

Chapter 1 Science, Technology and Innovation system in Flanders



1 – Competencies in the field of science, research and innovation

1 Federalism in Belgium

Flanders is an autonomous region located in the northern part of Belgium, with Brussels as its capital. It manages important competencies and budgets in many policy fields. This is the result of a gradual process of change since 1970, resulting from 6 state reforms that have introduced a far-reaching degree of federalism in Belgium. Consequently, many competences have been transferred to the federalised authorities (Communities and Regions). Institutionally, Belgium is divided into four language areas (the Dutch-speaking, the bilingual Dutch/French, the French-speaking and the German-speaking), and is composed of three Communities (the Flemish, the French and the German-speaking) and three Regions (Flemish, Brussels Capital and Walloon). Consequently, policy-making within the country is prepared and executed by various authorities, based on three distinct pillars, each with their own range of competencies: a federal, a community and a regional pillar. The Belgian form of federalism is unique in the world. Its main characteristics are briefly:

- each entity has exclusive powers and competencies in various areas (no shared competencies);
- each entity has its own separately elected parliament, government, administration, legislation, advisory bodies, etc.;
- no hierarchy exists between the different entities regarding their competencies (no overruling is possible);
- since the fourth state reform of 1993, the principle of “in foro interno, in fore externo” has been applied, meaning that each entity executes its competencies both inside and outside Belgium.

In 1980, the regional authorities were established. Thereby, the Flemish authorities decided to merge the existing institutions of the Flemish Community and the Flemish Region. Since then, a single Flemish Parliament, Flemish Government, and administration, with consultative or advisory bodies, have managed and overseen both community and regional competencies in the various policy domains. The Flemish Parliament debates and legitimates all official legal decisions pertaining to both community and regional competence. Likewise, the Government of Flanders is charged with the execution and implementation of policy decisions of both the community and the regional competencies. This situation differs from the French-speaking part of the country, where the French Community and the Walloon Region are separate institutional entities with different parliaments, governments and public authorities.

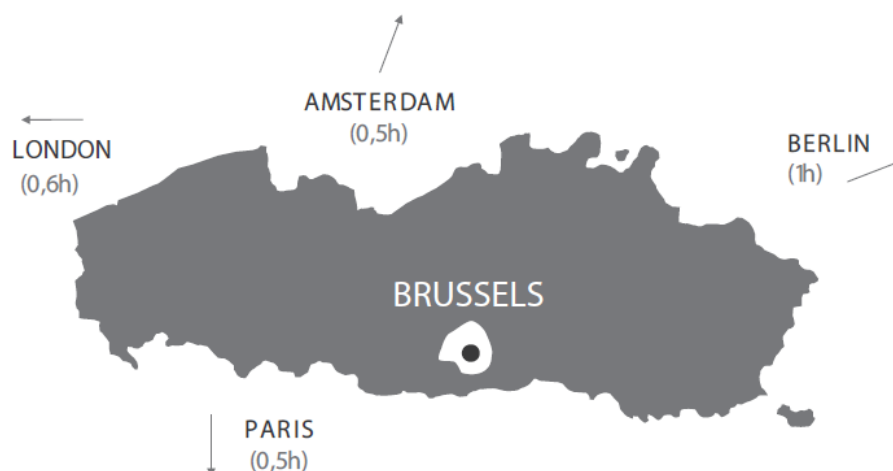


Table 1: *Key figures on Flanders (Flemish Region), Belgium and EU-28*

	Year	unit	Flanders	Belgium	EU-28
Surface area		km ²	13,521	30,528	4,381,376
Population	1/1/2016	million	6.48	11.27	508.29
GDP in current prices	2016	billion euro	247.8	421.6	14,819.8
Export	2016	billion euro	302.4	360.9	
GERD	2015	billion euro	6.472	10.118	
GDP per capita (PPS)	2015	euro	34,900	34,200	28,900
R&D intensity	2015	%	2.69	2.47	1.98
Annual public budget for R&D and innovation for Flanders, <i>(of which public budget for R&D in strict sense),</i> by funding authority:	2017	million euro	2,905 (2,007)		
Flemish authority:			2,435 (1,565)		
federal authority:			282 (282)		
EU / Horizon 2020:			160 (160)		
EU / ERDF + Interreg:			28 (0)		
Employment rate (% of the 20-64 years of age)	2016	%	72.0	67.7	71.0

Flanders' population accounts for about 58% of Belgium's total population, whilst its surface area covers about 44% of the country. The major part of the companies and the active population of Belgium are in its northern region, which also has a higher employment rate.

As a result, the economy of Flanders represents about 58% of the Belgian economy (as measured in GDP). It is also a very open economy: based on the EU (Eurostat) definition, exports from Flanders are worth about 123% (2016) of its GDP (partly due to the 'transition' effect and the 'gate' (harbour) effect). On the other hand, the relative wealth of Flanders - as measured in GDP per capita - is about 20% higher than the EU-28 average but slightly lower than the Belgian average. The main reason for the latter is the "capital city" effect of the small Brussels Capital region, with its strong presence of company headquarters and public administrations. If the wealth generated by the daily commuters from Flanders into the Brussels Capital Region were attributed to their residence in the Flemish Region, the Flemish GDP per capita would rise above the Belgian value. Total expenditure on R&D (GERD) in Flanders, which reaches almost 6.5 billion euro, equates to over 64% of the Belgium total (2015) and the Flemish R&D intensity exceeds the national value for Belgium (for details, see chapter 2). The Flemish Government is the main source of total public funding for R&D and innovation in Flanders, representing almost 85% of the total annual public budget (from Belgian origin) of 2.9 billion euro in 2017.

2 Competencies in the field of science, research and innovation

While certain policy domains remain exclusively federal (e.g., defence policy, monetary policy, nuclear power research, social security), other domains have largely or even completely been transferred to either the Communities or the Regions. The latter is the case for the Science, Technology and Innovation (STI) domain: in terms of legislation and budget, scientific research is mainly a community competence, whereas innovation is almost completely a regional competence. In Belgium, over 80% of total public R&D and innovation support is managed under the responsibility of the Communities and the Regions. After the 6th State Reform of Belgium, the overall policy budget of Flanders now adds up to 43.2 billion euro (of which 2.44 billion euro aimed at scientific research and innovation), which surpasses the federal policy budget both for the total amount and for the science policy field.

The federal authority remains responsible for a limited number of research programmes (notably in the field of climate and sustainable development), the support of research infrastructures of national interest, several federal scientific institutes, and a small number of exclusively attributed research themes, including the Belgian space policy, 'sustainable' nuclear energy and polar research at the Antarctic station. In addition, framework conditions such as IPR, normalization, standardization, tax credits and scientific visas for researchers also are exclusively managed by the federal authority. Tax credits aimed at R&D have become very substantial in Belgium in recent years. There exists a 80% fiscal exemption of salaries' social contribution for R&D employees at research/scientific institutes and companies in Belgium which totals € 1.3 billion annually (2015). Then there is an increased investment deduction or tax credit for assets that stimulate R&D and innovation, and finally a measure exists to deduct income revenue from patents income (= IPR friendly measure).

In summary, page 2 of the OMC Belgian peer review report (29 September 2011) provides an accurate description, i.e.:

*"the **research and innovation system in Belgium** has important specific characteristics by which it distinguishes itself of most other systems in Europe. (...) The Belgian research and innovation system is **a combination of two large and one small research system** that compete with each other, and cooperate through **a public governance system with six levels, and federal as well as confederal elements**. Consequently, **there is not one Belgian research and innovation system**; all regions (and communities) have **almost complete autonomy to set up their own system**."*

The various competencies, as well as the types of institutes for which Flanders is responsible in the field of science, research and innovation in practice, can be divided into the following areas:

2.1 Direct support for R&D and innovation in the broad sense

This includes:

- grants, fees, PhDs and subsidies or other support channels for basic, fundamental, cutting-edge and applied research that is conducted by researchers at universities, institutes, companies, knowledge networks, etc.;
- all business-oriented support (e.g., technology transfer, technology advice, technology scans, networking, dissemination of innovation, knowledge and technology, valorisation or research results, feasibility studies, knowledge vouchers, etc.);
- various forms of collective research (joint industry-science research, innovative networks, clustering);
- promotion and popularization of STI (in education, society, business, science centres, etc.), mobility of researchers, etc.

2.2 All research related to the community

This includes:

- broad innovation policy, as well as scientific research policy (fundamental, applied and strategic basic research);
- (research at) higher education institutions (university colleges, universities);
- (research at) public research organizations (PROs);
- (research at) scientific institutes and policy research centres of the Flemish Community;
- (research at) various institutes that generate knowledge or scientific output;
- infrastructure in the field of research and innovation (small, medium-scale and large-scale research infrastructure, such as supercomputers, data collections, networks, clean rooms, etc.);
- science parks, technology parks, incubator sites, etc.
- research in the policy fields for which Flanders is responsible: economic support, industrial policy, entrepreneurship, social economy, public works, employment, environment, nature conservation, forestry, agriculture, energy (except for nuclear energy), heritage, (primary, secondary and higher) education, water management, transport, vocational training, health, culture, tourism, care, health and well-being, data transmission, sports, media, youth, etc.

2.3 Access to finance

Support for start-ups, spin-offs, participations, seed capital, risk capital, guarantees, fast-growing or technology-oriented businesses, business angels, loans, etc.

In other words, apart from a number of competencies reserved exclusively for the federal level (space, nuclear energy research, IPR, normalization, etc.) and a certain number of institutions (federal scientific centres and various knowledge institutes), all competences and activities in the field of R&D and innovation are allocated to and implemented by Flanders.

2 – General orientations of Flemish STI policy

1 Instruments of policy-making in the field of R&D and innovation

As previously stated, at the governmental level a single minister is charged with both scientific research and innovation. The public authority charged with STI policy is the EWI policy-domain. EWI (= Economie, Wetenschap en Innovatie) manages the broad field of Economy, Science and Innovation, through the EWI Department (that prepares, monitors, follows up, reports about and evaluates policy), and a few agencies that execute and implement policy measures in the fields of scientific research, innovation, entrepreneurship and industrial policy (see part 4 in this chapter).

The Government of Flanders is aware of the importance of STI as a necessary condition for maintaining wealth and well-being in Flanders. From the mid-1990s onwards, it has elaborated a broad-based strategy for STI policy through various institutes, a broad instrument mix and appropriate budgets. This policy is developed through several agreements, initiatives and statements, including:

- the **government agreement** in which the various political parties that are part of the governing coalition outline their priorities for the five-yearly parliamentary term (currently 2014-2019);
- the **policy paper of the minister** charged with scientific research and innovation for the five-year governing period 2014-2019 (note: as of 2014, this theme has become a part of an overall policy paper for Work, Economy, Science and Innovation);
- the **annual policy letter of the minister**, which further elaborates and specifies the initiatives for the general policy framework that is announced in the policy note (note: as of 2015, this theme has become a part of an overall policy letter for Work, Economy, Science and Innovation).

Moreover, several multi-annual strategic plans and targets are agreed with a broad-ranging group of stakeholders from government, civil society and industry. These plans set out targets across a range of policy fields, amongst which STI is assigned a clear priority. The major plans include the **Flemish** and the Belgian National **Reform Programme for the EU2020 strategy** (in the framework of the European Semester), and the Transversal Policy Note **Flanders 2050** (VISIE 2050: a long-term strategy for Flanders).

Overall, policy in the field of science, research and innovation is being implemented through a whole set of relevant initiatives, treaties, parliament acts, decrees, agreements, engagements (e.g. the aim to reach the 3% R&D intensity goal), ministerial decisions, government communications, concept notes, MoU's, inter-ministerial decisions, or similar legislation / soft law that elaborates the public policy of the minister or the government in general. The role and tasks of the major actors in the STI landscape of Flanders is defined in the "Decreet betreffende de organisatie en financiering van het wetenschaps- en innovatiebeleid" (Flemish Parliament Act on the organisation and support of the scientific and innovation policy), which was approved on 30 April 2009 by the Flemish Parliament (and modified thereafter).

The coalition agreement for the 2014-2019 Flemish Government announced changes in policy priorities as well as in the organizational structure of the STI-domain.

It lists 3 focal policy points:

- a **demand-driven and market-oriented public policy** in the field of economy and innovation;
- a **simplification and rationalization of structures and instruments** with faster and easier procedures, more transparency, better client-friendliness and a clear one-stop-shop function;
- a **higher focus on business-oriented innovation and valorisation**, strong knowledge organizations with excellent research and a **growth path for the 3% target for R&D**, whereby public outlays strive towards 1% by 2020.

Several changes in the organizational structure of the policy domain of Economy, Science and Innovation (Economie, Wetenschap en Innovatie, EWI) are elaborated in a separate chapter on an “enterprise-friendly authority”.

For the period 2014-2019, the EWI policy field is a part of the responsibility of the **Flemish Minister for Work, Economy, Innovation and Sport**, Mr. Philippe Muyters. His policy priorities on scientific research and innovation are elaborated in the **policy paper 2014-2019 for Work, Economy, Science and Innovation** (which also includes policy on public companies). The annual policy letters state the on-going situation and the implementation of policy for the parliamentary year concerned. For the parliamentary year 2017-2018, the strategic and operational objectives in the policy letter for Work, Economy, Science and Innovation that regard scientific research and innovation are these (topics with the corresponding section):

Invest in agile employees and companies (1)
Invest in competencies (1.2)
<i>Focus on a grounded education and professional choice - STEM (1.2.1)</i>
Invest in the framework conditions for innovation-driven entrepreneurship (1.3.)
<i>Invest in knowledge building and innovation (1.3.1.)</i>
<i>Elaboration of a programme-wise approach for smart specializations and cluster pacts (1.3.2.)</i>
<i>Evaluations and research (1.3.4.)</i>
Invest into an excellent knowledge base (2)
Strive towards a qualitative elaboration of the 3% target (2.1.)
<i>Research at universities (2.1.1.)</i>
<i>The Strategic Research Centres (2.1.2.)</i>
Invest in state-of-the-art research infrastructure (2.2.)
Flanders develops a policy for open data and open access (2.3.)
Invest in a simplified and tailored delivery of services (3)
An integrated contact point for the entrepreneur (3.1.)
<i>Flanders Innovation and Entrepreneurship (3.1.1.)</i>
<i>Digital desk (3.1.2.)</i>
Invest in European, international and interregional networks (6)
European representation (6.3.)
Activate the innovation potential at SMEs and within large companies (9.)
Innovative public procurement (10)

2 Monitoring and reporting of the R&D and innovation policy

The policy initiatives, evolution, whereabouts, available budgets and statistics that describe the Flanders' research and innovation landscape are being monitored and reported on in a structural manner through various initiatives, publications, channels, presentations, reports, at different policy levels. Most of these are the responsibility of the EWI Department, but also other (government) entities produce STI data and information. Furthermore, the various EWI agencies involved in STI provide information and data about their own specific initiatives and budgets (e.g. through their annual report), or conduct studies (e.g. on innovation support, by the AIO), as does the advisory body VARIO (studies, advice, benchmarks).

The main sources of policy initiatives and statistical data and indicators in the STI field include:

- **“Speurgids Ondernemen & Innoveren”** (Budget browser Enterprise and Innovation): provides an overview of the budget allocations for economy, science, and innovation within the whole Flemish authority, and the R&D intensity (annually);
- **“Flemish Reform Programme”** (VHP) and **“National Reform Programme”** (NHP) of the **EU2020 strategy** in the framework of the **European Semester** (both programmes are submitted in April to the European Commission): the part that relates to R&D&I (annually);
- **“VRIND”** (Vlaamse Regionale Indicatoren): describes the demographic, macroeconomic and social context of Flanders in over 700 indicators, including a part innovation (annually);
- **“PACT 2020”**: 20 policy fields (including one on innovation) are monitored through a set of indicators (annually);
- **“Vlaams Indicatorenboek. Wetenschap Technologie Innovatie”** (Flemish indicators’ book. Science Technology Innovation): publication from ECOOM with a well-developed R&D and innovation indicator system measuring the development of the Flemish potential in the STI-field (bi-annually). ECOOM is the Centre for Research and Development Monitoring, an interuniversity consortium with participation of all Flemish universities;
- The **“3% nota”**: the so-called ‘3% paper’ is a publication from ECOOM in which the official data for Flanders on GERD, BERD, GBARD, the R&D-intensity, etc. are calculated (annually);
- The analysis of the **participation of Flanders into the EU programmes** (in 2017 this is a part of the ‘Speurgids Ondernemen & Innoveren’); previously: “Flanders’ participation in the EU support programmes 2007-2013”;
- A selection of important key statistics and data is included further in this publication.

Furthermore, regular overviews of the state of being and evolution of the policy developments, budgets, the profile and initiatives from Flanders in the field of scientific research and innovation, are available through many publications and reports from the EU and the OECD in the field of R&D and innovation.

These include the profile of Flanders described in the European Commission reports or in databases such as the report for Flanders of the RIM (Regional Innovation Monitor), the RIM policy initiative database, the Vanguard Initiative website, the S3-website of the Joint Research Centre (JRC), as well as in the many country reports on Belgium such as the reports on the ERA progress, the RIO (Research and Innovation Observatory), the OECD STI Outlook, the joint EC/OECD Policy Survey (and database) on Science, Technology and Innovation Policies (STIP), the R&D&I topics in the EC’s Country Report on Belgium (European Semester), and the OECD Economic Survey Belgium report. Benchmarking the R&D and innovation performance is conducted by comparing the information and data that are available in the EC RIS (Regional Innovation Scoreboard), the Report on Economic, Social and Territorial Cohesion, the Belgian profiles in the EIS (European Innovation Scoreboard, the EC ‘Innovation Union Competitiveness Report’, the Belgian (Member States’) Competitiveness Report, and the ‘Science, Research and Innovation performance of the EU’ report etc. The overall part of these reports are published by the European Commission.

In-dept peer reviews that analysed and evaluated the general systemic setting of research and innovation include the “OMC peer review” of Belgium (2010), specific ERAC-reviews or surveys, or the reports from the “Soete commission” (2007, 2013) that assessed the overall innovation landscape in Flanders.

3 – Flanders, centre of innovation

The backbone of the output generated by Flanders' academic and other knowledge actors is shaped by the **5 university associations** (KU Leuven, Ghent, Antwerp, Brussels, Limburg), the **4 strategic research centres** (Imec, VIB, VITO, Flanders Make), and some **other knowledge institutes** that exist in specific domains such as marine sciences (VLIZ), tropical health (ITM), agriculture research (ILVO), as well as in various collective research institutes active in specific fields.

Several of these knowledge actors in Flanders are recognized as centres of excellence in their field of activity and conduct research integrated in renowned international networks and with partners throughout the world. Some of these, such as the Catholic University of Leuven, Ghent University, Imec, or VITO, have established subsidiary activities abroad (US, Asia), often involving local counterparts or partners (see part 6 in this chapter for further examples).

The "HR Excellence in Research" award was given to FWO, KU Leuven, UGent, UA, VUB, UHasselt, Imec (previously also to iMinds), VIB, Vito, and University College Ghent and is a public recognition that they have made progress in aligning their human resource policies with the principles set out in the "Charter & Code" for researchers.

1 Performance from institutions benchmarked internationally

Several international rankings exist in which academic or knowledge institutes are listed, that can provide an indication of their relative strength in an international perspective. The presence of institutes from the Flemish Community therein is as follows:

Times Higher Education (THE) World University Rankings 2018

This lists 1102 top universities across the world.

World rank	
47	KU Leuven (highest ranked Benelux university, ahead of University of Amsterdam at nr. 59)
107	UGent
201-250	UA
301-350	VUB
401-500	UHasselt

The Catholic University of Leuven ranks as the best Belgian and Benelux university. The THE top 150 list of 'most international universities in the world 2017', ranked KU Leuven as the only Belgian institute at position number 40.

Academic Ranking of World Universities (ARWU) 2017 (so-called "Shanghai ranking")

World rank	
69	UGent
90	KU Leuven
201-300	UA
201-300	VUB

Ghent University ranks as the best Belgian university.

Quacquarelli Symonds (QS) World University Ranking 2018

World rank	
79	KU Leuven
125	UGent
182	VUB
210	UA

KU Leuven is the highest ranked Belgian university.

In some focus rankings, such as the THE world rank for young universities, UA reaches 10th, and the QS top 50 under 50 (fastest rising young universities from around the world), UA is 13th and UHasselt 73rd.

Thomson Reuters 2017

This ranks Europe's 100 most innovative universities:

European rank	
1	KU Leuven (ahead of London Imperial College and Cambridge University)
19	UGent
48	VUB

KU Leuven earned its first-place rank, in part, by producing a high volume of influential inventions. Its researchers submit more patents than most other universities, and outside researchers frequently cite KU Leuven inventions in their own patent applications. Those are key criteria in this Reuters ranking.

European Research Ranking 2016

This provides innovative estimates on the funding and networking performance of European research institutions, based on freely available data published by the European Commission:

8	KU Leuven
44	UGent
69	Imec
95	VUB
200-300	UA
300-400	VIB
400-500	iMinds (since end 2016 a business unit from Imec)
400-500	Flemish Region
400-500	ILVO
500-600	FWO
600-700	Transport and Mobility Leuven
800-900	Janssen Pharmaceutica nv
800-900	Boerenbondvereniging voor projecten vzw
900-1000	AGENTSCHAP VOOR INNOVATIE DOOR WETENSCHAP EN TECHNOLOGIE
900-1000	FONDS FLANKEREND ECONOMISCH EN INNOVATIEBELEID
900-1000	Stad Antwerpen
900-1000	LMS International nv
> 1000	BioBase Europe pilot plan vzw
> 1000	VLIZ

The partner countries of Belgium, with the list of the number of projects (country statistics 2016), are topped by Germany:

Germany	1654
Spain	1340
Italy	1321
UK	1316
France	1163
Belgium	1050
Netherlands	969
Austria	443
Sweden	430
Greece	368
Denmark	314
Switzerland	301
Finland	287
Poland	252
Ireland	252
Portugal	246
Norway	217
Romania	210
Czech Rep	163
Hungary	145

From the side of Germany, Belgium is the 8th partner country; from the side of Spain, Italy, the UK, France, and the Netherlands, Belgium is their 7th partner country;

An overview and analysis of the participation of Flemish actors into the FP8 for RTD, Horizon 2020, is available in Chapter 2, part 7.

Financial Times' Executive Education rankings 2017

World ranking	
32	Vlerick Business School

2 Performance from Belgium and/or Flanders in international perspective

Belgium and/or Flanders are listed in several EU or other international rankings based on (several) R&D&I criteria or indexes that are composed by various indicators. The main are:

European Innovation Scoreboard, EIS 2017 (previously the 'Innovation Union Scoreboard', IUS), from the EC:

Belgium has been a part of the second group of **'strong innovators'** (previously called 'innovation followers'), ever since the start of the EC's EIS-ranking. In the 2017 edition, it ranks as the 9th EU member state. Relative strengths of the innovation system are in 'Attractive research systems' (especially 'International scientific co-publications' and 'Foreign doctorate students' score very high), 'Linkages' (esp. 'Innovative SMEs collaborating with others'), and 'Firm investments' (esp. 'Enterprises providing ICT training'). Relative weaknesses are in 'Employment impacts' (esp. 'Employment fast-growing enterprises'), 'Sales impacts' (esp. 'Sales of new-to-market/firm innovations'), and 'Intellectual assets'.

Belgium scores in the top-3 of the 27 EIS-indicators for these topics: 'Foreign doctorate students', 'R&D expenditure in the business sector', 'SMEs with product/process innovations' (nr 1), 'SMEs innovating in-house', and 'Innovative SMEs collaborating with others' (nr 1 jointly with the UK). For the topic 'Linkages', it scores nr 1 in the EU.

