Strategy and its mission statement of "Making the Zero Carbon Society Possible", in the spring of 2016 the Federal Ministry of Transport, Innovation and Technology, together with the Climate and Energy Fund, began the consultation process "Dialog Energiezukunft 2050" (Future of Energy 2050), with the aim of aligning future energy research and innovation policy with the challenges of energy supply and current targets. The starting point for the dialogue was a topic-based paper in which experts from the individual focus areas set out the key challenges and courses of action along with future priorities and central issues. In a public consultation process between August and October 2016 a community of experts and interested members of the public were invited to comment on the key issues outlined and to work together to develop possible solutions.

The resulting ideas were compiled and consolidated in further expert workshops. In keeping with the mission statement of the vision –

"Making Austria the global innovation leader in energy for the future" –

the new Energy Research and Innovation Strategy aims to exploit the economic opportunities of the energy transition, accelerating energy research and innovation as trailblazers for step-by-step decarbonisation of the energy system, and thereby enabling Austria to make a significant contribution to a clean, safe and affordable energy future.

Shaping the future of energy with research and innovation

Access to safe, clean and affordable energy is essential to effect a fundamental transformation of the energy system. The issue of the future world of energy is crucial for Austria as a location for business and requires all the country's strengths to be harnessed together. Austria has already achieved international successes in the area of innovative energy solutions and positioned itself strongly in the global marketplace with ingenious solutions for the future of energy. In order to safeguard and further expand this position, priorities must be set which enable Austria to generate industrial policy and economic relevance based on research and innovation; this is the only way that Austria can survive in the global market. The huge task of shaping the decarbonisation agenda in a manner that is technically possible, as well as economically sustainable and socially compatible, requires a long-term research, technology and innovation policy.

Adapting and setting the future direction for energy research requires an integrated and systematic approach. To achieve this, conversion and storage technologies are exploited in four central innovation systems. Aside from technological changes, potential methods and scope should also be explored with a view to ensuring a socio-ecological transition to sustainable behaviour. In order to ensure long-term room for decisions and action, the systems of innovation stated below and known here as topic areas are intended to establish a framework for the future direction of energy research **(Figure 1)**.

Technological developments and intelligent system solutions should be aimed at generating new demand on the Austrian and European domestic market and addressing the competitiveness of Austrian-based producers for the global export market. Adjustments to the market and legal frameworks are inextricably linked with changes in the roles and the interaction of the various stakeholders and require multidimensional innovation strategies.

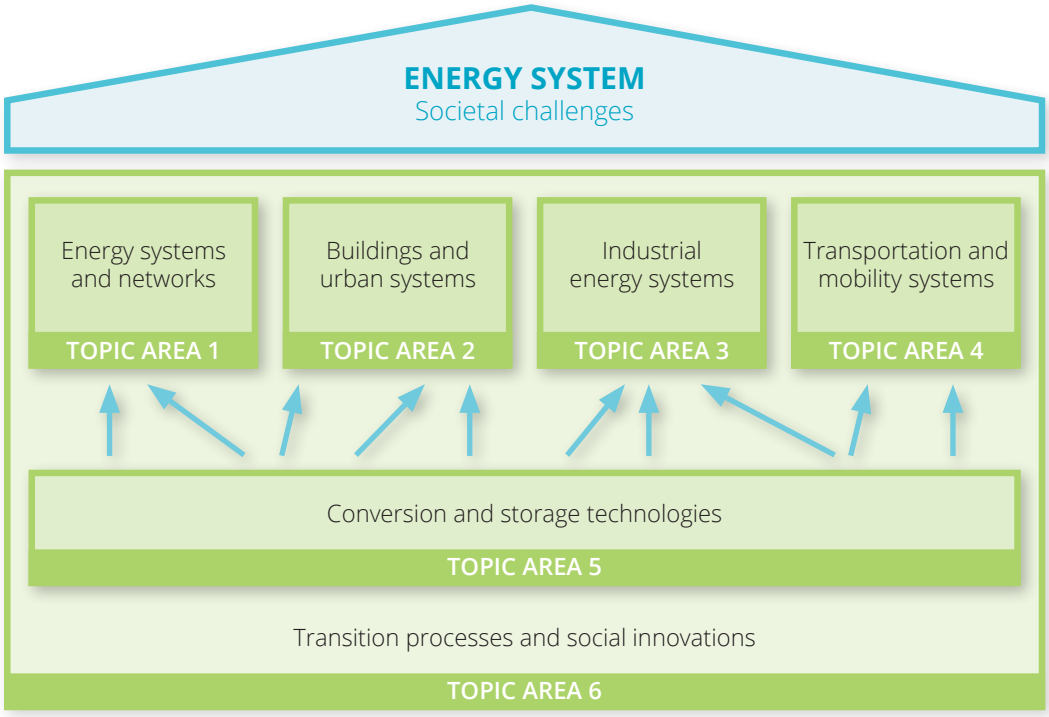


Figure 1: Topic areas for energy research

Austrian technologies and innovations as pioneers in decarbonisation

Developing an integrated view of the system is one of the key challenges in the energy system. Evaluation and system integration of the growing plethora of available technologies and solutions are important for this, as is targeted further development of the technologies and component parts. Research, development and innovation have crucial contributions to make here towards analysing complex interactions and devising possible solutions. The combination of drivers and trends arising from social, political, technological, economic and ecological developments results in a dynamic environment. The most significant drivers and trends currently include

- substantial decarbonisation of the economy,
- the future dominance of renewable and generally volatile energy sources,
- the anticipated increasing importance of electricity due to shifts in the use of types of energy (e.g. electromobility),
- technological drivers in the area of distributed energy and storage technologies,
- comprehensive digitalisation (e.g. Industry 4.0, digital construction) as well as
- trends in society such as individualisation, urbanisation, aspirations for participation and autonomy, and the sharing economy.

Against this background, energy research, technology and innovation policies are subject to change and must be focused on providing the foundation for sustainable energy supply for the future and expanding the required capacities and resources in a timely manner. However, another crucial factor is that the national market is generally saturated or too small for providers of innovative technologies and solutions. This means that in these areas, export becomes particularly significant for keeping value creation within Austria. As well as increasing international competitiveness, value creation also has a positive impact on employment and strengthens Austria's importance as a manufacturing base.

