What will drive the EU nanoremediation market till 2025 – opportunities and challenges for the utilisation of nanoremediation

Paul Bardos, r³ environmental technology ltd, UK

Stephan Bartke – Helmholtz Centre for Environmental Research – UFZ, Germany

House keeping

- Thank you
- Phones
- Chatham House Rules
- Recording discussions to assist with note taking only
- Notes from workshop will be circulated
- Format of the day

Aims

- To describe the broad market drivers and possible futures for nanoremediation markets by 2025
- Delegates will then have the chance to debate this presentation in a World Cafe™

Trainers

- Paul Bardos
  - Director, r3 environmental technology ltd
  - Adjunct professor University of Brighton
  - Visiting professor Universities of Reading and Nottingham

- Dan Elliott
  - Geosyntec. Dr. Elliott has more than 25 years of experience as an environmental engineer from the diverse perspectives of industry, consulting, and the university sector

- Petr Kvapil
  - R&D director and member of the board at AQUATEST a.s. company.

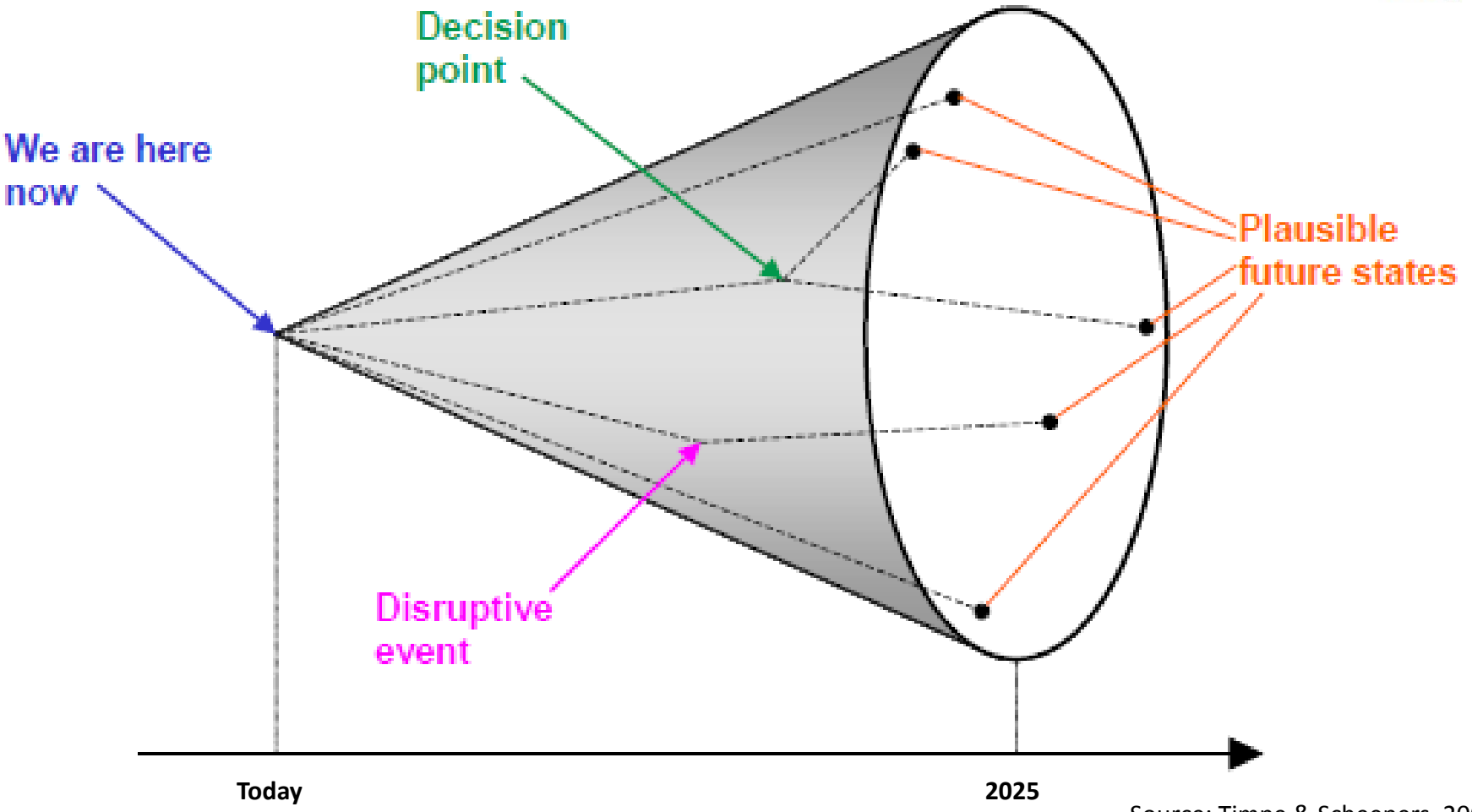
Agenda

Time	Topic
14:30	Introduction
	• Welcome / Objectives of session • Tour de table
14.45	Market assessment research outcomes from the NanoRem project
15:15	World Café™ to discuss nanoremediation market futures (with coffee)
	• Introduction to World Café format and points of discussion • Discussions and exchange in different facilitated breakout groups
16:30	Concluding plenum
16:00	• Reporting back from World Café groups in plenum • Concluding discussion on practical applicability of nanoremediation joining the morning and afternoon sessions
16:30	Closing comments
16.45	Adjourn

Context

- This workshop contributes to EU-project NanoRem WP9 task on “Exploitation Strategy and Consultation”
- Aim: Understanding of the “value proposition” for nanoparticles in remediation
- Workshops elicited expert and stakeholder opinions on the sustainability of nanoremediation and on factors affecting its potential market development and the risks associated with the deployment of NPs
- Outcomes are incorporated into scenario analysis to explore possible market developments and conclude on exploitation potentials

Understanding potential market developments



Source: Timpe & Scheepers, 2003

Caveat

This project received funding from the European Union Seventh Framework Programme (FP7 / 2007-2013) under Grant Agreement No. 309517.

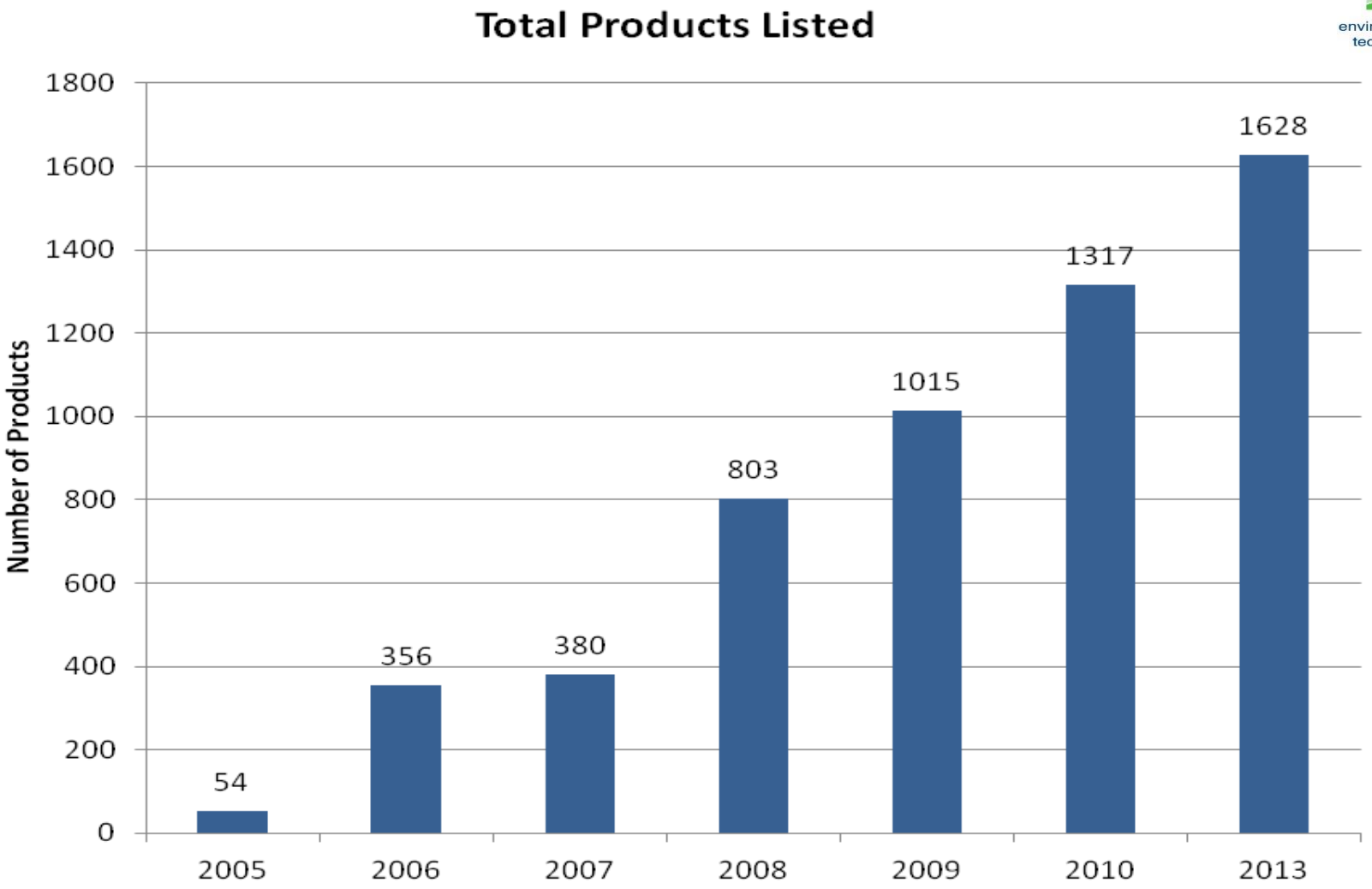
This presentation reflects only the authors' views and that the European Union is not liable for any use that may be made of the information contained therein.

