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Higher Education and Smart Specialisation in Lower Austria

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Executive Summary

Lower Austria as a unique case

Higher Education Institutions (HEIs) can be key players in regional innovation ecosystems and for the design and implementation of Smart Specialisation Strategies (S3). However, regions in Europe are diverse, in terms of their economic and institutional structures, higher education systems, and competences and capabilities for S3 management. The project on Higher Education for Smart Specialisation (HESS) has included several case studies where historic and internationally renowned universities have not played a significant role in S3. This can be explained by a variety of factors, from weak strategies and regional institutions, problems with multi-level governance, to a lack of local engagement by the universities concerned. On the other hand, this case study of Lower Austria shows that even in a region with a small higher education sector, an absence of traditional research-intensive universities and an economy in transition from agriculture, that HEIs both within and outside the region can be important partners for S3 managers.

The HESS project and action research

The HESS project is managed by the European Commission's Joint Research Centre on the initiative of the Directorate General for Education, Youth, Culture and Sport. Since 2016 a series of case studies have aimed to find out how HEIs are involved in smart specialisation and how stronger partnerships can be built with regional authorities. One of the features of the HESS case studies is that they are designed and carried out closely with the regional authority, HEIs and other innovation actors. This is because the one of the objectives of the HESS project is to help build stronger regional partnerships. In the case of Lower Austria, unfortunately the action research was handicapped to a large extent by the Covid pandemic, which broke out shortly after work had begun. Nevertheless, a wide range of innovation actors, regional and national policy makers were interviewed, and online methods were used as far as possible.

Economic development and higher education in Lower Austria

Lower Austria is a region defined by its proximity to Vienna, the country's capital city with high levels of research and innovation, and many leading HEIs. However, compared to the hinterlands of other capital cities in Europe, Lower Austria has turned this into an advantage, while also cooperating with regions in neighbouring countries of Central Europe. Economically, Lower Austria has grown at a faster rate than the rest of the country since the last financial crisis, especially in the manufacturing sector. Higher Education is dominated by Universities of Applied Sciences, accounting for half the overall number of students, compared to 20% nationally. The region also hosts a leading HEI catering for continuous professional development and lifelong learning, namely the Donau-Universität Krems, which has about 40% of the overall student population. In addition, there are a number of important research institutions that are joint ventures with Viennese universities, with some of them, including the Austrian Institute of Technology and the internationally renowned IST Austria, having a growing number of PhD students.

Smart Specialisation in Austria and Lower Austria

Austria has a relatively low allocation of European Structural and Investment Funds (ESIF), which in the 2014-2020 programming period have been used as co-financing for a single national Operational Programme. The ex-ante conditionality related to smart specialisation was therefore also met at national level through a research, technology and innovation (RTI) strategy of the federal government called "Becoming an Innovation Leader". However, a well-developed system of multi-level governance has been put into place, with a specific department of the federal ministry for Science, Research and the Economy being responsible for interacting with the states and distributing the ESIF via intermediary regional bodies. Furthermore, much of the national budget for R&I has been spent on the same programmes funded by the ESIF that follow the smart specialisation approach. The economic development strategy of Lower Austria included a strong focus on research and innovation before the advent of smart specialisation. Today, in line with guidance on smart specialisation from the federal level, the economic strategy combines identification of strengths and potential in vertical priorities with horizontal development of related diversity.

Intermediaries as key actors in the regional innovation ecosystem

The continued support for technopoles (physical sites bringing together business services and research centres) lie at the heart of Lower Austria's success in fostering innovation. Launched in 2014 and funded by the ESIF, the technopoles interlink the three components of the knowledge triangle, namely research, education and

training, and business development. At the core of the technopoles are technology and research centres (TFZ) offering tailor-made physical and research infrastructures, services for research-based businesses, and facilitation of networking and project cooperation. Investments into these technology centres have amounted to up to €37.5 million over ten years, while 3500 jobs have been created, including 1500 research positions. In addition to the technopoles, since 2001 a cluster policy programme has supported innovation in businesses through thematically and sector-oriented training, identification of innovation opportunities and potential partners as well as facilitation of collaborative projects amongst companies and / or researchers. A more recent innovation is *The House of Digitalization*, as an interactive platform offering personalised services to individuals and businesses with digital concerns and interests. It includes an online system to network Lower Austrian companies with research and educational institutions, as well as being a meeting point for interested citizens in the field of digitalization. Furthermore, a physical building is soon to be constructed. Such intermediaries as well as others described in this report provide the oil that lubricates the regional innovation ecosystem and connects HEIs with businesses and civic society.

Support for the region's higher education institutions

Another key element of Lower Austria's regional innovation policy is the support given to its growing HE sector. In 2011, a dedicated department was created to help Lower Austria in its transition from an agriculturally dominated region into the knowledge economy. It has supported university infrastructures, study programmes, personnel (such as sponsored chairs) and, since 2015, through administering project funding calls via its own research funding programme (in close concertation with the Department for Economy and Tourism). Furthermore, as qualified personnel is recognised as vital for innovation, the region has proactively supported HEIs in national competitive calls for new study programmes as well as expanding the training and continuing professional development offers for businesses (e.g. in digital transformation) in line with economic demand. While the main activity of the region was initially to support bottom-up initiatives, in October 2019 a Higher Education Strategy was adopted, which is embedded in the wider research, technology and innovation strategy processes.

Governance of regional innovation policy

Although the HE strategy cuts across regional and national competences, it is implemented in synergy with other strategic frameworks. This leads to the final section of this report and probably the most important success factor in Lower Austria's regional innovation policy, namely the governance structures that have been put in place. Within the region, innovation actors have praised the open, inclusive and transparent process in setting up and interacting with regional institutions, including the HEIs, technopoles and clusters, creating feedback loops to improve the overall strategic framework. HEIs in particular reported that the regional authority has been very active in promoting and expanding the sector, through its own competences and through advocacy at the federal level. Finally, within the regional government the departments for economic development and research and innovation have worked closely together to ensure the different strategies and measures are implemented coherently and with the support of actors in the regional innovation ecosystem.

Areas for improvement

While this report presents many positive aspects of the Lower Austrian approach to HE and S3, a number of open questions and improvements are suggested, including: engaging in partnership based foresight that brings together Viennese universities with Lower Austrian businesses to discover disruptive technologies that could make an impact in the regional economy; a more systemic integration of sustainability concerns into its technopoles and clusters; building on the success of Donau University Krems in attracting students from outside Lower Austria, through cooperation with other regional HEIs; and advocating for national incentives to promote cooperation between HEIs.

1. Introduction

This technical report presents the results of a case study in the region of Lower Austria, as part of the project on Higher Education for Smart Specialisation (HESS), an initiative of the Joint Research Centre and DG Education, Culture, Youth and Sport of the European Commission. The action research approach that is normally adopted in HESS case studies, namely to develop and implement the case study in close contact with the regional authority and local innovation actors, was limited due to the Covid pandemic, which broke out shortly after work began. Much of the research had to be conducted online, but a final event could be held to discuss the results once the pandemic has ended.

Nevertheless, the case study of Lower Austria provides a particularly interesting perspective on the subject of how Higher Education Institutions (HEIs) can be harnessed to support innovation. While many of the other HESS case studies involved regions with historically important traditional universities, Lower Austria only has relatively small Universities of Applied Sciences (UAS) and the Donau University Krems, an internationally renowned public university that specialises in continuing professional development courses and degree programmes. However, the government of Lower Austria has made up for this through strategically targeted cooperation initiatives with these HEIs, research institutes and traditional universities from neighbouring Vienna, while using its oversight of the UAS sector to boost their presence in the region.

The report is structured across four main sections. The first one presents the national and regional background to smart specialisation, higher education, and the financial measures to support innovation ecosystems. The particular situation of Lower Austria neighbouring Austria's capital is presented, showing how it has turned some of the usual threats to such regions into advantages. Moreover, it has connected to regions in neighbouring countries of Central Europe. This is followed by a detailed analysis of how the Smart Specialisation Strategy (S3) of Lower Austria was developed as part of the regional and national strategic frameworks for economic development and innovation. The third section focuses on the main success factor of the regional innovation ecosystem, namely the flagship technopole and clusters programmes that have remained stable and yet dynamic over the years, latterly being key players in linking business with HEIs in the context of smart specialisation. Finally, a section on governance explains how Lower Austria has reconciled multi-level governance challenges, increased participation among innovation actors, improved its funding schemes, and promoted the strategic interests of the region. A conclusion summarises the success of Lower Austria in working with HEIs but also some of the weakness that could still be improved.

2. Background analysis

2.1 Economic and Knowledge Base of the Region

With more than €61 billion gross regional product (2018), Lower Austria contributes 15.8% to the national economy of Austria. Since the financial crisis and its aftermath, the economy has revived and grown significantly, with annual growth rates of 1.8% (2019) to 2.8% (2018), above the Austrian growth rate since 2018, and higher growth compared to the rest of the country in the manufacturing/ production sector, which grew by 6.2% in 2018. Lower Austria is the second strongest Austrian region in terms of business creation, only closely behind Vienna, with 7887 business creations in 2018, which represents an increase of 75% over the past 18 years and 10% above the average Austrian increase. At the same time the last two decades have also seen a higher-than-average growth in business insolvencies (+26% in comparison to the overall decrease by 6.7% for the rest of Austria), reflecting the structural changes which the regional economy is undergoing.

The economic and research capacity of Lower Austria is distributed over several small to medium-sized locations. It is also characterised by its proximity to Vienna in which about half of the country's research and Higher Education (HE) capacity is located. Moreover, together with regions in the Czech Republic, Slovakia and Hungary, Lower Austria and Vienna form part of the Centrope transnational initiative to support innovation¹.

In Lower Austria, structural changes have not just occurred as consequences of global or European developments. They have been steered politically and supported strategically, over nearly two decades, by concerted efforts to increase not only the innovation capacity of the business sector but also applied research and development as well as cooperation between higher education/ public research and businesses in the region (see innovation strategy below). In the last decade, since 2008, more than 7.000 positions have been created in knowledge-intensive and technological services, increasing the proportion of this workforce among employed personnel by 0.82%. In particular, the employment figure in R&D has developed positively: since 2008, 853 such new employment positions were created and filled, particularly in so-called technopole areas which now host 1400 researchers.

The above-noted increase of innovation capacity is noteworthy in so far as Lower Austria constitutes a non-traditional region in terms of higher education and research:

1. Lower Austria has no large research-intensive universities to draw on. The recent addition of the ISTA, the Institute of Science and Technology Austria, is a research institute which hosts PhD candidates but no undergraduate students.
2. In terms of public Higher Education Institutions (HEIs), Lower Austria only hosts a few small and young Fachhochschulen (universities of applied sciences), namely the FH St Pölten and Wiener Neustadt, the IMC FH Krems and the Ferdinand Porsche FernFH, with 10209 students overall (2018), as well as the Teacher Training Colleges (Pädagogische Hochschule) with less than 2000 teacher training students (1191 in 2018).
3. Following the New Act on Private Universities in 1999, three private universities were founded in Lower Austria, namely the Karl Landsteiner Private University for Health Sciences (with 389 students in Health Sciences, Medicine and Psychology), the Danube Private University (with 1726 students mostly in Dentistry), and the New Design University St. Pölten, founded by the Wirtschaftskammer, with 480 students in design-related programmes.
4. The public Donau-Universität Krems specializes in continuing education and professional development, with 8272 enrolled students (2018) studying professionally oriented short and long courses part time.

Hence, with a large agricultural base, no more than 15000 regular students (in addition to another 8000 in continuing professional development), and limited natural science or engineering research at its own universities of applied sciences which have only started to expand their applied research during the last decade, Lower Austria is not an obvious candidate to be an innovation leader. Nevertheless, against such odds, it has received remarkable European visibility, having continuously expanded its innovation record over the years. To achieve this surprising success, to sustain and expand its competitive position and innovation potential, Lower Austria has strategically fostered close cooperation with Viennese Universities, expanded its own higher education and

¹ https://ec.europa.eu/regional_policy/en/projects/austria/centrope-acts-as-a-catalyst-for-regional-integration

research landscape, and systematically mobilised openness to innovation, technological development and cooperation amongst its businesses.

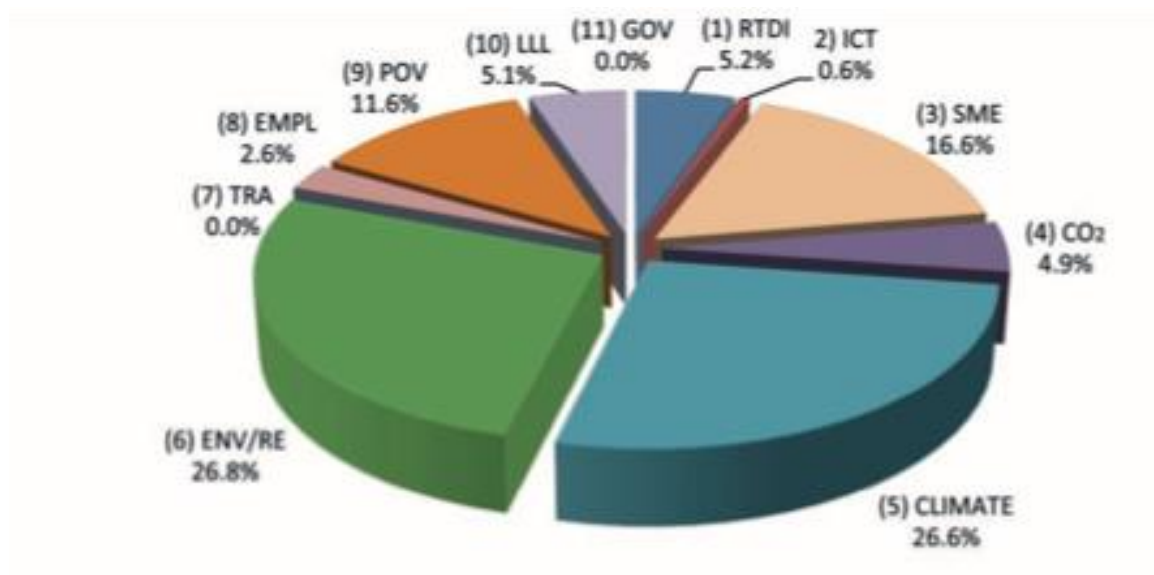
2.2 Financial Resources for Higher Education, Research, Innovation and Regional Development

In Austria, R&D Investments in 2019 amounted to €12.8 billion (4.5 % above those of 2018), i.e. an R&D expenditure of 3.19 % of GDP, which is one of the highest in Europe. 70% of the research investments are covered by the private sector and 22% by HEIs. However, the statistics are somewhat misleading, since the “Forschungsprämie”, i.e. the tax benefits which the state grants businesses for R&D investments and which amount to more than €630 million p.a., have been counted as part of the private expenditures since 2017.²

Of the remaining public investments in research, a comparatively high proportion (€525 million in 2017) is dedicated to applied business-facing research, through competitive grants that are promoted by the FFG (Forschungsfördergesellschaft). About 42 % of FFG projects are conducted in cooperation between businesses and academic institutions. Among the range of different cooperative formats, the COMET centres (Competence Centres for Excellent Technologies), which are also granted upon competitive calls, are said to have the most substantial structuring effect, according to interviewees. COMET Centres bring together at least one research group with at least five companies, combining their competences within a single centre around promising/emerging fields of research via science - industry collaboration, so as to stimulate new research ideas, encourage technology transfer, and strengthen the innovative capacity of companies. Eventually they should result in the creation of new products, processes, and service innovations. Each centre receives up to four million a year in federal subsidy, and up to two million in regional subsidy. Lower Austria hosts one such centre in Tribology in Wiener Neustadt, involving 65 companies that includes large corporations such as Siemens Mobility, Bosch, Toyota, OMV and Linde Gas, and 40 academic partners including the TU Vienna as well as international universities in California, UK, Sweden and Finland.

