



revitalising industrial sites

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The Use of Innovative Remediation Technologies in Brownfield Redevelopment Projects

Presentation given in course of the "Second international conference on managing urban land REVIT&CABERNET 2007"



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This report is part of the REVIT selfguiding trail.

The Use of Innovative Remediation Technologies in Brownfield Redevelopment Projects

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Aims of the investigation

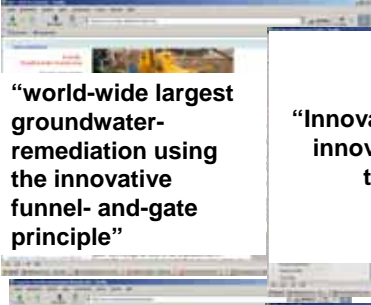
Research project for the City of Stuttgart in the REVIT- Project

Aims of the investigation:

- Derivation of a definition for the term “innovative remediation technology”
- Investigation of brownfield redevelopment projects to answer the questions:
 - Which are the remediation technologies used?
 - Are innovative technologies usually applied?
 - What are the criteria for the choice of the remediation technologies?
 - What are the requirements for the use of innovative remediation technologies in brownfield redevelopment projects?

What is an innovative remediation technology?

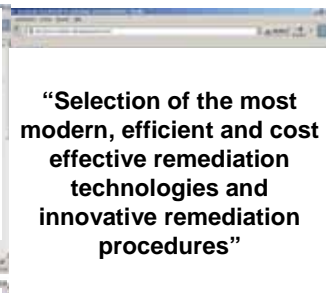
Background



“world-wide largest groundwater-remediation using the innovative funnel- and-gate principle”



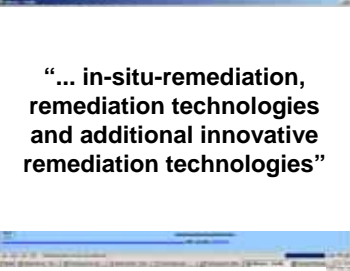
“Innovative techniques for innovative remediation technologies”



“Selection of the most modern, efficient and cost effective remediation technologies and innovative remediation procedures”



“Innovative remediation technologies”



“... in-situ-remediation, remediation technologies and additional innovative remediation technologies”



“...offers innovative remediation technologies”

Definition “Innovative remediation technology”



DUDEN (German dictionary):

- Innovative: concerning, containing or creating innovations or innovation, <latin>,
- the term innovative means:
 - regeneration,
 - improvement by application of new approaches and technologies,
 - development of new ideas, technologies, products etc.

The term “Innovative remediation technology”



What is an “innovative remediation technology”?

– Results of a small survey among specialists:

“...can be characterized as *state of the art*.”

“...*State of the art* is a technical term that describes the technical possibilities at a certain point in time, based on reliable and proven knowledge of science and technology.”

“... procedure that takes into account criteria of sustainability, e. g. natural attenuation, phytoremediation”

“...newly developed, ready for application procedure...”

Definition “Innovative remediation technology”



Differentiation

Proven remediation technology \leftrightarrow Innovative remediation technology with the definition “state of the art”

State of the Science

Developmental status when methods, facilities or operation modes are substantiated scientifically and have been proven as technically feasible in lab-scale and pilot tests. An implementation or a test of the practical feasibility for large-scale operation has not been carried out.

State of the Art

Methods or operation modes that do not necessarily have to be widely accepted. However, prerequisite is a developmental status, which shows that the practical feasibility on a technical scale seems to be ensured.

Acknowledged rules of technology

Represent the widely held view among technical experts in the particular field of application. They achieved this status, because they are accepted in theory and proven in practice.

Definition “Innovative remediation technology”



Federal Immission Control Act, Article 3 (6) (BImSchG):

„State-of-the-Art in the legal sense is that **level of development of up-to-date technologies**, which is generally considered as sufficient to ensure the suitability of these technologies for the following goals: **limitation of emissions** into air and water, **guarantee of plant safety** and **environmentally safe waste disposal** and **avoidance of any other impact on the environment** to achieve a high level of environmental protection. For the determination of state-of-the-art technologies, particularly the criteria shown in the appendix have to be taken into account.