Tour de table: Elevator pitches

- Please tell us in max. 1 minute:
  - Your name & institution
  - What are you interested to learn about in this meeting today?
  - What message do you bring to the meeting?

Factors found to drive European nano-remediation markets by 2025

>1,800 consumer nano-enabled products



Sales and profits of typical product life cycle stages

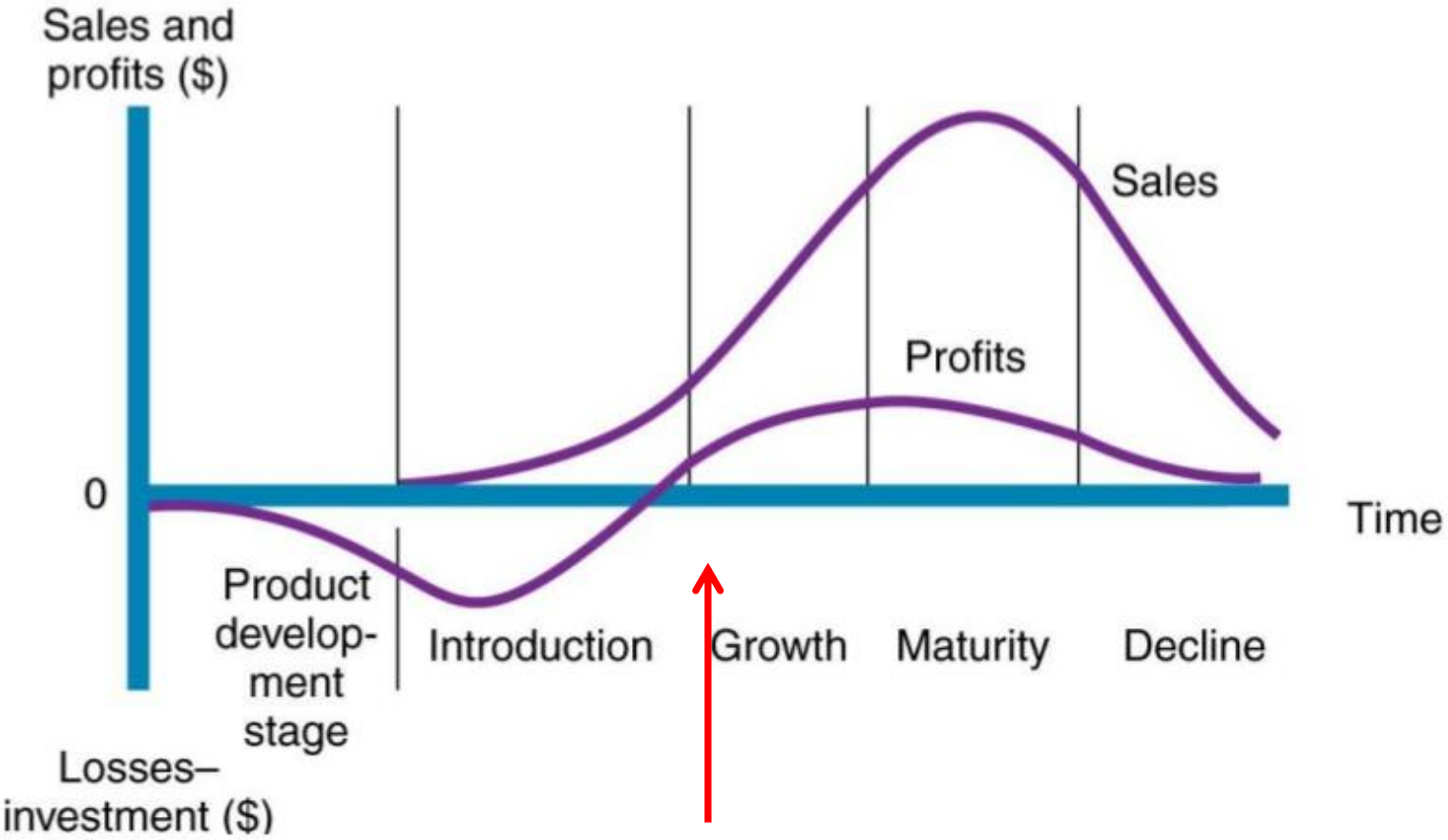


Image-Source: Moghimi 2013: http://image.slidesharecdn.com/kotler-10new-productdevelopmentandproductlife-cyclestrategiesmoghimi-130424085545-phpapp02/95/kotler-10-newproduct-development-and-product-lifecycle-strategies-moghimi-32-638.jpg?cb=1366811839

Nanoremediation technology: Is it a “normal” product?

- People do not buy technology; they buy products – Robust product development is critical to realize the potential
- Venture community (research, entrepreneurs, regulators…) behavior will determine outcomes

Approach to understanding pull- and push factors / uncertainties

- Instead of market assessment on dubious assumptions, we strive at a better understanding of drivers and decision points of the nano-remediation market through scenario analysis

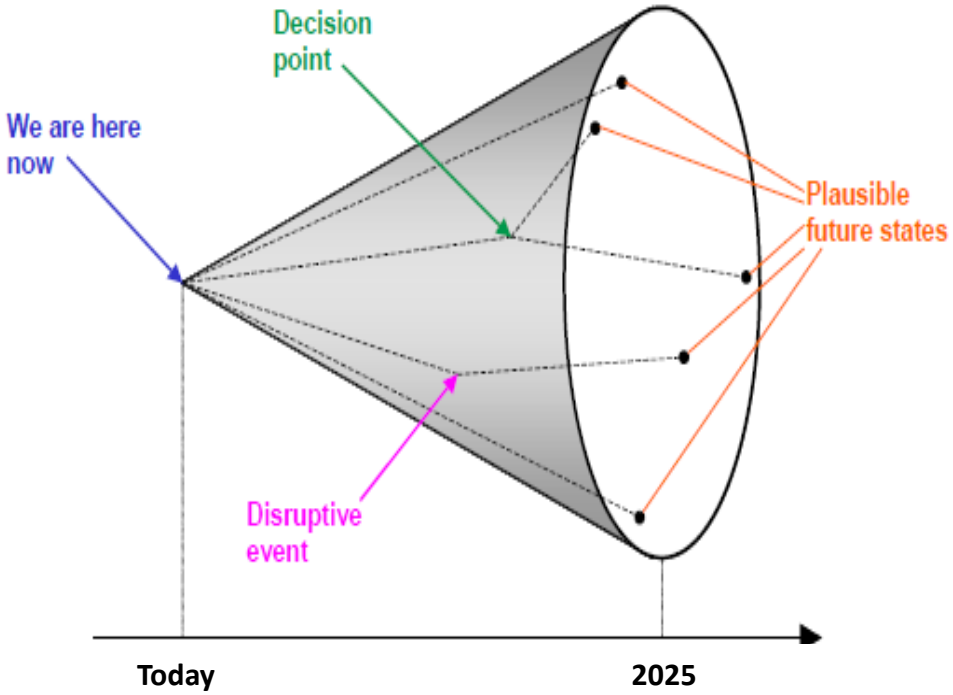
- **Scenarios are**

“internally consistent stories about ways that a specific system might evolve in the future”

(March et al 2012: 127)

Why scenarios?