For basic research, Austrian researchers received €948 million through the Research Council FWF, including €231 million for new research grants in 2018. However, only €8.9 million (3.8%) of these new grants were awarded to institutions in Lower Austria, mostly to IST Austria (€5.8 million). Neither the Donau Universität Krems nor the Fachhochschulen benefited significantly from such basic research grants (receiving less than €100 000).³

Figure 1: Relative distribution of European Structural and Investment Funds in Austria by Thematic Objective (2014–2020)



² BMBF, Statistisches Taschenbuch 2019, p.102.

³ FWF (2019), Jahresbericht 2018. Wien.
https://www.fwf.ac.at/fileadmin/files/Dokumente/Ueber_den_FWF/Publikationen/FWF-Jahresberichte/fwf-jahresbericht-2018.pdf

Higher Education expenditure has also risen in recent years: by 23% in real terms over the last nine years to €4.1 billion in 2017. However, while it has accommodated a 26% rise in student numbers, academic staff have increased by just 4% and non-academic staff by 7%.⁴ Hence the higher education system, especially at universities, is still suffering from a low student/staff ratio, leaving academic staff in some disciplines with high teaching loads and little time to dedicate to research and knowledge transfer activities.

In Austria, the Partnership Agreement (PA) – in Austria STRAT.AT 2020 – is the strategic framework that forms the link between the European Structural and Investment (ESI) Funds to the Europe 2020 targets and programmes and the common reference document for the ESI Funds at the national level. The ESI Funds address nine of the eleven thematic objectives defined in the Europe 2020 Strategy (see Figure 1 below). In international comparison, the focus on environmental objectives (climate, environment, resources) as well as on the objective of “competitiveness of SME” is stronger than the EU average and cuts across all funding instruments.

For the entire period 2014–2020, Austria has had at its disposal an indicative amount of approximately €5.18 billion from the ESI Funds (throughout Europe, the funds deployed amount to around € 469 billion). Of the €5.18 billion, €3.94 come from the EAFRD (European Agricultural Fund for Rural Development) and are concentrated in rural regions giving priority to the deployment of funds for environmental objectives, investments by companies, creation of infrastructure and the diversification of the rural economy. Only €0.536 billion (€ 536 million, i.e. an annual average of €76 million) actually derive from the European Regional Development Fund (ERDF). In Austria, the ERDF was invested for the first time via a joint nation-wide programme. However, it is implemented largely through existing national and regional financial assistance instruments, with only few new separate financial assistance instruments created exclusively for the ERDF. Only a small part of national and regional financial instruments and projects are co-financed by the ESI Funds. In Austria, the ERDF is fully integrated into existing financial assistance systems. The implementation takes place through established agencies and through co-financing. However, while the ERDF only represents a small proportion of Austrian funds available for economic development and innovation, it creates a strategic framework within which other funds are inserted.

The ERDF programme 2014-2020 provides funding to projects in the following five priority axes:

Priority 1: Enhancing regional competitiveness through research, technological development and innovation

Priority 2: Enhancing the regional competitiveness of SMEs

Priority 3: Supporting the shift towards a low-carbon economy in all sectors

Priority 4: Sustainable urban development

Priority 5: Integrated development of urban and surrounding areas.⁵

Roughly 90 % of the funding goes to the first three of these priorities. Special emphasis is placed on the shift to a low-carbon economy. Approximately € 110 million (at least 20 % of ERDF funding) is earmarked for projects related to climate protection. Overall, the focus on research, technology development and innovation amounts to only 5.2% of the ESI Funds.

In Austria, ERDF measures that are designed to meet the regional Smart Specialisation Strategies (S3) are strongly co-financed with national and regional funds to multiply their leverage. The thematic priorities for the Research and Innovation (R&I) funding are laid down in the focus areas of the Austrian operational programme, which are applied at national as well as regional levels, and are reflected in the regional (Länder) S3 (see section 4.). In Lower Austria, a key measure financed through the ERDF is the Technopole programme which aims to develop the region as an innovative high-tech location.

For Lower Austria, which receives 23% (122 million) of the EFRE funds), the investment priorities include higher investment in R&I priorities proportionally, amounting to €64,1 million. In addition, SME growth and start-ups are supported with €28 million and CO² and climate actions with 23 million (see table 1 below).

⁴ Cf. EUA Public Funding Observatory 2018.

⁵ IWB/EFRE-Programm Österreich 2014-2020, see <https://www.oerok.gv.at/region/eu-fonds-2014-2020/efre/ziel-iwb-efre/iwbefre-programm-oesterreich-2014-2020>.

Table 1: Investment Priorities for EFRD-Funds in Lower Austria 2014-20

Investment priority	Measures - Type	Responsible (EFRD-resp.)	Unit	EFRD-Funds
R&I Infrastructure and Centres	Investment, soft	WST3 Land NÖ		24.820.000,00
R&I Investments / Synergies	soft	WST3 Land NÖ		39.280.000,00
Entrepreneurial Spirit / Start-ups	soft	WST3 Land NÖ		2.500.000,00
SME growth & Innovation processes	investment	aws/ERP-Fonds		25.345.000,00
Energy efficiency & renewable energy in companies	investment	KPC		18.175.000,00
Strategies for CO ² emission reduction/ sustainable mobility	soft	WST3 Land NÖ		4.900.000,00

Source: IWB/EFRE-Programm Österreich 2014-2020

In Lower Austria, the EFRD has supported the development and coordination of the particular research and innovation sites (so-called technopoles), thematic clusters, digital platforms, incubators and start-up services, collaborative research and innovation project funding, as well as physical and research infrastructures. While providing only a small proportion of the overall ESI regional investment, in comparison to agricultural funds, they have been instrumental in mobilising and developing such innovation support and in the last decade's increasing emphasis on research capacity building.

2.3 The Higher Education and Public Research Sector

The Austrian Higher Education System is dominated by public institutions, comprising 22 universities (with ca. 268 600 students in 2019) and 21 generally smaller-size universities of applied sciences (UAS, *Fachhochschulen*, with ca. 53 400 students) and 14 teacher training colleges (*Pädagogische Hochschulen*, 13 660 students)⁶. The 16 private universities, which have to undergo state accreditation, only host 4% of the student population (ca. 14 000 of the overall 350 000 students). Both universities and UAS fall into the competence of the national state.

In the case of universities, the federal state has more steering capacity. However, the political priorities (such as digitalization or increasing the number of STEM graduates) and the institutional priorities which emerge bottom-up from the academic communities are fed into a coordinated national strategy process which occurs in three-year cycles and culminates operationally in the formulation of performance contracts (*Leistungsvereinbarungen*) where the aims and strategic measures of the universities are an important part of the global grant.

In the more business and labour-market oriented UAS sector, perhaps in response to the New Public Management spirit of the nineties, private initiatives were given much larger leeway in the establishment, ownership and legal structure as well as the governance of the UAS. For example, unlike universities, the UAS are free to select their students.⁷ It should be noted that the regional states (Bundesländer) have a stronger input into the political priorities attached to the *Fachhochschulen* than those of the universities, through deliberations on the *Fachhochschulentwicklungs und Finanzierungsplan* (most recently for the planning period 2018/19 – 2022/23), the federal strategic planning document. The overall distribution between the two sectors,

⁶ See <https://www.bmbwf.gv.at/Themen/Hochschule-und-Universitaet/Hochschulsystem.html>

⁷ Cf. Bundesgesetz über Fachhochschul-Studiengänge, § 2. See also Erich Leitner (2004) „Die österreichischen Fachhochschulen Entwicklung und Strukturen eines marktorientierten Hochschulsektors.“ In Beiträge zur Hochschulforschung, Heft 4, p.97.

universities and *Fachhochschulen*, is supposed to favour the UAS in the future, according to the ministry's most recent HE planning document.⁸

The university pillar of the HE system is characterised by a large degree of diversity of types of universities: In addition to the six universities with a comprehensive subject portfolio, which greatly vary in size from the small University of Klagenfurt with only 11500 students to the very large University of Vienna with 90 000 students, there is a high number of specialised universities; medical (three), technical or applied geosciences and engineering (three), creative arts and music (six), veterinary or agro-environmental (two), economics and business (one) and a university for continuing education and professional development. Since only the latter is located in Lower Austria, this means that the region hosts no university for regular studies and does not produce university graduates.

The rather young sector of UAS was founded in the nineties, i.e. considerably later than the equivalent in Germany. The basic profile of this type of HEI is characterised by orientation to professional practice and close responsiveness to business demands. Only very recently, applied research was introduced at the UAS. Unlike traditional universities, the UAS do not hold doctoral degree-awarding power and do not have assistant positions attached to professorial chairs or independent researcher positions and therefore lack any intermediate body of researchers. While knowledge transfer is central to their mission, until recently such knowledge transfer has been linked more strongly to continuing education and qualifications than to applied research cooperation projects. In the most recent national HE strategy cycle, the emphasis on expanding applied research at UAS in order to sustain the needs of the knowledge economy, especially in view of the innovation capacity of SMEs was explicitly emphasized, as was the focus on digital transformation and an increase of STEM graduates. 1450 additional study places were added as part of an expansion that aims to provide an additional 3279 federally funded study places in the UAS sector bringing the whole sector to more than 57 000 students by 2024/25.

2.3.1 The Lower Austrian Research and Higher Education Landscape

In Lower Austria, the number of students has doubled in the last decade. Currently there are ca. 22000 students enrolled in 14 HEIs, in four different sub-sectors:

About half of these students study at the four Universities of Applied Sciences (UAS) at several different locations. The UAS proportion in Lower Austria is thus considerably higher than in the rest of the country where they only make up about 20% of all HE students. As the federal state aims to increase this proportion steadily, the increase would also affect Lower Austria. Traditionally, the UAS were teaching institutions oriented to regional demands, but with very limited applied research. In recent years, also with explicit support from the federal state, the UAS' research capacity has been growing continuously, again benefitting the expansion of business-facing applied research in Lower Austria.

The second strong pillar, with ca. 8500 students, is constituted by the Donau University Krems, an internationally renowned public university that specialises in continuing professional development courses and degree programmes, offering master programmes, continuing professional development courses and a few doctoral programmes for adults with professional experience.

There are several private HEIs in Lower Austria which are partially state funded (by municipalities or the state of Lower Austria) and which have been accredited by the federal state through the independent agency AQ Austria. The largest, the Danube Private University (DPU), is also located in Krems, and is partly owned by the city of St. Pölten. More than 1900 students are enrolled in dentistry degree programmes, and since the academic year of 2019/20, also medical degree programmes. With an expanding research base, the DPU also holds doctoral degree awarding power and the right to award habilitation rights (*venia legendi*), thus playing an increasing role in research training. Another medical university, the Karl Landsteiner University, is located in Krems, St. Pölten and Tulln and offers accredited medical and psychology degrees for ca. 300 students on behalf of a consortium of 24 public university clinics. This private, not-for-profit university is owned by public or publicly funded organisations, namely the Medizinische Universität Wien, die Technische Universität Wien, as well as the state of Lower Austria (each holding 25% of the shares) and the Austrian center for ion-based cancer therapy MedAustron.

⁸ „Der Fachhochschulentwicklungs- und -finanzierungsplan sieht daher bis 2022/23 den weiteren, kontinuierlichen, strategischen Ausbau des Fachhochschulsektors vor.“ (The Development and Financial Plan for the University of Applied Sciences sector includes continuous strategic extension of this sector. *Author's translation*). Quote from the Federal Ministry of Education (BMBWF), accessible at its website: <https://www.bmbwf.gv.at/Themen/Hochschule-und-Universitaet/Hochschulsystem/Fachhochschulen.html>.

Finally, the teacher training colleges (*Pädagogische Hochschulen*), fall into the competence of Lower Austria. They are rather small in size but are important institutions for school quality and development.

Table 2: Students at Higher Education Institutions in Lower Austria 2008 – 2019

	2008/09	2010/11	2012/13	2014/15	2016/17	2018/19
Donau-Universität Krems*	5.020	5.870	7.128	8.900	9.067	8.455
Fachhochschulen	6.442	6.742	7.439	8.141	9.647	10.202
Fachhochschule St. Pölten	1.752	1.805	1.894	2.075	2.421	2.667
Fachhochschule Wiener Neustadt	2.745	2.966	3.309	3.414	3.678	3.944
IMC Fachhochschule Krems	1.945	1.971	2.236	2.652	2.859	2.810
Ferdinand Porsche FernFH**					689	781
Privatuniversitäten	175	369	581	942	1.236	1.565
Danube Private University		124	305	515	614	697
Karl Landsteiner Privatuniversität für Gesundheitswissenschaften				81	208	387
New Design University	175	245	276	346	414	481
Pädagogische Hochschulen	765	1.070	1.808	1.610	1.124	1.117
Kirchl. Pädag. Hochschule Campus Krems	350	461	698	681	504	433
Pädagogische Hochschule NÖ Baden	415	609	1.110	929	620	684
Theologische Hochschulen	293	290	375	364	374	381
Hochschule Trumau	99	68	77	65	60	71
Phil.-Theol. Hochschule Heiligenkreuz	129	142	235	216	215	210
Phil.-Theol. Hochschule St. Pölten	65	80	63	83	99	100
Insgesamt	12.695	14.341	17.331	19.957	21.448	21.720

Source: Statistical Handbook Lower Austria 2020 ()⁹

In addition to HEIs, public research institutes are also an important part of the region's innovation capacity. First of all, there are research institutes of Viennese Universities, such as Inter-University Department of Agrobiotechnology (IFA) in Tulln (abbreviated as IFA Tulln), a joint institution operated by the University of Natural Resources and Life Sciences (Univ. für Bodenkultur), Vienna, the University of Veterinary Medicine, Vienna and the Vienna University of Technology, where scientists from all three universities conduct research in a collaborative effort to advance animal breeding and reproduction through molecular and cell biology research.

The federally co-funded Competence Centers for Excellent Technologies (COMET Centres) play an important role in regional development. Launched in 2006, the COMET programme is recognised today as an international best-practice model and perhaps the most visible successful technology policy initiative within Austria. The COMET funding stream forms part of the portfolio of federal research funding instruments that are orchestrated by the FFG, the applied research funding agency, through competitive calls. The centres are an important component of the regional and national innovation systems as they link university research and research training with a large number of business partners in networks that combine access to joint infrastructures,

⁹ Amt der Niederösterreichischen Landesregierung, Statistisches Handbuch des Landes Niederösterreich 44. Jahrgang 2020. https://www.noel.gv.at/noel/Zahlen-Fakten/Statistisches_Handbuch_2020.pdf, pp.311-313.

testing facilities, competence development and collaborative pre-competitive research and technology development projects.

In the national and regional innovation landscape, the Austrian Institute of Technology constitutes another important component. Unlike universities and their focus on basic research or the publicly funded COMET centers which address short-term exploitation of university research, AIT covers the entire spectrum of applied research, from emerging technologies, first proof of concepts, to transferring these emerging technologies into specific applications up to demonstrators and prototyping, most often through contract research and development projects. While nationally funded, the AIT has an important regional innovation function since its thematic centres are distributed across different locations, three of which are situated in Lower Austria.

As small and young but nonetheless internationally outstanding public research institution, the IST Austria, a research institute with doctoral training, has become one of the most important and internationally oriented research and research training institutions in Austria. It was established in 2006, by the federal government of Austria and the government of Lower Austria, and opened its campus in 2009 in the city of Klosterneuburg, on the outskirts of Vienna. ISTA is home to more than 50 professors, 600 scientists as well as a growing number of PhD candidates (185 in 2018) from all over the world, who conduct research in biology, computer science, data science and scientific computing, mathematics, neuroscience, and physics. Its international competitiveness is shown by its outstanding record of ERC grants, in which it leads the European research landscape with a 48% success rate¹⁰ and more than 30 grants for just 50 professors. While the IST Austria is dedicated to cutting-edge research and is exclusively internationally oriented, with consequent structural hesitation to respond to any regional orientation, it is on a steady expansion course and increasingly open to technology transfer activities. It is clearly developing into a major innovation asset for the state of Lower Austria.