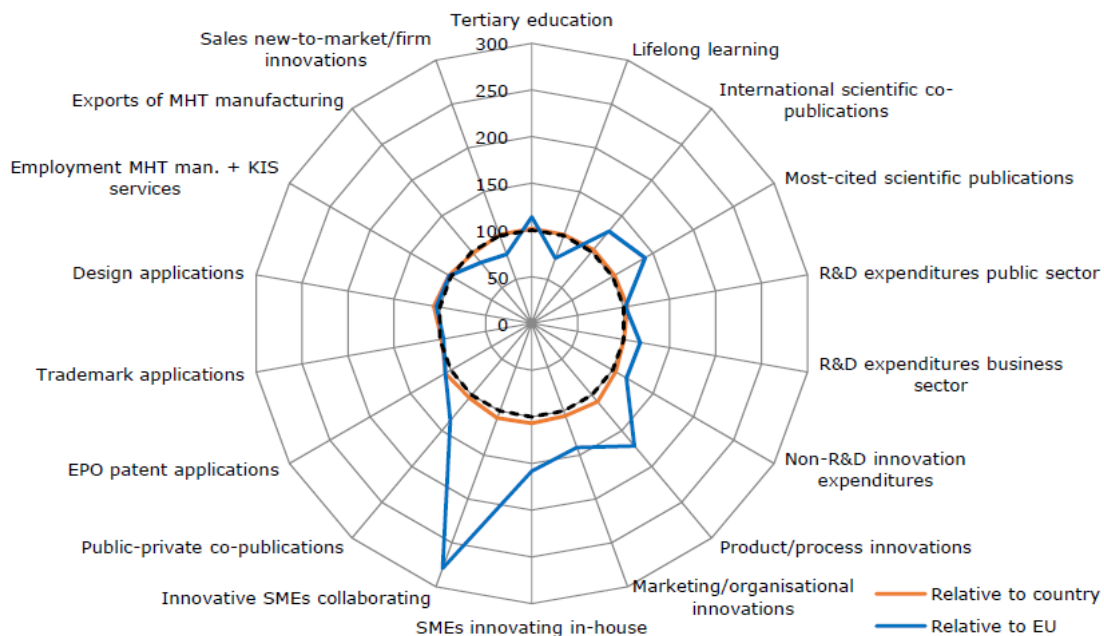
Regional Innovation Scoreboard, RIS, 2017, from the EC

Flanders is a part of the top group of 'Innovation leaders' (= performance > 120% of the EU average), like some other EU regions such as Ile-de-France, Scotland, Noord-Holland, Zuid-Holland, Helsinki, Hamburg, North-West (UK). Overall in the EU (ranking for 202 regions) it comes at position 37, whereas the 2 other Belgian regions are part of the second group of 'strong innovators' (previously called 'innovation followers'): the Brussels Capital Region ranks 56th in the EU and the Walloon Region 75th.

However, it is important to note that the EC has ranked in the RIS a combination of regions both at the NUTS1 and the NUTS2 level. If the Flemish provinces (NUTS2) would be considered separately (like the EC's practice for e.g. the Netherlands or Germany), the resulting score would differ. Nevertheless, if one looks at a ranking whereby the number of countries from which the separate regions are a part of, are being considered, then less countries proceed Flanders in the RIS 2017 than the number of countries that proceed Belgium in the EIS 2017.

The radar graph displaying the different indicators (see figure 1) shows that relative strengths compared to the EU28 are in the categories of "Innovative SMEs collaborating with others", "SMEs innovating in-house", and "product/process innovations". It scores weaker for 'Sales new-to-market/firm innovations' and 'lifelong learning'. The difference with the Belgian average is very limited indeed, which is evident because the Belgian figure and data consist for the largest part of the Flemish Community data therein.

Figure 1: Radar graph of Flanders' RIS 2017 indicators compared to EU average



The RIS 2016 edition also demonstrates that Flanders is a region with a positive specialisation in the Key Enabling Technologies (KET). The KET Observatory at the EC provides the data of the EU countries for the various KET domains, including the evolution in the past years, with the top-10 of the EU. Belgium ranks in 2 occasions in this top-10, namely for advanced materials and for industrial biotechnology. Flanders

represents 49% of the Belgian patents in advanced materials and 68% of those for industrial biotechnology (2011 data). In the other domains, it always holds over half of total Belgian patents.

Global Innovation Index, GII, 2017 from INSEAD, Cornell University and WIPO:

The GII considers 81 innovation input- and output-indicators into a global score listing 127 countries/nations/territories.

Belgium ranks 27th, resulting a 22nd position for input and 27th position for output. Strengths are 'education', 'knowledge workers', and 'creative goods and services', whereas weaknesses are 'credit', 'knowledge absorption', and 'knowledge diffusion'. Among the 7 main categories, its best score is for 'human capital and research' (11th position), and its relative worst score is for 'market sophistication'. For 8 indicators it reaches the top-10 of the world, among which is 'university-industry research collaboration'. The GII 2017 also lists a top-100 of world clusters, in which the cluster 'Brussels-Leuven' ranks 54th.

Innovation indicator 2017, from Centre for European Economic Research, ZEW, Fraunhofer ISI, Deutsche Akademie der Technikwissenschaften and Bundesverband der Deutschen Industrie.

The innovation indicator lists 35 countries their ability to produce and utilise innovation, based on input and output indicators. Belgium comes 3rd behind Singapore and the no. 1 Switzerland. Finland. Behind Belgium rank Germany, Finland, the UK, Denmark, Sweden, Austria, the Netherlands, the US, Ireland and South-Korea. Belgium, like Germany, is not outstanding in any of the categories, but scores well overall for the scores of the various topics of the composed index.

Community Innovation Survey, CIS, 2014

The CIS contains a broad set of indicators on innovation activities of enterprises and provides information on environmental benefits due to innovation.

Belgium ranked 3rd (64.2% of all companies) during the period 2012-2014, in the list of the highest proportions of enterprises with innovation activity, behind Germany (67.0%), G-D-Luxemburg (65.1%) and ahead of Ireland (61.0%), and the UK (60.2%). The EU average is 49.1% of enterprises of 10 employees or more that reported innovation activity during the period 2012-2014.

3 More resources for R&D

Flanders is committed to the EU 2020 target of investing 3% of its gross domestic product (GDP) in R&D, one-third being funded by the government (the so-called 1% objective) and two-thirds by the private (business) sector. In 2015, total expenditure on research and development amounted to 6.472 billion euros, which represents almost two-thirds of all R&D expenditure in Belgium (GERD).

Governmental resources

In 2017, the Government of Flanders budgetary allocations for R&D amounted to 1.565 billion euros. The EWI policy domain (Economy, Science and Innovation) manages 73% of this budget, the remaining part being from the Education and Training policy domain (23%) and the other policy domains (4%). This amount represents just over half of Belgium's total public allocations, the remaining half coming from the other four authorities (hence the sum of the budget allocations from the federal, French Community, Walloon Region and Brussels Capital Region authorities). To calculate the total public expenditure on R&D in the Flemish Region, it is necessary to add the federal and EU contributions. This federal contribution is assessed at 282 million euros for 2017 (based on 35.5% of the federal ESA budget plus 56% of the remaining federal allocations) and the EU contribution is assessed at 160 million euros (based on the return for Flanders from participation in the EU FP on RTD and current Horizon 2020 programme). Hence, the total public R&D effort

in Flanders (the sum of Flemish, federal and EU outlays) can be estimated at 2.007 billion euros in 2017. In addition to expenditure on R&D (as defined by the OECD), the Government of Flanders allocated a further 870 million euros for science and innovation, which is not R&D in a strict sense. The annual budget for research and innovation stemming from the EU's 2014-2020 ERDF programme towards Flanders (including the ERDF budget from Interreg) is assessed to be 28 million euro in total per year.

Consequently, in 2017 total available public budget for R&D and innovation in Flanders that originates from both Flemish, federal and EU authorities, amounts to 2.905 billion euros. The Flemish Government's part of this budget is 2.435 billion euro. Disaggregated by funding authority, the total public R&D&I budget available in Flanders (Flemish Region and Flemish Community incl. in the Brussels Capital Region) is being managed for the overall part by the Flemish Government: 83.8%, while the federal authority is responsible for 9.7%, the EU's Horizon 2020 programme for 5.5%, and finally the ERDF-Flanders and ERDF-Interreg programmes jointly represent about 0.9% of the annual R&D&I budget of 2.9 billion euro (details see Table 1).

In 2016, the direct public R&D-support of the Flemish Government (GBARD) represented 54.7% of the total of the public R&D budgets from all the Belgian authorities together, and the other 4 Belgian authorities stand for just over 45%.

It is essential that the 1% objective for public funding is reached by 2020. Achieving this 1% public R&D/GDP target has already been an important focus of attention. From the mid-1990s onwards, substantial budget increases for R&D&I have been allocated by the Flemish Government. Studies have shown that achieving the 1% objective has, through leveraging, a positive impact on private investment in innovation. In other words, higher government R&D funding leads to more private investment in R&D. The studies established a clear causal relationship and concluded that no crowding-out effects would occur. The R&D-intensity (total R&D expenditure as % of GDP) of the Flemish Region reached 2.69% in 2015. The R&D-expenditure in the private sector (BERD) was 1.89% of GDP and in the public sector (non-BERD) 0.80%. Of total R&D expenditures (GERD) in 2015, 71% was privately funded in Flanders (Belgium: 61%, EU28: 55%). Compared to the GDP of Flanders, this results in a proportion of 1.90% privately funded and 0.79% publicly funded. Hence the 2%-target, resp. 1%-target, remain within reach.

More knowledge-capital and human resources are important keys to stimulate the R&D&I-landscape. The Flemish Government has actively promoted its STEM action plan to increase the number of students and graduates in these subjects.

Employment in technology and knowledge-intensive sectors in Belgium is 4.58 million, of which 2.79 million in Flanders. The number of workers in the (medium) high-technological industry and services in Flanders was 8.5% (2016), and total R&D-personnel keeps increasing since several years and reached 46.517 FTE in 2015. Its share in total active population represents 1.54% (EU28: 1.14% (2014)).

The strong international embedding of the R&D&I-landscape of Belgium and Flanders is also demonstrated by the part of GERD that stems from sources abroad, 13.2% (2013 data). This is higher than in most Western-European countries except for the UK and G-D-Luxemburg (EU28: 9.9%).

Business efforts

Business Expenditures on R&D (BERD) represent 4.469 billion euro, of which the chemical and pharmaceutical sector led the way with 41% (2015). Other main performers were motion pictures, video and TV production, computer programmes, engineering, technical testing and analysis activities. The top-50 R&D-active companies jointly represent 60% of all R&D expenditures in Flanders. Of all total foreign investments in Flanders in 2014 (representing 2.8 billion euro), 13.04% took place in the R&D sector (2013: 9.42%). Belgium also has a quite high proportion of acquired companies from the high-technology sectors, whereas in most western European countries this is medium-technology sectors (source: 2014 EU Industrial R&D Investment Scoreboard).

Businesses that are substantially involved, or leading actors in their field, regarding in the field of R&D and innovation in Flanders include: Agfa Gevaert, Janssen Pharmaceutica (part of Johnson & Johnson), Barco, Bekaert, Solvay, UCB, BASF Antwerpen, Atlas Copco, Biocartis, Xeikon, Cargill, Du Pont de Nemours, Umicore, Thrombogenics, ON Semiconductor Belgium, Alcatel-Lucent, Ablynx, Bayer Antwerpen, Anheuser-Busch Inbev, Picanol, Daikin Europe, Case New Holland, Punch Powertrain (Yinyi Group), Tessenderlo Chemie, ExxonMobile, TP Vision (ex-Philips), Bosal Emission Control Systems, Intel, Michel Van de Wiele, Ion Beam Applications, Aliaxis, EVS Broadcast equipment, Etex, Materialise, Tigenix, Bone Therapeutics, Cockerill Maintenance, Gimco, Prayon, Fagron, Deceuninck, Elia Systems Operations, Newtec, Hansen Transmissions, Proximus, KBC, Xtrion, Recticel, Siemens, and Galapagos.

A sector that is intensely research-driven, with a large critical mass as well as an international reputation, is the biotechnological industry. With about 120 Flemish companies that conduct R&D in the field of biotechnology or life sciences, representing 10,000 to 15,000 jobs, it is part of the European top-3. The chemical sector (mainly located around the Antwerp harbour) represents a major part of the Flanders' and Belgian economy with a portfolio of 300 different chemicals – the most diverse in the world – and over 500 chemical companies. It is the largest chemical cluster in Europe and the second largest worldwide (after Houston (Texas), USA). These companies increasingly innovate to generate new and better types of products. The chemical and pharmaceutical industry represents the major share of all foreign investments. In total, there are 450 enterprises in chemicals, plastics, pharmaceuticals, and biotechnology that represent 42 billion euro turnover and almost 60,000 employees. Foreign companies active in chemicals, pharmaceuticals, and life sciences invest about 1 billion euro per annum in Flanders.

4 Focusing on strengths and “spearhead domains”

The relative specialisation index can be a useful indication to map the specialisation structure of the science, innovation and economy system, which in turn can be a starting point for the future potential for smart specialisation. This index compares the distribution of activities in resp. science production, technology production, economic performance from a region or a country with the average distribution of the same type of activities in the whole of Europe (or the world). The statistics on respectively the scientific publications, patents, and exports are used as proxies for these kinds of activities that can be considered as successive steps in the innovation trajectory, from idea to market. A more than average share of these suggests a specialisation in that specific domain.

In the **field of science**, long-time series exist of **scientific publications** that can determine the specialisation domains, as well as series on scientific citations, and scientific co-publications.

To find the degree of **technological specialisation**, the number of patents for a given technology domain in Flanders is being compared to the share for that technology domain worldwide, which results in the **RTAN** (Relative Technological Advantage). Patent data provide an insight in technological progression since they represent an indicator that is used to get a picture of the innovation degree within an organisation, region or innovation system.

A similar calculation as the RTAN, but using the export per sector (NACE) data instead of the patent volumes per technology domain, results in the **RCA** (Revealed Comparative Advantage) as a proxy for the degree of economic specialisation.

In addition, the coherence of specialisations in the subsequent stages of the innovation trajectory for a specific industry, from idea to (export) market, can be considered as competitive advantage of a region or country for this specific industry. However, the correspondence between these classifications is only partially assured, hence there is no direct match between science classifications and technology classifications. Between technology and economic classifications this matching has been achieved based on the so-called “Fraunhofer classification”.

4.1 Scientific specialisations

The scientific specialisation pattern of Flanders is rather typical for a mature economy with a long tradition in scientific research that covers the whole spectrum. The Flemish profile is similar to that of most Western countries, with life sciences and medical sciences as the dominant publications areas.

Chapter 5 provides more details on the scientific publication performance (as well as on the citations and co-publications) and contains a spider web display that benchmarks Flanders to the world standard.

4.2 Technological specialisations

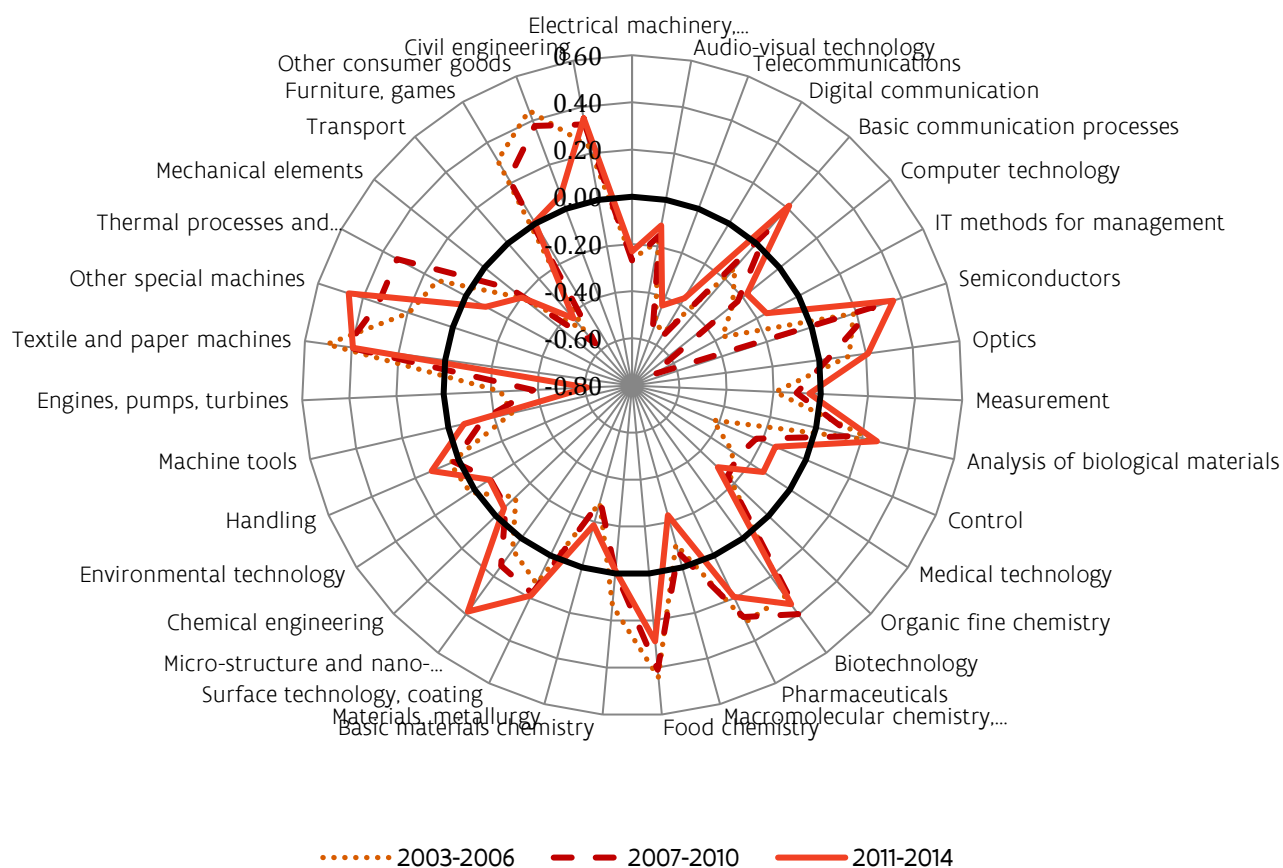
The technological specialisation of Flanders based on the EPO patents is displayed hereunder. It is mapped based on a grouping of patents in 35 technology domains (ISI, Fraunhofer Gesellschaft) and a specialisation-index RTAN that can vary between -1 (under specialisation) and +1 (maximal specialisation). The latter is based on the share of a given technology domain in Flanders compared to the share of the domain concerned in a reference group (composed by EU-15, US, Canada, Switzerland, Japan and South-Korea), which is the black line in the diagram below.

The radar graph (figure 2) hereunder reflects the activities of a relatively small number of companies and research institutes. The specialisation patterns for technology are therefore more dispersed than the ones for science. Flanders has built up a relatively strong technological position in certain **chemical domains** (e.g. food chemistry, macromolecular chemistry), **semiconductors**, **civil engineering (roads and water engineering)**, **pharmaceutical applications**, **biotechnology**, **analysis of biological materials**, **microstructures and nanotechnology**, **basic communication processes**, **semiconductors**, **optical applications**, **textiles and paper machinery** and **other specialised machinery**.

On the one hand, several companies with in-house R&D in sectors such as **machinery/mechatronics**, **foods**, **materials**, **civil engineering** and particularly **pharmaceutics** (which is the largest high-technology sector in Flanders) contribute to strong international specialisations of Flanders. Different niches in consumer goods, furniture and games are also specialized in technology production compared to their counterparts abroad. On the other hand, these specialisations also reflect the activity of the different Flemish strategic research institutes as is the case for nanotechnology (Imec), biotechnology (VIB), materials and energy (VITO) and specialised research departments at the five universities of the Flemish Community.

Flanders represents about two thirds of the total Belgian patent portfolio, and companies represent 84% of patent activity. Chapter 6 provides more details on the patents position of Flanders.

Figure 2: Technological specialisation (RTAN) of Flanders based on the EPO patents, 2003–2006, 2007–2010 en 2011–2014, index between -1 and +1.



Source: ECOOM

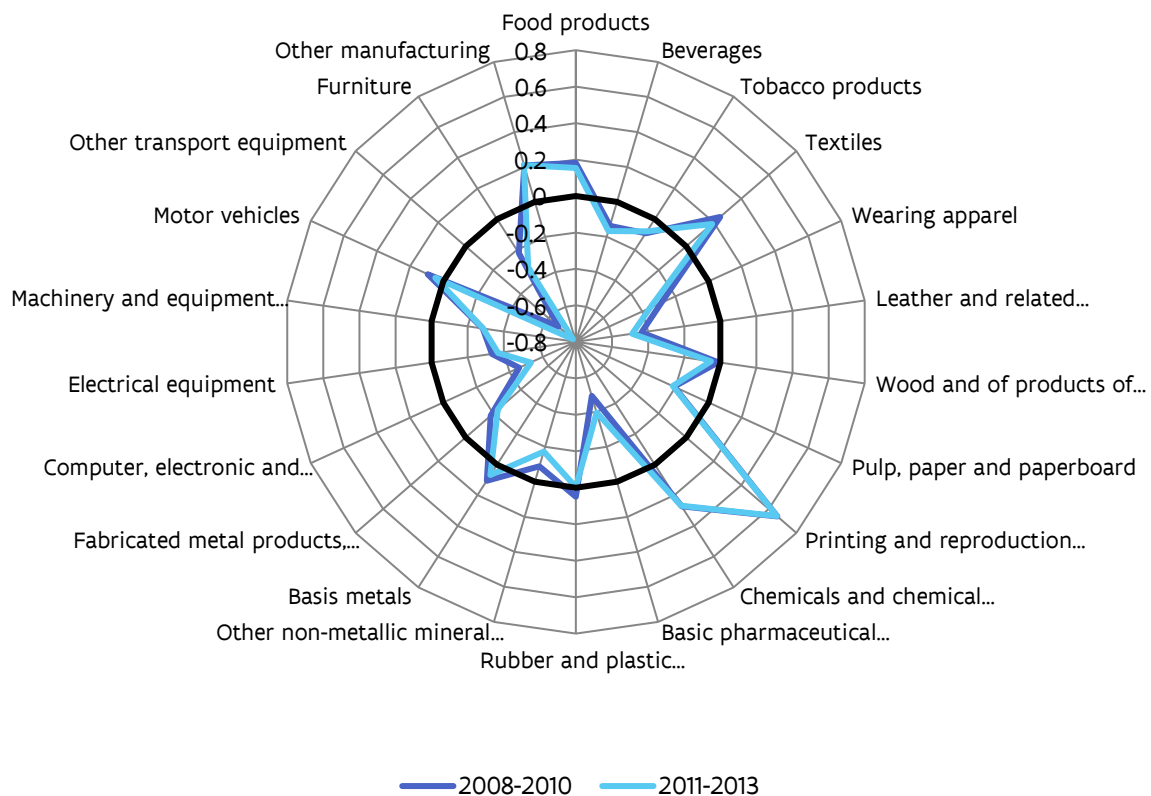
4.3 Economic specialisations

The economic specialisation pattern (based on the relative export shares) of Flanders reflects that of a mature economy as well as that of (still) highly diversified economy. In most sectors the Flemish economy has maintained a critical mass to remain competitive, while some do not appear as a specialisation due to the given conditions (e.g. mining).