- Advantages, risks and further developments of the remediation market are **uncertain**
- Uncertainties increase with the **long-term perspective**
- Projections of **extreme versions** of the future to derive **recommendations** for policy makers & entrepreneurs

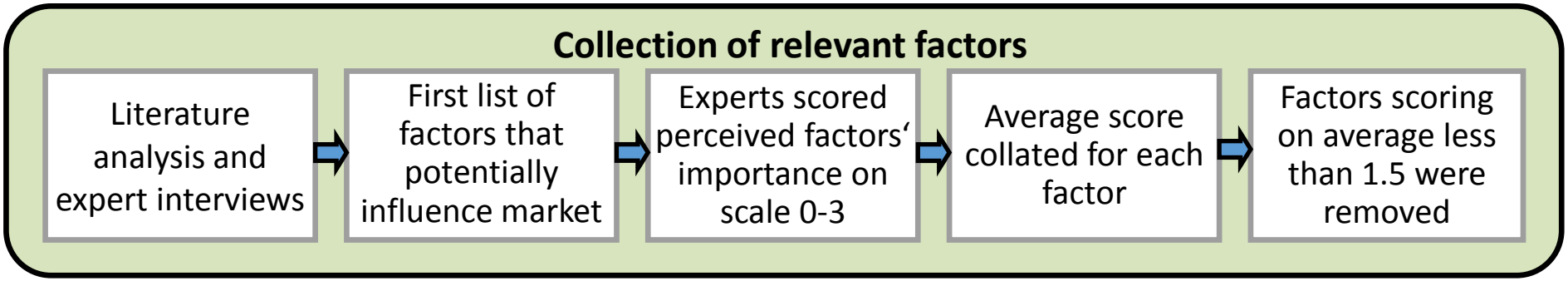


Source: Timpe and Scheepers (2003)

General Methodology

How we scored market factors' relevance

- Considering the **European Union in 2025**, indication of the relevance of market influencing factors using the scale:
  - (0) **Negligible relevance** – the factor is not an important driver or inhibitor.
  - (1) **Minor relevance** – the factor might have a limited but not very important effect.
  - (2) **Considerable relevance** – the factor is likely to have a notable (indirect) effect.
  - (3) **Key relevance** – the factor is of utmost importance to nanoremediation market development.



Of the factors we identified, which were considered most important?

The most important factors (>2.00)

1. Innovation on treatment of known contaminants with NP (2.48) – Technology
2. Regulation of nanoparticles (2.45) – Policy
3. Validated information on NP application potential (2.40) – Communication
4. Costs of competitive technologies (2.35) – Economy
5. Standardization for nanoparticles (2.20) – Policy
6. Innovations along NPs production chain (2.18) – Technology
7. Environment (especially soil) protection policies (2.10) – Policy
8. Synergies with other technologies (2.05) – Technology
9. Public stakeholder dialogue (2.00) – Communication

Less important factors (<2.00)

10. NP treatment of emerging contaminants (1.95) – Technology
11. Public perception of NPs in general (1.93) – Society
    Science-Policy-Interface (1.93) – Communication
13. Technology and research policies (1.75) – Policy
14. Growing number of nanoparticles suppliers (1.73) – Economy
15. Real estate market development (1.68) – Economy
16. Innovation attitude (1.60) – Society
17. Environmental awareness (1.55) – Society

Minor factors (<1.50)

18. EU economic development (1.50) – Economy
19. Globalization (1.20) – Megatrend
20. Industrial and military land use (1.00) – Society
21. Climate change (0.70) – Megatrend
22. Demographic change (0.60) – Megatrend

Key points found:

- We found **no "key factor"** with > 2.50 scoring, indicating that no factor alone is of utmost importance to pushing or pulling nano-remediation market development
- Instead we found **a wider set of considerably important factors** that might be subsumed to the following categories:
  - **Technical | – Policy | – Communication**
  - **Society | – Economy**
- All of the "megatrend" factors had only minor importance.
- Moreover, some "Economy" and "Society" factors were also not found to be decisive.

No simple outcome:

- **Driving factors** of the nanoremediation market **are diverse**, i.e. development depends not only on the technology, but also on political (dis)incentives, societal' preferences and the attitude of the industry.
- Several driving factors are **difficult to predict** and to influence such as public perception of NPs in general or soil protection policies.
- There are many **interdependencies** between factors.

What might these interdependencies be?

The importance of interdependecies

- To create scenarios, we next needed to learn about the interdependencies of the identified important factors.
- **Expert groups assessed the relevance of the development of one factor on the develop-ment of all other factors.**
- This has been collated as an „Influence Matrix“, confirmed by susequent focus groups

Influence matrix
Question: »How strong is the impact of factor A (row) on factor B (column)?«

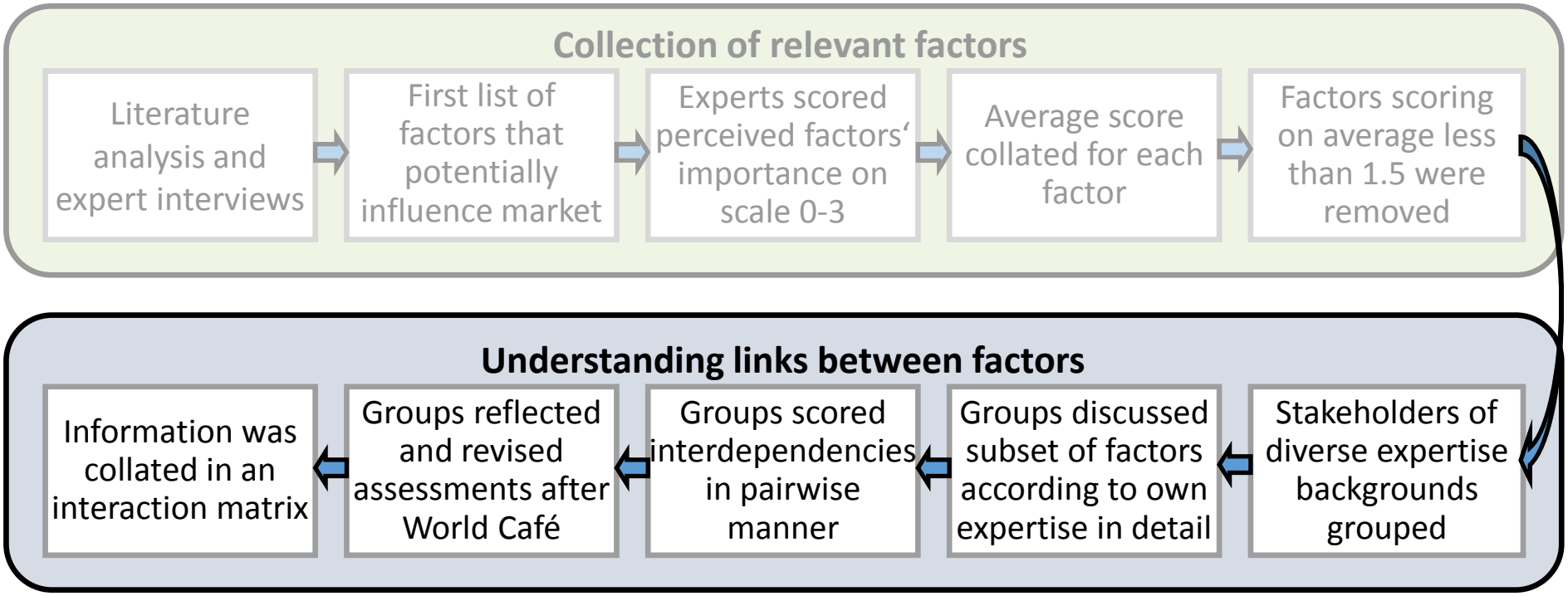
scale:
0 = no impact
1 = weak and delayed impact
2 = medium impact
3 = strong and direct impact

