PROJECT FINAL REPORT

Grant Agreement number:	**CSA-SA 247967 NanoCom**
Project acronym:	**NANOCOM**
Project title:	**Lowering the Barriers to the Commercialisation of Nanotechnology**
Funding Scheme:	**Seventh Framework Programme, Theme NMP2009-1.2-5**
Period covered:	**from 1 December 2009 to 30 November 2012**

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1 Summary

Grant Agreement number:	CSA-SA 247967 NanoCom
Project acronym:	NanoCom
Project title:	Lowering the Barriers to the Commercialisation of Nanotechnology
Funding Scheme:	Seventh Framework Programme, Theme NMP2009-1.2-5
Project Start:	01 December 2009
Project Duration:	36 months

NanoCom Vision

The NanoCom coordinated action will contribute to bridging the gap between lab based and industrial applications in nanotechnology by creating a European wide approach and mechanisms for lowering the barriers and spreading best open innovation practices for rapid commercialisation and investment in innovative nanotechnology driven products.

The NanoCom project mobilised resources from 16 partners across 10 European countries, including research partners, venture finance organisations, large industrial companies and SMEs, and Technology Clusters. The strong industrial drive within the project ensured that NanoCom met the challenges of commercialisation of nanotechnologies and the direct exploitation of the results across Europe.

The NanoCom project utilised a systematic approach, based on delivering five major outputs over the 36 month timeline:

- Identification of barriers to commercialisation and analysis of best practices.
- Open Innovation Model for rapid commercialisation.
- Programme of networking and dissemination events in support of open innovation.
- Commercialisation forum including an e-Portal with support services and Innovation Training Factory to deliver the required change in attitudes, thinking and commercial proficiency of key players in the innovation process.
- Commercialisation Guidelines, Strategic Roadmap and Policy Advice Framework to support the EU and national governments in increasing successful commercialisation of nanotechnology research.

In its approach, the NanoCom project delivered a radical shift from approaches based on passive studies and events towards the development of a pro-active environment based on proven principles. This delivered integrated solutions in terms of commercialisation readiness assessment, adaptable open innovation methodology and a portfolio of practical implementation measures as well as training and dissemination activities in support of accelerating value creation through nano manufacturing.

Further information on the project and public deliverables may be obtained from the project website at www.nanocom-eu.org

2 Project Context and Objectives

2.1 Motivation

The projected economic and societal benefits of nanotechnology have propelled global investments by nations and companies[1]. Efforts to develop and commercialise nanotechnology face a variety of challenges: technical hurdles, availability of capital, environmental, health and safety concerns, and immature manufacturing technology and infrastructure. Figure 1 indicates some examples of the application of nanotechnologies from a technologies push and market pull perspective.

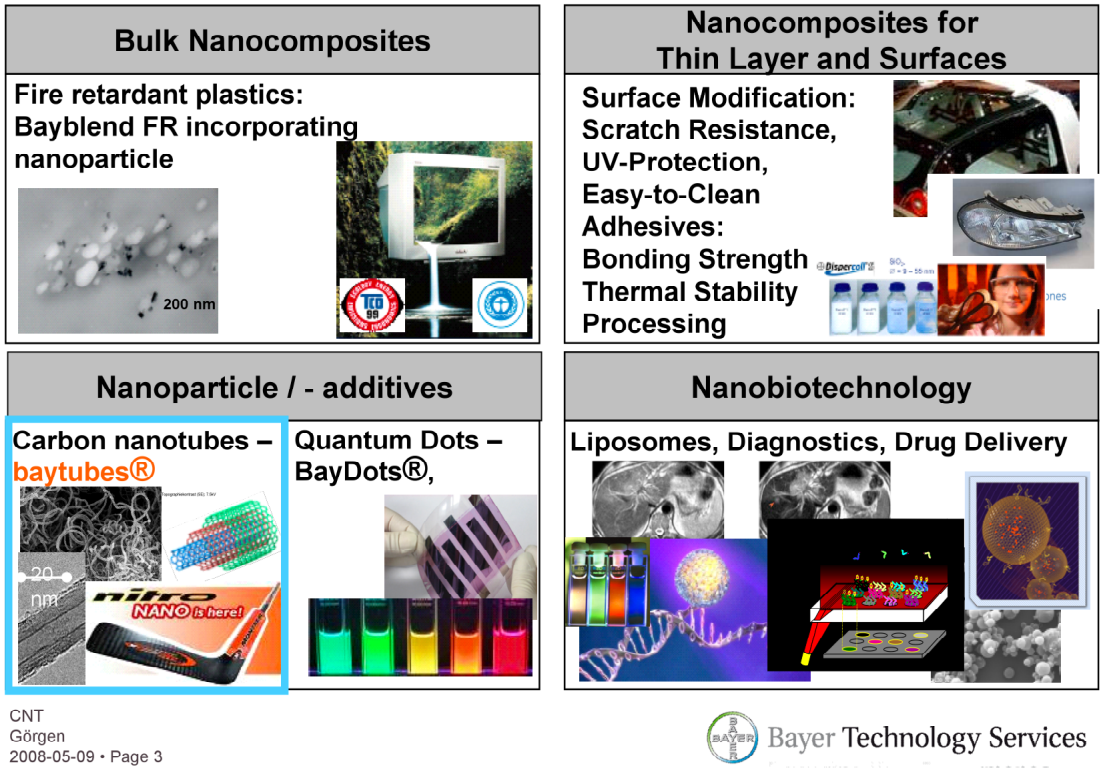

Figure 1. Core Areas of Nanotechnology Research (source: Bayer Technology Services GmbH)

Nanotechnology is heavily science-based, requiring theoretical understanding and specialist equipment[2]. This means that developments are made at universities, research centres and corporate laboratories. The 'product' at this stage is intellectual property, which may take the form of a patent; an exclusive right to exploit a technical innovation for a given period of time. The intellectual property is then developed by a company to become a saleable product.

Three areas of concern for Europe have been identified by previous studies[2]:

- A very low proportion (only 3.5%) of global nanotechnology venture capital is invested in Europe. The low level of venture capital is largely due to a shortage of suitable investment targets. Companies lack focused business models, commercial experience, and exit strategies. Whilst public funding sources may take the place of venture capital, the concern is that companies then

[1] J.F. Sargent, 2008, Nanotechnology and US Competitiveness: Issues and Options, RL34493, Congressional Research Centre, US

[2] Commercialisation of Nanotechnology – Key Challenges, Tom Crawley, Spinverse, http://www.spinverse.com/documents/NanotechCommercialisation_Helsinki_March07.pdf

lose the other benefits that investors would bring, such as in-depth industry understanding and networks.

- Despite public funding which is on a par with the US, Europe is lagging behind in the number of nanotechnology patents granted. The low patent productivity is a consequence of the difficulty in identifying the commercial potential of research, partly because research is not aligned to industrial needs. There are specific questions of motivation (publications being more highly prized) and patenting capability.
- Industrial investment in nanotechnology is also only half that of the US and Japan. The explanation for low industrial investment, despite the presence of nanotechnology 'global leaders' among European industry, is a failure to activate wider industrial interest. A company contemplating investment in a nanotechnology development will be dissuaded by the challenges (production scale-up, health and safety concerns) if they do not understand the less obvious opportunities that nanotechnology brings.

2.2 Vision and Key Objectives

Based on the project motivation, a number of critical factors were identified that needed to be addressed for successful implementation and commercialisation of nanotechnology. These included:

- Fragmentation of R&D and innovation efforts
- Critical underinvestment in nano-manufacturing research
- Rigid and complicated funding mechanisms
- Lack of effective technology and knowledge transfer routes
- Risk aversion and business growth barriers
- Lack of open innovation platforms in nanotechnology.

NanoCom set out to utilise a set of integrated measures and mechanisms to identify, analyse and address these barriers and offer advice to enable rapid commercialisation of nanotechnology research results.

The project aim agreed at the start of the project stated, 'The NanoCom coordinated action will contribute to bridging the gap between lab based and industrial applications in nanotechnology by creating a European wide approach and mechanisms for lowering the barriers and spreading best open innovation practices for rapid commercialisation and investment in innovative nanotechnology driven products.'

The following key objectives were set to support the project aim:

- Conduct a critical analysis of barriers for rapid commercialisation of emerging nanotechnologies that result from many complementary EC, national and industrially funded Research and Development (R&D) projects;
- Analyse and promote best practices via new nanotechnology and nano-manufacturing specific open innovation methodology and tools and provide roadmapping, policy and investment advice at EU, national and regional levels;
- Create a commercialisation oriented forum and mechanisms for coordinating the efforts of complementary R&D projects in ERA;
- Provide support for training and dissemination of best practices for open innovation and commercialisation of nanotechnology.

The NanoCom project outcomes target the creation of an open innovation approach and support environment for overcoming the barriers to commercialisation of nanotechnology results in

Europe as well as promoting and spreading best practices. The policy advice document and commercialisation guidelines issued by the project are directed at facilitating the development of a strong and thriving European nano-manufacturing sector.