BImSchG, Article 3 (6)

Definition “Innovative remediation technology”



Criteria for the determination “State of the Art” (Appendix of the Federal Immission Control Act):

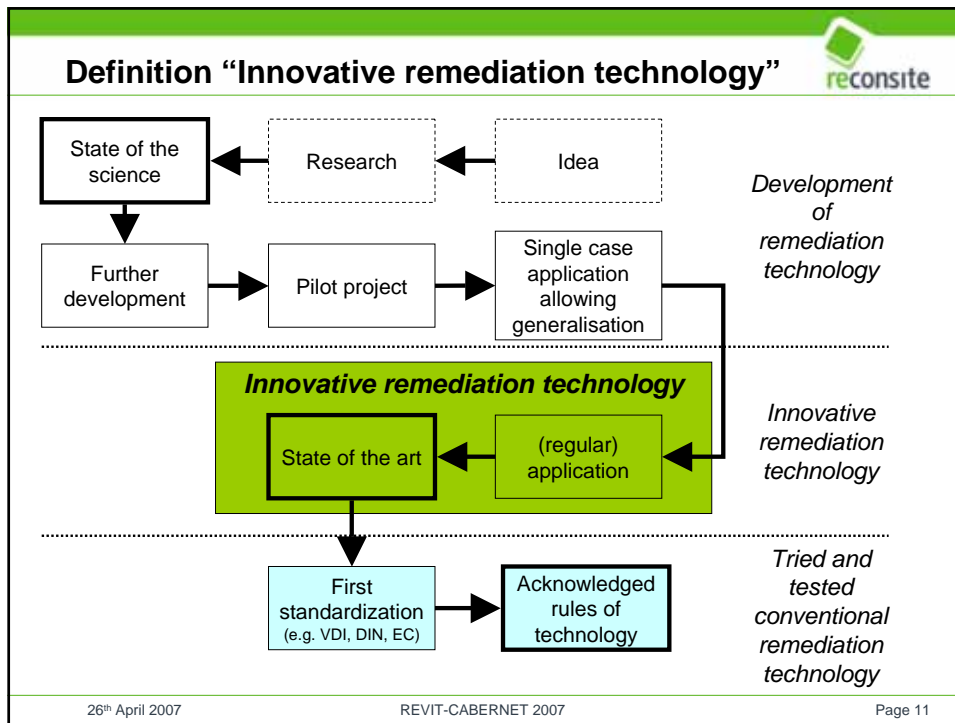
- (1) Application of technology **minimising waste production**,
- (2) Application of technology using materials with a **low risk potential**,
- (3) Promotion of **the recycling and reuse of materials used and waste produced** with a particular technology.
- (4) **Scientific and technological progress**.
- (5) Type and amount of emissions produced and their impact on the environment.
- (6) **Time** needed for the **start-up** of a **new** or **existing plant**; **time needed** for the **implementation** of a **better technology** that is available on the market.
- (7) **Consumption** of **resources** and types of resources used for a particular technology (including water), **efficiency** of **energy use**,
- (8) Necessity to **minimize the overall impact of emissions and to avoid or reduce the risks for man and environment as far as possible**,
- (9) Necessity to prevent accidents and to minimize their consequences for man and environment [...]
- (10) [...]

Definition “Innovative remediation technology”



An innovative technology for the remediation of soil or groundwater contamination is defined as a technology in the **transition phase between the state of the art and acknowledged rules of technology.**

Criteria for the classification can be found in the corresponding appendix of the Federal Immission Control Act.



Definition “Innovative remediation technology”

Results of the REVIT-Workshop in January 2007:

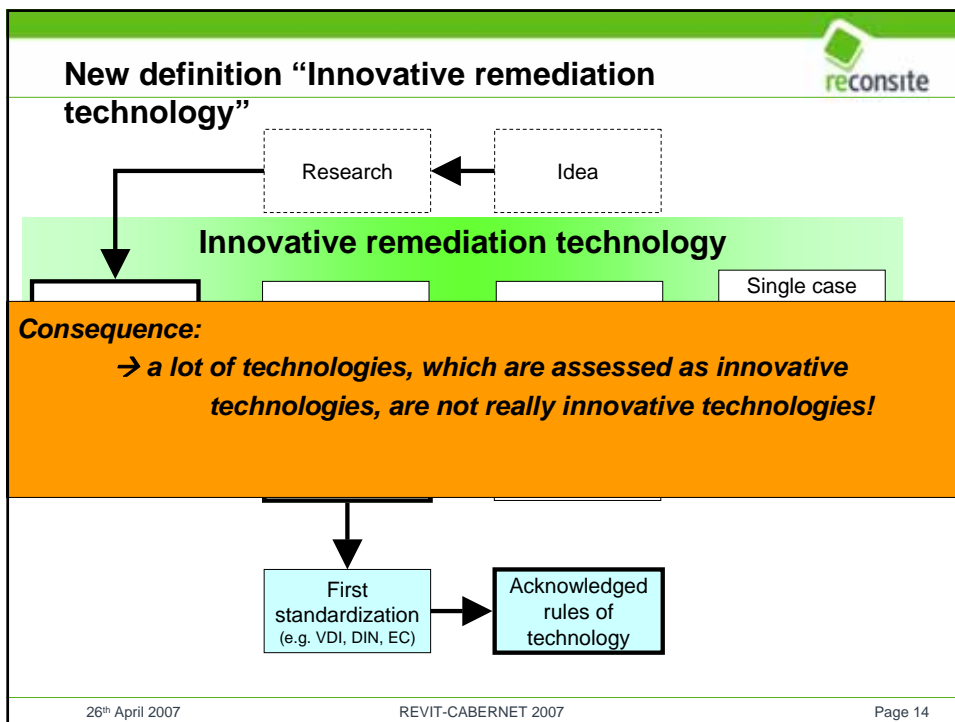
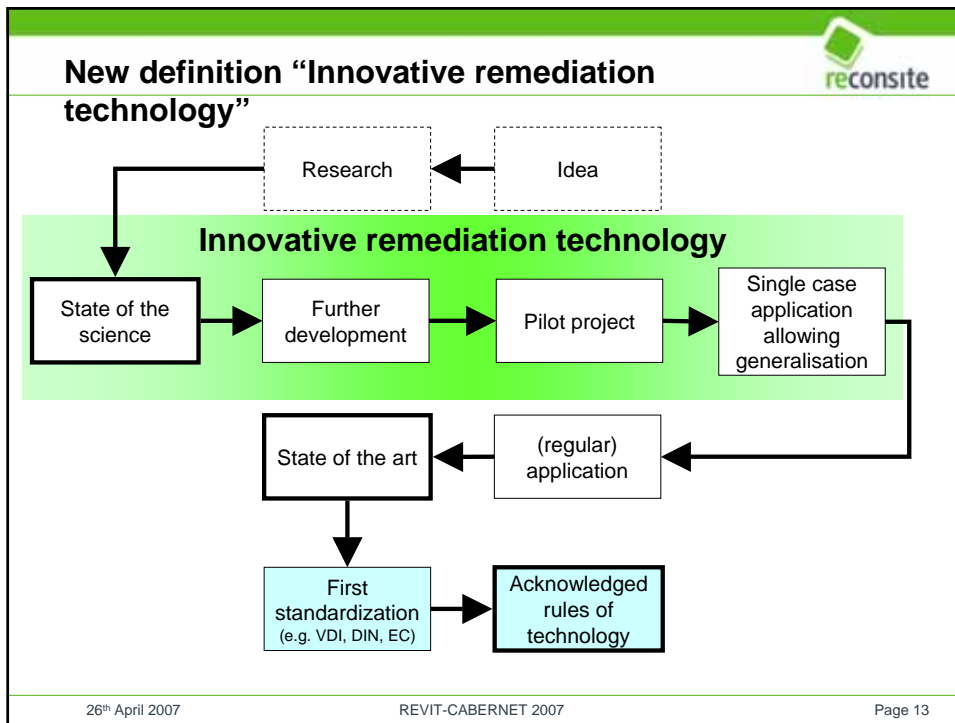
Difficult to find a common definition of “innovative remediation technology”:

- individual points of view and different conditions in the European countries
- different understanding of the term “state of the art”

Common sense in context of a definition

- An innovative technology is between the step “state of the science” and the step “state of the art” – but there is no clear border dividing innovative and non-innovative technologies.

