
POTENTIAL AND ACCEPTANCE OF NANOTECHNOLOGY

SESSION: RISK COMMUNICATION AND IMPACT ASSESSMENT

Dr. Axel Thielmann

Deputy Head of Competence Center Emerging Technologies

Fraunhofer Institute for Systems and Innovation Research ISI

1st Joint Symposium on Nanotechnology , **5–6 March 2015, Berlin**



Agenda

1

Potential of Nanotechnology:
promises of the past, realities today, prospects for the future

2

Acceptance of Nanotechnology:
before and after the hype – the stakeholder positions

3

How much time is left for a Responsible Nanotechnology
Development?

Agenda

1

**Potential of Nanotechnology:
promises of the past, realities today, prospects for the future**

2

Acceptance of Nanotechnology:
before and after the hype – the stakeholder positions

3

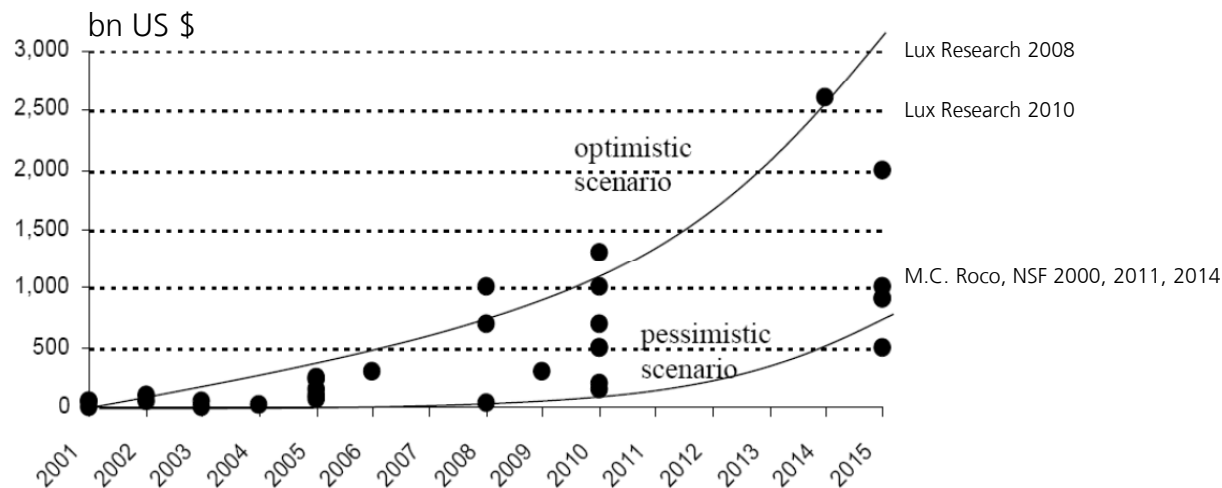
How much time is left for a Responsible Nanotechnology
Development?

The 1, 2, 3 trillion dollar Market in 2015

Promises of the past

Nanotechnology - a Key Enabling Technology of the 21st century

- Forecasts between 2000 and 2010 promised 1-3 trillion US \$ markets
- ~ 80% Nano-enabled Products, ~ 20% Nanointermediates, 0,1% Nanomaterials

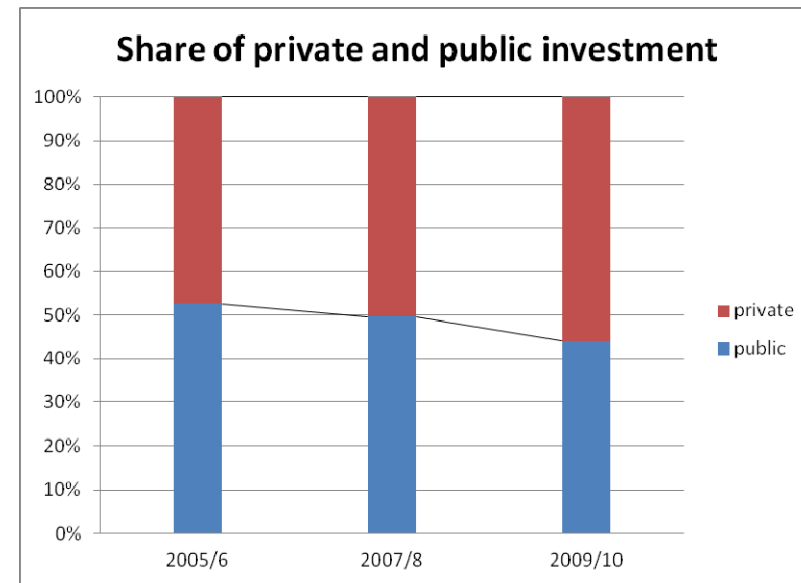
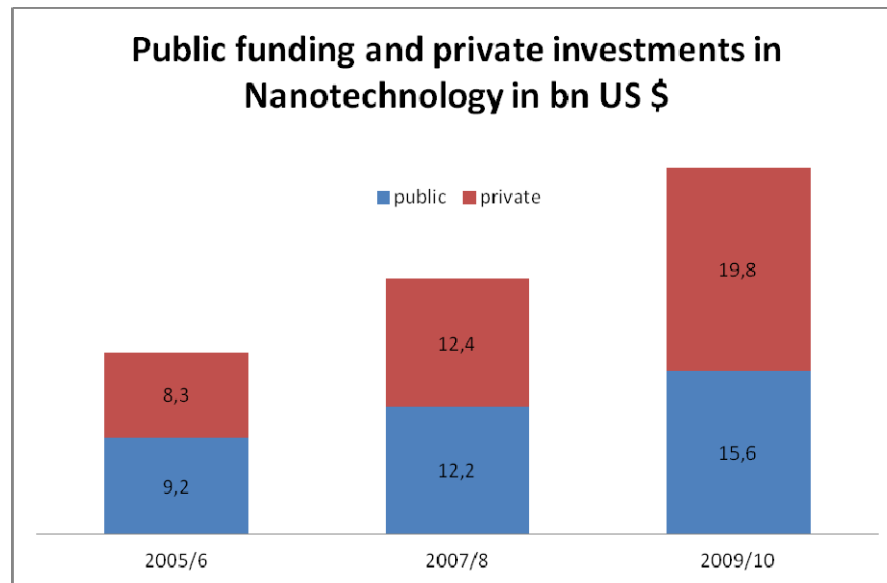


Sources: A. Hullmann and EURONANO (2009): Nanotechnology in Europe: Assessment of the Current State, Opportunities, Challenges and Socio-Economic Impact (Phase 1), Framework, Service Contract 150083-2005-02-BE; Lux Research 2010: <http://ceramics.org/wp-content/uploads/2010/03/nanomaterials-and-the-recession.bmp>

Public & private investments doubled from 2005 to 2010 and reached 18 bn US \$ in 2010 (world)

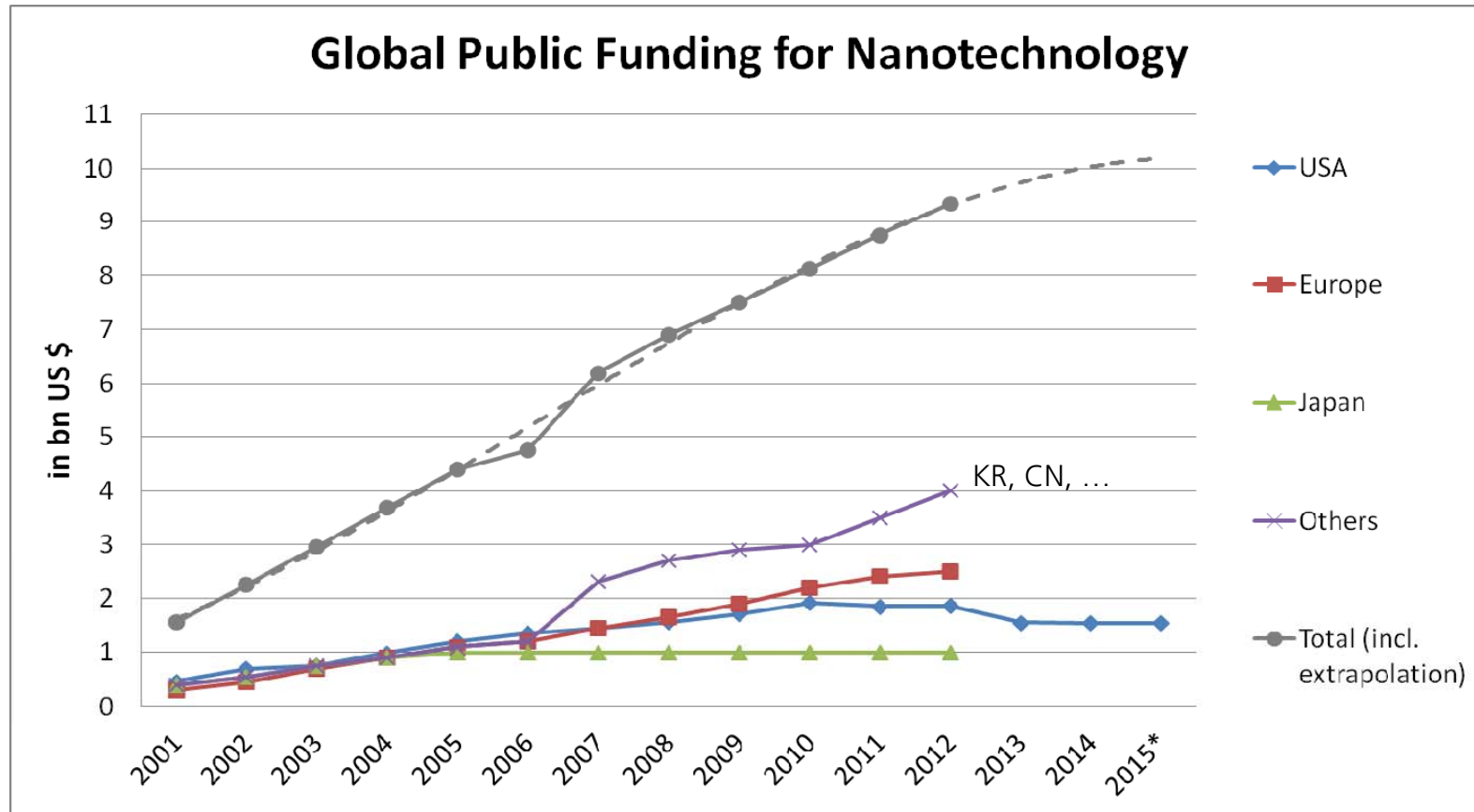
But: Venture capitalists reduced their investments by 21.4% from 2009 to 2010 (Lux Research - Corporations Grab the Reins 2011)

➤ The share of private investment seems to stop or **decline since 2010**



Sources: M.C. Roco, EuroNanoForum 2013, FROM DISCOVERY TO NANOTECHNOLOGY INNOVATION AN INTERNATIONAL PERSPECTIVE, National Science Foundation and National Nanotechnology Initiative; M.C. Roco 2011, The long view of nanotechnology development: the National Nanotechnology Initiative at 10 years, J Nanopart Res (2011) 13:427-445; Lux Research 2011 (Corporations Grab the Reins 2011). EC (2009): Nanosciences and Nanotechnologies: An action plan for Europe 2005-2009. Second Implementation Report 2007-2009, SEC(2009)1468; Nanosciences and Nanotechnologies: An action plan for Europe 2005-2009. Second Implementation Report 2007-2009, Accompanying Document: COM(2009)607.