Following a detailed analysis of the current situation in each of the relevant topic areas, the following strategies, objectives and key issues for energy research were defined jointly.

Energy systems and networks

GENERAL GOALS AND STRATEGIES:

The success of structural change in energy supply is a crucial factor in the interaction between the various parts and sectors. Sector coupling is a significant priority here, i.e. linking electricity, heating and mobility systems so that renewable energies can be used as effectively as possible in an integrated way. In this kind of holistic system concept the physical world of energy with its sectors of electricity, heating and mobility and associated infrastructures (networks) should be merged (convergence), and developed in conjunction with the economic organisational aspects (transformation); these should all be aligned at the various cellular, decentralised, central and international levels (coherence).

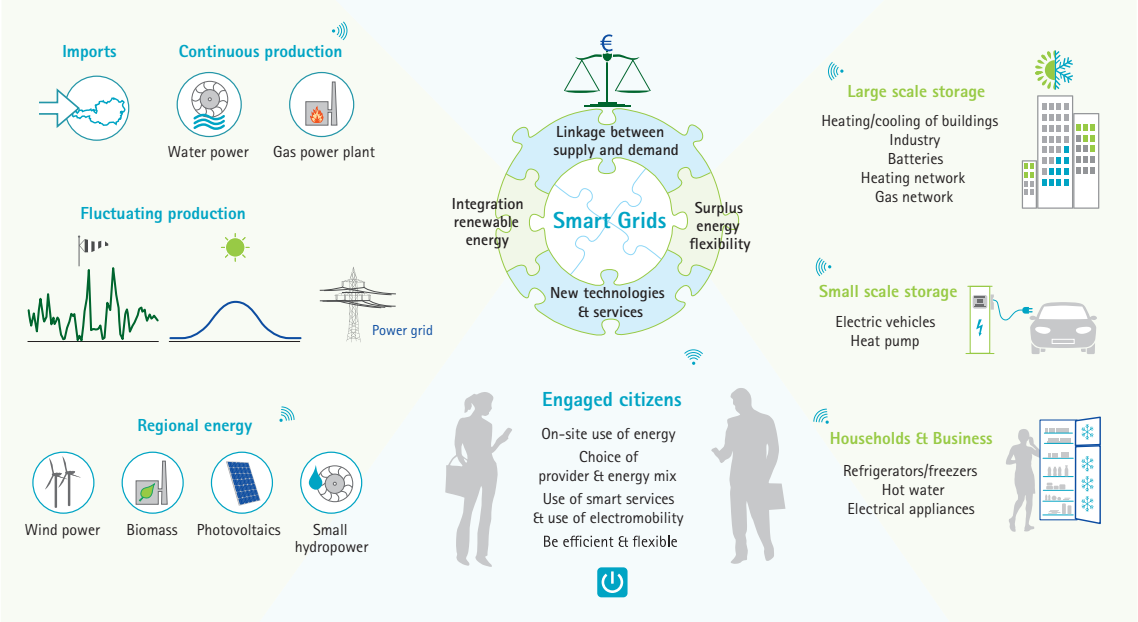


Figure 2: Energy management with smart grids

KEY ISSUES:

- Further development of the electricity systems with particular regard to distributed and cellular approaches
- Transformation of the heat and gas networks, for instance development of appropriate environmentally friendly renewable resources, differentiated network management or diversification of supply options to meet customer needs (green energy services, cooling, mobility, etc.)
- Creation of an innovative environment for user integration/development of technology-related energy services (including digital services)

Buildings and urban systems

GENERAL GOALS AND STRATEGIES:

The contribution of buildings to the future energy system, including the interaction and interplay with the infrastructures supplying these, requires a holistic approach.
The priority here is to expedite strategies aimed at increasing efficiency and reducing energy consumption in existing buildings. New buildings must have greater "energy flexibility", and be able to adapt their energy consumption to the sources available at any given time. Buildings are changing from being energy consumers into distributed power stations and play a role in balancing out thermal and electrical energy processes (generation and demand) locally across all sectors.

KEY ISSUES:

- Innovative concepts and strategies for building redevelopments which e.g. increase flexibility of use, develop local energy potentials or promote the development of ready-made, scalable technologies and solutions
- Decentralised energy storage systems which encourage use of the building or of individual sections for energy storage
- Energy-oriented planning tools, targeted e.g. at developments in the field of "digital construction" or holistic solutions on a district level
- Energy flexible buildings and districts

Source: danielschoenen/fotolia.com

Industrial energy systems

GENERAL GOALS AND STRATEGIES:

The long-term goal is to strengthen Austria's position as an industrial location and the central role this plays in the Austrian national economy. Austrian industry is developing optimised energy processes and procedures that are used in Austrian production firms and are also deployed globally by Austrian plant engineering and construction firms. Jobs in the manufacturing sector are amongst the highest quality and most secure. A reduction in the consumption of raw materials and energy, significant reductions in emissions as well as reduced dependency on raw materials and energy make a crucial contribution towards increased energy and resource efficiency.

KEY ISSUES:

- Highly efficient use of energy and resources used as well as a focus on cascading use
- A search for new products and processes ("breakthrough technologies") which achieve major reductions in consumption with the same output
- Alignment of the energy requirements of industrial plants with the energy supplies from fluctuating renewables
- Development of new products and processes

Source: Ayvengo/fotolia.com

Transport and mobility systems

GENERAL GOALS AND STRATEGIES:

To achieve decarbonisation in the area of transport, measures are needed to support the targets of avoidance, reduction, shift and improvement. In addition to optimising vehicle design, innovations will also be required for users and infrastructures in order to promote sustainable mobility behaviour. Priorities should be set for passenger mobility. In the transportation of goods the focus should be on stakeholders in the transport industry and logistics, as well as the end-consumers as users. Social as well as organisational innovations should be addressed with greater emphasis. Intelligent infrastructures in the transport and mobility systems need to be developed further in future, to facilitate innovations in usage and systems.

