

# Priority Sector Report: Life Science

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## Executive summary

- In this report, Life Science industries are defined as the combination of three sectors: Biotech, Medical Devices, and Pharmaceuticals.
- In 2007, the European Life Science industries employed a total of 1.31 million persons.
- Life Science industries in Europe exhibited a strong employment growth in the period 2002-2007, especially in regions less specialised in Life Science.
- Non-capital regions, such as Brabant Wallon (NL), Nordwestschweiz (CH), and Freiburg (DE), display the highest specialisation in Life Science industries, but the largest number of Life Science employees are found in the most populous regions
- Life Science industries display only a moderate regional concentration compared to other clustered sectors.
- E-health is an emerging industry expected to have a strong growth potential in the next few years. Fast progress in technological development and available infrastructures are two factors supporting the emergence of clusters in this field.
- Nanomedicine, in comparison, is yet less developed, but is considered a priority for most EU countries. Strong public support for the sector has promoted rapid development over the last five years.
- Networks of cluster initiatives have become a widespread approach to the expansion of Life Science industries. The aim of such networks is to achieve synergies through the combination of complementary specialities of the network members. Several national as well as trans-national networks are operative.

# Introduction

European policy makers have long been actively promoting the growth and expansion of Life Science industries, driven by factors such as the increasing life expectancy of the aging European population and the general aim to improve living standards of the population. Growth has been further spurred by technological progress in related sectors, which has allowed new research and development opportunities. The recently rolled-out “Europe 2020 Growth Strategy”<sup>1</sup> presents through two of its flagship initiatives, Innovation Union and a Resource Efficient Europe, the criticality of Life Science industries in achieving the prefixed goals.

This report defines Life Science Industries (LSI) as set of three core sectors: Biotechnology, Medical Devices, and Pharmaceuticals. Geographically, the report focuses on the following European countries: Austria, Belgium, Cyprus, Croatia, Czech Republic, Denmark, Estonia, Finland, France, Germany, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Netherlands, Norway, Portugal, Slovakia, Slovenia, Spain, Sweden, Switzerland, and the United Kingdom.

The statistical analysis presented in this report is based on regional data on the NUTS level 2 and 4-digit industry codes. In a way, the definition of Life Science used here underestimate the size of the Life Science industry, since it only includes firms classified in one of the three core sectors. Cross-sectoral firms engaged in Life Science but belonging primarily to other sectors are excluded. For example, e-health firms often are classified as part of the Information and Technology (IT) sector, though they would naturally belong to the LSI.

After the statistical analysis follows three thematic chapters, each focusing on a different emergent trend in the Life Science with respect to cluster initiatives in Europe.

## 1. Principal labour markets

In 2007, Life Science industries employed 1.31 million people, representing 0.75% of European employment.

The highest numbers of employees in Life Science industries are found in the most populous European regions of Île de France (FR) and Lombardia (IT). The top 25 employment regions for LSI, shown in Table 1, account for 45% of the total European LSI employment. However, the large number of LSI employees in these regions is not only because of the size of the regions. These regions are to various degrees specialised in LSI, giving them a higher-than-expected share of European LSI employment. In table 1, this is indicated by the location quotient (LQ) having a value well above 1. (The exception among Top 25 regions is Niedersachsen, which is slightly under-represented in LSI.)

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<sup>1</sup> Europe 2020 Growth Strategy - <http://ec.europa.eu/europe2020/>

**Table 1. Europe's Top 25 regions for Life Science Industries employment clusters.**

Region	LSI Rank	Employment	LSI LQ
Île de France, FR	1	52,388	1.62
Lombardia, IT	2	51,357	1.91
Ireland, IE	3	34,265	4.21
Cataluña, ES	4	31,064	1.30
Danmark, DK	5	27,579	1.40
Nordwestschweiz, CH	6	26,734	7.80
Madrid, ES	7	26,014	1.25
Veneto, IT	8	25,093	1.92
Rhône-Alpes, FR	9	24,479	1.83
Freiburg, DE	10	23,714	4.64
Lazio, IT	11	23,679	2.05
Karlsruhe, DE	12	23,594	3.37
Oberbayern, DE	13	23,498	1.96
Kozep-Magyarország HU	14	19,496	2.16
Düsseldorf, DE	15	19,085	1.52
Mazowieckie, PL	16	18,896	2.25
Tübingen, DE	17	18,031	4.18
Attiki, GR	18	17,722	1.47
Niedersachsen, DE	19	17,019	0.98
Rheinland-Pfalz, DE	20	16,614	2.01
Darmstadt, DE	21	15,505	1.52
Centre, FR	22	15,321	3.01
Emilia-Romagna, IT	23	14,569	1.20
Stuttgart, DE	24	14,076	1.30
Schleswig-Holstein, DE	25	14,006	2.40

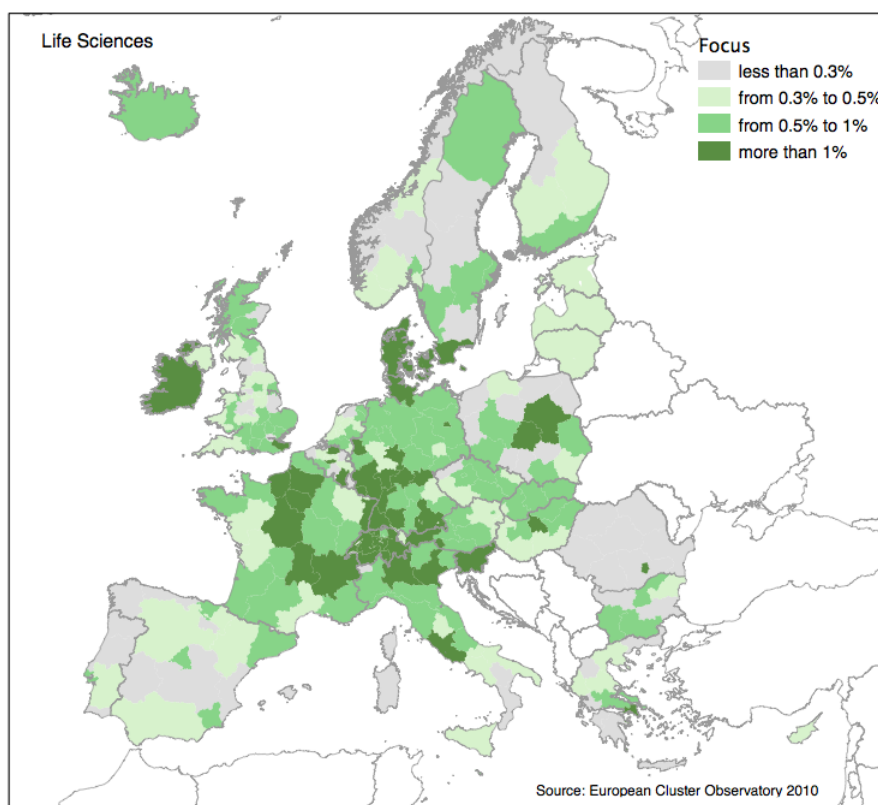
*Note: LQ is an indicator of LSI employment relative to the total employment of the region, where LQ>1 indicates an over-representation of LSI employment.*

## 2. Regional specialisation and focus

Life Science industries are unevenly distributed across Europe among few regions, with most of the concentration occurring in western Central Europe. Figure 2 shows a map of focus levels across Europe, and Table 3 lists regions with the highest focus levels.

Regions in the western part of Germany, France, northern part of Italy and Switzerland display high levels of specialisation. It is interesting to note that regions with high concentrations of LSI are located in adjacent regions, suggesting proximity effects that extend beyond individual NUTS-2 regions. In addition, a number of satellites regions can be found in the southern part of the Scandinavia, the Lazio region in Italy, London in the UK, and Ireland.

**Figure 1. LS Focus: LS share of regional labour force 2007.**



Of the 15 regions with highest degree of LS specialisation, the majority are neither capital city regions nor large regions. (This is in contrast to Creative and Cultural Industries, which are mostly concentrated in the capital city regions.) Two exceptions are Ireland and Slovenia, which are nation-regions, including the respective capital city.

**Table 2. Top 15 regions by LSI Focus**

	LS Focus	LS Rank	Employment
Brabant Wallon, NL	8.98	34	9,490
Nordwestschweiz, CH	5.67	6	26,734
Freiburg, DE	3.37	10	23,714
Ireland, IE	3.06	3	34,265
Tübingen, DE	3.04	17	18,031
Karlsruhe, DE	2.45	12	23,594
Centre, FR	2.19	22	15,321
Tirol, AT	2.04	73	4,941
Ticino, CH	1.81	129	2,839
Haute-Normandie, FR	1.79	37	9,158
Schleswig-Holstein, DE	1.74	25	14,006
Kassel, DE	1.73	51	6,450
Sydsverige, SE	1.71	61	5,678
Antwerpen, BE	1.65	31	10,082
Slovenija, SI	1.65	36	9,268

*Note: Focus indicates how large share of the region's total employment the LS industries constitute.*

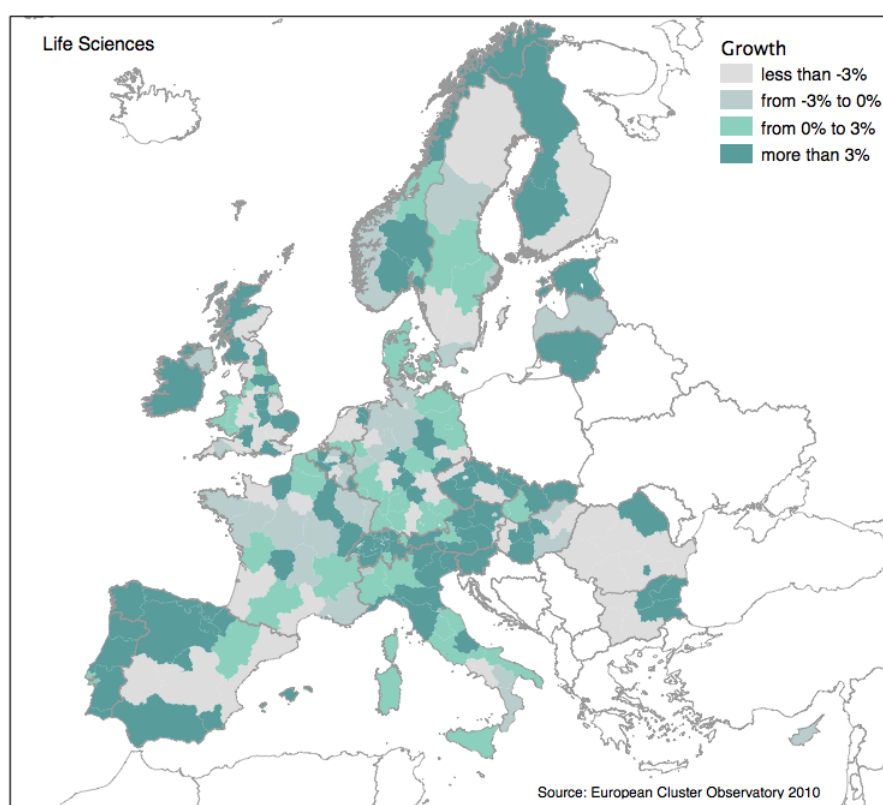
### 3. Growth

LSI employment in EU-27 increased by 2.1% between 2004 and 2009. During the same period, total European employment increased by 3.3%

In regions with the highest LSI growth, the LSI growth is well above the overall economy's. LSI growth is not evenly distributed across the EU, as can be seen in Figure 3. The map presents growth rates during the period 2004-2009, and shows a strong growth among emerging markets such as Estonia and Lithuania, but also in Finland, Norway, Ireland, Portugal, and north and the south of Spain. Comparing Figure 2 and Figure 3, showing respectively LSI focus and growth, a “catching up” trend is noticeable in many regions with low LSI specialisation are growing quickly, while many already established LSI regions grow at a slower rate.

