SPINVERSE
Capital & Consulting

Economic Report

Public Funding of Nanotechnology

June 2010

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1. Methodology

1.1. Definition

For the purposes of this report, nanotechnology is defined as "the study of phenomena and fine-tuning of materials at atomic, molecular and macromolecular scales, where properties differ significantly from those at a larger scale."[1] The specific focus of this report is on public funding of nanotechnology.

1.2. Methodology for Preparing the Report

The development of this report has been a three stage process. Desk research using publicly available sources of information was used to produce a first version of this report. Input and feedback is then sought from experts, via questionnaires, interviews and discussions, and from the ObservatoryNano symposium which takes place in March 2009. A final report is then produced, which synthesises the desk research and external expert input.

1.3. Methodology for Quantitative Assessment

Quantitative assessments of market size, growth rates, and the current market shares of nanotechnology enabled products are developed using external data sources such as market research providers, industry groups, and individual experts. Estimates and market size projections that are made by the authors of this report are clearly marked as such.

All forward looking estimates are necessarily a projection, and are therefore subject to error within the market models themselves, as well as to unforeseen external events. In particular, the current economic crisis has forced countries and companies to significantly adjust their growth forecasts – in most cases, this will not have been taken into account in projections which date from before 2008.

2. Trends and Development

This report is produced in early 2009, nearing the end of a decade in which billions of Euros have been committed by public funding agencies, national governments, and multinational organisations to the development of nanotechnology. The rest of this report contains a more detailed look at the activities of a number of countries, both inside and outside Europe. Before looking at individual cases, it is possible to extract some of the key themes that mark the development of public funding of nanotechnology.

Globally, public funding is yet to peak

Looking globally, it is clear that public funding of nanotechnology has yet to peak. Significant new funding is coming from countries which had yet to elaborate a nanotechnology strategy; Russia being the clearest example. Countries which have had longer funding commitments are continuing to increase their investment, albeit at slower rates of growth; US funding increased by 2.4% to US$ 1,527 million in 2009.

The uncertainty on the horizon is the effect of the current economic downturn. In some cases stimulus packages have increased the amount of funding available, though this affects nanotechnology indirectly – improving university buildings, or increasing the market for solar power. However, a combination of increased public spending and decreasing tax revenue may place a squeeze on public funding in the mid term, and any large public funding programme will be under greater pressure to justify its existence and generate tangible returns.

Individual national programmes are coming to an end

Some of the longer running European nanotechnology programmes are coming to an end; NanoNed in 2009, and Finland's FinNano in 2010. The question of what will follow these large and broadly successful initiatives is understandably preoccupying organisations in those countries. What seems clear is that there is commitment that the gains; the networks, the research base, the facilities, should not be abandoned. Developing models to sustain these, in the case that public funding input decreases in those countries, is a key challenge.

Developing industrial investment and commercialisation remains the primary challenge

The concern of almost every policymaker is how to develop the commercialisation of nanotechnology research, and specifically how to ensure that public funding acts to leverage increased industrial investment in nanotechnology. Even Japan, the country with second highest absolute amount of industrial investment, still reports some frustration about inefficiencies in the technology transfer process.

Countries are approaching this in different ways. Russia arguably has the most direct model; direct equity investments into promising companies, at a lower cost of capital and with longer term agreements than the private sector would offer. France is directly a very large sum of money (around €450 million) to single industry/research partnership, the Nano2012 programme. This is then being matched with a funding commitment from the companies involved.

Another model is to make funding more focused on the development of whole value chains. The Inno.CNT programme in Germany is an example of this; 80 partners are organised into 18 projects which are each targeted to a specific nanomaterial application (e.g. CarboInk, developing electrically conductive inks for solar panels). Finland is increasingly directing funding to industry clusters, which are largely technology agnostic – the metal industry cluster would seek to develop all range of relevant technologies, whether or not they are classically 'nano'.

Health, safety and environmental issues are receiving some attention

Funding agencies are also keen to mention that they are paying attention to HSE and ethical concerns. Austria has a NanoTrust programme, and the Netherlands directed €5 million of the NanoNed budget to a technology analysis project which studied the intersections between technology and society. An argument has been made that whilst HSE concerns are mentioned, research in this area accounts for a low share of total funding. This situation may also be changing; EHS research in the US National Nanotechnology Initiative accounted for 2.9% of the total 2005 budget, rising to 5% in 2009 (US$ 76.4 million).