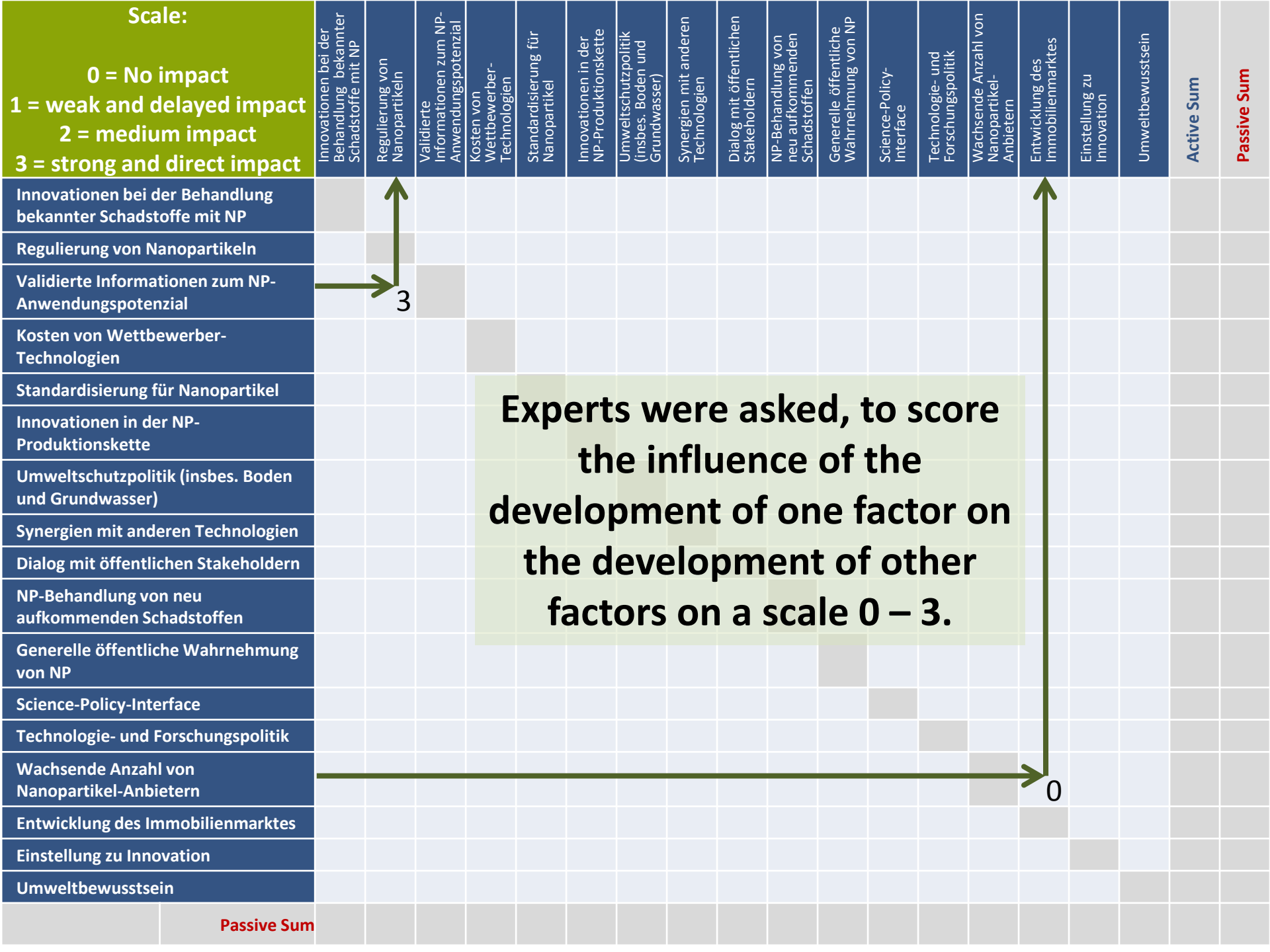
activity (sum of rows): How strong is the impact of a factor on all other factors?

	1 buying habits	2	3	4	5	6	7 cards	8 umer cards	9 -of-sale-networks		35 slues		active sum
1 buying habits		2	2	3	-	1	2	2	1		-	-	13
2 cashless money transfer	1		-	-	-	-	3	2	3		-	-	17
3 size of purchasing points	-	1		2	-	1	-	3	3		-	-	13
4 home-shopping	-	2	1		-	-	3	-	-		-	-	10
5 buying power	3	2	-	1		-	1	-	-		-	2	15
6 hours of opening	2	2	2	3	-		-	-	-		-	-	13
7 use of credit cards	-	1	-	-	-	-		1	1		-	-	10
8 use of consumer cards	-	1	-	-	-	-	2		3		-	-	6
⋮													
35 system of values	3	-	-	1	-	-	-	-	-			2	26
36 growth rate	2	-	-	-	3	1	-	-	-		-		19
passive sum	30	41	13	31	14	7	25	17	24		10	14	

How did we get the “raw data”?

activity (sum of columns): How strong is a factor impacted by all the others?


Collection of relevant factors
Literature analysis and expert interviews
First list of factors that potentially influence market
Experts scored perceived factors' importance on scale 0-3
Average score collated for each factor
Factors scoring on average less than 1.5 were removed
Understanding links between factors
Stakeholders of diverse expertise backgrounds grouped
Groups discussed subset of factors according to own expertise in detail
Groups scored interdependencies in pairwise manner
Groups reflected and revised assessments after World Café
Information was collated in an interaction matrix


Scale:
0 = No impact
1 = weak and delayed impact
2 = medium impact
3 = strong and direct impact
Innovationen bei der Behandlung bekannter Schadstoffe mit NP
Regulierung von Nanopartikeln
Validierte Informationen zum NP-Anwendungspotenzial
Kosten von Wettbewerber-Technologien
Standardisierung für Nanopartikel
Innovationen in der NP-Produktionskette
Umweltschutzpolitik (insbes. Boden und Grundwasser)
Synergien mit anderen Technologien
Dialog mit öffentlichen Stakeholdern
NP-Behandlung von neu aufkommenden Schadstoffen
Generelle öffentliche Wahrnehmung von NP
Science-Policy-Interface
Technologie- und Forschungspolitik
Wachsende Anzahl von Nanopartikel-Anbietern
Entwicklung des Immobilienmarktes
Einstellung zu Innovation
Umweltbewusstsein
Active Sum
Passive Sum
3
0
Experts were asked, to score the influence of the development of one factor on the development of other factors on a scale 0 – 3.

Scale: 0 = No impact 1 = weak and delayed impact 2 = medium impact 3 = strong and direct impact	Innovationen bei der Behandlung bekannter Schadstoffe mit NP	Regulierung von Nanopartikeln	Validierte Informationen zum NP-Anwendungspotenzial	Kosten von Wettbewerber-Technologien	Standardisierung für Nanopartikel	Innovationen in der NP-Produktionskette	Umweltschutzpolitik (insbes. Boden und Grundwasser)	Synergien mit anderen Technologien	Dialog mit öffentlichen Stakeholdern	NP-Behandlung von neu aufkommenden Schadstoffen	Generelle öffentliche Wahrnehmung von NP	Science-Policy-Interface	Technologie- und Forschungspolitik	Wachsende Anzahl von Nanopartikel-Anbietern	Entwicklung des Immobilienmarktes	Einstellung zu Innovation	Umweltbewusstsein		
Innovationen bei der Behandlung bekannter Schadstoffe mit NP		0	0	3	2	2	0	2	1	1	1	0	2	3	1	3	1		
Regulierung von Nanopartikeln	3		3	0		0	3	0	2	3	1	3	3	2	0	0	0		
Validierte Informationen zum NP-Anwendungspotenzial	3	3		2	2	2	3	3	3	2	3	3	1	1	1	1	3		
Kosten von Wettbewerber-Technologien	3	2	2		2	3	0	3	0	1	0	2	1	3	0	2	0		
Standardisierung für Nanopartikel																			
Innovationen in der NP-Produktionskette	2	0	0	3	3		0	2	0	3	0	0	2	3	1	3	2		
Umweltschutzpolitik (insbes. Boden und Grundwasser)	3	3	3	0		0		0	3	3	1	3	3	2	0	0	1		
Synergien mit anderen Technologien	3	0	0	3	2	2	0		1	2	1	0	2	3	1	3	1		
Dialog mit öffentlichen Stakeholdern	1	3	3	1	1	0	3	0		0	3	3	2	1	1	0	3		
NP-Behandlung von neu aufkommenden Schadstoffen	0	0	0	2	1	2	0	1	0		2	0	3	3	1	3	1		
Generelle öffentliche Wahrnehmung von NP	0	1	0,5	0	0,5	0	1	0	3	0		2	1	2	0	2	1		
Science-Policy-Interface	3	3	3	2	2	1	3	2	3	3	3		2	2	1	2	3		
Technologie- und Forschungspolitik	3	0	2	1		2	2	1	1	3	1	3		1	0	2	1		
Wachsende Anzahl von Nanopartikel-Anbietern	2	2	2	3	2	3	0	2	1	2	1	1	1		0	1	1		
Entwicklung des Immobilienmarktes	1	0	1	3	1	0	0	1	2	0	0	1	0,5	1,5		0	1		
Einstellung zu Innovation	1,5	0	0	1	0	2	0	2	0	2	2	2	2	2	0		0		
Umweltbewusstsein	1	2	1,5	0	0,5	2	2	1	1,5	1	2	3	2	0	1	2			