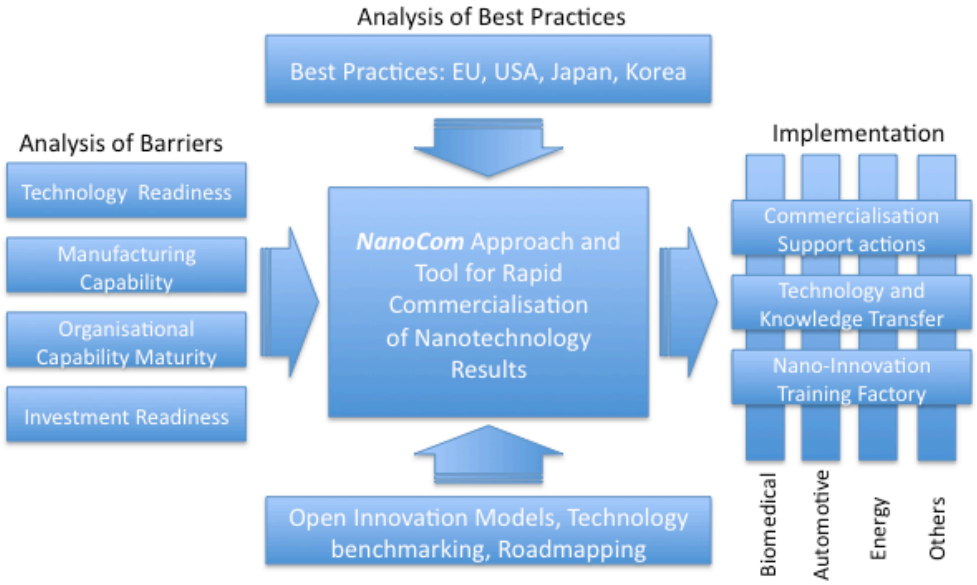

Figure 2. The NanoCom approach - an overview

The overview of the NanoCom approach (Figure 2) illustrates how the project addressed the analysis of barriers and best practises in order to implement fresh attitudes towards removing barriers and stimulating technology and knowledge transfer into new commercial applications and innovative products. A critical factor for success is overcoming the existing fragmentation of nanotechnology research and bridging the gap between research and industrial applications by providing a focused approach aimed at elevating research results to a pre-production level of maturity.

2.3 Approach

The NanoCom project adopted a systematic approach. Figure 3 provides a simplified overview of the project methodology based on delivering five major breakthroughs: (1) Identification of barriers to commercialisation and analysis of best practices; (2) Open Innovation Model for Rapid Commercialisation; (3) Programme of Networking and Dissemination Events in support of open innovation; (4) Commercialisation Forum and Innovation Training Factory to deliver the required change in attitudes, thinking and commercial proficiency of key players in the innovation process; and (5) A Strategic Roadmap and

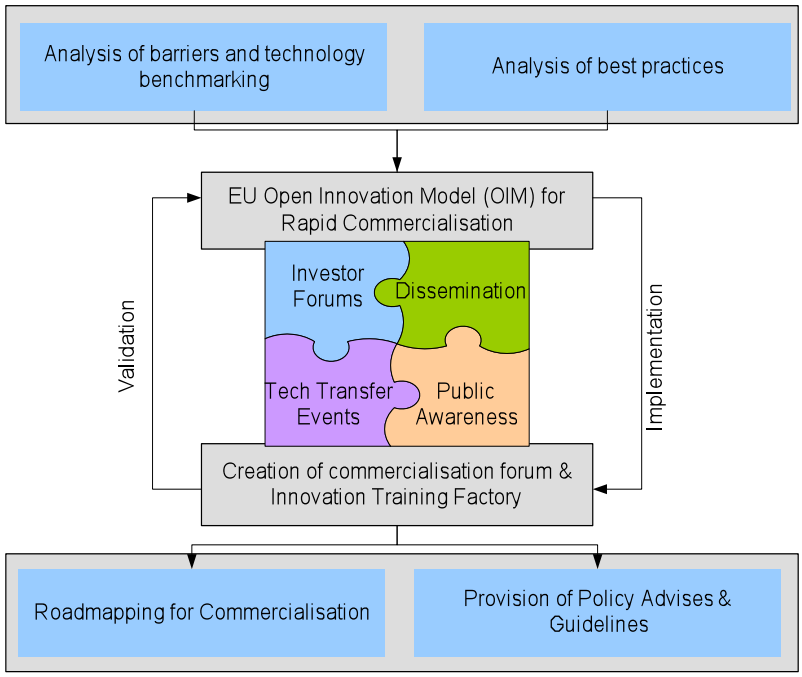

Figure 3: The NanoCom Methodology

Policy Guidelines to support the EU and national governments in increasing successful commercialisation of nanotechnology research.

With a strong interdisciplinary focus on current industrial requirements and future challenges, the barriers which prevent successful commercialisation of nanotechnology research have been identified and ranked using specific benchmarking techniques. Additionally, successful examples from other geographical regions and from other market sectors have been examined and adapted as potential best practices for improved commercialisation of nanotechnology in Europe whilst conducting an in depth SWOT analysis.

An Open Innovation Model for Rapid Commercialisation of nanotechnology research has been developed, taking into account the findings from the barrier and best practices analysis. Previous examples based upon the Open Innovation Principle show encouraging results in other or related business areas. Therefore, the implementation of this model constitutes an improvement for both academic research institutions and industry.

An intensive dissemination programme targeting all major stakeholders in nanotechnology focused the project networking aims. Related activities mobilised private investments for nanotechnology research and raised public awareness on the importance of this sector throughout Europe. The networking activities included regional networking events, investors forum, technology transfer events, scientific publications and fairs. In this context, an Innovation Training Factory was developed to implement core findings from the barriers and best practices analysis.

Finally, based on continuous dialogue within the wider nanotechnology community through the NANOfutures platform the project issued a strategic roadmap and comprehensive policy guidelines for the successful commercialisation of nanotechnology. These documents identified priority areas for research and development in Europe and included detailed timelines, milestones and decisions for commercialising nanotechnologies at European and national levels.

3 Project Results

At the start of the NanoCom project the expected key outcomes were summarised as follows;

'*In its approach the NanoCom project will deliver a radical shift from approaches based on passive studies and events towards the development of a pro-active open innovation environment based on proven scientific principles which will deliver integrated solutions in terms of commercialisation readiness assessment, adaptable open innovation methodology, a portfolio of practical implementation measures and training and dissemination activities in support of dramatic acceleration of value creation through nano manufacturing.*'

3.1 Public Documents

Whilst this section provides a summary of the main S&T results, the reader is directed towards the public documents that are downloadable from the NanoCom Project (www.nanocom-eu.org). These documents, issued at the end of the project, highlight the key findings and recommendations.

- Commercialisation Readiness Scale
- Commercialisation Guidelines
- Policy Advice Framework

3.2 Barriers to Commercialisation and Benchmarking

This package of work focused on performing a detailed identification and analysis of the barriers to commercialisation. A multidisciplinary approach was adopted with focus on the analysis of the results of collaborative nanotechnology research projects funded via FP6 and FP7 or through national or regional funding mechanisms. The study identified typical patterns and barriers related to different strategic industrial sectors and correlated these in the context of geographical regions in Europe. The identification of barriers to the commercialisation of nanotechnology was measured based on two scales: anchored scales and Technology Readiness Levels. Based upon these convergent approaches, it was possible to select and validate the most relevant barriers to the commercialisation of nanotechnology and publish a comprehensive SWOT analysis and proposed Commercialisation Readiness Assessment.

3.2.1 Analysis of Barriers, Success Factors and Common Challenges for Nanotechnology Commercialisation

The evolution of barriers was studied in relation to the readiness levels of the TRL (Technology Readiness Levels) scale. The methodology for the analysis of barriers relied on a set of building blocks grouped into the following main categories:

i) Commercial Development Parameters
   - Technology
   - Manufacturing
   - Marketing and strategy
   - Investment and organisation

ii) Innovation Management & Business Support Policies
   - Innovation management
   - Open innovation
   - Funding policies

Local support

Two surveys (30 answers from institutionally funded projects and 214 records from industry) provided sufficient data to evaluate the evolution of 'barrier importance' for the two main categories and building blocks as a function of TRL, as shown in Figure 4.

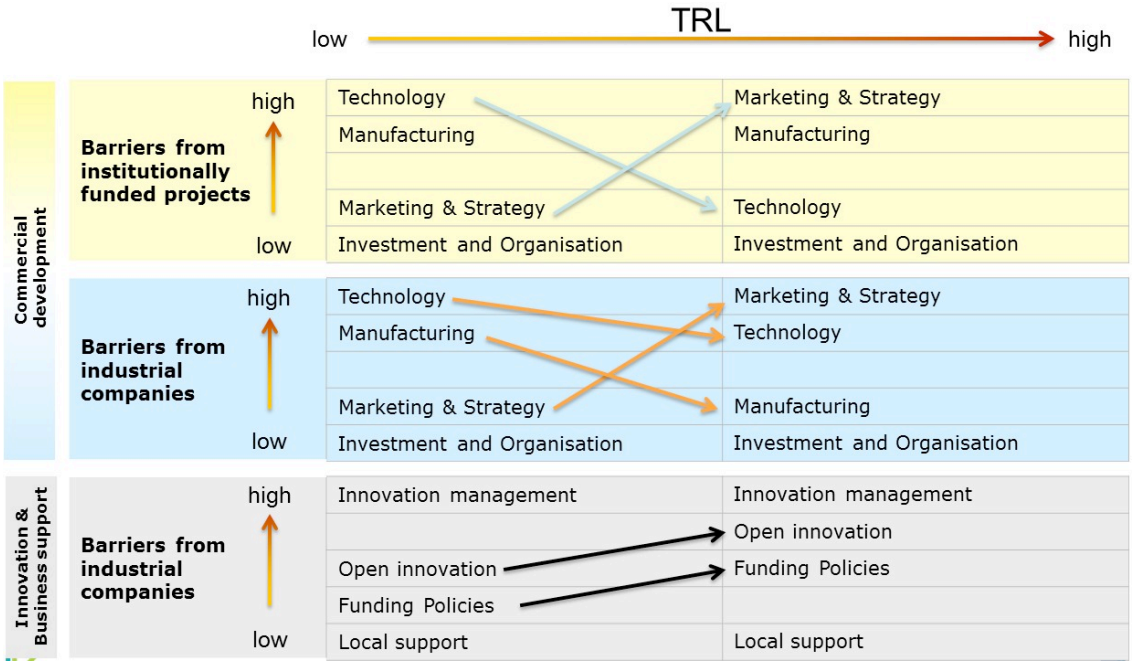

Figure 4. Evolution of the importance of barriers as a function of technological readiness level (TRL)

On performing further analysis, the main criteria responsible for the barriers were ranked as 'detailed barriers' in Table 1. The 'domain' column ranks the building blocks from 1 (extremely important) to 4 (moderately important).