Two exceptions to the constant growth are the Mellersta Norrland (SE) and Aquitaine (FR) regions, which present a negative growth trend. Conversely the region of Kassel (DE) with a high focus (2.30%) ranks among the top 25 growing regions.

**Figure 2. Regional Life Science industries average annual growth 2004-2009<sup>2</sup>**



<sup>2</sup> The period is 2004-2009 where those years are available; when not, shorter periods have been used.

**Table 3. Regions with the highest average annual growth in LSI employment 2004-2009.**

	LSI Growth	Rest of the economy	LSI LQ	LSI Rank	LSI Employment
Highlands and Islands, GB	549%	3.84%	0.91	202	1,064
La Rioja, ES	269%	9.70%	0.23	249	241
Moravskoslezsko, CZ	115%	2.96%	0.63	142	2,433
Andalucía, ES	72%	7.11%	0.46	32	9,815
Groningen, NL	70%	2.67%	1.06	160	1,917
Madeira, ES	67%	1.85%	0.23	256	146
Nord-Est, RO	54%	-0.59%	0.31	97	3,849
Galicia, ES	54%	4.28%	0.36	124	2,935
Murcia, ES	46%	5.02%	0.70	125	2,919
País Vasco, ES	46%	3.93%	0.69	75	4,812
Jihozapad, CZ	40%	2.11%	0.58	143	2,413
Navarra, ES	40%	5.22%	0.55	198	1,092
Stredni Cechy, CZ	39%	1.41%	1.04	88	4,124
Cantabria, ES	37%	6.35%	0.41	215	715
Del-Dunantul, HU	35%	0.78%	0.45	195	1,148
Severovychod, CZ	33%	1.70%	0.84	83	4,249
Vychodne Slovensko, SK	31%	15.15%	0.88	172	1,487
Açores, PT	28%	3.50%	0.05	265	22
Stredni Morava, CZ	27%	1.04%	0.76	122	3,011
SW Scotland, GB	26%	3.68%	0.56	86	4,136
Severoiztochen, BG	25%	3.33%	0.60	153	2,214
Kassel, DE	22%	2.30%	2.38	51	6,450
Kozep-Dunantul, HU	19%	0.92%	1.06	108	3,544
Castilla y León, ES	18%	6.59%	0.52	98	3,840
S Yorks, GB	16%	1.93%	0.56	152	2,223

*Note: LQ is an indicator of LSI employment relative to the total employment of the region, where  $LQ > 1$  indicates an over-representation of LSI employment. Growth is measured using compound annual growth rates (CAGR). The period is 2004-2009 where those years are available; when not, shorter periods have been used.*

Highlands Islands (GB), La Rioja (ES) and Moravskoslezsko (CZ) display growth figures above 100%, and other regions have double-digit growth rates. Especially, there are several Czech and Spanish regions among the fastest-growing LSI regions.

Please note that the LSI growth presented here includes only the three core sectors. Employment related to Life Science but in other sectors (such as IT, in the case of e-health), is not included.

## 4. National perspective on growth, size and specialisation

In the period 2004-2009 the Life Science industries at the national level have experienced a strong employment growth, outpacing the total national growth in most European countries. Three countries in particular, display remarkable two-digits growth rates, namely, Czech Republic, Spain and Ireland.

At the same time, a handful of countries, mostly mature economies, have registered a negative growth of LSI opposed to the country economy. Table 4 lists national growth rates in LSI.

**Table 4. National average annual employment growth 2004-2009 in life science industries and in all sectors of the economy**

Country	LSI Growth	All Growth
Czech Republic	22.41%	1.61%
Spain	12.38%	5.59%
Ireland	11.92%	6.55%
Luxembourg	9.52%	1.94%
Slovakia	8.51%	12.60%
Lithuania	7.63%	4.63%
Estonia	7.05%	7.31%
Romania	6.52%	0.13%
Slovenia	4.81%	3.15%
Portugal	4.68%	1.71%
Switzerland	4.54%	1.08%
Austria	3.80%	2.90%
United Kingdom	3.78%	1.82%
Italy	3.48%	2.25%
Belgium	2.54%	1.58%
Hungary	2.29%	0.04%
Norway	1.51%	2.28%
Denmark	0.84%	0.15%
Germany	0.75%	0.63%
Bulgaria	0.44%	3.13%
Latvia	-0.57%	2.66%
Cyprus	-1.49%	14.92%
Finland	-2.06%	3.48%
Sweden	-2.17%	3.01%
France	-2.70%	1.80%
Netherlands	-7.66%	-1.10%

*Note: Growth is calculated here as a Compound Annual Growth Rate (CAGR) over the period.*

Table 5 describes focus of LSI employment (an indicator of specialisation) for countries in Europe. Life Science is not a very large sector, and in most countries it represent only 0.5-1% of national employment. The European average is 0.75%. However, if LSI employment continues to outgrow the rest of the economy, this share will rise.



**Table 5. National labour markets and LSI Focus (2007)**

Country	LSI Focus	LSI Rank	LSI Employment
Ireland	3.06%	9	34,265
Switzerland	1.94%	6	65,809
Slovenia	1.65%	20	9,268
Germany	1.10%	1	291,054
Denmark	1.02%	13	27,579
France	0.95%	2	173,154
Italy	0.93%	3	162,913
Belgium	0.91%	11	31,125
Hungary	0.90%	8	35,097
Malta	0.86%	29	1,077
Austria	0.85%	15	23,448
Sweden	0.73%	18	17,801
Iceland	0.68%	28	1,078
Poland	0.66%	7	49,368
Slovakia	0.63%	23	7,316
Finland	0.61%	21	8,870
Czech Republic	0.60%	12	28,559
Greece	0.59%	14	25,357
Bulgaria	0.58%	17	18,688
Spain	0.51%	5	95,902
Netherlands	0.47%	10	33,062
United Kingdom	0.46%	4	124,379
Lithuania	0.39%	24	3,725
Latvia	0.38%	25	3,707
Cyprus	0.35%	27	1,246
Norway	0.35%	22	7,610
Estonia	0.30%	26	1,479
Portugal	0.30%	19	11,826
Romania	0.23%	16	20,647
Luxembourg	0.10%	30	233
Europe	0.75%		1,315,641

*Note: Focus indicates how large share of the nation's total employment the LS sector constitutes.*

Notably, countries with the highest LSI focus are fairly small sized countries, where a small absolute increase of the sector's employment results in a larger increase in the level of focus. For example, Germany, with as many as 291,054 people employed in the LSI still ranks lower in focus than Slovenia with only 9,268 employees.

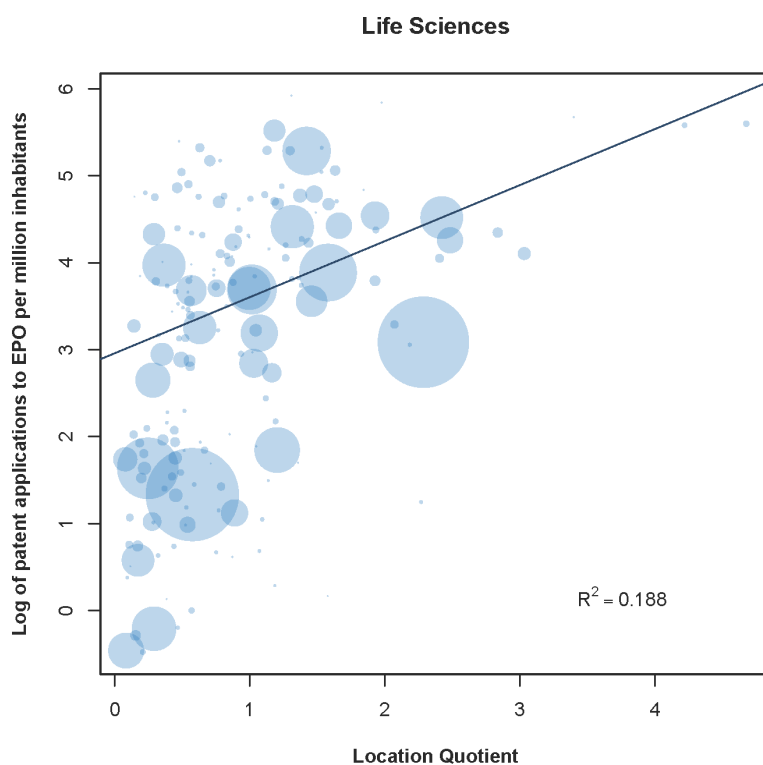
## 5. Innovation and Prosperity

Life Science is strongly innovation oriented, and it displays high levels of patenting. Large amounts of public support, from the EU as well as national governments is directed at promoting innovation in Life Science.

Innovation in the Life Science Industry is deemed critical and it is the industry for excellence in the use of the patenting framework. The essential role of innovation in the LSI is also clear by the great amount of resources committed by the policy makers, mostly EC and national government, as well as related innovation policy.

There seems to be only a weak positive relationship between overall regional innovation performance (as measured as patents per capita) and the total regional specialisation on Life Science, as shown in Figure 3. (The outlier Brabant-Wallon has been excluded in the analysis due to its extremely high patenting value.)

**Figure 3 - Life science concentration and patent applications (2009)**



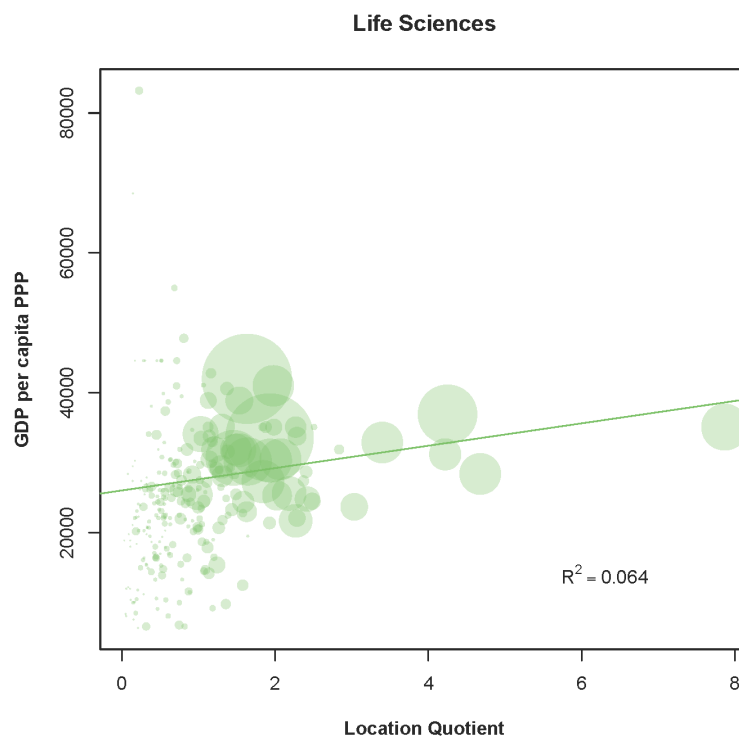
Nor does there seem to be any clear relationship between high regional innovation performance (as measured by the RIS) and high growth in Life Science industries. Table 6 shows that high-RIS regions display a mix of high-growth and low-growth Life Science employment.