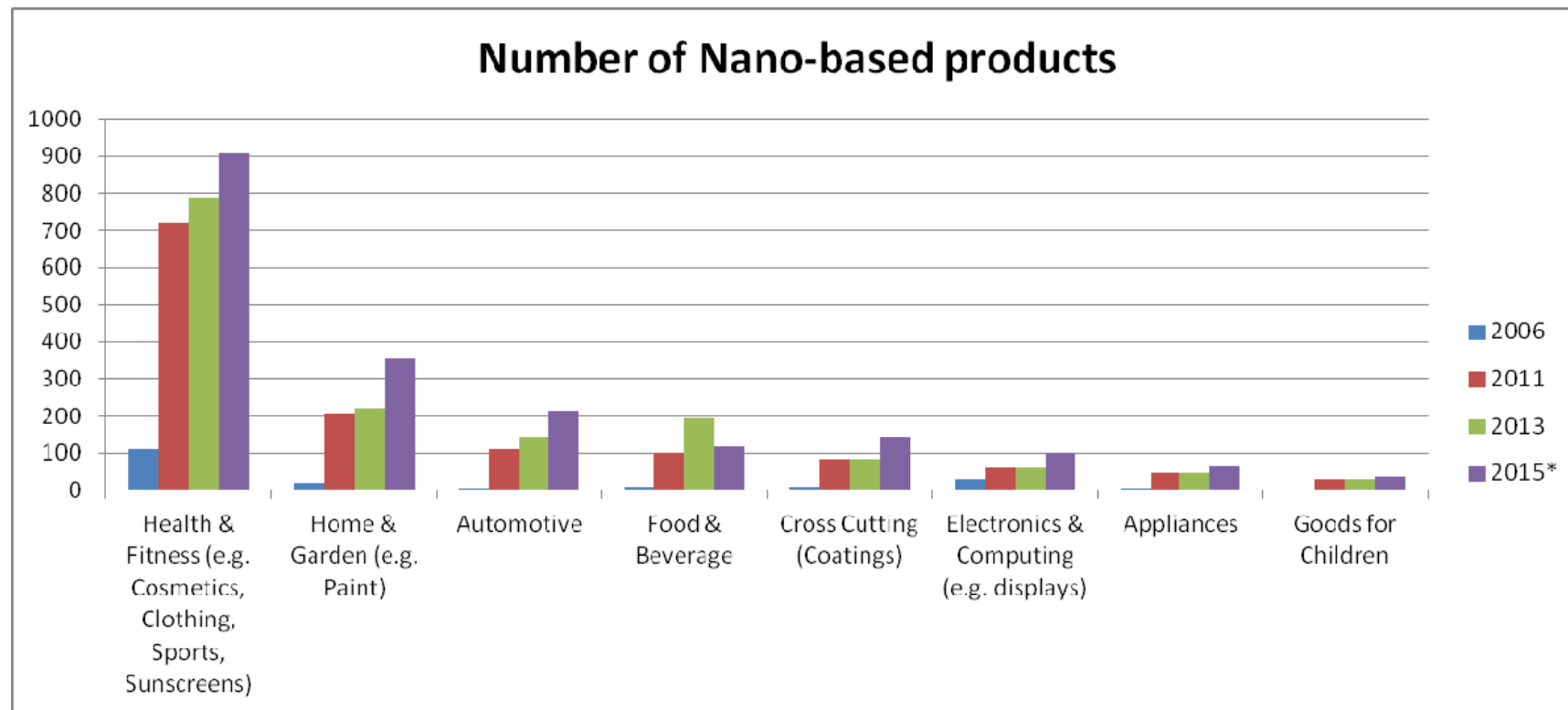
Stagnation of public funding in the US, world wide saturation (stabilization)...



Sources: J.F. Sargent Jr. December 2014, The National Nanotechnology Initiative: Overview, Reauthorization, and Appropriations Issues, Congressional Research Service; M.C. Roco, EuroNanoForum 2013, FROM DISCOVERY TO NANOTECHNOLOGY INNOVATION AN INTERNATIONAL PERSPECTIVE, National Science Foundation and National Nanotechnology Initiative; M.C. Roco 2011, The long view of nanotechnology development: the National Nanotechnology Initiative at 10 years, J Nanopart Res (2011) 13:427-445.

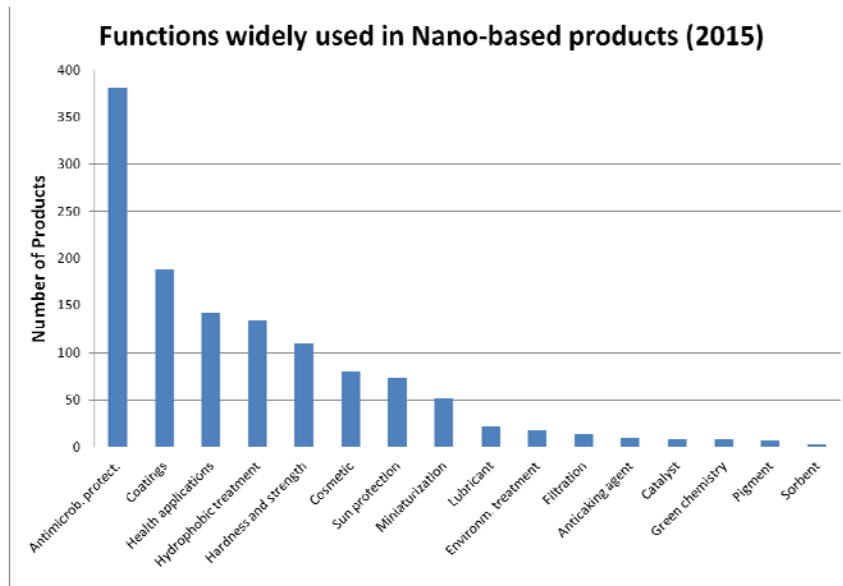
Nano-based products today are mainly used in health&fitness, home/paints applications

By February 2015: about 1800 nano-based products have been identified across different categories/applications, using different functions, materials, ...

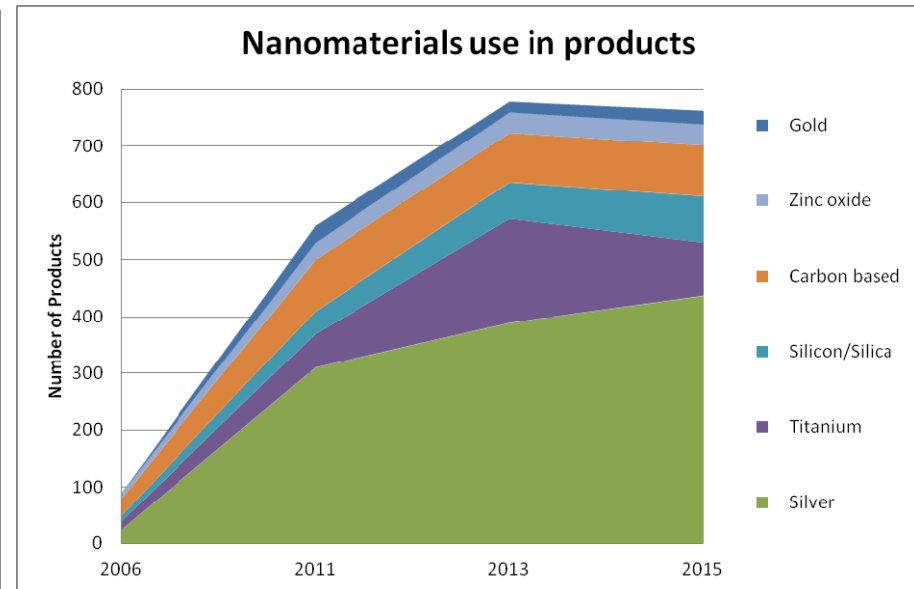


Consumer Products Inventory - An inventory of nanotechnology-based consumer products introduced on the market (<http://www.nanotechproject.org/cpi/>). Retrieved 02/2015*.

Different functions are used, nano-silver in 25% of the products



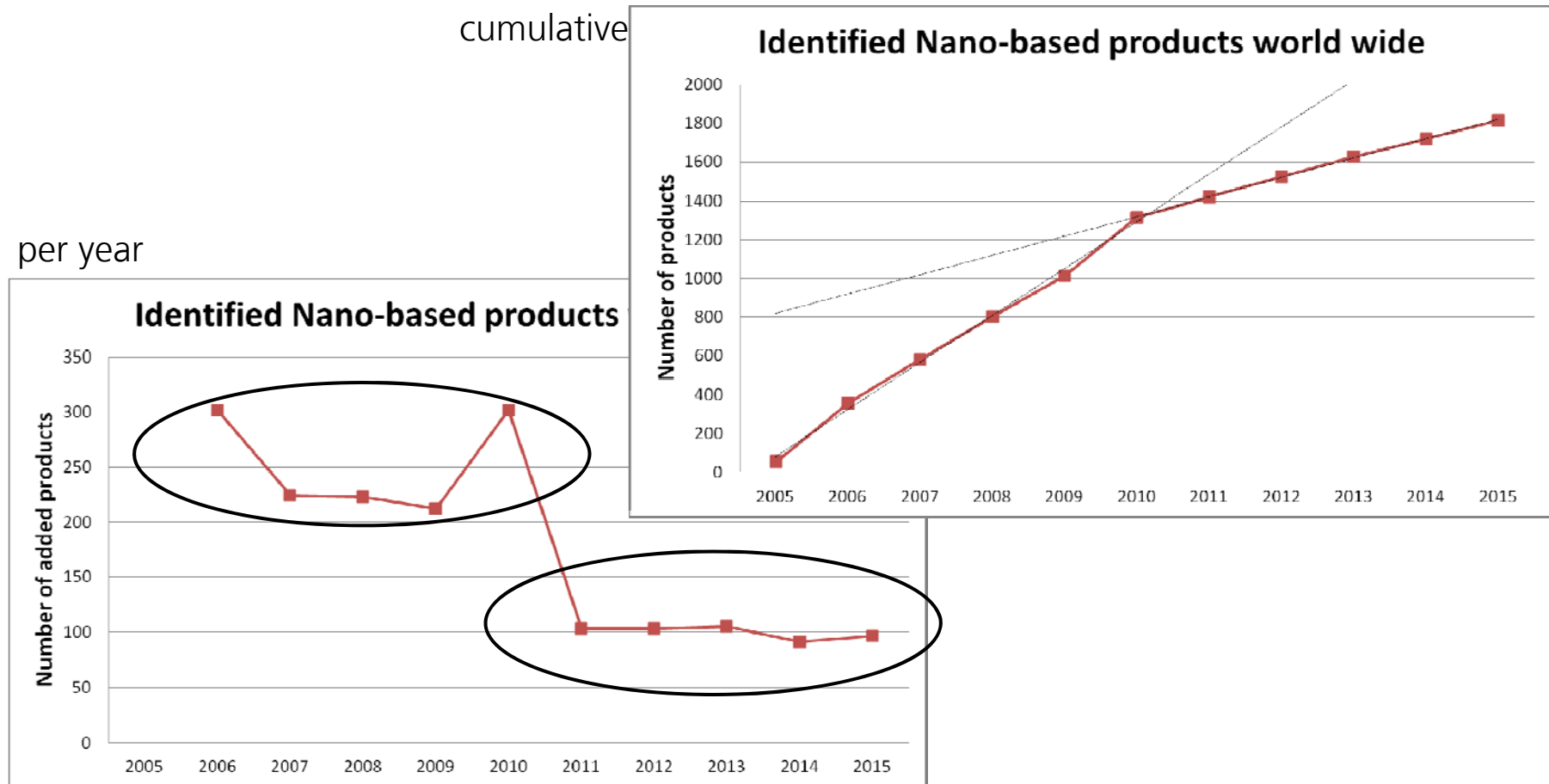
Most often use as Antimicrobial protection (nano-silver)



A large number of further nanomaterials is used (not displayed).