Domain	Detailed Barriers
1 Marketing and Strategy More important at high TRLs	• **Acceptability** • Competition
2 Technology and Manufacturing More important at low TRLs	• **Reproducibility** • Reliability • Efficiency • Costs
3 Innovation Practices	• Organized **absorption of external knowledge** • Organized dissemination of innovations • R&D project management
4 Funding Policies	• National funding • EU funding

Table 1. Detailed Barriers to Commercialisation of Technologies per Domain (building block), ranked by importance

Success factors for the commercialisation of nanotechnology and common challenges faced by companies were also extracted from the surveys. Table 2 and Table 3 present the main results.

KEY SUCCESS FACTORS
• Strong **focus on business point of view**
• Good **R&D project management** and **organised** in-house innovation activity
• **Funding**
• **Collaboration** and **open innovation**
• **Production establishment**
• **Inclusion of services**
• **Regulations knowledge**
• Implementation of **successful business models**

Table 2. Key Success Factors for Nanotechnology Companies

COMMON CHALLENGES
• **Scientific Background** Nanotechnology is strongly science-driven
• **R&D Cost**
• **Applications** Companies (at low TRL) consider finding applications a challenge
• Finding the right **Team**
• **Time-to-market** (often underestimated)
• **Establishing Partnerships** Finding the right partners
• **Collaborations** Working with large companies that have ever-lengthening decision-making cycles

Table 3. Common Challenges for Nanotechnology Companies

3.2.2 Analysis of the Strengths, Weaknesses, Opportunities and Threats

From the cluster surveys, analysis of the barriers and success factors and review of national programmes in nanotechnology, three key results were identified and are summarised below in Figure 5 - Figure 7:

1. Different strengths per country

2. SWOT analysis chart
3. Global recommendations

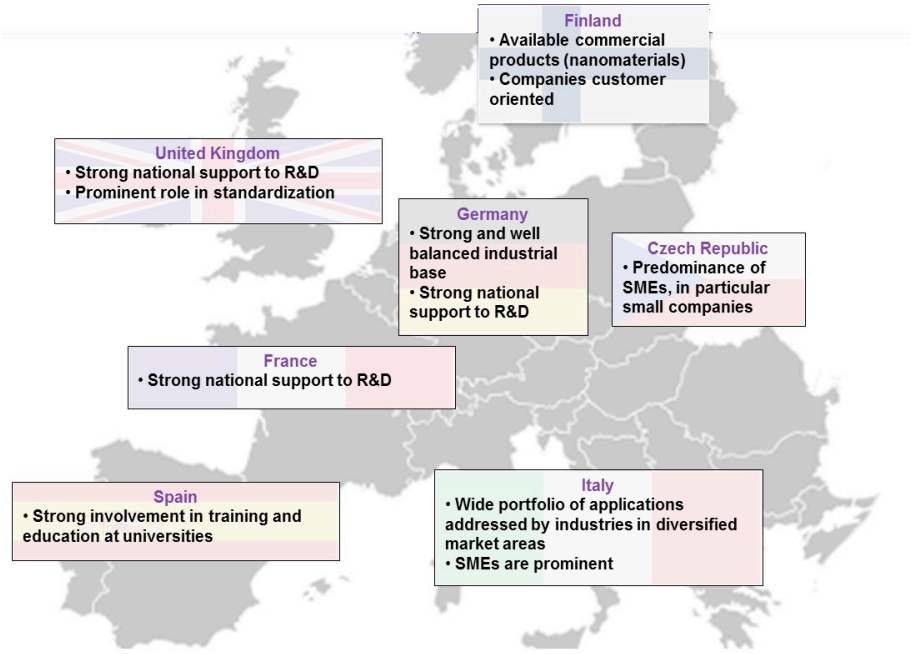

Figure 5. Different Strengths per Country

STRENGTHS	WEAKNESSES
• Highly active research area in Europe, with structured collaborations and recognized infrastructures • Public funding steadily growing • Nanotechnology helps European firms strengthen their competitive position • European leadership on nanosafety, risks assessment and EHS impacts	• Lack of market driven vision in R&D • Insufficient provision of private investment • Low "patent applications to scientific publications" ratio as compared with US and Japan
OPPORTUNITIES	**THREATS**
• Large number of potential applications • Opportunities for cross-sector and interdisciplinary approaches • Active standardisation working groups	• Strong non-European competitors (USA + Asia) • Low acceptability due to uncertainty on EHS impact

Figure 6. Global SWOT Chart for the Commercialisation of Nanotechnologies in Europe

- Base the innovation cycle on a **market driven approach**
- Increase awareness and attractiveness of nanotechnologies' benefits to **investors**
- Improve the awareness of the **strategic importance of IP**
- Improve **companies' position in the value-added chain**
- Be leader in the worldwide harmonization of **standards and competition rules**
- Make use of the higher **education system** to attract skilled personnel and improve companies' competitive position.
- Increase constructive and open **dialog with public** on nano safety
- Increase proactive and collaborative research into nano-specific **EHS issues**.

Figure 7. Global Recommendations

3.2.3 The Commercialisation Readiness Scale

The goal behind the Commercialisation Readiness Scale was to set up a nanotechnology commercialisation readiness scale integrating the four building blocks (or domains) which were used in the surveys in the commercial development parameter categories:

1. Technology,
2. Manufacturing,
3. Marketing and strategy,
4. Investment and organisation

The four building blocks have been divided into 7 steps (Figure 8), with market introduction occurring between steps 4 and 5. The commercialisation readiness scale details the progression of the four building blocks with respect to time, providing a tool to assist in reducing the time to market. The approach presented considers all of the building blocks simultaneously in the same graph.

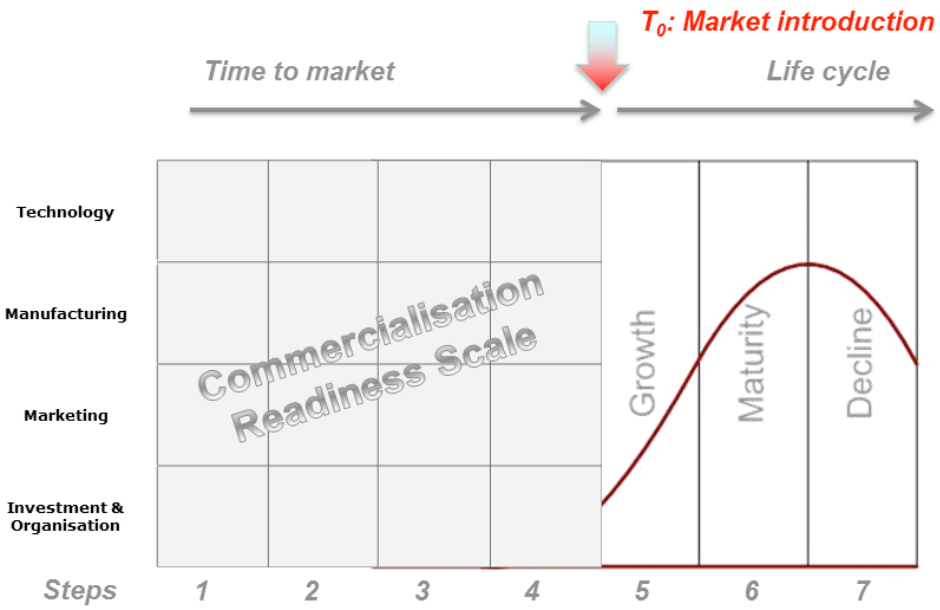

Figure 8. Schematics of the Global Nanotechnology Commercialisation Readiness Scale

This approach is a consolidation of well-known tools, such as Technology Readiness Levels (TRL scale), Manufacturing Readiness Levels (MRL scale), Product Life Cycle and includes the results of thorough discussions with the NanoCom industrial partners.

For any of the commercial parameters noted, the commercialisation process has to progress step by step. The barriers identified by the NanoCom project appear as specific issues between some steps, before market introduction. The market cannot be entered before each step is ready and issues overcome.

The following figures (Figure 9 and Figure 10) illustrate the specific steps referenced. Barriers identified from the analysis of survey results and interviews held during the NanoCom project are superimposed on the Commercialisation Readiness Scale in Figure 10.