To establish the degree of economic specialisation, the Revealed Comparative Advantage (RCA) is used, which measures the export per sector (NACE) and benchmarks Flanders with a set of reference regions and countries. This results in a very strong specialisation of Flanders in **printing and reproduction of recorded media** and strong specialisations in the **production of chemical products** (exc. pharmaceuticals), and **other industrial products**. These are usually sectors that are closely linked to the intermediate position of Flanders in international value chains that is linking Flanders to larger economies, in particular Germany. In addition, there also exists specialisation in a “traditional” sector such as **food products**, which is a very important industrial sector in terms of employment with a wide set of specialisations such as pork meat, frozen vegetables and potatoes, etc. Also, the **textiles sector** (and wearing apparel) is still a specialisation and relatively overrepresented in Flanders and has been undergoing for many years already a restructuring process to remain competitive and has thus strongly transformed. An increasing part in the turnover is taken by technical textiles for niche markets, besides the specialized carpet industry.

The Flemish industry is developing more and more **niches with international potential within the traditional sectors** (e.g. the treatment of soil and sludge in the construction industry). Such innovation-driven transformations can help to maintain a position because of the increasing role of innovation, as is the case for rubber and plastics products. Some sectors may score under the benchmark when based on exports data, but can represent a high added value, as is the case for example with electrical machinery. Furthermore, the role of specialized logistic services (e.g. for pharmaceuticals, food) is a competitive advantage for the manufacturing sectors, and the development of **services** such as software is an important transformative power because artefacts are parts of ‘solutions’.

Figure 3: *Economic specialisation (RCA) pattern of Flanders based on the relative export shares*



Source: ECOOM

4.4 Combined technological - economical specialisation profiles

The figure below displays the combination of the relative technological specialisation patterns (RTAN) with those for economic specialisation (RCA). For most domains, these patterns overlap in the sense that these are both respectively:

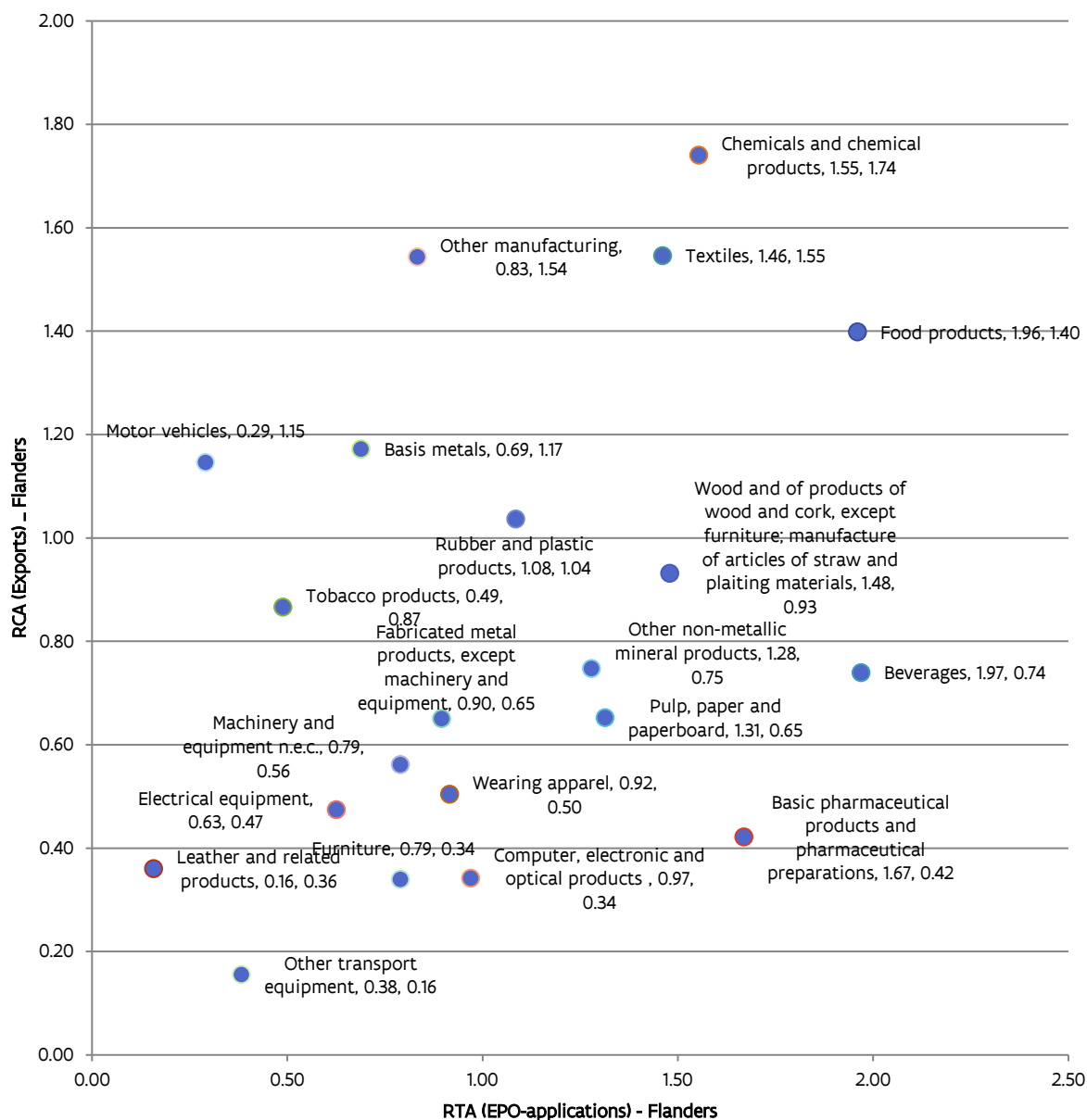
- high for **Printing and reproduction of recorded media, Chemicals and chemical products** (exc. pharmaceuticals), **Other manufacturing products, Textiles** and **Food products**;
- low for **Leather and related products, Machinery and equipment, Other transport equipment, and Electrical machinery.**

Some specific low-high combinations are these:

- a considerable technological specialisation that is not translated into an economic specialization of the same extent: basic pharmaceuticals and pharmaceutical preparations, pulp and paper products, beverages and wood products;
- a considerable economic specialization combined with a relatively limited technological specialization: motor vehicles and basic metals.

Chemistry and pharmacy are important technology areas; but whereas the specialisation in chemistry is being translated into an economic specialization, this is less the case for pharmaceuticals. The very strong pharmaceutical (biotech) sector is absorbing a large part of the life sciences and biotechnology research in Flanders (VIB) but it is not a specialisation as measured by the relative export of products. The challenge will be to have specialisations that build on each other by mutual reinforcement.

Figure 4: Combination of the relative technological specialisation patterns (RTA) with those for economic specialisation (RCA) (2008-2014)



Source: ECOOM

NACE 19 (Coke and refined petroleum products) is not included in the graph because for some EU-countries no export figures are available and the RCA values can be distorted. NOTE: NACE 18 (Printing and reproduction of recorded media) has both the highest RTA and RCA value (2,38; 4,91). This sector is not included in the graph to better visualize all other sectors.

5 More opportunities for research talent

5.1 Science popularization

STEM Action plan

Too few young people opt for science and technology disciplines and obtain a degree in this area in higher education. Consequently, more attention must be devoted to science communication and popularization. Therefore, the popularization of science, technology and innovation is an important focus of attention. A marketing and communication plan "Science, Technology and Innovation in Flanders 2012-2014" has contributed to greater visibility and an increased perception of STI among the public in general and among

(future) students in particular. The 2012-2020 STEM action plan aims to stimulate careers in Science, Technology, Engineering and Mathematics. In 2014, STEM education became more attractive thanks to improved STEM didactics. The focus is on strengthening competencies of teachers via refresher courses, encouraging school projects and deploying engineering coaches. The process of study and career choice is being optimised through study choice instruments such as “education selector” (onderwijskiezer) and the passion for STEM outside education is encouraged by means of founding a network of STEM academies. In addition, communication campaigns promote social appreciation of STEM professions and the sectors are encouraged to undertake actions about STEM. As of 2015, the Government of Flanders modified the world orientation learning area into two new learning areas: ‘science and engineering’ and ‘people and society’. Thanks to this, primary schools can focus more on science, technology and engineering. In secondary education, the share of STEM study certificates has risen compared with the past two years (44.6% of the total number of study certificates in the 2012-2013 school year), while in higher education the rise continues (25.8% of the total number of diplomas in the 2013-2014 academic year). Science, engineering and education will be stimulated from the infants’ class to higher education.

Technopolis interactive science centre

Technopolis is an initiative of the Flemish Government and a scientific do-centre aimed to bring science and technology closer to (young) people. The Flemish Science Centre is a permanent platform for science and technology in Flanders. All initiatives have the same goal in mind: to inform and raise awareness about the importance of science and technology and to increase enrolment, graduation and advancement in the exact and applied sciences. In addition to operating the science centre in Mechelen, Technopolis is also responsible for coordinating certain initiatives or projects from the Flemish Community: Dag van de Wetenschap (Science Day), STEM academies, Wetenschapsweek (Science Week). Technopolis also organises a thematic exhibition on science in the royal palace of Brussels during its Summer opening. “Science Day” is organised annually and is the largest science event in Flanders and the Brussels Capital Region. The participants are very diverse: innovative companies, universities, university colleges, musea, science-centres, research institutes,.... The “Science Week” allows pupils from secondary schools to conduct various types of research in universities, scientific institutes etc.

Universiteit van Vlaanderen

As of Autumn 2017, universities, the VRT (public TV broadcaster of the Flemish Community), and news magazine ‘Knack’, will collaborate on ‘Universiteit van Vlaanderen’ (University of Flanders). This is an online platform that offers talks by professors to the public by way of accessible lectures (similar to ‘Ted talks’ in the English-speaking world), which will last about 15 minutes. The videos will be both informative and entertaining and aim to spread knowledge towards the broader public.

Science careers

Working as a researcher could be made more attractive by the development of more transparent career paths and specific programmes to attract foreign talents or externally active Belgian (Flemish) researchers that offer perspectives. Flanders’ ambition to be a successful knowledge society can only be realized if it continues to invest in high-level research and good researchers. Apart from the regular funding channels, such as the Special Research Fund (BOF) or the grants, fellowships and research projects from the Research Foundation Flanders (FWO), several specific initiatives were developed to encourage excellent researchers and support these in a long-term career path. These include budgets for the “Odysseus programme” (a brain gain initiative), “tenure track mandates” that lead to a position within the ZAP (autonomous academic staff), Methusalem (LT-support for excellent researchers), ... worth a total of about 46 million euros in 2015. Moreover, the Flemish government supports the training on career development and transferable skills of PhD students and other young researchers through funding of the Doctoral Schools at the Flemish universities within the framework of the OJO-support (support of young researchers).

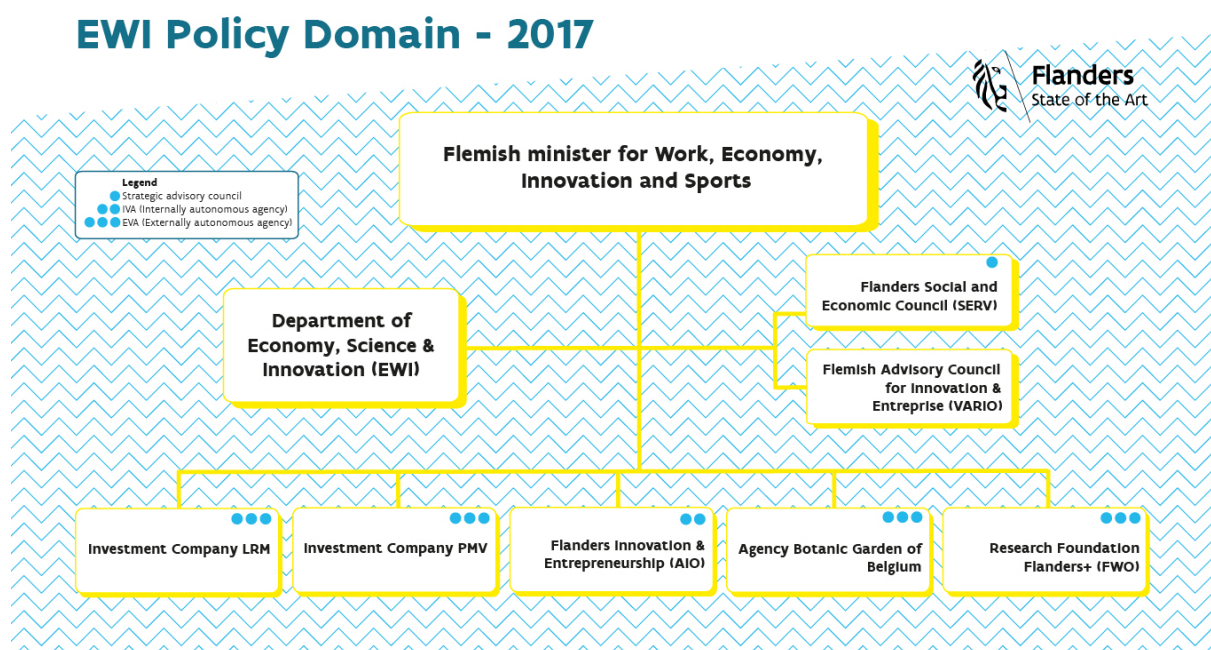
4 – Instruments and actors of Flemish STI policy

A wide range of actors and stakeholders are involved in the Flemish STI landscape: public administrations and agencies, advisory bodies, knowledge institutes and centres, universities, university colleges, scientific institutes, public research organizations (PROs), various networks active in (collective) STI, university hospitals, various collective research centres, data collection institutions, incubation centres, science and technology parks, technology transfer offices (TTOs), other intermediaries and (last but not least) many private companies and professional (technology and other) organizations.

At the public governance level, the field of science and fundamental research (= community competencies), as well as the field of innovation and applied research (= regional competencies), are dealt with by one specific commission of the Flemish Parliament and by a single minister in the government. Furthermore, there is a single advisory council and a single administration (department) responsible for preparing and monitoring policy within the policy domain. At the implementation level, there are agencies that manage the budgets and policy support instruments aimed at universities, university colleges, scientific institutes, research centres, knowledge institutes, and companies that are in the Flemish Region or in the Brussels Capital Region if these are institutes from the Flemish Community.

The following schedule presents the public bodies that are active in the STI field as of 2017.

Figure 5: *Economy, Science and Innovation (EWI) policy domain from the Flemish Government, anno 2017*



The governmental agreement of 2014-2019 announced some of decisions that affect the organization of the overall EWI landscape. The following section presents an overview of the missions and activities of the main (public) actors and some of their policy instruments.

1 Government department

The EWI Department (EWI = Economie, Wetenschap en Innovatie, or Economy, Science and Innovation) of the Government of Flanders is responsible for the policy-making process in the field of STI. This department was established in 2006 as part of a major administrative reform, entitled BBB (Better Governance), initiated by the Flemish public authority. Previously, the competencies and activities of the current EWI Department were divided between two distinct departments and policy domains (one included the economic domain and one included the science and innovation domain). Through the merger of these competencies and activities, the Flemish Government wanted to emphasize and strengthen the link between economy (industrial policy) and entrepreneurship on the one hand and scientific research and innovation on the other hand and reach more complementarities and lever. The EWI Department consists of four divisions: the Enterprise and Innovation Division, the Research Division, the Strategy and Co-ordination Division and the General Affairs & Support Division.

Like all the policy areas from the Flemish authority, the EWI policy area is composed of one (policy preparation) department and several (policy executing) agencies.

The role of the EWI Department is to prepare, monitor, evaluate and report on public policy in the field of enterprise (economic support and entrepreneurship), science and innovation, thereby contributing to greater wealth and well-being in Flanders. Its levers are the promotion of:

- excellence in scientific research;
- an attractive and sustainable business climate;
- a creative, innovative and entrepreneurial society.

The strategic aims of the EWI Department regarding STI are:

- create a sustainable economic tissue and facilitate entrepreneurship;
- stimulate innovation and creativity;
- stimulate knowledge creation and knowledge valorisation;
- putting Flanders on the map internationally in the field of economy, science and innovation;
- develop itself as knowledge centre within the Flemish authority for delivering and use of insights in the field of economy, entrepreneurship, scientific research and innovation.

More specifically, within the STI field, the EWI Department:

- prepares all legislative initiatives or position papers in the field of science, research and innovation;
- promotes close co-operation between research institutions, HEIs and companies;
- prepares multi-annual management agreements with a number of organizations, such as the four Flemish strategic research centres), the FWO (Research Foundation Flanders), or the Flanders Marine Institute (VLIZ), etc...;
- evaluates policy instruments and organizations that receive governmental and public support;
- coordinates all R&D&I topics inside and outside the Flemish Government, including the activities from the working groups in Horizon 2020 on behalf of the Flemish Community;
- has a representative in the General Representation of the Flemish Government to the EU (AAVR) within the Permanent Representation of Belgium to the EU, and participates in the advisory groups from the EC (ERAC) and OECD (CSTP);
- monitors the execution of policy measures and reports on policy developments in the STI domain towards the Flemish, federal and international (mainly EU and OECD) policy level;
- holds responsibility for the direct implementation of several policy (support) instruments, specific on-off initiatives, participation fees, or representational positions. Examples of these are: the support for the BOF (Special Research Fund), the IOF (Industrial Development Fund), and the PWO (Practice oriented scientific research at university colleges), governmental representatives in

strategic research centres or public knowledge organisations, membership fees e.g. of EMBRC (European Marine Biology Resource Centre).

2 Policy advice

The 'Vlaamse Adviesraad voor Innoveren en Ondernemen' (VARIO), the 'Flemish Advisory Council for Innovation and Enterprise', advises the Flemish Government and the Flemish Parliament on its science, technology, innovation, industry and entrepreneurship policy. The council does this on its own initiative as well as on request. The VARIO exists since 2017 and succeeds the 'Vlaamse Raad voor Wetenschap en Innovatie' (VRWI, or Flemish Council for Science and Innovation). It works independently from the Flemish Government and the Flemish stakeholders in the field of science, innovation, industry and enterprise. The chairman and nine members of the VARIO take part in a personal capacity.

The governing agreement for the 2014-2019 announced that the official advisory body VRWI would cease to exist. The Flemish minister for Innovation proposed early 2015 to create a new entity, the "Vlaamse Industrieraad voor Ondernemen en Innovatie (VARIO, or Flemish Industry Council for Enterprise and Innovation). In 2016, the VARIO was officially established, being the 'Vlaamse Adviesraad voor Innoveren en Ondernemen' (Flemish Advisory Council for Innovation and Enterprise). Thereby, the VRWI merged with the Industrieraad (Industry Board), established in 2011. Compared to the scope of the VRWI, the VARIO handles a broader array of topics, including entrepreneurship and the transition towards industry 4.0. Administratively, the VARIO is embedded within the EWI Department but maintains an autonomous position and is located separately.

The VRWI had been the strategic advisory body for the Flemish Government for science and innovation from 2010 until 2016. Yet, formal advice on science and innovation policy in the Flemish Community has a much longer track record: the VRWI was itself the successor of the 'Vlaamse Raad voor Wetenschapsbeleid' (VRWB, or Flemish Science Policy Council), established as early as 1985 as the Flemish Community's formal advisory body for science. The transformation from the VRWB into the VRWI resulted from a governmental decision in 2009 to broaden the scope of advice on science with the innovation field.

3 Other bodies of public interest in the field of science and innovation

Several other long-standing public institutions of the Flemish Community, which are related to science policy in a more academic context, play a promotional or advisory role. Although they are not directly involved in policy-making, they are part of the broader Flemish STI domain:

- Koninklijke Vlaamse Academie van België voor Wetenschappen en Kunsten (KVAB, Royal Flemish Academy of Belgium for Arts and Sciences), established in 1772;
- Koninklijke Academie voor Geneeskunde van België (KAGB, Royal Academy of Belgium for Medicine);
- Koninklijke Academie voor Nederlands Taal- en letterkunde (KANTL, Royal Academy for Dutch Language and Literature), established in 1886;
- STV Innovatie en Arbeid (Stichting Technologie Vlaanderen voor Innovatie en Arbeid) (the Flanders Foundation for Technology Assessment in Innovation and Work), which is a part of the SERV (Sociaal-Economische Raad van Vlaanderen, Flanders Social and Economic Council);
- Vlaamse Academische Stem (VLAAS, Flemish Academic Centre for Science and the Arts) is a non-profit organization supported by both the KVAB and the KANTL

4 Funding agencies

Whereas the Flemish Government's departments prepare, monitor, report about and evaluate public policy, a few agencies are charged with the implementation of the policy decisions. In the STI field, the responsible agencies have established a wide variety of initiatives and support instruments to implement R&D and innovation policy. These agencies are:

- AIO: Flanders Innovation and Entrepreneurship;
- FWO: Research Foundation Flanders;
- PMV: Flanders Holding Company (to a limited degree);
- LRM: Limburg Investment Company.

4.1 Flanders Innovation & Entrepreneurship (AIO)

The Agentschap Innoveren en Ondernemen (Flanders Innovation and Entrepreneurship) is a government agency, charged with implementing the economic, innovation and enterprise policy in Flanders. It helps companies with the start-up of their activities, the grow and continuity of their business, but also with the search for the right location, information on permits, financing, investments in innovation and ecological technologies, and other topics. The AIO also hosts the Enterprise Europe Network (EEN) Flanders, and acts as the managing authority for the EU ERDF calls and support in the Flemish Region.

In short, AIO manages all economic and innovation support for companies located or active within the Flemish Region.

AIO was established in 2016 after a merger of the Agentschap Ondernemen (AO, Enterprise Flanders) with the Agentschap voor Innovatie door Wetenschap en Technologie (IWT, Agency for Innovation by Science and Technology). 3 programmes from IWT aimed at fundamental innovative support were transferred to the FWO instead of the AIO. The establishment of the AIO had been announced in the Governing Agreement 2014-2019 of the Flemish Government. This new structure is part of a wider simplification exercise within the EWI domain. As of 2016, the AIO acts as the one-stop-shop for companies, hence the economic and innovation support at the benefit of businesses in Flanders.

Public support for economy (AO) for innovation (IWT) in the Flemish Region each have known a long - existing trajectory. AO had been established in 2009 after a merger of the 'Agentschap Economie' (AE, Economy Agency), charged with economic support, with the Vlaams Agentschap Ondernemen (VLAO, Flemish Entrepreneurship Agency), charged with entrepreneurship promotion. The Economy Agency was since 2006 the successor of the Economy administration, which had become a part of the EWBL (= economy, work, home affairs, agriculture) department since 1991. The IWT was initially set-up in 1991 by the Flemish Government and acted as the one-stop-shop for all industrial R&D and innovation support in Flanders.

In the field of innovation support, AIO assists companies, research centres and knowledge centres in realizing their research and development projects, by offering funding, advice and a network of potential partners in Flanders and abroad. More precisely, AIO encourages and stimulates innovation through:

- **Direct funding:** supporting the innovative projects of companies, research centres, collective research initiatives, organizations and individuals through assignments set by the Flemish Government;
- **Advice and services:** offering support to all Flemish SMEs and large companies and research centres by helping them with their applications or by providing technological advice during their innovative projects;
- **Co-ordination and networking:** stimulating cooperation by bringing innovative companies and research centres into contact with Flemish intermediate organizations that stimulate innovation;

to this end, the AIO manages the Flemish Innovation Network (VIN) and 5 provincial innovation centres;

- **Policy development:** supporting the Flemish Government in its innovation policy; e.g. by studying the effectiveness of the innovation initiatives and different support programmes.

The AIO supports all types of innovators in Flanders:

- **Companies** that are actively innovating, from small start-ups to multinationals with a branch in Flanders; specific attention is paid to SMEs, although partnerships between companies and knowledge centres are also eligible for innovation support. As of 2016, the AIO has recognised a series of 'innovative business networks' (following a call end 2015, see page 48), and selected a few spearhead clusters;
- **Individual researchers and research centres** can apply to the AIO for the appropriate support and can also receive funding, advice and contacts with potential partners for innovative scientific research, applied research and technology transfer;
- **Organizations of various types (e.g. collective research centres) that stimulate innovation** in Flanders can receive financial support; AIO also brings these organizations together via the VIN to facilitate active support of innovation.

