Nanometer: Assessing Opportunities and Risks of Nanotech Applications. Offline version.

Interactive online version:

http://www.observatorynano.eu/project/questionnaire/nanometer

Content

Introduction

The NanoMeter

The NanoMeter is a tool for the assessment of applications that are enabled by nanotechnologies. It covers aspects such as health, environment, ethics, and societal issues beyond standard product assessment.

Purpose:

- Identify opportunities and risks of single applications.

Results:

- Identification of knowledge gaps.
- Overview on aspects where the application could possibly be improved.
- Basis for specific measures to assure performance and public acceptance and support market success.

Assessment process:

- Start from a nanotechnology-enabled product, ingredient or application (currently under development or already on the market).
- Answer questions that guide you through relevant opportunity and risk areas.
- Follow “further information” links if needed.
- View your condensed results as a PDF document **– please use the online version!**
- Share your findings and perception with colleagues or partners.

Get started

Application name

Please insert the name or working title of the application to be assessed. This is for your personal record only and will (as free text data) not be available to any third person (see information on data protection).

Application assessed: ☐

Reference application

Please name an existing application or current technology that you are about to enhance or substitute with the nanotechnology-enabled version. Throughout the assessment process this will serve as reference point.

In cases where the nanotechnology-enabled application is not designed to replace any existing application, try to provide a similar non-nano parallel e.g. by specifying a current application that addresses the same function. Example: Laboratory diagnostic instruments compared to a nanotechnology-enabled “lab-on-chip” application carrying out a similar examination.

Reference application: ☐

Technology Sector

Please select the most suitable technology sector(s). This enables a more specific application assessment.

- ☐ Aerospace, Automotive & Transport
- ☐ Agrifood
- ☐ Chemistry & Materials
- ☐ Construction
- ☐ Energy
- ☐ Environment
- ☐ Health, Medicine & Nanobio
- ☐ Information & Communication
- ☐ Security
- ☐ Textiles
- ☐ Not attributable / other

Assessing opportunities and risks

Environment, health and safety (EHS)

1. Exposure to the environment

Nanomaterials (especially particles) can have multiple effects that are difficult to predict. To reduce the risk of adverse effects on the environment, an important first step is to prevent the exposure of unbound manufactured nanomaterials.

While exposure of nanomaterials is commonly addressed and monitored on the production side, other life cycle stages may pose different environmental risks. Hence, this question also includes environmental exposure during use / consumption and at the end of an application's life cycle (e.g. due to incineration).

Be aware that this question does not refer to unintended release only, but also addresses foreseeable or even intended release of nanomaterials e.g. for soil remediation purposes.

How do you rate the likelihood of exposing the environment to unbound nanomaterials?

During production	During use / consumption	During recycling / disposal	Production includes R&D, resource extraction, pre-production, manufacturing, logistics and distribution up to the final application use Use / consumption describes business and private (end) use Recycling / disposal involves recycling, treatment for reuse, and disposal (esp. incineration)
☐	☐	☐	High
☐	☐	☐	Medium
☐	☐	☐	Low
☐	☐	☐	Nanomaterials can under no circumstances be released
☐	☐	☐	Not applicable / no use of nanomaterials

Indicate your degree of certainty:

☐	☐	☐	Very sure
☐	☐	☐	Fairly sure
☐	☐	☐	Not sure

Provide facts for your rating:

For example: measures on safety taken to prevent release of nanomaterials; reasons for your rating, including probability of release, properties during recycling / disposal, results of exposure monitoring

☐

Further information: → online version

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2. Environmental hazard

As materials become smaller and enter nanoscale dimensions their characteristics and properties change; properties such as colour, transparency, solubility and chemical reactivity can all be altered. Their impact on the environment can differ immensely depending on the context, amount, and duration of exposure. Answering the following guiding questions will provide you with a first overview of environmental hazard implications:

1. Evidence of eco-toxicity?
2. Bulk material toxic?
3. Nanomaterial more reactive than bulk?
4. Readily purified and characterized?
5. Evidence for environmental fate?
6. Resists biodegradation?
7. Tends not to agglomerate or aggregate?