				Market introduction			
Technology Readiness Level	Technology development and demonstration 4-6	Prototype demonstration 7	Qualified and tested demonstration 8	Ready to produce, preseries 9	Expertise acquisition Prepare 2nd generation	Incremental R&D, Define 2nd generation	Disruptive or incremental innovation (or exit)
Manufacturing Readiness Level	Producing in a relevant environment Take care of safety issues 4-6	Pilot line Take care of safety issues 7-8	Capability in place to begin full rate production Take care of safety issues 9	Full rate production demonstrated 10	Ramp-up management Optimisation of supply chain	Monitoring yield management Increase production efficiency	Production line termination Recycle or dismantle
Marketing, and communication	- Detailed market analysis done, - IP strategy done - Product introduction plan ready - Identify and meet customers - Identify competitors	- Pre-sampling Alpha test - Agreement with a leading customer	- Pre-announcement - Beta test, - External communication/ trademark - Competitiveness strategy	- Ramp-up forecast, - Product deployment strategy - Broad communication	- Manage competition - Increase awareness - Decrease prices	- Market saturation is reached, - Emphasize brand and differenciation	Increase distribution efficiency
Organisational & investment stages	Set up of a coordinate team, leaded by product manager Evaluate pilot line investment	Pilot line and scale-up investment, CAPEX, resource increase, find and involve key competencies (industrial operation, sales, supply chain, quality)	Identify production strategy and funding, risk analysis	Implement production strategy Sales and technical support force	Fine optimisation of the organisation Leaded by sales and marketing	Stable organisation ROI	Return on experience Investment to improve the production throughput ROI

Figure 9. The Global Nanotechnology Commercialisation Readiness Scale with detailed step-by-step descriptions for each building block (Technology, Manufacturing, Marketing, Organisation)

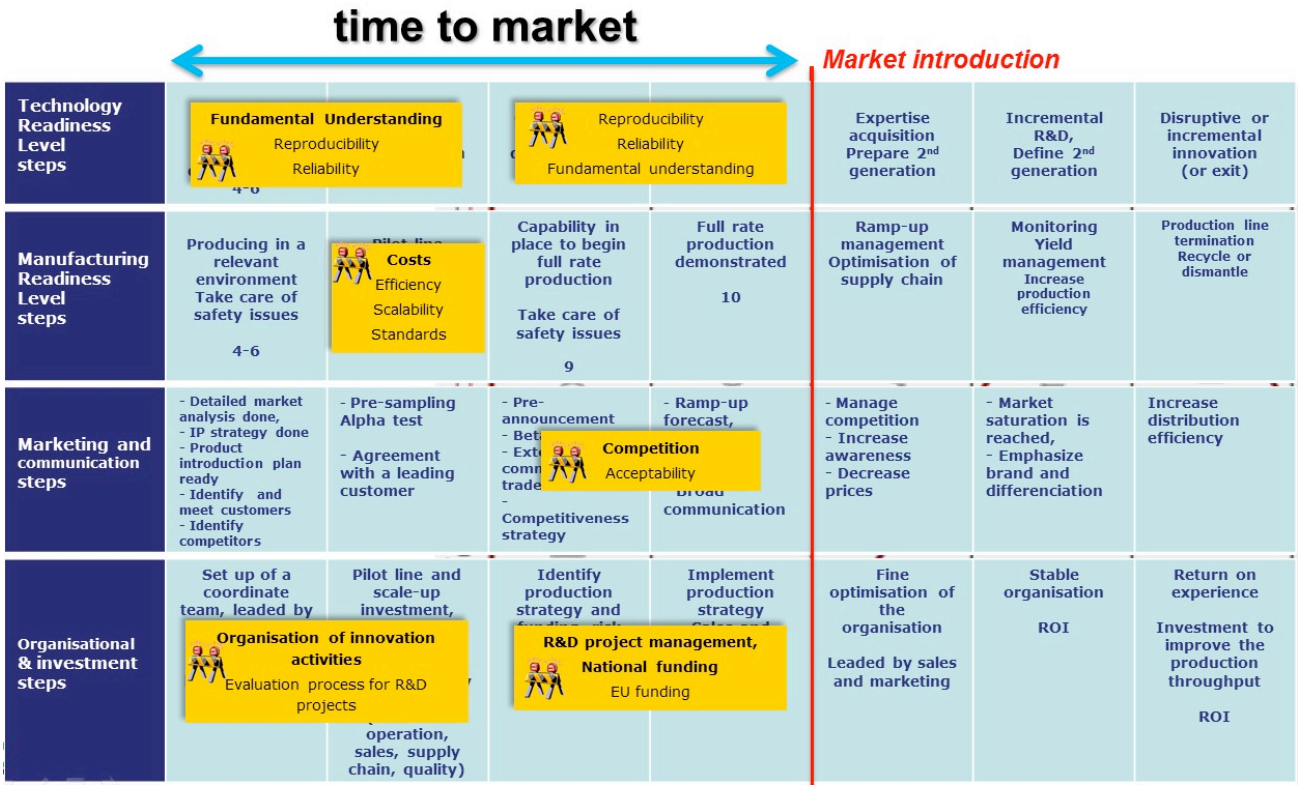

Figure 10. The Global Nanotechnology Commercialisation Readiness Scale and the main barriers faced

3.3 Best Practices for Commercialisation

A second package of work focused on identifying successful innovation approaches to nano-technology and the key performance characteristics of European manufacturers (whilst also comparing them with the best of the rest in the world). Investigations specifically addressed issues related to technology and organisational capability maturity levels, innovation models, investment patterns, risk management, contracting and development of an open innovation model for rapid commercialisation of nanotechnology results. Based on the analysis of best practice criteria and the SWOT results a strategic roadmap, commercialisation guidelines and policy advice document for overcoming the barriers to commercialisation of nanotechnology have been issued.

In summary, Table 2 and Table 3 highlight the key success factors identified, as well as the issues and challenges faced by nanotechnology companies.

3.3.1 Best Practices and Key Success Factors in Investment and Commercialisation of Nanotechnology

Analysis of the success factor data input by companies into the NanoCom questionnaire indicated varying priorities across the spectrum. However, a set of commonly shared factors that were deemed critical to success were identified. The same success factors were also derived from examining the national nanotechnology commercialisation efforts of several leading countries. Although there is no universal or 'one size fits all' solution, all interviews mentioned common factors that can allow companies to keep sustainable competitive advantage. The list of key success factors is presented in **Error! Reference source not found.**.

Key Success Factor	Comment / Specific focus on…
1. Strong focus on business	• Attention to marketing and strategy issues • Networking with customers • Inclusion of services in the business model • Emphasis on product added value (not on technology)
2. Organised in-house innovation activities	• Specific focus to be paid towards R&D project management
3. Utilisation of local support as a competitive advantage	• Incubators, clusters, networks, R&D facilities, development agencies
4. Collaboration and open innovation	• At all phases in the product development cycle
5. Establishment of production mechanisms	• Focus on product reliability and reproducibility
6. Funding mechanisms	• No underestimation of funding issues
7. Strong activity around standards and regulations	• Investigation of current standards to avoid a situation where commercialisation would be hindered by regulation or safety issues • Participate in the creation of new standards
8. IP protection	• IP protection as a means to decrease commercialization risk

Table 4. Key Factors for Successful Commercialisation of Nanotechnologies

3.3.2 Challenges for Entrepreneurs in Commercialising Nanotechnology Funded Research

Entrepreneurship patterns in different strategic industrial sectors were analysed to identify common features for the successful commercialisation of technology developed in large collaborative public funded projects.

A total of 41 interviews were conducted across a wide spectrum of technical interest and expertise areas, organisation and/or investment fund size and target markets.

The results illustrate that researchers and entrepreneurs do see value in publicly funded projects. Common challenges across the interview responses are mapped according to the three key life cycle phases associated with a project. The key findings are summarised in Table 5.

Project phase	Challenges for Entrepreneurs
1. Project Conceptualisation & Design	• Entrepreneurs struggle to design a project to fit the topics outlined by the EC • Funding is necessary but is not a sufficient driver for participation. Opportunity for collaboration in areas of interest and with key players in the field is of utmost importance • Finding the right partner is key • Preventative measures around the protection of IP ownership are necessary

2. Project Execution	• Overcome administrative barriers • Researchers and entrepreneurs struggle to meet present EC goals and rigid milestones
3. Activity following Project Completion	• Public agency support is not specifically designed to aid commercialisation • Entrepreneurs also require more flexible funding over a period of time to bridge the gaps between 'research' and 'development'

Table 5. Challenges for Entrepreneurs for the Commercialisation of Nanotechnologies

3.3.3 Investors' Concerns and Key Decision Criteria

Analysis of the investor interviews highlights the fact that investors are ambivalent about value-added from publicly funded projects. The participation of a start-up in a publicly funded project is not viewed as a decision criterion for deciding to invest. The key elements extracted from the investor interviews indicate:

Investors' Concerns and Decision Criteria	Comment
1. Management Team and Business Model	Investors are drawn to companies with a strong management team and strong business model.
2. Risk Mitigation	The risks of market acceptance and longer time to market are associated with nanotechnologies.
3. Market Potential	Interest is in the market potential of the product, *not in the technology*. Investors have the same expectations for start-ups in nanotechnology as for any other start-up.
4. Expectations from Public Funding	Start-ups participating in a publicly funded project are expected to use the opportunity to increase their market value. Investors feel disconnected from the EC process in determining the research focus areas that will receive funding.