KEY ISSUES:

- In the area of vehicle technologies, e.g. innovative drive technologies, lightweight construction and optimised vehicle electronics
- Automation and transport telematics
- Intelligent infrastructures for the transport and mobility system along with transport infrastructure research
- Usage-related innovations and system innovations in freight traffic, in transport logistics and in passenger mobility
- Energy research in air transport

Source: vbaleha/fotolia.com

Conversion and storage technologies

GENERAL GOALS AND STRATEGIES:

For the development and implementation of energy system solutions, a variety of conversion and storage technologies are required so that these can be linked in buildings, in urban and industrial systems and in networks, as well as in transportation and mobility systems, in order to form one integrated energy system (sector coupling, Figure 3). Only when the individual technologies are successfully developed and optimised will it be possible to adapt these to the given requirements for each specific application and to find cost-effective and integrated system solutions. In an international context this opens up new target markets and opportunities for Austrian firms and industries focused on exports, where innovative technologies and solutions will be in demand, and so strengthen their position further. The key issues identified affect all end-use energy sectors: heating and cooling, electricity and fuels.

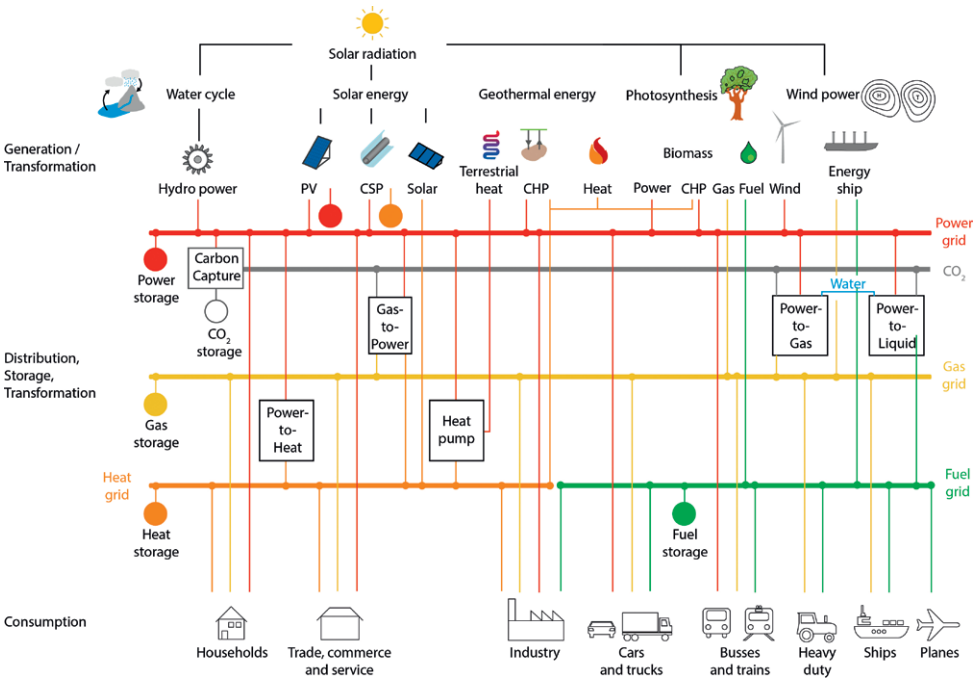


Figure 3: Energy storage systems as a key element in sector coupling (Sterner and Stadler 2014)

KEY ISSUES:

- The efficiency potential for existing and future systems must be exploited and losses minimised along the entire conversion chain – from provision to transport and storage, through to usage.
- Optimising conversion technologies and developing new cost-effective procedures (in the areas of bioenergy, solar thermal energy, heat pumps and cooling systems, photovoltaics, wind power, water power, fuel cells, geothermal energy)
- Further development of storage technologies, since direct electrical as well as thermal, mechanical and physical storage systems will be important components in an integrated network structure in future. Attention must be paid to the optimum selection and coupling of storage technologies from the systems perspective.

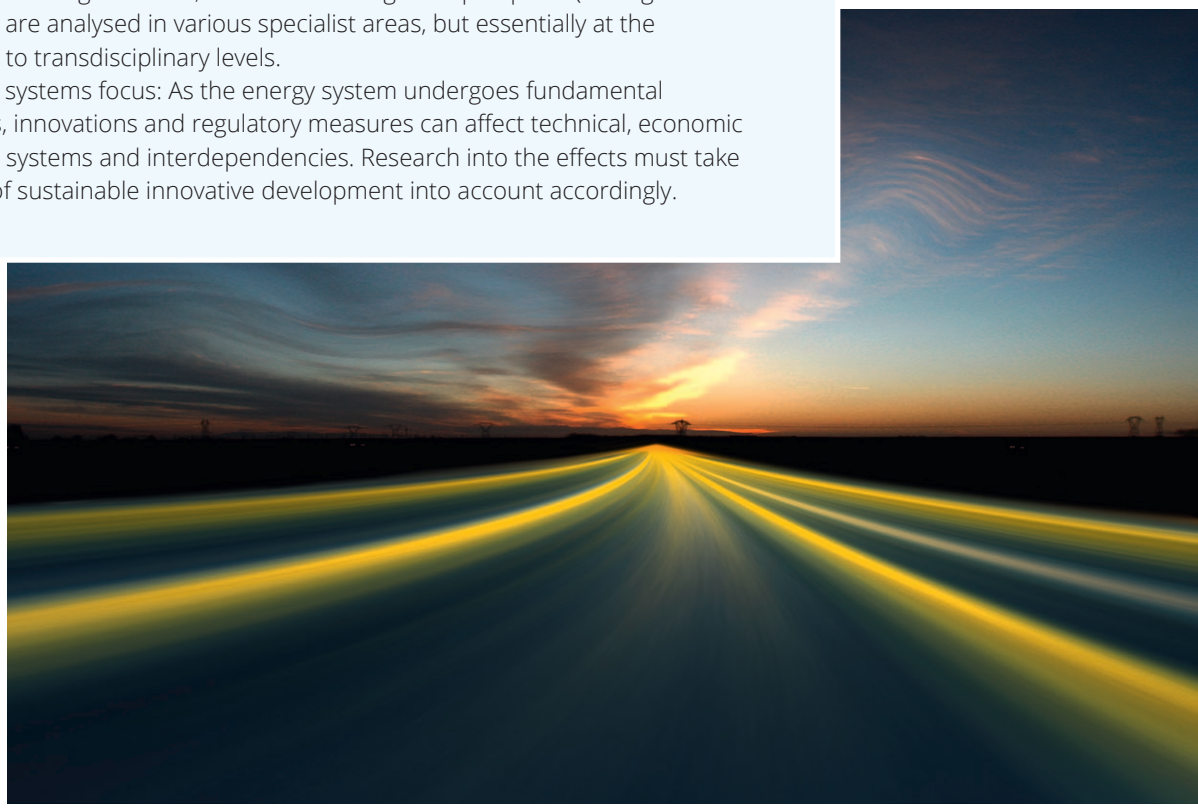
Transition processes and social innovation