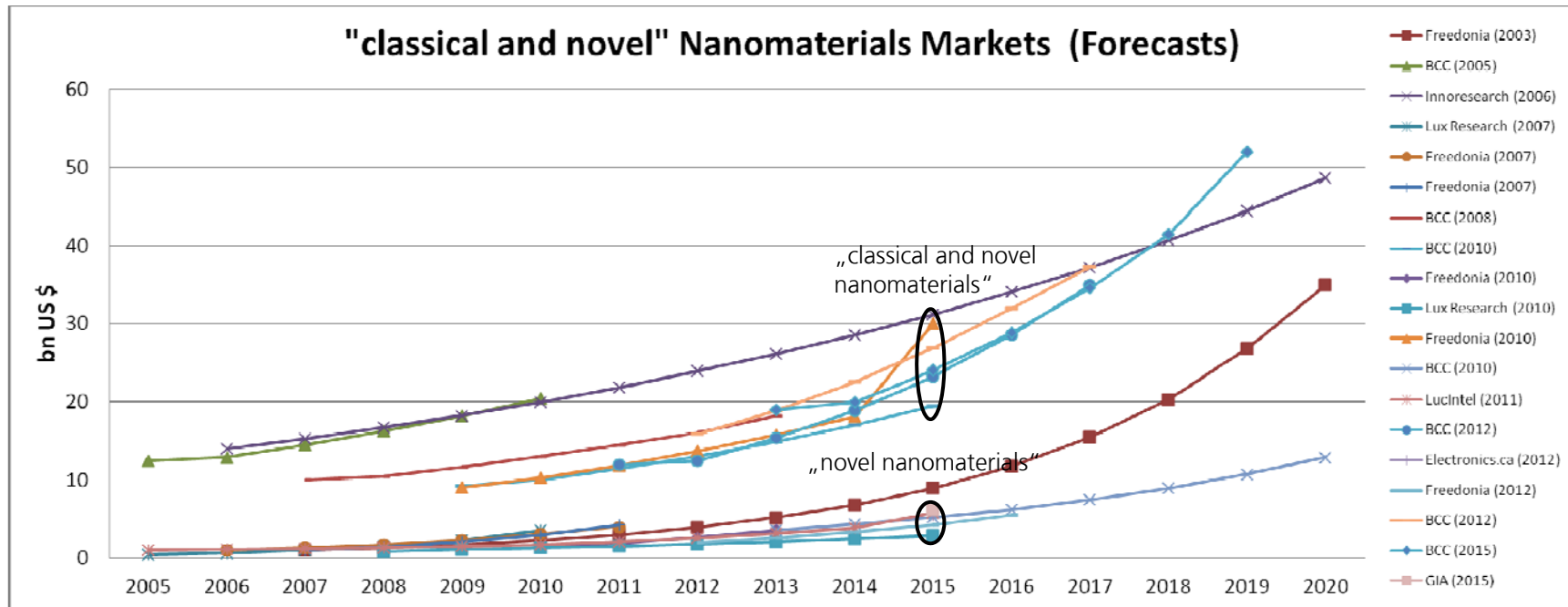
Consumer Products Inventory - An inventory of nanotechnology-based consumer products introduced on the market (<http://www.nanotechproject.org/cpi/>). Retrieved 02/2015.

Decreasing number of new nano-based products/innovations since 2010



Consumer Products Inventory - An inventory of nanotechnology-based consumer products introduced on the market (<http://www.nanotechproject.org/cpi/>). Retrieved 02/2015*.

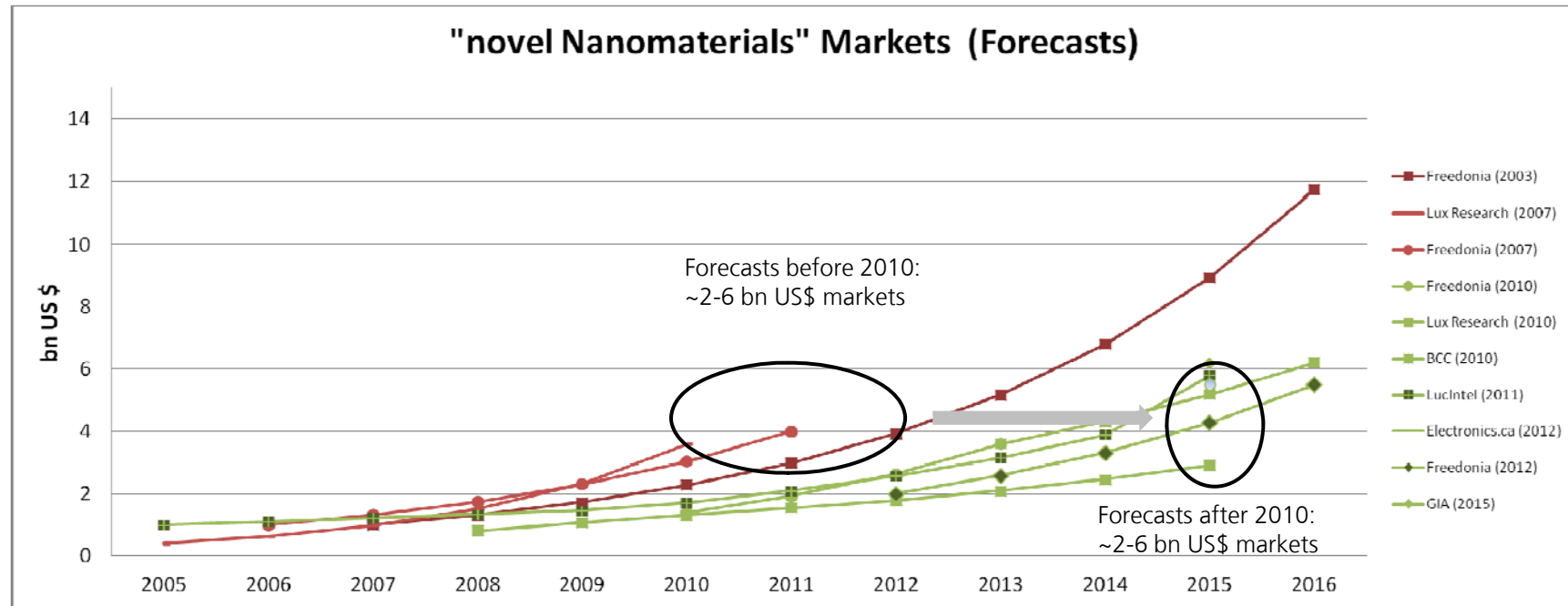
Nanomaterials, -intermediates, –enabled products already at market: „classical and noval“



- „classical nanomaterials“ market around 20-30 bn US \$ in 2015 (>11-12 million tonnes)
- still dominated by materials in use for decades (e.g. carbon black, synthetic amorphous silica).
- “Novel nanomaterials”: med. vol. (e.g. TiO₂, CNT), low vol. (many different substances, e.g. used in catalysts, batteries, PV cells)

Tonnes/year: Carbon black (10 Mio.), Cerium oxide (10000), Synthetic amorph silica (1,5 Mio), Zn oxide (8000), Al oxide (200000), CNT and nanofibres (hundreds or less), Barium titanate (15000), Nanosilver (20), Titanium dioxide (10000); see: http://ec.europa.eu/enterprise/sectors/chemicals/reach/nanomaterials/index_en.htm.

Market forecasts for novel nanomaterials have generated high expectations ...



- Forecasts before 2010 projected a 2-6 bn \$ markets around 2010-2012 (e.g. CNT were expected to grow to 5-6 bn \$ in 2012)
- Forecasts after 2010 do as well (for 2014-2016)
- Expectations calm down - markets need more time

The „Hype is over“

Expectation on Nanotechnology have not been met, diverse reasons:

- technical or economic barriers too high (cost/function)
- attempt to drive devel. from material to application, not asking for best solutions
- tailored materials/ techn. needed (nanomaterials uneconomic or niche markets)
- scalability
- potential techn. solutions achieved with other (non-nano) materials and techn.

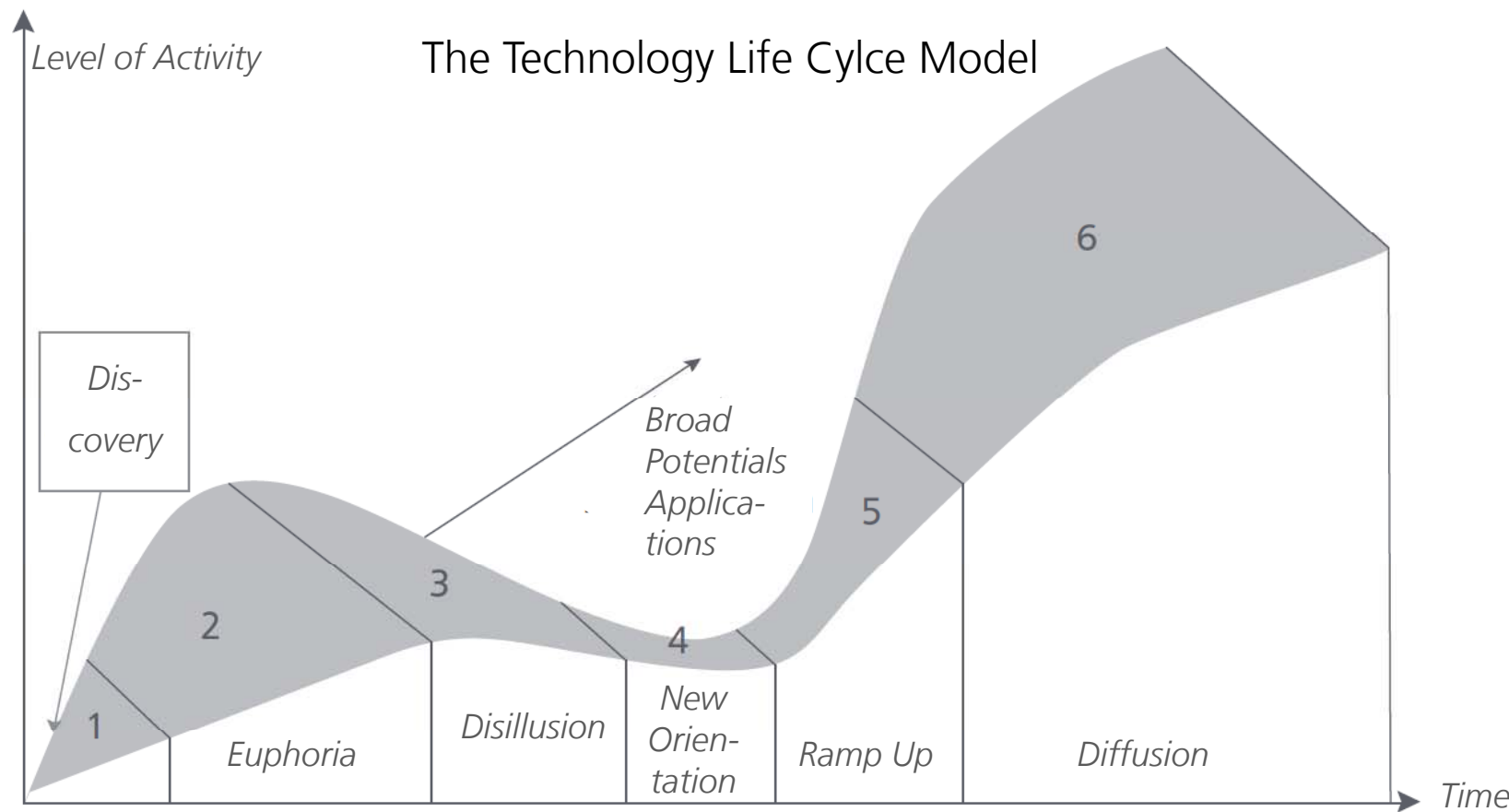
Consequences

- Companies: skip Nanotechnology R&D, focus on best solution (functions/ costs) for applications

Indicators:

- investments/funding stagnate/saturate
- new products/innovations stagnate/decline
- market forecasts calm down

Hype Cycle or Double Boom: Where are we today?