The agency applies a bottom-up approach: subsidies and advice are typically awarded to initiatives proposed by the actors themselves and any project including a technological innovation component is eligible for funding. Apart from direct financial support through a wide range of support measures, the policy mix of AIO also consists of various forms of indirect support and services (advice, technology scans, partner search, networking, etc.). There are relatively few thematic Flemish research programmes and support is awarded usually through generic initiatives. Each year, the Flemish Government provides the AIO with a budget to finance R&D by and for businesses. The AIO continues to adapt its policy instruments to broaden and deepen the innovation trajectory, as well as adapting this trajectory to specific demands.

The support schemes aimed at innovation within Flanders Innovation and Entrepreneurship, AIO, aim businesses (from SME's to large companies), research organisations, service-providing organisations, non-profit organisations, and individual persons. The main support instruments for innovation and R&D are:

- O&O-bedrijfssteun (R&D business support);
- kmo-programma (SME programme), that includes kmo-haalbaarheidsstudies (SME feasibility studies) and kmo-innovatieprojecten (SME innovation projects);
- SPRINT-projects;
- Innovatiemandaten (Innovation mandates);
- Baekelandmandaten (Baekeland-mandates);
- VIS-trajecten (VIS trajectories, whereby VIS stands for 'Vlaamse Innovatiesamenwerkingsverbanden', or Flemish cooperative innovation networks);
- VIS IV-trajecten voor innovatievolgers (VIS IV-trajectories for 'innovation followers');
- Landbouwonderzoek (LA, agriculture research);
- TETRA-fund for technology transfer;
- Proeftuinen (Living laboratories);
- Lichte Structuren (LS, innovation platforms; currently phasing-out due to the new cluster policy);
- Wetenschapsparken en Incubatiecentra (science parks and incubation centres);
- VIN (Vlaams Innovatienetwerk, or Flanders' Innovation Network) and 5 innovation centres located in each province of Flanders (which are being merged administratively as of 2018);
- Clusterbeleid (cluster policy), supporting either:
 - 'Innovatieve bedrijfsnetwerken' (IBN, innovative business networks), or
 - 'Speerpuntclusters' (spearhead clusters);

4.2 Research Foundation Flanders (FWO)

The Fonds voor Wetenschappelijk Onderzoek Vlaanderen (FWO, Research Foundation Flanders) supports fundamental and strategic scientific research. It also stimulates international cooperation and promotes equal opportunity. Its main mission is to deepen knowledge about people and their environment. The FWO funds both excellent and promising researchers, as well as research projects, following an interuniversity competition and an evaluation by national and international experts. The only criterion is the outstanding quality of the researcher and the research proposal. Researchers can apply for support from the FWO through a broad range of funding instruments, providing they are affiliated to a university within the Flemish Community.

A system of peer review by the scientific community is used to assess all applications and scientific activity reports. To this end, the FWO has organized several scientific committees, including top researchers from Belgium and abroad. The FWO's scientific committees, called "FWO Experts Panels", are crucial to ensuring the excellence of FWO-funded activities. The FWO now has 29 of these specialised committees and one interdisciplinary committee, which cover all the scientific research disciplines of Flemish concern. Each committee consists of 16 experts, the majority being affiliated to a non-Flemish university.

The two main instruments of the FWO are support to fellowships (PhD students, postdoctoral researchers, etc.) and to research (via grants and projects). Furthermore, extensive means are available for promoting international cooperation and mobility, including participation in multilateral initiatives (e.g. the European Molecular Biology Laboratory) or in "big science" research facilities, such as CERN-CMS and CERN-ISOLDE. Finally, the FWO also awards scientific prizes to distinguished researchers, often in collaboration with private companies.

The Governing Agreement 2014-2019 of the Flemish Government announced the incorporation of the Hercules Foundation (an agency established by the Flemish Government in 2007 to support research infrastructure) into the FWO. This was conducted as of 2016, including the transfer to FWO of an additional 3 programmes from the IWT that support innovation in businesses. As of 2016, the renewed FWO acts as the one-stop-shop for researchers in Flanders. This transformation due to a merger/transfer was part of a wider simplification exercise within the whole EWI domain. Consequently, the FWO now manages four main (regulatory) types of activities, namely, support for:

- Fellowships and support for research grants/projects;
- Strategic basic research;
- Clinical-scientific research;
- Research infrastructure.

In short, the support instruments from the FWO are these:

- PhD fellowships;
- Postdoctoral fellowships;
- Research Grants;
- Research projects;
- Research infrastructure (medium-scale and large-scale);
- International mobility (outgoing, incoming);
- International collaboration (exchange agreement, scientific cooperation, bilateral research co-operations, 'Lead Agency' procedures);
- International contacts (international coordination action, organisation of a scientific conference in Belgium, scientific research network (WOG));
- Scientific prizes (a wide range, and in different domains);

- European programmes involvement (e.g. FWO acts as the national contact point for the Flemish Community within COST, and acts as National Contact Point (NCP) for the Flemish Community institutes in the EU's Horizon 2020 programme).

The FWO actively stimulates international cooperation and promotes scientific mobility. Flemish researchers are offered a choice of numerous funding schemes for financing short or long-term stays abroad and research teams are offered logistic and institutional support for their collaboration with foreign colleagues. Foreign researchers can apply for a visiting postdoctoral fellowship to undertake research at a university in the Flemish Community (more details: see page 61).

The FWO supports research infrastructure that serves for cutting-edge and strategic basic research in all scientific disciplines, including the humanities and the social sciences. Applications may be submitted following a call for funding for:

- medium-scale infrastructure: proposals submitted by HEIs (higher education institutions: universities and university colleges);
- large-scale infrastructure: proposals submitted by HEIs and other knowledge institutes, such as the Flemish strategic research organizations, the ITM (Institute of Tropical Medicine) and the Vlerick Business School.

The Flemish Government funds 70 to 90% of the costs of the investment. If a third party is part of the consortium, 100% of the eligible costs can be funded. These third parties can be either private or public bodies (such as companies or other organizations) and need not necessarily be based in Flanders.

Starting from 2018, the FWO, in collaboration with the FNRS (the research foundation from the French Community), will be responsible for the management of the IUAP-programme (Inter University Attraction Poles). This programme was previously managed by the Programmatic Public Service for Science Policy, and transferred from the federal authority to the Communities due to the 6th state reform of Belgium. Before the start of the new programme, a major revision will have taken place. The new bi-Community programme will be called 'Excellence of Science' (EOS) and aims to promote joint research between researchers in the Flemish and French Community by funding joint fundamental research projects in any scientific discipline.

The overall part of the annual budget of the FWO is granted by the Flemish Government. In addition, there is a small part stemming from the federal authority, as well as an amount generated by federal fiscal and para-fiscal measures.

4.3 PMV – Flanders Holding Company

The Flanders Holding Company, PMV (Participatie Maatschappij Vlaanderen), provides financial leverage to projects that are important for the future of Flanders, acting both as an "entrepreneur" and as a facilitator. It supports investment projects that strengthen the structure of the Flemish economy and fit the government's economic policy objectives. The organization creates, structures and manages co-operation with private partners. Its goals are to support innovative starters, facilitate the growth of Flemish companies, stimulate "spearhead" sectors, support specific sectors and solve the temporary liquidity problems of creditworthy companies. The PMV invests in companies, projects and sustainable development. The PMV's activities consist of three main pillars: risk capital, loans and mezzanine finance. It has developed a wide range of instruments aimed at different purposes and various target groups, ranging from the pre-start phase to the international growth phase. Innovative companies are eligible for support through these instruments, with complementary incubation support being managed through the AIO. The total value of the amounts managed by the different PMV instruments exceeds 1 billion euros.

Among its instruments, there are several innovation-oriented initiatives. The “Vlaams Innovatiefonds” (Vinnof, Flemish Innovation Fund) is specifically aimed at innovative start-up companies. It provides risk capital for the early stage of a company’s development, in the expectation that entrepreneurs will find it easier to attract private investors in later phases. Vinnof invests seed capital during three stages: pre-start, start and initial growth. The PMV also manages the TINA Fund, a 200 million euro fund aimed at assisting innovative projects that support the transformation of the economy in Flanders. The SOFI and SOFI2 Fund have been established to support the setting up of spin-off companies from research results produced by one of the Flemish strategic research centres or by the universities of the Flemish Communities. Flanders’ Care Invest is another PMV initiative, designed to invest in innovative companies in the care sector. Finally, the Innovation Mezzanine scheme provides subordinate loans for starting companies that have already received a grant from the AIO. The new Flemish Government in 2014 decided that the Vlaams Energiebedrijf (VEB, Flanders’ Energy Company) will be integrated into PMV. In 2016, PMV launched its “PMV/Z” division aimed at self-employed, start-up companies and SME’s. It provides a standardised solution that is tailor-made and regroups the existing PMV support measures of Startlening+, kmo-cofinanciering (SME co-funding), Waarborgregeling (Guarantee regulation) and Winwin-lening (win-win loan). This will allow to simplify the offer towards this specific target-group.

4.4 Investment Company LRM

LRM is an investment company that develops and stimulates economic growth in the Flemish province of Limburg. LRM targets all sectors and companies, from starting companies to growing SMEs and larger businesses. LRM provides venture capital to growth-oriented companies who are related to Limburg and is a catalyst for the transition of the Limburg manufacturing economy towards an innovative and technological economy. LRM is developing qualitative clusters within the spearhead sectors in Limburg. LRM invests in companies in the following five business areas:

- Technology & Services;
- Health & Care;
- Sustainable Societies;
- Space & Experience;
- Smart Manufacturing

5 Innovation intermediaries

Several intermediaries and co-operation networks are active between, on the one hand, the government agencies that offer instruments and budgets aimed at innovation and, on the other hand, the companies and industries that conduct research and initiate innovative projects.

5.1 Infrastructure: science parks and incubators, and support for spin-off companies

In Flanders, several science parks, research parks and incubators offer facilities for research-based young companies and innovative enterprises. Often, these are spin-off companies from a university or a PRO and are located close to the knowledge centre in question. In some cases, an incubator is specifically oriented towards a particular scientific area.

A good example of this is the Ardoyen Science Park, which is part of the Zwijnaarde Technology Park near Ghent (now called 'Tech Lane Ghent Science Park'). It hosts the incubation and innovation centre of Ghent University (UGent), the bio-incubator from the VIB (biotechnology) and a bio-accelerator supported by Ghent University and catalyzed by VIB. As a result, the majority of its 40 companies are spin-offs from UGent and start-ups of the VIB. Zwijnaarde also hosts the HQ of Innogenetics (now a part of Japanese Fujirebio), that was established in 1985 and the first European biotech company listed on the EASDAQ. The technology park near Ghent also hosts the 'Materials Research Cluster' (MRC) that provides its customers a multidisciplinary offer (with equipment, training modules,...) in the field of materials science. The partners of the MRC are OCAS, CRM, BIL, Sirris, Ghent University, Clusta, and SIM. Another example is the Arenberg Science Park and the Haasrode Business and Research Park in Leuven, where several of the actors are related to the Catholic University of Leuven (KU Leuven) and Imec, including the KU Leuven bio-incubator, the Arenberg ICT cluster, the Leuven Incubator and Innovation Centre, and the Leuven Spin-off Centre. At the Greenbridge science park in Ostend, UGent supports activities to foster 'Blue Growth' of those maritime activities which are undergoing rapid innovation (blue energy, aquaculture, marine biotechnology, deep sea mining, coastal engineering). One of the features of the new maritime research centre is the Coastal and Ocean Basin (COB) wavemaker that is part of a larger complex with a 174m long towing tank.

Universities and strategic research centres are increasingly able to professionally guide spin-off companies, e.g. with finding the appropriate CEO, financial structure, and administrative issues. An important trend is the establishment and elaboration of different types of incubators. The Flemish Government supports these science parks and incubators through both regulatory measures and financial means, mainly through the AIO (Flanders Innovation & Entrepreneurship). A list of the science/ technology parks and the incubation centres is included in part 6 of this chapter.

5.2 Financial intermediaries

BAN Vlaanderen, the Business Angels Network in Flanders, is a platform in which starting or growing entrepreneurs seeking risk capital are matched with informal private investors, the so-called "business angels". The latter offer not only money but also their own know-how, experience and contacts. BAN Vlaanderen is a marketplace where demand and supply meet, rather than an investment fund.

GIMV (Flanders Investment Company) is Belgium's most important provider of private equity and venture capital, and is also a major European and international market player. It makes venture capital investments in promising high-tech companies and focuses on buyouts and growth financing, in order to support companies in their development and growth. As a recognized market leader in selected investment platforms, Gimv identifies entrepreneurial and innovative companies with high-growth potential and supports them in their transformation into market leaders. Gimv's four investment platforms are: Consumer 2020, Health & Care, Smart Industries and Sustainable Cities. Each of these platforms works with a skilled

and dedicated team across Gimv's home markets of the Benelux, France and Germany and can count on an extended international network of experts. Initially, it was set up by the Flemish Government, which still holds a minority stake in the company. Gimv is listed on Euronext Brussels and currently manages around 1.8 billion euros (including co-investment partnerships) of assets under management. Gimv currently has 60 companies in portfolio, which jointly realise a turnover of more than 6 billion euros and employ over 26,000 professionals.

Biotech Fonds Vlaanderen (BFV) was established in 1994 as Flanders' public fund aimed to further stimulate the biotechnology sector in Flanders with venture capital. The operational management was conducted by the GIMV with whom BFV co-invested. Companies such as Ablynx, Cropdesign, Devgen, Galapagos, Innogenetics, and Plant Genetic Systems were setup or could grow thanks to investments from BFV. The Flemish Government decided to transfer in 2016 the management of BFV to PMV, which will allow to better coordinate the investments in the biotechnology sector and hence increase the impact. PMV started in 2008 with direct investments in the Flemish biotechnology sector.

The various private risk capital funds providers in Flanders (that manage seed capital, start-up capital, growth funding, MBO funding, take-over funding...) include the large banks in Belgium, and specific funds such as Capital@Rent, Capricorn, Down 2 Earth Capital, Falcon Fund, Hummingbird Ventures, etc.

There also exist several funds that are linked to the Flemish universities or the strategic research centres. For example, KU Leuven has a seed capital fund, the Gemma Frisius funds, which was set up with a few banks. Other universities have taken similar initiatives, e.g. UGent had a seed capital fund in the past (Baekeland Fonds). Imec supports the establishment of spin-off companies through its subsidiary company FIDIMEC NV. In 2016, Imec created an investment fund, imecXpand, aimed at start-up companies in the sector of Internet of Things (IoT). The Flemish Government decided to invest 30 million euro in imecXpand, for which Imec strives to collect 100 million euro for this fund from private partners and the European Investment Fund (EIF). VIB has its own technology fund and launched the V-Bio Ventures Fund 1 (75 million euro of which 30 million euro of EIF), which will invest in European start-up companies and young companies in biopharmaceuticals, diagnostics, and agricultural improvements. iMinds (since end 2016 a part of Imec) has its iStart Business Incubation programme that offers coaching, support and infrastructure to (future) technology start-up companies. iStart was awarded the 2nd place by UBI Global in its category "European Top University Business Accelerators" and the 4th place in the "UBI Globals' worldwide ranking. Almost 90 start-up companies are involved in iStart. The incubation activity from iMinds (now a part of Imec) is worth 300 FTE and generates a total turnover of 16 million euro, spread over 100 companies. Every euro invested by iMinds lead to 3.6 euro external investments (24 million euro in 2010-2014), which put iMinds in the top-3% incubators worldwide in this respect. The Qbic Fund is a multi-sector fund supporting spin-off companies of the Ghent, Brussels and Antwerp university associations and of VITO. Through its strategic partnership with these institutes it has early and privileged access to promising research projects at these partner universities. The fund mainly targets life sciences, new materials, cleantech and ICT start-ups. Qbic is the first interuniversity seed and risk capital fund from Belgium, and supported by the KBC bank. After an increase of its capital in April 2015, the Liège University (ULg) of the French Community has also become eligible for initiatives from the fund. June 2017, 250 million euro was gathered by 20 Flemish captains of industry into a new investment fund, Smile Invest (Smart Money for Innovation Leaders Invest). It is aimed at innovative SME's from Western Europe, with a focus on the Benelux and willing to grow (internationally), but unable to find the necessary funding. Targeted areas are health care, consumer products and services, ICT and high-technology, and the investments size ranges from 10 to 40 million euro per firm.

FINMIX is a project from Flanders Innovation and Entrepreneurship aimed at companies with innovative challenges, growth ambitions or take-over plans, that use risk capital for their plans. It provides the possibility to these businesses to propose their plan to a panel of funding experts who will provide advice on the best funding mix.

An overview of risk capital providers in Flanders is available at the URL:

<http://www.vlaio.be/content/overzicht-van-de-risicokapitaalverschaffers-vlaanderen>

5.3 Innovative networks

Collaboration is an important aspect of Flemish innovation policy. It enables companies and knowledge centres to develop their internal know-how and allows them to tackle common technological issues efficiently, by using a shared platform for the demand and supply of R&D and other innovative matters. Two major public players in this field are the VIN and the TTO Flanders.

Vlaams Innovatienetwerk (VIN, Flemish Innovation Network)

The VIN is a network of intermediary organizations and knowledge centres that are active in the field of innovation support. The network is coordinated by the AIO. 1548 people from 260 different organizations/divisions offer a broad range of expertise to support the innovative efforts of entrepreneurs. Each province from Flanders, hosts an establishment of an innovatiecentrum (provincial innovation centre (PIC), which are in resp. Kortrijk, Ghent, Antwerp, Leuven and Hasselt), where every company or entrepreneur / self-employed may seek advice. Since 2008, the VIN has also organised “VIN voor VIN” (VIN for VIN) sessions, which look at practical cases and provide mutual networking opportunities. As of 2018, the 5 offices will be merged administratively to reach economies of scale and improve client-orientation towards companies. Other related networks that support companies and entrepreneurs, but are not primarily oriented towards innovation, are the VON (Vlaams Ondernemersbevorderend Netwerk or Flanders Network for Entrepreneurial Stimulation), which after the take-off of AIO in 2016 changed into the ‘sterkondernemen’ site, Flanders Competento (Kenniscentrum Ondernemersvorming or Knowledge Centre for the Vocational Training of Entrepreneurs) and the various initiatives launched by FIT (Flanders Investment and Trade).

TTO Flanders (Technology Transfer Offices - Flanders)

TTO Flanders is a joint initiative by the five Flemish universities that offers a unique portal to the knowledge and technology available within the different Flemish universities and university colleges. It aims to:

- be a unique point of contact for industry looking for research expertise and licensing opportunities;
- maximise the valorisation of the available knowledge and technology;
- further improve the collaboration between the TTOs of the Flemish universities;
- strengthen the performance of the TTOs by developing common means and sharing best practices;
- become a player on the European and international innovation scene.

The various strategic research centres in Flanders also have services that fulfil a similar role as the TTO's in each university of the Flemish Community (see below).

Local and thematic initiatives

Examples of place-based initiatives, driven by one or more knowledge actor(s), and supported by various public stakeholders are Leuven Inc., Leuven Mindgate, or Ghent Bio-Energy Valley (GBEV) and BBEU (Bio-Base Europe). Thematic or sector-oriented organisations and networks exist in a broad variety. Examples include the FlandersBio network (life sciences – biopharmaceuticals, medical technologies or agricultural / industrial biotech products), Agoria Flanders (federation for the technology industry), MedTech Flanders (medical technology). The “Agoria International Business” helps technology companies increase their international market share and profitability by identifying business opportunities abroad.

5.4 Research – business links

Considerable effort has been made to increase and broaden the links between the academic world and the business sector. With this aim in mind, the Flemish Government has developed a number of initiatives to increase the valorisation of research results, to better diffuse technology, and to strengthen the direct links between companies seeking to innovate and researchers from higher education institutions. Support can be made available to companies, institutions, networks and private individuals (researchers). In addition, promotional campaigns (such as “Ik innoveer!” - “I innovate!”) focused at low-innovation intense companies and SMEs have also been set up to better disburse innovation among smaller and less-technological firms.

Examples of recent measures include support through the AIO for Baekeland mandates and innovation mandates allowing researchers to conduct research with a specific business-oriented purpose. Other examples are the subsidies for interface activities from the five participating university associations (in practice, these are the different TTOs), support via the TETRA Fund (aimed at applied-oriented projects), and the various IOF mandates and projects. Calls for support were launched by the AIO for setting up “roadmaps” leading to value creation for KETs (Key Enabling Technologies) and specific value chains in which knowledge organizations and companies are involved. Networking in the field of innovation takes place primarily through the VIN (underpinned by its five PIC) and the TTOs of the five university associations (and the similar services of the strategic research centres). To develop strategic alliances with companies, the Flemish universities have created dedicated expertise centres. These expertise centres are divided in different research domains. Each expertise centre is coordinated by a business developer that one can contact. The business developers have a full overview of the expertise within their research domain and can refer efficiently within the university. The domains are divided into 6 groups:

- Food & Agriculture;
- Health;
- Materials & Chemistry;
- ICT & Electronics;
- Cleantech & Energy;
- Engineering

For example, the domain for “Materials and Chemistry” includes:

- Applied Physics and Photonics (B-PHOT - VUB)
- Chemical Engineering (CHIS - VUB)
- CHEMTECH - Chemistry Technologies (UGent)
- CleanChem: Cleantech for sustainable chemical production (UGent)
- Composites: innovative platform for composites (UGent)
- DuraBUILDMaterials - Innovative technologies for durable cementitious and mineral building materials (UGent)
- Electrochemical and Surface Engineering (SURF - VUB)
- EMAT - Electron Microscopy for Materials Research at UAntwerp
- IMO: Institute for Materials Research (Hasselt University)
- Industrial Valorisation of Research on Non-Destructive Testing and related Materials Characterisation within the KU Leuven Association (KU Leuven)
- L-MRC - Leuven Materials Research Centre at KU Leuven
- Materials research overview (VUB)
- Metals Consortium (UGent)
- SIM² - Sustainable Inorganic Materials Management (KU Leuven)
- SusChema - Sustainable Chemistry Network Antwerp (UAntwerp)
- Sustainable Chemistry (KU Leuven)
- Sustainable Chemistry overview (VUB)
- TANC - Applied and Analytical Chemistry - Services and Collaboration (UHasselt)
- SPARC: Sustainable Polymers and Applications Research Cluster (UHasselt)

5 – Main research and innovation performers

1 Higher education institutions, and university associations

The universities represent the first pillar of the higher education system and play a major role in (the output of) Flemish R&D. The universities generate almost 90% of all non-private scientific output in Flanders. The five universities of the Flemish Community are:

- Katholieke Universiteit Leuven: KU Leuven;
- Universiteit Gent: UGent;
- Universiteit Antwerpen: UA;
- Vrije Universiteit Brussel: VUB;
- Universiteit Hasselt: UHasselt.

Public funding for the universities can be categorised into three budgetary flows:

- a basic allowance (from the Flemish Government's department Onderwijs en Vorming (OV, or the Education and Training department));
- support granted on a competitive basis;
- a variety of (project-based) external (private) sources, donations, income from IPR, etc.

The FWO (Fonds Wetenschappelijk Onderzoek Vlaanderen, Research Foundation Flanders) and the BOF (Bijzonder Onderzoeksfonds - Special Research Fund) mainly support academic fundamental, basic research: FWO support is granted based on competition between the different universities, while BOF support is a performance-based research funding system of which the funds are allocated and disbursed based on fixed competitive parameters the Flemish universities. FWO also manages as of 2016 the support for strategic basic research, and doctoral grants for strategic basic research, which were previously managed by the IWT (now AIO). The AIO and the IOF (Industrial Research Fund) mainly support industrial and applied research. AIO support is granted on a competitive basis, whereby applicants are evaluated on several criteria. The AIO also provides support at academic level for research conducted at the request of companies; for example, through innovation mandates and Baekeland mandates. IOF support is a targeted subsidy for applied and strategic basic research, allocated on fixed criteria and then granted based on intra-university competition.