Finally, Lower Austria has seen a significant expansion of research training, in part co-funded by the state, which plays an important role for expanding R&I capacity. This includes the rise of IST Austria, as well as the PhD programmes of the Austrian Institute of Technology (AIT) on its Lower Austria campuses in Tulln, Wiener Neustadt, and Seibersdorf, and an increasing number of PhD candidates at the continuing education university Donau University Krems which has introduced two PhD programmes. For the technological development of industry, the university PhD candidates from Viennese universities who conduct research at technopoles in Lower Austria are of particular relevance, as are those hosted at the AIT sites. At AIT, PhD theses are also carried out in cooperation with national or international universities, with academic supervision provided by both organisations. As an applied Research and Technology Organisation, AIT's PhD Programme also includes training for value creation and start-up training and support services.

The private universities, which are partly owned by regional organisations, do not yet play a significant role in research training (with only six PhD candidates enrolled at Danube Private University).

In conclusion, the Lower Austrian research and higher education landscape is characterised by the absence of a basic research-oriented university but a growing sector of UAS with increasing applied research capacity that is oriented toward regional demands. There has been a recent addition of a remarkably successful and internationally oriented federally funded basic research institute with graduate research training. Finally, there is an increasing number and size of applied research outposts of Viennese universities that have been attracted by Lower Austrian regional policy measures with targeted infrastructural investments and well managed networking opportunities in strategically supported site development.

¹⁰ <https://ist.ac.at/en/news/ist-austria-is-in-first-place-at-the-european-research-council-erc/>

3. Strategy development

3.1 Regional Innovation and Smart Specialisation Strategy

3.1.1 Innovation Strategy: Framework, Core Elements and Instruments

Development of an innovation strategy in Lower Austria goes back to the late nineties and the beginning of the millenium when the national and regional innovation and technology development campaign was started in the context of Austria's accession to the EU and the programming of associated structural funds.

The most recent research, technology and innovation (RTI) strategy of the federal government "Becoming an Innovation Leader" was accepted by the European Commission as the core document for Smart Specialisation in Austria and as fulfilment of the ex-ante conditionality within the Common Provisions Regulation for the ESI Funds 2014–2020.

In the period 2014-2020, Austria used its ERDF allocation for investment in growth and jobs to co-finance a national programme since 87% of public expenditure for R&I comes from the federal government.¹¹ The federal strategy provides the framework for both national priorities and their implementation by federal funding agencies as well as for regional innovation strategies. In Austria, regional innovation, research and technology development (RTI) by the Länder has gained importance through the instruments of EU regional policy and "impulses from the federal government, especially within the framework of the "structural programmes".¹² The interlinkage between federal and regional levels of strategy development is reflected by the fact that the Federal Ministry for Science, Research and the Economy has a staff unit for knowledge-driven business location policy and Smart Specialisation.¹³

Within the scope of the "STRAT.AT Partnerships", an almost two-year discussion process on smart specialisation in Austria was launched at the start of 2015. In February 2017, the final results of the partnership were presented at a dialogue event of the Länder organised by the Federal Ministry of Education, Science and Research, and presented in a joint publication that explains the key ingredients of Austria's and the Länder's Smart Specialisation Strategies (S3).¹⁴

In Austria, the smart specialisation concept informs the framework of a new generation of business location strategies that define thematic investment priorities based on specific strengths, international market success, and innovation potential, addressing the future challenges of a knowledge-driven economy and society. Support for new knowledge-driven location policy and for the development of a productive regional "eco-system" are the corner stones of the national framework as well as regional policy in the *Länder*. According to the STRAT.AT Partnerships framework, the regional innovation strategies supporting further development of a regional economic structure should not concentrate primarily on "a narrow core of clusters or strong points, but rather along auxiliary, related industries and on promising technologies that are still weakly developed", i.e. focusing on "diversification of economic structures, combined with well-thought-out vertical priorities".¹⁵

Lower Austria provides a good example of a balanced regional innovation strategy that combines identification of strengths and potential in vertical priorities with horizontal development of related diversity of thematic priorities. Having started its regional innovation development in the early millennium, its innovation strategy and implementation had already acquired European visibility as a benchmark for European top innovation

¹¹ ÖROK (Markus Gruber, Renate Handler, eds.) (2016), Policy Framework for Smart Specialisation in Austria, Vienna, p.11.

¹² Loc.cit.

¹³ It should be noted that Austria was one of the key partners for the European Commission and the JRCa (S3 Platform) for putting the academic concept of smart specialisation into practice, including in the development of the "RIS3-KEY", which provides European regions with start up help for developing S3. The Federal Ministry for Science, Research and the Economy as well as regions of Lower and Upper Austria also cooperated with DG REGIO to ensure a comprehensive implementation of the concept. See ÖROK (Markus Gruber, Renate Handler, eds.) (2016), Policy Framework for Smart Specialisation in Austria, Vienna, p.11

¹⁴ Namely, the above-cited publication by ÖROK.

¹⁵ Op.cit., p.13

regions and host of good practice in 2017, when it was selected as a European Entrepreneurial Region (see Figure 2 below).

Figure 2: Progression of Regional Innovation Strategy Development in Lower Austria



Source: Presentation of Economy Department of Regional Government¹⁶

Smart specialisation in Lower Austria is implemented through its economic strategy (*Wirtschaftsstrategie*), which combines knowledge-driven location policy with diverse thematic technology development, and which we call the region's innovation strategy or S3 in this report. In fact, economic strategies in Lower Austria have from the beginning focused on technology networks at particular sites and in cooperation clusters, at first with focus on inter-company cooperation and qualification measures, and then, since 2007, with a growing emphasis on business cooperation with research and technology development partners from universities and research institutes.

The Lower Austria S3 rests on three pillars:

1. The development of particular sites that are characterised by critical mass of industry and/or research expertise and competitive advantage and potential;
2. Cooperation around common thematic concerns of technological and sector development which reach across different sites;
3. Support for innovation processes within companies, through cooperation between companies and between companies and research partners.

Figure 3, presenting the so-called innovation pyramid, aims to visualise the Lower Austria S3 and its combination of focused support in a few selected sites with support across the whole region in selected thematic areas. The graph is used by the Department of Economy, Tourism and Technology to illustrate how these instruments serve as backbone to the long-term innovation strategy.

Lower Austria's Innovation Strategy includes a wide portfolio of instruments which have been adapted over time and matured into a highly complementary and integrated set of measures, including support for:

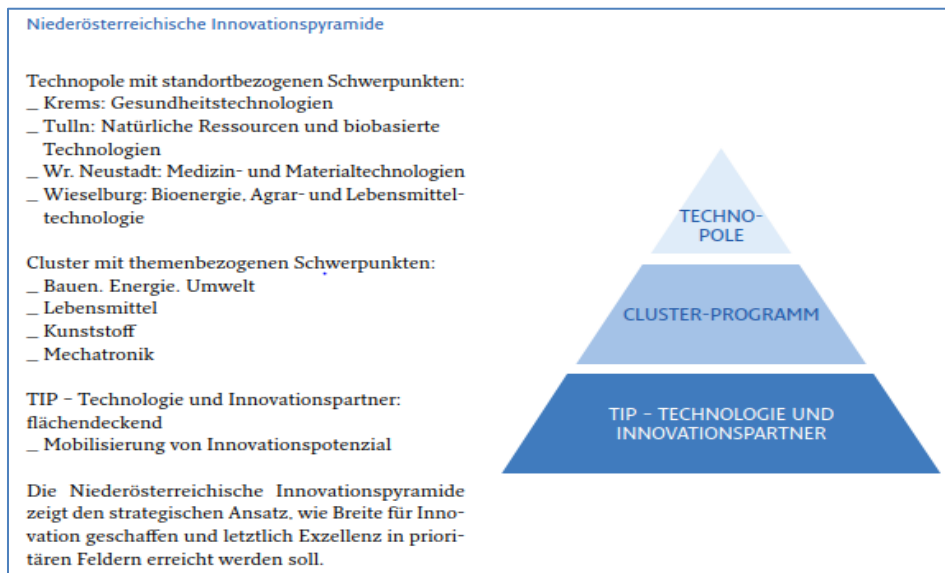
1. **Technopoles**, i.e. the development of critical mass and international competitiveness at technology and research centres at particular sites which offer existing concentrated expertise and industry fabric as well as potential for further development. The Technopole programme has been the cornerstone of the Lower

¹⁶ Presented by Kerstin Koren, of the Department of Economy, Tourism and Technology, at Regional Government, (WT3) at the European Peer Exchange on Regional Innovation in 2018. Available at https://s3platform.jrc.ec.europa.eu/documents/20182/279010/Final_PXL+Monitoring_Vilnius_LA.pdf/c1bbac2-fd0e-4006-ba85-b66f889c7ffd

Austria innovation strategy since 2004 and has resulted in continuous strategic development and investment at four sites in the state.

2. **Cluster development** of thematic areas with high innovation potential for industry and society. The cluster programme supports innovation in businesses through thematically and sector-oriented training, identification of innovation opportunities and potential partners as well as facilitation of collaborative projects amongst companies or of companies with research institutes (see also point 3 below). This instrument has been in place since 2001 and has been continuously adapted.

Figure 3: Progression of Regional Innovation Strategy Development in Lower Austria



Source: Ecoplus¹⁷

3. **Research and technology development funding**, in particular for collaborative research and development projects of companies with researchers from universities/ UAS or other research institutes or of single firm R&D&I projects (TIP, the *Technologie und Innovationspartner-schaften*). Such research funding is designed to complement existing national funding opportunities and focuses on thematic priorities with high regional development potential. The funding schemes for companies are thus combined with soft measures for networking communication. The region's own research and technology programme (*Forschungs- und Technologieprogramm*) has emphasised industry-university cooperation since 2015. In the current innovation strategy / S3 the priority areas that were selected through such a multi-stakeholder-based process comprise:

- Humanities, Social and Cultural Studies
- Museology/Collections
- Ecosystems
- Water
- Renewable Materials and Bio-energy
- Food and Feed safety
- Sustainable land management and production optimisation
- Medical technology and medical biotechnology
- Materials and surfaces
- Manufacturing technology and automation engineering

¹⁷ By courtesy of the Department of Economy, Tourism and Technology of Lower Austria. Also available at: <https://www.slideshare.net/ClusterIX20/rti-programme-of-lower-austria>.

4. Establishment of regionally funded **Start-up centres/ services (accent), incubators and venture capital** funds to support the establishment and growth of student start-ups or researcher /industry spin-offs.
5. **Applied research centres, so-called COMET centres or Christian-Doppler Institutes**, for which national funding (by FFG) is complemented with infrastructural support by Lower Austria. These centres are aligned with the above-listed priority areas.
6. **Establishment or expansion of private and public HEIs**, such as the Universities of Applied Sciences (recently especially in expanding its research capacity), the Karl Landsteiner Privat Universität (in which the state holds shares), through funds for additional personnel, study places, infrastructures.
7. **Investment in research infrastructures connected** with the establishment or expansion of public or public-private-partnership-based research institutes, some of which are primarily federally funded, others being connected to public universities. The provision and development of state-of-the-art physical and research infrastructures acts as a key attractor to the region. These include:
 - The Austrian Institute of Technology (AIT), a federally funded applied-research institute which is financed as public-private partnership with half of its funding from public sources, with sites in Seibersdorf, Wiener Neustadt and Tulln;
 - The Institute of Science and Technology Austria (IST Austria) in Klosterneuburg where Lower Austria invested in joint development of a technology center (and supports the institutional technology transfer);
 - The Inter-university Research Institute for Agrobiotechnology, (IFA) in Tulln, which started as an inter-university institute of four Viennese universities (TU Vienna, Veterinary University Vienna, Universität für Bodenkultur (BOKU)) and has now become incorporated within BOKU.
8. **Endowed chairs** in thematic high priority areas which serve to fuel innovation in the region.
9. **Research Training Stipends** for PhDs or PostDocs based in Lower Austria (e.g. at IST Austria, AIT or DUK).
10. **Innovation Assistants**: a scheme to encourage SMEs to employ recent university graduates in order to strengthen the technological and innovation capacities of businesses. This innovative action – part-funded by the ERDF – targets small SMEs in rural areas to provide them with support from the university graduates/ innovation assistants. These ‘intrapreneurs’ with a university background manage innovation projects tailored to the specific needs of the SME.

Since the current S3 (*Wirtschaftsstrategie Niederösterreich*) 2020, which was adopted in 2015, is reaching the end of its cycle, it was adapted and developed further for the new cycle. The new *Wirtschaftsstrategie Niederösterreich 2025*, was published together with the formulation of a new higher education strategy (*Hochschulstrategie*, see below). When adapting the innovation strategy, the regional government reviewed the implementation of the existing innovation strategy, including an externally contracted evaluation of the effectiveness of the technopoles, as well as trend studies and a benchmark analysis with structurally comparable regions. The Technopole evaluation confirmed that the investment in Technopoles continued to be successful, as made evident by accelerated structural transformation into knowledge and technology-based economies (see above). Based on this evaluation and a structured dialogue with stakeholders, the goals, instruments, and measures of the strategy were adapted to meet new challenges and opportunities. The new innovation strategy (*Wirtschaftsstrategie 2025*) highlights four core concerns:

1. **The industrial core of the regional economy**, which should be developed through strategies which aim to **foster intelligent innovative production processes**, incl. new materials, machine learning, robotics, with reduced use of resource and new services and business models.
2. **A climate and resource-oriented development**, which recognizes circular economy and CO² and resource-efficient production and sustainable energy systems as drivers of innovation.
3. **Digitalization, smart production, use of big data, and agile working methods** as competitive opportunities, especially for more traditional SMEs. Public investment in the expansion of digital connectivity for more remote areas will be a key part of strategic development in this phase.
4. **Competitive profile and international visibility of particular sites**, which will be further developed by offering attractive infrastructures, living and working environments, transport and digital connectivity, and efficient services. In particular, those sites which are characterized by a dense and

diverse cooperative fabric of businesses and educational, training and research organisations will receive support through state-of-the-art infrastructures and expanded service and networking opportunities in order to increase their international visibility and competitiveness.

As support instruments for the above-mentioned focus areas, technopoles and clusters have been the key instruments of the innovation strategy since the beginning, and hence deserve to be described in more detail below. However, while these key instruments have remained constant for more than 15 years, both the choice of the technopoles or the clusters as well as the different support measures have evolved over time. Changes have also occurred with respect to project support. Thus, more recently, regional funding has concentrated on larger “lead projects” (*Leitprojekte*) that support core facilities for strategic technology areas with grants of €200 000 to €300 000. These funding instruments complement the larger scale FFG-funded COMET centres, which bring together industry and university partners (about 70 partners) and are co-financed by federal funds (40-50%).

The strategy’s continuous development and adaptation to new demands is ensured through regular exchange between public and private actors and stakeholders of different levels (see section six on governance).

3.1.2 Development of Research and Technology Centres and Technopoles

In 2004 the cornerstone of the Lower Austria innovation strategy was launched, namely the development of technopoles, which are supported with EU structural funds and implemented by the regional business and innovation development agency *Ecoplus*. The four technopoles were selected based on their performance and potential as internationally recognised applied research sites, with different research and innovation orientations, namely:

- Technopole Krems for medical biotechnology,
- Technopole Tulln for agricultural and environmental technology,
- Technopole Wiener Neustadt for medical and material technologies, and
- Technopole Wieselburg as a competence centre for bioenergy, agricultural and food technologies.

In addition to the above technopoles, which have been supported already since 2004, two more remote inter-communal regional development hubs were established in 2018 in Seibersdorf and Klosterneuburg, in view of their promising thematic development strengths and potential as well as intercommunal cooperative culture.

At the technopoles, research, education and training, and business development are systematically interlinked. At the core of each technopole, a technology and research centre (TFZ) offers tailor-made physical and research infrastructures and services for research-based businesses and facilitates networking and project cooperation. Investments into these technology centres have amounted to up to €37.5 million over ten years (in the case of Wiener Neustadt 2004-2015 with a site covering 17,390 m²).