As the nature of nanomaterials and associated hazards may change during the life cycle, different stages are considered.

How do you rate the potential environmental hazards of your application caused by the nanomaterials used?

During production	During use / consumption	During disposal	
☐	☐	☐	High
☐	☐	☐	Medium
☐	☐	☐	Low
☐	☐	☐	None

Indicate your degree of certainty:

☐	☐	☐	Very sure
☐	☐	☐	Fairly sure
☐	☐	☐	Not sure

Provide facts for your rating:

For example: most relevant hazards per life cycle stage; number and type of toxicity tests carried out, results of tests, known hazards, potential (unknown) hazard areas; measures taken to limit hazards

☐

Further information: → online version

3. Human exposure to nanomaterials

Nanomaterials (especially particles) can have multiple effects that are difficult to predict. To reduce the risk of adverse effects on human health, an important first step is to prevent the exposure of unbound manufactured nanomaterials.

Organisational and physical safety protection and training of affected workers are important means to limit potential risks to health. While occupational health and safety is commonly addressed by organisations working with unbound nanomaterials, other life cycle stages may pose different health risks due to a different nature of nanomaterials and related hazards. Please also consider user/consumer protection as well as the risk of nanomaterial exposure at the end of an application's life cycle (e.g. due to incineration) while answering this question.

Be aware that this question does not refer to unintended release only, but also addresses foreseeable or even intended human exposure to nanomaterials.

How do you rate the likelihood of exposing humans to unbound nanomaterials?

During production	During use / consumption	During recycling / disposal	
☐	☐	☐	High
☐	☐	☐	Medium
☐	☐	☐	Low
☐	☐	☐	Nanomaterials can under no circumstances be released
☐	☐	☐	Not applicable / no use of nanomaterials

Indicate your degree of certainty:

☐	☐	☐	Very sure
☐	☐	☐	Fairly sure
☐	☐	☐	Not sure

Provide facts for your rating:

For example: measures taken to prevent release of nanomaterials; reasons for your rating, including probability of release, properties during recycling / disposal, results of exposure monitoring

☐

Further information: → online version

4. Health hazard

As materials become smaller and enter nanoscale dimensions their characteristics and properties change; properties such as colour, transparency, solubility and chemical reactivity can all be altered. Their impact on human health can differ immensely depending on the context, amount, and duration of exposure. Answering the following guiding questions will provide you with a first overview of health hazard implications:

1. Evidence of toxicity?
2. Bulk material toxic?

3. Nanomaterial more reactive than bulk?
4. Readily purified and characterized?
5. Evidence for bodily accumulation / fate?
6. Resists biodegradation?
7. Tends not to agglomerate or aggregate?

As the nature of nanomaterials and associated health hazards may change during the life cycle, different stages are considered.

How do you rate the potential human health hazard of your application caused by the nanomaterials used?

During production	During use / consumption	During recycling/ disposal	
☐	☐	☐	High
☐	☐	☐	Medium
☐	☐	☐	Low
☐	☐	☐	None

Indicate your degree of certainty:

☐	☐	☐	Very sure
☐	☐	☐	Fairly sure
☐	☐	☐	Not sure

Provide facts for your rating:

For example: most relevant hazards per life cycle stage; number and type of toxicity tests carried out, results of tests, known hazards, potential (unknown) hazard areas; measures taken to limit hazards

☐

Further information: ⟶ online version

5. Reduction or substitution of harmful substances

In some cases the use of nanotechnologies enables the reduction or even the complete substitution of harmful (i.e. environmentally burdening, toxic, hazardous) substances.

To assess the applications overall improvement the quantity and quality of harmful substances reduced needs to be balanced against the quantity and quality of substances additionally or increasingly required. For an overall assessment, keep in mind that technological changes can also significantly influence the application of harmful substances in other stages of the production chain or during use, e.g. by reducing the need for harmful supplies or additives.