Table 6. Investors' Concerns and Decision Criteria

3.3.4 Open Innovation Model for Rapid Commercialisation of Nanotechnology

The mechanism by which open innovation practices can be applied to nanotechnology in order to improve the efficiency of commercialisation was also analysed. It was determined that in order to tackle the barrier of commercialisation, the broadcast search mechanism is the most suitable open innovation method to overcome this. Broadcast search aims towards more directed, target oriented research and also helps to improve matching between supply and demand of research. Nanotechnology is a platform industry and thus matching is a crucial element in improving commercialisation.

The key finding from both the questionnaire and success stories is that finding the right partner to cooperate with is the most crucial element in realising a successful open innovation strategy. Intermediaries, in particular technology transfer offices and innovation intermediaries can help to overcome these barriers by acting as a trusted third party, thus providing standard and easy to use contracts and linking between partners. However, collaboration is only useful (and will be exercised)

if it is mutually beneficial and this requires (complementary) knowledge and allocation of resources from all partners.

Based on the Open Innovation model, an open innovation based web portal was designed and implemented. This integrated web database connects markets, technologies, applications and products related to nanotechnology. The tool[3] is accessible via the NANOfutures website and is fully integrated with other related nanotechnology news feeds and portals.

3.3.5 Commercialisation Guidelines, Strategic Roadmap and Policy Advice

The Commercialisation Guidelines document[4] links the analysis conducted by the NanoCom project with related parallel activities to provide a detailed set of guidelines for planning a nanotechnology project and aiming for a commercial outcome from the outset. An overview of the contents page is illustrated in Figure 11. The document guides the user through a number of stages from identifying a business opportunity through to considering an Open Innovation model. The reader is directed to the web version of the guidelines document for further information.

Figure 11. Commercialisation Guidelines

The roadmap produced in parallel with the Commercialisation Guidelines is a strategic document that offers a comprehensive nano-commercialisation roadmap. It proposes short to longer term steps needed to address commercialisation success of EU developed nanotechnology.

The NanoCom roadmap is built on the results of the analysis of both barriers and success factors to commercialisation and is strongly linked to the policy advice issued by the project. The roadmap recommendations take into account the requirements and wishes of the European nanotechnology landscape regarding successful commercialisation of nanotechnologies. Together with the policy advice document the purpose of the roadmap is to provide a short- to long-term projection and outline for nanotechnology commercialisation through 2022.

[3] http://nanocom.nanofutures.info/

[4] http://www.nanocom-eu.org/NanoCom/Dissemination_files/NanoCom%20Commercialisation%20Guidelines.pdf

The roadmap is based on 54 identified and documented survey topics. The analysis of these 54 identified barriers for successful commercialisation led to a set of policy recommendations grouped into 16 barrier topics. The 16 barrier topics represent a high level overview of the challenges that the EU Nanotechnology players face regarding commercialisation of their technology. All conclusions are based on surveys, interviews and the views provided by the NanoCom consortium partners and the wider project network.

The 16 barrier topics are categorised according to the 4 building blocks defined earlier (barrier analysis) and further subdivided by criteria such as efficiency and cost (Manufacturing Domain), reproducibility or reliability (Technological Domain). The 16 barrier topics highlighted as needing to be addressed during the period 2012-2022 are detailed in Table 7.

Domain	**Criteria**	**Barrier Topic Description**
Manufacturing	*Efficiency*	1. Lack of available access to adapted equipment necessary for pre-production development
	Cost	2. Lack of investment in production capability (1M€ to 5M€ generally)
Technological	*Reproducibility*	3. Lack of investment in technical process control and development
	Reliability & Durability	4. Lack of resources for, and awareness of up-scaling technologies
		5. High cost of testing of new nano-enabled products for the market
Marketing & Strategy	*Regulations & Standards*	6. Lack of agreement between regulatory environment, consumer organisations and technical community
		7. Lack of standard definitions, test methods and guidance documents for industry
	Market Opportunities	8. Lack of specific applications and new markets for nanotechnology
		9. Cautious public attitudes and perceptions for nano-enabled products
		10. Lack of commercialisation expertise within community
Investment & Organisational	*Return on Investment*	11. Lack of coverage, readiness level, continuity and timeliness of funding schemes
		12. Lack of suitable protection and exploitation of IP
		13. Difficulty in attracting enough private investment funding
	Innovation Infrastructure	14. Lack of high quality collaborations by SMEs
		15. Lack of good technology transfer mechanisms
		16. Lack of workforce training and readiness

Table 7. 16 Barrier Topics to be Addressed by Policy Advice

The nanotechnology commercialisation roadmap presents a plan with short, mid and long term goals. In the Policy Advice document these goals are matched with specific solutions to help meet them. For each barrier topic presented in this Roadmap, the Policy Advice document discusses and proposes specific solutions and recommendations.

As such, the purpose of the NanoCom Roadmap is to provide a framework to help with the planning of the Policy Advice[5]. This Roadmap is a generic document and also fairly wide in its application for the European nanotechnology industry (i.e. not focused on a specific technical area or region).

The purpose of the policy advice report is to formulate solutions and make recommendations regarding nanotechnology commercialisation at the EC, Member state and Regional levels. Underpinning policy making is the desire to transform society in a sustainable manner. It can either do this by measures which accelerate or regulate adoption of new products into the market, balancing the risks and benefits for society as a whole. Nanotechnologies are no exception to this however the issues are amplified by the lack of certainty around their apparent economic and environmental impact and its degree of technical difficulty in their assessment (often at the very leading edge of human endeavour and ingenuity).

The basic context for the policy advice document is that significant investments have been made into nanoscience and nanotechnology (N&N), however the projected commercial returns have not been realised yet by industry and funding agencies alike. Mostly, the problems lie in the translation of this research into value added products. Such problems can range from investment issues, cultural norms and practices in Europe about research and development, general business acumen and skills training. This policy advice document issued by the NanoCom project does not attempt to solve all the issues but gives specific recommendations and examples of best practice in those fields that are relevant to nanotechnologies.

Forming policy is a complex and demanding discipline which attempts to balance many inputs and conflicting views to derive sensible policies that can be implemented with the general consent of the community it affects. The NanoCom project has established a framework to capture these inputs and the evidence provided by the interviews and surveys so far. The innovations in the advice document are the development of the 'structured policy card', which attempts to capture the essential features of current policy making and the identification of 16 key topics. These measures enable good decision making which will promote nanotechnology development leading to better policy making in general.

Policy making involves the gathering of a credible and critical mass of evidence and then formulating actions which need to be validated through consensus among key groups and individuals in the community. NanoCom has completed this process via 'experts' and through wider consultations with the communities affected. A summary of the key barrier topics and associated recommendations are provided in Table 8. For a more in depth view of the recommendations and proposed solutions the reader is directed to the web version of the Policy Advice Framework available on the NanoCom Homepage.

Topic Description & Key Recommendations
Access to adapted equipment necessary for pre-production development *Short term:*

[5] http://www.nanocom-eu.org/NanoCom/Homepage_files/NanoCom%20Policy%20Advice%20Framework.pdf

The EC and member states should promote the exploitation of suitable existing open access or commercially available pilot plant facilities by the creation of a "European Directory" of such capabilities.

The EC and member states should identify and fill gaps in the above provision by promoting strategic, publically-funded, open access facilities delivering key enabling pilot plant capabilities e.g. nanomaterials & dispersions, MEMS, Thin Films.

The EC and member states should seek to encourage SME use of pilot facilities by promoting existing funding mechanisms creating flexible procedures e.g. in the FP7 Capacities programme or ERDF.

Medium term:

The EC and member states should to support the development of manufacturing infrastructures suitable for full scale production of proven nanomaterials or nano-enabled products by increasing the budget of existing funding mechanisms.

The EC should develop flexible financial support for access to European research infrastructures by e.g. providing access vouchers within new EC projects to be used during the lifetime of the project

Investment in full production capability (1M€ to 5M€ generally)

Medium term:

The EC and member states should employ existing funding mechanisms (e.g. ERDF) to support the development of manufacturing infrastructure suitable for full scale production of proven nanomaterials or nano-enabled products.

Medium/Long term:

The EC and member states should develop suitable and favourable investment and tax structures to support the development of manufacturing infrastructure for nanomaterials or nano-enabled products.

Technical process control and development

Short term:

The EC and member states should ensure that the development of metrology, standards and modelling tools are supported by specific programmes and projects of the Framework programme and are linked to the aims of the EMRP and driven by application need.

The EC and member states should promote the importance of quantification by incorporating metrology and manufacturing control (especially for pilot line development) into EC and National RTD projects.

The EC should develop create specific programmes or theme areas which address nano metrology and process control.

The EC and member states should promote thought leadership within nano standards development (ISO definitions etc.) by emphasising its importance and supporting initiatives.

Medium term:

The EC and member states should promote the development of a skilled technician workforce, capable of using sophisticated metrology and implementing advanced manufacturing techniques.

Academia and Industry should disseminate developments and good practice in nano metrology and process control as widely as possible e.g. via training programmes and trade associations.

Capital resources and technical awareness of up-scaling technologies

Short term:

The EC and member states should promote and support dissemination of good practice in scale up of nanomaterials and nano-enabled products by encouraging leading commercial manufacturers and

academia to share good practice with SMEs.