GENERAL GOALS AND STRATEGIES:

Innovative processes depend not only on excellent technology and economic competitiveness, but also on the cultural, social and legal environment. The correlation between the technology selected and developed on the one hand and the market structure, legal conditions and appropriate institutional and organisational structures on the other requires systematic examination and better understanding in order to develop innovative technologies and improve their market conditions. Transition processes and social innovations are an important component in energy research, and greater knowledge of transition processes can assist in developing a deeper understanding of social and economic change and in shaping the foundations for better regulation as a result.

KEY ISSUES:

- Fundamental issues related to how the transition processes accompanying any fundamental restructuring of the energy system can or should be better understood, analysed and communicated as part of public discourse.
- Practical issues affecting the short, medium and long-term prospects (through to 2030 and 2050) are analysed in various specialist areas, but essentially at the interdisciplinary to transdisciplinary levels.
- Research with a systems focus: As the energy system undergoes fundamental transformations, innovations and regulatory measures can affect technical, economic and sociological systems and interdependencies. Research into the effects must take all dimensions of sustainable innovative development into account accordingly.



Source: Lulu Berlu/fotolia.com

Energy Research and Innovation Strategy

The energy revolution has already started

The **WORLD OF ENERGY** is undergoing major changes Research and innovation are essential pillars of a promising future strategy for shaping the energy supplies of tomorrow. The Paris Climate Agreement, signed by 195 nations, came into force on 4 November 2016, setting the course for decarbonisation and defining a set of common goals The international community has declared the binding goal of aiming to limit global warming to well below 2°C as compared with pre-industrial levels and to below 1.5°C if possible.

Austria was one of the first countries to ratify the Paris Climate Agreement as decided in the meeting of the National Council on 8 July 2016. From a global perspective therefore the entire energy supply system is facing fundamental change. The dramatic development in costs and the markets at the same time in relation to new energy technologies (see Figure 1) show that this upheaval has already started. Austria is seizing this opportunity for domestic firms in one of the world's largest growth markets and intends to play an active leadership role in this structural change in energy supply and in developing new business areas. Climate change and new technologies, as well as social and economic conditions in a state of upheaval are placing energy research and innovation at the centre of many relevant processes. An aggressive research and innovation strategy can make an contribute significantly towards Austria becoming an important stakeholder and market participant in this development.

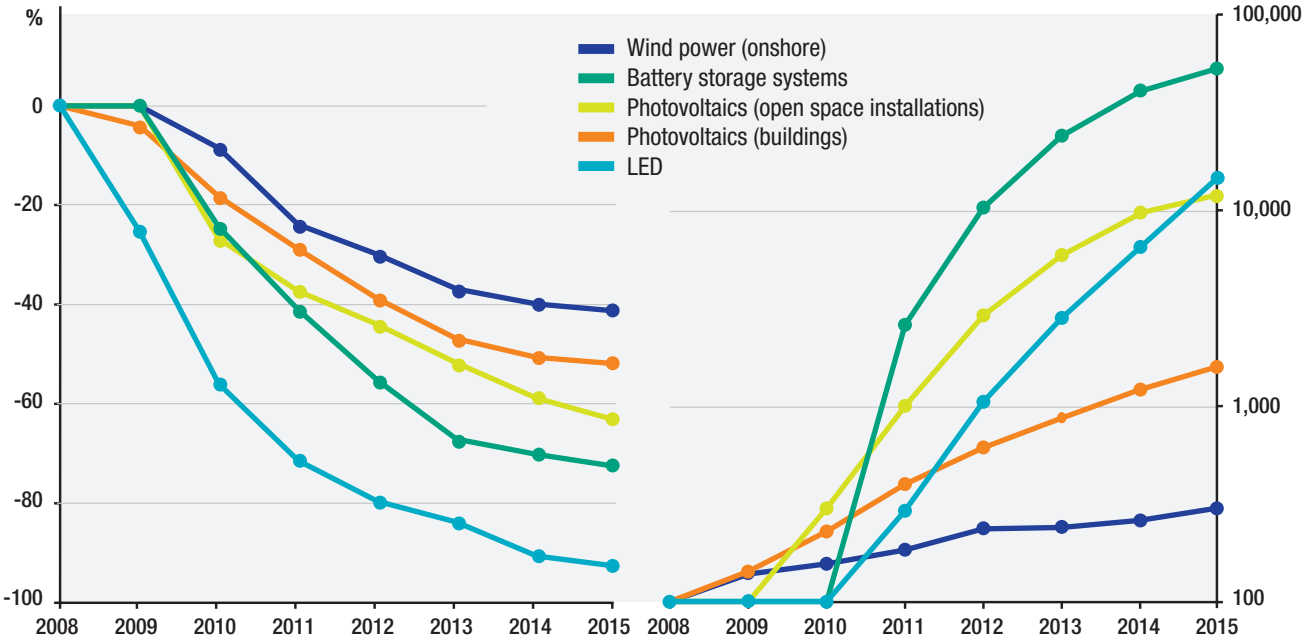


Figure 4: The costs trend (on the left in percentage terms) and market dynamics (logarithmic presentation on the right) in five areas of technology since 2008 (USA)[1]

1 Logarithmic presentation: Annual installed capacity in MW (PV and wind), installations (LED) and cumulative sales figures for electric vehicles
Source: US Department of Energy: Revolution...Now: The Future Arrives for Five Clean Energy Technologies – 2015 Update,"
http://www.energy.gov/eere/downloads/revolution-now-future-arrives-five-clean-energy-technologies-2015-update

Based on the Energy Research Strategy published by the Austrian Council for Research and Technology in 2010, the Federal Ministry for Transport, Innovation and Technology, in conjunction with the Climate and Energy Fund, launched a consultation procedure in the spring of 2016, to support the alignment of future activities in the area of energy research and energy innovation with the current objectives. Content-related as well as strategically relevant issues were discussed by representatives from research, business, administration and interested members of the public. The substance of the discussion is summarised in the discussion paper and in the documentation for the "Future of Energy Dialogue 2050" which also included a series of events and an online survey. The Energy Research and Innovation Strategy is intended to form a basis for decision-making and an important reference point for research, technology and innovation policy through its multi-year focus. The aim is to outline a long-term perspective and at the same time an instrumental framework, in order to anticipate new developments in the highly dynamic world of energy and to enable corresponding adjustments to research, technology and innovation policy measures. Rapid action and responses will be essential to success in the new energy markets in order to achieve “first mover” advantages for stakeholders in the domestic market.