In addition to the funding from FWO and BOF, the EWI policy domain provides extra support aimed at further strengthening academic working conditions and research excellence; for example, via the so-called 'tenure track' system, the Methusalem programme (long-term structural support for top researchers), and the research infrastructure programme at FWO (until 2015 managed by the Hercules Foundation). The major budget sources for 2017 are consequently these:

- FWO (371.1 million euro), of which 56 million euro for strategic basic research including doctoral grants, and 15.4 million euro for research infrastructure;
- BOF (170.2 million euro);
- IOF (32.4 million euro).

As well as the main support pillars offered by the FWO, BOF, AIO and IOF, the higher education institutions also receive support from private partners (to conduct contract research), donations and bequests from private persons or institutes, the federal authorities, other Flemish public bodies (mainly the Department for Education and Training) and the EU (mainly through the Horizon 2020 programme, and to a limited extend from other EU programmes such as ERDF-Interreg).

Apart from the EWI domain (via the EWI department, FWO and AIO), the HEIs receive a considerable budget for science and innovation from the Flemish Government's Department for Education and Training. This reaches 1.131,2 billion euro in 2017, of which 354.5 million euro allocated for R&D-related initiatives (the largest part is being allocated for education and training purposes).

Funding sources from commercialising research results has also increased in recent years. In 2015, the KU Leuven earned 118 million euro through this channel (representing one 10th of its total income), ahead of UGent with 1 to 2 million euro million, and the 3 other universities that each make a few hundred thousand euros or less through this channel.

All information relating to on-going research conducted at the Flemish universities can be consulted via the **FRIS** (Flanders Research Information Space) research portal by browsing through the database using several search options (by research projects, organisations or persons) at www.researchportal.be.

The other pillar of the Flemish higher education system is the “hogescholen” or university colleges. These colleges provide higher education and advanced vocational training, and their mission includes research and the provision of other services to society. The bachelor qualification is the highest obtainable at the university colleges; master diplomas (and higher) remain the preserve of the universities.

Since the academic year 2013-2014, the academic education of the university colleges has been integrated in the university system. This took place within the framework of the so-called “associations”: cooperation agreements between one university and one or more university colleges. These associations were set up at the introduction of the Bachelor-Master structure in 2004 and are the result of the Bologna process. Several university colleges merged with each other, affiliated to one of the five university associations.

The 5 university associations of the Flemish Community are:

KU Leuven	KU Leuven and 5 university colleges diffused over various locations in Flanders
Ghent	UGent and 3 university colleges, 2 in East-Flanders and 1 in West-Flanders
Antwerp	UA and 3 university colleges in the city of Antwerp
Brussels	VUB and Erasmushogeschool Brussel, and a cooperation agreement with the Royal Military School
Limburg	UHasselt and university college PXL, along with TuL (= the Transnational University Limburg a cooperation between UHasselt and Universiteit Maastricht)

Only statutorily registered universities and university colleges can take part in this system and receive government funding to support their educational and research activities.

Apart from universities and university colleges, several other officially registered institutions exist that are recognized by the Flemish Community and offer education in (specific) domains. These are:

- other registered institutes: e.g. ITM (Antwerp), Vlerick Business School, Antwerp Management School (AMS),...;
- ‘special university institutes’: e.g. Institute for European Studies, Institute for Jewish Studies, etc.;
- Registered institutes that can offer Ba-Ma education after approval of their dossier: Vesalius College Brussel, Flanders Business School Antwerpen, College of Europe Brugge, University of Kent Brussel, etc.;
- Higher institutes and other institutes for fine arts: Orpheus Instituut Gent, P.A.R.T.S. Brussel, Hoger Instituut voor Schone Kunsten - Vlaanderen (HISK) Gent (Higher Institute for Fine Arts – Flanders), etc.

Within the field of (higher) education, these advisory bodies exist:

- the **VLOR** (Vlaamse Onderwijsraad, or Flemish Education Council), the official advisory body on the education and training policy of the Flemish Community;
- the **VLIR** (Vlaamse Inter-universitaire Raad, or Flemish Inter-university Council), which defends the interests of the universities, advises the Flemish Government on university matters, and organises consultation between the universities;
- the **VLHORA** (Vlaamse Hogescholenraad, or Flemish University College Council) fulfils the same role as the VLIR, but for the university colleges of the Flemish Community;
- the **VLUHR** (Vlaamse Universiteiten en Hogescholen Raad, or Flemish University and University College Council) integrates all the actors at the higher educational level within the Flemish Community.

2 Business enterprise sector

The companies are of major importance within the STI system in Flanders. 70% of R&D in Flanders is privately funded (by the business enterprise sector). However, they are a very heterogeneous group. Most large companies are clearly innovation-active. Some of them have significant research budgets. Given the industrial texture in Flanders, most of these large enterprises belong to multinational groups, so that their research policy is not exclusively determined in Flanders. The main sectors that conduct research are life sciences and chemistry, ICT and communications, and the electrical machinery and apparatus industry.

Alongside the large, innovation-intensive companies, a group of high-technology SMEs has arisen in recent years and continues to grow steadily, notwithstanding the setbacks (and the failures) that have been caused because of the difficult economic climate. Moreover, even though the large majority of SMEs do not conduct research directly, many of them outsource research to some extent, so that they can also be regarded as innovation-oriented.

According to the Community Innovation Survey (CIS) carried out in 2015, 68% of all companies (2014) in Flanders can be called innovative (= introduction of new or renewed product or process innovations, or organizational or marketing innovations). Nevertheless, innovation continues to be largely concentrated in industry and large companies. The results of the CIS further demonstrate that in 2012 the average Flemish company generated 7% of its turnover from innovative goods or services (2014). Almost half of this stems from new-to-market goods and services, while the remaining part comes from goods or services that are only new to the company itself (the so called “imitation” products). For more detailed information, also see chapter 4.

International comparisons demonstrate that the share of people employed in (medium) high-tech industry and high-tech services in Flanders is lower than the EU average (8.5% versus 8.7% for the EU-28 in 2016). The R&D activities (expenditure) within companies in Flanders are mainly focused on the following high-tech sectors (2015): chemicals and pharmaceuticals (NACE 20-21) account for more than 41% of total BERD expenditure on R&D (based on a sample); motion picture, video and TV production, computer programmes, engineering, and technical testing and analysis activities (NACE 59-63, 71-72) account for 12.7%. information technology, electronic products, optical products and electrical equipment (NACE 26-27) account for about 12.5%; machinery and transport (NACE 28-30) account for more than 10.1%. In 2015, the R&D intensity in the business sector was 1.89% and higher than in 2014 (1.82%). Flanders therefore ranks higher than the EU-28 average and the Netherlands, but much lower than the Scandinavian countries, Germany, the USA and Japan.

3 Strategic research centres

Flanders aims to be a front-runner in the European knowledge society and economy by continuing to build on and utilize its existing knowledge base and by increasing its innovation potential. Apart from the

universities, the leading Flemish research and innovation actors are the four strategic research centres (SRC, or 'Strategische Onderzoekscentra' (SOC) in Dutch), sometimes referred to as public research organizations (PRO). Each of the centres is active in a specific research area and they have co-founded several spin-off or start-up companies (in total 109 by 2016), often based on breakthrough research. The Flemish Government concludes with each of these SRC a multi-annual management agreement including key performance indicators, in return for an annual grant. In addition, some SRC receive a grant for the execution of reference tasks on behalf of the Flemish government. The total budget from the Flemish Government for the 4 SRC reaches 240.9 million euro in 2017, compared to 182 million euro in 2016. The amount of public support of for Imec alone is 108.7 million euro in 2017, which makes it the highest single support budget from the Flemish Government awarded to any knowledge institute.

3.1 Imec

Imec was set up in 1984 and performs world-leading research in the field of nano-electronics and nano-technology. This research includes digital components, organic electronics or scaling-driven nano-electronics and is applied in healthcare, smart electronics, sustainable energy and transport. Imec cooperates with companies such as Intel, Samsung and SanDisk in developing new generations of chips technology. Its 1,900 staff (figure until 2015) includes over 500 industrial residents and guest researchers of over 73 nationalities. With its state-of-the-art infrastructure, strong worldwide network and clean-room facilities, it is well-placed both to conduct research at the nano-scale and bridge the gap between research and industry. The spin-off companies that have been set up are active in photovoltaics, analogue chip design, satellite navigation and infrared detectors. Imec is also very well integrated internationally and has established several subsidiaries abroad, e.g. the Nanoelectronics Design Center in Kissimmee (Florida, US), or Imec Microelectronics located in Shanghai (China).

Key figures Imec until 2016: output: 40 spinoff companies (1984-2015); publications: 10,504 journals and proceedings, WoS databases (2000-2014); patents: 981 applications and 476 grants, EPO, PCT and USPTO (2007-2014).

iMinds had been established in 2004 as the 'Interdisciplinary Institute for Broadband Technology (IBBT)', which in October 2012 changed its name into iMinds. This strategic research institute engaged in research in ICT in general and the development of broadband applications more specifically. Its research was interdisciplinary and demand-driven, and conducted in close collaboration with both industry and government. Its objective was to offer solutions to complex problems and thereby assist society to meet future challenges. iMinds stimulated research that addresses key social and economic issues: e-Health, new media, mobility and logistics, enabling technologies, and e-Government. It drove digital innovation for society and economy, through strategic and applied research on key digital technologies and turned digital know-how into future-proof products and services.

For its last calendar year as a separate institute, iMinds' total staff in 2015 was 976, representing in total 55 nationalities, and total revenue reached 58 million euro, whereby iMinds was granted 27.3 million euro public funding from the Flemish Government. iMinds produced 3,902 publications in journals and proceedings, WoS databases (2005-2014), and the institute was successful for incubation and entrepreneurship reaching 101 (start-up) companies (320 jobs and 16 million euro turnover) (until 2016).

In February 2016, the merger was announced between the strategic research centres Imec and iMinds, which was completed in October 2016, when iMinds vzw was disbanded to become one of Imec's business units.

The 'new' Imec

The renewed Imec confirms its role as the world's leading research centre for nanoelectronics and digital technology. It brings together nearly 3,500 researchers from all over the world and has a unique infrastructure, with the most advanced equipment for research into next-generation IC technologies, and

state-of-the-art bio, network and imaging labs. This includes 12,000 square meters of cleanrooms (of which the most recent 4000m² 300mm facility was inaugurated in March 2016).

Imec is also a driver of the 'City of Things' project, that builds a Smart City 'Internet of Things' (IoT) living laboratory in Antwerp. IoT is a network of digitally connected objects and infrastructure via wireless gateways that exchange data using embedded sensors. Companies, researchers, residents and local authorities can experiment with smart technology through the participation in IoT and share information on mobility, energy consumption and air quality as part of a major urban digital project.

Key figures Imec, after the integration of iMinds at the end of 2016: 496.5 million euro turnover (increase of 81 million compared to 2015, of which 48 million euro resulting the integration of iMinds); public funding from the Flemish Government: 75.6 million euro in 2016, which has increased to 108.7 million in 2017. Output 2016: Patents: 246 applications; 2143 publications. Contract research with industrial partners and universities worldwide increased to 384 million euro (342 million euro in 2015); 61 spin-off companies (1984-2016);

3.2 VIB

The mission of the **VIB**, the Flemish (Inter-university) Institute for Biotechnology, is to conduct frontline bio-molecular research in diverse fields of the life sciences for the benefit of society. It was founded in 1996 and its main task consists of acquiring new knowledge through strategic basic research, based on the use of advanced molecular biological technologies to study the functioning of human cells, plants and microorganisms. Another of the institute's core tasks is to translate this knowledge into useful applications, such as diagnostics, medicines or agricultural usages. The VIB's third core activity consists of informing the people of Flanders about discoveries and developments in the life sciences. The institute has already achieved major breakthroughs in the fields of cancer research, immunology and inflammation, neurobiology and neurogenetics, angiogenesis and cardiovascular disease, plant biology and plant systems biology. VIB's total number of employees intra muros and extra muros is 1,504 (2016) and it manages 2 bio-incubators and 1 bio-accelerator in Ghent and Leuven.

Key figures VIB: revenue: 84.853 million euro (2016); 59.96 million euro public funding from the Flemish Government (2017). Output: 19 spin-off companies (1995-2016) representing 690 employees and 930 million euro capital investments. Patents: 255 applications (1995-2016). Publications: 738 publications (257 top 5 publications) (2016), external income 29.2 million euro of which 13.3 million euro industrial income (2016).

3.3 VITO

VITO was founded in 1991 and is the largest and best-equipped multidisciplinary research centre for energy, materials, chemistry, health, environmental and terrestrial observation in Flanders. As an innovative customer-oriented research organization, it wants to create technological solutions and give independent scientifically-based advice and support that will strengthen the economic and social fabric of Flanders and make an essential contribution to sustainable development. The scientific research includes energy technology (renewable energy, biofuels, smart grids), environmental and process technology (reuse of waste water), research into sustainable materials and chemistry, environmental measuring (water and air quality), environmental toxicology and earth observation, as part of its integrated environmental studies programme. VITO has 772 employees (2015) of in total 24 nationalities.

Key figures VITO: total revenue: 174,47 million euro (2016); 53.67 million euro public funding from the Flemish Government (2017). Output: 12 spin-off companies (1991-2016), 226 publications (2016), 21 patents, patent applications (2016).

3.4 Flanders Make

In 2013, the Flemish Government decided to establish a new strategic research centre for “Slimme Maakindustrie” (Smart Manufacturing). The centre’s activities focus on product and production technology and know-how for the sector of automotive and machine capital assets and production-related companies with (smart) assembling operations. It is known as Flanders Make and was officially launched in October 2014. The aim of this centre is to support companies from various industries by conducting research into product and production technology and processes. Flanders Make’s mission is to strengthen the international competitiveness of Flemish manufacturing industry in the long term, through industry-driven, pre-competitive, excellent research in the field of mechatronics, product development methods, and advanced production technologies. The excellence centres of Flanders’ DRIVE and the Flanders Mechatronics Technology Centre (FMTC), as well as the laboratories from the 5 universities of the Flemish Community were integrated into Flanders Make, to further support the transformation of industry. Research priorities include these themes: Clean energy-efficient motion systems, Smart monitoring systems, High-performance autonomous mechatronic systems, Intelligent product design methods, Design and manufacturing of smart and lightweight structures, Additive manufacturing for serial production, Manufacturing of high-precision products, Agile and human-centered production and robotics systems. Flanders Make has 100 employees (2016) (note: payroll only. Total staff for 2016 reached 458).

Key figures Flanders Make: total revenues: 13.80 million euro (2016); 13.28 million euro public funding from the Flemish Government in 2016, which increased to 18.46 million euro in 2017. Output (2016): 218 publications in international peer-reviewed magazines, 262 publications in international scientific conferences, 5.7 million euro revenues from direct cooperation with industry, 5.95 million euro turnover from participation in European programmes.

4 Collective research and clustering initiatives

The Government of Flanders supports several innovative networks, involving various knowledge actors and industries, usually including companies from a specific sector. As of 2016, calls for proposals for cluster organisations were launched and decisions to support consortia were taken.

4.1 Early initiatives and the VIS-scheme

Mid-1990s, several bottom-up organisations in different domains were accredited by the Flemish Government as ‘economic’ clusters (e.g. FLAG (aerospace), VRI (space), Clusta (metal plating operation...)). Towards the end of the century, so-called Vlaamse Technologievalleien (Flemish Technology Valleys) were supported by the Flemish Government, active in several domains (Language, Multimedia, ...).

In 2001, a new policy scheme was approved: the “VIS-scheme” (VIS = Vlaamse Innovatiesamenwerkingsverbanden, or Flemish Cooperative Innovation Networks). This offered a legal structure for 4-year support for various types of bottom-up networks/projects for innovation stimulation, collective research and supply of services. The VIS-scheme provided support for innovative solutions to a specific problem or a demand-driven opportunity relating to a collective of companies, resulting in a clear (economic) added value for a broad target group. These initiatives were relative small-scaled and supported mainly on ad-hoc basis.

4.2 Excellence centres and Innovation Platforms

Within the legal framework of the VIS-scheme, so-called “**Competentiepolen**” (excellence centres) were supported as of 2002. These fulfilled the tasks of an innovation platform and an infrastructure for collective knowledge building. As of 2009, some of these excellence centres were streamlined, transformed into another platform, scaled-up or consolidated, or even merged to become a new strategic research centre (e.g. into Flanders’ Make). After 2011, another transformation took place, towards “**Lichte Structuren**” (innovation

platforms). These organizations structure(d) cooperation between actors (such as industrial partners, PROs, universities, professional organizations) of a specific industry, by providing relevant research and innovation potential and create and diffuse knowledge in Flanders. Initiatives that were supported included for example: Flanders' DRIVE (automotive industry; which became together with the FMTC (Flanders' Mechatronics Technology Centre) a division of the new strategic research centre Flanders' Make end 2014); VIL (logistics – Flemish Institute for Logistics); MIX (innovative media); FLAMAC (Flanders Materials Centre; incorporated into the SIM (Strategic Initiative on Materials) in 2011, Flanders' Food (innovative food industry); VIM (mobility – Flemish Institute for Mobility); Flanders Inshape (product development and industrial design); Flanders' Synergy (innovative labour organization); Flanders Innovation Hub for Sustainable Chemistry (FISCH) which absorbed Flanders' PlasticVision (plastics processing industry); MIP3.0 (environment), etc. Due to the elaboration of the new cluster policy in 2016 (see below), most of these initiatives are phasing-out under the VIS-scheme.

4.3 Cluster policy

The 2014-2019 governing agreement of the Flemish Government calls for a **cluster policy** as the lever to deal with the innovation paradox in Flanders and focus more on marketisation of innovation and research results. In 2014, the policy note 2014-2019 for Work, Economy, Science and Innovation referred to a cluster as a cooperation whereby actors from the triple helix engage to develop innovative value chains in specific domains. To elaborate this policy, the Flemish Government approved Summer 2015 a Concept Paper on a Cluster policy that describes the framework of a more general Flemish cluster policy. By way of strategic cooperation networks, companies and knowledge institutes should set up projects, and add an international dimension. The aim is to unlock unused economic potential and to increase of competitiveness among Flemish companies through an active and continuous cooperation of actors, to contribute to a solution for societal challenges with an economic added value for companies. The concept paper included initiatives that reshuffle the existing landscape, among other by adapting funding criteria, and direct future innovative cooperation among companies' networks into two types of clusters: small-scaled initiatives called **"innovative business networks" (IBN)** and large-scaled initiatives for **"spearhead clusters"**.

A call for **innovative business networks** was launched by Flanders Innovation and Entrepreneurship Autumn 2015, leading to the approval of support for 14 initiatives in Summer 2016. The innovative business networks (IBN) are being shaped on a smaller scale, are bottom-up initiatives, have a future potential and come from emerging markets or the bundling of various small initiatives. During a 3-year period, a 50% public support part will be available. A simplification and streamlining of the large number of intermediaries, structures and innovation actors are leading principles.

- Euka vzw (topic: drones)
- Innovatieve Coatings (coatings)
- Flanders' Bike Valley vzw (bicycle industry)
- Platform Power to Gas (hydrogen)
- Offshore Energy
- Flemish Aerospace Group (aerospace)
- Digitising Manufacturing (Industry 4.0, manufacturing, digitalisation)
- IBN Composieten (composites)
- Groen Licht Vlaanderen (lightening, digitalisation)
- BIM (Bouw Informatie Modellen) (construction teams, digitalisation)
- Off-Site Construction – bouwindustrialisatie (building)
- Air Cargo Cluster (air freight)
- Smart Digital Farming (agriculture, ICT)
- Eggsplora (financial technology, internet of things).

The introduction of the new cluster programme consequently lead to a phasing-out of the support for Lichte Structuren (Innovation Platforms) and the various VIS-initiatives.

Spearhead clusters are to be complementary to the domains and themes in which the strategic research centres (Imec, VIB, VITO, Flanders' Make) are active. They must be large-scaled, limited in number, strictly selected, require a triple helix model, and in future make a difference from economic point of view. Support will be awarded for a 10-year period with a 50% public part. Spring 2016, the domains of sustainable chemistry, logistics, materials and agro-food were asked to submit a proposal for support for the establishment of such spearhead cluster. This resulted in proposals from the fields of sustainable chemistry (by FISCH), logistics (by VIL), materials (by SIM) and energy (by Smart Grid Flanders). After an evaluation, it was decided to support spearhead clusters in the domains of sustainable chemistry and logistics (October 2016) and in the fields of materials and energy (December 2016). As of 2017, these 4 spearhead clusters have been supported and started their activities. An additional proposal in the field of agro-food was submitted in 2017, and granted the status of another spearhead cluster in April 2017 (due to start in 2018). Currently, the existing spearhead clusters and their corresponding cluster organisation are:

- Logistics (VIL)
- Chemistry and Plastics (Catalisti)
- Strategic Initiative Materials in Flanders (SIM)
- Flux50 (Smart Grids Flanders, now called 'Flux50')
- Agro-Food (Flanders FOOD) [due to start in 2018]

4.4 Support for research performed by collective (research) centres

The AIO has accredited several research centres under the VIS scheme (see page 48.), some of which are **collective (research) centres**. All of these institutes are also recognised as a scientific organisation by the federal PPS Science Policy (and eligible for the scheme of reduced social contributions on researchers' salaries). Their main activities include collective research, various services of a scientific or technical nature (provided individually to their members), dissemination of technical information and training. The collective centres were founded after WWII by the Belgian business federations, usually by way of an association, and in over the years several of other institutes have gained a similar status. The target groups of their applied research activities are either defined by sector, or rather by theme. In addition, they often participate in European, federal and Flemish research programmes and carry out self-generated research to maintain their overall levels of knowledge and expertise. These centres conduct (contract) research (supported by the AIO for the companies in the Flemish Region) at the request of individual companies. These centres, including the equivalent organisations, are:

- Belgian Institute for Wood Technology and the Wood Training Centre (wood.be);
- Belgian Welding Institute (BWI);
- Belgian Research Centre for the Cement Industry (CRIC);
- Belgian Road Research Centre (BRRC);
- Scientific and Technical Service Centre for the Belgian Textile Industry (Centexbel);
- Belgian Building Research Institute (BBRI);
- Scientific and Technological Research Centre for Diamond (WTOCD);
- Collective Centre for the Belgian Technology Industry (SIRRIS), which includes several sub-sectors (e.g. "Aeronautics, Space, Security & Defence Industries");
- Coatings Research Institute (CORI);
- Research Centre for of certification and standardisation (CRIC-OCCN);
- Belgian Ceramic Research Centre (BCRC) (includes ceramics, glass and bricks industry);
- Metallurgic Research Centre (CRM) (for ferro and non-ferro metals);
- Tecnolec (electrical business).

4.5 Policy research centres

In 2001, the Flemish Government launched the 'Steunpunten' programma (policy research centres programme) to provide a scientific basis for policy research. The focus of the policy research centres was both on problem-driven, short-term research and on fundamental, long-term basic research regarding themes that the Flemish government considers as priorities and relevant to its policy. The task further includes the transfer of knowledge, the provision of scientific services, the building up of data collections, the unlocking of data sources and data analysis. In the period 2012-2015 twenty-one policy research centres received support. From 2016 on, a decentralised approach towards policy research centres was elaborated whereby every policy domain was made responsible for setting up, funding and following up its own centres. The EWI department (Economy, Science and Innovation) remains responsible for the funding and follow-up of the policy research centres from its own policy fields, in case:

- **Expertisecentrum Onderzoek en Ontwikkelingsmonitoring van de Vlaamse Gemeenschap** (ECOOM, Expert Centre Research and Development monitoring of the Flemish Community): an inter-university consortium in which all Flemish universities participate;
- **Steunpunt Economie en Ondernemen** (Policy Research Centre Economy and Entrepreneurship): a cooperation between KU Leuven and UGent.