Scale: 0 = No impact 1 = weak and delayed impact 2 = medium impact 3 = strong and direct impact	Innovationen bei der Behandlung bekannter Schadstoffe mit NP	Regulierung von Nanopartikeln	Validierte Informationen zum NP-Anwendungspotenzial	Kosten von Wettbewerber-Technologien	Standardisierung für Nanopartikel	Innovationen in der NP-Produktionskette	Umweltschutzpolitik (insbes. Boden und Grundwasser)	Synergien mit anderen Technologien	Dialog mit öffentlichen Stakeholdern	NP-Behandlung von neu aufkommenden Schadstoffen	Generelle öffentliche Wahrnehmung von NP	Science-Policy-Interface	Technologie- und Forschungspolitik	Wachsende Anzahl von Nanopartikel-Anbietern	Entwicklung des Immobilienmarktes	Einstellung zu Innovation	Umweltbewusstsein		
Innovationen bei der Behandlung bekannter Schadstoffe mit NP		0	0	3	2	2	0	2	1	1	1	0	2	3	1	3	1		
Regulierung von Nanopartikeln	3		3	0		0	3	0	2	3	1	3	3	2	0	0	0		
Validierte Informationen zum NP-Anwendungspotenzial	3	3		2	2	2	3	3	3	2	3	3	1	1	1	1	3		
Kosten von Wettbewerber-Technologien	3	2	2		2	3	0	3	0	1	0	2	1	3	0	2	0		
Standardisierung für Nanopartikel																			
Innovationen in der NP-Produktionskette	2	0	0	3	3		0	2	0	3	0	0	2	3	1	3	2		
Umweltschutzpolitik (insbes. Boden und Grundwasser)	3	3	3	0		0		0	3	3	1	3	3	2	0	0	1		
Synergien mit anderen Technologien	3	0	0	3	2	2	0		1	2	1	0	2	3	1	3	1		
Dialog mit öffentlichen Stakeholdern	1	3	3	1	1	0	3	0		0	3	3	2	1	1	0	3		
NP-Behandlung von neu aufkommenden Schadstoffen	0	0	0	2	1	2	0	1	0		2	0	3	3	1	3	1		
Generelle öffentliche Wahrnehmung von NP	0	1	0,5	0	0,5	0	1	0	3	0		2	1	2	0	2	1		
Science-Policy-Interface	3	3	3	2	2	1	3	2	3	3	3		2	2	1	2	3		
Technologie- und Forschungspolitik	3	0	2	1		2	2	1	1	3	1	3		1	0	2	1		
Wachsende Anzahl von Nanopartikel-Anbietern	2	2	2	3	2	3	0	2	1	2	1	1	1		0	1	1		
Entwicklung des Immobilienmarktes	1	0	1	3	1	0	0	1	2	0	0	1	0,5	1,5		0	1		
Einstellung zu Innovation	1,5	0	0	1	0	2	0	2	0	2	2	2	2	2	0		0		
Umweltbewusstsein	1	2	1,5	0	0,5	2	2	1	1,5	1	2	3	2	0	1	2			

Standardisation removed, on advice from regulatory SH

Scale: 0 = No impact 1 = weak and delayed impact 2 = medium impact 3 = strong and direct impact	Innovationen bei der Behandlung bekannter Schadstoffe mit NP	Regulierung von Nanopartikeln	Validierte Informationen zum NP-Anwendungspotenzial	Kosten von Wettbewerber-Technologien	Standardisierung für Nanopartikel	Innovationen in der NP-Produktionskette	Umweltschutzpolitik (insbes. Boden und Grundwasser)	Synergien mit anderen Technologien	Dialog mit öffentlichen Stakeholdern	NP-Behandlung von neu aufkommenden Schadstoffen	Generelle öffentliche Wahrnehmung von NP	Science-Policy-Interface	Technologie- und Forschungspolitik	Wachsende Anzahl von Nanopartikel-Anbietern	Entwicklung des Immobilienmarktes	Einstellung zu Innovation	Umweltbewusstsein
Innovationen bei der Behandlung bekannter Schadstoffe mit NP		0	0	3	2	2	0	2	1	1	1	0	2	3	1	3	1
Regulierung von Nanopartikeln	3		3	0		0	3	0	2	3	1	3	3	2	0	0	0
Validierte Informationen zum NP-Anwendungspotenzial	3	3		2	2	2	3	3	3	2	3	3	1	1	1	1	3
Kosten von Wettbewerber-Technologien	3	2	2		2	3	0	3	0	1	0	2	1	3	0	2	0
Standardisierung für Nanopartikel																	
Innovationen in der NP-Produktionskette	2	0	0	3	3		0	2	0	3	0	0	2	3	1	3	2
Umweltschutzpolitik (insbes. Boden und Grundwasser)	3	3	3	0		0		0	3	3	1	3	3	2	0	0	1
Synergien mit anderen Technologien	3	0	0	3	2	2	0		1	2	1	0	2	3	1	3	1
Dialog mit öffentlichen Stakeholdern	1	3	3	1	1	0	3	0		0	3	3	2	1	1	0	3
NP-Behandlung von neu aufkommenden Schadstoffen	0	0	0	2	1	2	0	1	0		2	0	3	3	1	3	1
Generelle öffentliche Wahrnehmung von NP	0	1	0,5	0	0,5	0	1	0	3	0		2	1	2	0	2	1
Science-Policy-Interface	3	3	3	2	2	1	3	2	3	3	3		2	2	1	2	3
Technologie- und Forschungspolitik	3	0	2	1		2	2	1	1	3	1	3		1	0	2	1
Wachsende Anzahl von Nanopartikel-Anbietern	2	2	2	3	2	3	0	2	1	2	1	1	1		0	1	1
Entwicklung des Immobilienmarktes	1	0	1	3	1	0	0	1	2	0	0	1	0,5	1,5		0	1
Einstellung zu Innovation	1,5	0	0	1	0	2	0	2	0	2	2	2	2	2	0		0
Umweltbewusstsein	1	2	1,5	0	0,5	2	2	1	1,5	1	2	3	2	0	1	2	

Influences and interactions

- Active sum (rows)
  - How strongly does a factor influence other factors
- Passive sum (columns)
  - How strongly is a factor influenced by other factors.

Scale: 0 = No impact 1 = weak and delayed impact 2 = medium impact 3 = strong and direct impact	Innovationen bei der Behandlung bekannter Schadstoffe mit NP	Regulierung von Nanopartikeln	Validierte Informationen zum NP-Anwendungspotenzial	Kosten von Wettbewerber-Technologien	Standardisierung für Nanopartikel	Innovationen in der NP-Produktionskette	Umweltschutzpolitik (insbes. Boden und Grundwasser)	Synergien mit anderen Technologien	Dialog mit öffentlichen Stakeholdern	NP-Behandlung von neu aufkommenden Schadstoffen	Generelle öffentliche Wahrnehmung von NP	Science-Policy-Interface	Technologie- und Forschungspolitik	Wachsende Anzahl von Nanopartikel-Anbietern	Entwicklung des Immobilienmarktes	Einstellung zu Innovation	Umweltbewusstsein	Aktive Sum
Innovationen bei der Behandlung bekannter Schadstoffe mit NP		0	0	3		2	0	2	1	1	1	0	2	3	1	3	1	20
Regulierung von Nanopartikeln	3		3	0		0	3	0	2	3	1	3	3	2	0	0	0	23
Validierte Informationen zum NP-Anwendungspotenzial	3	3		2		2	3	3	3	2	3	3	1	1	1	1	3	34
Kosten von Wettbewerber-Technologien	3	2	2			3	0	3	0	1	0	2	1	3	0	2	0	22
Standardisierung für Nanopartikel																		
Innovationen in der NP-Produktionskette	2	0	0	3			0	2	0	3	0	0	2	3	1	3	2	21
Umweltschutzpolitik (insbes. Boden und Grundwasser)	3	3	3	0		0		0	3	3	1	3	3	2	0	0	1	25
Synergien mit anderen Technologien	3	0	0	3		2	0		1	2	1	0	2	3	1	3	1	22
Dialog mit öffentlichen Stakeholdern	1	3	3	1		0	3	0		0	3	3	2	1	1	0	3	24
NP-Behandlung von neu aufkommenden Schadstoffen	0	0	0	2		2	0	1	0		2	0	3	3	1	3	1	18
Generelle öffentliche Wahrnehmung von NP	0	1	0,5	0		0	1	0	3	0		2	1	2	0	2	1	13.5
Science-Policy-Interface	3	3	3	2		1	3	2	3	3	3		2	2	1	2	3	36
Technologie- und Forschungspolitik	3	0	2	1		2	2	1	1	3	1	3		1	0	2	1	23
Wachsende Anzahl von Nanopartikel-Anbietern	2	2	2	3		3	0	2	1	2	1	1	1		0	1	1	22
Entwicklung des Immobilienmarktes	1	0	1	3		0	0	1	2	0	0	1	0,5	1,5		0	1	12
Einstellung zu Innovation	1,5	0	0	1		2	0	2	0	2	2	2	2	2	0		0	16,5
Umweltbewusstsein	1	2	1,5	0		2	2	1	1,5	1	2	3	2	0	1	2		22
Passive Sum	29,5	19	21	24		21	17	20	21.5	26	21	26	27,5	29.5	8	24	19	