Since the beginning of the Technopole programme, the four sites have developed dynamically: Since 2004, over 3 500 new jobs have been created, 1 500 of which are researchers – in comparison with 180 researchers in 2004. Since then 5825 publications and 4113 patents have been produced. The Technopoles provide 32 000 m² of office- and lab facilities in Technology and research centres for more than 75 technology-based companies that have been set up there. From 2004-2018, €428 million worth of cooperation projects have been supported e.g. through K-projects or K-centres of the FFG. In 2018 alone, 247 cooperation projects are conducted between industry and research groups.

3.1.3 Cluster development

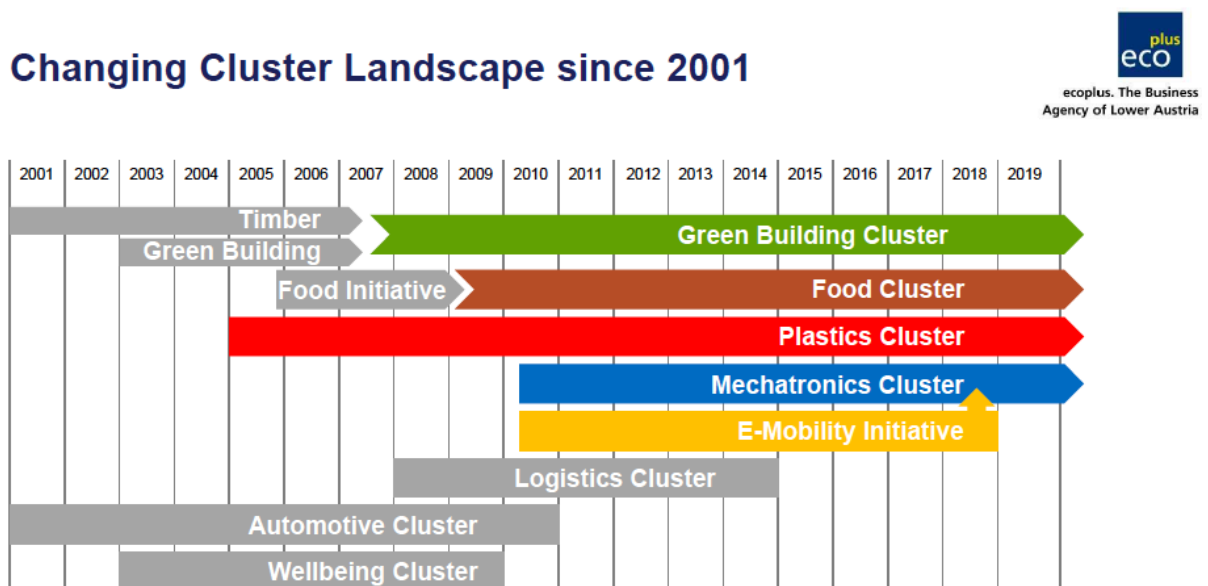
In addition to technopoles, regional innovation has been developed through the instrument of **clusters** already since 2001. While the technopoles develop particular sites with high innovation potential into specialized hubs, clusters reach across different locations bringing together companies and research groups in joint thematic innovation development. The clusters interconnect the strengths of individual companies within one sector as well as across sectors. In the context of cluster development where cooperation is promoted through low-threshold competitive project funding, cooperative project funds focused strongly on demand-driven qualification measures for businesses in earlier years. Since 2007, cluster-based innovation support has focused more strongly on expanding the research capacity of businesses through cooperative projects with universities and on connecting individual companies with research partners in *Technology Innovation Partnerships* (TIPs) which focus on sector-relevant innovation challenges. The project calls have thus focused on strategic areas, such as data, materials and automation. The themes of the calls vary, in accordance with

demand and key topics that are identified by the technopole and cluster managers. Since its inception more than 1 400 projects with over 4 200 project partners have been supported in the context of cluster-based cooperation. Cluster managers help with identifying and developing relevant qualification measures, facilitating access to relevant research partners or cooperation with so-called “Lead companies”.

The choice and effectiveness of the thematic clusters are continuously monitored and adapted. In the past, such adaptation included:

- the focus of several clusters having been adjusted in response to cooperation and innovation potential and national competition, such as the former automotive cluster having been transformed into the mechatronics cluster to reflect regional strengths more sharply,
- clusters having been discontinued, such as the logistics or well-being clusters
- clusters having merged with others, such as the “Wood” to “Ecological construction” clusters into the current cluster “Construction. Energy. Environment”,
- or some clusters having joined forces with similar cluster initiatives in other regions (such as the plastic or the mechatronics clusters with Upper Austria). The continuous development cluster themes are shown below in Figure 4 .

Figure 4: Changing Cluster Development in Lower Austria since 2001



Source: Ecoplus¹⁸

The five clusters that have received regional funding in recent years are:

1. Green construction
2. Food industry
3. Plastic
4. Mechatronics (with Upper Austria)
5. E-mobility

Most recently the E-mobility Initiative was integrated into the Mechatronics cluster.

Over time the continuous adaptation of thematic focus for the most future-oriented perspectives (“themes of the future”) of the funding instruments, the emphasis on access to business-facing research, and the increasing density of networking opportunities and cooperation experience, have built trust in the added value of cluster

¹⁸ Accessible at <https://www.slideshare.net/TCINetwork/tci-2016-learnings-from-lower-austria>.

engagement and cooperation. The success of the Lower Austrian Cluster orchestration was also recognised by the European Cluster Excellence Gold Label, the highest of a set of European-wide benchmarking quality labels, which was awarded to four Lower Austria clusters.¹⁹

3.1.4 The House of Digitalization

Most recently, the establishment of the House of Digitalization, which is co-funded by the ERDF, may be seen as a structural innovation as it brings together the logic of technopole site development with the thematic cooperation logic of the clusters: The House of Digitalization is an interactive platform which offers personalised services to its network of persons and businesses with digital concerns and interests. As an interface for digital transformation it includes an automatic proposal system to network Lower Austrian companies with research and educational institutions, as well as being a meeting point for interested citizens in the field of digitalization. Artificial Intelligence and interactive services help visitors find relevant partners and information. The House of Digitalization was developed jointly by two division heads of the regional development agency *Ecoplus* (the agency for economic development (*Wirtschaftsförderung*) of the regional government) together with their technopole and cluster managers, based on a SWOT analysis of research, training and business innovation in digital transformation.

Despite its name, the *House of Digitalization* is actually a network, rather than a physical location, even though a building will be constructed in 2022 to serve as a contact point. The *House of Digitalization* offers an integrated service to help businesses understand digital technologies, acquire relevant competences and implement as well as market new ideas. Services include qualification courses, events on digital transformation topics, digitalization projects for remote regions, including a discussion forum on the “Digital Village 2030”, and *digital labs* to develop and present digitalization projects. The different activities build on each other but can also be accessed individually, like floors in a building. The metaphor of the house thus visualises the construction of a platform, as illustrated in Figure 5.

Figure 5: The House of Digitalization and its 8 Floors (Services)



Source: Ecoplus²⁰

¹⁹ The European Secretariat for Cluster Analysis (ESCA) is the one-stop shop for promoting excellence in cluster management through benchmarking and quality labelling of cluster management organisations worldwide. The Berlin-based organisation coordinates a network of around 200 cluster experts from more than 30 countries, which offer benchmarking and labelling services on behalf of ESCA. See: <https://www.cluster-analysis.org>

²⁰ Ecoplus (2019), Haus der Digitalisierung. Das niederösterreichische Ökosystem für digitale Transformation.

The *Digital House* also connects start-ups and tech transfer centres, chamber of commerces, technology and innovation partners (TIP), with a few nodal points (in Klosterneuburg, Krems, St Pölten, Tulln, Wieselburg and Wiener Neustadt). By 2022 the network's virtual structure will be complemented by a physical one, a Centre in Tulln with a digital showroom, an incubator, co-working space and event area.

The partners networked in the House of Digitalization also formed the core of a consortium that successfully bid for one of three Digital Innovation Hubs funded by the federal ministry for digitalization. The "Digital Innovation Hub East" (DIHOST) focuses primarily on making available the opportunities offered by numerous digital technologies to small commercial and industrial enterprises in recent years. The experts represented in the consortium develop solutions tailored to the needs of the companies free of charge. Given the success of the recently established digital network and services in the framework of the "Digital House", regional development agencies are looking into extending this successful networking model to other thematic areas.

3.2 The Higher Education Strategy as part of a RTI Strategy Framework

In 2011, Lower Austria **established a science and research department (K3)** in its regional government to address the increasingly central role of research and higher education in the transition from an agriculturally dominated region to a knowledge economy. Since then, the department has accompanied the rapid expansion of the tertiary-level training and research capacity with public support of university infrastructures, study programmes, personnel (such as sponsored chairs) or, since 2015, through administering project funding calls via its own research funding programme (in close concertation with the Department for Economy and Tourism). From its beginning, the new **department's existence was inserted in an innovation perspective** and commissioned to coordinate the expansion of the regional knowledge base and research and innovation capacity.²¹ Its first task resulted in the formulation of a **Research, Technology and Innovation Basic Strategy** (*FTI Grundstrategie*) which offers SWOT analysis of the region's research landscape and offers principles of research and innovation development. Among other things, the SWOT analysis highlighted the expanding HE and research base and the potential connections to an expanding UAS sector, the proximity of Viennese universities and the new federal institutions (IST Austria), but also pointed to the fragmentation and lack of critical mass and international visibility of the Lower Austria landscape and to the further potential of a more concerted innovation eco-system (without using that term). Its key aims comprise the following:

1. Targeted Investment in Research, Technology and Innovation (RTI)
2. Setting Thematic Priorities
3. Strategic expansion of R&D structures
4. Strengthening RTI in companies
5. Promote Training and Continuing Professional Development
6. Thinking and acting transregionally
7. Enhancing visibility
8. Increasing effectiveness

The *FTI Grundstrategie* served as the point of departure for the development of the **RTI programme**, from 2013-25, on the basis of an extensive multi-stakeholder participation, with scores of workshops and hundreds of participants – a transparent process that interviewed stakeholders still look back with appreciation today. In this RTI programme, Lower Austria has developed its **own research funding scheme** for cooperation between HEI, research institutes and companies, in high priority areas, with a view to increasing critical mass, improving national and international competitiveness and regional innovation capacity. Such funding seeks to complement federal funding instruments.

²¹ „Mit Jahresende 2011 wurde die beim Amt der NÖ Landesregierung neu gegründete Abteilung für Wissenschaft und Forschung von Landeshauptmann Dr. Erwin Pröll in Abstimmung mit Wirtschaftslandesrätin Dr. Petra Bohuslav mit der Erstellung einer umfassenden Strategie für Forschungs-, Technologie- und Innovationspolitik des Landes Niederösterreich beauftragt.“, Amt der Niederösterreichischen Landesregierung, Abteilung Wissenschaft und Forschung (2013), Forschungs-, Technologie- und Innovationsstrategie für das Land Niederösterreich. Teil I: Ziele, Grundsätze, Optionen.

In Lower Austria, the **availability of qualified personnel is recognised as a key success factor of innovation development**. Ensuring the development or inflow of such qualified labour is a key task of regional strategic HE development. Hence, support for HEIs in national competitive calls for new study programmes as well as the expansion of the training and continuing professional development offer for businesses (e.g. in digital transformation) to respond to economic demand have been key focus areas of regional development measures. To develop human resources systematically, Lower Austria (or any other Austrian region) has several instruments at its disposal:

1. They can invest in an expanded offer of the UAS, or formulate their respective demand vis-à-vis the federal HE authority (i.e. the ministry). In Lower Austria, the regional state and the municipality are co-owners of the UAS. Even though the UAS are entirely publicly funded they are not-for-profit private legal entities (gGmbHs). While they are federally funded with respect to their “study places”, the regional ownership of the institutions means that their infrastructural and organisational development is supported and overseen by the regional government. Most recently, the regional state's strategic investment has expanded its sponsored chair programme to strengthen capacity in areas with high potential for regional innovation development.
2. Likewise, the regional state can invest in the establishment, or further development, of private universities (or HEIs – by law these institutions can only be called universities even though some of them may have very little research or research training that would usually be associated with that label). In the past, the regional state has invested in expanding the medical qualification base in the state through the establishment of a private university, Karl Landsteiner Universität, together with the clinics in the state and in partnership with the public medical schools in Vienna.
3. Regional state or regional private companies can apply for FFG public grants for continuing professional development networks (CPD) in which employee CPD costs are publicly supported. While small-scale funding instruments that support the development of smaller modules to meet business demand for qualifications have been successful practice for many years, regional government and its partners are also searching for new innovative formats to identify and support the demand of regional businesses and other stakeholders.
4. Individual stakeholders (public or private) can cooperate with/ or contract an individual HEI/university to address a particular CPD demand. Lower Austria examples include qualifying staff for the further digitalization of government services which was addressed by an offer that the *Donau Universität Krems* was contracted to develop, the Teacher Training College Baden (PH Baden) developing teacher training courses in cooperation with the Chamber of Commerce (*Wirtschaftskammer*) to help teachers promote applied research and innovation competences in school children.
5. Private companies can participate in qualification/ training workshops offered by Universities of Applied Sciences or in the framework of Technopoles or Clusters. Examples include the digital training offer of the Digital Innovation Hub Ost, e.g. in IoT, Sensors systems, Blockchain and IT security, 3D-printing, offered by the research and transfer agency FOTEC of the FH Wiener Neustadt.
6. Private companies can receive grants for the first years of employment of recent university graduates (*innovation agents*) in high innovation areas.

To support of the expansion of the HE offer, the regional government had mainly built on supporting the bottom-up emergence of thematic strengths in previous years, rather than setting top-down priorities or focusing on particular sites. In recent years, thematic priorities and strengthening the critical mass and potential of particular sites at which institutions have already built cooperative networks will play a more central role. In this context, new structural instruments to strengthen concentrated expertise will play an increasingly important role, through competitive calls for endowed chairs, or by strengthening the competence profile of particular sites with supporting infrastructures.

In October 2019, the State parliament adopted a Higher Education Strategy, which is seen as an embedded element of the wider research, technology and innovation strategy process. The strategy follows nine overarching aims or guidelines:

1. Structured and competence-oriented expansion of the tertiary offer in Lower Austria
2. Improvement of study quality and feasibility (reduction of drop-outs, *Studierbarkeit*)
3. Internationalisation of study programmes and mobility
4. Better use of national and international research and research training funding

5. Further development of regionally tailor-made instruments from the national research and technology and innovation programme
6. Targeted and criteria-based expansion of research infrastructures
7. Opening HEIs to society
8. Promotion of cooperation between HEIs, research institutes and businesses
9. Promotion of diversity and equality of opportunity.

For each of these key areas of action, detailed measures are proposed, such as, just to give a few examples (from the wide range of more than 50 measures) that are most directly related to the innovation dynamics in the region:

- Developing a bridging offer to ease transition from technical secondary schools to technical subjects at universities – in pursuit of aim two above;
- Expanding research capacity by establishing new regional services and network of research services at different institutions, which provide information on international research grant opportunities (in pursuit of aim four);
- Mobilising future talents through programmes for school students at universities, so-called “young universities” (in pursuit of aim seven).

The aim to expand the talent pipeline cuts across a wide range of measures, from supporting the development of new study programmes in industrially relevant areas at the UAS, to improving access and ensuring equality of opportunity by mobilising school students’ interest in research and innovation through science communication measures. Indeed, a wide range of science communication measures have been developed in the region, with good practice at ITS Austria serving as one of several examples, as described in Box 1.