The reference application defined in the beginning helps you to assess relative changes in the use of harmful substances. Also at this point the reference application can be added or edited by selecting …

To what extent are harmful substances reduced or substituted compared to current applications (*reference application*)!

☐ High
☐ Medium
☐ Low
☐ Increasing use of harmful substances
☐ Not applicable

Indicate your degree of certainty:

☐ Very sure
☐ Fairly sure
☐ Not sure

Provide facts for your rating:

For example: name and quantify harmful substances reduced, substituted, or increased

☐

Further information: ⟶ online version

6. Contribution to risk-related research

To broaden the scientific knowledge base on potential impacts of nanotechnologies a number of experts plead for sharing the results of application testing and risk-related research. They fear that a significant amount of early risk data may be generated by industry, without being publicly available. A resulting risk could be that important (safety) decisions are not based on most recent knowledge.

On the other hand, organisations involved in nanotech-related R&D need to go a tightrope walk; they need to find ways to share relevant risk data specific to nanotechnology in a manner that does not affect competitive advantages.

To what extent do you publish research and assessment data to enlarge the public scientific knowledge base on nanotechnology-related risks?

☐ High
☐ Medium
☐ Low
☐ None
☐ Not applicable

Indicate your degree of certainty:

☐ Very sure
☐ Fairly sure
☐ Not sure

Provide facts for your rating:

For example: kinds of information shared, groups you share information with, risk-related research published

☐

Further information: ⟶ online version

Resource requirements

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7. Energy usage

Actively managing the amount of energy consumed during an applications life cycle may have important implications on

- Production costs,
- Costs of use / consumption (total costs of ownership), and
- Societal acceptance (due to negative effects of current fossil- and nuclear-based energy production and concern about climate change)

During production, the energy use is defined by

- The energy intensity of materials and components used;
- The amount of energy required for production; and
- Energy requirements of distribution and logistics.

During use / consumption, energy consumption is influenced by

- The application's direct energy requirements (e.g. electricity or fuel),
- Its indirect influence on other forms of energy use (e.g. insulating nanofoams lowering the heating requirements of houses)

The **overall energy usage** aims to balance production and use related energy requirements. For some applications high production-related energy input for a use-efficient product may quickly pay off when considering the whole life cycle.

How high is the energy usage compared to current applications (*reference application*)?

During production	During use / consumption	Overall energy usage	
☐	☐	☐	Significantly higher
☐	☐	☐	Higher
☐	☐	☐	About the same
☐	☐	☐	Lower
☐	☐	☐	Not applicable

Indicate your degree of certainty:

☐	☐	☐	Very sure
☐	☐	☐	Fairly sure
☐	☐	☐	Not sure

Provide facts for your rating:

For example: energy usage data, measures taken to lower direct / indirect energy requirements

☐

Further information: ⟶ online version

8. Resource consumption

The miniaturization of applications due to nanotechnologies does not necessarily lead to a decrease in resource consumption. Studies have shown that the material intensity (i.e. the overall resource requirements from raw material extraction to the final product) does not necessarily lower according to the shrinking of applications (see e.g. Steinfeldt, M. et al. 2007).

During production, the material intensity can be assessed

- Roughly through (1) the amount of highly processed components and (2) costly (non-renewable) materials used.

- Or more scientifically: through concepts such as the ecological backpack or footprint.

During use / consumption, resource consumption is defined

- Directly, by the actual material demand of the application (e.g. a car requiring lubricants, tyres etc.)
- Indirectly, by the number of applications needed (e.g. if they are designed for one-time use) or by influencing usage patterns (e.g. if people are encouraged to purchase more of the same or similar item, or use it more extensively than the application it is about to replace)

The **overall resource consumption** aims to balance production and use related resource requirements. For some applications high production-related resource input for a use-efficient product may quickly pay off when considering the whole life cycle.

How high is the resource consumption compared to current applications (*reference application*)?