The energy supply and energy services of the future will be heavily influenced by further technological developments and innovations, as evidenced by the breakthrough for renewable energies in the international electricity markets over the past few years. However, changes in society which enable the required gradual move away from the use of fossil energy will also exercise considerable influence.

Vision: Making Austria the global innovation leader in energy for the future

This vision forms the basis for strategic planning. It makes it all the more important to have some idea of the desired outcome for the Austrian Energy Research and Innovation Strategy from a future perspective. The next chapter attempts a look back from the energy world of tomorrow:

The energy of tomorrow is clean, safe and affordable. The switch to a post-fossil energy system required on environmental, climate and resource grounds has resulted in a massive reorganisation of the global energy infrastructure. Our understanding of the energy system and our handling of energy have changed fundamentally as a result. CO_2-neutral solutions based on renewable raw materials and energy sources are the norm. Intelligent energy systems are able to compensate easily for fluctuations in production and consumption using smart controls and a variety of storage concepts. This allows society's basic needs in terms of energy and energy services to be covered for everyone; social inequalities and conflicts over resources have also been reduced considerably at both national and global levels.

Thanks to the initiative of numerous individual stakeholders, firms and social groups, Austria has used its position as an innovation leader to exploit the required reorganisation of the energy system as an economic opportunity. This has resulted in CO_2-neutral energy supplies based on renewable energy at the national level. Internationally Austria has provided significant momentum in terms of achieving the goals of the Paris Climate Agreement and been able to overcome one of the most important economic and social “grand challenges” of the 21st century as a result. One important driver has been the creation of an innovation and market environment that does not focus on producing and transporting energy, but concentrates instead on meeting the demand for energy-based solutions and services.

Austria has been able to improve its trade balance considerably through increased use of local and regional resources and by boosting exports of technologies and services in the energy sector. In cooperation with international partners the country has now established itself as a technology and innovation leader in energy-related areas. A social transition has been made possible as a result of improvements to the environment for technological developments and energy innovations. This allowed the essential levers to be set in motion for CO_2-neutral production and use of energy across all sectors. Successful location development and increased international competitiveness were the crucial factors here. Energy-related research and innovation provided the trigger for a successful boost to employment and played a crucial role in guaranteeing the security of the energy supply. As a result Austria was able to position itself as an attractive location with optimum infrastructure conditions for the best talents and innovative firms.

The population has accepted energy-efficiency measures and intelligent energy systems and there is a high level of awareness towards the environment and energy issues. Enthusiasm for research, development and innovation are now self-evident in Austria and across Europe. Austrian stakeholders have been able to make crucial contributions to a global learning process which has ultimately led to a fundamental transformation in energy systems. A significant success factor in this has been the consistent focus of technical solutions on developments in society and the needs of the population. Users and consumers have been seen as integral components in the energy system and more intensively involved in energy research and innovation development. A "mission-oriented" energy research and innovation policy set the course for this.

High standards have transpired to be crucial factors in the transition and drivers of technological development both within the European Union and at the international level. This has strengthened Austria's position as a production location for the long term. Lifecycle considerations, the circular economy, energy efficiency by design and cascading use of resources have now become established aspects of the economy.

Energy-related research is now a matter of course and regularly used as an input for political decision-making processes. Setting the right course for shaping the energy systems of the future had already been a concern in the past. Increasing public as well as private funding for energy research was seen as a crucial investment. The clarity of political and social objectives created certainty for correspondingly far-sighted investment. Responsible science and a proactive approach to open innovation became the guiding principles in energy research. This resulted in the innovation system being opened up, expanded and developed further, with increased efficiency and a focus on output and digital fitness for stakeholders. Stakeholders from science, civil society, politics and public administration now cooperate in a different way, focusing on objectives through more open knowledge and innovation processes.

Current situation

The European Union (EU) has set itself the long-term goal of reducing greenhouse gas emissions by 80–95% by 2050, in comparison to the levels of 1990, as well as increasing the ratio of renewable energy sources as a proportion of overall energy consumption, and increasing energy efficiency. The architecture of the Paris Climate Agreement includes an option for intensifying the voluntarily reported climate protection plans of the signatory countries, as part of the review process that takes place every five years, in order to achieve the goal of 2° or 1.5° and the greenhouse gas neutrality which is a target for the second half of the Century.

The upheaval in the energy supply system is now not purely a feature of declarations of intent and political documents, but is also being reflected in the markets. The pull towards decarbonisation and a transition of the global energy system has already gathered pace over the last few years. In 2015 and 2016, around EUR 270 billion was invested globally in renewable energy sources – this was considerably more than the investments in new fossil and nuclear power plants and around double the amount invested a decade earlier.[2] The development and installation of technologies for using renewable energies have made huge progress over the last decade. In 2015 there were 147 gigawatts (GW) of power installed as new from renewable energy – more than ever before. A further 38 GWth (thermal) was also installed for heating. This development will continue and also be stepped up. The International Energy Agency (IEA) also expects a significant increase in investments in other areas, e.g. energy efficiency measures. This can be seen in industry and in services, as well as in the building sector, where higher energy efficiency standards in many countries demand corresponding measures.[3] Global success is also reflected in the employment market: 8.1 million employees could be attributed to the renewable energy sectors in 2015.[4] International market development in renewable energies, intelligent energy technologies and energy efficiency, supported by innovation, offers major opportunities to Austrian firms for successful cooperation, thanks to the skills and expertise in Austria. International competition for the best ideas, concepts, implementation projects and technologies is heavily driven by innovation. Strong positioning as an innovation driver in the transformation of the energy system is therefore a relevant goal from both economic and social perspectives.