ECOOM is a.o. responsible for the calculation of the official R&D-intensity indicator of Flanders, whilst the PRC Economy and Entrepreneurship analyses spearhead clusters and maps entrepreneurship in Flanders.

4.6 Scientific institutes

Within the Flemish Community, there are five scientific institutes, each managed by a department of the Flemish Government. These perform scientific research in a specific policy field. Apart from building up and diffusing the knowledge gained from scientific research, the institutes also provide advice and assistance to policy-makers, as well as services to society as whole. Furthermore, they strive to develop and exchange their knowledge through international contacts or programmes and via cooperation with other (foreign) institutes; for example, through membership of EU research networks.

The five scientific institutes from the Flemish Community are:

- **Institute for Agricultural and Fisheries Research** (Instituut voor Landbouw en Visserijonderzoek, ILVO) conducts research in four main areas: plant sciences (applied genetics, breeding, crop protection), animal sciences (functional nutrition), technology and food science (food safety) and social sciences; in many cases this research is conducted in collaboration with various international partners;
- **Research Institute for Nature and Forest** (Instituut voor Natuur- en Bosonderzoek, INBO) conducts research on themes such as fauna, flora, biotopes, areas and regions, sustainable land and water use, with a focus on factors such as ecohydrology, acidification, pollution and climate change;
- **Royal Museum of Fine Arts Antwerp** (Koninklijk Museum voor Schone Kunsten Antwerpen, KMSKA) is charged with the care of a unique art collection, composed of mainly Flemish works, complemented with several pieces from other schools;
- **Agency for Archaeological Heritage** (Agentschap voor Onroerend Erfgoed, AOE) conducts research into the immovable heritage of Flanders (archaeology, monuments, landscapes), focusing on themes such as the restoration of historic gardens, sea wrecks, historic organs, parks, industrial and maritime heritage, etc.;
- **Agency Botanic Garden Meise** (Agentschap Plantentuin Meise) is a scientific research institute, that operates as a centre of excellence for research into tropical and European botany, with a collection of over 18,000 species of plants and one of the largest herbaria in the world. It has been a part of the Flemish Community, following its de-federalisation in 2014, as an agency of the EWI domain.

4.7 Other knowledge institutes, and networking platforms for R&D and innovation

Apart from the aforementioned organizations, which are part of a clear category such as the universities, the public research organisations (PROs), innovation platforms, collective research centres or the (Flemish or federal) scientific institutes, there exist a variety of other institutions and organizations in the public domain with activities that primarily focus on (scientific) data collection, research and/or knowledge generation. In most cases, they are mainly of to some extent supported by the Flemish Government. Some of these organisations play a prominent worldwide role in their field of activity.

The knowledge institutes include:

- **The Flanders Marine Institute, VLIZ** (Vlaams Instituut voor de Zee): is renowned for supporting coastal and marine scientific research. It operates the Simon Stevin vessel (the Flemish multidisciplinary coast research ship), manages the InnovOcean site and the Flanders Marine Data and Information Centre, which is active in international networks such as the IOC of UNESCO, the European Marine Board and supports the European-level initiatives EMODnet and JPI Oceans;
- **The Institute for Tropical Medicine, ITM** (Instituut voor Tropische Geneeskunde, ITG): is one of the world's leading institutes for training, research and support of tropical medicine and health care in developing countries, providing (reference) clinical services for the management of tropical diseases. ITM hosts many international reference laboratories and is an expert centre on HIV;
- **The Centre for Research and Conservation (CRC)**: is the research department of the Royal Zoological Society of Antwerp (RZSA), conducting applied and fundamental hypothesis-driven conservation research in various zoological disciplines (e.g. veterinary sciences). Research takes place in Flanders, in zoos and associated institutions, as well as in Brazil, Cameroon and Congo (bonobo research);
- **Neuro-electronics Research Flanders, NERF**: this basic research initiative is a collaborative venture between Imec, the VIB and KU Leuven, which aims to unravel the neuronal circuitry of the human brain through research that combines nano-electronics and neurobiology;
- **Energyville vzw**: association of the Flemish research institutes KU Leuven, VITO, Imec and UHasselt in the field of sustainable energy and intelligent energy systems. It provides expertise to industry and public authorities on energy-efficient buildings and intelligent networks for a sustainable urban environment. This includes, for example, smart grids and advanced district heating and cooling.

Other related initiatives include so-called “Proeftuinen” (**Living Laboratories**, or test beds), which originally were set up in various domains. These were/are structured test environments in which organizations through projects test(ed) innovative technologies, products, services and concepts, using a representative sample of individuals, who are used as testers in their normal living and working environments. Current Living Labs are active in the fields of **Huisrenovatatie** (housing renovation) and **Zorginnovatieruimte Vlaanderen** (care innovation space Flanders).

Some organizations do not perform research as such, yet do have a role in supporting or stimulating innovation, or act as knowledge cluster in specific thematic areas. These organizations include:

- **I-Cleantech Vlaanderen vzw**: aims at the internationalization of clean technologies developed in Flanders, by e.g. establishing innovative projects and promoting strategic initiatives;
- **Flanders' Care**: increase care quality through innovative entrepreneurship in the care economy;
- **Gen4Wave**: action plan on wave and tidal energy;
- **Tecnolec**: (a part of Volta), technical knowledge centre for the electro technical sector;
- **Clusta**: metals' plating treatment;

- **VIGC:** Vlaams Innovatiecentrum voor Grafische Communicatie (Flemish innovation centre for graphical communication);
- **DSP Valley:** cluster of excellence in smart electronic systems and embedded technology solutions;
- **Flanders DC** (Flanders District of Creativity): entrepreneurial creativity through innovation;
- **Microsoft Innovation Centre Vlaanderen** (MIC Vlaanderen, ICT in the care sector and e-health, which merged in 2017 with 'BlueHealth Antwerp' into a new organisation: 'BlueHealth Innovation Center').

4.8 Institutes governed by other authorities

Federal authority

Belgium has ten federal scientific establishments, which are of diverse types and cover a wide variety of research activities and collections; these include museums, libraries, weather and space observatories, as well as research institutes dealing with crime, African culture, geology and public health. Some of these bodies not only perform research in specific fields of expertise, but also have a publicly orientated scientific mission. At the administrative level, they are managed by various policy fields and under the overall responsibility of the federal State Secretary for Science, as part of the Programmatic Public Service (PPS) for Science Policy. The new federal governing agreement 2014-2019 announced the abolishment of the PPS for Science Policy as an autonomous entity and its integration into another federal public service. As of today, this transformation has not taken place.

The federal scientific establishments have a two-fold mission: a scientific public service mission on the one hand (the development, maintenance and dissemination of scientific, technical and cultural information and documentation, collection conservation, etc.) and a research mission on the other hand (through research often conducted in partnership with the universities of the Flemish and/or French Community). As such, these establishments interact with and enhance the scientific potential and outcome generated by the actors in the Flemish STI landscape, particularly the researchers in HEIs who are active in the same field of activity. The federal scientific institutes in the field of nature and space (excluding the domains of arts and documentation) are:

- the Belgian Institute for Space Aeronomy;
- the Royal Belgian Institute of Natural Sciences;
- the Royal Meteorological Institute;
- the Royal Museum for Central Africa;
- the Royal Observatory of Belgium (including the Planetarium).

In addition to these institutes, there also exist federal partner institutions and other organisations subsidized by the PPS (for example, the University Foundation), whilst some of the federal scientific institutes report to other federal public services. In the field of public health, for example, there is the (federal) Scientific Institute of Public Health and the (federal) Veterinary and Agrochemical Research Centre (CODA). Summer 2016, the federal government decided to merge these 2 institutes as of 2017. The governing board of the new merged scientific institute (called 'Sciensano') will include representatives from the Communities, Community Commissions (from the Brussels Capital Region) and Regions. Note: the start of Sciensano is postponed until Autumn 2017.

The Federal Government also has responsibility for two other research organizations, being the National Institute for Radio-elements (IRE), and the renowned Nuclear Energy Centre (SCK or CEN). The latter is in Mol, nearby the Flemish VITO (responsible for the non-nuclear aspects of energy research) and nearby one of the eight Joint Research Centres (JRC) from the EU, the IRMM (research on reference materials).

Most of these federal institutes and centres are located in the Brussels Capital Region, while two are in Flanders (the Central Africa museum (Tervuren) and the SCK (Mol)), one is in Wallonia (the IRE), and Tervuren is also home to the CODA's second establishment.

International institutions, organizations or platforms in the STI field

Apart from institutes related to or managed by the Government of Flanders and the Federal Government, there are also a few other EU or international institutions located in Flanders that collect scientific data or conduct research. Some of these receive funding or support from the Flemish Government.

Examples include:

- the **Von Karman Institute (VKI)** for fluid dynamics, location: Sint-Genesius-Rode;
- the **EU's joint research centre (JRC)** known as the Institute for Reference Materials and Measurements (IRMM), location: Mol (nearby the Flemish VITO and the federal SCK/CEN);
- **United Nations University Institute on Comparative Regional Integration Studies (UNU-CRIS)**, location: Bruges;
- the **ESA Business and Innovation Centre**, location: Mol and Geel;
- the **Project Office of the Intergovernmental Oceanographic Commission (IOC)** of UNESCO for the International Oceanographic Data and Information Exchange (IODE) programme, location: Ostend;
- the **European Marine Board (EMB)** and the **European Marine Observation and Data Network (EMODnet)**, location: Ostend.

Other examples of international research-related establishments are the executive offices of the EU's joint initiatives for Innovative Medicines (IMI), Clean Sky, ECSEL (previously ENIAC (nano-electronics), ARTEMIS (embedded systems)), Fuel Cells and Hydrogen (FCH), all of which are located in Brussels.

4.9 Cooperation among different knowledge actors within Flanders

Apart from cooperation between research performers and the academic world on the one hand, and business or societal actors on the other hand, or between collaborations between knowledge institutes and their foreign partners or counterparts, the various Flemish R&D&I performers also cooperate increasingly among each other. This may develop via scientific networks or ad hoc projects. Yet in some cases, this takes place through formal institutes or cooperation agreements as well.

Universities are closely connected via the involvement of entities of their different faculties in VIB and iMinds (now a part of Imec). In other cases, there exist cooperation between universities and strategic research centres or scientific institutes. Examples of these is NERF (Neuro-Electronics Research Flanders), an academic research initiative that is set up as a long-term collaboration between three Flemish institutes (Imec, KU Leuven and VIB) that receives structural funding from the Flemish Government, and actively collaborates with UA and UGent. In EnergyVille (located in Genk), the KU Leuven, VITO and Imec are united for research on sustainable energy and intelligent energy systems. Another example is the strategic cooperation agreement signed in 2016 between VIB and ILVO to bundle their complementary expertise of basic and applied research in related fields of activity of life sciences and agriculture research.

Cooperation may also take place on a project-basis and include federal or international institutes that are in Belgium. For example, ILVO (agriculture research, located in Merelbeke, Melle and Ostend) cooperates with the UGent, the federal scientific institute for public health, and the Federal Public Service (FPS) Public health, Safety of the food chain, and Environment. The InnovOcean site in Ostend is home to an array of actors in the field of marine issues: the province of West-Flanders, VLIZ (Flanders), IODE (UNESCO/IOC Project Office), the secretariats from the European Marine Board (EMB) and from the European Marine Observation and Data network (EMODnet). The EC's JRC IRMM in Mol cooperates in Belgium with, among other, VITO, Imec, KU Leuven, VLIZ, and UGent.

6 – Overview of the various actors in the STI domain in Flanders

This table shows the main (types) of institutes and actors within the overall R&D&I system in Flanders.

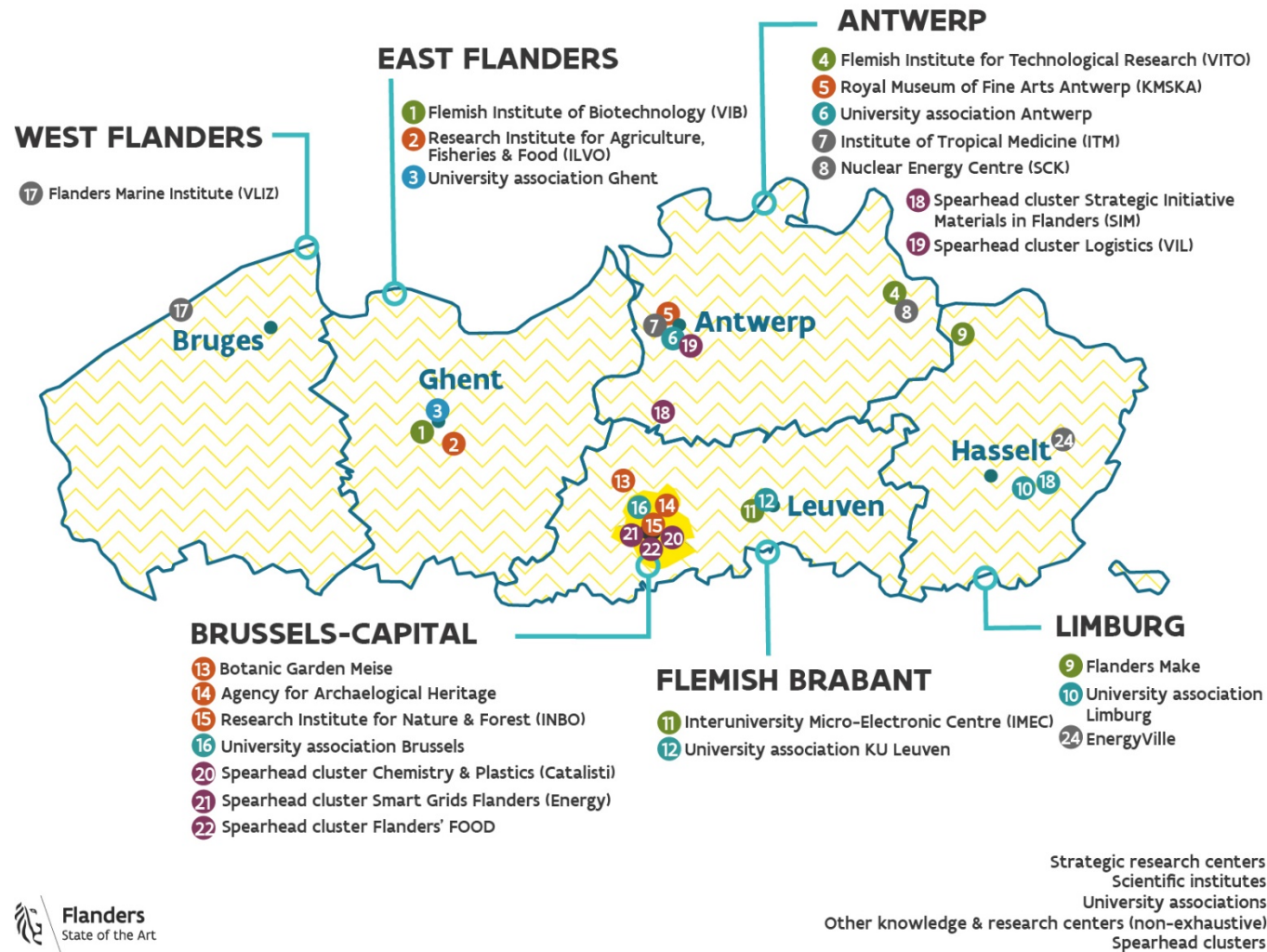
Type of organization	Actors
Public authority	
-- policy preparation, monitoring, reporting and evaluation	
	EWI department of the Flemish Government
-- policy execution (agencies)	
	Flanders Innovation and Entrepreneurship (AIO)
	Research Foundation Flanders (FWO)
	Flanders Holding Company (PMV)
	Flanders Investment and Trade (FIT)
Advisory council	
	Flemish Advisory Council for Innovation and Enterprise (VARIO)
Scientific institutes (from the Flemish Community)	
	Agentschap Botanic Garden Meise
	Institute for Agricultural and Fisheries Research (ILVO)
	INBO
	KMSKA
	AOE
University associations one university linked to one or more university colleges (from the Flemish Community)	
	Antwerpen
	Brussel
	Gent
	KU Leuven
	Limburg
Strategic research centres	
	Imec
	VIB
	VITO
	Flanders Make
Other knowledge institutes	
	ITM
	VLIZ
	Energyville
	NERF
	BioBase Europe
Spearhead clusters	
	Chemistry and Plastics (Catalisti)
	Logistiek (VIL)
	Strategic Initiative Materials in Flanders (SIM)
	Flux50 (Energy)
	Flanders' FOOD (agro-food) [to start in 2018]

Innovative business networks (IBN) (start-up of projects for IBN is currently on-going)	
	Euka
	Innovatieve Coatings
	Flanders' Bike Valley
	Platform Power to Gas
	Offshore Energie
	Digitising Manufacturing
	IBN Composieten
	Groen Licht Vlaanderen
	BIM (Bouw Informatie Modellen)
	Off-Site Construction / Bouw-industrialisatie
	Air Cargo Cluster
	Smart Digital Farming
	Eggsplore
	Flemish Aerospace Group
Mixed initiatives	
innovative networks technical knowledge centres knowledge clusters and consortia various research centres	DSP Valley I-Cleantech / MIP 3.0 (environmental and energy technology innovation platform), Flanders' Care, Blue Health Innovation Centre (former Microsoft Innovation Centre Vlaanderen), Flanders' Synergy, Sociale Innovatiefabriek, Vlakwa, Gen4Wave / Blue Growth, Flanders DC, Cogen Vlaanderen, Living laboratories (housing renovation, care innovation), Packaging Technology Centre, Laser Cladding Centre, VIGC, Clusta, various centres initiated by universities or university colleges (e.g. computational linguistics, maritime research).
Provincial innovation centres (PIC)	
	Each of the 5 Flemish provinces hosts an innovation centre that provides innovation advice and support (in Kortrijk, Ghent, Antwerp, Leuven, Hasselt respectively).
Vlaams Innovatienetwerk (VIN)	
	The VIN is an online network of intermediaries and knowledge centres active in innovation support, coordinated by Flanders Innovation and Entrepreneurship.
Technology transfer offices (TTO) at the universities and the strategic research centres	
	KU Leuven Research & Development
	UGent TechTransfer
	VUB TechTransfer
	AUHA Interfacedienst
	UHasselt Tech Transfer Office
	The TTO's of the 4 strategic research centres
Federal scientific institutes	
	Belgian Institute for Space Aeronomy (BIRA)
	Royal Meteorological Institute of Belgium
	Royal Observatory of Belgium
	Royal Belgian Institute of Natural Sciences
	Royal Museum for Central Africa
Federal research centres	
	Scientific Institute of Public Health
	Veterinary and Agrochemical Research Centre
	National Institute for Radio-elements
	Nuclear Energy Centre (SCK)

Collective research centres and equivalent institutes	
	Belgian Institute for Wood Technology and Wood Training Centre (Wood.be)
	Belgian Welding Institute (BWI)
	Belgian Research Centre for the Cement Industry (CRIC)
	Belgian Road Research Centre (BRRC)
	Scientific and Technical Service Centre for the Belgian Textile Industry (Centexbel)
	Belgian Building Research Institute (BBRI)
	Scientific and Technological Research Centre for Diamond
	Collective Centre for the Belgian Technology Industry (SIRRIIS)
	Belgian Ceramic Research Centre (BCRC)
	Metallurgic Research Centre (CRM) (ferro and non-ferro)
	Coatings Research Institute (CORI)
	Tecnolec (electrical business)
International institutes, organisations or platforms in the STI field, located in Flanders	
	Von Karmann Institute, VKI (Sint-Genesius-Rode)
	IRMM (Mol)
	IOC for the IODE (Ostend)
	EMODnet (Ostend)
	EMB (Ostend)
	UNU-CRIS (Bruges)
	ESA Business and Innovation Centre (Mol and Geel)
Science / technology parks	
	Tech Lane Ghent Science Park (previously the Ardoyen and Eiland Zwijnaarde parks) (Ghent), Wetenschapspark Universiteit Antwerpen (previously Waterfront) (Niel), Zellik (Asse), Arenberg, Haasrode (Leuven), Feed Food Health (Tienen), Thor Park (Genk), Corda Campus (previously Research Campus Hasselt) (Hasselt)
Innovation and incubator centres (IIC)	
	Greenbridge IIC (Ostend), IIC Kortrijk (Kortrijk), iCubes – iMinds (now Imec) Incubator, IIC UGent 1&2, VIB Bio-incubator and Bio-accelerator (Ghent), Textile Innovation Centre (Ronse), IIC Brussels (Asse), Bio-incubator KU Leuven, Creative Minds - De Hoorn, ICT-cluster Arenberg, IL Research Building Haasrode, IIC Leuven, Spin-off Centre (Leuven), Innotek (Geel), Technology House of Environment (Mol), C-Mine, Energyville (Genk), Incubator Science Park Limburg, Bioville (Diepenbeek), Bio-generator Tienen (Tienen), Agropolis (Kinrooi), Incubator Darwin (Niel), Greenville, Bike Ville (Paal), IncubaThor (Genk), CordaINCubator (Hasselt), Greenville (Houthalen-Helchteren), Bioscape (Ghent), Mia-H (Hasselt), Watt Factory (Gent) (x)

(X): source: Flanders Innovation and Entrepreneurship, 2017

Figure 6 : Geographical presentation of the main public actors in scientific research and innovation in Flanders



7 – Flanders in the international STI field

The international aspects of STI cover a wide range of activities and institutions, embedded at the public, semi-public and private level. Consequently, no single administrative entity or agency has been set up to specifically manage these international aspects. This means that all the different public and private actors that are interested or eligible can initiate their own policy initiatives and programmes at the international level. The following overview lists the main types of activities and initiatives that are carried out in the field of international scientific research and innovation.

1 Policy preparation, support and follow-up

Since 1993, the Belgian Communities and Regions have been able to execute their competencies at the EU and international policy level. Since then, a substantial effort has been made to internationalize STI policy. More concretely, this policy is shaped by the preparation and follow-up of policy initiatives at the bilateral (towards a region or a country), inter-regional, inter-governmental, EU and international (OECD, UN) policy levels. The overall focus of policy lies at the (supranational) EU level, in casu the decisions and actions of the European Council and the European Commission.

In the European Council meetings dealing with research and innovation policy, Belgium is represented by its Communities/Regions, whilst the federal authority acts as assessor. Consequently, Flanders is one of the authorities directly involved in the preparation of decisions within this Council, and takes its turn to represent Belgium according to a rotation system agreed with the other authorities. The meetings of the Council Working Group are attended by the Flemish representative for research and innovation, who is assigned to (and is an integral part of) the Belgian Permanent Representation to the EU. Principal fields of action include the EU 2020 strategy, the Framework Programme for Research and Technological Development (FP on RTD), the Horizon 2020 Programme for 2014-2020, the European Research Area (ERA) objectives, the Innovation Union flagship initiatives, and all related R&D and innovation matters in the broadest possible sense (for example, SFIC, ESFRI, etc.).