3. Profiles of Selected European Countries

3.1. Germany

Germany has the highest public sector investment in nanotechnology of any European country, second only to the European Commission. The German Ministry of Education and Research (BMBF) claims that over half of all European nanotechnology companies are based in Germany, with the BMWi identifying 600 (mainly small) companies. Public investment in Germany reached €330 million in 2006, following regular annual increases of 5-10%.

Nanotechnology development is guided by the Nano Initiative Action Plan 2010, which like the US NNI sets a framework for the activities of seven German Federal ministries. The main aim of this action plan is to improve the interface between research and implementation, and to open up new markets. This is being approached with a variety of measures, including branch-level industrial dialogues which highlight the research needs of particular sectors, describe application scenarios and constructs complete value chains. Other priorities of the Action Plan include keeping the public informed, ensuring responsible development, and identifying future demands for research.

The Federal Ministry of Labour and Social Affair (BMAS) has an interest in nanotechnology both as a technology which will influence future economic development in Germany, and as a topic in occupational health and safety. The Federal Ministry for the Environment, Nature Conservation and Nuclear Safety similarly has a dual interest; the potential for nanotechnology to improve resource efficiency and improvements in environmental protection, as well developing greater understanding of the effects of nanoparticles on people and the environment.

Key Organisations:

Federal Ministry of Education and Research (BMBF)

Federal Ministry of Labour and Social Affair (BMAS)

Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU)

Federal Ministry of Food, Agriculture and Consumer Protection (BMELV)

Federal Ministry of Defence (BMVg)

Federal Ministry of Health (BMG)

Federal Ministry of Economics and Technology (BMWi)

Key Documents:

Nano-Initiative Action Plan 2010
http://www.bmbf.de/pub/nano_initiative_action_plan_2010.pdf

3.2. France

Funding for nanotechnology research and development in France comes from several sources. The National Research Agency (ANR) supports a number of nanotechnology programmes, including Pnano, Materials and Processes, and Health, Environment and Health Work, which considers nanoparticles toxicity.

France has three networks for advanced research (RTRA) which include nanotechnology in their research. These include the Triangle of Physics in the Paris area, the Strasbourg-based International Center for Frontier Research in Chemistry, and the Nanosciences Foundation in Grenoble (www.fondation-nanosciences.fr). The latter includes 32 laboratories in the Grenoble area, accounting for around 1000 researchers.

France's Nano2012 programme is intended to develop technology to design and produce the next generation of integrated circuits. The industry/research alliance is driven by STMicroelectronics and has received € 450 million from the French government. The total cost of the programme is €2 billion.

Key Organisations:

National Research Agency (L'Agence nationale de la recherché - ANR)
http://www.agence-nationale-recherche.fr/

Foundation Nanosciences

http://www.fondation-nanosciences.fr

Triangle of Physics
http://www.triangledelaphysique.fr/

International Center for Frontier Research in Chemistry – Strasbourg
http://www.cirfc.fr/

3.3. Finland

The Finnish nanotechnology programme, FinNano, ran from 2005 to 2010 and had a total budget of €70 million, of which Tekes, the National Funding Agency for Research and Innovation, commited €45 million. FinNano funded cooperative, innovative and risk-intensive projects, preferably with a strong industrial component. Target sectors included ICT, Health and Wellbeing, Energy and Environment, the Metals industry, and the Forest Cluster.

A biannual survey of Nanotechnology in Finnish Industry is carried out by Spinverse for Tekes. This study found that there were currently 202 active Finnish nanotechnology companies at the end of 2008, compared to 61 that existed in 2004. Of these companies 65 had commercial products or processes in 2008 (compared to 27 in 2004). A 'nanotechnology company' in this sense is defines as a company which has commercial products, research and development activities, or a strategy for how nanotechnology will impact their business.

Revenue from nanotechnology-related products and activities were estimated at € 300 million in 2008, with employment of 3-4,000. Industrial funding (at € 56.6 million) exceeded public funding (€38 million) and venture capital (€ 9.5 million).

3.4. Sweden

Despite not having a formal nanotechnology programme, Sweden has directed public funding to the sector. Interest in nanotechnology began in the 1980s with the Micronics programme, followed by materials research consortia in the 1990s.