Increasing significance of energy research and innovation

In recent years energy research has become significantly more prominent in Austria. Its importance for shaping the future of energy supply is undisputed both against the background of the challenges posed by climate protection, and from the perspective of economic and social policy. Public expenditure on energy research has increased significantly in recent years. In 2015 expenditure amounted to EUR 128.4 million. The largest share (EUR 57 million) of this was spent on "energy efficiency".

The effectiveness of research sponsorship and funding can be measured amongst other things by how research results are reflected in energy market developments. Austrian firms in many market segments can refer to their technology leadership, and the interaction between research, development and innovation on the one hand and the economic conditions for the individual technologies on the other are crucial to future success. Austria can already build on industrial success in plant construction, energy and environmental technology. More than 195,000 “green jobs” are attributed to the environmental technology sector. Around one in every twenty employees in Austria works in environmental technology, including service firms. Approximately 12% of GDP stems from revenues in the environmental technology area. Two in every three biomass boilers installed in Germany come from Austria, while exports account for 82% of thermal collectors and 70% of the wind power supply industry.

Austrian firms involved in biomass, photovoltaics, solar thermal energy, heat pumps and wind power generated revenues of EUR 4.3 billion in 2015. Significant stimulus is attributed to successful research programmes in terms of developing and consolidating the technological expertise of research stakeholders and the market position of Austrian firms. The area of sustainable construction can be used as an example here. Austria has become a frontrunner – both in terms of research skills and expertise and in relation to specialised firms that are proving successful in national and international markets. This requires further development of an environment that is conducive to energy innovation, including in the reference and domestic markets of Austrian providers.

2 Based on Bloomberg New Energy Finance: Clean Energy Investments Fact Pack, January 2017
3 See International Energy Agency (IEA) among others: World Energy Outlook 2016, Paris 2016
4 International Renewable Energy Association (IRENA): Renewable Energy and Jobs: Annual Review 2016

Austria's efforts in energy research policy are also finding recognition internationally. A series of Austria's actions received positive mentions as part of the International Energy Agency report on the in-depth review of Austrian energy research and energy policies in 2014[5]. The IEA highlighted the success of energy research in developing sustainable energy technologies intended largely for export markets, the increase in energy research expenditure and the integrated approach to research, demonstration projects and market development, for instance in the founding of the Climate and Energy Fund.

Austria's involvement in international research and innovation activities

Energy research and innovation also enjoy a high priority at the European level. One particular highlight in this context is the Strategic Energy Technology Plan (SET Plan) aimed at stimulating energy-related research and industry activities in the European Union. European Technology and Innovation Platforms (ETIPs) were set up to develop strategies for achieving the goals stated above; through these platforms the relevant European industrial organisations and joint research programmes at the European Energy Research Alliance (EERA) work together to develop shared roadmaps. Innovation targets and implementation plans are being set out in specific working groups of the high-level SET Plan Steering Group, under the auspices of the EU Member States in coordination with the corresponding ETIPs and the European Commission: the goal is to make Europe the global market leader in technologies for the use of renewable energies, create an intelligent and innovative energy system and reduce dependency on fossil energy sources by consistently pursuing the climate targets. A significant driver in implementing the SET Plan comes from the energy research grants offered by the EU Framework Programme for Research and Innovation ("Horizon 2020"), as well as multilateral research funding cooperation by the European states, e.g. joint programming initiatives or "ERA-NET" projects.

Since more than 80% of research in Europe is funded by the public sector at the national level, principally via national and regional research programmes, Europe's national and regional research programmes need to be coordinated more effectively and aligned with each other in order to realise the major strategic goals. This was the principle behind the ERA-NET scheme, which was developed as a part of the 6th and 7th EU Framework Programme. It has been strengthened further in the current Horizon 2020 Programme in order to continue cross-border cooperation in research and technology. The Federal Ministry for Transport, Innovation and Technology is currently coordinating the "ERA-Net Smart Grids Plus" and "ERA-Net Smart Cities and Communities" initiatives, and is involved in further energy-related ERA-NET campaigns, such as "ERA-NET Transport", "ERA-NET Smart Urban Futures", "ERA-NET Sustainable Urbanisation - Global Initiative", "ERA-NET Bioenergy" and "SOLAR-ERA.NET" (working in conjunction with the Energy and Climate Fund for the latter two). Projects on topics such as smart grids, buildings and cities are also currently in progress within the scope of the Germany-Austria-Switzerland (D-A-CH) cooperation. The decision in the Austrian Governmental Programme 2018-2022 to participate in the **"Mission Innovation"** initiative, a global clean energy initiative, was a further step towards greater international cooperation and coordinated research and development efforts. The countries taking part are pursuing the goal of significantly accelerating the development of technologies for the use of CO_2-neutral energies and making these available to society. The public funds to be spent on research and development should be doubled in the next five years.

Austrian experts and firms are also actively involved in numerous IEA Technology Collaboration Programmes and groups of experts, which constitutes a further important instrument for Austria's global positioning in the area of energy and environmental technologies.

5 https://www.iea.org/countries/membercountries/austria/

Levels and areas for action

In developing the structure already used in the Energy Research Strategy 2010 this strategy paper employs an amended form of the levels of action defined there. The Energy Research Strategy is being expanded to include an innovation strategy, to ensure that any products of this research are taken to the global markets. The structure also takes account of the fact that transnational research funding and the realisation of research outcomes in global markets has become increasingly important.