**Table 6. Top 20 regions on the Regional Innovation Scoreboard (RIS) and average annual growth in Life Science industries.**

Region	RIS 2006	Annual LS Growth (CAGR)
Stockholm, SE	0.895	0%
Västsverige (Gothenburg), SE	0.828	-8%
Oberbayern (München), DE	0.791	2%
Etelä-Suomi (Helsinki), FI	0.782	-3%
Karlsruhe, DE	0.775	1%
Stuttgart, DE	0.768	1%
Braunschweig, DE	0.759	-1%
Sydsverige (Malmö), SE	0.758	-1%
Île de France (Paris), FR	0.746	-9%
Östra Mellansverige (Uppsala), SE	0.742	1%
Berlin, DE	0.737	2%
Tübingen, DE	0.718	3%
Praha, CZ	0.698	-5%
Darmstadt (Frankfurt am Main), DE	0.693	-3%
Dresden, DE	0.687	-4%
Köln, DE	0.686	-2%
Danmark, DK	0.681	1%
Pohjois-Suomi (Oulu), FI	0.679	9%
Mittelfranken (Nürnberg), DE	0.676	6%
Wien, AT	0.675	0%

Figure 4 shows the relationship between specialisation in LSI and regional prosperity (measured as GDP per capita). Again, the relationship is positive, but not very strong.

**Figure 4. Life Science concentration and regional prosperity (2009)**



## 6. Breaking down the life science industries

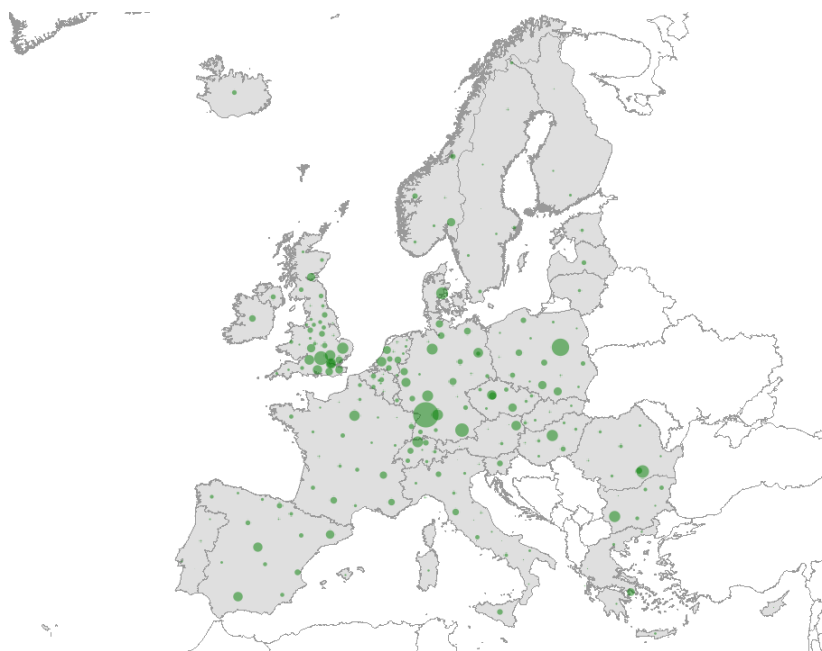
The Life Science industries are a combination of three sectors: Biotech, Medical Devices, and Pharmaceuticals. Despite the similarities among these sectors, there are specific traits that cannot be analysed unless considered separately. Below, the three sectors are analysed individually. In 2007, Biotech represented 8.37% of LSI employment, Pharmaceuticals 54.19%, and Medical Devices the remaining 37.44%.

The Top-15 regions in Biotech employment, shown in Table 10, highlight the significant role of German's regions in the European Biotech landscape. Although the region of Karlsruhe (DE) accounts for as much as 8.91% of the all European Biotech industry employment, the remaining employment is spread out over a large number of regions. This is consistent with the emergent nature of the Biotech sector compared to the more mature Pharmaceutical and Medical Devices sectors. Contrary to the other two sectors, Biotech is highly dispersed across Europe and mostly concentrated in less populated regions.

**Table 7. Top 15 employment centres for biotech**

Region	Biotech Employment	European Share
Karlsruhe, DE	9,813	8.91%
Mazowieckie, PL	4,616	4.19%
Berks, Bucks and Oxon, GB	2,871	2.61%
Oberbayern, DE	2,780	2.52%
Bucuresti – Ilfov, RO	2,439	2.21%
Danmark, DK	2,360	2.14%
Kozep-Magyarország, HU	1,937	1.76%
East Anglia, GB	1,916	1.74%
Yugozapaden, BG	1,909	1.73%
Darmstadt, DE	1,820	1.65%
Nordwestschweiz, CH	1,812	1.64%
Niedersachsen, DE	1,794	1.63%
Stuttgart, DE	1,780	1.62%
Beds and Herts, GB	1,684	1.53%
Inner London, GB	1,665	1.51%

**Figure 5. Biotech Employment (2007)**

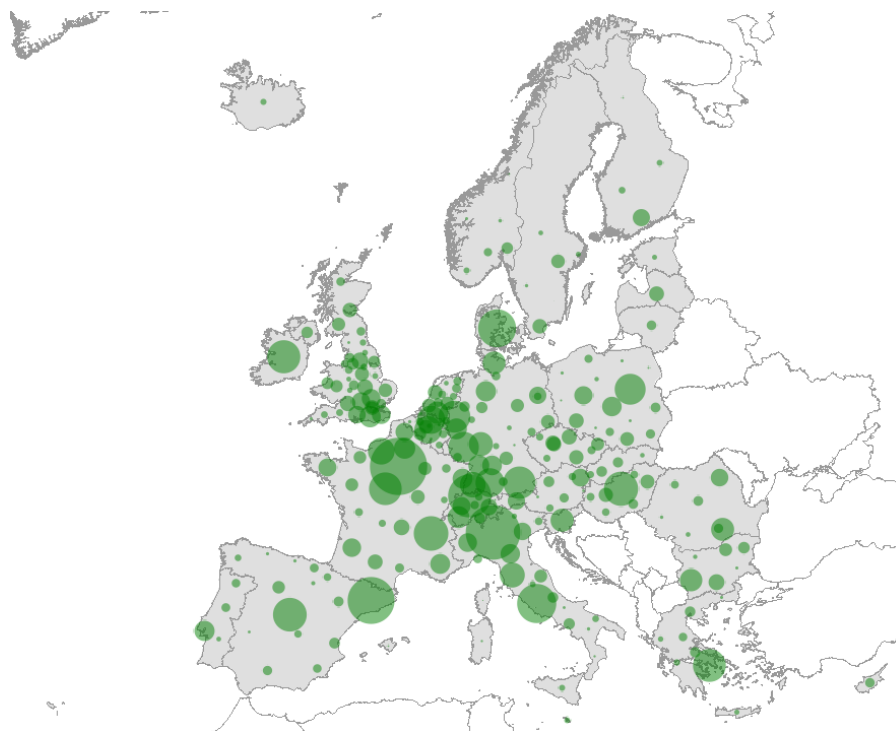


The Pharmaceutical sector is more concentrated, as shown in Figure 6, with several regions with high level of employment. The pharmaceutical industry is mostly concentrated in populous regions, which is consistent with a more longstanding history that has favoured industrial agglomeration close to the major population centres. Regions with high Pharmaceutical employment are found on both sides of the French-Germany border, and also display a high concentration in Switzerland and in the Northern part of Italy.

**Table 8. Top 15 employment centres for pharmaceutical (2007)**

Region	Pharmaceutical Employment	European Share
Île de France, FR	39,591	5.55%
Lombardia, IT	35,872	5.03%
Cataluña, ES	24,050	3.37%
Nordwestschweiz, CH	22,436	3.15%
Madrid, ES	19,432	2.73%
Lazio, IT	18,493	2.59%
Danmark, DK	17,270	2.42%
Rhône-Alpes, FR	14,416	2.02%
Közép-Magyarország, HU	14,087	1.98%
Ireland, IE	13,235	1.86%
Attiki, GR	13,032	1.83%
Centre, FR	12,891	1.81%
Oberbayern, DE	12,657	1.78%
Düsseldorf, DE	12,259	1.72%
Mazowieckie, PL	11,516	1.62%

**Figure 6. Pharmaceutical employment (2007)**

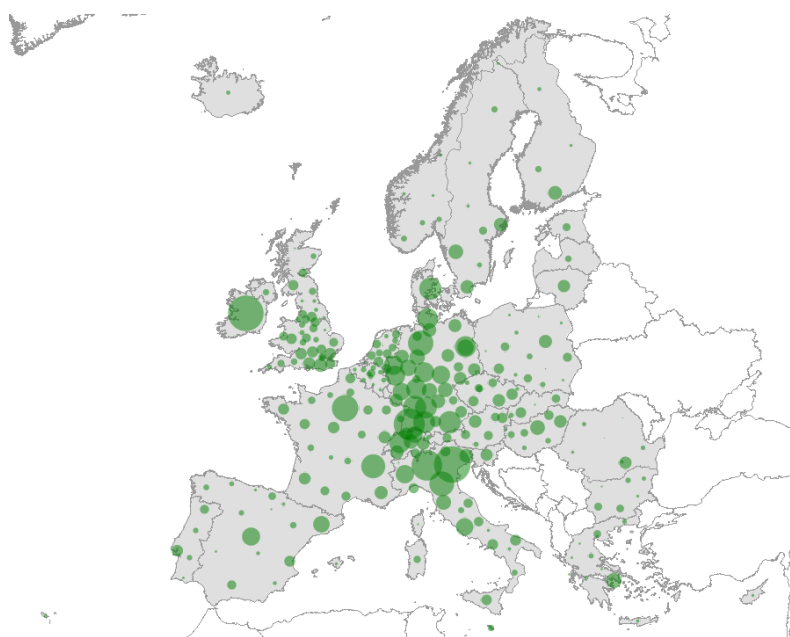


The Medical Devices sector is also quite dispersed, but displays a certain concentration to regions in France, Germany, Ireland, and Italy. Medical Devices employment is located in highly populous regions.

**Table 9. Top 15 employment centres for medical devices (2007)**

Region	Medical Devices Employment	European Share
Veneto, IT	21,269	4.32%
Ireland, IE	20,360	4.13%
Freiburg, DE	15,526	3.15%
Lombardia, IT	15,005	3.05%
Île de France, FR	11,158	2.27%
Niedersachsen, DE	10,289	2.09%
Emilia-Romagna, IT	9,860	2.00%
Rhône-Alpes, FR	9,252	1.88%
Karlsruhe, DE	8,565	1.74%
Oberbayern, DE	8,061	1.64%
Danmark, DK	7,948	1.61%
Tübingen, DE	7,740	1.57%
Stuttgart, DE	7,614	1.55%
Espace Mittelland, CH	7,155	1.45%
Berlin, DE	7,133	1.45%

**Figure 7. Medical devices employment (2007)**



## 7. The degree of concentration of individual life science industries

The Life Science industries can be further broken down into six industries. Table 10 shows the degree of concentration for each industry, calculated with three different concentration measures. Results vary very little depending on which measure is used. Production of basic pharmaceutical products is the most concentrated of the six industries, and medical and dental instruments and supplies the least.