Active involvement in the EU's research and innovation policies includes:

- preparation and follow-up of the ministerial decisions within the EU Competitiveness Council (Research);
- the EU's Horizon 2020 and COSME programmes: preparation of the programme themes, act as National Contact Point (NCP), involvement as programme committee members in H2020, the ERA networks, OMC networks, and other support actions;
- preparation and participation in the meetings of the ERAC, the entity in which the EU member-states are gathered to advise the European Commission on its research and innovation policy;
- preparation for the meetings of the Enterprise Policy Group (EPG), the body of the EU member-states that advises the European Commission on enterprise and industry policy and the non-R&D innovation);
- participation in the bilateral meetings between the Commission and Belgium for the European Semester (Fact Finding Mission) and preparation of the bilateral meeting at ministerial level for the R&D&I themes;
- preparation and follow-up of the decisions relating to various EU initiatives in the field of R&D and innovation, emanating from the Council or the Commission, such as the JTI (Joint Technology Initiatives), ESFRI (large research infrastructure), the KET (Key Enabling Technologies), the EIT (European Institute for Technology, now a part of Horizon 2020) and the JPI (Joint Programming Initiatives), etc.;
- contributions to or revision of the many reports and consultations involving the European Commission and the Committee of the Regions in the field of scientific research and innovation (for example, the Flemish and Belgian National Reform Programmes for the EU 2020 strategy (European Semester), the various ERA reports, , R&I Country report, the report of the Research and Innovation Observatory (RIO), the EC/OECD STI Policies report, the ERDF R&D and innovation

actions, the progress reports on the Innovation Union, thematic/specific questionnaires from ERAC, EPG and peer reviews of the STI system, R&D legislation, the ERA roadmap progress, the research conducted by PROs and universities, etc.).

Other involvement in EU policy networks includes membership of ERRIN (European Regions Research and Innovation Network) and the Vanguard Initiative for new growth by smart specialisation.

In addition to the EU level, Flanders also has representative functions linked to the preparation and follow-up of the policy-making of various international organizations and other specific support initiatives. This includes the Organization for Economic Cooperation and Development (OECD) and the United Nations (UN). More precisely:

- **OECD:** participation in the CSTEP (Committee on Science and Technological Innovation Policy), the TIP (Technology and Innovation Policy), NESTI (National Experts on Science and Technology Indicators) group, and in thematic subgroups on e.g. ICT, biotechnology, and researchers' mobility. A substantial contribution is provided for the OECD's STI Outlook report (as of 2016: the STI Policy (STIP) report, jointly from the OECD STI Survey and European Commission ERAC survey);
- **UN:** support for the Flanders UNESCO Science Trust Fund (FUST: capacity building in development countries), the Flanders UNIDO Science Trust Fund for Industrial Biotechnology (FUSTIB), UNU-CRIS (United Nations University – Centre for Regional Integration Studies, located at the Europa College in Bruges) and the project office of the IOC (Inter-governmental Oceanographic Commission) for IODE at Ostend.

2 Bilateral and international co-operation and agreements

Many institutions and organizations in the field of STI have developed international links; are part of international networks; have established representations; have set up joint initiatives; or have concluded bilateral agreements with a foreign partner in the host country. Such initiatives are the result of a gradual trend towards greater internationalization, whereby companies, universities, research institutes or knowledge centres develop bottom-up cooperation with foreign partners in a network context. These initiatives can either be independent of or complementary to the initiatives of the Flemish, federal or EU actors in respect of these foreign countries or regions.

2.1 STI actors: universities, university colleges, strategic research centres, scientific institutes and other knowledge organizations

At the level of the universities, for example, KU Leuven (Catholic University of Leuven) provides grants for students to visit developing countries. It cooperates with partner universities in the Netherlands, Poland, the US, Japan and South Africa, and for decades has maintained intensive contacts with China through cooperation programmes with top universities, the Ministry of Education, bilateral agreements and memoranda of understanding. Furthermore, KU Leuven is also a member of various international networks, such as the Coimbra Group, the IAUP (International Association of University Presidents), the IMHE (International Management in Higher Education) programme of the OECD, the EAIE (European Association of International Education) and the EUCEN (European Universities Continuing Education Network). It has also concluded a number of agreements with foreign institutes, for example with Cambridge and Heidelberg Universities (the Health Axis Europe). In 2016, it signed with six universities in Hungary, Slovenia and Czechia, the Central Europe Leuven Strategic Alliance (Celsa), a co-operation agreement to set up joint study programmes and work together to find solutions for major European problems.

Similarly, Ghent University has concluded bilateral framework agreements outside Europe with various institutions in every continent. It has a formal representation in Peking (China) and even a Chinese alumni network in both Peking and Shanghai. It has concluded partnerships with other European universities (U4 with Groningen, Göttingen, Uppsala; with the University of Kent; and with Université de Lille) and takes part in international organizations, including the Santander Group, the EAIE, the EUA, the European Centre for Strategic Management of Universities (ESMU), the European Association of Institutions of Higher

Education (EURASHE), the UK Research Office (UKRO), the Association of European Science and Technology Transfer Professionals (ASTP), the Magna Charta Observatory of Fundamental University Values and Rights, and the United Nations Academic Impact Programme. Its India and China platforms also include industrial partners. Since 2014, UGent offers an academic degree in Songdo (South Korea).

All 5 universities of the Flemish Community are a member of the EUA (European University Association), whilst some have joined pan-European interest associations. Examples of these are:

- **LERU** (League of European Research Universities), that includes the Catholic University of Leuven;
- **The Guild** (the Guild of European Research-Intensive Universities), that includes UGent;
- **YERUN** (Young European Research Universities Network), that includes UA.

Among the Flemish strategic research centres or PROs, Imec in particular has been very active at the international level. Apart from its home-based offices in Leuven and Leper, it has also agencies in the Netherlands, Taiwan, China, India, the US and Japan. VITO has set up an Asian office in Hong Kong and is developing activities in India and Vietnam. In 2011, it established a joint venture with a counterpart institute in Peking (China) and it also signed a cooperation agreement with the Tianjin Academy of Environmental Sciences (TAES) in China. Its Chinese joint venture LIBOVITO now manages the Operational Prediction of Air Quality (OPAQ) tool for 26 Chinese cities, including Peking. VITO also has an establishment in Qatar and cooperates with local partners in the UAE. VIB has set up together with international partners EU-life and Core For Life. Eu-life is an alliance of top research centres in life sciences to support and strengthen European research excellence. Core4Life aims at exploring the potential of coordinating and bundling core facility expertise and resources across institutes and countries to advance knowledge and to benefit the entire scientific and technological community. Self-evidently, these organizations take part in the activities of various networks within their field of activities. For example, DSP Valley is Chair of the Silicon Europe Alliance, in which Imec and KU Leuven are active, and which unites 12 world-class clusters from 10 leading micro- and nano-electronics regions to strengthen the leading role of the European semiconductor industry in the global economy and value chain.

In addition to the universities, the university colleges, the four SRC (strategic research centres) and the five scientific institutes, all the other knowledge centres and organizations in Flanders cooperate with international partners in various initiatives, networks or actions. For example, the VLIZ (marine sciences) concludes cooperation agreements with international universities, research institutions and individual research groups, and participates in international networks and projects in the field of marine sciences. The ITM (tropical medicine) works with many scientific institutions, governments and organizations all over the world for the long-lasting improvement of health care and disease control in developing countries.

The knowledge institutes of the Flemish Community, and the various public and private organisations in Flemish Region are eligible for or involved in a number of public support measures. The part hereunder gives an overview of the main types of these instruments.

2.2 Public authority level: the EWI policy domain and the International Flanders (IV) policy domain

EWI policy domain: FWO, AIO, EWI Department

Different entities from the EWI policy domain act as a (national) contact point in various EU or international STI initiatives. Within the EWI landscape, the Research Foundation Flanders, FWO, is a crucial actor to stimulate internationalisation of research. Basically, its actions can be divided into these types: international mobility including research projects, international collaboration, international contacts, and involvement in international policy.

The FWO support schemes for, and involvement into, internationalisation are listed hereunder:

i) International mobility

Incoming:

- Odysseus programme: a “brain-gain” programme to attract Flemish and other top researchers from around the world (back) to the universities of the Flemish Community;
- Pegasus Marie Curie Fellowships: attract excellent postdoctoral researchers to Flanders in order to contribute to the advancement of Flemish research. From September 2015 on, the scheme is altered and includes incoming and outgoing possibilities;
- Postdoctoral fellowship: to support (visiting) researchers who have only recently completed their PhD, in developing an independent, international research career.

Outgoing:

- Grants or fellowships: for participation in an international conference, for a short stay abroad, for participation in an international workshop or course, for a long stay abroad, Belgian Historical Institute in Rome, fellowship Japan, Scientific Prize Gustave Boël Sofina.

ii) International collaboration

- Exchange agreement: scientific collaboration with other countries through the exchange of researchers via bilateral agreements with academies from: Czechia, China, Romania, Slovakia, Slovenia (Science Foundation);
- Scientific cooperation: agreements with a number of countries for the funding of potential exchange projects, namely with: Japan, Bulgaria, Poland, China, Brazil, Argentina, France, South-Korea, Taiwan, Turkey, Mexico, France-Tournesol, Hungary;
- Bilateral research cooperation: with Brazil, China, Ecuador, Vietnam, South-Africa, Québec (Canada);
- Big Science projects: the “Big Science” programme supports researchers at institutes of the Flemish Community who want to conduct research projects at major international research facilities, the membership for which is paid for by the Belgian Federal or Flemish government. Examples of these include: CERN-CMS and CERN-ISOLDE (Genève), ESRF-DUBBLE (Grenoble), the Mercator telescope (La Palma, Spain), Spiral2 (Caen), and Ice Cube (the Arctic area).

iii) International contacts

- International Coordination Action: support for coordination activities of international collaborative associations (= those created in the context of multilateral and supranational entities such as EU, OECD, UN, UN-Unesco, WHO, etc.);
- Organisation of scientific meetings: support for researchers for the organisation of scientific conferences where the international and inter-university dimension is a central element of the programme;
- Scientific Research Network (WOG): support for researchers with the coordination of scientific research networks (= international networks of researchers that encourage national and international cooperation at postdoctoral level).

iv) European programmes:

FWO acts as National Contact Point (NCP) in Horizon 2020, as contact point (along with the EWI Department) for COST, participates in joint calls for ERA-Nets, and provides a “top-up” budget for participations (of on-going FWO projects) into joint calls for Joint Programming Initiatives.

v) Involvement in international policy:

The FWO cooperates with its European and international sister organizations in various networks and with other European research organizations or similar institutions; for example, the European Science Foundation (ESF), Science Europe, CECAM and the ECT. At the level of international (policy) collaboration, the FWO has signed so-called lead agency agreements with the Netherlands (NWO), Austria (FWF), Slovenia (ARRS) and Grand Duchy of Luxembourg (FNR). This demonstrates a high degree of transnational confidence between the institutes involved.

The FWO supports the participation in ESFRI-initiatives on research infrastructure. In 2017, 10.4 million euro was allocated thereto for ESS, ICOS, SHARE, LifeWatch, AnaEE, EMBRC, DARIAH, INSTRUCT, ELEXIR, and PRACE. Several Flemish Community institutes also follow-up the Euro-bioimaging initiative.

In the field of international innovation, the **AIO (Flanders Innovation and Entrepreneurship)** provides co-funding for participants from Flanders to take part in EUREKA projects. EUREKA is an inter-governmental initiative to promote international cooperation through projects (as well as clusters and “umbrellas”) for applied and market-oriented industrial R&D, based on a bottom-up principle. After a quality check, the projects that are approved receive a EUREKA label. Participants from Flanders in the EUROSTARS innovation programme, which is aimed at innovative cross-border SMEs, are likewise supported by the AIO. Flanders Innovation and Entrepreneurship is involved in the daily management of the EUREKA-network and the representation in the management entities of EUREKA, Eurostars and the EUREKA-clusters.

The AIO is also the NCP (national contact point) for Flanders for supporting applications relating to thematic programmes within Horizon2020, the ERA nets, EUREKA, some Joint Technology Initiatives (JTIs), and initiatives which have phased-out such as INNO nets. Moreover, the AIO shares best practices with other European agencies in the innovation domain (such as TEKES from Finland or VINNOVA from Sweden) and is involved in various international networks and actions. For example, it is a member of the Association for Technology Implementation in Europe (TAFTIE), which fosters an exchange of best practice between eighteen government agencies supporting innovation in Europe. Another example is FLAG-ERA, the network of funding agencies for the Future and Emerging Technologies Flagships, of which both AIO and FWO are a member.

In the field of international cooperation via the EU Regional Fund, there are several ERDF-Interreg initiatives in which STI actors, public authorities and private partners from Flanders jointly support(ed) multi-annual projects. For the past multiannual period 2007-2013, these included BioBase Europe, Waterstofregio Vlaanderen - Zuid-Nederland (Hydrogen Region Flanders - South Netherlands), NanoSensEU and Organext, Food2Market, InnoFun (Funding of Innovation), TANDEM, ECO-LASERFACT, GCS, SCINNOPOLI (“Scanning Innovation Policy Impact”), and SPIDER (“Supporting Public Service Innovation using Design in European Regions”), or AMCER (“Advanced Monitoring and Coordination of R&D policies at European level”, within ESPON). For 2014-2020, examples of new Interreg projects with the Netherlands are Hydrogen Network 2.0, CrossRoads2, Link2Innovate and Crosscare. Furthermore, cooperation with the neighbouring regions of North Brabant (the Netherlands) and North Rhine-Westphalia (Germany) takes place within the framework of the ELAt (Eindhoven-Leuven-Aachen triangle). In recent years, collaboration has been extended to the domain of sustainable chemistry.

The Enterprise Europe Network (EEN) Flanders consists of the AIO (and in the past both the IWT for innovation, and Enterprise Flanders (AO) for entrepreneurship) and the FIT (Flanders Investment and Trade), and provides companies with information about (innovative) internationalization.

The **EWI Department** manages several multi-annual agreements and their accompanying budgets to implement action within the framework of the United Nations (UN). These are:

- the Flanders UNIDO Science Trust Fund for Industrial Biotechnology (FUSTIB);
- the Flanders UNESCO Trust Fund (FUST);
- the UNU-CRIS (United Nations University - Centre for Regional Integration Studies).

It also manages the financial support for the European Marine Ocean Data & Information Network (EMODnet) and the IOC-IODE project office (Inter-governmental Oceanographic Commission), both located in Ostend close to the Flanders Marine Institute, VLIZ. The EWI department is active in the Programme Committees for the implementation of Horizon 2020 and COSME, and the governing boards for the management of ESFRI.

The EWI Department prepares and monitors the memoranda of understanding (MoU) that are concluded directly between the administrations or ministers charged with R&D and innovation. These include, for example, agreements with Slovenia (2008) and China (2012). During ministerial missions abroad or during the official visits of foreign delegations to the Flemish minister or to public EWI entities, such agreements may be discussed and/or signed officially.

In some cases, treaties that include topics relating to scientific research exist or are being prepared between Belgium and another country. These may impinge on either Community or Regional competencies in the field of STI. Whenever it is required, the EWI Department acts as the responsible entity to monitor such agreements, if public or private STI actors from Flanders are the subject of the agreement.

Finally, the EWI Department also hosts, or is part of the Flemish delegation during, visits from foreign authorities, delegations, or EU and multilateral authorities. On the other hand, it can be a part of, or represented in, Flanders' delegations abroad.

Firstly, the EWI Department hosts visits from foreign delegations or representatives, from e.g. various EU regions, Northern Ireland, China, Vanguard Initiative members, etc. The same holds for EC-visits and OECD-visits: until 2015, the EWI Department acted as the coordinator and contact point for the overall Flemish authority in the framework of the European Commission's annual Fact Finding Mission (FFM) to Belgium for the European Semester and Belgian Country Report. In 2015, the EWI Department acted in addition as the coordinator and contact point for the whole of Belgium and hosted the bilateral Belgium-EC meeting. In 2016, the EC changed the meeting's whereabouts. As a result, a meeting took place in the field of R&D and Innovation separately and directly between the EC and Flanders (attendance from the EWI Department and AIO), while for the economy domain, the EWI department was part of the Belgian delegation that met with the EC. At the end of 2016, the EC decided to conduct yet another FFM to Belgium, in which all Belgian authorities were involved, incl. the EWI Department and AIO. Autumn 2017, a new FFM from the EC to Belgium will take place. Aside the EC, the OECD as well undertook a FFM to the Flemish Government during Autumn 2016 (as a part of its overall Belgian visit) in the framework of the drafting of the Belgian Economic Survey report. Here, the EWI Department has reported on behalf of the overall Flemish authority about the Belgian coordination meeting, and its secretary-general attended the final meeting in Paris during which the Belgian Economic Survey report was finalised after discussions with all the authorities involved.

Through initiatives as the "Flanders Inspires International Visitors Programme" (FIIVP), the EWI Department presents Flanders' strengths in the fields of economy, science and innovation, and learns from other countries and regions too. The FIIVP has been on-going since 2010 and is inspired by the US "International Visitor Leadership Programme". Its aim is to establish long-term relationships with high-level international opinion makers and decision makers by organising (once or twice a year), a broad multi-sectoral programme, usually focussed on a specific theme. Visitors come from all over the world and represent a region, country, or institution from the EU (or an international organisation). The FIIVP visit of October 2014 focussed on the topic of New Industrial Policy and Innovation, a theme successful in the two previous years with in particular the topics of "renewable energy and biotechnology", "smart specialisation", and "transformation by greening". The EWI Department hosted guests from - among other - Basque Country, Canada, Catalonia, Estonia, South-Africa, and the US. Autumn 2015, the topic of clustering was presented to visitors from Bavaria, Czechia, Hungary, Latvia, South-Africa, and Taiwan. The delegations thereby visit, or are given a presentation of, STI institutes or innovative companies in Flanders such as VLIZ, FlandersBio, VITO, Imec, UGent, KU Leuven or VIB.

Finally, the EWI department (or FWO) is also involved or present when the Flemish Government hosts visits from delegations from foreign regions or countries, located in Brussels or abroad, whereby EWI-related policy issues are being discussed, reviewed or signed.

IV (Internationaal Vlaanderen) policy domain

The Departement Buitenlandse Zaken (Flanders Department of Foreign Affairs, previously the Department International Flanders) is the responsible administration for bilateral and multilateral treaties, agreements and declarations of intent, as well as the framework agreements of the Flemish Community. At overall governmental level, Flanders (meaning the Flemish Community, the Flemish Region, or both jointly) has concluded many bilateral treaties over the years with foreign regions or countries. These general treaties are often elaborated through multi-annual working programmes that cover various policy domains, one of which is scientific research and innovation. Consequently, the treaties foresee collaboration between EWI actors and one or more of their foreign counterparts. These agreements are managed by the Flanders Department of Foreign Affairs, of the IV policy domain. The current active agreements include those with

Estonia, Latvia, Russia, South Africa, Rumania, Lithuania, Croatia, Slovenia, Hungary, Bulgaria, North Rhine-Westphalia (Germany), Catalonia (Spain) and the German-speaking Community (Belgium). Several other agreements are currently being negotiated and various meetings are taking place with other regions and countries. Previously, general agreements were concluded in the field of R&D&I between Flanders and various non-European partners; for example, with Israel for cooperation in R&D in industry (2000) or with Alberta (Canada) for scientific and technological cooperation (1990).

Since 2011, the minister-president of Flanders has offered Flemish STI actors (universities, university colleges, research organizations, other knowledge institutes, etc.) the possibility to participate in his official missions abroad, based on the so-called “academic diplomacy” principle. During these missions, the opportunity sometimes arises to conclude general or specific cooperation agreements with actors from the region or country being visited. Examples of this include the mission to Québec (Canada), during which a project agreement was signed between KU Leuven and McGill University (Montréal), and a visit to China (with the universities of Antwerp, Brussels, Ghent and Leuven among the delegates), during which the VITO concluded cooperation agreements with two Chinese partners. The new governing agreement for the period 2014-2019 puts even greater emphasis on both academic diplomacy and economic diplomacy.

Another important actor in the IV policy domain is the agency known as Flanders Investment and Trade (FIT). FIT has appointed since 2007 a few technological attachés to focus on future-oriented, innovative and technological fields of development, specifically in growth markets outside Europe. Each attaché is active in several technological sectors that are most relevant and offer opportunities for the region concerned. They are in Singapore (Cleantech & Mechatronics), Los Angeles (ICT and mechatronics), New York (biotechnology and life sciences), Tokyo (biotechnology and nanotechnology).

Flemish STI actors (universities, innovative companies, knowledge institutes) can also participate in Belgian economic missions or other official missions (e.g. State visits) that take place all over the world. These missions can be led by the King of the Belgians, the Belgian Foreign Affairs Minister, or a Belgian prince or princess. Examples include missions to China and South Africa. Conversely, official visits of foreign head of state, prime ministers, ministers or other officials to Belgium may also lead to cooperation with Belgian (including Flemish) actors in the field of research, or signing of agreements at the public level or bilaterally among STI actors. This was the case, for example, during the visit of the President of India to Brussel in 2013 during which some MoUs were signed between the key Belgian universities and their Indian counterparts, such as the JNU, the University of Delhi and the University of Hyderabad, to collaborate on improving India's research capabilities in cutting-edge areas such as molecular biology.

vleva

The aim of the Flanders-Europe Liaison Agency (vleva) is to provide greater visibility for Flanders in Europe (the EU) and to emphasize the importance of Europe for Flanders. In particular, VLEVA monitors the calls from various EU initiatives, in order to provide maximal information on opportunities for EU programme participation for actors from Flanders. To this end, VLEVA cooperates with the AAVR (Office of the General Representative of the Government of Flanders to the EU within the Permanent Representation of Belgium to the EU), but it cannot express any formal point of view, since this is the domain of the permanent representation and the administrations in charge. The AAVR is therefore the “front office” that closely follows up the European dossiers and reports on recent EU developments, to draft an official Flemish point of view. To make this possible, it interacts with the respective administrations (the “back offices”) and the EU cabinets that are responsible for the content.

3 Participation in EU and international programmes, networks and initiatives

Flanders needs to adjust its priorities in the field of R&D and innovation to coincide as much as possible with the priorities defined at the EU-level regarding the grand challenges, the European Research Area, the Europe 2020 strategy (European Semester) and Horizon 2020 / COSME programmes. Such goals can be achieved by striving towards excellence, increasing budgets, facilitating researcher mobility and participating in EU and international cooperation programmes and networks. This is particularly relevant

for the future well-being of Flanders, given its open economy (with an export-to-GDP ratio of almost 100%) and the high proportion of international companies active in R&D. In addition to funding from the Flemish and the federal authorities, research actors also receive important amounts from various EU programmes (mainly Horizon 2020 and, to some extent, COSME and ERDF).

Researchers can participate in the previously mentioned international or bilateral programmes and initiatives (see page 60), for which purpose the Flemish and/or federal authorities have set up support channels or assured formal access (for example, the European Space Observatory, CERN). Institutes and companies from Flanders are likewise active in the long-standing international research initiatives known as COST and EUREKA (including Eurostars). For example, experts from organizations in Flanders participate in the management committees of 188 actions of the 256 on-going actions from COST, while the AIO each year provides support for about a dozen companies active in EUREKA initiatives. The AIO has also opened its business support programmes for (innovative) international cooperation projects and provides budgets to foreign partners participating in a consortium with companies from Flanders.

A major focus for attention - and a major source of R&D budget - lies at the EU level; namely, the participation in the EU's Horizon 2020 programme (until 2013: Framework Programmes for Research and Technological Development (FP on RTD)) for the promotion of competitive and excellent research. Framework programmes (FPs) have been the main financial tool through which the European Union supports research and technological development activities in almost every scientific discipline.

3.1 EU Framework Programme for Research and Technological Development (FP for RTD), Horizon 2020, and the EU Competitiveness and Innovation Programme (CIP)

EU Framework Programmes for Research and Technological Development have been implemented since 1984 and cover a period of several years, with the last year of a given FP for RTD overlapping with the first year of the next one. Since 2014, Horizon 2020 and COSME are the follow-up programmes of FP7 for RTD, CIP, and EIT. The participation data (status at October 2014) on the FP7 programme show that actors in Flanders are participating strongly. With a financial return of 2.50%, Flanders is scoring above the expected level (also see page 88). The percentages for FP6 and FP5 were 2.12% and 2.19% respectively. Regarding FP7, Flanders participated in total with 490 participants some 2,884 times into 2,232 projects, which generated approximately 1,125 million euro during the whole period or about 160 million per annum.