During this decade, Sweden has directing funding from a number of sources, including five national agencies and three foundations:

- the Swedish Research Council;
- VINNOVA (The Swedish Governmental Agency for Innovation System)
- The Swedish Research Council for Environment, Agricultural Sciences and Spatial Planning (Formas)
- The Swedish Energy Agency
- The Swedish Defence Research Agency (FOI)

Foundations:

- SSF, Foundation for Strategic Research
- KK-stiftelsen, The Knowledge Foundation
- MISTRA, the Foundation for strategic environmental Research

Together with the European Commission and the Nordic Innovation Centre, these organisations have committed approximately € 50 million in 2007. This has resulted in a structure in which there are 100 industrial actors and 15 universities engaged in nanotechnology-related activities. There is a debate in the country about the about to which the lack of an identified national programme has hampered development; whilst it has resulted in 'under-labelling' of nanotechnology activities, research and industrial activities is still relatively widespread.

3.5. Norway

In contrast to Sweden, Norway has a large scale programme on nanotechnology and new materials, called NANOMAT. This is one of seven such programmes (others address climate change, management of petroleum resources, aquaculture, for example) which each have a long term funding commitments and are targeted to research and technology development, as such involving research centres and companies.

The NANOMAT programme runs from 2002 -2016 and aims to develop world leading research in specific areas, to provide a basis for innovation and growth, and to promote commercialisation. The budget for the programme in 2008 is €8.4 million, with €10.9 available for funding. Total funding from NANOMAT to projects has been €74.7 million.

The programme has four thematic areas:

- Energy and environment
- ICT and Microsystems
- Health and biotechnology
- Sea and food

Cross functional competences are being developed, including nanostructured materials and surfaces, and ELSA including health safety and environment. Just less than 50% of total funding has been allocated to the first two thematic priorities, Energy and ICT, with 42 projects funded in this area. Another large funding category is the expertise area 'New Functional and Nanostructured Materials', which has received €17.8 million for 42 projects. The intriguing 'Ocean and Food' thematic area has received just € 0.8 million for two projects. 104 projects are running in total.

3.6. Austria

The Austrian Nano Initiative began life in March 2004, following a 2002 recommendation from the Austrian council for research and technology development for targeted support of nanotechnology. The Initiative has a budget of €35 million and targets research funding, networking, education and training. It is intended to spam research and industry, focusing on basic and applied research and pre-competitive development.

Austria has also issued seven calls for specific project clusters, such as NANOCOAT (Development of Nanostructured Coatings for the Design of Multifunctional Surfaces) in 2004. The goal of this project is to develop knowledge for "load orientated design of coatings and surfaces". The project is coordinated by Materials Centre Leoben and has funded eight projects with €3.2 million over two years.

Additional funding for nanotechnology comes from the following agencies:

- The Austrian Research Promotion Agency (FFG), €8 million
- The Austrian Science Fund (FWF), €6 million
- Federal States, €0.3 million

These figures represent a yearly average.

The Austrian Nano Initiative also includes the project NanoTrust, which is intended to survey the state of knowledge regarding potential risks of nanotechnology, to act as a clearing house for information, and to promote discussion.

3.7. United Kingdom

The United Kingdom lays claim to one of the earliest nanotechnology programmes, the LINK Nanotechnology Programme (LNP) National Initiative on Nanotechnology (NION). This was an initiative of the then Department of Trade and Industry (DTI) which began in 1988, and which directed around GBP 11.5 million over its lifetime. A contemporary assessment judged that the project had been relatively successful.[2]

After a lengthy interlude, in 2003 the former Science Minister Lord Sainsbury announced that GBP 90 million would be directed to funding nanotechnology commercialisation over the following six years. GBP 40 million was allocated to capital projects, which formed the basis for the current MNT Facilities Network. The intention of this project was to create a distributed network of facilities, which were intended to form a coherent national portfolio of capabilities – rather than being primarily intended for national development. The remaining GBP 50 million was allocated to collaborative research and development projects by the DTI.

In 2007 the Nanotechnology Knowledge Transfer Network (KTN) was established to continue these activities by facilitating interactions between organisations in the UK, as well as to provide input to future policy decisions. The Nanotechnology KTN is now under the auspices of the Technology Strategy Board, which is responsible for all 24 KTNs. The Technology Strategy Board was established in 2007 as an executive non-departmental public body, sponsored by the Department for Innovation, Universities and Skills.

The Technology Strategy Board published its Nanoscale Technologies Strategy 2009-12 in October 2009. The strategy directs funding to nanotechnologies which address one of three specific challenges; Living with Environmental Change, Living with an Ageing and Growing Population, and Living in an Intelligence, Connected Modern World.