During production	During use / consumption	Overall resource consumption	
☐	☐	☐	Significantly higher
☐	☐	☐	Higher
☐	☐	☐	About the same
☐	☐	☐	Lower
☐	☐	☐	Not applicable

Indicate your degree of certainty:

☐	☐	☐	Very sure
☐	☐	☐	Fairly sure
☐	☐	☐	Not sure

Provide facts for your rating:

For example: ecological rucksack/footprint calculations, amount / percentage of highly processed / costly materials used, strategies to increase renewable resources

☐

Further information:

The following **strategies** can help you in reducing use-related resource requirements of applications:

- Reduction of application-related requirements (e.g. fuel, water etc.)
- Increase of durability and longevity
- Increase of modularity and compatibility to allow various forms of usage and/or potential adaptation to technological changes
- Design to ease maintenance and repairing activities
- Assessment of usage patterns
- More information: → online version

9. End-of-life

The end-of-life treatment options include reusability, recyclability, biodegradability, as well as dumping and incineration of the assessed application. Through biodegrading renewable resources become nutrients for biological cycles again. For non-renewable resources reuse and recycling are the most favourable options as the application's resources remain useful and the need for virgin materials is reduced.

Safe and sustainable end-of-life treatment is one of the key challenges for many nanotechnology-enabled applications. Using nanomaterials within a compound material may impair, or even inhibit, the recyclability of materials that were previously easily extracted. Examples may include compounds in which nanomaterials are fixed or embedded (for example in plastics, displays etc.). Furthermore, economical obstacles frequently prevent a closing of resource loops, e.g. when the cost of resource recovery exceeds the value of the resulting source materials.

How safe and sustainable is the end-of-life treatment of the application compared to current applications (*reference application*)?

☐ Improved
☐ Not changed
☐ Impaired
☐ With current treatment technology, the application can not be reused or recycled and does not biodegrade

Indicate your degree of certainty:

☐ Very sure
☐ Fairly sure
☐ Not sure

Provide facts for your rating:

For example: percentage of applications' weight that is biodegradable or can be reused/recycled, recovery technology/process used; measures implemented to support a safe and sustainable end-of-life treatment

Further information: ⟶ online version

User benefits

10. Benefits of nanotechnology

Due to the uncertainty and lack of (long-term) understanding of impacts and implications, consumers tend to expect applications that are

- Free from any risks or
- Provide important benefits that justify a certain risk level.

While hardly anyone would deplore the use of nanomaterials for treating serious illnesses, products introducing potential risks but with a low functional added value are increasingly put into question.

Does the application offer significant functional improvements over the "non-nano" reference application (reference application)?

☐ High improvements
☐ Medium improvements
☐ Low improvements
☐ No improvements

Indicate your degree of certainty:

☐ Very sure
☐ Fairly sure
☐ Not sure

Provide facts for your rating:

For example: data demonstrating application improvements / user benefits

Further information: ⟶ online version

11. Limitations of application performance

As the use of nanotechnologies may pose additional risks, it requires careful assessment if the overall application performance is potentially compromised by other functions or side effects and hence be less compatible with user expectations. You should carefully assess if the use of nanotechnologies potentially compromises the application's overall performance in one or more of the following areas:

- Durability and longevity
- Safe application
- (Additional) maintenance requirements
- Ease of use
- Match with existing consumer habits and technologies
- Need for expert knowledge or consultation (e.g. to correctly interpret results of medical diagnosis)
- Drawbacks in (minor) application functions

To what extent may the use of nanotechnologies have negative (side-) effects compared to current applications (reference application)?

☐ High
☐ Medium
☐ Low
☐ None

Indicate your degree of certainty:

☐ Very sure
☐ Fairly sure
☐ Not sure

Provide facts for your rating:

For example: areas where drawbacks are possible / need to be overcome

☐

Benefits and risks for society

12. Contribution to tackling relevant human problems

In the debate concerning the public funding of nanotechnologies it is often argued that those applications that are expected to deliver the greatest societal benefits should be promoted. Or to put it differently: many people are not willing to bear

the unknown risks of nanotechnology-enabled applications that do not aim to solve relevant human or individual problems.