Box 1. Nourishing the innovation talent pipeline at IST Austria

To mobilize talents and interest in natural sciences and engineering, the IST Austria has developed some good practice by organizing experimental science summer camps and school projects for young school students. Annually, it organizes and hosts research camps for elementary, middle, and high school children during the summer. At one of these “Sommercampus”, 60 children between the ages of seven and ten spent a week on campus carrying out exciting experiments. Guided by students at the Lower Austrian University of Education (PH NÖ), as well as IST Austria staff and scientists, the children discussed bacteria in extreme habitats, the evolutionary family tree, as well as the colours of light and experimented with the trajectory of Robin Hood’s arrows, launched vinegar-powered rockets, built robots, and programmed computer games. In “Top Models in Science”, a three-day research camp about scientific models and how scientists use these models to describe and understand nature and natural phenomena, participants tested the models for free-fall and projectile trajectories in experiments, then analysed their data and computed statistics. Game theory challenged the teenagers to think logically and strategically, and during a session on engineering, they simulated collisions, computed the carrying capacity of bridges, and even built their own computers. During lab tours and lectures, students learned about chaos theory, fluid mechanics, and quantum bits.

In addition to summer camps, over 300 students aged nine to 19 came to IST Austria to tour the labs, see scientists at work, meet graduate students, and more. Some younger classes had the opportunity to participate in a multi-session research projects in which schoolchildren ran experiments and prepared microscope samples to learn about plant development and observation. From 2019 onwards, high school students have the opportunity to complete their “pre-scientific work” (*“vorwissenschaftliche Arbeit”*) under the supervision of IST Austria scientists.

In conclusion, this section has shown that Lower Austria has a well-developed strategic framework for smart specialisation based on previous experience of regional innovation policy and several tried and tested measures such as the technopole and clusters programmes. Furthermore, the framework includes a plan to strengthen human capital for innovation, both in the economic and higher education strategies. This supports ongoing processes of transition from an agricultural based region overshadowed by Vienna to a knowledge based region. Lower Austria has used proximity to Vienna to its advantage by attracting talent through new institutions or hubs of those based in the capital.

4. The Importance of Intermediary Agents and Services for Connecting Universities with Industry and for Facilitating Regional Innovation

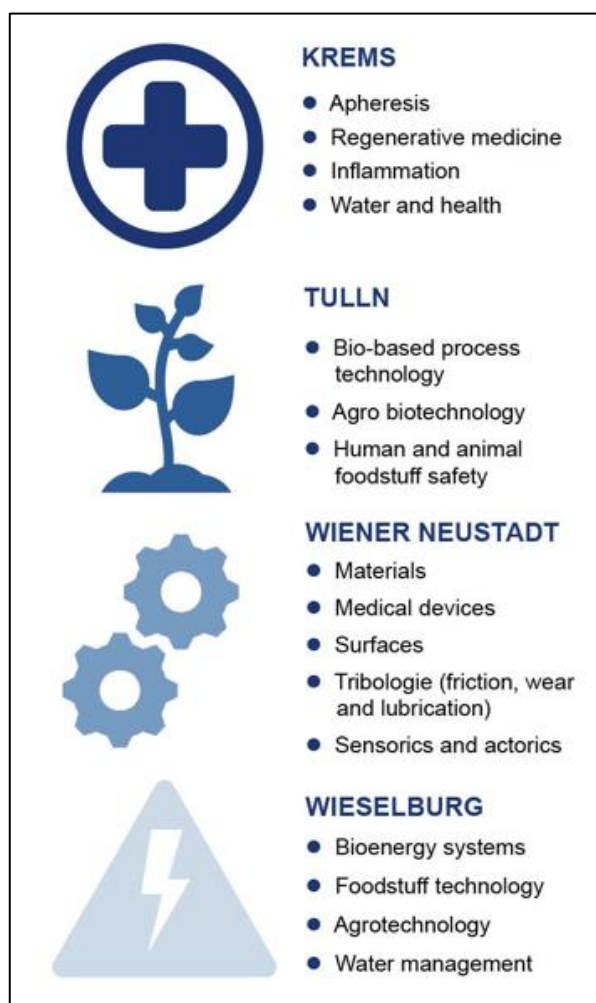
The Lower Austrian regional innovation system is characterised by a dense web of intermediary agents and services which serve to connect universities, public and private research institutes and businesses through shared facilities and research infrastructures, facilitating services, innovation funds for businesses and cooperative project funds in priority areas that have been identified and selected in a multi-stakeholder process. Hence, the central role of the intermediary agents and agencies deserves a closer look.

4.1 The Technopoles as Connective Tissue between University Research Groups and Companies

The technopoles were established as technologically oriented business centres which continuously aim to expand the innovation absorption of businesses by making use of study and research institutions in the vicinity. Thereby they enable a close interlinkage between innovation and HE strategy. The existing four technopoles have been set up at locations where internationally competitive research is already performed, where critical mass and further potential with respect to industry innovation, research institutes and HEIs can be found, and where there is room and support for further infrastructural development. The selection of the four technopoles was preceded by an elaborate assessment. Following the establishment of the first three technopoles, the decision to add a fourth one was subject to long and controversial deliberation. Today, there are four technopoles with different thematic profiles, namely in Krems (biotechnology and regenerative medicine), Tulln (agricultural and environmental technologies), Wiener Neustadt (new materials, process technologies, medical technologies, sensor technologies, surface technologies), and Wieselberg (bioenergy, biomass, energy technologies, agricultural and food technologies, water technologies), as illustrated in Figure 6.

Technopoles support the development of eco-systems which are attractive for research-oriented companies or start-ups as well as for applied research groups or institutes in related thematic areas, focusing on their cooperation and synergies. In addition to all partners sharing research infrastructures, networking opportunities and support services, their joint critical mass and wide coverage of different phases of the innovation life cycle - from basic research via business facing applied research and prototype development to product development and production technology innovation - help them gain access to more substantial funding grants from national and international funding programmes and attract talents from inside and outside the region more easily. Over years of ever-denser interactions, increasing number of cooperation and innovation successes, and new talents, research groups and businesses joining the ecosystem, trust is built among all partners facilitating new cooperation projects and generating new innovation ideas. The result is a self-reinforcing system that improves business dynamics as compared with other regions. As the most recent

Figure 6: The Four Technopoles



evaluation of the technopoles shows, this is precisely the case in Lower Austria.²² The below example of the technopole in Wiener Neustadt serves as a case in point.

4.1.1 The Technopole in Wiener Neustadt: Development and Success Factors

Like all Lower Austrian Technopoles, the Technopole in Wiener Neustadt (TWN) connects research groups and industry partners around common interests of technological development and services. The TWN manager, who has been responsible for its development during the last 13 years (and already contributed to the Lower Austria's technology development programmes in other research and networking functions before), identifies possible partners and funding opportunities based on existing strengths and potential, facilitates collaboration, develops services that cater to the specialised technological development needs of the TWN tenants and their partners. He is also responsible for the infrastructural development strategy (Ansiedlungsstrategie), on the basis of current and future needs.

The Technopole, as network facilitator and physical infrastructure, brings together a variety of different types of partners, a variety that also reflects the range of instruments which Lower Austria uses to facilitate innovation. These include more than 20 institutions in its core network, such as:

- The COMET Centre *AC²T* (a private sector research facility active in interdisciplinary, pre-competitive research focused on the areas of Lubricants & Interface Mechanisms Wear Processes & Protection, Friction Surface Phenomena & Tribodiagnostic, Computation & Experimental Simulation), *CEST* (Austria's Competence Centre for Electrochemical Surface Technologies), and *ACMIT*, the Austrian Centre for Medical Innovation and Technology, a research and development centre in the field of medical technology.
- The *AIT Biomedical Systems* business unit (of the Health & Environment Department of the Austrian Institute of Technology) which offers research and tech development services for the health-care sector and healthcare industry, in particular cardiovascular & biomedical applications and homecare solutions, which also hosts an endowed chair, on a part-time basis (for a professor from a Viennese University) that is funded by Lower Austria.
- The Department for Integrated Sensor System (DISS) of the Danube University Krems, which is devoted to basic, yet application-oriented research on concepts and methodologies for smart sensor design, interconnection, and application²³.
- The Research and Technology Transfer Service of the University of Applied Sciences *FOTEC*, which coordinates and implements research and development projects in close cooperation with industry partners.
- Clusters offices of both the *Plastics Cluster and Mechatronics Cluster* (abbreviated as KC and MC, respectively) of Lower Austria. These clusters are cross-sector networks for their respective industries, spanning both Lower and Upper Austria and supported in equal measure by the business agencies TMG of Upper Austria and ecoplus of Lower Austria.
- The start-up support service and accelerator *accent*, which is supported by Lower Austria (30%)
- Innovative high-tech companies such as the AIT spin-off *Aerospace & Advanced Composites* or *Attophotonics* (surface nano-coatings producing colour effects without use of pigments), technological centres interface.

In addition to these institutions, many of which themselves have an interface function between basic and applied research and industrial technological development, the TWN benefits from research and development grants from ESA, a wide range of EU funding programmes, the Lower Austrian competitive project grants, including larger ones which implement the national research and innovation strategy (FTI grants) amounting to more than €500 000, as well as large national grants, administered through FFG in the form of COMET centres, which receive up to €60 million over five years (such as the K2 Center for Tribology). The technology promotion programme of Lower Austria played an important role for the technopole's step-by-step development (see below). Part of the function of the Technopole is to identify appropriate funding instruments and helping to bring together cooperation partners for third party funding projects.

²² Economica (2019), Die wirtschaftliche Bedeutung der niederösterreichischen Technopole. Evaluierung 2019. Studie im Auftrag von ecoplus.

²³ <http://www.tfz-wienerneustadt.at/ecoplus/technopole/tfz/e/default.asp?id=75583&m=>

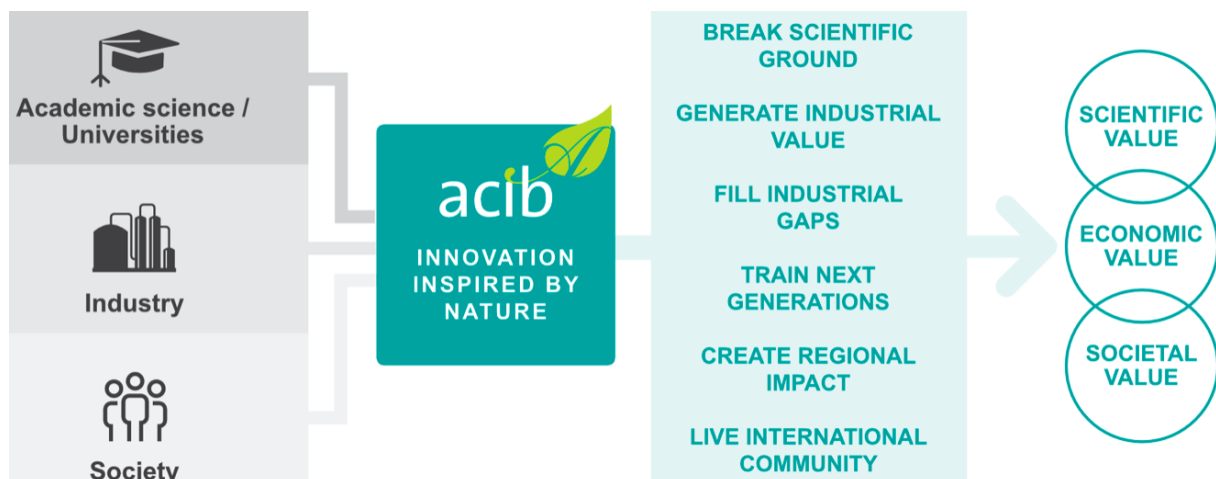
A key success factor of the TWN's development over the last 13 years has been its modular step-by-step expansion. Rather than building a very large infrastructure from the outset and filling it up with a coincidental range of institutions, TWN's expansion was planned based on the needs and development plans of existing institutions, the fit of new institutions with existing tenants in terms of technical facility assets and needs as well as the complementary competences they bring to the existing competence and thematic portfolio. In this way, a close-knit network of partners emerged that can benefit from each other's presence at the technopole. Regularly, the partners at the technopole meet to discuss future development, including at annual strategy meetings, or at more frequent informal breakfast exchanges, to develop new ideas for projects and cooperation. Accordingly, TWN offers a range of technology fields that are closely linked among each other:

- new materials
- surfaces and surface coatings
- tribology, wear, friction
- sensor systems
- medical technology

4.2 University-Industry Collaboration in COMET Centres

COMET Centres are federally funded (FFG) applied research centres that develop key research and technological development competences through cooperation between science and industry. The centres bring together a critical mass of research groups of universities, including many international partners, with a consortium of businesses that also includes regional and international partners. Within a single centre, promising/emerging fields of research and new research ideas are developed via science - industry collaboration, technology transfer is orchestrated, and the innovative capacity of companies strengthened. The collaboration is designed to result in the creation of new product, process, and service innovations. In short, one may describe COMET Centres as applied research and technology transfer centres that bridge technology readiness levels from TRL 3 to 7 or above. Figure 7 below illustrates the knowledge transfer mission of one such centres (ACIB).

Figure 7: The Knowledge Transfer Mission of a COMET Centre (example ACIB)



Source: ACIB <https://www.acib.at/network/>

The following COMET centres are located in Lower Austria, either with their headquarters or single departments:

- AC²T X Tribology (a K2 centre) in Wiener Neustadt, a European Center of Tribology which transfers holistic tribology knowledge and professional experience to industry by providing high-quality personnel and state-of-the-art equipment in a synergistic and cost-effective "multi-user system".
- ACIB, the Austrian Centre of Industrial Biotechnology, with one site in Tulln, developing new, environmentally friendly, economically and technically advanced processes for the biotechnological, pharmaceutical and chemical industry that are modelled on nature. ACIB has four university partners from all over Austria and more than

- ACMIT, the Austrian Centre for Medical Innovation and Technology”, (a so-called K1 center) in Wiener Neustadt, which is an application-oriented and translational research and development centre in the field of medical technology which develops mechatronic systems and procedures for the purpose of making medical treatment less invasive, less risky and more efficient, for the benefit of patients, physicians and medical device manufacturers.
- CEST, Centre of Excellence for Electrochemistry and Surface Technology in Wiener Neustadt and Tulln (and Linz), with 30 university and other public research institutes and 24 business partners, offers its customers high level contract research in the areas of electro chemistry, surface technology, corrosion technology and bio sensors.
- FFOQSI (feed and Food Quality, Safety, and Innovation) in Tulln, with more than 30 companies from several countries and positions along the feed-food value chains as partners (innovative start-ups, small and mid-sized enterprises up to national and international market leaders), explores and improves plant-derived feed and food (green value chain) and animal-derived food (red value chain).
- Bioenergy 2020+, based in Graz with a site in Wieselburg, with the TU Graz, the TU Wien and the Institute for Environmental Biotechnology (IFA Tulln) as well as 5 international universities and 10 companies as partners, addresses the thermal conversion of biomass, fermentation , bio-fuels, biomass-CHP, polygeneration systems.
- WOOD K Plus in Tulln, a centre for materials research and process technology in the area of wood and wood-related renewable resources in Europe, along the complete value chain – from raw material to finished products.

4.3 Research and Technology Transfer Agency FOTEC

In order to increase its research capacity and to facilitate technological innovation through university-industry collaboration, the University of Applied Science (FH) Wiener Neustadt has established the Research and Development Centre FOTEC (Forschungs und Technologiezentrum) which hosts all its research and technology transfer activities in its three technology-driven and most research-active faculties: Engineering Technologies, Innovative Software Systems, and Aerospace Engineering. FOTEC caters to regional businesses with R&D services and training measures, in close response to their demand. The self-description of its portfolio, core topics and services are illustrated in Figure 8 and gives an impression of its service orientation to business innovation.

Figure 8: FOTEC's Research Service Portfolio



Source: FOTEC (Website)

As can be seen from the description of services in Table 3, FOTEC's thematic portfolio does not present itself as an integrated part of the UAS but wholeheartedly as a service provider to the high tech business sectors of the region, in full alignment with the innovation strategy and its priority areas (FTI-programme), specifically in digitalisation, materials and surfaces and automation in manufacturing. Accordingly, FOTEC staff closely follows

thematic development in research and industry and feeds any emerging themes and needs back into the strategic development of the regional development agency *Ecoplus*.