**Table 10. The most concentrated and clustered life science industries sub-sectors<sup>3</sup>.**

NACE Category	Gini		Krugman		Theil	
Manufacture of basic pharmaceutical products	0.750	(1)	1.159	(1)	1.148	(1)
Manufacture of irradiation, electromedical and electrotherapeutic equipment	0.717	(2)	1.082	(2)	1.097	(2)
Manufacture of pharmaceutical preparations	0.660	(3)	0.966	(4)	0.953	(3)
Manufacture of perfumes and toilet preparations	0.654	(4)	0.976	(3)	0.814	(4)
Research and experimental development on biotechnology	0.587	(5)	0.864	(5)	0.659	(5)
Manufacture of medical and dental instruments and supplies	0.506	(6)	0.730	(6)	0.460	(6)

<sup>3</sup> Based on data for 2007 for 16 countries where 4-digit NACE data was available at a regional level. The countries are: BE, BG, CH, DK, DE, FI, FR, IE, IS, LT, LV, NL, NO, RO, SE and UK.

'Gini', 'Krugman' and 'Theil' are statistical measures of regional inequality or coefficients of variation.

## 8. eHealth

The eHealth sector has arisen out of the healthcare services automation which started in the 1990s, driven by the local use of computers and computers networks. eHealth today signifies services supported by technology in the healthcare sector to increase accessibility and availability of healthcare. The sector, which was initially driven by entrepreneur initiatives, due to its predominant systemic nature has become gradually more driven by government programs.

### What is eHealth?

The concept of eHealth intersects two major sectors – healthcare, and information and communication technologies (ICT) – building on the strength of the latter to deliver the former more efficiently and effectively.<sup>4</sup> The European Commission's Information Society defines "eHealth" as:

*"The interaction between patients and health-service providers, institution-to-institution transmission of data, or peer-to peer communication between patients and/or health professionals. Examples include health information networks, electronic health records, telemedicine services, wearable and portable systems which communicate, health portals, and many other ICT based tools assisting disease prevention, diagnosis, treatment, health monitoring and lifestyle management."*

The potential benefits expected by eHealth implementations have pushed the EC<sup>5</sup> and national governments to endorse it as a priority industry. The expansion of the e-health sector, at this initial stage, has been given support by policy makers taking an interest in the systemic nature of large part of this sector.

The global eHealth market is currently estimated to be worth €60 billion, of which the EU market represents approximately one forth<sup>6</sup>. The European eHealth landscape includes a number of large corporations world-leader in their segment accompanied by approximately 5000 small and medium enterprises<sup>7</sup>. The eHealth sector has been growing steadily during the last decade. The growth has been fuelled by the increasing demand for care caused by the aging population, changing disease patterns and the need to improve the sustainability of health delivery systems.

In the past decade European eHealth companies have taken substantial market shares in two emerging fields: personalized health systems and telemedicine, and integrated eHealth solutions.

Firms in the eHealth sector generally fall into two groups. One group of firms mainly deals with national and regional healthcare information networks and electronic record systems, while the second group focuses on telemedicine solutions:

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<sup>4</sup> The eHealth sector is still yet not clearly defined, but in academic literature it generally includes the two principal fields that is used here as the reference.

<sup>5</sup> EC Health policy - [http://ec.europa.eu/information\\_society/activities/health/policy/index\\_en.htm](http://ec.europa.eu/information_society/activities/health/policy/index_en.htm)

<sup>6</sup> The European Files: eHealth in Europe -

[http://ec.europa.eu/information\\_society/newsroom/cf/document.cfm?action=display&doc\\_id=611](http://ec.europa.eu/information_society/newsroom/cf/document.cfm?action=display&doc_id=611)

<sup>7</sup> eHealth LMI - <http://ec.europa.eu/enterprise/policies/innovation/policy/lead-market-initiative/ehealth/>



- *National and regional healthcare information networks and electronic record systems:* including information systems for healthcare professionals and hospitals, online services such as electronic prescriptions, databases used for patient care, research and public health, health related portals and online health promotion services.
- *Telemedicine systems* used to support remotely accessible medical data as well as to provide remote diagnosis (e.g. teleconsultation, teleradiology, telemonitoring, etc.).

Starting from the beginning of 2008 after two decades of policy and over 450 projects supported by the EC, eHealth has been included as one of the six market sectors in the Commission's Lead Market Initiative<sup>8</sup> (LMI). The purpose of the inclusion in the LMI is to address barriers to deployment, with a 3-year e-Health action plan currently underway aiming to: reduce market fragmentation and lack of interoperability; improve legal certainty and consumer acceptance; facilitate access to funding; and support procurement of innovative solutions.

Further, in 2008 eHealth indicators were included in the annual Euro Health Consumer Index (EHCI) report. The indicators mostly measure aspects of the eHealth implementation, which directly affect the delivery of cares to the patients. It can be noted that countries having high scores in those indicators are also at the forefront in the deployment of most of eHealth service and with eHealth policy and strategy in place. According to EHCI, the leading countries in eHealth are the Scandinavian ones and the Netherlands. Denmark has a long track record in developing eHealth, with its first policy dating back to the beginning of the 1990s. However, the EHCI figures suggest that eHealth implementation is not mainly a matter of national wealth, as several emerging Eastern European countries reported fairly higher scores compared to Southern European ones. A possible reasons for this faster response is that their more recent integration in the EU have triggered national policy reform as well as re-hauling of their healthcare system to improve quality and efficiency. In fact, healthcare information can and will be used for a variety of other purposes beside the provision of medical care. Chief among those is financial management, either the direct billing and/or reimbursement of costs, or for internal transfers of charges.

## **eHealth policy in Europe**

The European Commission has been engaging in supporting the eHealth sector since 2002, when the eEurope 2005 action plan was launched. The initiative focused on pushing forward the digitisation agenda for the EU, which included relevant infrastructures and fundamental applications for the promotion of eHealth. In 2004, the EC launched the e-health action plan, detailing a series of steps for the EU countries in order to harmoniously and consistently implement eHealth. In June 2005, the eEurope 2005 initiative was completed leading to the i2010 strategy, including the plan for a subgroup focusing on eHealth. The new strategy clearly endorsed eHealth as a priority, contributing and facilitating the implementation of the eHealth action plan. The objectives of the subgroup are twofold:

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<sup>8</sup> eHealth LMI - <http://ec.europa.eu/enterprise/policies/innovation/policy/lead-market-initiative/ehealth/>

to develop a European e-Health service and information space supporting improved quality and access to care while enabling cost-effectiveness of e-Health systems and services. In addition the e-health sub-group acts as facilitator for the EU countries in implementing the e-health action plans. In 2006, during the second year of the i2010 strategy, all the member states drafted their eHealth strategies and action plans, often closely linked with the development of relevant information societies within countries. These plans were developed and implemented in different organisational contexts – namely, health, medical and telecommunications – which often included close partnerships between the public and private sector. By the end of 2006, a compilation<sup>9</sup> was made of all the available Member States' plans and roadmaps, good practices in the development of country's e-Health action plans, and in the field of eHealth more generally.

Currently the EC, DG Information, Society and Media is charting the Digital Agenda 2010-2020, defining the future strategy for the EU countries in developing the digital economy. E-health is expected remain a priority, in view of the strategic relevance for the EU member states, most of which are currently in the deployment phase beginning to deliver tangible benefits.

One example is cost control of the health budget, which is a growing concern for the EU members' financial stability. Therefore we may be likely to see increased efforts in deploying eHealth systems across EU countries and a new focus on cross-border integration.

EC actions have played a significant role in fostering the development of national and regional policies. The actions mainly consisted in providing a regulatory framework to be used as a blueprint across Europe and substantial financial resources allocated through competitions among the states of the union. While each member country is responsible for its own health care system and related policy developments, the development of eHealth policies and strategies is challenging, and the EU has provided a common platform for policy-makers and industries to meet, share and advance. Today, the eHealth policy landscape among the EU countries looks rather uniform, partly due to the strong push made by the EC to make eHealth strategic to the EU development.

A turning point for eHealth policy adoption across EU countries occurred in the period 2004-2006. Before 2004-2006, only ten countries out of the EU27+3 had some sort of national policies in place. The adoption of eHealth policy led in two-thirds of the EU countries to the implementation of new ICT-based systems aiming to support health policy objectives<sup>10</sup>.

In ten countries, eHealth is a central part of the national overall health system strategy, and in another 14 countries there are more focused objectives, such as cost containment, efficiency, and/or quality of healthcare services. In 13 countries, eHealth is one of several topics under the umbrella of ICT development, one of the Information Society goals, or is part of the e-Government strategy. However,

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<sup>9</sup>eHealth Policy and Deployment in the European Union - <http://www.stakes.fi/verkkojulkaisut/raportit/R26-2008-VERKKO.pdf>

<sup>10</sup> eHealth : priorities and strategies in European countries - <http://www.ehealth-era.org/documents/2007ehealth-era-countries.pdf>

at present many of the countries with eHealth policies are still finalizing their infrastructures that will allow substantial progresses.

Two major challenges have been affecting the implementation of eHealth among EU members, one technological and a second one related to concerns about privacy. The technology hurdles has been delaying the implementation of the infrastructure in several countries, which is no surprise for such large and heterogeneous projects. While a wave of concerns about privacy has emerged among the general public about the safety and reliability of these systems in managing and hosting very sensitive data that required policy makers to introduce additional safeguards.

By 2007 Denmark was the leading country within the EU concerning eHealth policy and infrastructure implementation. Already in the mid 1990's, the Danish government adopted policies grouped under the label MedCom, focusing on the development of the technological infrastructures and investigating the development potential. The outcome of these policies, and identification of certain weaknesses, led the Danish health ministry in 1999 to introduce a national strategy outlining the use of IT in the healthcare sector. Denmark's early recognition of the strategic importance of the eHealth sector created a competitive advantage for the country, which became the benchmark for many other nations as well as the creation of a strong knowledge base in the sector. At the end of 2003, Danish citizens were offered a new tool to access health care information consisting in a web portal, which has been expanding since then, in accordance with to the National IT-strategy 2003-2007.

A different approach was chosen by the Netherlands, another front-runner in the eHealth sector within the EU according to the EHCI 2009. The Netherlands, a later starter than Denmark, initiated e-health actions only in 2002 with the establishment of the National ICT Institute for the Health Sector (NICTIZ) aiming to coordinate the organizations in building the national ICT infrastructure. Starting from 2004 the Netherlands followed EC recommendations for adopting an eHealth strategy. One of the distinctive characteristic of the Dutch approach is that from the beginning the aim was to establish a national system involving all potential stakeholders, which has allowed more comprehensive policies and actions. The policies focused on promoting adoption and implementation of eHealth practices for each stakeholder (e.g. patients, care providers, insurance). This allowed comparatively a rapid deployment of the infrastructure in country otherwise prone to long mediation periods.

## **eHealth innovation in Europe**

The nature of eHealth innovation has changed over time. The sector originated in 1999 when there was an initial interest, particularly among SMEs, in applying IT to healthcare, and out of this grew gradually what is today known as eHealth. Innovation goals have shifted from local, mostly aiming to digitization of adjacent offices, to broad and systemic, such as regional and national initiatives involving several different stakeholders. The broader scope of eHealth and its systemic influence have been the reason of the engagement by the EC in developing European policies aiming to support a common pace of implementation among the EU countries as well as stimulating the interoperability among the eHealth systems.

One of the goals of the EC is the creation of a “European eHealth area”. In 2004 the EC published an eHealth strategy, where member states are encouraged to set up national eHealth strategies and action plans, and to boost investments in e-Health. The innovation within eHealth has been largely supported by the policy established at the European level, which led to the delineation of a common strategy for the EU countries favouring a European systemic approach of the national projects.

To date is difficult to identify regions of excellence for the eHealth industry. Leading examples of innovation in the eHealth sector have occurred mainly in regions with the advanced technological infrastructures – or in the process of building it – that represent the necessary foundation for eHealth industry growth.