Key Organisations:

Technology Strategy Board

http://www.innovateuk.org

Key Documents:

Nanoscale Technologies Strategy 2009-12

http://www.innovateuk.org/_assets/pdf/Corporate-Publications/NanoscaleTechnologiesStrategy.pdf

3.8. The Netherlands

The Netherlands has had one of Europe's most high profile nanotechnology programmes, NanoNed. The project partners include eight research centres and Phillips Electronics. Three further research centres are cooperation partners of the project.

The programme has a total budget of € 235 million, of which 50% is provided by a grant from the Dutch government. € 80 million of the NanoNed budget is directed to an infrastructure element called NanoLab NL, and €5 million to a technology assessment programme which is intended to 'improve the interaction between science, technology and society'.

The largest element of the project budget, €150 million goes to 11 'Flagship' programmes, which as of 2007 contained a total of 185 projects:

- NanoFabrication, 13 projects, lead by University of Twente

- NanoSpintronics, 22 projects, TU Eindhoven
- NanoFluidics, 24 projects, University of Twente
- Nanophotonics, 22 projects, AMOLF
- NanoInstrumentation, 18 projects, TNO
- Advanced NanoProbing, 15 projects, Radboud University
- NanoElectronic Materials, 25 projects, U Twente
- Bottom-Up Electronics, 12 projects, RU Groningen
- BioNano Systems, 13 projects, BioMade
- Chemistry and Physics of Individual Molecules, 12 projects, RU Groningen
- Quantum Computation, 9 projects, TU Delft

In 2009 it was announced that 125 million Euros in funding for nanotechnology R&D would be allocated from the Fonds Economische Structuurversterking (FES), under the auspices of the programme 'Towards a Sustainable Open Innovation Ecosystem'. This funding resulted in large part from the development of the Strategic Research Agenda of the Dutch Nano Initiative, which had been drawn up by Nanoned, FOM and STW. The total budget for this initiative is 300 million Euros, with the remaining 175 million coming from participating universities, institutes and companies.

4. Profiles of Other World Regions

4.1. Russia

The Russian Corporation of Nanotechnologies (RUSNANO) was established in 2007 with a commitment of 130 billion roubles from the Russian government. The organisation has an explicit focus on the commercialisation of nanotechnology, though it takes a fairly broad view of this mission, funding projects in three areas:

- 'Nanoproduct' fabrication
- Scientific forecasting and roadmaps, standardisation, certification and safety
- Education and popularisation

The bulk of the financial commitment; 3.28 billion USD is directed to Nanoproduct fabrication, with 0.54bn for education and 0.82bn for infrastructure, foresight, certification and standardisation. Investments are being ramped up to reach a level of 1.05 billion USD by 2012.

Applications for projects are submitted to RUSNANO and assessed on their investment and scientific potential. Applications are reviewed by an external Technical and Scientific Board, and an Industrial Policy Committee, with final decisions being made by RUSNANO's Supervisory Board. Funding decisions which involve sums in excess of 1.3 billion roubles (1% of the organisation's funding) are made by the Advisory Board.

The organisation essentially operates like a large venture fund, taking equity stakes (of less than 50%) in the projects to which it invests. Funding support is long term – over 10 years. The organisation states that when exiting it plans to sell to offset investment costs, rather than seeking to maximise profit.

By end 2009, RUSNANO had approved 61 projects, committing to investment of €2.4 billion (92.4 billion roubles). The organisation predicts that by 2015 the volume of nanotechnology production will reach 900 billion rubles per year (19,8BEUR), from a current volume of 4-5 billion rubles annually (88MEUR).[3]

4.2. United States

The National Nanotechnology Initiative was established in 2000 and links 25 Federal Agencies whose work relates to nanoscience and nanotechnology. Overall authority for management of the NNI lies with the White House's Office of Science and Technology Policy. The NSET subcommittee coordinates the development of the NNI strategic plan, and the National Nanotechnology Coordination Office (NNCO) provides technical and administrative support, produces reports, and is a point of contact for the public.