Table 3: FOTEC's description of its Core Research Services to Businesses

Engineering Technologies:	FOTEC operates a modern and state-of-the-art laboratory for additive manufacturing (3d printing) of metals and polymers. Since 2010 highly complex prototypes and structural parts are designed and manufactured at FOTEC by laser beam melting. Additive manufacturing allows a high degree of design freedom, which is not allowed with conventional technologies. Furthermore, FOTEC operates a laboratory for powder injection molding (PIM) of metallic (MIM) and ceramic (CIM) parts.
Innovative Software Systems:	FOTEC develops customized individual software, covering apps, web applications, applications for augmented and virtual reality as well as business applications. The overall goal is to use latest state-of-the-art technologies for software development and to transfer the gained know-how to our customers and partners. For this purpose, FOTEC continually provides trainings, to allow customers and partners to keep their teams of developers fit for brand new technologies. Customers and partners of FOTEC always have access to the source code during and on project finalization.
Aerospace Engineering:	The department of Aerospace Engineering, acquired from the Austrian Institute of Technology in 2011, has more than 30 years of experience in the support of space-related technology developments. The international team, consisting of experts from different fields, regularly supplies the European space industry with innovative technology solutions, such as electrical and chemical propulsion technologies and energy systems. Over the past 30 years, technology developed by FOTEC has been distributed throughout our solar system. They can be found everywhere from low earth orbit to comet 67P/Churyumov-Gerasimenko (Rosetta). Our technologies have contributed to the success of missions such as Geotail, Equator-S, Cluster, Cluster-II, Rosetta, DoubleStar and MMS.

Source: FOTEC (Website)

As a private research subsidiary of the public UAS which acts as a business service provider (in the form of a limited society, GmbH), FOTEC offers the advantages of being able to contain the risk of research investments, of being eligible for the federal research tax benefits for such investments (*Forschungsprämie*) and of being allowed to subtract research infrastructural investments from its VAT. Moreover, its governance allows swift and flexible response to company needs.

The CEO of FOTEC and its support staff build trust among their business partners by responding carefully to their needs and demands and by identifying applied research and innovation partners that fit such needs as well as innovation opportunities and funding sources that they may not even have considered. FOTEC also responds to businesses' training needs, either by developing short training modules with the help of their network of experts or, in the case of more substantial long-term needs, by feeding them back into the UAS study programme development. For mere increase of demand, the UAS may be able to shift resources from one programme to another; however, the establishment of new study programmes depends on relevant national calls.

FOTEC's credibility in the eyes of its customers relies first on its role as a neutral service provider and network moderator, with complete independence from any particular business or institutional interest. As the research subsidiary of the public FH, it does not want to sell a service but is designed to serve the needs of regional businesses. Secondly, its credibility depends on the network moderators' ability to translate between the diverse institutional cultures and discourses of universities and businesses. This ability to translate derives from the researchers' and employees own hybrid professional biographies, with past exposure to both technological research and industry innovation.

4.4 Accent and Tecnet: The regional start-up support services

Accent was set up in 2005 to support regional start-ups, with a primary focus on deep tech spin-offs from university and UAS research, from their early launch to their growth phase²⁴. For more advanced start-ups that are ready to scale up, there is a regional venture capital fund, *tecnet*, with which *accent* is closely interlinked. *Accent* accompanies start-ups for three years after launching their businesses: from one-year *creative pre-incubator* programme, which it developed together with the FH St Pölten, to an 18-month incubator programme for research spin-offs with intense “impulse sessions” and coaching that cover all aspects of business creation, up to the alumni phase in which access to business angels, business networks and VC funding is most decisive. In conjunction with the *riz-up* service, it helps start-up founders with the development of business plans, building successful teams and task profiles, finding first start-up grants, offices and access to technical facilities, as well as with presenting themselves to business angels and understanding their expectations or the legal implications of founders agreements. Business angels are invited as potential investors, access to business networks and funding is facilitated to accelerate their growth. In recent years, *accent* has prioritised attention to start-ups with high growth potential and based on the service’s network, helped them scale-up and access new (often international) markets.

The quality of the support service, its coverage of all aspects and phases from pre-incubation (*creative pre-incubator* programme) to incubation and scale-up phase and its seamless interlinkage with the VC agency are very positively reviewed by users and have resulted in a growing national and international visibility of the service, which has resulted in its selection as the national service for the CERN start-up venture programme. With Lower Austrian proportion of new created businesses amounting to an impressive 20% of all Austrian business creations in 2019 according to the WKO^{25,26} – although some regional policy makers still see room for improvement according to the Economica study – any such performance data is all the more impressive if put into perspective: with no classical university or technical university in the state, which offer the usual seeding ground for spin-offs, Lower Austria has to rely on far less voluminous spin-off pipelines: the few research outposts of Viennese universities in the state, the continuing education-based Donau-Universität Krems with only few spin-off prone research institutes, the universities of applied sciences which have only expanded their research over the last decade, or the young IST Austria, whose core mission is internationally competitive basic research. Nevertheless, the start-up momentum and potential are rising on all fronts, such as:

1. **IST Austria with its spin-off relevant disciplinary portfolio** comprising life sciences, information and system sciences and physical and mathematical sciences, **has been developing its own start-up environment** with an institutional support service, **IST-Cube**, and an increasingly high tech facility support systems, which may act as an attractor to high tech companies. Managers of the regional development strategy have recognised this potential and are seeking close cooperation, not only through close communication with *accent* but also with infrastructural investment support.
2. The **research capacity of the Universities of Applied Sciences is expanding, especially in areas of high spin-off potential** thanks to strategic institutional steering, through shifting funds and prioritising investments in the most research active areas (as is done in both Wiener Neustadt and St Pölten) as well as by introducing additional study programmes in high tech areas, as promoted by national competitions for additional programmes in such areas, or shifting capacity (study places) to programmes in high tech areas that are in high demand (such as robotics).
3. The **infrastructural investments** in core facilities and large research infrastructures in the context of larger industry-university research cooperation projects, COMET centres and technopoles is **attractive also to new businesses** in those thematic areas.

²⁴ <https://www.accent.at>.

²⁵ <https://www.ecoplus.at/wirtschaftsstandort-noe/> or on the site of the WKO itself, under http://wko.at/statistik/ng/ng2019-bl.pdf?_ga=2.234890370.228660560.1591124655-943543943.1591124655.

²⁶ According to the evaluation of the Lower Austria innovation strategy by Economica (2019), *Die wirtschaftliche Bedeutung der niederösterreichischen Technopole. Evaluierung 2019. Studie im Auftrag von ecoplus*. It is unclear how the Austrian Start-up monitor could come to such a different number of only 7% of all Austrian start-ups (see Karl-Heinz Leitner, et al. (2020) *Austrian Start-up Monitor 2019*).

4. The state-of-the art service provided by **accent** and its proactive international benchmarking networks, including cooperation with eight other incubators in the Netherlands, Norway, Italy and Spain, has helped it move beyond a regional to a national and international role, most prominently reflected in its function as the chosen **Austrian national coordinator of CERN's European-wide start-up venture**. CERN is known not just for its fundamental astronomical research (and its astronomical costs) but also for spinning off a wealth of high tech innovative technological ventures which have resulted in a vibrant start-up arm. In recent years, this start-up arm and its benefit to economic growth has been emphasized strongly by funding authorities, resulting in its expansion across Europe. In Austria, accent has been cooperating with CERN for more than five years and is now coordinating the promotion of CERN-funded incubation competitions and ventures. In the CERN *Idea Square*, regional UAS students undergo a three-month long process in which they are exposed to two to three technologies with the aim of developing a product which is presented at the end. Those start-ups been selected by the CERN screening process benefit from the CERN-quality label and gain easier access to international VC funds.
5. In addition to the regional start-up service, some **municipalities** have developed **local start-up platforms, such as smart-up in St Pölten (www.stp-smartup.at)** which help local founders communicate with local users and markets to ensure the marketability of their business venture.
6. The UAS have developed their technology transfer together with their growing research capacity. As research at the UAS is applied and business-facing, its transfer to business innovation is part of its mission. In some areas, such as digital technologies, such transfer is particularly closely linked with start-up activities. The UAS (FH) St Pölten's digital ecosystems is a case in point since the UAS research and the digital start-up scene are closely connected. Accordingly, the chief research and innovation officer at the UAS St Pölten is also connected to the *Smart-up* St Pölten and heads the *Digital Makers Hub*, which connects companies, experts and developers (digital makers) to develop innovative solutions with creative ideas and unconventional approaches.

Tecnet is Lower Austria's VC equity arm which invests in shares of new technology firms. It emerged in 2003 from Lower Austria's earliest technology transfer initiatives initially focusing on evaluating and supporting patents that were creating value out of UAS research. From 2008 onwards *tecnet* also started to provide seed funding for the most promising early-stage spin-offs and acquiring shares. *Tecnet* also helps early-stage tech firms develop their markets and facilitates their access to the next higher level of investments when scaling up further.

With *accent* and *tecnet*, Lower Austria has created a seamless well-functioning start-up support system that builds on close contacts with university researchers in technological fields. It has developed a strong focus on high tech areas in cyber security, social media, mechatronics, and plastics, in close alignment with the expanding research capacity of the Universities of Applied Sciences and the network of research partners that have formed at the technopoles or in the framework of cluster cooperation. *Accent* and *tecnet* have thereby helped strengthen early-stage companies and focused on realising their growth potential, resulting in strong client satisfaction and a steadily growing number and scale of high-tech companies. The start-up and VC services have helped to build denser ecosystems around the technopoles and high-tech strengths of the different regional sites, with health-related red biotechnology and digital start-ups developing more strongly in St Pölten, green biotechnology in Tulln, and mechatronics, plastics, materials and aerospace technology development in Wiener Neustadt.

The importance of intermediary agencies consists in their ability to translate between the international research and technological expertise of universities and the demands and challenges of the business sector. Their credibility relies not only on their overview over a wide range of relevant expertise of different organisations, an informed sense of their interfaces, as well as the ability to mediate between different organisational cultures and perspectives. It also depends on their neutral role as brokers, facilitators, and network moderators, whose success is defined by the success of the interconnections that they help to build and the solutions they help bring about, rather than their own separate agenda.

Lower Austria has invested in its intermediary organisations for two decades, investing in their provision of state-of-the-art physical and research infrastructures, in supporting research, training and development funding incentives, and providing highly qualified expert service personnel with an ability to bridge different interests, expertise and perspectives. Its technopoles, clusters, and variety of applied research and transfer centres, have been instrumental in translating research expertise into business.

5. Governance and Implementation of Regional Innovation Strategy

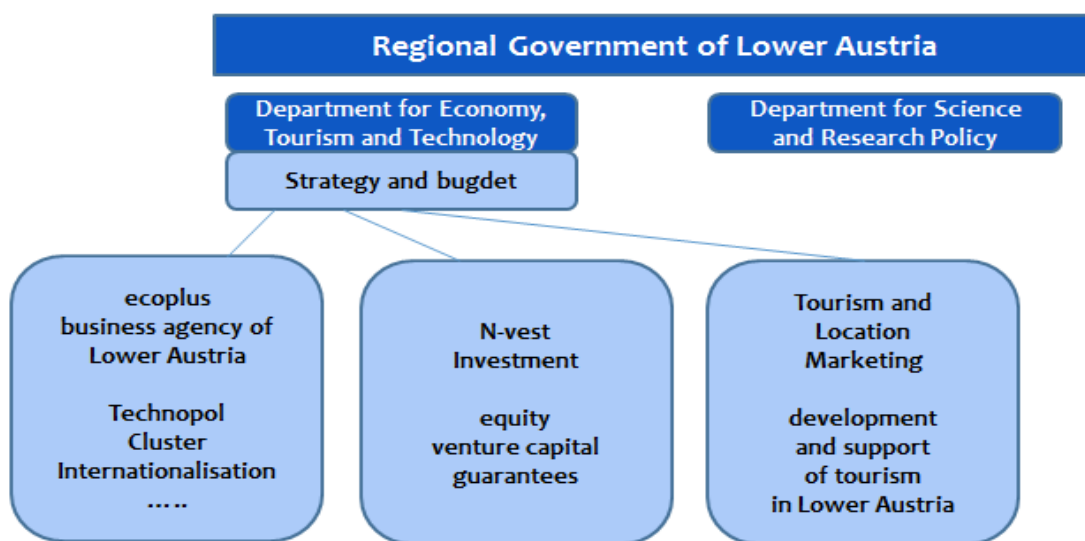
5.1 Governance within the region

The S3 of Lower Austria builds on shared governance and wide participation, as well as a strong facilitating role by regional government and its agencies. The development and implementation of regional innovation policy is a shared responsibility of two government departments, the Department for Economy, Tourism and Technology (DETT) and the Department for Science and Research (DSR). Together they are tasked with bringing together all relevant stakeholders from the business, higher education and research worlds in the definition and realisation of the strategy. Innovation capacity is supposed to be built through concerted interplay between the economic, research and higher education fabric of the region.

Back in 1997, with the inception of the Regional Innovation Strategy, a regional **Steering Committee** (*Lenkungskreis*) was established to coordinate and oversee regional development and its research and innovation priorities. The Steering Committee brings together all relevant technology and innovation service providers and helps prioritise and build consensus regarding policy choices and instrument design.

Together both regional government departments (DETT and DSR) form part of the steering group (*Steuerungsgruppe*) to ensure regular exchange on new challenges, emerging relevant themes for regional site or cluster development, new ideas for funding instruments, potential new partners, attraction of new companies, foreign investments in regional ventures or monitoring of success. The departments' proactive role in this development is widely recognised as an important success factor of the dynamic regional innovation development in the last decade.

Figure 9: Key Innovation Actors of the Lower Austrian Regional Government



Source: Regional Government, Dept. Economy, Tourism and Technology

The Department for Economy, Tourism and Technology is responsible for developing, monitoring and steering the economic strategy ("Wirtschaftsstrategie"), in close exchange and concertation with the Department for Science and Research, which was established several years ago to reflect the growing higher education and research intensity of Lower Austria. The Department for Science and Research oversees and coordinates all aspects of higher education research or teaching offer, investments in the HE infrastructures at the public UAS and the private university in which it holds shares and orchestrates the regional research project funding calls. It is also responsible for the development and implementation of the research and technology regional funding (FTI) programme and its thematic calls. Finally, it organises regular meetings of advisory and developing committees and working groups to support its continuous further development and adaptation, in close communication with the DETT.

In addition, a so-called regional **Site Forum** (*Standortforum*) was established in 2015, that twice a year brings together research institutes and universities to develop new ideas, discuss strategic developments and suggest

new thematic areas, policies or instruments at the level of particular sites. The *Standortforum* reflects the increasing importance of responsive higher education and research for innovation dynamics.

The development of the Research Technology and Innovation (RTI) strategy and the calls of the FTI programme is coordinated by the Department for Science and Research Policy, in close concertation with the Department for Economy, Tourism and Technology. The thematic priorities are crucial for regional innovation dynamics since they guide cluster and technopole developments and define the FTI. They are identified with the help of regional stakeholders in an elaborate reiterative process that ensures concentration of areas of high added value for regional innovation. For the development of the previous RTI strategy and its thematic priorities, the process included over 30 workshops for different thematic areas with more than 600 participants. Stakeholders are associated with thematic areas and will feed into thematic development of those areas.