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The use of remediation technologies in the case of brownfield redevelopment projects

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Input data

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50 collected projects

40 evaluated projects

14 projects analysed in detail

The REVIT-Study

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Overview of the projects



| | |
|-------------------------|---|
| Former use | industry – commerce – military – railway yard |
| Subsequent use | housing – trade – services |
| Size | 5000 – 320000 m ² |
| Pollutants | PAH, chlorinated hydrocarbons, heavy metals, BTEX |
| Duration of brownfields | 0 years to 40 years |
| Duration of remediation | 6 month up to 20 years |

Results – Overview (1)



| | Technology | Number of applications | Technology rating |
|--|---------------------------------------|------------------------|-------------------|
| | Excavation & disposal | 29 | standard |
| | Soil washing (ex-situ) | 1 | alternative |
| | Thermal treatment (ex-situ) | 2 | alternative |
| | Biological treatment on-site | 1 | alternative |
| | Biological treatment off-site | 6 | alternative |
| | Soil vapour extraction | 1 | alternative |
| | Surface sealing | 6 | alternative |
| | Containment structures | 5 | alternative |
| | Containment by sealing with buildings | 3 | alternative |
| | Immobilization | 2 | alternative |

Results – Overview (2)



| Technology | Number of applications | Technology rating |
|---------------------------------|------------------------|--|
| Vertical barrier | 1 | alternative |
| Mixed-in-place vertical barrier | 1 | alternative |
| Microbiological in-situ methods | 2 | innovative |
| Groundwater circulation well | 1 | alternative |
| Pump & Treat | 7 | standard • innovative character: → filtration technology |
| Air-Sparging | 1 | alternative |
| Funnel & Gate | 2 | alternative |

Unsaturated Zone



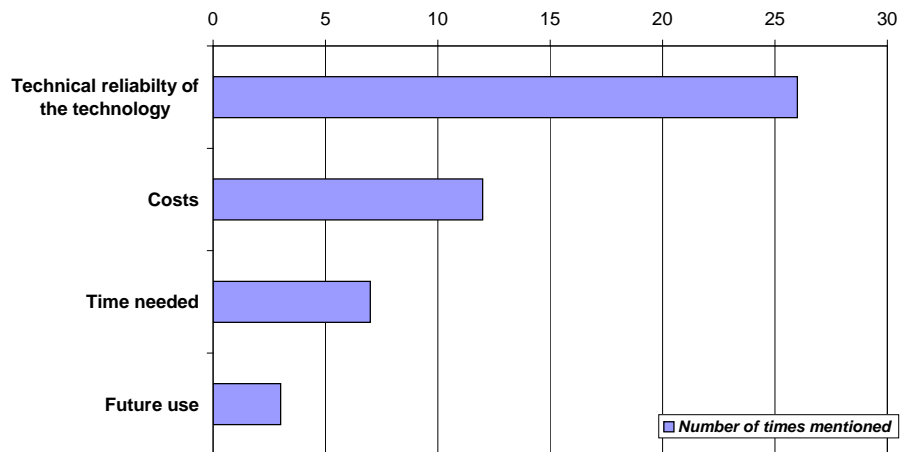
Reasons for excavation & disposal

- Low disposal costs
- Deadlines
- Need for a definitely clean site
- Foundation of new buildings



- Cost of disposal
- Depths of the contaminated zone
- Accessibility
- Surroundings
- Health and safety issues

Criteria for the choice of remediation technologies



Requirements for remediation technologies

- **Cost efficiency:** technologies have to be at least equal to the standard technologies or preferably more favorable with respect to cost and efficiency
- **Remediation goals should be reliably obtainable in a certain period of time:** Assessment of remediation time should be possible
- **Interfaces** between the remediation and other construction processes in a brownfield redevelopment project should be controllable.

Conclusions (1)



1. **Innovative remediation technology: between State of the Science and State of the Art**
2. **The application of innovative remediation technologies in brownfield redevelopment projects is unusual**
3. **Excavation & disposal** in 70 % of all examined cases, because:
 - only 15 % of the examined remediation were groundwater contaminations
 - decontamination was the main goal
 - combination with the demolishing of buildings and other construction actions

Conclusions (2)



4. **Saturated zone: pump & treat and the use of alternative remediation technologies:**
 - Air-sparging
 - Funnel & gate
 - Microbiological remediation technologies
5. Formulation of **requirements for the application of other remediation technologies instead of excavation & disposal and pump & treat**
 - cost-efficient
 - reliable reaching of remediation goals

Thank you for your attention!



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