The most evident examples of innovation have so far originated in locations likely to gain benefits from advances in the sector. Specifically specializing expertises at existing university and research institutes as well as attracting funds supporting job creations and improve local healthcare. One example is the eHealth network<sup>11</sup> started in Wroclaw, Poland. The Wroclaw eHealth network was established leveraging the local expertise at the two existing local universities active in both ICT and Medicine.

The national and regional approaches to eHealth, however, have favoured the emergence of innovation networks, rather than cluster organisation, linking regions in different countries sharing similar geographical challenges (e.g. impervious landscapes) and healthcare accessibility. The northern periphery of Europe supported by European regional funding program, promoting innovation in these regions, has launched a network called Competitive Health Services<sup>12</sup>. The network focuses on developing innovative e-health solutions, finding common solutions, and enabling interoperability.

### **Cluster initiatives in eHealth (ICT for Health)**

eHealth cluster initiatives development can be found in the two focus areas highlighted at the beginning of this chapter: national and regional e-health infrastructures, and telemedicine. Depending on the type of focus there are different type of opportunities for the emergence of clusters.

The research carried out for this report has not been able to identify any cluster initiative in the area of national and regional e-health infrastructures business. This may perhaps be because the sector is typically dominated by large corporations catering to government procurement. It is possible that once eHealth infrastructure, which represent the indispensable foundation for businesses to emerge, is more widely available in most of the EU countries such cluster initiatives will emerge. It is notable that to date only few cluster initiatives have adopted “eHealth” as part of their name or description, possibly because of the lack of agreement about the definition of eHealth.

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<sup>11</sup> E-health network Wroclaw -

<sup>12</sup> Competitive Health Services Project - <http://www.ehealthservices.eu/>

In contrast, the eHealth industries emerging around the telemedicine have been rapidly growing with strong focus on mobile real time monitoring of the patients and remote diagnostic. This aspect of the eHealth industry has been favored by the less systemic type of products and services, which has sparked entrepreneurial activities and cluster origination. In Europe, there are several examples of cluster initiatives, mostly active in the IT sector, focusing in the eHealth, of which four will be described below.

Italy has an ICT cluster organisation, called ThinkUp<sup>13</sup>, located in Piemonte focusing on information communication technology, which lists eHealth among its principal activities. This cluster organisation represents an isolated case in the Italian landscape even if the implementation of eHealth infrastructure has progressed far also in several neighbouring regions.

i2Cat<sup>14</sup> in Catalonia, Spain is a regional foundation dealing with technological innovation, which has established a cluster initiative focusing on eHealth and eDependence. The cluster initiative focuses on supporting regional enterprises as well as research institutions in growing new technologies for health, in particular telemedicine.

The city of Eindhoven in The Netherlands hosts Brainport<sup>15</sup> a cluster initiative supporting the highly innovative companies and research institutes present in the region. Lifetec is one of the characterizing sector of the cluster, which also encompass eHealth activities.

Countries in the Baltic Sea Region have engaged in an innovation network started with the support of the European Regional Development Fund a project named ICT for Health<sup>16</sup>. The project aims to foster the adoption of cross-regional standards for e-health and educate people to the use e-health solutions, as this should enable the emergence of new markets and consequently entrepreneurial opportunities.

## **Potential for E-health cluster initiatives**

The extensive research conducted in identifying eHealth clusters initiatives and regions presenting potential to host cluster initiatives suggests that such initiatives occur in regions with long tradition in Information Technology with established technical universities. A second characteristic of regions likely to support cluster growth is the existence of innovation policy and the availability of running eHealth infrastructures on top of which entrepreneurial effort might develop.

A handful of regions show already initial signs of activity in the eHealth industry and a potential to develop specialized eHealth clusters. For example, the region of Murcia (South-East Spain) hosts TICBioMed<sup>17</sup>, a cluster organisation with relevant activities in eHealth. The choice of developing a

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<sup>13</sup> ThinkUp (IT) - <http://www.thinkupict.org/>

<sup>14</sup> i2Cat eHealth and eDependence Cluster (ES) - <http://www.i2cat.net/en/cluster/ehealth-and-edependence>

<sup>15</sup> Brainport - <http://www.brainport.nl/>

<sup>16</sup> ICT for Health - <http://www.ictforhealth.net/>

<sup>17</sup> TICBioMed - <http://www.ticbiomed.net/>

cluster was made on the basis of an existent infrastructure able to support the deployment of eHealth services, existence of a lean government supporting fast implementations, the presence of R&D of a large multinational firm active in the healthcare, and a consistent and coordinated healthcare delivery.

A second example is the growing Bulgarian ICT clusters initiative, which counts among its member the “E-health Bulgaria Foundation”<sup>18</sup>. The foundation is the organization in charge of managing collaboration among stakeholders involved in deploying an eHealth solution. This could quite possibly lead to the creation of a specialized cluster organisation that supports the growth of the field in Bulgaria.

## **9. Nanomedicine**

Nanomedicine as a concept emerged in the late 1990s, and large scale policy actions began only about 2005. The sector is not yet distinguishable in industry statistics, and very few cluster initiatives specifically aimed at nanomedicine have yet been established. Nevertheless, there is considerable interest in this sector, which is gradually maturing from basic research to commercialization. This chapter will present the current situation, outlining the concept of nanomedicine, policies in Europe targeting nanomedicine, major innovation regions, and cluster initiatives.

### **What is nanomedicine?**

Nanomedicine stem from the nanotechnology scientific field, which investigates the methods and processes linked to controlled manufacturing, analysis and application of structures and materials with dimensions of 1 to 100 nanometres. In the last two decades, the development of these technologies has had considerable impact on several industries, enhancing their economic competitiveness. So far, the principal sectors benefiting from nanotechnologies have been mass-market electronics, chemicals, and optical industries. However, expansion of nanotechnology research is expected to have commercial influence also on life science, car manufacturing, construction, and textile industries.

In Europe, Germany is the leading country in the field of nanotechnologies. Both in terms of investment and research, Germany surpasses all its European peers. Germany ranks third in the world, after USA and Japan, in registered patents and R&D expenditures in nanotechnology.

Nanomedicine is the application of nanotechnologies applied to healthcare. In particular, three major application areas for nanomedicine can be distinguished, namely, drug delivery, nanomedical engineering, and diagnostic. The term nanomedicine was introduced in the late 1990s, gaining a particular momentum around 2005, when nanomedicine research advanced to the point of being recognised as a key discipline for growth in business and science.

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18 E-health Bulgaria foundation - <http://www.ehealth-bg.org>

The US market for nanomedicine products and services have been estimated<sup>19</sup> to 8bn USD in 2008, expected to grow strongly to 119bn USD by 2021. We have found no corresponding estimate for the size of the European market.

The highly technological content of nanomedicine is strongly dependent on research, usually conducted at the academic level and serving as main drive of this sector.

The industry is dominated by start-ups and small firms. 47% of European nanomedicine firms are start-ups, 32% are SMEs (up to 250 employees), and only 21% are large firms, mainly active in the pharmaceuticals<sup>20</sup>. The dominance of start-ups is not surprising, considering the research-driven nature of the sector, where many of the firms are start-up and spin-offs create for commercialising products from universities and research institutes.

With 75% of the total nanomedicine market, drug delivery represents the main application area<sup>21</sup>. Underlying this dominance is a corresponding focus of research, where drug delivery has been averaging around 50% of research spending during the last decade. However, the commercialisation is expected to slow down, due to heightened public concern resulting in increased regulatory scrutiny, and currently also some technological barriers.

## **Nanomedicine policy**

The policy landscape differs greatly between nanotechnology and nanomedicine in terms of maturity. The former has been widely targeted by policies and program in most of the EU countries while the latter is hardly recognized and only specifically mentioned in upcoming initiatives.

At the European level, the emerging role nanomedicine sector is noticeable by the direct engagement by both the European Commission and national governments, which have launched specific programs for the development of the sector. Several billion Euros have been committed by both EU and national governments aiming to expand the nanotechnology field, which also include nanomedicine, through programs run by public agencies. Nanomedicine research is expected to have a great societal impact, offering improved healthcare leading to higher living standards, expansion of the job market to highly skilled labour that should strengthen the competitiveness of the area supported.

The EC has highlighted the importance of growing nanomedicine research initiating two major large initiatives, which developed on two distinct line of action. The European Technological Platform on nanomedicine was the first initiative, launched in 2006, and the European Commission partnered with leading industry actors to create a strategic research agenda and to build a forum supporting the efforts in the nanomedicine sector, mobilising additional investment to achieve the breakthrough potential of nanomedicine technology. The second initiative EuroNanoMed developed within the

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<sup>19</sup> nano.DE Report 2009 - [http://www.bmbf.de/pub/nanode\\_report\\_2009\\_en.pdf](http://www.bmbf.de/pub/nanode_report_2009_en.pdf)

<sup>20</sup> Nanomedicine: Drivers for development and possible impacts - <http://ftp.jrc.es/EURdoc/JRC46744.pdf>

<sup>21</sup> V. Wagner et al, The emerging nanomedicine landscape, Nature Biotechnology, Vol. 24(10), October 2006

European Research Area (ERA) scheme aiming to strengthen coordination and cooperation of national and regional programs across Europe. One of the priorities of the EuroNanoMed program is strengthening the transnational collaboration within Europe, increasing its competitiveness in the nanomedicine sector and providing financial contribution.

One of the priority of most of the recently started programs and the ones currently under formation concerns the low capacity of research institutes to connect with firms and establish effective technology transfer, which has been one thing hampering the development and commercialization of several nanotechnology projects. Here, policy maker hope for a virtuous circle leading to an increased self-sustainability of the sector as well as societal contribution (e.g. improved healthcare treatment and a virtuous job market).

At the national level several European countries have been promoting and supporting research in nanotechnology rolling-out targeted programs with attached considerable budgets.

The leadership achieved by Germany in the nanotechnology field resulted from a long continuous commitment by the government dating back to 1998. The Ministry for education and research launched a program which established nine competence centres through the country, one focusing on nanobiotechnology. The government in 2001 increased its effort launching a framework of funding focusing on nanobiotechnology. The commitment was renewed in 2006, when the German government launched a four-year program “Nano Initiative – Action Plan 2010”. The program touched on all the critical aspects concerning the development of nanotechnology research.

The UK has also invested heavily in the nanotechnology sector. The UK Research Councils have been investing considerable resources to enhance British competitiveness of the field. More recently the Department of Trade and Industry actively engaged in financing nanotechnology research prioritizing nanomedicine initiatives.

The Dutch and Finnish governments have been running two large programs, NanoNed<sup>22</sup> and FinNano respectively, promoting the development of nanotechnology. The NanoNed, a six-years program ending in 2009, was launched by the Dutch government with a total budget of 300 mn €, equally split by the government and the participating partners. Similarly, the Finnish government committed € 120 mn over a period of four years ending in 2010 through four programs focusing on developing infrastructure, basic research, applied research and development, and a cluster initiative program in the nanotechnology sector.

Both programs have been deemed to be successful, and the NanoNed program was refinanced with a new strategic research agenda for the period 2010-2020. However, the future development of the FinNano program is still unclear because of the current financial uncertainties, which have reduced the

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<sup>22</sup> NanoNed initiative (NL) - <http://www.nanoned.nl/>



financial resources available, their strategic relevance will likely support the launch of more targeted initiative building upon the existing track.

The trend of investment in nanotechnologies research is increasingly growing, according to ObservatoryNano<sup>23</sup> (June 2010), especially in those countries still lacking a clear nanotechnology strategy. One example is Russia, which so far has been financing individual nanotech ventures but without a structured program.

Extensive research undertaken for this report concerning European nanomedicine policies showed that despite large commitments undertaken in nanotechnology research, programs focusing on nanomedicine are still lacking, with only few exceptions.