For each theme, thematic development will also be discussed regularly by cluster or technopole managers, with concrete assessments and proposals regarding cooperation and industry potential. Companies are involved through large-scale questionnaires and strategy meetings, both formally and informally (e.g. at the weekly breakfast meetings of the technopoles). The results of such regular feed-back loops (or coordinated reviews) feeds into the regular meetings of all technopole and cluster managers at the level of *Ecoplus*, the Lower Austrian Business Agency, which acts as the State's Regional Development and Innovation Agency and oversees all cluster and technopoles. Eventually such continuous feed-back and idea development will also feed into the adaptation of the joint Research and Technology Programme, e.g. in jointly concerted definition of funding calls or thematic priorities of the research and innovation programme (FTI), which is coordinated by the Department for Science and Research. Thus, the development of the S3, also called Economic Strategy (Wirtschaftsstrategie) is coordinated by the Department for Economy, Tourism and Technology, as is its day-to-day implementation (by its economic development agency *Ecoplus*) while the RTI strategy and programme and its calls are coordinated by the Department for Science and Research. To an outsider this may well seem confusing, but to the insiders the information flow and network dynamics seems to be unimpaired, and even well-developed.

Figure 10: The Organisational Structure of the Lower Austrian Business Agency Ecoplus



Source: Regional Government, Dept. Economy, Tourism and Technology

Hence, one may say that the Departments for Economics, Tourism and Technology, and the sister Department for Science and Research coordinate the development and definition of the regional S3, in a close concertation that seems to be widely viewed as effective by innovation actors. Moreover, **the high quality of its**

implementation and development, which stakeholders widely comment on, seems also to be due to the regular feed-back loops through technopoles and clusters themselves and with their regional government departmental coordination. For the quality of regional development, the feed-back and strategic reflection at both levels is the key to success: the fact that both technopole and cluster managers regularly meet their key members for discussion of project development and emerging themes and demands, and the technopole and cluster managers meet regularly with the *Ecoplus* agency to exchange their experience, discussing new ideas for development and reviewing current projects and instruments, constitutes the recipe for success. On this foundation, a deep quality culture was able to develop, which is experienced by its stakeholders as responsiveness to diverse regional realities and changing demands and continuous improvement of regional innovation policies and measures. Moreover, it allows transparency and flexibility with respect to diverse needs and situations. As one technopole manager commented, part of the success of the technopoles is owed to the fact that they can respond and develop differently, in accordance with local demands and potential under a common framework that leaves some leeway for such individual differences. While the FTI calls follow joint criteria and aims, their development can respond to contextual specificities.

5.2 Coordination and interaction between national and regional strategy development

At national level, there are several guiding strategies and monitoring frameworks that set the policy for regional innovation.

- A **strategic monitoring process** was established to implement Austria's Partnership Agreement with the European Commission for the ESI Funds 2014–2020 ("STRAT.AT 2020"). As part of this monitoring process, "**STRAT.AT 2020 Partnership**" was created as a platform for the federal government and the Länder to share their views on relevant strategies related to smart specialisation. "The goal was to achieve a common understanding of the interaction of the national RTI strategy with the economic and innovation strategies of the Länder thereby creating impulses for new ideas – internally and externally."²⁷ The Partnership also serves as framework to support the regular communication between the federal government and the Länder regarding RTI policy matters, e.g. in the context of the development or implementation of the national research and innovation strategy (see below). Communication takes place within established exchange platforms, e.g. the *Bundesländerdialog* organised by the Federal Ministry of Science, Research and Economy and also within the ÖROK Subcommittee for Regional Economy, which deals with regional policy in the context of RTI.
- The **national research and innovation strategy** (FTI-Strategie) dates back to 2011 and covers the ten-year period until 2020. It defines overall innovation aims, e.g. in terms of increasing the scope and competitive funding instruments of RTI investments, but refrains from setting any aims or thematic priorities for individual regions. Instead, it formulates in very general terms, that "national strategies for generic science and technological fields"²⁸ should be developed, taking Austrian strengths and critical mass in science and business into account. Moreover, systemic "grand challenges" are also supposed to be defined and addressed. With respect to the specific development of Lower Austria, the national strategy mentions the establishment and expansion of some national institutions that are of immediate relevance because of their location in Lower Austria: the establishment of IST Austria and reorientation of AIT are both mentioned. For the business sector, a concrete target of their R&D investments is set and the increase of their innovation absorption capacity emphasised. Incentives and instruments for increasing the interaction between business and university sectors are highlighted. With respect to universities, an increase of competitively awarded research funds and other strategic incentives are supposed to do justice to their autonomous nature.

To develop the new national research and innovation strategy, a strategy process was started two years ago and is being concluded this year, which brings together different stakeholders at different levels. In this context, there is a regular exchange between federal level actors and regional ones, e.g. biannually in the preparation of the Research and Innovation Strategy (FTI-Strategie).

²⁷ Markus Gruber, Renate Handler (eds.) (ÖROK) (2016), *Policy Framework for Smart Specialisation in Austria*. Vienna.

²⁸ Bundesregierung der Republik Österreich, Potenziale ausschöpfen, Dynamik steigern, Zukunft schaffen. Der Weg zum Innovation Leader. Strategie der Bundesregierung für Forschung, Technologie und Innovation.

- In the **university sector**, which prides itself in having assumed full autonomy and supporting quality assurance systems that ensure their accountability, the **key steering instrument** for interfacing national and institutional interests consists in the three-year contracts by objectives (**Leistungsvereinbarungen**) between the government and each university. This instrument has been continuously adapted and, since 2013, has demanded the formulation of so-called site development plans **“Standortkonzepte”** to ensure the inclusion of universities’ regional development strategies. Moreover, an overarching national planning document, the so-called GEUP (Gesamtösterreichischer Universitätsentwicklungsplan) which serves as the set basis for all institutional contracts, explicitly emphasises regional “concertation” (“dient der GUEP der Entwicklung eines überregional abgestimmten und regional ausgewogenen Leistungsangebots”), and the expansion of science and innovation transfer as well as locational advantages (“Ausbau des Wissens- und Innovationstransfers sowie der Standortvorteile”).
- For the **universities of applied sciences**, however, **no systematic interface between national and regional perspectives is foreseen**. While there is a national UAS-Development and Financial Plan (Fachhochschulentwicklungs- und Finanzierungsplan 2018/19 – 2022/23), this only set out the scope and modalities of federal financial investment in UAS study places but does not address the development plans of individual UAS. There are no contracts by objectives between national and institutional levels which would include regional development concepts, nor is there a regular dialogue (and institutionally informed contact person within the ministry) between national government and regional UAS. Hence, at the Ministry of Education, Science and Research (BMBWF), there is little depth of knowledge of regional or institutional realities of individual UAS, their developments and strategic opportunities which could involve interfacing national and regional funds and priorities, as is the case for universities. Hence, there is a communicational and steering gap between the federal and the regional level, at least with respect to individual strategic developments of UAS and its interface with national developments.

Hence, concretely, if UAS want to develop their study programmes in accordance with regional priorities, they depend on national study places and national competitions for being awarded additional study places and subsequent programme accreditation before they can introduce such programmes, which greatly reduces their responsiveness to emerging regional demand. Currently, such calls for new study places address programmes in computer science and STEM subjects. If a UAS is not successful in such calls or would like to introduce a programme that does not fall in the scope of new calls, it would have to finance these programmes entirely through business sponsorship. Of course, to a limited extent, the success in national competitions can be influenced through seed funding for piloting new offer of the UAS, or through winning calls by organising the required stakeholder support.

Finally, with respect to research capacity development, UAS depend entirely on additional regional government investments or competitive federal research grants. Since there are no institutional grants for research, neither at national nor at regional level, UAS can only build additional capacity through federal (applied research) funding competitions, especially those from the FFG (e.g. for COMET Centers) or the Christian Doppler Gesellschaft (for Joseph Ressel Centers), or by stretching the more limited possibilities of internal resource prioritisation or redistribution. At national level, such capacity building relies on subject-based grants of limited duration to expand research capacity in particularly well-positioned areas (FFG or CDG). There are also no incentives to promote collaboration between traditional universities (with their emphasis on basic research) and UAS (with their emphasis on applied research that is business-facing).

- With respect to **public research institutes**, such as the AIT or IST Austria, and their expansion or regional locations, the process of decision-making which clearly takes place at national level, did not appear transparent in the scope of this inquiry. There seems to be some doubts voiced by various stakeholders as to the overall transparency of such national decision-making processes on the locations of national institutes if ever such questions arise.

5.3 Monitoring and Evaluation

Regional innovation policies and instruments are monitored and evaluated at three levels:

1. Project level

At project level, especially with respect to grant proposals and funding measures, project inputs, outputs and effects on the regional companies are assessed. Many funding instruments are organised through competitive

calls and with the help of previously agreed criteria that help increase transparency with respect to funding decisions and return on investment.

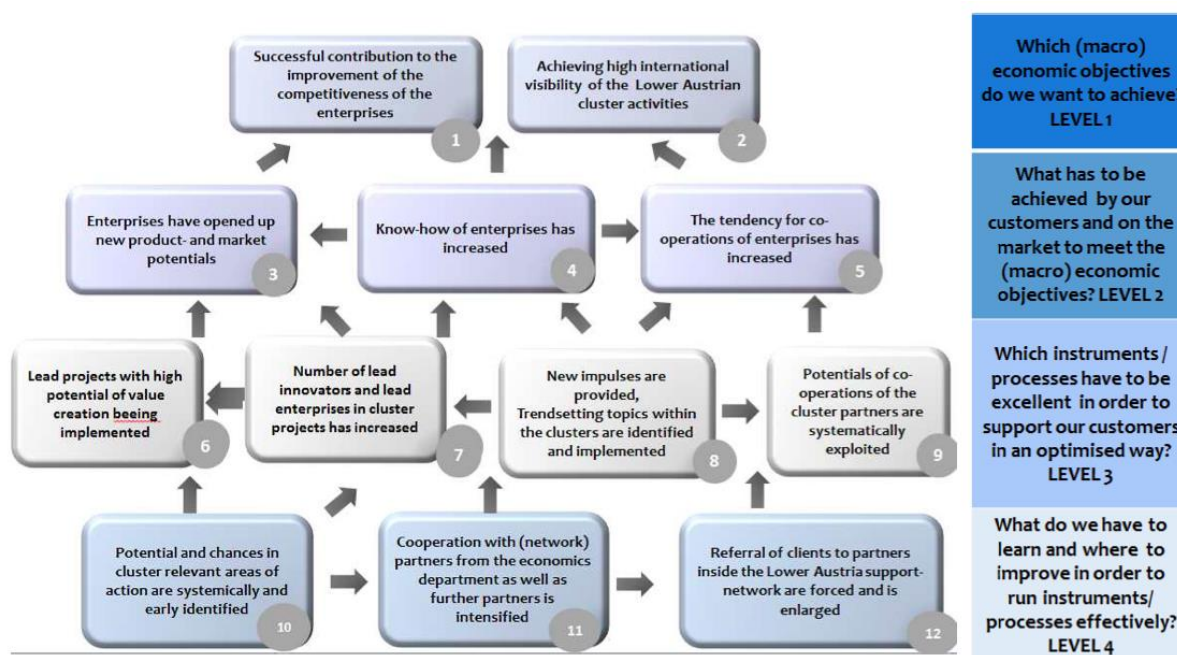
2. Programme level

There is agreement on objectives, e.g. for technopole or cluster organizations, and management by objectives with a balanced scorecard approach to assessing their realisation. To steer all business units and monitor progress, this approach focuses on measurable aims. It has been used and found to be helpful over a number of years. For example, with cluster development, a number of targets for reaching the economic objectives have been set and against which success will be checked, including:

- Number of lead R&D projects that are initiated,
- Number of big innovative companies involved,
- Number of products, services or system innovations initiated,
- Number of qualification projects initiated,
- Percentage of cluster members newly involved in collaborative projects and
- Number of cross-organizational projects.

To show how the balanced score card approach is used, we may take the example of cluster development, for which a target map was created for the period 2015-20. This spells out the overall economic objectives in terms of key achievements and instruments to realise these, as well as key learning processes for the cluster managers (see Figure 11). On this basis, indicators have been fixed to measures progress (see Table 4).

Figure 11: Balanced Score Card: Cluster Programme - Target Map 2015-2020



Source: Regional Government, Dept. Economy, Tourism and Technology²⁹

²⁹ Presented by Kerstin Koren, of the Department of Economy, Tourism and Technology, at Regional Government, (WT3) at the European Peer Exchange on Regional Innovation in 2018. Available at https://s3platform.jrc.ec.europa.eu/documents/20182/279010/Final_PXL+Monitoring_Vilnius_LA.pdf/c1bbac2-fd0e-4006-ba85-b66f889c7ffd

Table 4: Example of Indicators for Cluster Development Targets (3 – 5)

Objective	Indicator	Target value 2021 / monitoring	Measurement	Explanation / concept of measurement
3 Enterprises have opened up new product- and market potentials	Number of co-initiated product- and system solutions	Determine target value 2021	Count of projects	Funded or not-funded projects in the area of R&D, Product development, system solutions, which are significantly initiated and supported by the initiative and are not part of the category lead projects; Included are projects for opening up new markets on the basis of existing know-how (key word: competence map); no pure marketing projects
4 Know-how of enterprises has increased	Participation rate at initiatives for increasing competence or productivity	Determine target value 2021	Quota	An initiative is understood as coherent cluster activities, which should lead to increased competence- or productivity within a defined target group in the cluster. requirement: continuing cluster membership; integration of the partner for min. 2 days; counted once; Basis for the calculation of the participation rate: BEUC: 220; LMC: 90, KC: 110, MC: 130 CP
5 The tendency for co-operations of enterprises has increased	Participation rate at cluster initiated co-operations: 2nd order	Determine target value 2021	Quota	Cooperation rate 2nd order: participation in a cooperation project or project-like Cooperation; from 2. cooperation; requirement: continuing cluster membership; R&D&I institutions as well as external know-how only, if own share / -risks Basis for the calculation of the participation rate: BEUC: 220; LMC: 90, KC: 110, MC: 130 CP

Source: Regional Government, Dept. Economy, Tourism and Technology³⁰

According to the interviewed managers of intermediary agencies, the combination of clear objectives, clear measurables, and a large degree of freedom with respect to their realization, which is also the approach taken toward staff management, is widely appreciated and seen as a strong motivator for engaged work ethic and everyday quality culture in the work environment.

In addition, programme success is evaluated through company surveys, which are carried out every five years, and contracted evaluations. The evaluation of the technopole programme, which has looked at the measurable economic successes of technopole development in recent years and which was cited in the context of this case study, is an example of such regular evaluations.

3. Regional level

There is a similar agreement on objectives and corresponding assessment of effects of regional (innovation) policy through indicators, statistical analyses and comparison (R&D survey, Community Innovation Survey, company specific monitoring). The key indicators which signal progress against the key aims of the strategy are already highlighted in the strategy document itself (See Table 5 below).

For levels 2. and 3., international benchmarks with other European regions, are well integrated into development reflections. They are usually carried out in the context of the Interreg programme or with the help of audits in the European Cluster Excellence Award programme, complementing such assessments with a platform for peer-to-peer reflection. European benchmarking has been carried out with the regions of Helsinki, Tampere, Emilia Romana, and Brittany, addressing different kinds of shared challenges at all levels, with different regions as benchmarks according to the chosen key challenges or topics.

The governance of regional innovation in Lower Austria builds on four pillars of success:

1. A wide process of participation that interconnects different levels and thematic fields, with their diverse analyses of strengths, weaknesses and potential;
2. A subsequent clear prioritisation of the steering committee that allows for concentration of resources on the sites and themes that have been assessed to bear the greatest added value for the region;

³⁰ Loc.cit.

3. A strong emphasis on close coordination between the Department of Economy, Tourism and Technology, and the Department Science and Research on the other, in the implementation and continuous adaptation of the multi-annual policies; and
4. A transparent set of criteria for measuring progress and success against which projects, programmes and policies are held accountable.