The EC and member states should encourage development of up-scaling technologies and commercialisation by explicit support through Factories of the Future calls or its successor in Horizon 2020.

The EC and member states should promote alternative funding schemes such as ERDF for pilot line and scaled up production development (potentially via incubator or cluster promotion) beyond the TRL level currently implemented in Framework 7.

Medium term:

The EC and member states should build upon existing dedicated up-scaling facilities for nanomanufacturing.

Cost efficient testing of new nano-enabled products for the market

Short term:

The EC should promote thought leadership by creating support for a European resource database for EHS and testing capability

The EC should promote improved transnational sharing of information so that best use can be made of currently available data by funding of transnational calls.

The EC and Member states should continue to support the standardisation of testing and specifications, for products containing nanomaterials where appropriate by investing in projects and facilities.

The EC and Member states should promote identification of key knowledge gaps which need to be addressed by investing in new computational models, simulation equipment and data mining in order to maximise the effectiveness of current knowledge.

Consensus between regulatory environment, consumer organisations and technical community

Short term:

The EC and member states should encourage and promote balanced stakeholder dialogue regarding nanomaterials and nano-enabled products in all respective member states via structured forums, the NanoSafety cluster. community websites and specific CSA action

The EC and member states should determine rapidly the potential risks of key exemplar nanomaterials and nano-enabled products by developing and funding EHS programmes to quantify their occupational health and toxicological impacts.

The EC should promote rapid information gathering and sharing by embedding EHS studies and dissemination work packages into NMP programmes and projects featuring nano-enabled product innovation.

The EC should assist SMEs with EHS issues and signpost them to relevant authorities by providing support for 'first point of contact' desks.

Medium term:

The EC and member states should use and disseminate quantified toxicological data gathered using agreed EHS test protocols to expedite the development of harmonised regulatory standards within Europe. This may be implemented through an extension of the REACH process.

The EC should sponsor and promote EHS discussions between EU-US and also EU-Asia Pacific countries to develop European leadership in EHS development and by chairing key multilateral initiatives, e.g. OECD WPMN.

Standard definitions, test methods and guidance documents for industry

Short term:

The EC and Member states should support critical protocol and instrument development for pre-normative research (PNR) through the EMRP and also the main NMP programme both explicitly and embed via projects.

The EC should encourage and the National Standards bodies (NSB's) should deliver normative standards through a mandated programme (measurement and characterisation, EHS and material specification) delivered via CEN TC 352 [Ref 8] and the EC mandate M461 [Ref 9].

The EC should encourage and support companies, trade associations and appropriate research bodies to develop commercially relevant trading (grading) specifications and good practical measurement guides through the IRMM, OECD WPMN [Ref 10] and ISO TC 229 to expedite commercialisation of the prime nanomaterials i.e. TiO2, ZnO, Carbon black, SiO2, SWCNT, MWCNT, CaCO3, CeO2.

The EC should directly support industry participation in standards development through specific NMP funding schemes. Such programmes should seek deliver to enhanced targeted dissemination of existing project results as well as collating and publicizing information from previous project.

Medium term:

National Governments should promote international standardization by continuing to fund national experts where appropriate and existing pre-normative research work (e.g. OECD WPMN).

National Governments should promote international EHS standards development and the upgrade of current ISO TR (Technical reports) to ISO TS's (Technical Specifications) by continuing to fund national experts and encouraging industrial participation.

Development of specific applications and new markets for nanotechnologies

Short term:

The EC and Member states should promote identification and exploitation of business opportunities by providing training in marketing and business skills particularly targeted at SMEs and start-ups.

The EC and Member states should encourage best practice in business skills for the nanotechnology industry by supporting the development of technology clusters and knowledge transfer networks.

The Member states should provide enhanced support to nano SMEs to assist with international marketing of their products.

The EC and Member states should support networking events and promotion activities to highlight new nanotechnology market opportunities.

The EC and Member state should extend provision of support for market feasibility and technical proof of concept studies.

Public attitudes and perceptions for nano-enabled products

Short term:

The EC and Member states and companies should provide information regarding nanotechnology and nano enabled products via case studies to permit informed consumer choice.

The EC and Member states and companies should provide information regarding nanotechnology and nano enabled products via case studies (and also by building on recommendations in topic 6, 7 & 8) to permit informed insurance risk decision.

The EC and Member states should ensure an effective dialogue with consumers by encouraging an informed debate of the societal acceptability of nanoenabled products.

The EC and Member states should encourage and coordinate transnationally efforts to develop and refine

codes of conduct for academic and industrial exploitation of nanotechnologies.

Commercialisation expertise within nano community

Short term:

The EC and Member states should support the training of entrepreneurs so that they can effectively commercialise nanotechnology by business support programmes.

The EC and Member states should support SME innovation by provision of proof of concepts and proof of market by support of appropriate programmes and schemes.

The EC and Member states should encourage basic entrepreneurship skills by incorporation of short programmes and course into graduate programmes.

The EC and Member states should support mentoring programs for SME managers via linkages with senior corporate managers with extensive business experience by facilitating local and regional networks.

The EC and Member states should organise regular physical events where large and small companies can efficiently articulate their product and service requirements.

Coverage, readiness level continuity and timeliness of funding schemes

Short term:

The EC and Member states should extend the focus of funding in Horizon 2020 to include programmes covering projects TRL 5-7

The EC and Members states should investigate additional ways of promoting commercialisation at TRL 5-7 by us of tax breaks, de-risking private finance support and widening the scope of regional funds (ERDF).

The EC and Member states should introduce new instruments with smaller budgets (<€200k) shorter delivery times (< 9 Months) and smaller consortia (<3 partners) to support commercialisation of nanotechnologies especially for SMEs.

The EC and Member states and regions should promote flexible funding instruments available on a continuously open method, to facilitate quicker commercialisation of nanotechnologies. Application of these should be not overly bureaucratic.

Suitable protection and exploitation of intellectual property

Short term:

The EC should encourage commercialisation of the outcomes of RTD by allocating a portion of the budget to realise commercialisation potential. Suitable IP protection should be included within the dissemination work package. This work package will extend beyond the term of the normal R&D work packages.

The EC should support commercialisation performance in collaborative RTD projects by providing guidance and support e.g. the ESIC service and monitoring commercialisation performance for at least 3 years after RTD completion.

The EC and member states should encourage commercialisation of nanoscience by delivering IP courses. Typical content should the strategic importance of IP, IP landscaping and the assessment of FTO.

The EC and member states should promote the importance of commercialisation of nanoscience by reassessing the relative values of publications versus commercialisation (widen academic research metrics).

Medium term:

The EC and EPO should ameliorate the effect of patent thickets by encouraging patent holder to license

patents where they are not choosing to exploit.

The EC should seek to reduce the cost of patenting by encouraging all member states to accede to the EPO agreement.

The EC should promote the good practice in nanotechnology IP by instigating a study to determine current trends for IP protection and exploitation for nanoscience and publicising the outcomes.

Attracting private investment funding for nanotechnologies

Short term:

The EC, Member states and regional funding authorities should encourage nanoscience commercialisation by the development of innovative financial instruments which de-risk private equity participation. And provide longer term (5 year) funding.

Medium term:

The EC, Member states should promote the benefits of nanotechnologies to the investment community to reignite their interest by holding high quality events.

High quality collaborations by SMEs

Short term:

Member states should promote development of SME products and services by encouraging University TTO offices to assist at a local level.

The EC and member states should encourage SME participation in collaborative RTD by ensuring that funding calls are SME friendly.

The EC, Member states and regional funding agencies should continue to encourage and support SME entry into supply chains and assist route to market by assisting with alliance building, networking events and brokerage activities.

Member states should foster SME entry into supply chains and assist route to market by organising bi-lateral missions for knowledge exchange and development of collaborations specifically for nanotechnologies.

The EC, Members states and regional agencies should support SMEs by continuing to sponsor the Enterprise Europe Network (EENs).and the National Contact Points (NCP).

Medium term:

The EC and Member states should promote nano skills and experience sharing by the establishment of strategic technology clusters. This should integrate specific centres of academic expertise, large corporate entities, relevant SMEs and physical infrastructure.

Technology Transfer mechanisms and incentives

Short term:

The EC and Member states should promote skills and experience sharing by supporting technology exchange networks and platforms so that these can enhance technology transfer across the ERA.

The EC and Members states should promote skills and experience sharing by encouraging the formation of super clusters to facilitate transnational collaborations.

The EC and Member states should promote rapid commercialisation by application of skills and knowledge transfer mechanisms including open innovation.

The EC and member states should make knowledge transfer easier by promoting models for IP sharing.

Workforce training and readiness

Short term:

The EC and member states should promote skills capability by encouraging companies to invest in business skills acquisition.

The EC and member states should consider how the costs of training can be reduced for high tech SMEs.

The EC should support an initiative to provide enhanced training and mentoring opportunities for project coordinators within Framework projects.

Medium term:

The EC and Member states should promote nanotechnology skills by supporting appropriate training projects.

Companies should be encouraged to enhance internal skills base by use of short term exchanges of personnel with academia.