KU Leuven is the strongest Flemish (and Belgian) participant, and the only Belgian university in the top-10 of all academic participants in the FP. Behind the KU Leuven, the UGent and Imec complete the top-3 of Belgian participants and together they represent 483 million euro, which is more than ¼ of the total FP7 contribution to Belgium. In total, 7 Flemish knowledge institutes rank in the Belgian top-10: KU Leuven, UGent, Imec, VIB, UA, VUB and VITO in decreasing order. The top-5 of countries with who Flemish actors cooperated in FP7 consist of Germany, the UK, France, Italy, and the Netherlands (Belgian partners/authorities rank 9th), whereas the top-5 regions consists of Ile-de-France, Bavaria, Baden-Württemberg, North-Rhine Westphalia, and Comunidad de Madrid (the Brussels Capital Region is 7th).

The first results of the participation on the Horizon 2020 programme for 2014-2020 demonstrate again a very successful participation from behalf of actors in Flanders. KU Leuven and UGent rank in the top-50 of the participations from higher education institutes, whereas Imec, iMinds (now a part of Imec), VITO and VIB rank in the top-50 of all participations from research centres. More details are in Chapter 2, section 7).

Evidence of the allocated budget for the participation in the CIP, the EU's Competitiveness and Innovation Programme 2007-2013, shows that about 47 million euro went towards various actors from Flanders, including the Enterprise Europe Network (EEN) Vlaanderen. This represents 3% of all the EU's CIP-allocations towards EU member states for the period 2007-2013.

3.2 EU Regional Policy

Some EU support for R&D and innovation is also granted through the ERDF and INTERREG programmes of the EU Regional Policy Funds. Under the latter, cross-border cooperation is set up in specific areas with research actors from neighbouring regions and countries. Examples from the 2007-2013 period were BioBase Europe, NanoSenseEU, Photovoltaic, Waterstofregio Vlaanderen – Zuid-Nederland (Hydrogen Region), and Organext.

In the new multi-annual programming period 2014-2020, Flanders is entitled to a budget of 345.5 million euros from the ERDF, of which 173.5 million euros is allocated to initiatives within Flanders and 172 million euros is foreseen for actions in the various Interreg programmes (Flanders - The Netherlands, Euregio Meuse-Rhine, Flanders – Wallonia - France, Two Seas, North-West Europe, etc.). The budget for R&D and innovation stemming from the ERDF budget in the ESIF (European Structural and Investment Fund) amounts to about 28 million euro per annum (note: this figure is based on the assumption that 50% of the total ERDF Flanders budget will be focussed on innovation, and 65% of the ERDF Interreg budget will be allocated for innovation). A new focus for policy initiatives and budget allocations for which the EU will use for the ERDF budget from 2014 onwards is smart specialisation strategy.

Flanders has developed an intensive cooperation with the Netherlands in the field of STI and this country is a priority partner. Cooperation examples include the FP projects in which both sides participate, the Holst Centre (Leuven and Eindhoven; Imec and TNO), the ELAt (Eindhoven-Leuven-Aachen triangle) and a number of important EU Interreg projects such as BioBase Europe and Hydrogen Region.

3.3 EU initiatives that are inter-governmental and complementary to the topics and initiatives in the EU programmes for R&D and innovation

Since 2007, various variable geometry initiatives have been set up at the EU level, whereby certain countries can participate in research complementary to the EU-FP/Horizon2020 themes. These are all initiatives to strive towards the accomplishment of an ERA, European Research Area. In several cases, actors from Flanders have joined in these projects and have occasionally received public support (from the EWI Department, the AIO (previously the IWT) or the FWO). The initiatives in which research actors from Flanders participate or follow-up the evolution are these:

- **JTI (Joint Technology Initiatives):** Innovative Medicines Initiatives 2 (IMI2), Fuel Cells and Hydrogen 2 (FCH2), ECSEL (previously nanoelectronics ENIAC and embedded computing ARTEMIS), BBI (BioBased Industries), Clean Sky 2;
- **Article 185 initiative:** Eurostars, AAL;
- **JPI (Joint Programming Initiatives):** Neurodegenerative Disease Research (JPND - Alzheimer), Cultural Heritage and Global Change, A Healthy Diet for a Healthy Life (HDHL), More Years, Better Lives (demographic change) (JPI-MYBL), Antimicrobial Resistance (AMR), JPI Oceans; P.M.: Agriculture, Food security & Climate Change (FACCE), Cultural Heritage, Climate Change and Security (JPI CH), The Microbial Challenge - An Emerging Threat to Human Health (JPIAMR); Connecting Climate Knowledge for Europe (JPI Climate); Urban Europe - Global Challenges, Local Solutions (JPI UE), Water Challenges for a Changing World (Water JPI);
- **ESFRI (European Strategy Forum on Research Infrastructures):** participation from actors of the Flemish Community in the European Social Survey (ESS), the Survey of Health, Ageing and Retirement in Europe (SHARE), the Integrated Carbon Observation System (ICOS), LIFEWATCH (biodiversity), PRACE (Partnership for Advanced Computing in Europe), AnaEE (Analysis and Experimentation on Ecosystems), EMBRC (European Marine Biological Resource Centre), DARIAH (Digital Research Infrastructure for the Arts and Humanities), INSTRUCT (Integrated Structural Biology Infrastructure for Europe), ELIXIR (A distributed infrastructure for life-science information. FWO granted 10.4 million euro to support the participation into these 10 infrastructures in 2017. Also, several Flemish knowledge actors follow-up EURO-BIOIMAGING;

- **COST** (European Cooperation in Science and Technology): representatives from Flemish knowledge actors are involved in the management committees of 188 actions of the 256 on-going actions in total, and some more are involved in the working groups alone;
- **EUREKA**: companies (as well as business-oriented organisations such as collective research centres) from Flanders have been participating in many initiatives from EUREKA, including clusters, umbrellas etc. Currently they are involved in these EUREKA clusters: PENTA (ex-CATRENE), ITEA, EURIPIDES, CELTIC+, ACQUEAU, Metallurgy. Flanders Innovation and Entrepreneurship is involved in the daily management of the network and the representation in the management entities of the intergovernmental organisations EUREKA and Eurostars and the EUREKA-clusters CATRENE (now PENTA), ITEA 2, EURIPIDES, CELTIC, en METALLURGY. During 2014 – 2016, Flemish actors received support in 24 EUREKA-projects (bottom-up and clusters). Total investment from Flemish companies in these projects was 48 million euro, incl. 24.2 million euro AIO-support. The average annual support for EUREKA-projects is 8 million euro. AIO has granted 8.27 million euro to support 7 projects in Eureka clusters in 2016;
- **Big Science (CERN, ESRF,...)**: participation from Flanders in CERN-CMS (VUB) and in CERN HEI - ISOLDE (KU Leuven) (European Organization for Nuclear Research) located in Geneva, ESRF-DUBBLE (KU Leuven) (European Synchrotron Radiation Facility) in Grenoble, Mercator telescope (KU Leuven) in La Palma, Spiral 2 in Caen, Ice Cube (VUB) in Antarctica. FWO provides support of 20.58 million euro in the period 2013-2018 for these six projects;
- **ESO (European Southern Observatory)**, located in La Palma (Spain) and the Atacama desert (Chili): Flemish researchers are active in projects;
- **ESA (European Space Agency)**: Belgium has always been committed to space research as an active member of ESA. Therefore, Flemish research groups and industry participate actively in ESA programmes. An ESA Business and Innovation Centre has been in Flanders (Mol and Geel) since 2012;
- **EMBO/EMBL (European Molecular Biotechnology Organisation/Laboratory)**, located in Heidelberg): Flemish research groups from the universities and the strategic research centre VIB are involved in its actions in the domain of molecular biotechnology;
- Related to the FP on RTD and Horizon 2020:
 - **ERA-nets** (50 in total by end 2014) in which Flanders was / is active, with Dep EWI, FWO and AIO (and certain other departments) acting as the partner and various organisations as participants in the network e.g. universities, strategic research centres, scientific institutes, companies;
 - **ERC-grants**: 126 participations in FP7 on RTD and to date 73 participations in Horizon 2020;
 - **Marie-Curie grants**: 403 participations in FP7 on RTD and to date 243 participations in Horizon 2020;
- **EIT-KICs** (European Institute of Technology - Knowledge Innovation Communities), with in each case the participants / partners from Flanders that are involved:
 - KIC InnoEnergy: Eandis, KU Leuven, VITO. Genk hosts the co-location centre for the KIC InnoEnergy Benelux;
 - Digital (previously known as ICT Labs): Imec, (previously iMinds);
 - Raw Materials: KU Leuven, UGent, Umicore, VITO, CRM Group, Imec, JM Recycling nv, Ocas NV. Leuven will host the Western Co-location Centre on the KIC Raw Materials;
 - Health (consortium Innolife): KU Leuven, UGent, iMinds (now a part of Imec), Imec, Barco, Gimv;
 - Food: Establishment Franz Colruyt, KU Leuven, Puratos. Leuven hosts the co-location centre for the KIC Food
- **EIP (European Innovation Partnerships)**:
 - Raw Materials: Flemish authority takes part in the sherpa group;
 - Smart Cities and Communities, Water: stakeholders' participation;
 - Active and Healthy Ageing (AHA); participation by Flemish authorities;

- **FET (Future and Emerging Technologies) Flagships:**
 - Graphene: Imec;
 - Human Brain: UGent, KU Leuven;
 - FLAGERA: FWO and AIO (previously IWT) are member;
 - FUTURICT: KU Leuven,;
 - Guardian Angel: Imec, KU Leuven, NXP Semiconductors;
 - ROBOCOM (Robot Companions for Citizens): VUB, UA, KU Leuven.
- **SET Plan:** follow-up of the European Industrial Initiatives (EII) in the various themes (wind, solar, electricity grids, bio-energy, smart cities).

In other related EU initiatives to stimulate the European Research Area, Flemish actors are involved or are following up the state of play; as is the case, for example, with the EU Innovation Partnerships for Agricultural Productivity and Sustainability (AGRI), as well as the ETP (European Technology Platforms) and the KETs (Key Enabling Technologies). Regarding the KETs, a call was launched in 2013 for the possible participation of Flemish actors, which resulted in five roadmap exercises; namely, in the fields of micro-electronics, photonics, factories of the future, materials and industrial biotechnology. In the Vanguard Initiative, Flanders leads the pilot line “High Performance Production through 3D Printing”, and takes part in several other pilots of the Vanguard Initiative (details see page 71).

Occasionally, one-off budgets are available for initiatives that stimulate internationalization in a broad sense and build on existing strengths in specific fields or with certain foreign entities.

The figure hereunder provides for the field of internationalisation of R&D and innovation, an overview of the different responsibilities and types of involvements from the 3 EWI actors (the EWI Department, FWO, AIO).

Figure 7: Overview of the different responsibilities and types of involvements from the 3 EWI actors

Policy-related	Dep EWI	FWO	AIO		Dep EWI	FWO	AIO
ERAC, EPG / EC	+			STI bilateral cooperation	+	+	+
CSTP, CIIE / OECD	+			STI multilateral cooperation	+	+	
(WG) Council EU	+			STI inter-governmental cooperation	+	+	
NCP, National Contact Point		H2020	H2020, Interreg	VLA international cooperation incl. a part on STI	+		
PC, Programme Committee delegate	H2020, COSME			JRC, Eureka, COST		+	+
Policy projects e.g. ERA, OMC, R4R	+	+	+	Various internat. policy networks (e.g. ESF, Taftie)	+	+	+
ERDF Mgt authority			calls, RIS3	ERRIN	+	+	+
Reports, positions to FED, EC, OECD, CoR, AGS, EU Semester	+			JPI, JTI, JU, EIP, KET, ESFRI, EIT-KIC,.... follow-up / budget	+	+	+
E.E.N. Vlaanderen			+	Vanguard Initiative	+		+

Note: for the participation in the EU Council Working Group, a staff member of the EWI department is detached to the AAVR (Office of the General Representative of the Government of Flanders to the EU within the Permanent Representation of Belgium to the EU).

8 – Smart Specialisation in Flanders

1 More targeted approach in policy design

Structural change and economic transformation have been on the policy agenda for a decade. In 2005, the Flemish Government launched a discussion on a “new business plan for Flanders” as a consequence of increasing pressure on the competitiveness position, resulting in accelerating de-industrialisation (in electronics, automotive and several other branches) while not enough new innovative branches could take the relief. In 2006, the VRWI (Flemish Science and Innovation Council) conducted a SWOT analysis of the scientific and technological potential of Flanders in comparison with the EU (assessing the scientific, technological, innovative and economic characteristics of the Flemish region), combined with a European foresight study of 15 key areas. By means of a wide expert consultation, **six thematic clusters** were identified that would be prioritised for further STI support by “spearhead initiatives”. These clusters were:

- logis-tech (transport, logistics, services and supply management);
- i-health-tech (ICT and services in health);
- medi-tech (Healthcare, food, prevention and treatment);
- nano-tech (new materials, nanotechnology, manufacturing industry);
- socio-tech (ICT for socio-economic innovation); eco-tech (energy and environment for services and industry).

The initiatives were intended to strengthen research and innovation base in domains with economic potential to initiate breakthroughs. Therefore the focus was mainly technology-driven and the thematic domains were very broadly defined.

During 2012-2013, the VRWI conducted a **foresight study** with a time horizon up to 2025. This study -building on its 2006 foresight study- aimed at establishing scientific, technological and innovation priorities to help address grand societal challenges, such as energy, mobility, ageing population, health, environment and climate change. An inventory was made of both (1) national and international societal trends and (2) trends regarding Science, Technology and Innovation (STI). Subsequently, a matching exercise was performed based on a foresight workshop to link (1) and (2), resulting in a model with different areas of transition. Running parallel with this, a strengths/weaknesses analysis of the current situation in Flanders was performed regarding scientific research, technological development, innovation, economic activity and societal developments. Based on the results of the transition areas and the strengths/weakness analysis, a steering committee including Captains of Industry and Captains of Society set **seven priority transition areas** for Flanders.

Consequently, this resulted in a transition model consisting of:

- one horizontal transition area: Society 2.0;
- six vertical transition areas: (a) E-Society, (b) Food, (c) Health - Well-being, (d) Smart Resources Management & Manufacturing Industries, (e) Urban Planning, Mobility Dynamics & Logistics, (f) New Energy Demand and Delivery.

Smart specialisation was adopted by the Flemish Government as a guiding strategic policy principle for innovation and industrial policies in the Concept Note “**Smart Specialisation Strategy** for a Targeted Cluster Policy” of 8 March 2013. The policy note of the EWI Department “Strategic framework for Smart Specialisation in Flanders” (December 2014) described the policy process towards the designation of prioritised areas in the evolving innovation and transformation strategy of Flanders. It provides an overview of the specialisation structure in Flanders, the policy evolution, the policy design, the policy discovery process and

the strategic focusing process for smart specialisation. Given its intertwining with initiatives/organisations of R&D and innovation, some of these findings are relevant in this context.

The 2014-2019 new governing agreement calls for a **cluster policy** as the lever to deal with the innovation paradox in Flanders and focus more on marketisation of innovation. The policy note 2014-2019 for Work, Economy, Science and Innovation mentions cluster as a cooperation whereby actors from the triple helix engage to develop innovative value chains in specific domains. Thereafter, the Flemish Government approved July 2015 a Concept Note on a Cluster policy. By way of strategic cooperation networks, companies and knowledge institutes should set up projects, and add an international dimension. The aim is to unlock unused economic potential and to increase of competitiveness among Flemish companies through an active and continuous cooperation of actors, to contribute to a solution for societal challenges with an economic added value for companies. In 2015-2016, further steps were taken towards the elaboration of 2 types of clusters to be developed due to this strategy: (large-scaled) **spearhead clusters** on the one hand, and (smaller-scaled) **innovative enterprise networks** on the other hand (see further details in 5.4 of Chapter 1). These are all steps in the development of a more focused demand-driven approach.

2 Smart specialisation spearhead domains in the EU context

In 2012, following the Communication 'Regional Policy contributing to smart growth in Europe 2020', the EC set up its **S3 Platform** to assist EU countries and regions to develop, implement and review their Research and Innovation Strategies for Smart Specialisation (RIS3). The EC's Joint Research Centre maps the profiles forwarded by various authorities in Europe. In total, the Flanders' profile consists of seventeen priorities that are part of a smaller group of specialisation domains. These focus on various target markets (e.g. "Manufacturing & industry"; "Computer, electronic & optical products"), correspond with different capabilities (e.g. "manufacturing and industry; "Energy production & distribution"), and are in line with the major EU priorities such as the KETs, Digital Agenda etc. The complete overview of all priorities and corresponding targets and capabilities for Flanders is available online at the S3 platform <http://s3platform.jrc.ec.europa.eu/regions/be2>.

Examples of the Flemish specialisations include:

- "Micro- and nano-electronics and embedded systems, mechatronics (part of 'Smart systems' smart specialisation domain"); □
- "Pharmaceutical applications of biotechnology, with focus on clinical trials, neuro-degenerative and infectious diseases, molecular diagnostics, and nanotechnology for medical applications (part of 'Sustainable chemistry' smart specialisation domain");
- □ Sustainable energy technologies with focus on hydrogen, wind energy and electrical vehicles (part of 'Sustainable living' smart specialisation domain");
- "Specialised industrial value chains and logistical services for food, pharmaceuticals, recycling, offshore maintenance (part of 'Value-added logistics' specialisation domain)".

In 2013, the European Commission conferred the EU member-states to include in their Operational Plans 2014-2020 for the European Structural and Investment Funds (ESIF) a few specialisation domains, to become focus of a "**Smart Specialisation Strategy**" or **S3**. These domains would be the focus of initiatives and budgetary allocations for the European Regional Development Fund (ERDF). Based on the analysis of comparative economic/technological advantages and responding to policy developments in recent years in the field of an oriented innovation policy, Flanders identified eight spearhead domains with a potential for a smart specialisation strategy. These domains are also important for societal challenges.

They will be the focus of strengthening of R&D and promotion of transformation of knowledge into economic and societal valorisation. These are (Source: The strategic policy framework for smart specialisation in Flanders; policy note of the Department Economy, Science and Innovation (rev. 12/2014)):

- a) **Sustainable chemistry:** cluster domain for the transition in the chemical industry, connected to clusters in plastics, sustainable construction or technical textiles. Innovation will drive new bio-based value chains (enabled by advances in materials sciences, industrial biotechnology). FISCH is a possible model for establishing a spearhead cluster for smart specialisations;
- b) **Specialised manufacturing solutions:** cluster domain for customized production in 'factories for the future' (e.g. niches in specialized components, intelligent textiles, new materials, graphics, urban mining) that emerge thanks to new business models (e.g. for open manufacturing, value-added logistics, recycling of materials and energy efficiency) and new production technologies (such as mechatronics, 3D printing). The new strategic research centre, Flanders' Make, will be supportive for the modernization of manufacturing;
- c) **Personalised cure and care:** cluster domain connected to a well-developed health system, an ecosystem for clinical trials and a strong pharmaceutical industry, with specific focus domains such as neuro-degenerative diseases and infectious diseases, and new opportunities in molecular diagnostics and other medical technologies. This value-chain is supported by VIB, Flanders Care;
- d) **Value-added logistics:** cluster domain with strong connections to specialised industrial value chains in food (frozen products, meat, chocolate) or pharmaceuticals, and providing specialized services, e.g. for recycling (reverse logistics, urban mining) or the off-shore cluster (maintenance);
- e) **Specialised agro-food:** cluster domain with diverse value chains in meat, vegetables, fruits that are capitalising on values such as life quality (health and experiences) and the reduction of food waste as competitive advantages;
- f) **Integrated building-environment-energy cluster:** cluster domain seeking affordable solutions and new ways of housing in smart and sustainable cities (including smart grids and utilities).
- g) **New ICT-platforms:** cluster domain for hardware and software developments (including embedded systems, based on micro-electronics and photonics) for smart systems and services (including mobile applications, internet of things, e-health or digital media, which are enabling the ecosystems that produce smart specialisations), often in new product-service combinations; also crucial for increasing productivity of service sectors (including public services). This domain is supported by strategic research centres such as Imec.

An update of the S3 is under preparation, but the topics of focus domains remain similar.

The efforts within this smart specialisation strategy will specifically be oriented on the elaboration of the missing links in the Flemish innovation instruments; namely, living laboratories and demonstration projects that contribute to the stimulation of product development and to the market introduction/dissemination of innovative products and services. The challenge for the smart specialisation strategy in Flanders is to specialisations in unique combinations of Flemish strengths, e.g. cross-fertilisation between nanotechnology and health sector for the emerging industry of molecular diagnostics in personalised medicine (Nano4Health). The knowledge base in informatics (iMinds, now a part of Imec) or material research (VITO) are also important fertilizers of new activities, such as applications for mobile services or recycling. Thereby, the challenge is to find the possible linkages and mutual strengthening of scientific, technological and economic specialisations.

3 Vanguard initiative

An important initiative in the development of a more focused demand-driven approach is the so-called “**Vanguard Initiative**”, an inter-regional network of currently 29 regions from 13 EU Member States.. Among these regions are for example Baden-Württemberg, the Basque Country, Lombardy, North-Rhine Westphalia, Saxony, Rhône-Alpes, Wallonia, Catalonia, and Scotland. The Vanguard Initiative ‘New Growth through Smart specialisation’ originated on the occasion of the High-Level Conference ‘Regions as motors of new growth by smart specialisation’ that was co-organised by the European Commission and the Flemish Government on 8 November 2013 in the European Parliament in Brussels, with the support from the President of the European Council Herman Van Rompuy, and from the Committee of Regions. As of 2017, the ‘Vanguard Initiative’ is formally a non-profit organisation, of which the EWI Department is one of the founding entities.

Driven by a political commitment embedded in the signature of the Milan Declaration, the Initiative’s main ambition is to contribute to the European agenda and boost industrial transformation by innovation in the EU as well as set up networks among regions of different (non-bordering) countries in several domains. The cooperation of the regions also aims at generating an evidence base to support the EU Commission in the development of Smart Specialisation Platforms in key growth areas. The first area of exploration was ‘Advanced Manufacturing’. The Vanguard Initiative supports the development of innovative industrial value chains in Europe by building on smart specialisation (S3) strategies. More specifically, it aims to provide industrial stakeholders with easier access to (connected) demonstration facilities. These activities are based on a four-step Vanguard Initiative methodology: learn, connect, demonstrate, commercialize. This methodology is being applied in 5 industry-led pilot actions, each based on one priority area (KET) in Europe.

Flanders takes the lead in the pilot action called “High Performance Production through 3D Printing”. This focuses on creating a (virtual) platform for 3D printing infrastructure, capacities and competences aimed at developing a European demonstration and piloting network. Moreover, Flanders is also involved in all the other existing pilot actions:

- Bio-Economy – Interregional cooperation on innovative use of non-food Biomass;
- ADMA Energy - Advanced Manufacturing for Energy-Related Applications;
- NANO - New nano-enabled Products;
- ESM - Efficient and Sustainable Manufacturing.

The Vanguard Initiative seeks to lead by example in developing interregional cooperation and multi-level governance for supporting clusters and regional eco-systems to focus on smart specialisations in priority areas for transforming and emerging industries. Vanguard regions want to build synergies and complementarities in smart specialisation strategies to boost world-class clusters and cluster networks, through pilots and large-scale demonstrators. These investments will strengthen Europe’s competitive capacity to lead in new industries in the future and develop lead markets that offer solutions to societal challenges.