Table 5: Indicators for Measuring Success in realising the Key Aims of the Regional Innovation Strategy

Strategic Aim 1: Increase international visibility and attractiveness	Strategic Aim 2: Expand highly innovative business environment	Strategic Aim 3: Increase sustainable business growth
Indicators:	Indicators:	Indicators:
1. Export dynamics	1. Business R&D expenditures	1. Start-up rate and survival
2. Human resources in Science and Technology	2. Human resources in high technologies	2. Regional Business Structure
3. Bandwidth	3. Patents	3. Business growth
4. Conferences and symposia	4. National and international research cooperations	4. Number of fast growing companies
5. Foreign Direct Investments	5. Third party funding	5. Persons employed

Source: Amt der Landesregierung Niederösterreich, Wirtschaftsstrategie 2025 (own translation)

Stakeholders widely comment on the value and achievement of such wide participation and transparency over recent years, which they feel contrasts greatly with the previous traditions of decision-making and which they credit for the increasing success of regional innovation and its attraction of research and innovation champions. The governance has built trust in the quality orientation of regional innovation development.

In conclusion, this section has shown that while interaction between different levels works well within the region, there is still some room for improvement for the interplay between regional and national innovation policy, in particular with respect to the further strategic development of the UAS whose role and potential in conducting business-facing applied research that would be highly complementary to university research is not sufficiently strategically valued and supported at national level.

6. Conclusions and Recommendations

Lower Austria offers a particularly interesting case study of a region orchestrating its structural transformation by enhancing the innovation capacity of its businesses through strategically targeted cooperation incentives as part of a comprehensive portfolio of support measures. It is also a remarkable case study of a region that has little higher education capacity at the outset successfully expanding such university and research capacity by offering attractive conditions to “offshore” institutes of existing universities in other regions, by expanding its own HE offer in areas of high demand and potential and by growing a dense connective tissue between its higher education and research institutions and regional businesses. To build such dense connectivity, it has established a functioning and adaptable set of intermediary agents, in particular its technopoles and clusters, that have targeted the potential of particular sites as well as key sectors and technologies which promise the highest added value for increasing innovation capacity. The region’s steady structural transformation and steadily increasing innovation success show that Lower Austria’s strategy development was well thought through, comprehensive in its design, and well adapted to changing demands and new challenges and opportunities. The quality of such strategy development and steering capacity reflected a proactive administration as well as the ability to continuously include its stakeholders its design and to select priorities and projects in transparent processes with clear success criteria.

In order to be attractive to research institutes, knowledge intensive businesses and highly qualified talents, Lower Austria has developed a set of **success factors** that it is able to develop and build on with a long-term perspective, namely:

- **Long-term investment in state-of-the-art infrastructures** for universities, research institutes and knowledge intensive businesses in selected areas of high technological and innovation potential. For universities and businesses, high quality infrastructures are the bottleneck of any strategic development. To know that a region offers reliable long-term support for developing and maintaining infrastructures is an outstanding asset and point of attraction for a region. Consequently, Lower Austria has been remarkably successful in attracting research institutes of Viennese universities and internationally visible non-university research institutes to the region.
- **The ability to grow its talent pool**, first of all by expanding its UAS, which offer a sufficient number of qualified graduates, according to interviewed are stakeholders, as well as by attracting university researchers and graduates from Vienna, the whole of Austria (e.g. to Donau University Krems) and globally (in the case of IST Austria).
- **The decision to design its own research and development funding in clear complementarity to national funding schemes**, by adapting its own priorities, thresholds, and criteria to complement national funding instruments, and by using matching funding schemes wherever possible to leverage existing funds for the region. In Lower Austria, researchers and businesses can find a seamless portfolio of applied research funding for cooperative projects from lower threshold funding in smaller projects and seed funding with industry partners from the regional FTI programme to larger scale projects with large critical mass from federal FFG funds or EU projects.
- **The ability to hire and keep highly qualified innovation brokers** in its technopoles and clusters and other intermediary organisations, who are able to span the boundaries of the perspectives and needs of diverse organisations, connect them and identify synergies, emerging themes and opportunities for their interactions. Lower Austrian innovation agents, such as its Technopole or cluster managers, have clearly developed a highly responsive mode of operation which enables them to identify new topics and demand rapidly as they emerge from industry and research institutes and feed such ideas, assessments and proposals into strategic development. In this sense, the public-private exchange is remarkably agile in Lower Austria, with respect to applied research and business-facing developments.
- **The readiness to compare its own practice with international benchmarks** in other regions and to consider the technological developments and needs of international partners and businesses in order to ensure the competitiveness of its own business sectors.

However, there are still some questions which an outsider may raise to offer room for reflection or perhaps even improvements:

1. Firstly, when it comes to new scientific and technological developments that emerge from fundamental research, Lower Austria lacks the critical mass of university research to be at the knowledge frontier. Instead, it has to rely on Viennese partner universities or the national funding agencies to identify emerging

fields that could be of interest to its own innovation developments. Hence, given its successful record of partnerships with Viennese universities, it may be advisable to also engage in partnership-based foresight by taking account of scientific developments that may have an impact, perhaps even a disruptive one, on the technologies and sectors that are currently responsible for Lower Austria's dynamic innovation development. Identifying such partners and connecting these with existing networks and strategy processes in Lower Austria is recommended.

2. Secondly, as the current global health crisis and recent radical transformations in relation to planetary boundaries, climate change disruptions and globalisation challenges show, Lower Austria may want to extend its attention to sustainability in its biotechnology sectors to a broader consideration of social, ethical and ecological threats or opportunities for innovation in the whole range of its key technology areas and high tech sectors. A more systematic integration of such concerns into technopole and cluster themes and developments, even beyond the explicit ecologically oriented ones, as it has already begun in the plastic cluster may point to additional innovation opportunities and respond to the high proportion of social and ecological start-ups that characterise the Lower Austria region.
3. Thirdly, while Lower Austria seems to have established a remarkably effective interlinkage between different types of institutions (including businesses, research institutes, traditional universities, UAS) in its regional ecosystem, there are not enough national incentives to promote cooperation between universities and UAS that would benefit from complementary time lines and business orientation. While UAS are oriented to finding solutions to SME innovation challenges, universities usually prefer more long-term basic research perspectives, even if the latter is then applied. This complementarity could be systematically used to mutual advantage, as is already done in some regional ecosystems in Lower Austria. Political lobbying for national funding incentives to promote such cooperation would benefit innovation dynamics in both Lower Austria and the country as a whole.
4. The success of *Donau University Krems* in offering continuing professional development and attracting students from outside the region and even Austria may be extended more systematically - in cooperation with the UAS, the Viennese Universities in Lower Austria, IST Austria and the non-university research institutes - to cover the key technology areas that have been successful priorities of regional innovation.
5. The outstanding international success of IST Austria may not have an immediate relevance for regional cooperation research and innovation projects but could perhaps still be used more systematically to its advantage. The cooperation that *accent* and others have set up with ISTA's growing start-up scene and the dynamic development of its technical facilities points to a promising direction and should be scanned systematically for further opportunities to have ISTA development benefit regional development. Communication channels should be extended, especially with formats that address graduate students, intermediate research and technical staff. The increasingly national and international role of *accent* may offer further cooperation opportunities for IST Cube as well.

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Annex 1: Research Questions and Interview Questions for Lower Austria HESS-Case Study

Guideline for Semi-Structured Interviews, with overarching research questions marked under each section in bold.

1. Regional economic structure

- How does the economic structure (higher agricultural and industry proportion, mostly SMEs, traditionally few high-tech firms) influence innovation policy and structural policy and the role of higher education institutions in it? What particular challenges and opportunities does this bring for innovation?
- ## 2. Policy Mix – Development of Policy Instruments: How can the region further improve the effectiveness of its key policy instruments, namely promoting cooperation among companies and between businesses and higher education institutions (HEI) in thematic clusters and geographically concentrated internationally competitive technopoles?

What other forms of cooperation have emerged in the region and which other policy instruments have been used to support regional development?

2.1 Cluster development

- Clusters have been a key instrument of the innovation strategy since the early millenium. How do the clusters support the focus areas exactly (cooperative research project funding, funding for coordination and service personnel, etc.)?
- What formats of cooperation are being supported and how have they developed? Which have proved to be successful and why?
- What is the role of universities in the development and implementation of cluster cooperation and how has it evolved? What role do regional agencies want the HEI to play?
- What instruments help to identify the right cluster focus areas? On the basis of what criteria is it decided to change their focus or discontinue them? What role do HEI play in this process?
- Cluster development was emphasized in last economic/ innovation strategy, seems to be less prominent in the most recent one. How has the role of cluster development support evolved, especially with the growing impact of technopole support? How mutually complementary or competing are these instruments

2.2 Technopole development

- What factors can be made responsible for the higher or lower success in developing particular R&D hubs at technopole sites?
- What role do HEI play in this respect? How do their research and teaching programmes feed into technopole capacity building?

2.3 Other cooperative formats and policy instruments:

- What other forms of cooperation have emerged and been supported in the region? How dynamic and effective are they? How are they being supported? Why have they not been prioritised in the strategy?
- What is the role of HEI in these other cooperative formats and how can this be supported?
- What kinds of inter-institutional networks or cooperation formats between universities and regional enterprises and state agencies have been found to work well beyond clusters and technopoles (e.g. mutual presence on advisory boards, strategic partnerships, etc.)?
- Given the success if the recent digital network, incl. the House of Digitalisation, the question arises how this successful networking model could be transferred to other thematic areas?
- Which other formats of cooperation between HEI and businesses are known but not supported and why?
- What is the role of start-up incubators and accelerators for other innovation agents, businesses or HEIs (not just the newly founded businesses)?

3. Interaction between businesses and HEI: What channels of communication and cooperation between businesses and HEI have emerged or developed dynamically in the last decade? How are they being supported? What do businesses need and not yet find with respect to support for interaction with universities/ HEI?
 - Has there been a noticeable development of open innovation practices among companies? How so? If so, how has open innovation practice of companies affected HEI knowledge transfer and cooperative practices? How should HEI adapt further to respond to this new cooperative openness?
 - Cooperation with other regions and international orientation was stressed in the last innovation strategy – how has this been realized? How can HEI contribute to this international orientation?
 - Innovation with respect to purpose-driven economic and scientific development (Sustainable Development Goals), climate change, demographic change, digital transformation in society, globalization and effects on social inequalities) may provide new opportunities for cooperation between public universities and private companies and state facilitators, as well as for accessing new funds (incl. in view of *Horizon Europe* (Mission-Pillar)). How do regional businesses and HEI assess and respond to these opportunities?

4. Role of higher education institutions (and research institutes)

How do HEI respond to the regional needs for human capital and knowledge capital? How do they learn about these needs? What incentives do HEI have to respond to these needs (rather than to national and international ones)?

- Role of IST Austria and its international orientation/ talent pipeline is not mentioned in the strategy. How can one foster connections between IST Austria (ISTA) and innovation agents in Lower Austria? In so far as this has proven to be difficult what are the reasons? Where can one identify regional development potential in ISTA's activities? What forms of cooperation would allow mutual added value between Lower Austria's SMEs (98% of regional companies) and ISTA's research, research training and knowledge transfer? How does the new technology and business facilitation center recently established at Klosterneuburg contribute to fostering such cooperation?
 - What is the special role of *Donau University Krems* in its ability to respond to business innovation demand in CPD? Ex. digital qualifications for future production or E-government. (incl. use of national funding FFG in supporting qualification networks)?
 - How has the financial investment of Lower Austria in the establishment of a private medical university (Karl Landsteiner Universität) and its role in the region contributed to fueling innovation?
 - NÖ surrounds Vienna: Relation to Viennese universities? How do they affect the innovation capacity of the region? Could Lower Austria play the role of a big green suburb of Vienna with easier co-location and cheaper rents for innovators? Is the biotechnological Technopole in Tulln a model of good practice that can be extended to other sites (with specialized outposts of the Viennese universities of TU Wien, Veterinary Univ. of Vienna, BOKU making use of close on-site cooperation and state-of-the-art facilities that have been supported by Lower Austria)?
 - What is the role of public research institutes in the regional innovation system(s)? Can their contribution to the region be promoted more systematically?
 - New challenges in learning and competence development (Digital Literacy, problem-based learning, entrepreneurial skills) – What is the growing role of PH?
5. Financial instruments to support regional development: How effective are the financial instruments at institutional, regional, national and ERDF levels and their interrelation / complementarity? How could this be improved?
 - How do EU structural funds (ERDF) support the interaction between universities/ HEI and businesses or other organisations or otherwise enhance the contribution of HEI to the innovation in the region? What types of measures are funded by ERDF, how have these changed and why? How are ERDF used to support open innovation or new forms of cooperation?

- What types/instruments of financial support are provided by the region?
 - What national instruments of financial support are important for regional innovation?
 - What types of institutional support measures do HEI invest in to promote regional development?
 - How do businesses invest in regional development (apart from the tax income they provide to the region)?
 - How can one optimize access to and best make use of external funding opportunities for cooperation between businesses and HEI, incl. challenge-driven funding, as increasingly provided at EU and national levels?
 - Digital transformation and increased needs to analyse big data– which new funding opportunities at national level or industry funds (Continuing Professional Development) are strategically prominent for the region and how does one organize multiple actors to access them jointly?
6. Governance and Strategy Process: How effective is the governance of multi-stakeholder interaction in the development and implementation of innovation strategies?
- How do different stakeholders participate in the strategy processes (e.g. FTI strategy development or higher education strategy Gesamtuniversitärer Entwicklungsplan, FFG priorities) and how do they interact in the process?
 - How do national funds and their framework support the governance and strategy process?
 - How do ERDF funds and their framework support the governance and strategy process?
 - What is seen as effective in the governance in clusters and technopoles, and what could be improved?
 - How do the different innovation agents in the innovation system perceive their own role? What kind of notions of innovation do they have? (How) Should one support a wider notion of innovation? With what benefits?
 - How can one make the strategy process itself more innovative (e.g. through crowd sourcing)?
 - How can information from international good practice be used more systematically to stimulate regional approaches in Lower Austria?
7. Quality Development and Monitoring: Are the monitoring and quality development instruments used by the regional agency also well adapted to the role of HEIs in regional innovation?
- The Balanced Score Card is mentioned as the favoured monitoring tool? In what way is it considered particularly effective? How are activities of HEI reflected in the BSC?
 - What are other methods used to monitor progress, implementation of strategic aims, in particular regarding the contribution of HEI to these?
 - How can HEI themselves, in their own development processes, assess their contribution to regional innovation more systematically (e.g. through use of OECD instrument *HEI Innovate*)?
 - Radical Innovation: In an age of increasingly disruptive transformation, what indicators are good for measuring such innovation? How can one go beyond incremental innovation?

Annex 2: List of Interviewees

Harald Bleier, Manager Kunststoff- sowie Mechatronik-Cluster der ecoplus, Business Agency of Lower Austria.

Prof. Hubert Brückl, Head of Department of Integrated Sensor Systems, Donau University Krems

Thomas Ecker, Senior Investment Manager, tecnet equity.

Rainer Gotsbacher, Technopolmanager Wiener Neustadt, ecoplus. The Business Agency of Lower Austria.

Simone Hagenauer, Project Manager Clusters Niederösterreich, ecoplus. The Business Agency of Lower Austria.

Wolfgang Hochgerner, Head of Division Education, Department of Science and Research, Regional Government of Lower Austria.

Armin Mahr, CEO, University of Applied Sciences, Wiener Neustadt.

Michael Moll, CEO, accent (Tech Incubator of Lower Austria).

Kerstin Koren, Head of Division Research and Development, EU Projects, and Office for Technology and Digitalisation, Regional Government of Lower Austria.

Helmut Loibl, CEO, FOTEC Forschungs- und Technologietransfer GmbH, Forschungsunternehmen der Fachhochschule Wiener Neustadt (Research Subsidiary of the University of Applied Sciences Wiener Neustadt)

Prof. Andreas Pauschitz, CEO, AC2T research GmbH (COMET Center)

Prof. [Hannes Raffaseder, FH St. Pölten, Chief Research and Innovation Officer \(CRO and CINO\)](#)

Prof. Thomas Schalkhammer, CEO, Attophotonics Biosciences

Claus Zeppelzauer, Head of Division Business and Technology, ecoplus.

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