The Millennium Development Goals (MDG) of the United Nations provides a helpful and generally accepted list of the most pressing human problems. It includes issues such as extreme poverty and hunger, education, gender equality, child mortality, maternal health, serious diseases (such as HIV/AIDS, malaria), and environmental sustainability.

Additionally, there are challenges that are particularly relevant to industrialized countries. Relevant challenges include: sustainable construction, mobility, renewable energy generation, the general "greening" of production, products and life styles, and the fight against illnesses such as cancer, diabetes and others.

How do you assess the application's contribution towards tackling relevant human problems?

☐ High (e.g. it is the primary purpose of the application)
☐ Medium
☐ Low (e.g. it will more generally improve the quality of life, but not directly address the most relevant human problems)
☐ The application addresses other issues

Indicate your degree of certainty:

☐ Very sure
☐ Fairly sure
☐ Not sure

Provide facts for your rating:

For example: relevant issues addressed, expected contribution

☐

Further information: ⟶ online version

13. Technology transfer and active development assistance

Applications designed to tackle relevant human problems can only deliver benefits if they are regionally and financially accessible by those who are expected to benefit most. In the debate on nanotechnologies an often-quoted fear is the creation of a "nano-divide", meaning that only those who have the knowledge, technical requirements and financial capabilities will benefit from nanotechnology-based improvements.

To bridge such a gap, and also serve markets in developing and transition countries, you may consider a number of strategies, including:

- A business model customized to markets in developing countries (e.g. offering a reduced price in poorer regions or a cheap version of the application);
- Significant (expected) price drops due to technological innovations and mass production;
- The establishment of pilot projects and partnerships in developing countries to better match local needs and manufacturing capabilities; or
- Technology joint ventures with domestic producers in developing or transition countries.

To what extent are strategies in place to make the application accessible and affordable for those people who will benefit most?

☐ High
☐ Medium
☐ Low
☐ None
☐ Not applicable / the application does not (directly) contribute to solving relevant human problems

Indicate your degree of certainty:

☐ Very sure
☐ Fairly sure
☐ Not sure

Provide facts for your rating:

For example: concrete strategies planned/carried out, organisation prerequisites, established partnerships

☐

Further information: ⟶ online version

14. Personal data

The aspects of privacy can be relevant when your application enables the generation of, or access to, personal information that an individual or group might want to restrict. This may include the generation or collection of personal data – whether intended or not.

Application examples include

- Various forms of medical diagnosis that can cause ethical issues in the area of medical insurance, employment, or prenatal diagnostics,
- RFID (radio frequency identification) functionality that wirelessly transmits product information (and potentially on consumer behaviour or movement), or
- "Spy" applications that are substantially reduced in size as a result of nanotechnology advances.

To what extent can your application be used, or misused, to collect or generate personal data or trace individual behaviour?

☐ High (personal data is collected/generated)
☐ Medium (e.g. only anonymous data is concerned that can under no circumstances be related to a person)
☐ Low (e.g. involves only non-personal data, such as environmental monitoring etc.)
☐ None (the application does not contribute to the collection or generation of personal data)
☐ Not applicable

Indicate your degree of certainty:

☐ Very sure
☐ Fairly sure
☐ Not sure

Provide facts for your rating:

For example: data collected or generated, measures taken to prevent the misuse of sensitive data

☐

Further information: → online version

15. Other ethical implications

New or even revolutionary technological advancements often require an accompanying ethical discourse about desirable and undesirable implications and results. Nanotechnologies may have significant effects on a number of critical issues that may have direct effects on public acceptance and regulation.

Within the NanoMeter two aspects with ethical implications can be assessed separately:

- The question on "Technology transfer and active development assistance" asks for strategies to address the danger of a "nano-divide", meaning that

only those who have the knowledge, technical requirements and financial capabilities will have access and benefit from nanotechnology-based improvements.
- The question on “Personal data” explores the extent to which privacy issues may arise from the applications capabilities.