Table 8. Policy Advice Summary Statements for Identified 16 Barrier Topics

4 Dissemination and Exploitation

The NanoCom project implemented an effective networking programme to stimulate interest in the nanotechnology sector and raise public awareness. A key part of this involved setting up a web based events database for industry, enterprises and research organisations to monitor the most relevant scientific events to nanotechnology. An extension to this included the setting up of an Open Innovation web portal in conjunction with the NANOfutures platform to encourage the uptake of OI mechanisms. A dragon's den style approach has also been applied to building an attractive and inspiring environment where investors and innovators can work together in promoting new commercial opportunities.

As means of 'up-skilling', a new integrated training programme has been proposed in the form of an Innovation Training Factory for rapid commercialising of nanotechnology results. The programme is based around a comprehensive concept that covers both the training and evaluation of entrepreneurs as well as the refinement of their specific training needs by both NanoCom and external experts.

Results from the project have been thoroughly disseminated at key nanotechnology conferences and EC events, through related projects and platforms including NANOfutures, MINAM and Manufuture as well as via the NanoCom Satellite Group.

4.1 Innovation Training Factory

The Training Factory comprised a series of training modules which could be combined in almost any manner in order to define tailor-made training activities matched to any audience, e.g. from a technical or financial perspective as well as from an organisational point of view. Several Training Factories (Summer Schools) were organised with the aim of fostering the transfer of existing ideas for the commercialisation of nanotechnologies. NanoCom developed a comprehensive concept that covers both training of entrepreneurs ('on the idea') and the evaluation and refinement of specific business models by both NanoCom and external experts.

4.1.1 General Aspects

NanoCom organised Training Factories on the most important aspects regarding the commercialisation of nanotechnology research results and on how to transfer existing ideas into marketable products.

The target audience not only consisted of students or entrepreneurs, but also of mediators, such as technology transfer coaches and industrialists interested in modern concepts such as Open Innovation. To reach mediators and experienced professionals through the Training Factory route proved extremely useful since these groups were then able to disseminate the knowledge from the Training Factories further afield. Training Factories were held in different European regions where the local organiser had the opportunity to implement regional aspects.

4.1.2 Training Modules

Based on the topics from the analysis of barriers and best practices (Figure 12), four core training modules were identified:

- Technical basics
- Business development
- Financing
- Open Innovation and collaboration

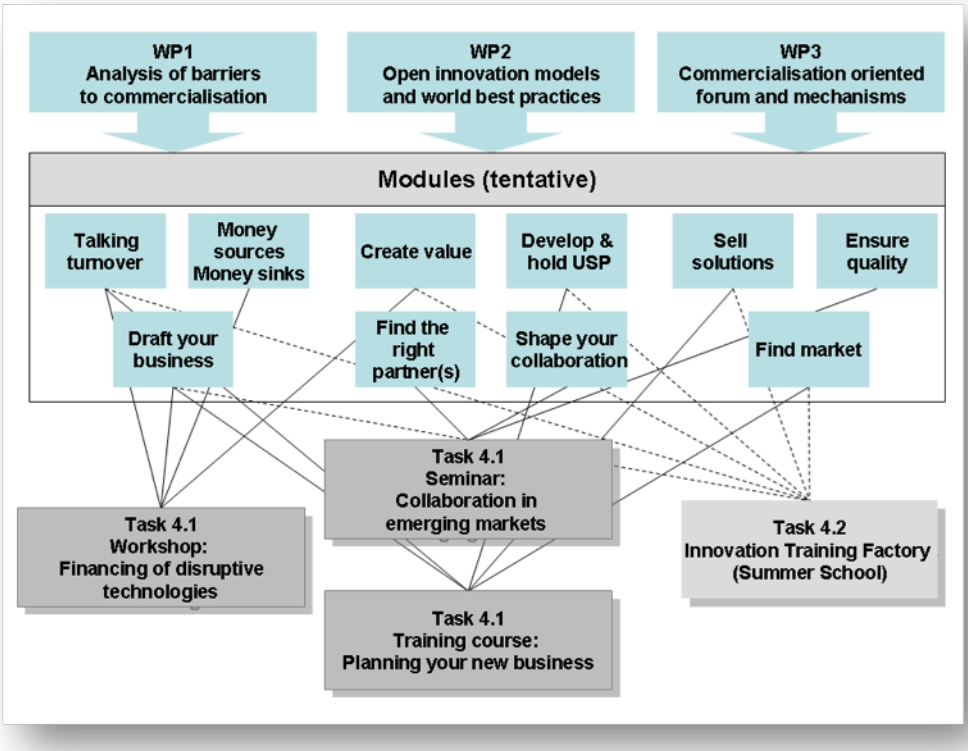

Figure 12. Development of Training Modules

The four main modules were supplemented by a set of subtopics, as detailed below:

Technological Basics

- Quality Management
- Barriers
- Maturity and Readiness Levels

Business Development

- Business Plans (incl. practical training)
- Business barriers
- Alliances and collaborations
- Project management
- Product Life Cycle (Product Launching)
- Product development
- My customers -the end-consumer market
- Best practices and definitions of USPs
- Special interest group -SMEs
- Special interest group -international market

Financing

- Financing -the basics
- Financing -advanced skills
- Best practices

- Strategy management
- Investment strategies
- Market

Open Innovation and Collaboration

- Fundamental understanding of innovation
- Fundamental understanding of open innovation
- Fundamental understanding of open collaborations
- Effective collaborations
- Practical training - best practices
- Practical training -tools for effective collaboration and open innovation
- Innovation Process Management

4.1.3 Innovation Training Factory - Two Models

Two different models for the one-day Training Factories were developed, depending on the need identified for the specific region where the training modules were aimed.

Model A: One day – one module

In this model, only one module was presented during the one-day workshop. The topic ranged from the basics "What is Open Innovation" for example to special case studies. Success factors from a company's perspective as well as success factors from a university perspective were communicated through the case study.

Model B: One day – all modules

This model provided an overview of the four core modules; *Technical Basics* (duration 1 h), *Business Development* (1.5 h), *Financing* (1 h) and *Open Innovation and Collaboration* (1.5 h), as well as nano specific modules. In addition, these modules were supplemented by a case study presented by a local expert.

4.1.4 Programme

Six Training Factories were organised by NanoCom between September 2010 and June 2012:

- Workshop on Open Innovation, Aachen, Germany (15/09/2010)
- Innovation Training Factory, Stuttgart, Germany (31/03/2011)
- NanoCom Training Session, NanoTechItaly, Venice, Italy (24/11/2011)
- Commercialisation & Entrepreneurship Training Course, Nottingham, UK (19/04/2012)
- NanoCom Innovation Training Factory, Achema 2012, Frankfurt, Germany (20/06/2012)
- NanoCom Innovation Training Factory, Coms 2012, Tønsberg, Vestfold, Norway (24/06/2012)

4.2 Investors Forum

The overall aim was to establish an Investors Forum taking inspiration from a 'Dragon's Den' style format. The NanoCom Investors Forum was organised in conjunction with the Swiss NanoConvention on 23rd May 2012 in Lausanne, Beaulieu Palace Congress. Forty-three participants from across Europe and the USA (more than 15 countries represented) attended the Forum. This included 12 investors, 14 business opportunities and participants from the organiser's side.

The selection and coaching of companies was completed by a select group of NanoCom partners. A proposal call was widely distributed to European Key Research Organisations (KROs); Twenty-seven KROs submitted a proposal. From the proposals received, a total of fourteen were selected for the Investors Forum, based on criteria such as the overall quality of the proposal, the potential of the

company (technology, market, competition, financial plan, IP, team), and their development status (concept, lab demo, prototype, commercialisation). The list of the fourteen companies selected, from 8 different countries, are noted below:

Nanto Protective Coating	Italy
Reactive Metal Particles	Norway
Biogas	Spain
Innovnano	Portugal
Krystalia	Italy
Namos	Germany
Orthox	United Kingdom
Osmotex	Switzerland
qidnano	Italy
Adara	Spain
Swisslitho	Switzerland
Technoorg Linda	Hungary
Thundernil	Italy
Wise	Italy

The fourteen selected companies were well distributed over the whole value chain (nano-materials, nano-intermediates, nano-related products, as well as production processes and control equipment's), and presented a broad range of TRL levels (from lab validation to products already on the market).

The forum organisers dedicated three months to the coaching, to allow sufficient time for the entrepreneurs to prepare a presentation, to receive feedback from their coach, and to revise the presentation according to the feedback before final acceptance by the coach. Regarding the coaching: the objective was focused on the presentation itself, in order to provide the investors with the most pertinent information. Working on other themes such as the business model, was outside the scope of the investors' forum. The participants were however provided with copies of all guideline documents produced by the NanoCom Project and made aware of the Innovation Training Factory programme.

In addition to the presentation, the entrepreneurs were also asked to provide a one-page summary that was provided to the investors prior to the forum. The purpose of the one-pager was to allow the investors to choose the face-to-face meeting with the entrepreneur that interested them the most.

There were twelve investment companies (Venture Capitals, business angels, corporate ventures and incubators) representing different investment stages and from different countries. The investors actively participated during the Investors Forum.

Forty-five Face-to-Face meetings took place during the Forum, from which around a third (15) have led to further discussions between the investor and the entrepreneur. Moreover, feedback from the participants, both from the investors and the entrepreneurs, was positive. The key metric quantifying the success of the Investors Forum is considered to be the fifteen Face-to-Face meetings that have taken place post forum.