Source: Meyer-Krahmer F.; Dreher C. (2004): Neuere Betrachtungen zu Technikzyklen und Implikationen für die Fraunhofer-Gesellschaft. In: Spath, D. (Hg.): Forschungs- und Technologiemanagement: Potenziale nutzen – Zukunft gestalten. München, S. 27–35; Thielmann A. et al. (2009), Innovationsreport: Blockaden bei der Etablierung neuer Schlüsseltechnologien. Im Auftrag des Büros für Technikfolgen-Abschätzung beim Deutschen Bundestag (TAB), Arbeitsbericht Nr. 133, Juli 2009;

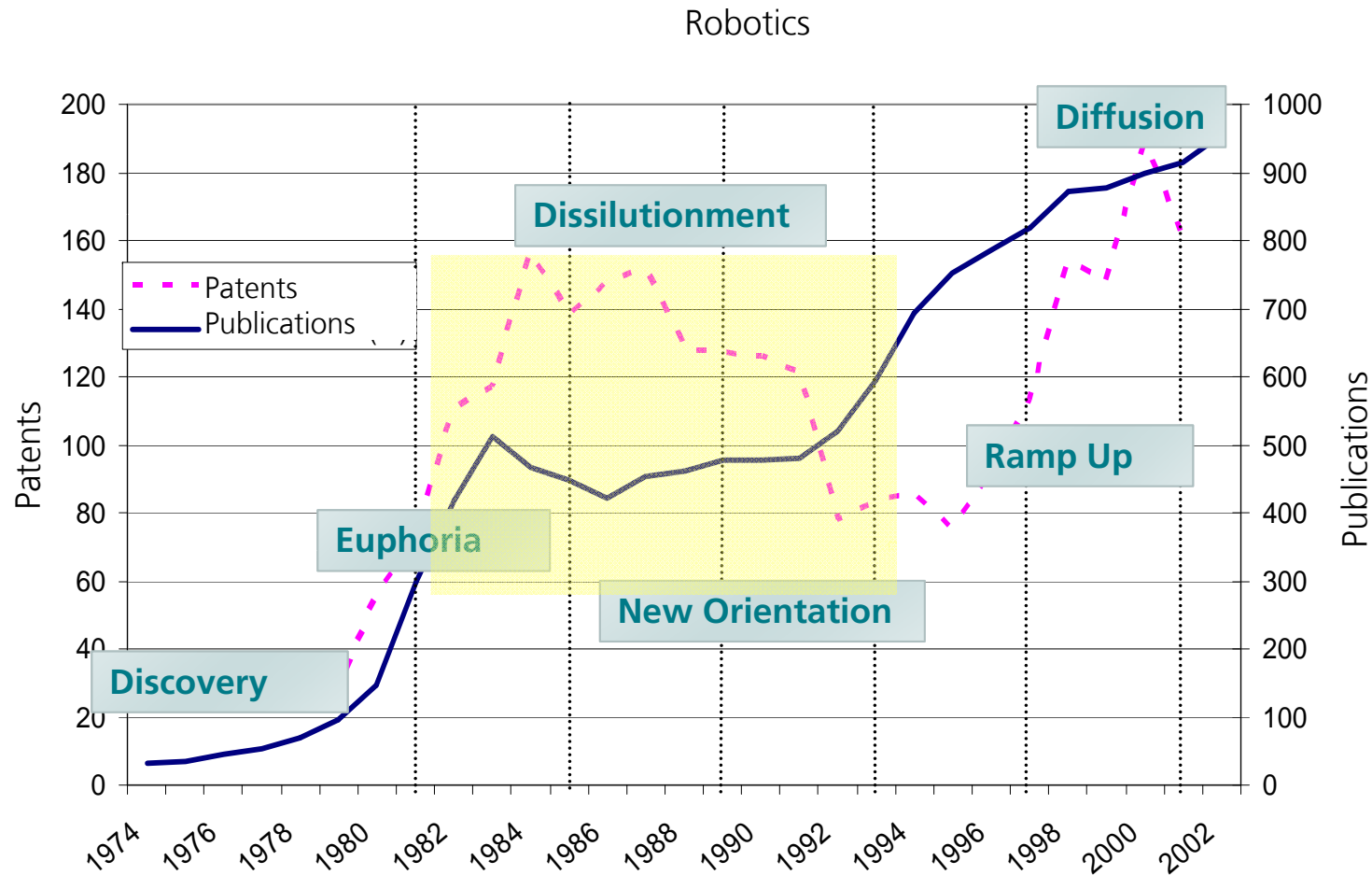
Patterns and typical characteristics of Publication and Patent dynamics

Double boom has been proven to show up in specific publication and patent patterns:

- Technological trends typically follow scientific trends.
- **Stagnation of scientific trends before first patent boom** and acceleration before second patent boom
- Scientific activities less fluctuating than patent activities since companies more rapidly react when expected technological and commercial results can not be achieved in relatively short time
- The technology cycle is long: **typically 15 years or more between first and second boom** (realistic: **in total 30 to 40 years or even longer**)
- No substantial Markets before the second technological boom

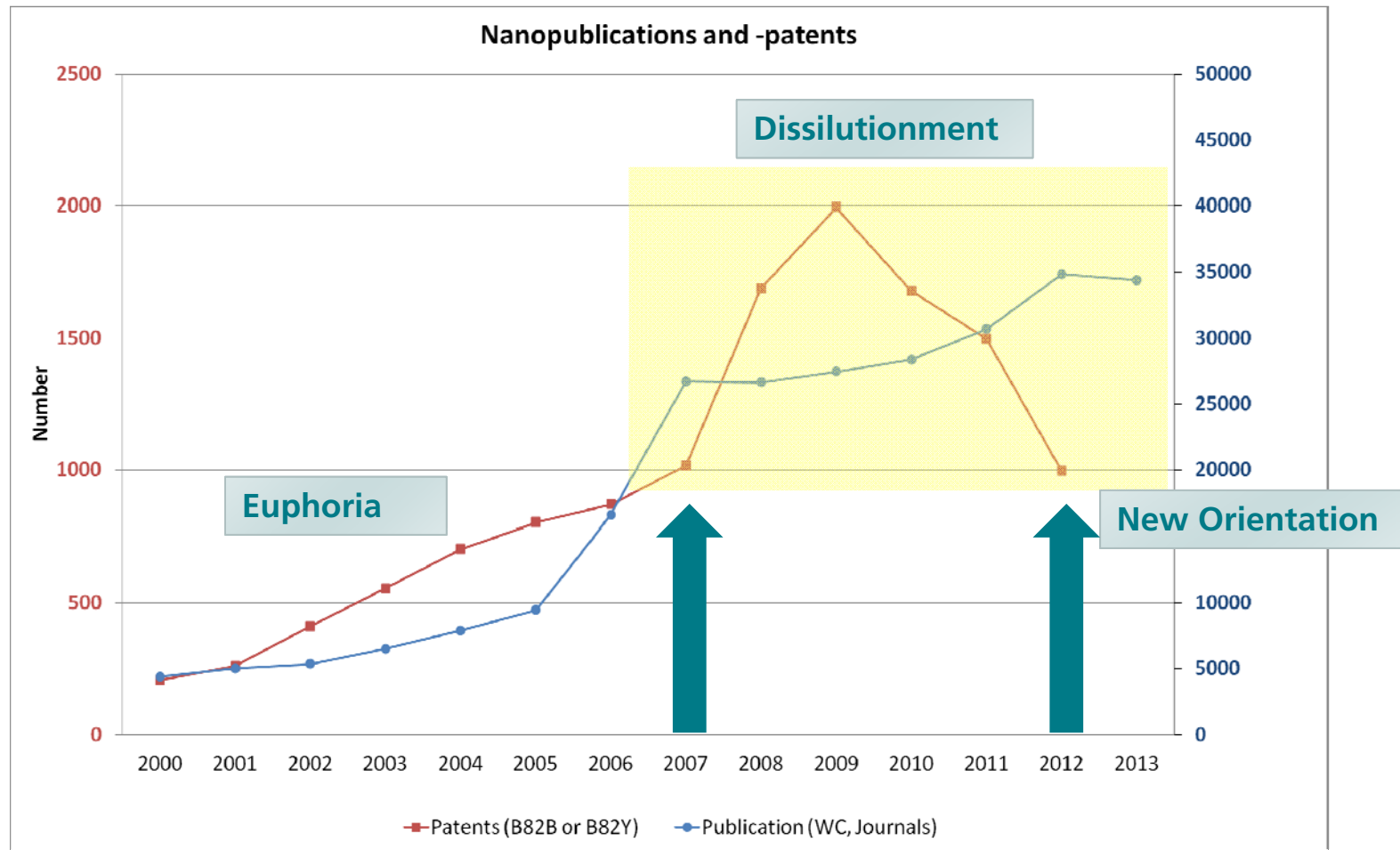
Source: Thielmann A. et al. (2009), Innovationsreport: Blockaden bei der Etablierung neuer Schlüsseltechnologien. Im Auftrag des Büros für Technikfolgen-Abschätzung beim Deutschen Bundestag (TAB), Arbeitsbericht Nr. 133, Juli 2009;

Hype-Cycle and double boom patterns in Publications and Patents (example Robotics)



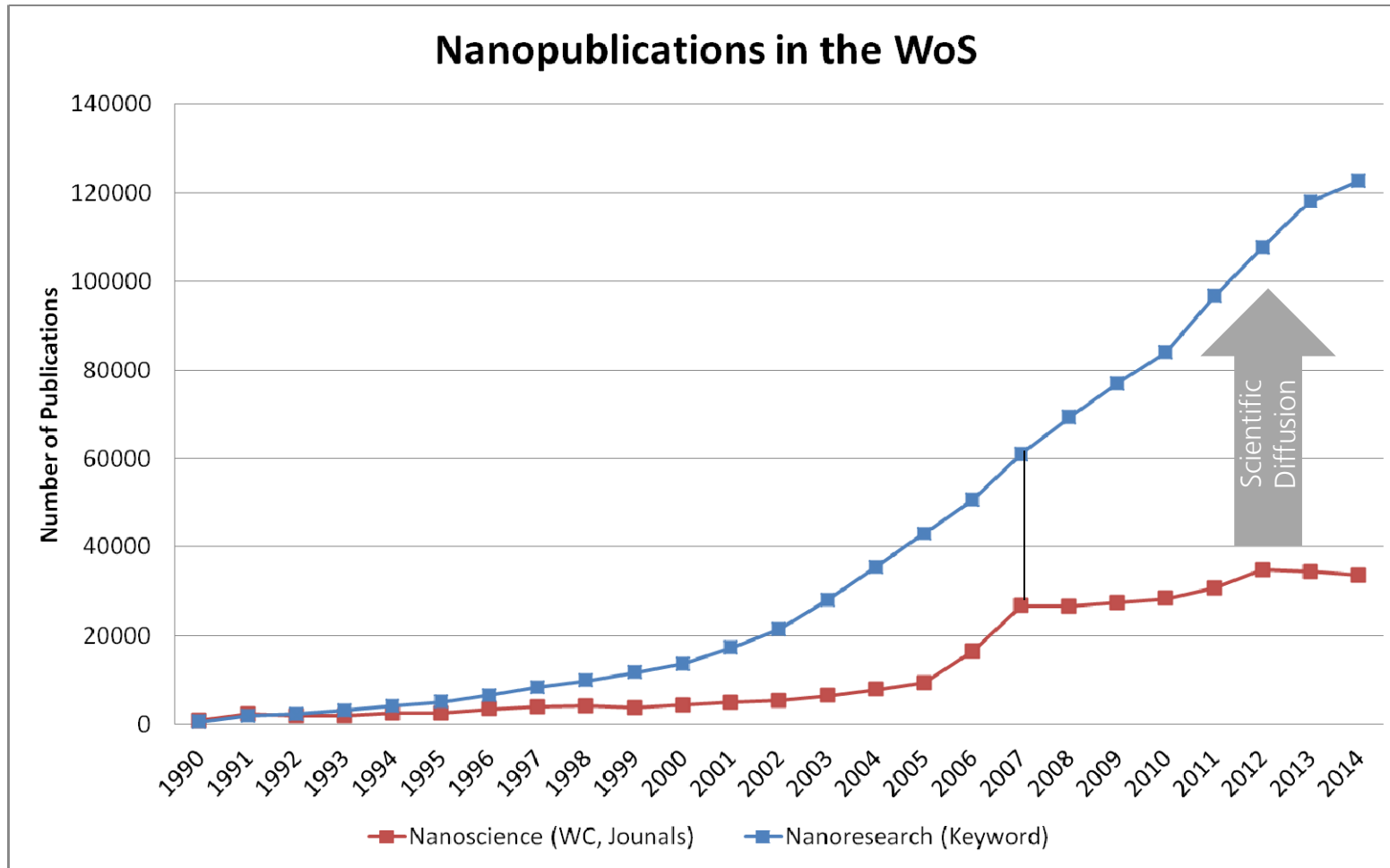
Meyer-Krahmer F.; Dreher C. (2004): Neuere Betrachtungen zu Technikzyklen und Implikationen für die Fraunhofer-Gesellschaft. In: Spath, D. (Hg.): Forschungs- und Technologiemanagement: Potenziale nutzen – Zukunft gestalten. München, S. 27–35;

Hype-Cycle patterns can be observed in Publications and Patents on Nanotechnology