Further ethical and societal implications of upcoming applications that concern many, and / or can evoke a public debate, may include:
- Possibilities for human enhancement and the potential transgression of the border between human body and machine
- The blurring distinction between what is natural and what is artificial
- Diagnostic complexity of nanomedical devises requiring new definitions of “healthy”
- Potential use for military purposes (“dual use”)

To what extent may your nanotechnology-enabled application cause ethical concern?

☐ High
☐ Medium
☐ Low
☐ None (no ethical implications)

Indicate your degree of certainty:

☐ Very sure
☐ Fairly sure
☐ Not sure

Provide facts for your rating:

For example: ethical implications or concern, measures / dialogues implemented

☐

Further information: ⟶ online version

Product responsibility

16. Product-related regulation

With new technologies such as nanotechnologies industry standards and regulatory testing requirements emerge slowly as the specifics and implications for defined applications become more apparent. In the absence of comprehensive information on potential risks of engineered nanomaterials it

remains difficult to assess the extent to which current regulation (e.g. concerning product safety) applies.

R&D, marketing, and sales of nanotechnology-enabled applications may therefore take place in a climate of uncertainty. There is the risk of non-compliance with future regulatory requirements or those that have so far not been considered as relevant. It is hence not sufficient to comply with current regulation, (foreseeable) future developments need to be anticipated and prepared for.

To what extent would you consider your application to be sufficiently prepared for the implications of existing and upcoming regulation?

☐ Comprehensive (concerning current and future regulation)
☐ High
☐ Medium
☐ Low

Indicate your degree of certainty:

☐ Very sure
☐ Fairly sure
☐ Not sure

Provide facts for your rating:

For example: procedures to take control of current and upcoming regulation, sources consulted

☐

Further information: ⟶ online version

17. Precautionary programmes

Developing and marketing nanotechnology-enabled applications still takes place in a context of uncertainty as regulatory standards have not yet matured. The principles of risk governance – including risk assessment, management and communication – need to be applied to mitigate insecurities, limit risks and increase consumer confidence.

Organisations operating under such conditions are expected to take an active approach in preparing for and responding to the unknown risks of their (future) applications. To apply such a precautionary approach industry initiatives and commitments may often provide a good platform.

Does your organisation have precautionary programmes in place and support voluntary (sector) initiatives?

Select all activities that apply

☐ Extensive internal safety testing and risk management procedures beyond legal compliance
☐ Customer-related provision of information that include those aspects with the highest relevance and potential risk
☐ Active participation in (sector-related) self-regulation / standardisation initiatives
☐ Implementation of (sector-related) EHS standards
☐ Application of equally high health & safety standards in all sites/ countries of operation
☐ Use of independent third party application testing and risk assessment

Provide facts for your rating:

For example: measures to limit risks, initiatives participated in, additional initiatives/ measures needed to manage application-related risks, standards implemented

Further information: → online version

18. Consumer information

With consumers and citizens becoming increasingly aware of nanotechnologies and related benefits and risks, the demand for transparent and balanced information constantly grows. Refusing to respond to obvious questions may no longer be accepted, instead increasingly resulting in rejection. These questions commonly include:

- The role of nanotechnologies for enhancing the mode of operation
- The fate of nanomaterials being (accidentally) released during use or end of life
- Potential impacts on health and environment and findings of risk assessments

Companies need to prepare for commenting on these and other issues in a generally understandable way. Also companies without direct contact to consumers need to prepare for addressing critical issues targeted at the ingredient or component they provide.

An important first step is to put your own materials used and applications produced in the context of official nanotechnology definitions.

Do you provide comprehensive application-specific user information?