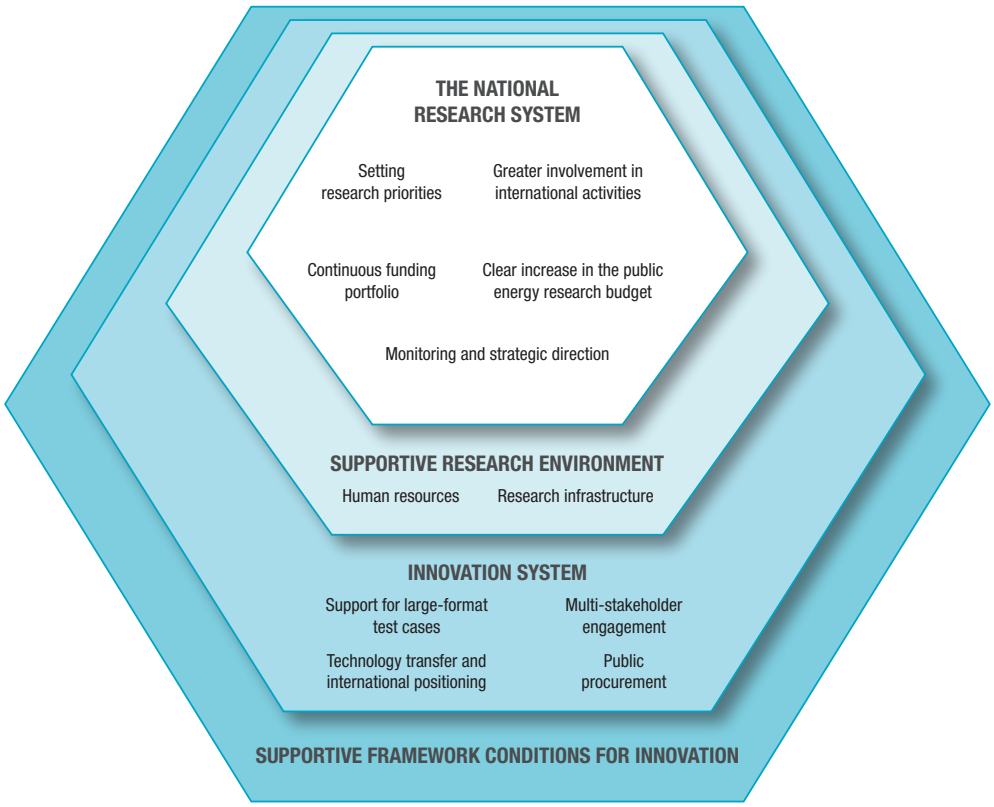


Figure 5: Levels and areas for action in the Energy Research and Innovation Strategy

Austrian energy research system

To provide the long-term scope necessary for decisions and actions to be taken to achieve the goals, it is essential to develop a systematic approach which takes full account of the interdependencies between individual levels of activity. The system of grants for energy research and innovation should be developed further based on the following proposals:

Clear research priorities

Austria's researchers working in university and non-university research cover a broad range of energy-related topics. This positioning receives significant support from the technology programmes of the Federal Ministry for Transport, Innovation and Technology and the Climate and Energy Fund.
The priority topic areas defined through the "Future of Energy Dialogue 2050" process are an important reference point for the future direction of activities in energy research and energy innovation.
The links between research, business and policy which are required for the transition to be widely accepted must focus on people and their basic needs (housing, mobility, etc.). Ongoing monitoring of developments should allow new research priorities to be set, and also phase out topics that are no longer relevant.

Greater involvement in international activities

Austrian research is well established in the international environment. Early identification of relevant international topics by the Austrian energy research community and the international network of contacts for Austrian exporters is supported and enhanced by greater transnational research funding cooperation. Austria's promising position in these areas can be recognised inter alia through its leadership role in EU programmes (such as JPI Urban Europe or ERA-NET Smart Grids Plus) and IEA activities. This kind of funding cooperation should be boosted both at the level of public-public partnerships (ERA-NETs and JPIs) and through public-private partnerships. Collaboration in global innovation initiatives should also be stepped up considerably. The need for these types of transnational cooperation arises not only from the comparatively small size of the Austrian market, but also from the importance of involvement in global value creations chains at the highest possible level. Austria must be seen as a reference market which constitutes a basis both for the European domestic market and for global markets.

Continuous funding portfolio, from basic research through to transition to the market

The system migration required for transition to a climate-neutral economic system will rapidly succeed if the conditions are improved for innovations and market penetration. This means that appropriate actions are taken in the whole energy-related innovation system and along the entire development chain which allow new technologies to be integrated in a wide range of areas. Breakthrough technologies will increasingly find applications not just in energy production, but also in energy use. To push these developments forward, new conditions must be created for focused basic research.

Increase in the public research and innovation budget in the energy area and greater involvement of private investment

The Energy Research and Innovation Strategy aims to make Austria an innovation leader in the energy sector. To achieve this, public expenditure on research and innovation need to be increased significantly. A high proportion of this should be processed via the Climate and Energy Fund, as the funding institution across all stages of innovation development. The specific role of public expenditure for research and innovation in stimulating private funding for energy innovations must be taken into account against the background of future-oriented investment in Austria. In accordance with the Austrian federal government's Strategy for Research, Technology and Innovation (RTI), further incentives should be provided to achieve a significant improvement in the amount of research and innovation, by involving private investment in research, development and market realisation.

Monitoring and directing research and innovation

Research and development are embedded within complex interactions, provide analyses and ideally also solutions, and are subject to constantly changing drivers and trends. Whether it is digitalisation, Industry 4.0 or urbanisation, such social, political, technological, economic and ecological developments all require continuous adjustments to the priorities and measures aimed at achieving the set goals. Any such adjustments are derived from by impact-oriented evaluations of RTI programmes and regular monitoring of the research and innovation system, then drawing appropriate conclusions. Strategies are ideally developed and coordinated on a cross-ministry basis and in agreement with the federal states. The RTI Task Force deployed in connection with the federal government's RTI strategy and the "Climate and Resources" working group (RTI WG2) are already delivering good work in this area.

Supportive research environment

For the required transformation of the energy system, firms and (research) institutions also need adequately qualified staff. The goal therefore is to achieve a significant increase in the number of researchers at universities, universities of applied sciences and also at non-university research establishments in the energy sector. This should be targeted at an early stage of education in order to arouse an interest and appetite for becoming a researcher. Further development and expansion of targeted sponsoring for up-and-coming talent in the energy area should contribute to this, as well as creation and expansion of training opportunities throughout the value creation chain of research, innovation and market. Even if the issues are predominantly technical and scientific, care must be taken to ensure that social science-related issues are also considered with regard to acceptance of technologies, system transition and changes in the economic system.