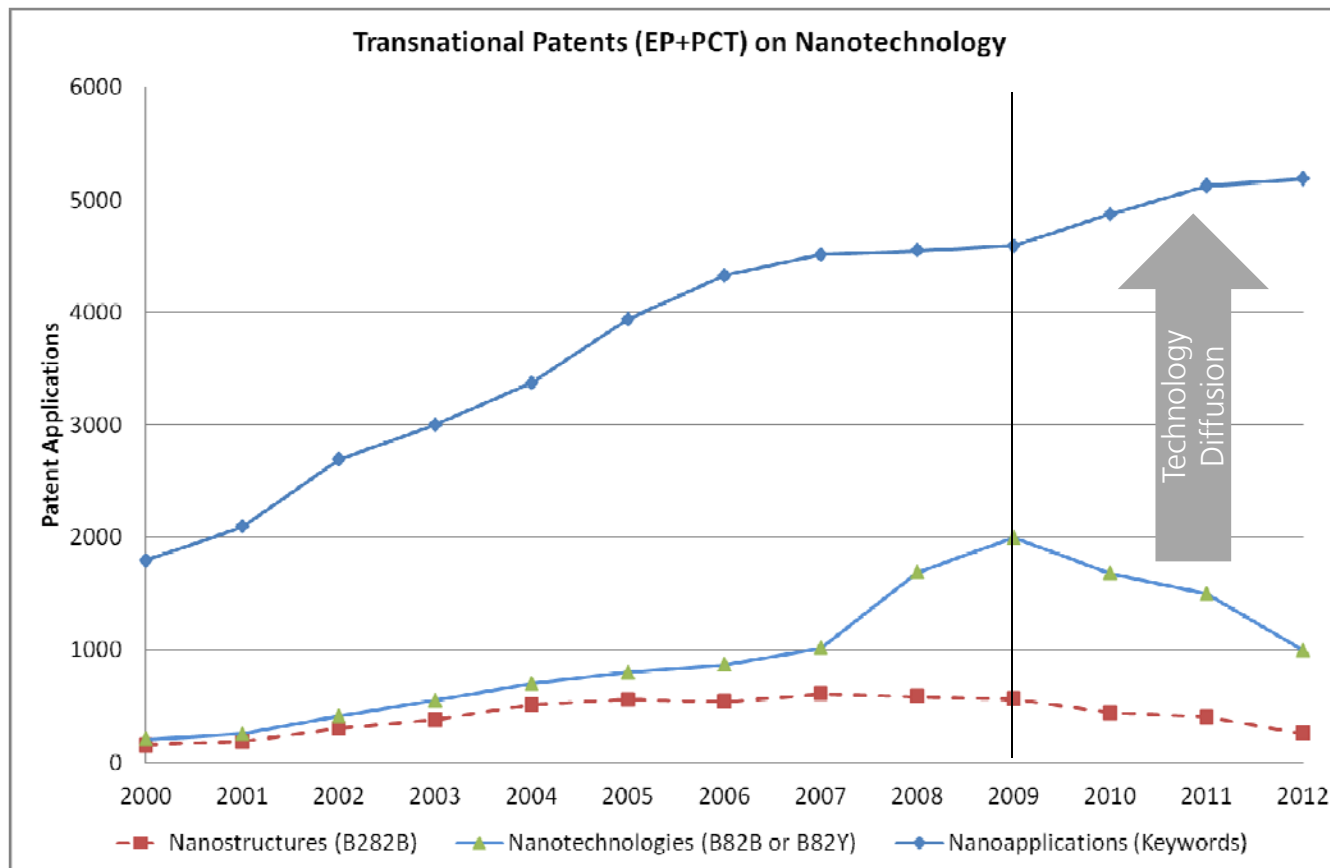
See also: U. Schmoch and A. Thielmann 2012, Cyclical long-term development of complex technologies – Premature expectations in nanotechnology? Research Evaluation 21 (2012) pp. 126-135.

Publications: an ongoing scientific diffusion Nanoscience vs. Science using Nano

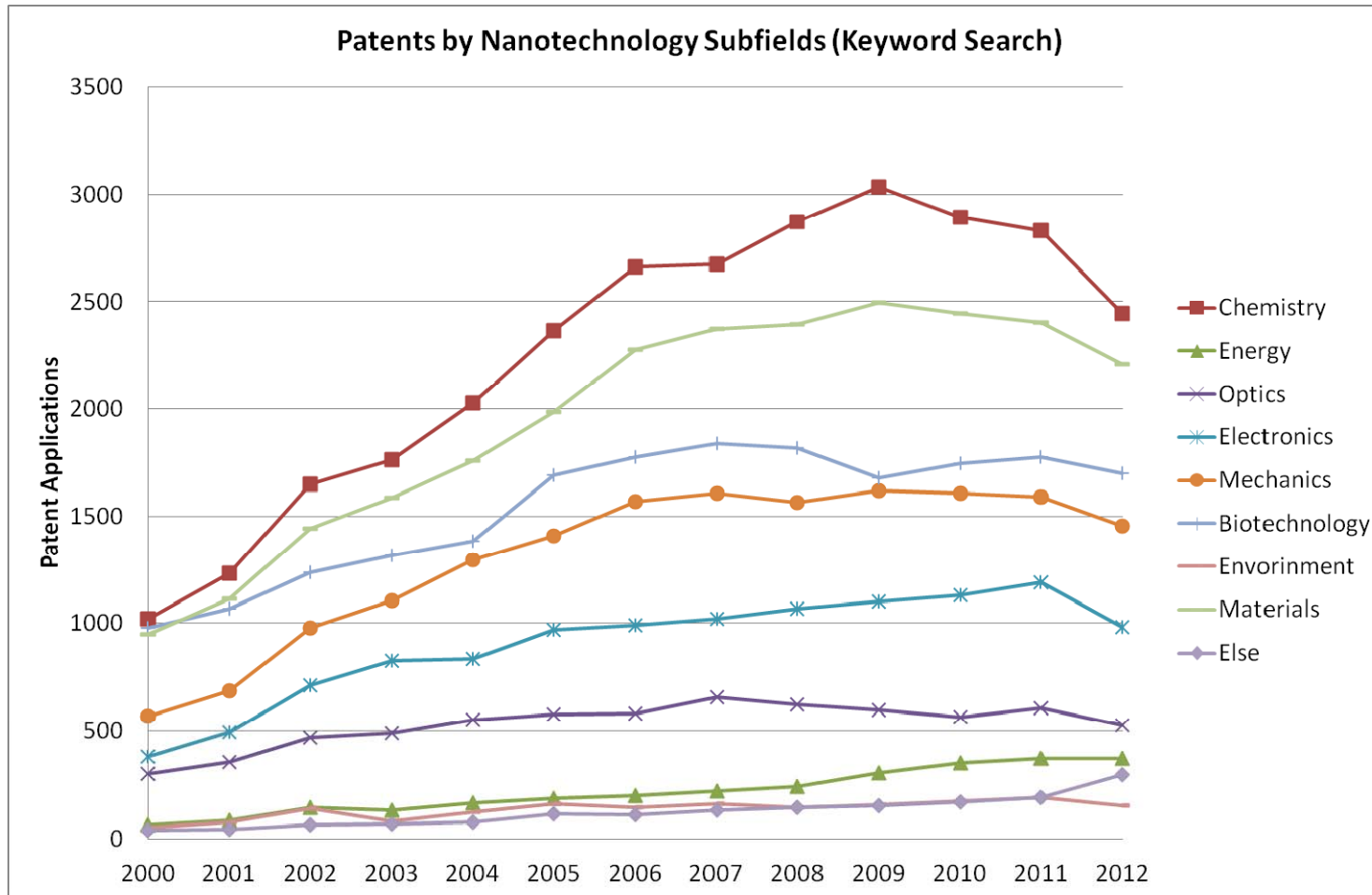


Patents: an ongoing technology diffusion

Nanotechnology vs. Innovations using Nano



Declining uptake/ diffusion in particular in Chemistry/Materials → declining Innovation



Agenda

1

Potential of Nanotechnology:
promises of the past, realities today, prospects for the future

2

**Acceptance of Nanotechnology:
before and after the hype – the stakeholder positions**

3

How much time is left for a Responsible Nanotechnology
Development?

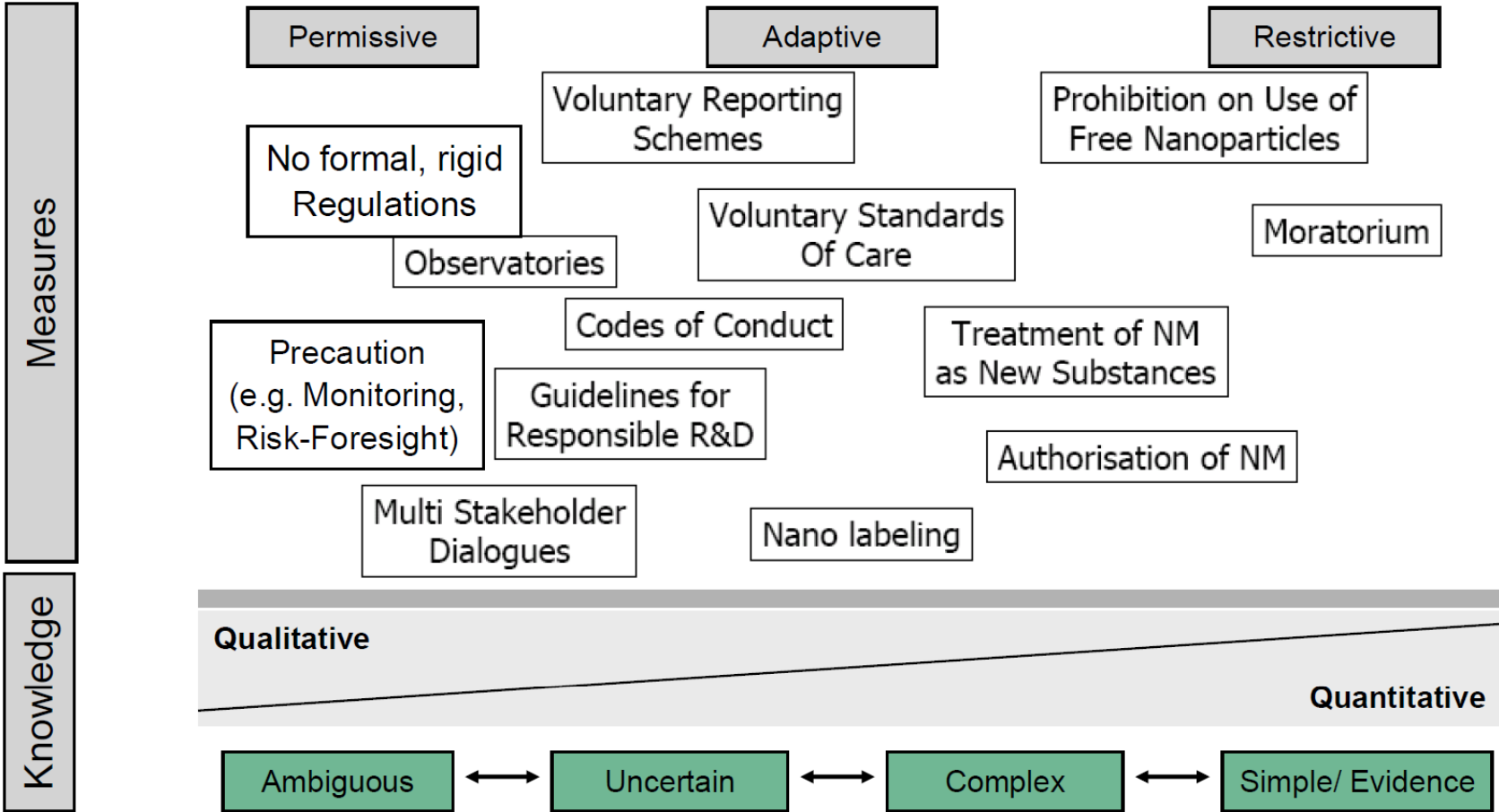
Acceptance of Nanotechnology (Expectations, Perception, ..)

- Acceptance can have different meaning for different stakeholder
 - Investors, Companies expect results, markets
 - NGOs transparency, ...
 - the public, consumers ... ?