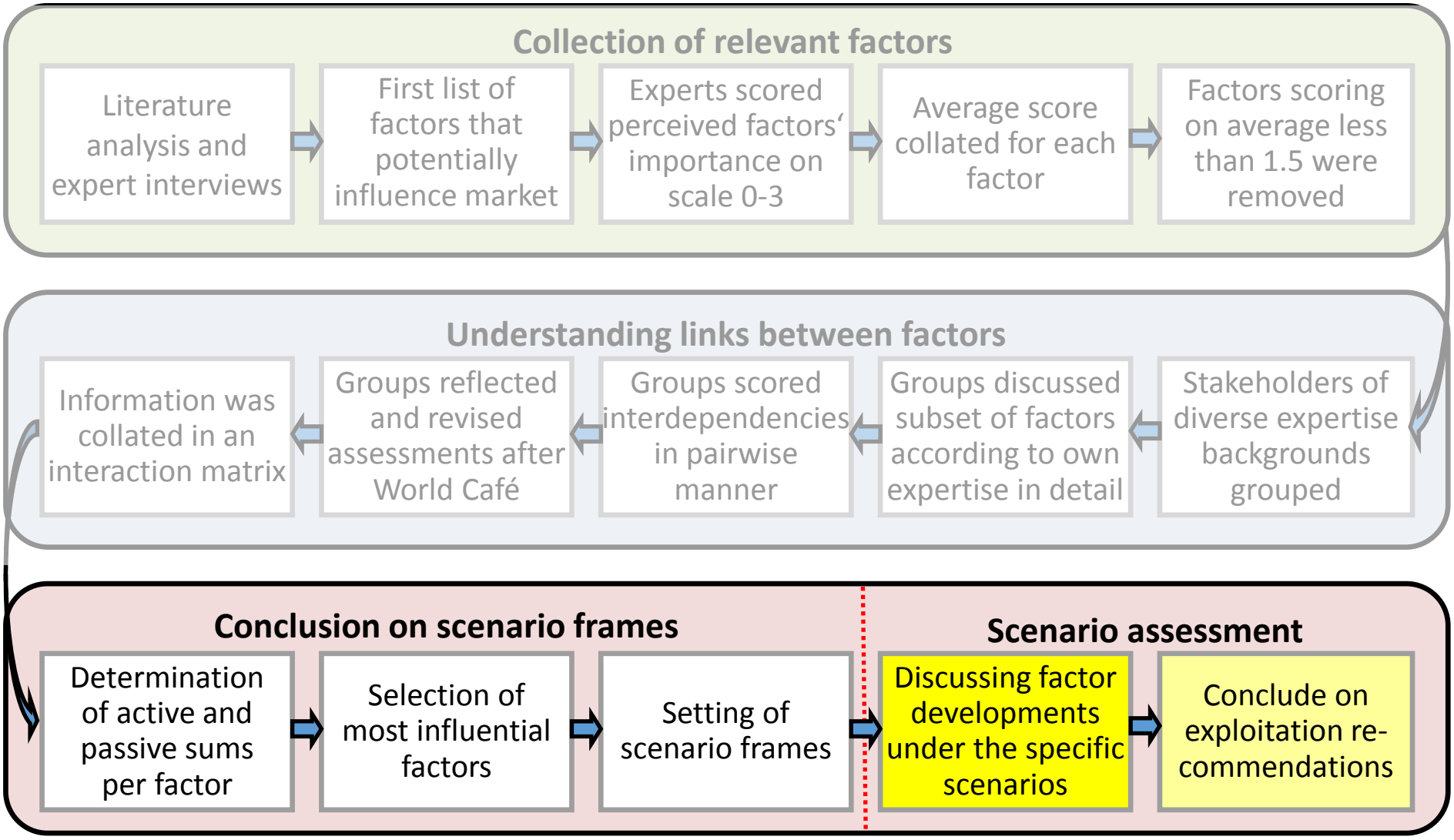
HELMHOLTZ CENTRE FOR ENVIRONMENTAL RESEARCH – UFZ

environmental technology

Outcome

- 16 factors identified as market determining
- The five most influential factors were:

Factor	Active sum*	Passive sum*
Science-Policy-Interface	38	26
Validated information on NP application potential	36	21
Environment (especially soil) protection policies	25	17
Public stakeholder dialogue	25	20
Synergies with technologies	24	20

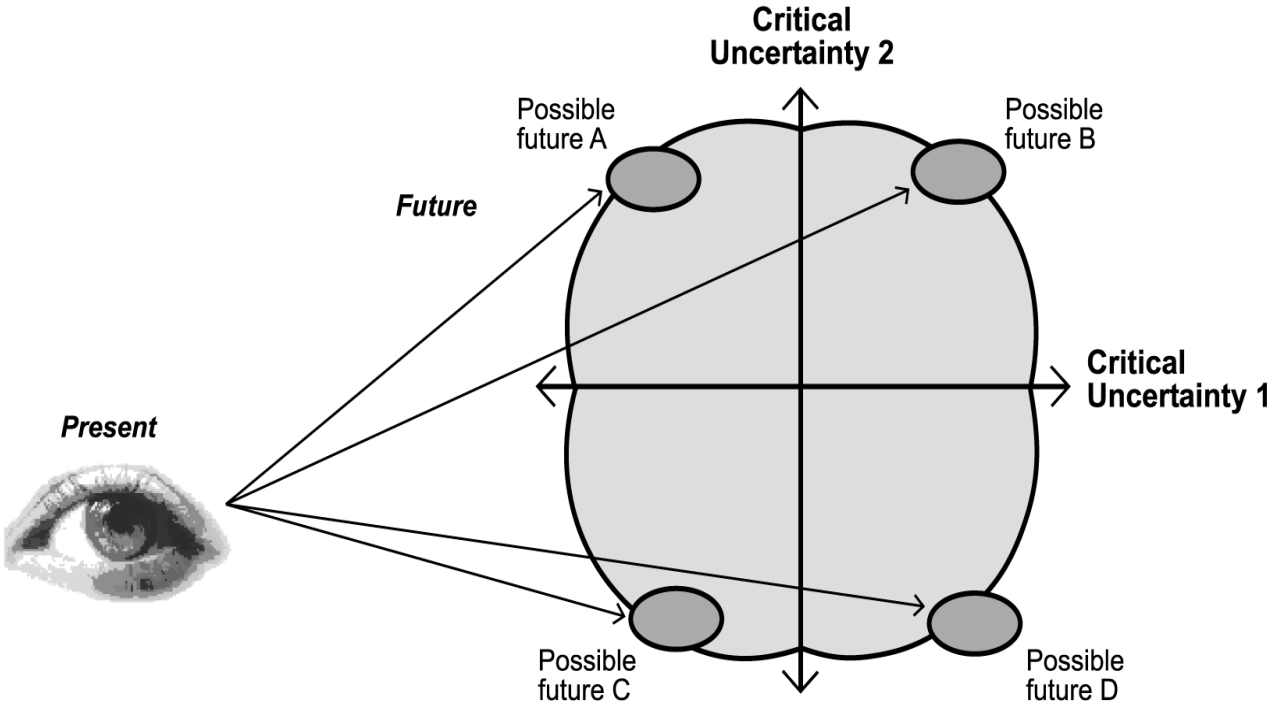

Collection of relevant factors
Literature analysis and expert interviews
First list of factors that potentially influence market
Experts scored perceived factors' importance on scale 0-3
Average score collated for each factor
Factors scoring on average less than 1.5 were removed
Understanding links between factors
Information was collated in an interaction matrix
Groups reflected and revised assessments after World Café
Groups scored interdependencies in pairwise manner
Groups discussed subset of factors according to own expertise in detail
Stakeholders of diverse expertise backgrounds grouped
Conclusion on scenario frames
Determination of active and passive sums per factor
Selection of most influential factors
Setting of scenario frames
Scenario assessment
Discussing factor developments under the specific scenarios
Conclude on exploitation re-commendations