Select all communication activities applied:

☐ Communicate contained nanomaterials classified according to most common definitions
☐ Signify use of nanomaterials on packaging and handbooks / inserts
☐ Provide safety requirements covering use phase and end of life
☐ Provide answers to frequently asked questions intelligible to all
☐ Communicate background information concerning benefits and risks of nanotechnologies applied
☐ Use of third party reliable certificates/ labels proofing product safety
☐ Not applicable

Provide facts for your rating:

For example: specific communication activities, contents and / or channels used, labels applied

Further information: → online version

19. Responsiveness to stakeholder opinions and concern

Your organisation's stakeholders are those people and groups who

- May affect,
- Be affected by, or
- Perceive themselves to be affected by

a decision or activity of your organisation.

Among others, this includes owners, employees, customers, regulators, suppliers, and neighbours of facilities, but can also include societal groups that act for certain public interests such as Amnesty International or Greenpeace.

Companies that engage in dialogue and respond transparently to issues raised by stakeholders can benefit from:

- Reduced potential risks that may arise from neglected stakeholder needs
- More cooperative and constructive relationships even with highly critical stakeholder groups
- Positive and stabilising effects on the organisation's reputation
- Additional stimuli for the innovation process

To what extent do you address and act upon the concern and perspectives of your stakeholders?

☐ High (e.g. stakeholder concern is systematically fed into R&D and product information decisions)
☐ Medium (e.g. regularly compare R&D and product information decisions with stakeholder concern)
☐ Low (e.g. no systematic procedure to include stakeholder views)
☐ None (stakeholder views are not identified and/or have no impact on R&D and product information decisions)
☐ Not applicable

Indicate your degree of certainty:

☐ Very sure
☐ Fairly sure
☐ Not sure

Provide facts for your rating:

For example: issues raised by external stakeholders, procedures to consider stakeholder concerns for related decisions, results of dialogue processes

☐

Further information: → online version

Results

For creating a result document: ⟶ online version

For interpreting the results: ⟶ online version; ⟶ FAQ

In this version an empty result matrix without comments and interpretation is shown.

Date of assessment: _____

Application assessed: _____

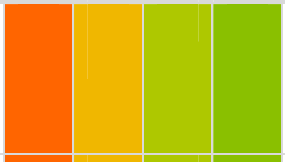
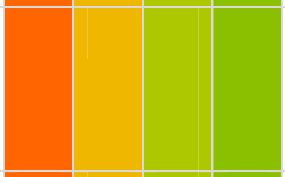
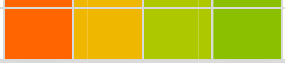
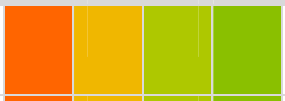
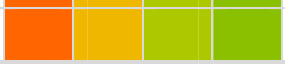
Reference application: _____

Technology sector(s) _____

This table summarizes the NanoMeter assessment results. It provides an indication of the **level of potential concern** (red areas) and of **potential benefits or strengths** of your application (green areas).

The "degree of certainty" is indicated by ●=Very sure, ❍=Fairly sure, ○=Not sure

Aspect	potential risk	---------	--------	potential benefit	Comments
Environment, health and safety (EHS)					
Exposure to the environment … during production … during use / consumption … during recycling / disposal					
Environmental hazard … during production … during use / consumption … during recycling / disposal					
Human exposure to nanomaterials … during production … during use / consumption … during recycling / disposal					
Health hazard … during production … during use / consumption … during recycling / disposal					
Reduction or substitution of harmful substances					
Contribution to risk-related research					

Resource requirements	
Energy consumption … during production … during use / consumption … overall energy consumption	
Resource consumption … during production … during use / consumption … overall resource consumption	
End-of-life	
User benefits	
Need for nanotechnologies	
Limitations of application performance	
Benefits and risks for society	
Contribution to tackling relevant human problems	
Technology transfer and active development assistance	
Note: To provide benefits for society the application needs to address relevant problems AND be available to those who benefit most.	
Personal data	
Other ethical implications	
Product responsibility	
Product-related regulation	
Precautionary programmes	
Consumer information	
Responsiveness to stakeholder opinions and concern	
Results in %	