NNI investment in the period 2001-2009 totals almost $10 billion, with an annual budget that has increased from US$ 464 million in 2001 to US$ 1,527 billion in 2009 (requested). Funding is allocated to the Federal Agencies responsible for this project, with the largest recipients in 2009 being:

- Department of Defence, US$ 431 billion
- Department of Education, US$ 311 billion
- National Science Foundation, US$ 397 billion
- National Institutes of Health, US$ 226 billion
- National Institute of Standards and Technology, US$ 110 billion
- Other Organisations, US$ 52 billion

Funding can also be broken down by Program Component Area (PCA) which gives some indication of the target of each funding element:

1. Fundamental Nanoscale Phenomena and Processes US$550.8 billion
2. Nanomaterials, US$227,2 billion
3. Nanoscale Devices and Systems, US$327,0 billion
4. Instrumentation Research, Metrology, and Standards, US $81,5 billion
5. Nanomanufacturing, US$62,1 billion
6. Major Research Facilities and Instrument Acquisition, US$161,3 billion
7. EHS, US$76,4 billion
8. Education and Societal Issues, US$40,7 billion

One of the effects of the NNI has been the creation of the National Nanotechnology Infrastructure Network (NNIN), which involves 13 universities and houses 700 tools which are accessible for the wider research community. The NNI has also directed an increasing share of budget to Environment Health and Safety research. US$ 34.8 million was directed to EHS in 2005, rising to US$ 76.4 million in 2009.

The recent stimulus package also contains elements which may assist the development of nanotechnology, placing an emphasis on clean energy sources and infrastructure upgrades. The newly confirmed director of the Office of the Science and Technology Policy, John P. Holdren, commented that:[4]

> …he was gratified that the stimulus bill passed by Congress recognized the importance of ongoing investments in innovation by including crucially needed funding for an array of science and engineering efforts with large potential payoffs for society – biotechnology, nanotechnology, information technology, renewable energy, and more efficient cars and buildings, among others. Also important, he noted, is that a portion of the recovery package is designated explicitly for high risk/high-reward research — “the kind that, when successful, proves truly transformative.”

For 2011, the National Nanotechnology Initiative has requested $1,8 billion, mainly to DOE, NSF, HHS/NIH and DOD. $511 million for nanotechnology was included in the Recovery Act stimulus package

4.3. Japan

The main bodies in Japan's innovation system are the Minister of State for Science and Technology Policy, and the Council for Science and Technology Policy in the Cabinet Office, in addition to seven Ministries with S&T responsibilities. These include the Ministry of Economy, Trade and Industry (METI) under which falls the large New Energy and Industrial Technology Development Organization (NEDO). The Ministry of Education Culture, Sports, S&T (MEXT) oversees the Japan Science and Technology Agency *(JST)* and the Japan Society for the Promotion of Science (JSPS).

Japan is currently nearing the end of its 3rd Basic S&T Plan, which runs from 2006-2010. This plan has a total budget target of 25 trillion Yen (€162 billion), equivalent to 1% of Japan's GDP. One of the four priority areas of this plan is Nanotechnology and Materials; a priority originally introduced during the 2nd Basic Plan. Spending on nanotechnology research has been:

- 76.2 billion Yen (~ €494M) in Financial Year 2006
- 78.6 billion Yen (~ €510M) in Financial Year 2007
- 86.5 billion Yen (~ €562M) in Financial Year 2008

This level of funding is projected to be maintained until 2010. The nanotechnology and materials priority areas have been further broken down into ten strategic priorities:

- Materials for reducing costs of clean Energy
- Materials for replacing rare or deficit materials
- Nanotech and Materials supporting security and safety
- Materials for innovation
- Electronics for Break-through Devices
- Nano-biotechnology and Nano-medical Technology for very early diagnosis
- R & D for the Social Acceptance of Nanotechnology
- Advanced R & D at Innovation COE's for commercialization of Nanotechnology
- Nano-measurement and Nano-Processing technology
- X-ray Free Electron Lasers

Japan has seen high industrial investment in comparison to Europe – US$ 4.7 billion in 2005. However, concerns remain that the efficiency of the technology transfer process could be enhanced, with the International Advisory Committee for the evaluation of JST Basic Research Program reporting that Japan has seen "excellent scientific outcome, but some frustration in tech-transfer to innovation".

One of the efforts to investigate EHS issues has been the NEDO project "Risk Assessment & Management of Manufactured Nanomaterials", which runs from 2006-2010.

5. References

[1] Introduction to Nanotechnology, http://ec.europa.eu/nanotechnology/index_en.html

[2] http://www.berr.gov.uk/dius/innovation/innovation-statistics/evaluation-reports/page10795.html

[3] http://bfm.ru/news/2009/02/25/chubajs-rosnano-budet-prinosit-900-mlrd-rublej-k-2015-godu.html

[4] http://ostp.gov/galleries/press_release_files/holdren_confirmation_release_3-20-09.pdf