HELMHOLTZ CENTRE FOR ENVIRONMENTAL RESEARCH – UFZ

environmental technology

Envisioning future market state

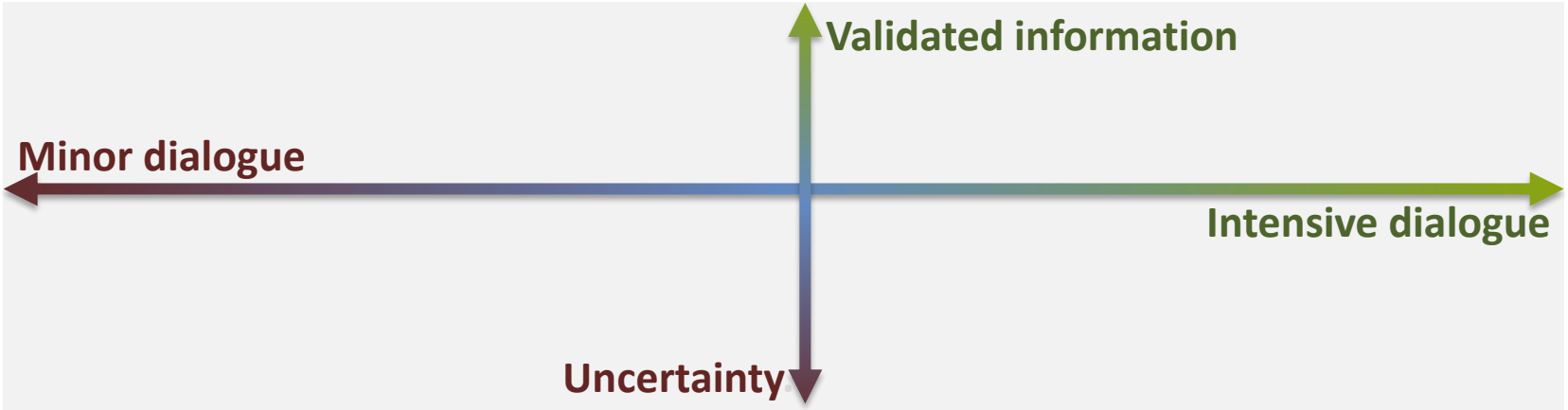
- Compiling projections of plausible drivers' developments into plausible futures (scenarios)
- Elaborating storylines



The scenarios' development process based on critical uncertainties. Source: Kelly et al. (2007: 87).

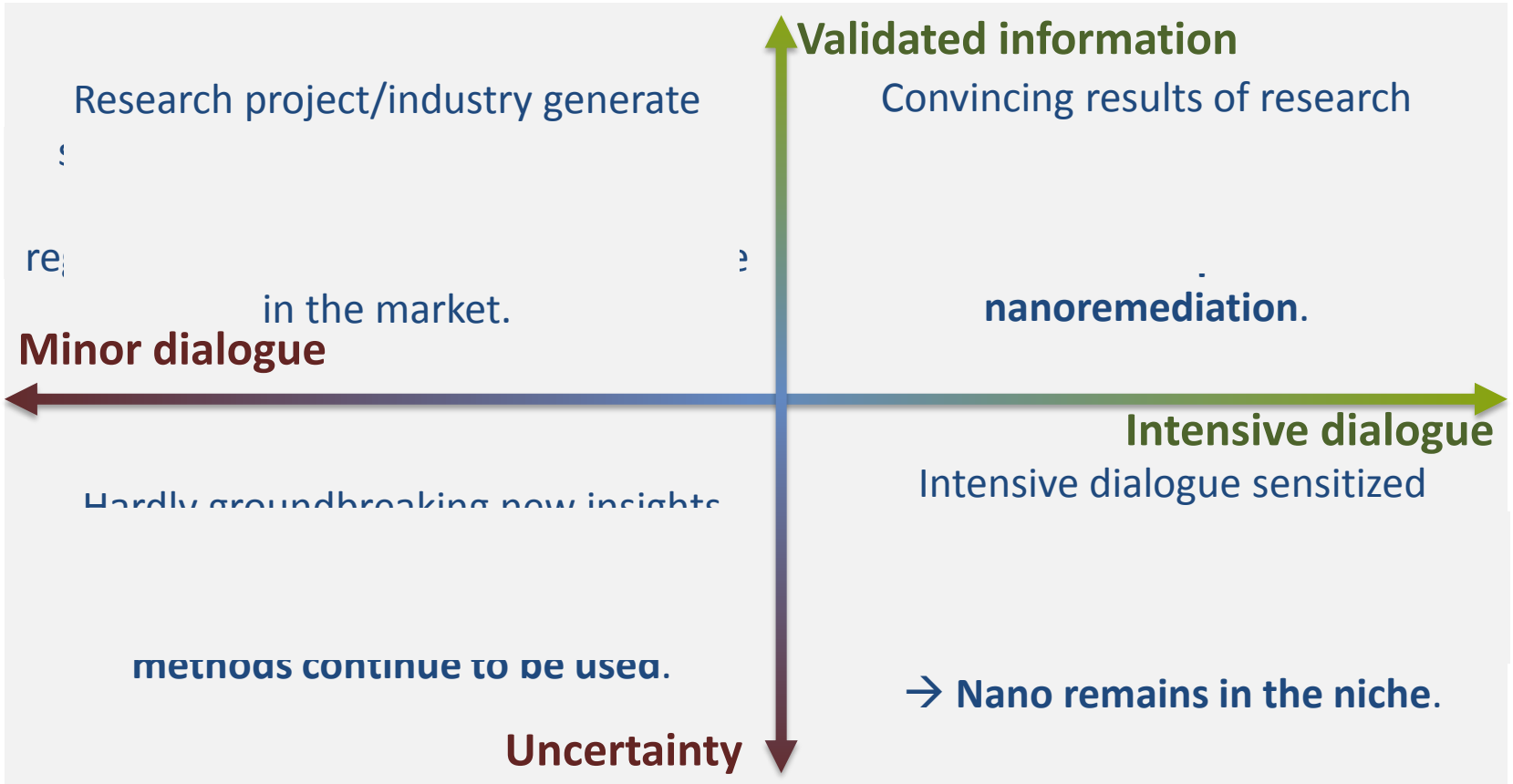
Envisioning future market state

- Using what we have found about individual factors and their interdependencies to envision potential future market states
- The factors that were most influential on the others („most active“) have been used to frame potential futures.



Future nanoremediation market states in broad terms

- F1: Innovations with regard to the treatment of known contaminants with NP



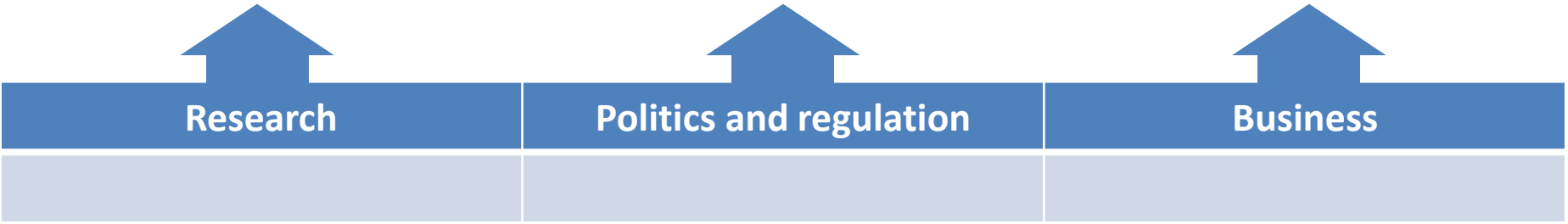
HELMHOLTZ CENTRE FOR ENVIRONMENTAL RESEARCH – UFZ

Questions?

World Café Discussion: "Take home" messages about nanoremediation use

Format for discussion

- Form **say three groups** – maybe according to expertise / background.



HELMHOLTZ CENTRE FOR ENVIRONMENTAL RESEARCH – UFZ

We would like to have your view:

1. How is the nanoremediation market changing / likely to change by 2025?

2. What is the most critical information needed to achieve a positive shift in the uptake of nanoremediation?

3. How are the factors identified likely to influence you or your organisation?

Format for discussion

- To start with: each group drafts answers on a flipchart and elect a rapporteur from your group (you have 30 min)
- Then in a **World Café style**, groups rotate to the next tables and have a quick review of the draft from the last group there. They may add comments - in a different colour (15 mins for each other group).
- **Rapporteurs** remain at the same tables and will report back to the plenum about the conclusions of the process (5 min reports).
- A **facilitator** will remain at each table.

It is a “real” café!