Germany was the first country in Europe recognizing a need for specific funding measure for nanomedicine, introducing the lead innovation program “NanoForLife” already in 2005. This aligned Germany to USA and Japan, two countries at the forefront of nanomedicine research. The recently strategic agenda 2010-2020 for NanoNed the Dutch nanotechnology initiative pinpoints nanomedicine as one of the strategic program to be pursued.

## **Nanomedicine innovation**

The nanomedicine sector has been growing through a process of continuous innovation during the last decade. At the beginning of 2000 the nanomedicine sector was not recognized as such, and this resulted in policies and financial support usually allocated on a project basis, rarely part of a strategically designed program specifically prioritizing nanotechnologies applied to health. Around 2005 nanomedicine began to gain recognition as a sector, and the European Commission, national and regional governments strengthened their role in policy. The research in the sector has been progressively expanding, but with few products having reached the market its visibility is still low.

Conscious of the difficulties in delivering output to the market, both EC and firms have engaged in the development of organisations aiming to bring stakeholders in the nanomedicine arena closer. In a relatively short period (2004-2005) two triple-helix initiatives, namely, European Technology Platform Nanotechnology<sup>24</sup> and Nano2Life<sup>25</sup> were launched to support nanomedicine, but with different underlying scope. The European Technology Platform Nanotechnology, initially led by the industry, has a first task drafted a vision of nanomedicine till 2020 through a joint effort of all the triple-helix actors interested. Nowadays has been opened up to all actors potentially interested in actively contributing in furthering nanotechnology policies and also serve as central resource of information about nanomedicine policy. Differently Nano2Life was founded as a network of excellence bringing together the expertise dispersed across Europe fostering collaborations and knowledge exchange as well as a common strategic research agenda.

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<sup>23</sup> Observatory Nano - <http://www.observatory-nano.eu/>

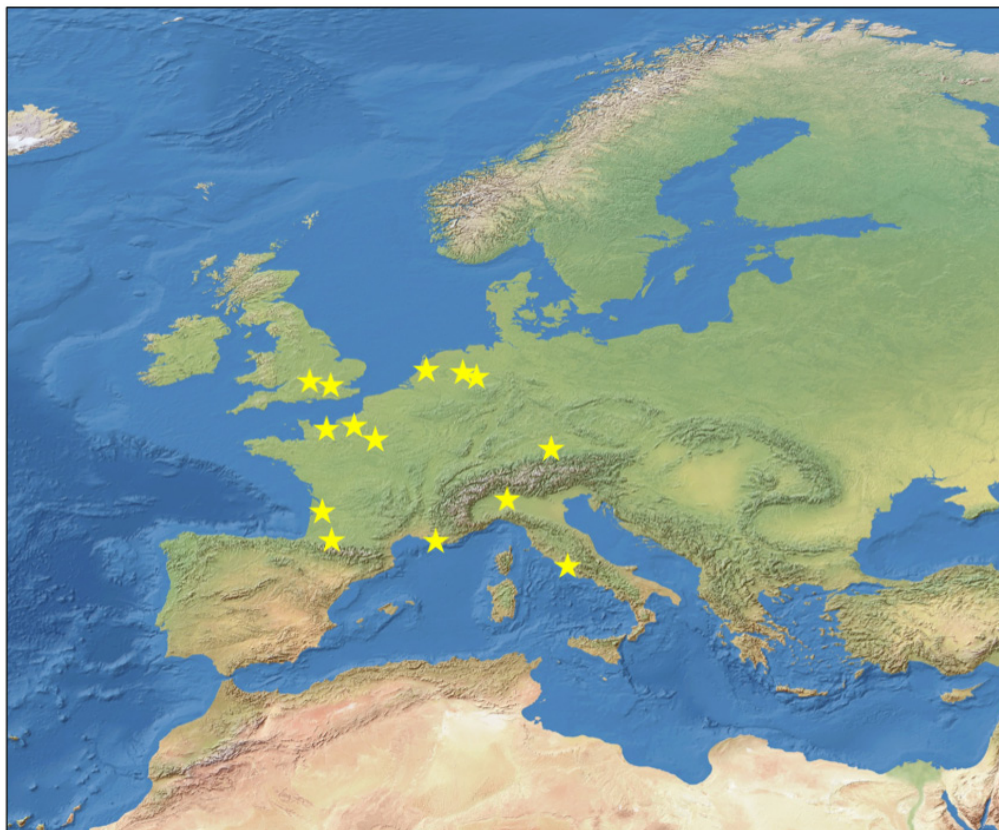
<sup>24</sup> European Technology Platform Nanomedicine - <http://www.etp-nanomedicine.eu>

<sup>25</sup> Nano2life - <http://www.nano2life.org>

To date the majority of EU countries are active with initiatives for nanomedicine innovation, partly driven by the strong impulse sent by the EC. Innovation has mostly emerged in those countries with a long-standing tradition in basic research and strong educational systems. The areas where innovation projects have been developing had an established presence of skilled workers, relevant educational programs, facilities and a dynamic entrepreneurial environment.

A number of regions with high nanomedicine innovation activities can be identified within the EU, principally located in Germany, UK, France, Italy, and the Netherlands.

**Figure 5 – Map of Nanomedicine innovation activities across Europe.**



Germany conforming to its role of leading country within the EU has been setting an example at the policy level developing a coherent and forward-looking program, which has contributed to the formation of EU policies with regard to nanotechnologies.

The nano.DE<sup>26</sup> program has been the main driver of the research expansion in nanotechnologies, which have been injecting around 300mn € a year of research funding since 2007. The three regions Bavaria, Baden-Württemberg and the North Rhine-Westphalia present the highest number of establishments for nanomedicine research, counting on several research institutes and companies active in development and commercialization.

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<sup>26</sup> Nano Initiatives - <http://www.bmbf.de/en/nanotechnologie.php>

One example is the Nanosystems Initiative Munich<sup>27</sup> (NIM) a research initiative located in the Bavaria region bringing together research groups active in the nanotechnology domain from the Munich area. The strengths of this initiative are nanomedicine and information processing. A second example is a research cluster<sup>28</sup> located in the area around Münster, North Rhine-Westphalia, originated in 1998 within a national program aiming to create a centre of excellence. The cluster was started with a focus on biomedical and clinical research, expanding through time to host nanotechnology research and more recently nano-biotechnology.

The United Kingdom has currently no national strategy concerning nanomedicine but across the country there are several centres engaged in nanomedicine research. Oxford University hosts the Institute of Nanoscience for Medicine<sup>29</sup>. While in London a joint venture between two major universities, University College London and Imperial College London, established the London Centre for Nanotechnology<sup>30</sup> that feature Biomedicine as one of its research theme.

The French government has developed a wide reaching initiative to support innovation in the nanotechnology field. During the period 2004-2005, the government rolled-out the establishment of five competence centres (C'nano<sup>31</sup>) located across the nation linking together existing research centres in nanotechnology and fixing research priorities for each centre. There is no location where nanomedicine is specifically mentioned; however, two major centres of nanotechnology research show relevant activities for the field. A significant level of innovation in nanotechnology research is found in the Grenoble area, where about 32 research laboratories employ about 1000 researchers. The strong presence of nanotechnology research is mostly due to existing research excellence located in the area linked to nuclear research and later to nanoelectronics. The current research focus is far ranging including nanotechnology applied to create a new generation of integrated circuit production, considered a national priority, and nanomedicine research. The massive presence of research institutes in the Grenoble area has lead to the establishment of the Nanosciences foundation<sup>32</sup>, which coordinates the nano research initiatives of CEA (Atomic Energy Commission), CNRS (National Centre for Scientific Research), INPG (National Polytechnic Institute of Grenoble) and UJF (Joseph Fourier University) all located in the area. Strasbourg is the second pole of research active in nanomedicine related innovation, hosting the French centre of excellence in chemistry<sup>33</sup>, which in recent years has been broadening its research activities focusing on nanotechnologies applied to health.

Italy despite the lack of a national strategy for nanotechnology research has been achieving innovation in the nanomedicine field participating in EU initiatives and developing regional initiatives. Only recently, the government has recognized nanotechnology as a research priority including it in the two-

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<sup>27</sup> Nanosystems initiative Munich - <http://www.nano-initiative-munich.de/>

<sup>28</sup> Wirtschaftsförderung Münster - <http://www.wfm-muenster.de/index364.htm>

<sup>29</sup> Institute of Nanoscience for Medicine - <http://nanomed.bioch.ox.ac.uk/index.php>

<sup>30</sup> London Centre for nanotechnology - <http://www.london-nano.com/research-and-facilities/themes/areas/biomedicine>

<sup>31</sup> C'nano - <http://www.cnano.fr/>

<sup>32</sup> Fondation Nanosciences - <http://www.fondation-nanosciences.fr/>

<sup>33</sup> International Centre for Frontier Research in Chemistry - <http://www.icfrc.fr/>

year National Research Plan (PNR) for the period 2010-2012. A concentration of nanomedicine research is currently taking place in the region of Lazio, where a joint program between the state, the region and primary research and academic institutes have been working together to establish in 2008 the Lazio Bioscience Technology District (DTB). One of the priorities of the DTB is the expansion of nanomedicine field. A second example of innovation in Italy is the “European Center of Nanomedicine” established in Milan through the alliance between nine universities and research institutes located in the area with an annual budget of 20 million €, aiming to become one of the leading actors in the field of nanomedicine. The Veneto region has also been actively investing in nanotechnology research, jointly participating in a public agency promoting nanotechnology research, Veneto nanotech<sup>34</sup>, part of the EC initiative EuroNanoMed.

The Netherlands, with its national initiative to stimulate nanotechnology research, has fostered the emergence of several areas of innovation through the country. At the current stage of development there only few centres showing innovation activities in the nanomedicine field. One is the MESA+ an internationally recognized institute for nanotechnology research at the University of Twente. However, the Dutch government has presented the extension to the existing nanotechnology initiative for the period 2010-2020, introducing nanomedicine as a new focus area. The new initiative will likely lead to the inclusion of nanomedicine in the research priorities of existing research centres and universities already active in the field of health and nanotechnologies.

Countries with a low urbanization density, characterized by several urban agglomerations distant from each other, such as Norway, have been pursuing the creation of networks bringing together universities, research institutes and company active in the field. The network aims to create a platform for knowledge exchange and collaborations as well as a single interface for international collaborations. One example is the “Norwegian Nanomedicine Network”<sup>35</sup> created by the national research council.

## **Cluster initiatives in nanomedicine**

To date there are hardly any nanomedicine clusters initiative active within the EU, probably due to the nascent nature of the sector which so far has been focusing on fundamental research trying to understand the application of nanotechnologies to healthcare and the interaction between human body and nanotechnology. The existence of several European and national programs aiming to increase the competitiveness of the nanomedicine sector has created several opportunities for existing biotechnologies and pharmaceuticals clusters to expand their research in nanomedicine building upon their existing expertise.