- Hype cycle: time and level of activity matter!

- What is the position/attitude of different stakeholders (LE, SME, NGOs, Public, ..)?
- Is there a difference/change before and after the hype?
- How does it evolve over time?
- What are impacts of (risk) communication or non communication?

With the Nano-Risk-Debate of the past decade a number of measures have been discussed (tested)



A. Thielmann, OECD Policy Roundtable on Risk Governance for Nanotechnology. The Path from Risk Assessment to Risk Management Decision Making. Statement of Fraunhofer ISI Vienna, 25th of September 2009

EC Definition & discussion on EU Nano-Registry led to controversial discussions in the last years

since 2010 ...

Definition of a nanomaterial: Commission recommendation 2011/696/EU

- *"Nanomaterial" means a natural, incidental or manufactured material containing particles, in an unbound state or as an aggregate or as an agglomerate and where, for 50 % or more of the particles in the number size distribution, one or more external dimensions is in the size range 1 nm - 100 nm"*
- *Number size distribution percentage can be adapted*
- *Fullerenes, graphene and carbon nanotubes are nanomaterials*

Regulations:

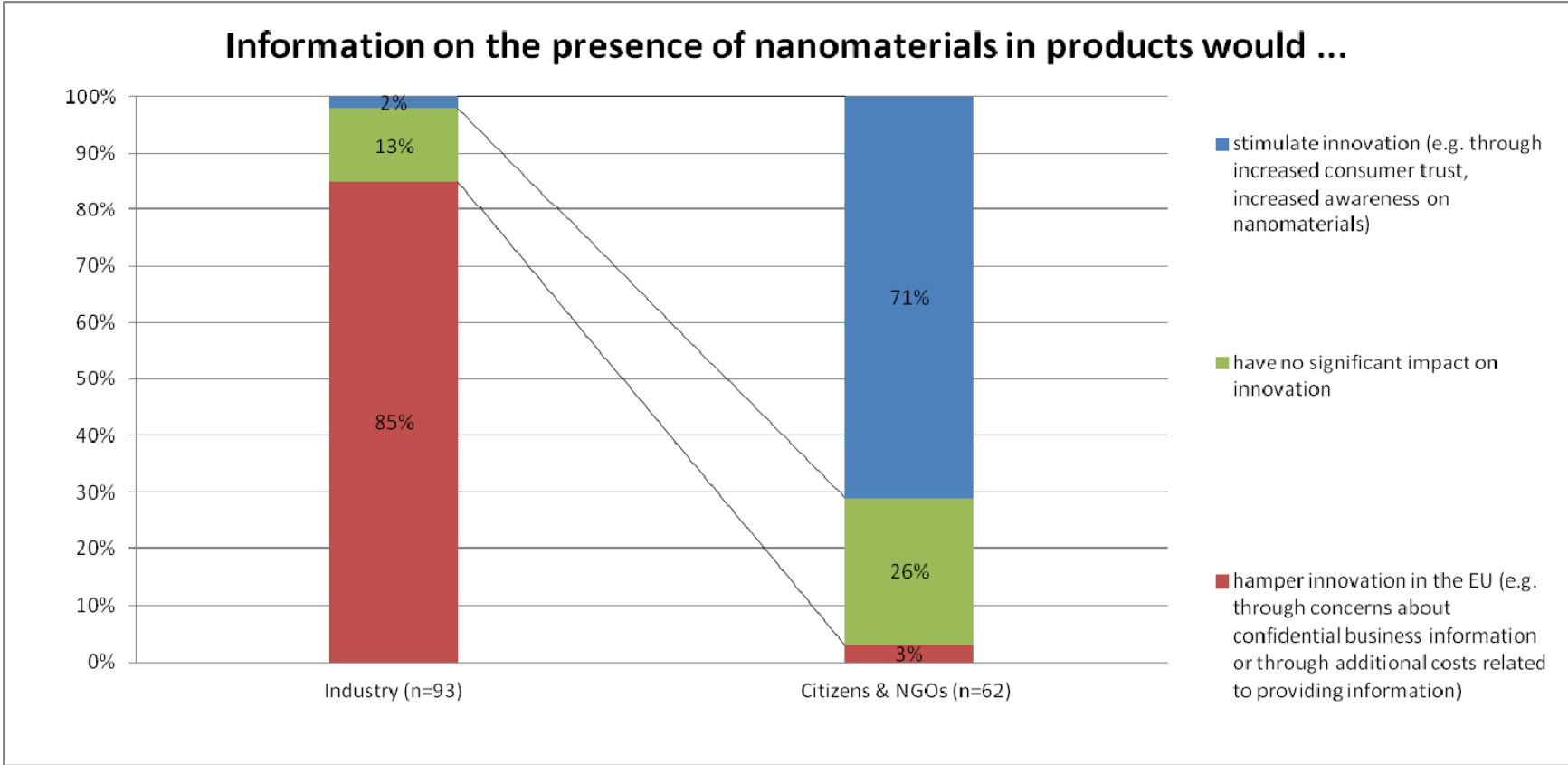
- REACH (modifications, amendments of annexes),
- CLP, ...

Nano-Registry:

- Example of France, Denmark, Belgium
- Impact assessment of possible EU Nano-Registry

See: http://ec.europa.eu/enterprise/sectors/chemicals/reach/nanomaterials/index_en.htm

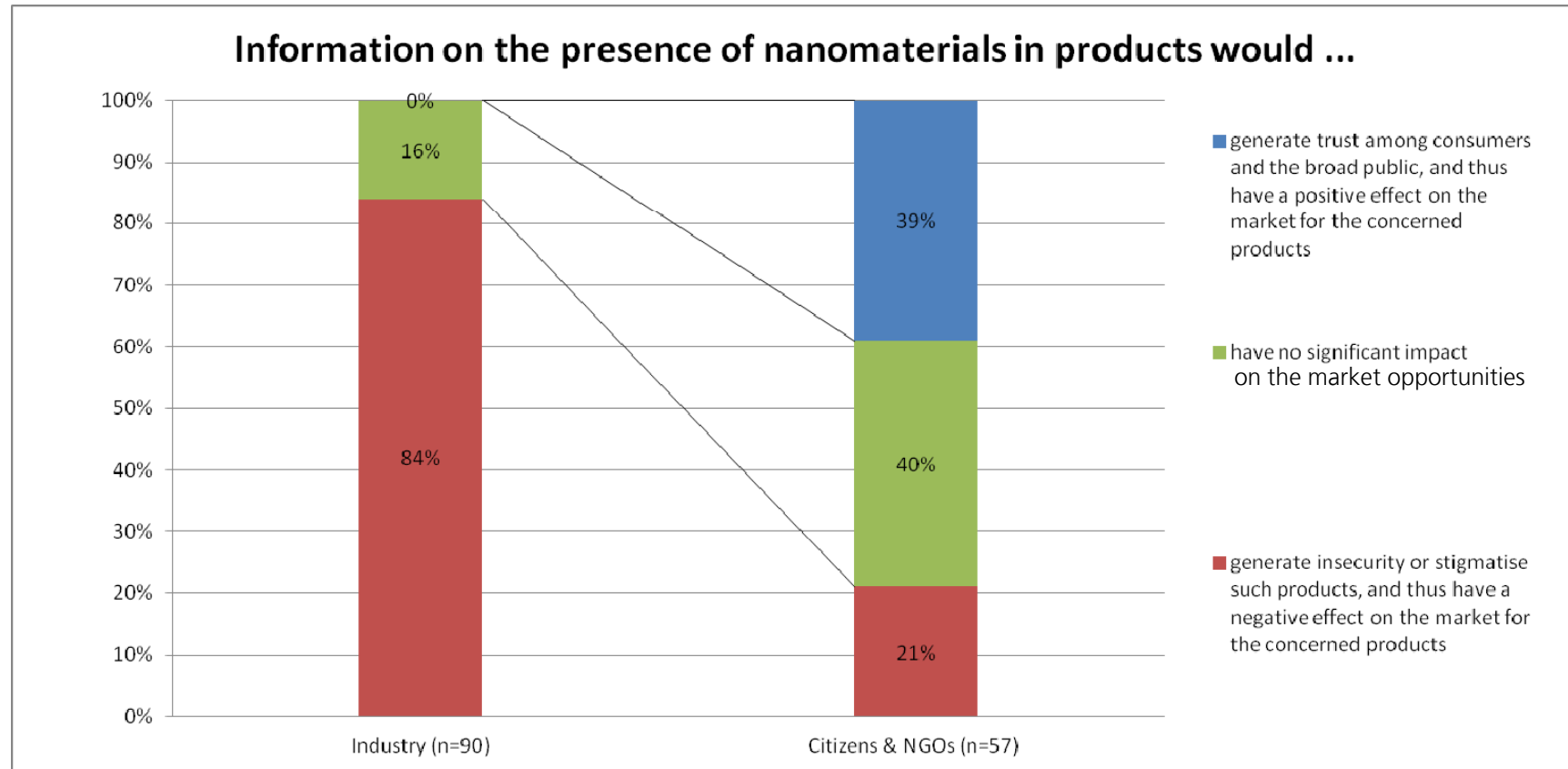
Industries see/feel the additional burden Citizens/ NGOs see/expect awareness & trust



About 200 Participants, ~ 100 from **Industries**, thereof **70% LE** (>250 Employees), 30% SME (<250 Employees)

Source: RPA & BiPRO. Summary of the public consultation on transparency for nanomaterials on the market. November 2014.

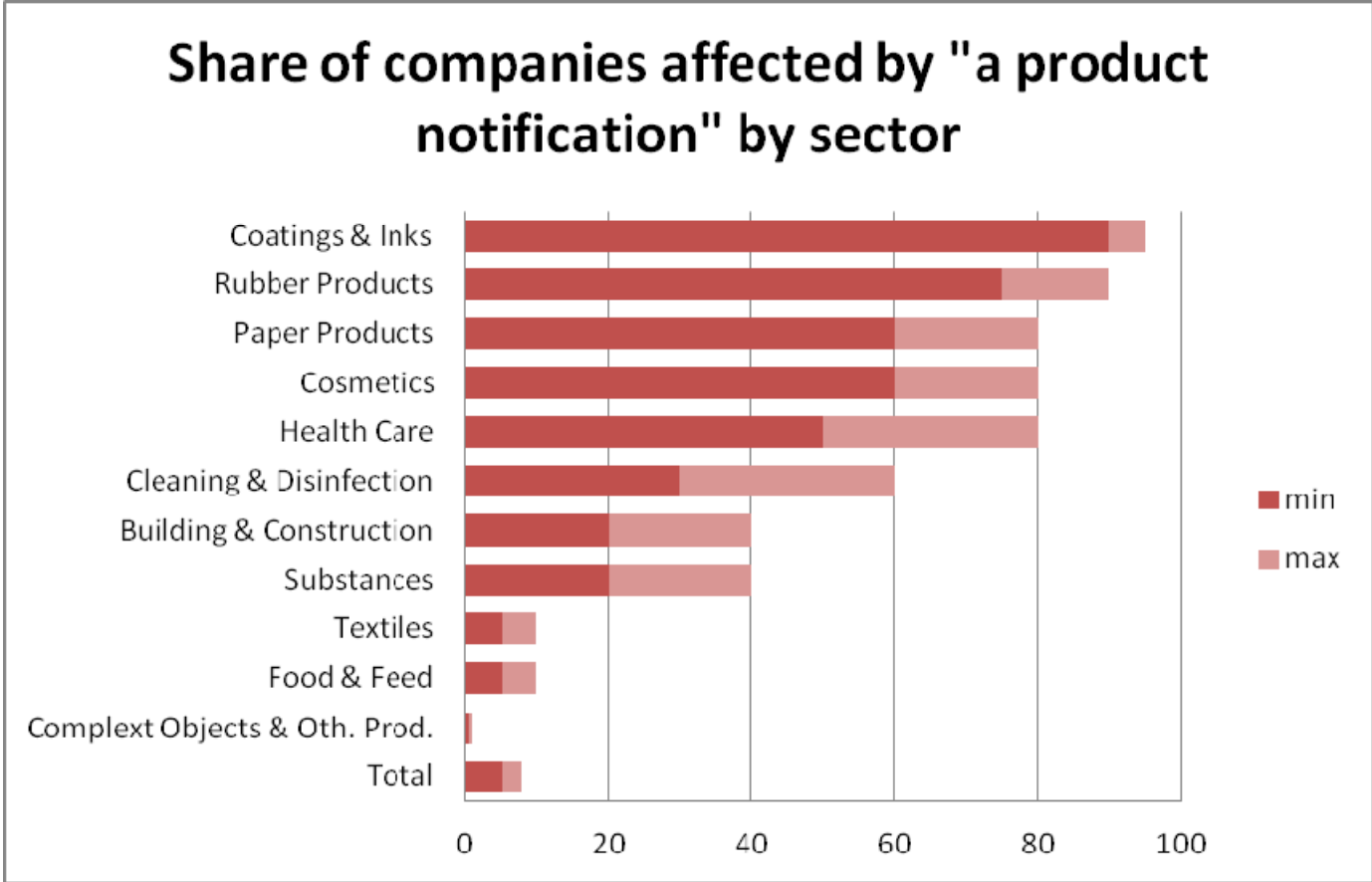
Industries want to avoid a labelling of nano. Is a nano-registry the only solution?