Interlinking research with the stakeholders in implementation is important in order to increase the relevance of research results to solutions. More integrated approaches should be offered in future. Increasing the transfer of knowledge and technology, particularly from HE institutions to industry, should help the results achieved in research also to generate socially relevant applications and value creation on the market. Creating and expanding joint research infrastructures in the energy system supports Austrian energy researchers and firms in positioning themselves more effectively on the European and global markets.

Innovation system

Austria aims to be an international innovation leader. The energy sector offers outstanding opportunities both in the application of new technologies and in particular in marketing machinery, equipment, procedures and services developed in Austria. New energy solutions and energy technologies will most probably become the 21st century's biggest growth market. For export-oriented technology providers in the energy sector it is important to consider not only application-oriented potential in the reference market of Austria, but also the European domestic market and global markets, particularly the emerging markets. Structured interaction between technology providers and users is required for the reference market. This can help providers to overcome what is often the difficult phase leading to initial launch on the market. In this phase, frequently referred to as the "Valley of Death", options for public research funding often run out before private investors have been found who are willing to take a risk and support the market launch. A range of funding instruments should offer appropriate support at different stages of innovation development.

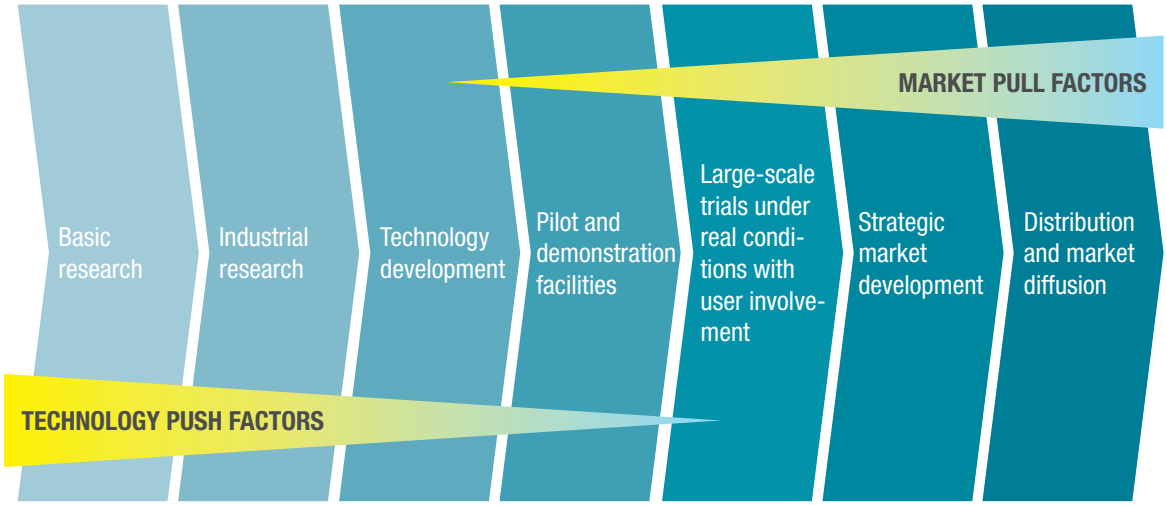


Figure 6: Stages in the innovation process

Large-scale trial phases under real conditions

Particular importance is attached to the implementation of large-scale solutions as well as development and test phases. This involves integrating individual technologies into entire systems, where their interaction is optimised and where relevant findings and empirical values can be gathered under real conditions, and with user involvement, which can then be used to guide wider implementation. Different funding options need to be combined and coordinated within the scope of a long-term setup and test phase in order to enable these types of large-scale trial phases. These test phases requirement the alignment and merging of research funding, investment funding and also private investment. Support is also provided for the development and implementation of Austrian innovation in pioneering flagship projects.

Multi-stakeholder engagement

When implementing complex energy solutions there is often a wide range of stakeholder groups that need to be involved. Strategic linkage between Austrian firms is sought in order to combine skills and strengths and make it possible to offer comprehensive solution packages. Solutions in the area of "smart cities" for instance require numerous stakeholders to work together to enable a coordinated approach in target countries, offering implementation appropriate to the market. Effective cluster management, technology platforms and networking activities have already been established in some topic areas in Austria. These should be continued and linked in with regional approaches across Austria.

Technology transfer and international positioning

Since there is no alternative to internationalisation for firms focused on innovation, not least on account of globalisation and the relatively straight-forward domestic market, firms receive support through a number of measures in this challenging growth stage. A range of measures and programmes should support firms with the active transfer of technology. Crucial factors for the successful positioning of Austrian energy technology providers are active networking and cooperation on international initiatives and strategic bundling of individual strengths to form comprehensive solutions. Firms can organise themselves into clusters and offer these solutions jointly on the international stage. Clear positioning for Austria in terms of decarbonisation, which conforms with the goals of innovative firms, also contributes to strategic market development and international visibility of the firms active in this area.

Public procurement in the energy sector that supports innovation

Demand-side stimulation for innovations is becoming increasingly important as a complement to supply-side approaches, such as direct and indirect funding for research, technology and innovation (RTI). The introduction of energy innovations is helped by pre-competitive procurement arrangements and visible examples of success for energy-related procurement that supports innovation.

Supportive framework conditions for innovation

The success of energy research and innovation is dependent on many factors. Tax law conditions, energy and climate protection policy, market and price developments as well as the start-up culture are just a few examples of this. Framework conditions are needed that are stable and allow long-term planning and provide new scope for long-term innovations. The development of a European domestic market, with Austria as the reference market, is crucial for the prospects of long-term innovations. Despite the significant focus on exports in Austrian industry, Austria also needs appropriate market conditions to provide reference markets and to keep promising Austrian-based firms in the country. For this, an environment that is conducive to investment, the process for dealing with intellectual property, access to research for small firms, market conditions that are friendly to innovation, energy prices, standards and regulations along with appropriate communication of energy research and innovation must all be taken into account.

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Publications

All of the publications and technology roadmaps and strategic papers created in the Future of Energy Dialogue 2050 are published on the website www.e2050.at.
Overview of publications:

- ENERGY Research and Innovation Strategy – Strategy
- ENERGY Research and Innovation Strategy – Discussion paper
- ENERGY Research and Innovation Strategy – Summary
- ENERGY Research and Innovation Strategy – Analysis document

Publications on the Strategy

STRATEGY

DISCUSSION PAPER

SUMMARY