Nanomedicine projects grown within existing cluster initiatives in other sectors can be found in several countries throughout Europe (Figure 6), especially in regions featuring advanced biotechnology

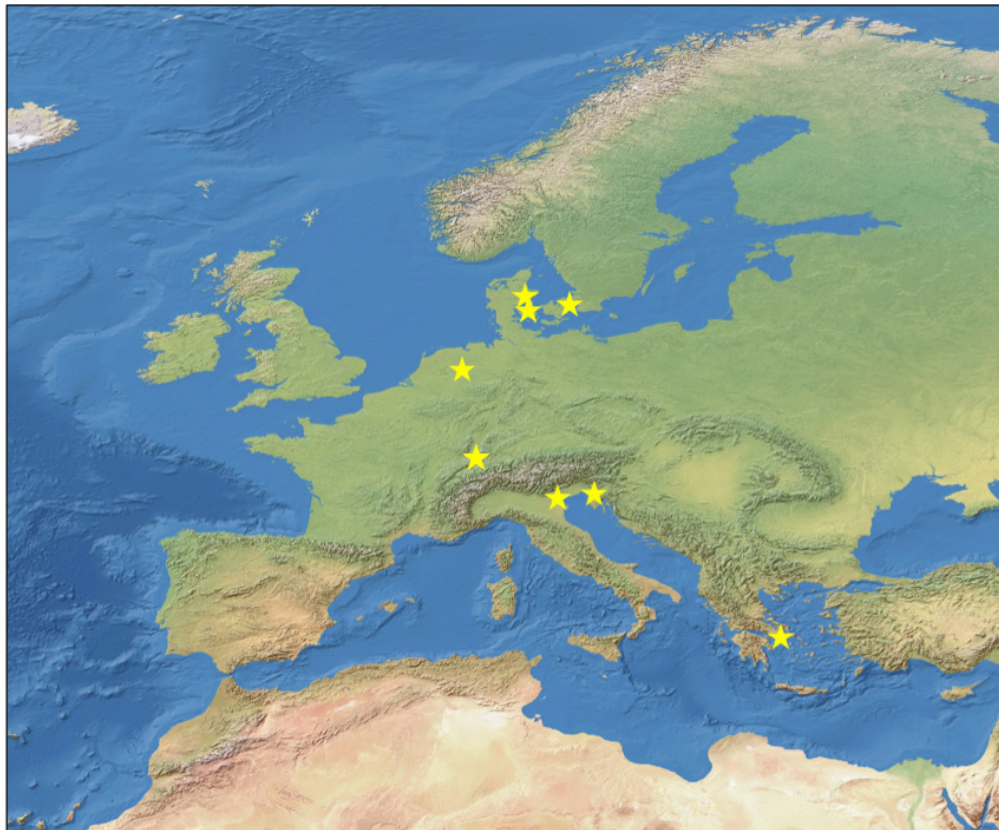
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<sup>34</sup> Veneto nanotech - <http://www.venetonanotech.it/>

<sup>35</sup> Norwegian Nanomedicine Network - <http://www.sintef.no/Projectweb/Nanomedicine/>

research of which nanomedicine represent a natural evolution. Pharmaceutical clusters have also been playing a role in nanomedicine, actively engaging in projects but mostly limiting the amount of resources invested because not yet fully ready for commercialization. A search looking at existing biotechnology and pharmaceutical clusters have pinpointed several areas with strong potential to grow in nanomedicine clusters during the next decade because already active in activities related to nanomedicine. Analysing Europe from north to south, a number of location have been identified.

**Figure 6 – Map of emerging Nanomedicine cluster initiatives.**



During 2010, Denmark emerged as a new frontrunner in the nanomedicine research race. Three centres of excellence have been started through a considerable investment by a private foundation linked to a major Danish pharmaceutical company. The excellence centres have been opened in several regions through the country with established biotechnological clusters and available expertise, one located in Copenhagen<sup>36</sup> (Medicon Valley Cluster), the second in Odense<sup>37</sup> (University of Southern Denmark), and the last in Aarhus<sup>38</sup> (Biomedico Cluster).

In The Netherlands the city of Enschede hosts MESA+<sup>39</sup>. The MESA+ is an emergent cluster in the nanomedicine field. In the northern part of the country in the city of Groningen a cluster active in biotechnology, which has been extending its reach to nanomedicine research through active participation in European projects.

<sup>36</sup> Lundbeck Foundation Center for Biomembranes in Nanomedicine (DK) - <http://www.nanomedicine.ku.dk/>

<sup>37</sup> NanoCAN center (DK)- <http://www.nanocan.dk>

<sup>38</sup> Interdisciplinary Nanoscience Center Aarhus University (DK)- <http://inano.au.dk/>

<sup>39</sup> MESA+ Institute for nanotechnology (NL) - <http://www.utwente.nl/mesaplus/>

In Switzerland the city of Basel and its surrounding region show a great potential that could lead to the development of a successful nanomedicine cluster initiative. The area has an international reputation for its pharmaceutical and biotechnological industry, supported by high level education, the presence of several research centres and state-of-the-art infrastructures. The city hosts major institutions in the field of nanotechnology the Swiss Nanoscience Institute<sup>40</sup> based at the University of Basel and the European Foundation for Clinical Nanomedicine<sup>41</sup>, the latter planning to open a translational laboratory for nanomedicine. Also, i-net BASEL Nano<sup>42</sup> is an organisation that has taken several steps towards becoming a full-blown cluster initiative, and one of its innovation circles focuses on nanomedicine.

In Italy several areas have already started exploring the nanomedicine field, with the potential in the mid-term to grow into nanomedicine cluster. One example is the existing Veneto Nanotech cluster active in nanotechnology research applied to materials and is actively engaged in the Euronanomed<sup>43</sup> ERA program as a partner. In view of public sponsor supporting the current development is likely a further push in supporting a more specialized cluster in nanomedicine. A second example is the cluster in Biomedicine (CBM<sup>44</sup>) located in the AREA science park (Friuli Venezia Giulia), where they conduct research in the broad field of biotechnologies but recently have started few projects in nanomedicine.

A last area of interest is located in Greece, where the Biomedical Research Foundation Academy of Athens<sup>45</sup> (BRFAA) part of the Hellenic Bio Cluster is one of the examples of an existing cluster broadening its research scope to move into nanotechnologies leveraging the existing infrastructures and funding.

The analysis of the current status of the nanomedicine sector shows an on-going development toward higher maturity, paving the path to the development of cluster initiatives in the next five to ten years. The expected timeframe is tightly linked to the completion of the running priority programs aiming to the development of the nanomedicine sector. The clusters will likely emerge in the areas supported by current initiatives, often located around or within existing Biotechnology clusters.

## 10. National and transnational Life Science networks

Transnational Life Science cluster networks have been growing across Europe as well as globally in the last decade. Networks of clusters appear to be of great value for the expansion of Life Sciences, which usually present a few specialized clusters in each country.

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<sup>40</sup> Swiss Nanoscience Institute - <http://www.nanoscience.ch/nccr/>

<sup>41</sup> European Foundation for Clinical Nanomedicine - <http://www.clinam.org/>

<sup>42</sup> i-net BASEL Nano – [www.inet-basel.ch](http://www.inet-basel.ch)

<sup>43</sup> Euronanomed - <http://www.euronanomed.net/>

<sup>44</sup> Cluster in Biomedicine in Friuli Venezia Giulia (IT) - <http://www.cbm.fvg.it/>

<sup>45</sup> Biomedical Research Foundation Academy of Athens - <http://www.bioacademy.gr/>

The European Commission indicated in the 2002 Biotechnology strategy and action plan<sup>46</sup> the excessive fragmentation of the research communities, suggesting the creation of networks.

Policy makers have aimed for the creation of ties among principal players in the Life Sciences, pursuing the development of “mega clusters” considered to be a coherent approach in achieving a critical mass to compete with other global players.

### **The nature of Life Science cluster networks**

The use of the label “life science” in branding networks initiatives still find some resistance in the community because of the diverging definitions of the life science industry, especially in terms of sectors that should be included. So far the networks using “life science” as part of their branding mostly pursue activities in the sector of biotechnologies.

European life science networks vary greatly in terms of initiating entity and scope. Among the initiators, there are not only cluster initiatives but also universities and research institutes aiming to create a flow of ideas and knowledge among critical actors. Three specific types can be distinguished: network of clusters initiatives, research network, and cooperation networks. The networks can be also differentiated on the base of the members’ location, national and/or international.

For Europe as a whole, the leading initiator of network initiatives has been the EC. However, national champion have increasingly engaged in fostering transnational cooperation to boost international competitiveness. One example of the latter is the large support offered by three Norwegian Innovation agencies through the Norwegian Centre of Expertise program<sup>47</sup>, which have strongly engaged in supporting the expansion of the Oslo Cancer Cluster and the building of an international network of collaboration.

The network initiators are dispersed across European regions without noticeable clustering. This may be the result of a strategy to offer opportunities to most of the EU countries, leveraging their strongest capabilities. In many circumstances the success of a network depend upon its ability to attract partners, emphasizing the importance of having partners in as many countries as possible.

The first large transnational network of clusters in Europe was ScanBalt, formed in 2001, covering regions around the Baltic Sea. The network found a nurturing environment, in view of the presence of most Scandinavian countries already cooperating on other matters.

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<sup>46</sup> EC Biotechnology strategy and action plan - <http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2002:0027:FIN:EN:PDF>

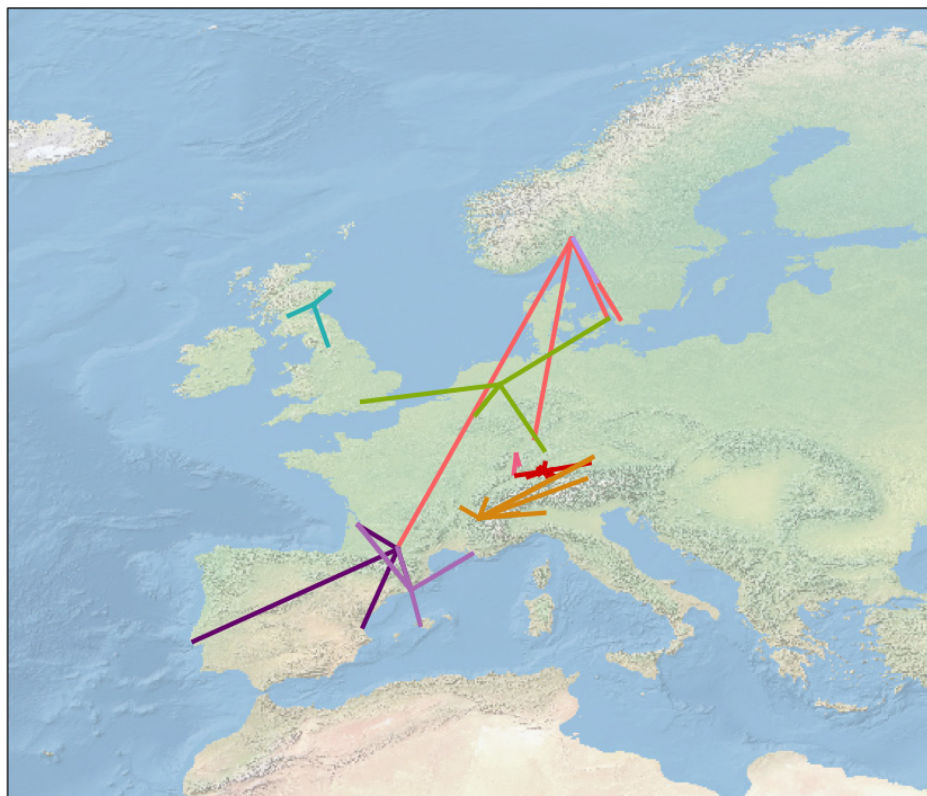
<sup>47</sup> Norwegian Centre of Expertise - <http://ekstranett.innovasjon Norge.no>



## Transnational Life Science cluster networks

The European landscape present several examples of established life science networks of various form and nature. This report will look specifically to 11 networks describing the salient characteristics of each one.