About 200 Participants, ~ 100 from **Industries**, thereof **70% LE** (>250 Employees), 30% SME (<250 Employees)

Source: RPA & BiPRO. Summary of the public consultation on transparency for nanomaterials on the market. November 2014.

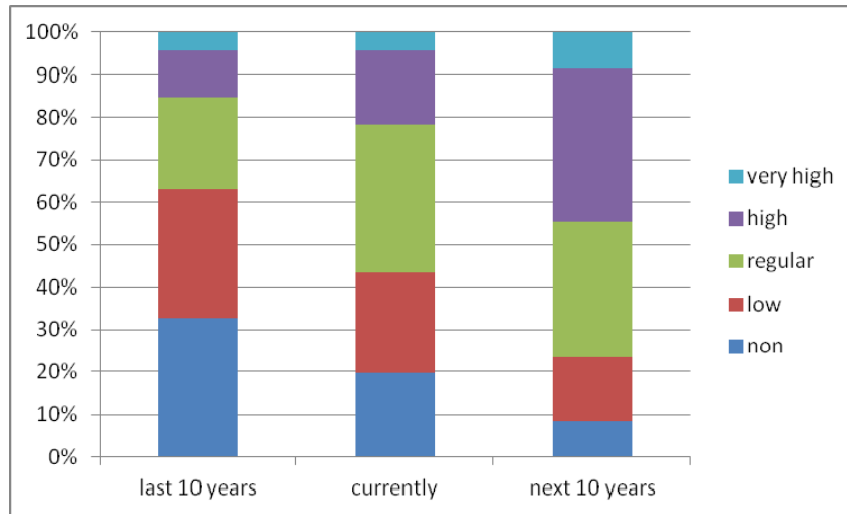
Coatings & Inks: the paint industries is most affected/ linked to Nano-products



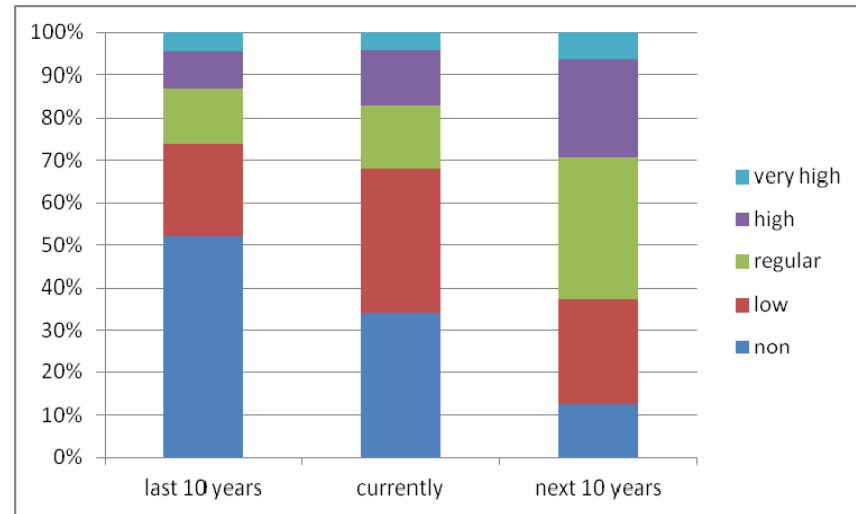
Source: RPA & bipro. Study to Assess the Impact of Possible Legislation to Increase Transparency on Nanomaterials on the Market, Evaluation Report prepared to DG Enterprise and Industry, November 2014.

Nanotechnology gains importance for paint industry (~90% of companies affected)

The relevance of Nanomaterials /-techniques for the **product development** in our company has been/ is/ will be ...

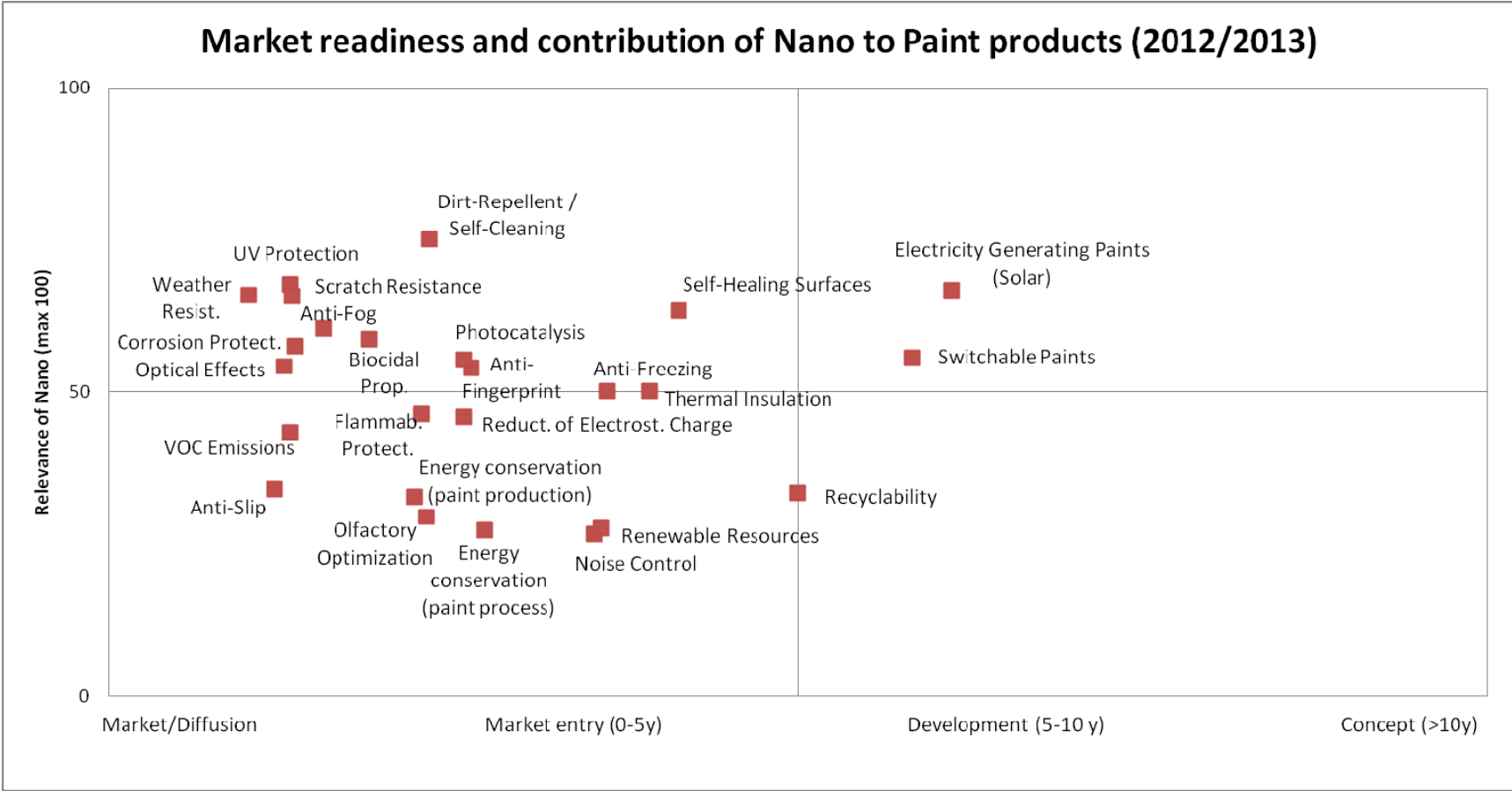


The **economic** relevance of Nanomaterials /-techniques for our company has been/ is/ will be ...



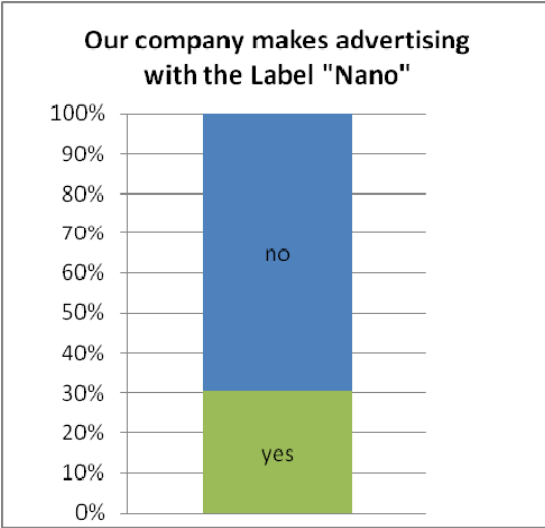
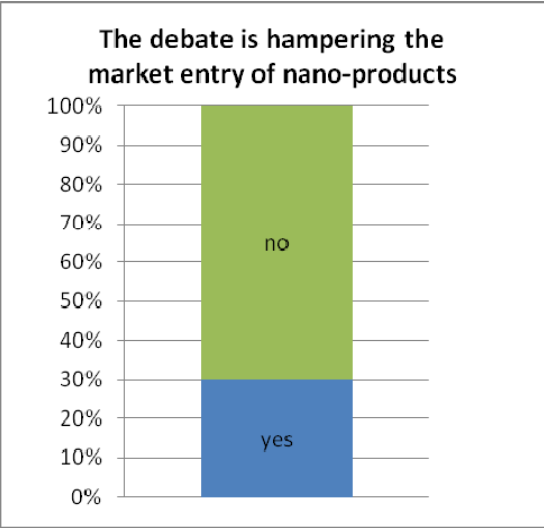
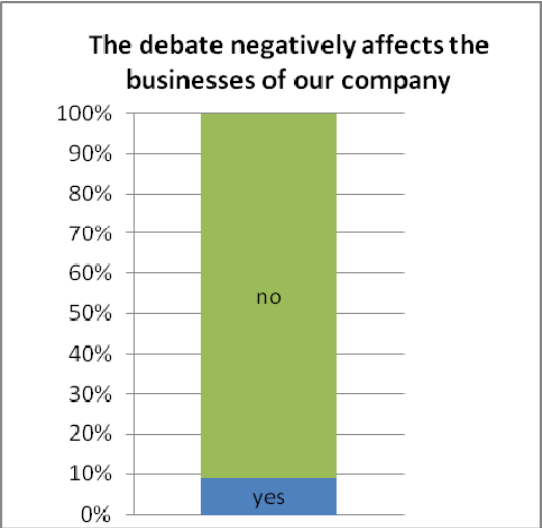
Source: Fraunhofer ISI 2012 supported by German association for paint and printing ink manufacturers (VdL) and NanoValley.eu, Online Survey among the members of the VdL (n=59 from 190 members, 31% participation, 65% SME/ 35% LE)

Potential contribution of Nanotechnology to products of paint industry and market entry