Plenary

Closing Remarks

Closing Remarks

- Thank you for your participation
- Further actions
- Conferences to be aware of
- Visit the NanoRem website – keep up to date as project draws to a close dissemination will ramp up
- Series of NanoRem bulletins will be published

Final Conference

- **DECHEMA 2016**
  Frankfurt Main, Germany, **21 November 2016**
  One-day pre-conference
  www.dechema.de/nanorem2016.html
  ➔Final Conference

- **RemTech 2016**
  Ferrara, Italy, Wednesday 21 September 2016
  Main organiser: Paul Bardos
  http://ferrarafiere.it/portfolio/remtech-coastesonda-inertia-21-23-settembre-2016/

- **Nanocon 2016**
  Brno, Czech Republic,19 to 21 October 2016
  Main organiser: Miroslav Cernik
  http://www.nanocon.eu/en//

NanoRem Final Conference

Nanoremediation for Soil and Groundwater Clean-up - Possibilities and Future Trends

Date: 21st November 2016

Venue: DECHEMA, Haus Frankfurt, Theodor-Heuss-Allee 25, 60486 Frankfurt am Main, Germany

Directions: http://dechema.de/en/anfahrt.htm

Registration: www.dechema.de/nanorem2016

Costs: 90 € including catering and the NanoRem final reception

Topics:

1) What´s behind nanoremediation - technique, particles,…

2) Field application of nanoremediation tools and lessons learned from NanoRem

3) Operating windows and recommendations from NanoRem


Thank
You
Merci
Gracias
Danke
Spacibo
Arigato
Hvala
KamSahHamnida
Xièxie
Mèsi
Grazie
Chokrane
Dziakuju
GratiasAgimus
GratiasAgo
Kiitos
Takk
Rahmat
TerimaKasih
Dakujem
Gràcies
Faleminderit
Efharisto
NajisTuke
Obrigado
Salamat
Saha
Multumesc
Cámon
Gracie
KopKhunKha
Motashakkeram
Tänan Väga
Tak
Dankie
Ačiū
Tenki
Tanemirt
Bayarlalaa
Nirringrazzjak
Mercé
Matondo
Blagodaram
ThintKo
Buznyg
Takk
aDank
BarakAllahuFiik
Köszönöm
TapadhLeat
Murakoze
WaadMahadsantahay
Grazzi
Aabhar
Mauruuru
Barkal
Chnorakaloutioun
Gratzias
Sagolun
Tanmirt
Mochchakkeram
Dhanyabaad
Grandmercé
Nirringrazzjak
Bayarlalaa

Scenario framing elements	
Validated information on NP application potential	'Information' dimension describing the quality of available information for decision-making. Information quality can range from a level with great uncertainty with regards to the potential developments of the market and the set of factors driving the market, to a situation where information about nanoremediation is readily available, well tested, and broadly accepted (i.e. "validated").
Science-Policy-Interface - Communication with others	Broadly understood as 'Dialogue' process by which stakeholder groups (in particular those from science, policy and regulation) have informal/formal discussions, consultations and other forms of engagement in order to ascertain the potential application of nanoremediation (in general or in specific cases).
Market determining factors as known now	
Innovation on treatment of known contaminants with NP	NPs are effective in treating a range of contaminants. They may be superior to existing remediation approaches (being quicker or cheaper to apply or offering another added value) on a site specific basis.
Regulation of nanoparticles	While moratoria against use of NPs for remediation still exist in a few instances, the emerging trend is that NPs can be deployed using existing regulatory regimes. Uncertainties are those experienced in general for the injection of "new" types of material into the subsurface.
Costs of competitive technologies	There are already competitive nanoremediation technology solutions, but their international market penetration is low and they face strong competition from more established in situ technologies. Cost effectiveness is highly site specific.
Innovations along NPs production chain	The production of NPs could be boosted by improved efficiency based on increasing knowledge and economies of scale, making NPs cheaper.
Environment (especially soil and groundwater) protection policies	There is policy uncertainty at a European level for remediation drivers in general (e.g., withdrawing of Soil Framework Directive versus increasing concerns over 'emerging contaminants'). Specific to nanoremediation 'moratoria' against use exist in some countries/regions but these may be reconsidered, particularly as a result of current research work
Synergies with technologies	NPs can be applied in remediation integrated with other approaches, e.g. bioremediation.
Public stakeholder dialogue	Refers to communication with general public. Risks, uncertainties and benefits should be communicated in targeted formats. (Dialogue work currently being conducted in the UK may indicate increasing acceptability of nanotechnology use in remediation.)
NP treatment of emerging contaminants	NPs are may be effective in remediating various emerging contamination problems, but research and practical experience are fairly limited at present.
Public perception of NPs in general - What people think of nano	Public perception of NPs is patchy with low consumer knowledge and ambiguity in risk perception. The increasing use of 'nano-products' implies increasing levels of public acceptance for the technology in general, although concerns over some specific potential pollutants such as nano-silver remain.
Technology and research policies	European and national policies fund R&D into innovative technologies, generating new knowledge, including a range of nanoremediation R&D and demonstration work (such as NanoRem).
Growing number of nanoparticles suppliers - supplier having available more produces	More producers are entering the market. Suppliers are typically remediation service providers, such as consultancies. More suppliers are considering nanoremediation, although the number investing in expertise, capacities and credibility to provide nanoremediation remains relatively small at present
Real estate market development	The property market has begun to recover since the financial crash increasing the demand for suitable areas for development – which in turn influences the demand for the remediation of contaminated land.
Innovation attitude – People like new technology	There is an increasing openness in the remediation sector towards innovation paired with willingness to invest in inventions and knowledge creation along with greater readiness to apply innovative technologies.
Environmental awareness and sustainability	There is increasing support for ensuring a more sustainable approach to contaminated land management, and this will increasingly affect remediation decision-making. This is a highly site specific consideration.

NANOPARTICLE-BASED REMEDIATION TECHNOLOGIES – POTENTIAL MARKET DEVELOPMENT BY 2025

RemTech, Ferrara IT, September 2016

NanoRem
Nanotechnology for contaminated land Remediation

Validated information

Scenario 4 – Isolated knowledge

Innovation on treatment of known contaminants with nanoparticles (NPs)
Regulation of nanoparticles
Costs of competitive technologies
Innovations along NPs production chain
Environment (especially soil and groundwater) protection policies
Synergies with technologies
Public stakeholder dialogue
NP treatment of emerging contaminants
Public perception of NPs - What people think of nano
Technology and research policies
Growing nanoparticle supply
Real estate market development
Innovation attitude – People like new technology
Environmental awareness and sustainability

Scenario 1 – Kmowledge exchange

Innovation on treatment of known contaminants with nanoparticles (NPs)
Regulation of nanoparticles
Costs of competitive technologies
Innovations along NPs production chain
Environment (especially soil and groundwater) protection policies
Synergies with technologies
Public stakeholder dialogue
NP treatment of emerging contaminants
Public perception of NPs - What people think of nano
Technology and research policies
Growing nanoparticle supply
Real estate market development
Innovation attitude – People like new technology
Environmental awareness and sustainability

Minor dialogue

Intensive dialogue

Scenario 3 – Isolation in uncertainty

Innovation on treatment of known contaminants with nanoparticles (NPs)
Regulation of nanoparticles
Costs of competitive technologies
Innovations along NPs production chain
Environment (especially soil and groundwater) protection policies
Synergies with technologies
Public stakeholder dialogue
NP treatment of emerging contaminants
Public perception of NPs - What people think of nano
Technology and research policies
Growing nanoparticle supply
Real estate market development
Innovation attitude – People like new technology
Environmental awareness and sustainability

Scenario 2 – Dialogue under uncertainty

Innovation on treatment of known contaminants with nanoparticles (NPs)
Regulation of nanoparticles
Costs of competitive technologies
Innovations along NPs production chain
Environment (especially soil and groundwater) protection policies
Synergies with technologies
Public stakeholder dialogue
NP treatment of emerging contaminants
Public perception of NPs - What people think of nano
Technology and research policies
Growing nanoparticle supply
Real estate market development
Innovation attitude – People like new technology
Environmental awareness and sustainability

Uncertainty

Selected references

- Bardos, P., S. Jones, S. Bartke, E. Limasset, B. Bone 2015. IDL 9.4 Broad exploitation strategy and risk benefit appraisal. NanoRem EU project nr. 309517, project Internal Deliverable IDL9.4, 119p., doi: 10.13140/RG.2.1.3773.0728
- Bruch, M. 2012. Role of insurance for innovative technologies: Nanotechnology. Presentation at Risk and Responsibility in Innovation event, 27 November 2012, Università Bocconi, Milano, http://www.fondazionebassetti.org/en/focus/2013/01/risk_and_responsibility_in_inn_1.html#bruch
- Gausemeier, J., Fink, A., Schlake, O. 1996. Szenario-Management. Planen und Führen mit Szenarien. München, Wien, Carl Hanser Verlag.
- Geels, F. W. (2002). Technological transitions as evolutionary reconfiguration processes: a multi-level perspective and a case-study. Research policy, 31(8), 1257-1274.
- Geels, F. W. (2011). The multi-level perspective on sustainability transitions: Responses to seven criticisms. Environmental Innovation and Societal Transitions, 1(1), 24-40.
- Kelly, R., Sirr, L., & Ratcliffe, J. (2004). Futures thinking to achieve sustainable development at local level in Ireland. foresight 6(2), 80-90.
- March, H., Therond, O., & Leenhardt, D. (2012). Water futures: reviewing water-scenario analyses through an original interpretative framework. Ecological Economics 82, 126-137.
- Timpe, C. and Scheepers, M.J.J. 2003. A look into the future: Scenarios for distributed generation in Europe. Available at: http://www.ecn.nl/docs/library/report/ 2004/c04012.pdf.