**Figure 7 – Map of Transnational Life Science Networks\***



*\*The map displays only some of the networks identified to facilitate readability. List of networks: AlpineBio (orange), BioLago (red), BioValley (light pink), BSE (orchid), FASILIS (green), INTERBIO (purple), MedCoast Scandinavia (light purple), Oslo Cancer Cluster's network (pink), TMRC (turquoise). Networks with large number of nodes have been excluded for clarity.*

The ABC Europe ambassador program<sup>48</sup> is a project aiming to create a network of cluster organizations active in the biotechnology sector across Europe. The project was launched in 2009 supported by the European Commission for a period of three years. Contrary to other networking program, this introduces the figure of the ambassador. The project is lead by Medicon Valley Alliance<sup>49</sup>, which is expanding its already existing ambassador program to the European setting. The goal is to create tighter relation among the European biotechnology clusters supporting trans-national collaborations. The ambassador programme will pursue the goal through initiatives, like matchmaking, training, technology showcase and guidelines to regulate joint research activities.

<sup>48</sup> ABC Europe Ambassador program - [http://www.ambassadorprogramme.com/content/us/abc\\_europe](http://www.ambassadorprogramme.com/content/us/abc_europe)

<sup>49</sup> Medicon Valley Alliance - <http://www.mva.org/>



The Alpine BioCluster<sup>50</sup> is a European project aiming to support the growth and expansion of Biotech and Medtech in the Alpine cross-national meta region of the Alps. Within the eight partners led by ADEBAG<sup>51</sup>(FR) and Lyonbiopôle<sup>52</sup> (FR) have specialized in two networks, “autonomy and healthcare” and “new diagnosis and therapies”. The project is co-financed by European regional funding. The network aims to support the identification of competencies and cooperation among the actors present in the Alpine region in developing innovative solutions.

CEBR<sup>53</sup> (Council of European Bio Region) is a network linking biotechnology clusters across Europe founded in 2006 with the contribution of European FP6 funds. The network is coordinated by the One Nucleus<sup>54</sup> organization based in London counting over 100 full and associate members. The organization is also active in engaging the members to collaborate, exchange best practices and developing suggestions for the policy makers. The network established with temporary funding succeeded in becoming self-sustainable, with a continuous expansion of the member base that have doubled in size in the first two years of its existence. To foster participation, the network engages the members in yearly activities (i.e. conferences, production-meeting) supporting research collaboration and knowledge transfer.

Biolago<sup>55</sup> is a transnational network developed around the Lake of Costance, which crosses the territories of Austria, Germany and Switzerland. The initiative is headquartered in the city of Costance (Germany). Within the network four highly specialized universities collaborate together with local companies.

FASILIS<sup>56</sup> (Facility Sharing in Life Sciences) is a project supported by the European Union aiming to network together public and private research infrastructures in the life science industries (biotech, pharmaceutical and medical technology) with SMEs, who will be offered the opportunity to use these infrastructures for their scopes. The goal is to enable the access from SMEs to the vast diverse pool of research infrastructure available in Europe.

INTERBIO<sup>57</sup> is a project developing transnational networks among life science clusters located in France Portugal and Spain. The principal supporter of the initiatives is the EU through interregional funds for the South of Europe. The timeframe estimated to support the launch of the network spans over 6 years, 2007-2013. The focus is on the development of long lasting networks through policy favouring an active participation by the members, strengthen existing collaborations and enable synergies among key players. The network counts on five main partners and aim to make South-West Europe a competitive area for life science research.

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<sup>50</sup> Alps BioCluster - <http://www.alpsbiocluster.eu>

<sup>51</sup> ADEBA – Grenoble Alps Bio Network - <http://www.adebag.org>

<sup>52</sup> Lyonbiopôle <http://www.lyonbiopole.org>

<sup>53</sup> CEBR network - <http://www.cebr.net>

<sup>54</sup> One Nucleus - <http://www.onenucleus.com/>

<sup>55</sup> BioLago - <http://www.biolago.org/>

<sup>56</sup> FASILIS - <http://www.fasilis.eu/>

<sup>57</sup> INTERBIO - <http://www.interbio-sudoe.eu>

MedCoast Scandinavia<sup>58</sup> is a Norwegian/Swedish network organization grouping together the actors of the biomedical industry of the Gothenburg (SE) and Oslo (NO) regions. The network focuses on facilitating the collaboration among the principal actors in each cluster with the goal of favouring entrepreneurship and commercialization of innovative solutions. MedCoast Scandinavia is co-financed by local, regional public institutions and the EU through inter-regional program. In recent year, the network has been increasingly acting as facilitator for venture capital as well as foreign investors interested in investing in the regions. The network has close collaboration with local biomedical competence networks, GöteborgBIO<sup>59</sup> and Oslo Bio<sup>60</sup>.

One Nucleus<sup>61</sup> is a life science and healthcare network formed in 2010 with the merger of two existing regional life science networks, ERBI and LBN. The network is membership based counting more than 500 members from both the industry, and institutions active in the life science industries. The overarching goal of One Nucleus is to enable networking between the members and with outside organizations.

The Oslo Cancer Cluster's network<sup>62</sup> grows out of an established cluster organization aggregating actors active in the life sciences in the Oslo (Norway) region. Contrary to other networks, this network has a specific focus on Cancer research. The network is steadily growing internationally, especially within the EU. One of the initiatives originated from the collaboration Cancer-Bio-Santé<sup>63</sup> has been the European Cancer Cluster Partnering program, aiming to enable and facilitate collaboration in oncology research.

ScanBalt<sup>64</sup> was the first life science clusters network established in 2002. The network brings together cluster initiatives focusing on life sciences around the Baltic region. The founding members launched the network initiative to promote research, policy alignment among the participating regions and have one single point of dialogue for potential partners.

The Southern Europe Biocluster<sup>65</sup> (BSE) was founded in 2007 as a collaboration by the principal cluster initiatives located in the Pyrenees Mediterranean Euroregion, grouping together three regions in the north-east of Spain and two regions in the south-west of France, and financed by the Catalonia department of external affairs within the Euroregion program. In July 2010 the collaboration has been transformed in a formalized network. The network is established among the eight biotechnology and biomedicine clusters present in the members regions and the ministry of health of the Balearic Islands. The scope of the network is to establish a unitary international presence as well as acting as coordinator in the acquisition and running projects. To strengthen the ties among the network members several type of activities are planned throughout the year, joint events, seminar, and cross-

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<sup>58</sup> MedCoast region - <http://www.medcoast.org>

<sup>59</sup> GöteborgBIO (SE) - <http://www.goteborgbio.se/>

<sup>60</sup> Oslo Bio (NO) - <http://www.oslo.teknopol.no/English/TradeSectors/Life-Science/>

<sup>61</sup> One Nucleus - [www.onenucleus.com/](http://www.onenucleus.com/)

<sup>62</sup> Oslo Cancer Cluster – <http://www.oslocancercluster.no/Default.aspx>

<sup>63</sup> Cancer-Bio-Santé - <http://www.cancerbiosante.fr/>

<sup>64</sup> ScanBalt <http://www.scanbalt.org/>

<sup>65</sup> BSE - Southern Europe Biocluster - <http://www.bio-se.org/>

regional project to facilitate knowledge transfer. The principal event organized by the network is the Biotechnology and Healthcare Euro-Regional Meeting held annually.

## **National life science networks**

Several national Life Science networks have also emerged. National network have become increasingly popular to boost the competitiveness of adjacent regions. University networks principally bring together academic members aiming to collaborate on specific subjects and interested in creating collaborations with industrial actors. One last type of network is the one enable by network mediators, who are entities, specialized in offering access to their networks to external actors.

### ***National Networks***

Network Life Science<sup>66</sup> was established by Bayern Innovativ, the Bavarian centre for innovation and knowledge transfer, in the Bavarian region in the South of Germany where there is a high concentration of biotech research institutions and industries active. The network pursues knowledge distribution as well as fosters collaboration using different approaches ranging from an updated webportal, cooperation forums by research theme, congresses and one-to-one cooperation events. In addition it acts as mediator with other international networks to link-up potential partners. The network is sponsored by the state government and is complementary to the cluster initiatives active in the region.

Thames Valley Life Sciences Network<sup>67</sup> (TVLSN) is a network located in the South of the United Kingdom, specifically in the Thames valley, targeting Life Sciences and Healthcare industries. TVLSN goal is to foster entrepreneurial creation and innovation among its members as well as external parties. The network engages in networking events aiming to enable an easy access and collaboration between the members and external parties. The initiative is supported by the South East business innovation and growth agency through the “Solution for Business” program.

The Translational Medicine Research Collaboration<sup>68</sup> (TMRC) is a network constituted mainly by academic and research institutions, specifically four Scottish universities and four NHS trusts but also Scottish Enterprise and a top ten global pharmaceutical company. The actors participating in the network are currently mainly localized in Scotland. The goal of the network is concerned with translational research, the practice of moving basic research findings into new drugs and medical products for the market. The network is strongly supported by the Scottish government through the life science strategy, aiming to boost the competitiveness of Scottish clinical research.

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66 Bayern Innovation - <http://bayern-innovativ.de/lifescience/>

67 Thames Valley Life Sciences Network (TVLSN) - <http://www.tvlsn.org>

68 Translational Medicine Research Collaboration - <http://www.tmrc.co.uk>

## **From Life Science Network to Life Science Cluster**

Networks can be seen as a first step in formalizing collaborations among different actors, which in circumstance of geographical proximity among the actors may result into the creation of a full-fledged cluster organisation.

In Europe we found two examples of network initiatives, which evolved into cross-regional/national clusters, BioValley<sup>69</sup> and Eurobiomed<sup>70</sup>.

BioValley was launched in 1998 as a tri-national network linking together 300 companies, four universities, private institutions and a number of start-ups spread across three countries, namely France, Germany, and Switzerland. The initiative initially received a very strong support by the EU inter-regional funding, but also from national and local authorities as well as member contribution. After the first five years, thanks again to the support received from the EU, they started the process to shift from a network to a cluster leveraging the existing ties and strengthening them. The cluster has become an active actor in the region favouring cross-pollination among business, academic and political members exchanging knowledge and practices across borders.

Eurobiomed was established as cross-regional cluster network based in the south of France among three major life science clusters, namely Bioméditerranée, Holobiosud and Orpheme. The fund supporting the network came from national regional funds and inter-regional EU funds. The initial ambition of the network was to create synergies and to become a prominent actor in life sciences to attract research funding and expertise. The activities undertaken in the pursuit of the goals range from scientific seminars, networking events and fostering of collaborative R&D projects facilitating the identification of competencies within the network. The network successfully accomplished its goal and strengthened the ties among its partners becoming a cross-regional cluster from the beginning of 2009.

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69 BioValley - <http://www.biovalley.com/>

70 Eurobiomed Biocluster Méditerranée - <http://www.eurobiomed.org>

## About the European Cluster Observatory

The European Cluster Observatory, launched in June 2007, is the most comprehensive database and knowledge platform for clusters and regional competitiveness in Europe. It is managed by the Center for Strategy and Competitiveness ([www.hhs.se/csc](http://www.hhs.se/csc)) at the Stockholm School of Economics, and is funded by the European Commission, Directorate General for Enterprise and Industry.

The European Cluster Observatory website offers:

- Cluster mapping tools providing information on more than 40 cluster categories in over 250 European regions
- Regional competitiveness data and regional framework conditions
- Information, maps and lists of cluster organisations, science parks and other types of organisations involved in clusters
- A library that works as an open European depository for various cluster-related documents
- Reports on regional competitiveness, clusters, cluster policies and transformation of the European economic landscape

Please visit the European Cluster Observatory at [www.clusterobservatory.eu](http://www.clusterobservatory.eu).