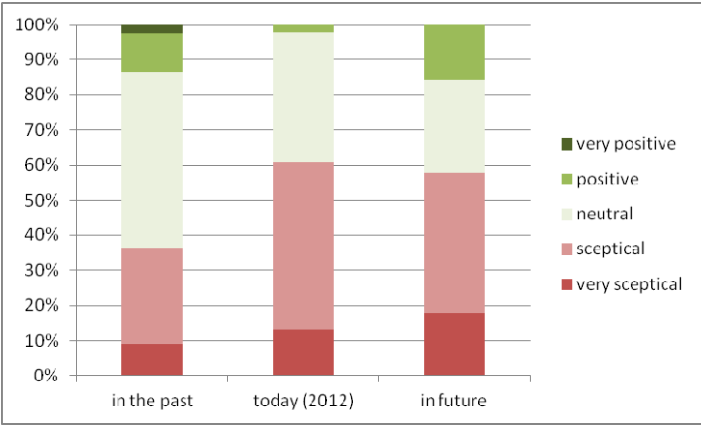


Source: Fraunhofer ISI 2012

The debate on Nano-Risks neg. affects 30% of companies, 30% explicitly mention „Nano“



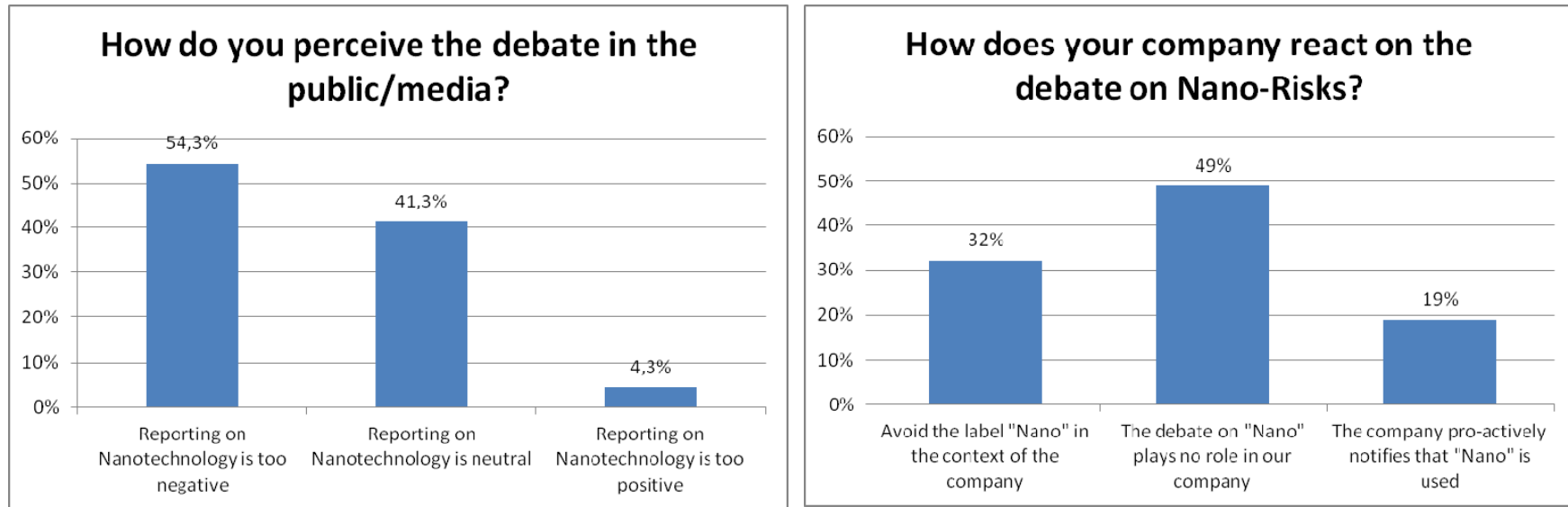
What is your personal attitude with respect to the Nano-Risk debate?



➤ 50% of companies express scepticism

Source: Fraunhofer ISI 2012

Reporting has been perceived too negative while debate is ignored or labelling avoided

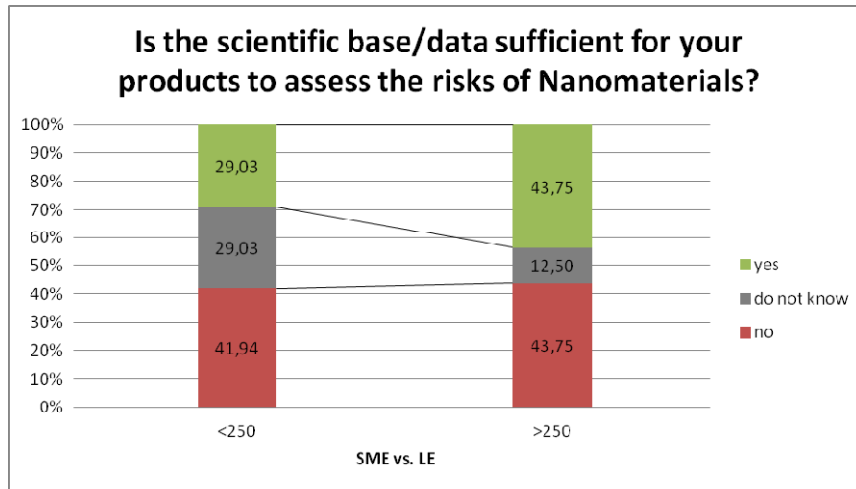


Several aspects concerned the companies:

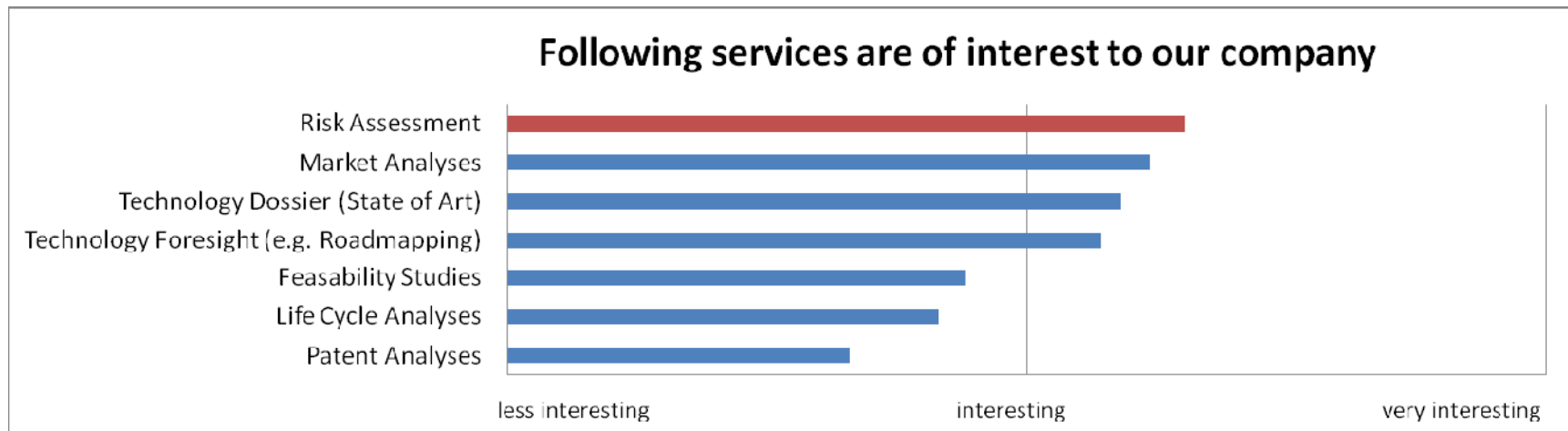
- negative image/ press,
- unclear/broad nano definition (also classical products, pigments),
- stigmatisation with labelling/registry, additional burden,
- lack of information

Source: Fraunhofer ISI 2012

Need for better science base / data and Risk Assessment – in particular for SMEs

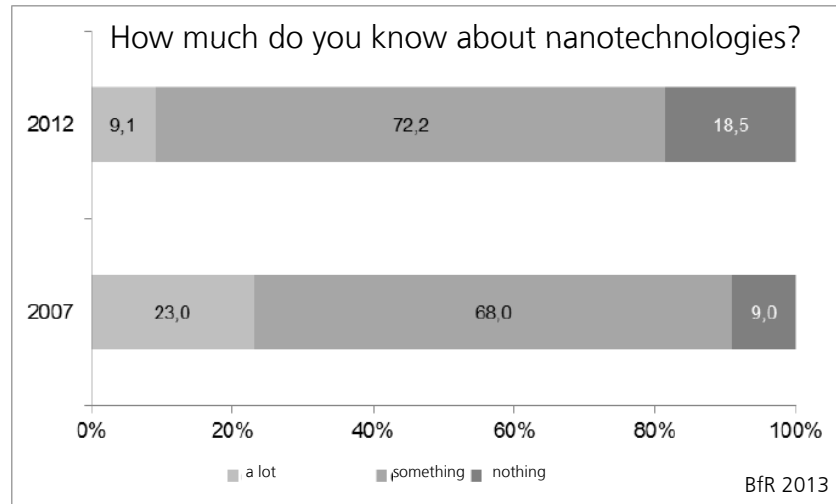


- SMEs have a particular need for information
 - data sheets
 - risk assessment



Source: Fraunhofer ISI 2012

The public seems to be lost, disconnected in the development and debate



Consumer knowledge is declining, less aware of Nano (BfR 2013, A. Grobe 2012)

People (over 60% of respondents) fear health or environmental risks (BfR 2013).

Willingness to buy products made with nanomaterials generally declining (BfR 2013).

Nano-food is viewed with scepticism; surface applications and clothing positively (BfR 2013).

The positive image of nanotechnologies is fading, because the positive applications are not communicated (A. Grobe et al. 2012).

Communication on Nanotechnology has been increasingly neutral, unpoltical in the last years (Marcinkowski, F. et al. 2012).

BfR 2013: G. Correia Carreira, A. Epp, M. Lohmann, G.-F. Böhl; Bundesinstitut für Risikobewertung (BfR). Nanoview – Einflussfaktoren auf die Wahrnehmung der Nanotechnologien und zielgruppenspezifische Risikokommunikationsstrategien. (Representative survey (n=1000), comparing results from 2012 to 2007).

A. Grobe et al. 2012: Grobe, Antje; Rissanen, Mikko; Funda, Philippe; de Beer, Joel & Jonas, Uschi: Nanotechnologien aus der Sicht von Konsumenten. Was Verbraucher wissen und was sie wissen wollen. BAG Bundesamt für Gesundheit, Bern & Stiftung Risiko-Dialog, St. Gallen. (comparing results from 2011 to 2008).

Marcinkowski, F., Kohring, M., Pruisken, K., Donk, A. & Metag, J. (2012): Das Bild der Nanotechnologie in der deutschen Presse: Eine Langzeitbeobachtung 2000 bis 2011. ifk-Forschungsbericht, Westfälische Wilhelms-Universität Münster, Münster. http://www.uni-muenster.de/imperia/md/content/kowi/forschen/projektbericht_berichterstattung_nanotechnologie_2000_bis_2011.pdf

Agenda

1

Potential of Nanotechnology:
promises of the past, realities today, prospects for the future

2

Acceptance of Nanotechnology:
before and after the hype – the stakeholder positions

3

**How much time is left for a Responsible Nanotechnology
Development?**

Summary and Conclusions

Potential (a new boom and thus visibility will come):

- Nanomaterials already at market, Novel nanomaterials, products will enter markets in future
- A broad diffusion will come in the next decades (currently in the phase of new orientation)

Acceptance (stakeholders/ activities seem fragmented today, still need for discussion):

- Companies (LE) rather against nano labelling/information (e.g. stigmatisation, financial burden)
- SME (example of paint industries) need more information for the nanomaterials in use
- NGOs expect transparency
- Consumers/ the public are about to forget what nanotechnology is (they do not differentiate)

Responsible Nanotechnology Development (not reduce to risk assessm., communic.)

- Acceptance, awereness, and trust by consumers essential (transparency);
 - no risk does not mean acceptance, nano-community has to learn also from the public
- Broad continuous inclusion and integration of stakeholders and their perspectives
- Neutral and trusted moderation (not the affected stakeholder)
- Adopted measures (e.g. depending if free particles, bound, embedded – Frames 1 and 2, Roco)

Contact

Dr. Axel Thielmann

Deputy Head of Competence Center Emerging Technologies

Fraunhofer Institute for Systems and Innovation Research ISI

Karlsruhe, Germany

Phone: +49 721 6809 299

axel.thielmann@isi.fraunhofer.de