4.3 Nanotechnology Sessions

The NanoCom partners have represented the project at conferences and fairs through presentations, workshops and at booths. Presentations were also held at EU-Initiatives and EU funded events. As a mechanism to bridge the gap between intensive training courses (Innovation Training Factory) and summary presentations given at conferences, three nanotechnology specific sessions were organised in industrial workshops. These included:

- NanoEntrepreneurs Event in the UK focused on 'lowering the barriers to commercialisation and industrialisation of emerging and nanotechnologies'
- Nanotechnology as an emerging market in the Czech Republic
- Rapid commercialisation of nanotechnologies in the construction industry in Spain

A summary of the key dissemination events attended by the NanoCom project are detailed below.

4.3.1 Presentations and Booths at Conferences

2010

19 May	'Studies on Barriers to Commercialisation of Nanotechnology', UK Nanotechnology Knowledge Transfer Network Nano Entrepreneurs event, BioCity Nottingham (University of Nottingham)
24 Jun	NanoCom overview presentation at MINATEC Crossroads Workshop, http://www.minatec-crossroads.com/ Grenoble, France (Plastipolis)
28 Jun	CLUSTERPLAST event ''Toward a common European and regional strategy for plastic clusters'', http://www.clusterplast.eu/news2.html Charbonnières-les-bains / Lyon (Innobridge)

2011

16 Feb	NanoTech Japan 2011, http://www.nanotechexpo.jp/en/outline.html, Tokyo, Japan (Plastipolis)
01 Jun	NanoCom overview EuroNanoForum, http://www.euronanoforum2011.eu/nanofutures, Budapest, Hungary (CEA, Culminatum)
12 Jul	Management Committee meeting of MATERPLAT Technological Platform (Spain), http://www.materplat.es/ Madrid, Spain (Acciona)

2012

19 - 21 Jun	Industrial Technologies Aarhus, Denmark http://industrialtechnologies2012.eu/ (MINAM booth, Markus Dickerhof)
24 - 27 Jun	COMS 2012, Tønsberg, Norway http://industrialtechnologies2012.eu/ (KIT booth, Markus Dickerhof)

4.3.2 Presentations at Fairs

2011

4 Apr	Hannover Messe 2011, Hannover, Germany, Plastipolis Networking (Maudez Le Dantec)

2012

18 - 22 Jun	ACHEMA 2012, Frankfurt, Germany (KIT booth)

4.3.3 Presentations at EU Initiatives

2010

11 May	ETP Conference 2010 Brussels (Joel Segal/Svetan Ratchev)
16 Jun	NANOfutures Launch Event http://www.nanofutures2010.eu/, Gijón, Spain (José Vera Agulló)
18 Oct	Meeting – Implementation of the Innovation Union and Industrial technologies, how to foster the transfer of technology from research to market place? Brussels, Belgium (University of Nottingham)

4.4 Exploitation Strategy Seminar

The project Exploitation Strategy Seminar in March 2012 yielded seven core recommendations. The recommendations and the action(s) taken by the NanoCom project to address these (indicated by ✓) to ensure impact are noted below:

Recommendation 1

The state of the art of nanotechnology commercialisation should be thoroughly investigated and relevant reliable reports reviewed. A paper summarising the finding should be developed and submitted as a deliverable. Such exercises should be repeated / up-dated periodically to respond to the dynamic nature of these technologies. These investigations should lead to strong benchmarks that will allow NanoCom to show their progress with respect to the state of the art.

Policy Advice Framework ✓

Recommendation 2

NanoCom has been developing a considerable number of exploitable results, which could make a difference if they are considered and addressed as real and pragmatic tools to break down barriers. The stakeholders already know these barriers and it might be difficult to identify new ones. What is missing are the effective tools for specific steps towards reducing or eliminating the significant barriers to the commercialisation of nanotechnology innovation. Priorities should be given to the most important tools to match them with the available resources.

Policy Advice Framework, Commercialisation Guidelines, SWOT Analysis, Investors Forum, Innovation Training Factory ✓

Recommendation 3

Despite its large number of beneficiaries, NanoCom does not currently have a sufficient critical mass to address all the problems to nanotechnology commercialisation. It should recruit additional participants in the different competences subjects such as issues on intellectual property, licensing, capitals, law, standards and standardization, Health and safety, user acceptance, public policy, human resources, risk management, etc. All these issues are influencing the nanotechnology process towards the market.

Commercialisation Guidelines, Innovation Training Factory, Satellite Group ✓

Recommendation 4

The involvement of additional regional clusters should significantly increase in order to organize a more distributed coordination and promotion centres to accelerate the up take of nanotechnology. The low number of industrial partners participating in NanoCom was raised as an issue during a seminar. These partners should be the drivers of the Coordination Action and should avoid the attitude of wait and see.

Nanotechnology sessions in industrial workshops, Satellite Group, Newsletters, Joint Meetings with related projects ✓

Recommendation 5

Special attention should be given to the nanotechnology patent ticket phenomena, which is a real hurdle to commercialisation. Good understanding of IP issues surrounding nanotechnology could enable effective application of open innovation concepts among industry players through solutions that may help clear the patent thicket and slow down hold-up problems.

Commercialisation Guidelines, Open Innovation Model ✓

Recommendation 6

The "Integrated Commercialization Readiness Scale" has great potential as a tool that could provide managers with guidance for developing a nanotechnology commercialisation strategy and plan. This result should be part of the commercialization guidelines and should also describe, step by step, the activities necessary to implement the nanotechnology commercialisation process. It should lead to the determination of the level of maturity of nanotechnology and consequently the level of risk for commercial adventures.

Commercialisation Guidelines, Commercialisation Readiness Levels ✓

Recommendation 7

The level of success of NanoCom would be measured by a wide acceptance and use of its exploitable results by the nanotechnology community at large and by setting up a viable design of a European Organization with a mission of follow up and continuous promotion of nanotechnology commercialization.

EC Innovation Workshop ✓

4.5 Partner Specific Exploitation Plans

Arising out of the recommendations from the Exploitation Strategy Seminar, under the coordination of University of Nottingham, the project partners were encouraged to develop their own exploitation plans. A summary of the individual exploitation plans on how the results from the NanoCom project will be used and investigated further are provided below.

Partner	Exploitation Comments
Culminatum	▪ Wide dissemination of commercialisation guidelines and policy advice framework to Finish network ▪ Contribute to national government policy advice ▪ Further discussion and involvement with NANOfutures

	▪ LinkedIn promotion of NanoCom results ▪ Incorporation of NanoCom training material into existing and new training activities to support local R&D project impact
Veneto Nanotech	▪ Contribute to regional government policy advice ▪ Web portal promotion and further development ▪ Incorporation of NanoCom training material into existing and new training activities ▪ Continuation of Investors Forum
Bayer Technology Services	▪ Wide dissemination of commercialisation guidelines to assist with internal assessment of projects for exploitation ▪ The project has provided wider validation of recognised barriers
IPA-Fraunhofer	▪ Wide dissemination of commercialisation guidelines and policy advice framework via the nanotechnology alliance ▪ Contribute to government policy advice groups ▪ Incorporation of NanoCom training material into existing and new training activities
RWTH Aachen	▪ Development of an interactive OI model (nano specific) ▪ Development of an interactive Commercialisation Readiness Scale ▪ Training videos based on the project outcomes ▪ Incorporation of NanoCom training material into existing and new training activities
NanoTrade	▪ Wide dissemination of commercialisation guidelines through appropriate networks ▪ Contribute to national government policy advice ▪ Road show style events to encourage companies to review their approaches based on the project recommendations (policy advice framework)
Plastipolis	▪ Use Commercialisation Readiness Scale with SMEs to measure current level of 'commercialisation preparedness' ▪ Incorporation of NanoCom training material into existing and new training activities ▪ Further dissemination of project outcomes through network
CEA Liten	▪ Dissemination and testing of Commercialisation Readiness Scale with industry and SMEs ▪ Publication of the Commercialisation Readiness Scale with University of Nottingham
KIT	▪ Incorporation of NanoCom training material into existing and new training activities ▪ Testing of the Commercialisation Readiness Scale with local industry ▪ Further dissemination and promotion through networks ▪ Involvement in SMARTFRAME workshops in Central Europe
Innobridge	▪ Continuation of Investors Forum ▪ Incorporation of NanoCom training material into existing and new training activities
NineSigma	▪ Wide dissemination of commercialisation guidelines and policy advice framework to network ▪ Incorporation of NanoCom training material into existing and new training activities

CPI	▪ NanoKTN - wide dissemination of commercialisation guidelines and policy advice framework at national events ▪ Policy guidance discussion with national government ▪ NanoKTN - Involvement in ENF 2013 ▪ Inclusion as partner in further the investors forum concept
LUX	▪ Promotion through ENF Advisory Group ▪ Inclusion of NanoCom outcomes in number of thought pieces to be included in the LUX blog ▪ Wide dissemination of commercialisation guidelines and policy advice framework at LUX Executive Summit
Acciona	▪ Promotion through ENF Advisory Group ▪ Dissemination of barrier analysis and project recommendations to large industry and SMEs ▪ Engagement with technology platforms (EU and national) and through national incubators
University of Nottingham	▪ Engagement with UK government ▪ Linking up to MNM agenda and Horizon 2020 guidance ▪ Incorporation of NanoCom training material into existing and new training activities ▪ Development of entrepreneurship training course for Europe ▪ Development close links with NanoKTN and Nanoscience centre ▪ Lead further research into and formally publish Commercialisation Readiness Levels (with CEA)