# Save and Sustainable by Design: A Potential Approach for Nanoinnovations

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nanoSAFE'16

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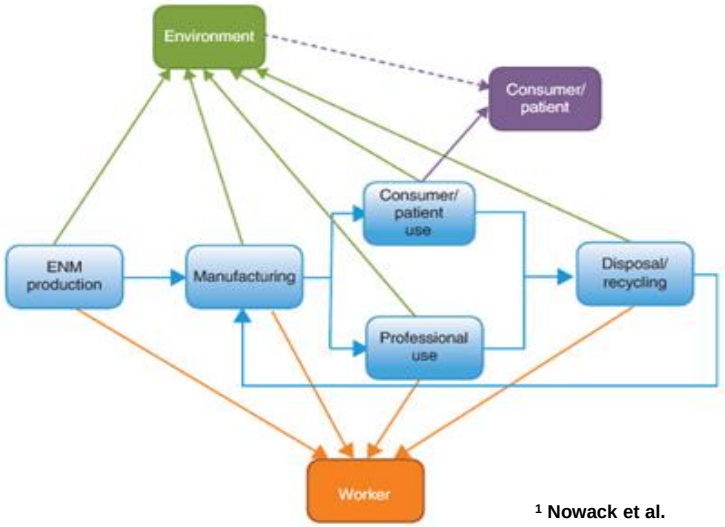
# Emerging Technologies and Uncertain Risks

- Manufactured nanomaterials/products can offer a wealth of benefits but may also carry **risks** for **human beings** and the **environment**

- Aim: BioNanoNet is focused to develop
  - An innovative **nanosafety strategy** to identify the potential risks upon exposure to nanomaterials **along the entire life cycle** (from synthesis to disposal)
    - Qualitative: Hazard/Risk assessment
    - (Semi) Quantitative: Risk estimation
  - Company-oriented recommendations on risk mitigation and improvement actions following the **NANoREG Safe-by-Design (SbD) Approach**




[1] Nowack et al.

[1] Nowack, Bernd, et al. "Analysis of the occupational, consumer and environmental exposure to engineered nanomaterials used in 10 technology sectors." Nanotoxicology 7.6 (2012): 1152-1156.

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# Safe-by-Design Approach NANOREG

- **Main pillars of SbD:**

Life cycle assessment (LCA) and risk assessment (RA)

- **Central question:**

How may design influence quality and safety of nano-enabled products?

- **Major aim:**

Following the Safe-by-Design concept, a **safer product/process** will be created if the hazards and risks that could impact on downstream users in the lifecycle **are eliminated or controlled during design/manufacture**

**FROM UNCERTAINTIES AND POTENTIAL RISKS TOWARDS CERTAINTY AND MANAGED RISKS**


[2] http://www.nanoreg.eu/
[3] modified from http://www.designworkexperience.com.au/students/the-design-process1.aspx

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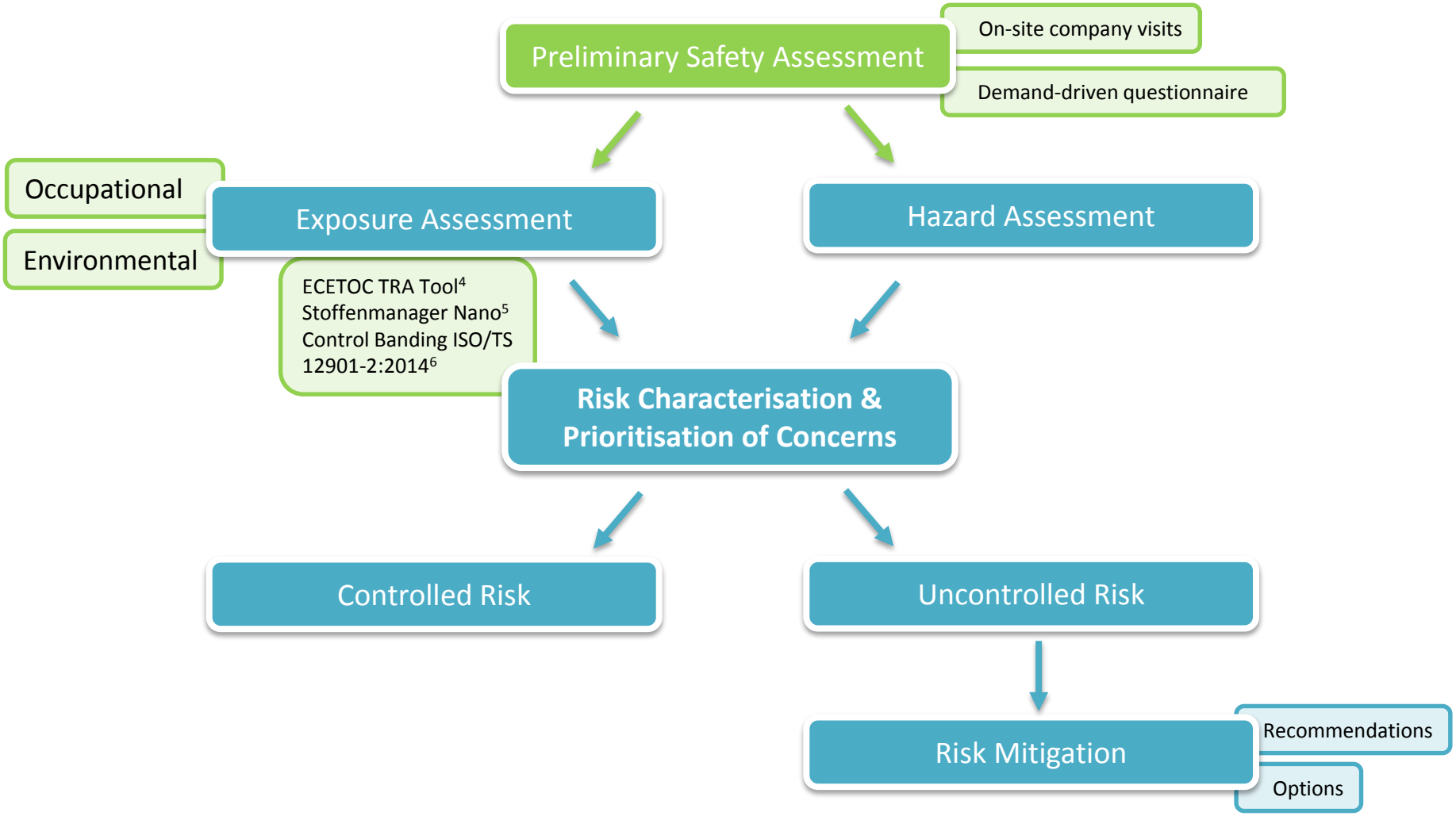
# Nanosafety Strategy




[4] http://www.ecetoc.org/tools/targeted-risk-assessment-tra/
[5] https://nano.stoffenmanager.nl/
[6] ISO/TS 12901-2:2014. "Nanotechnologies — Guidelines for occupational risk management applied to engineered nanomaterials — Part 2: The use of the Control Banding approach in occupational risk management." 2014

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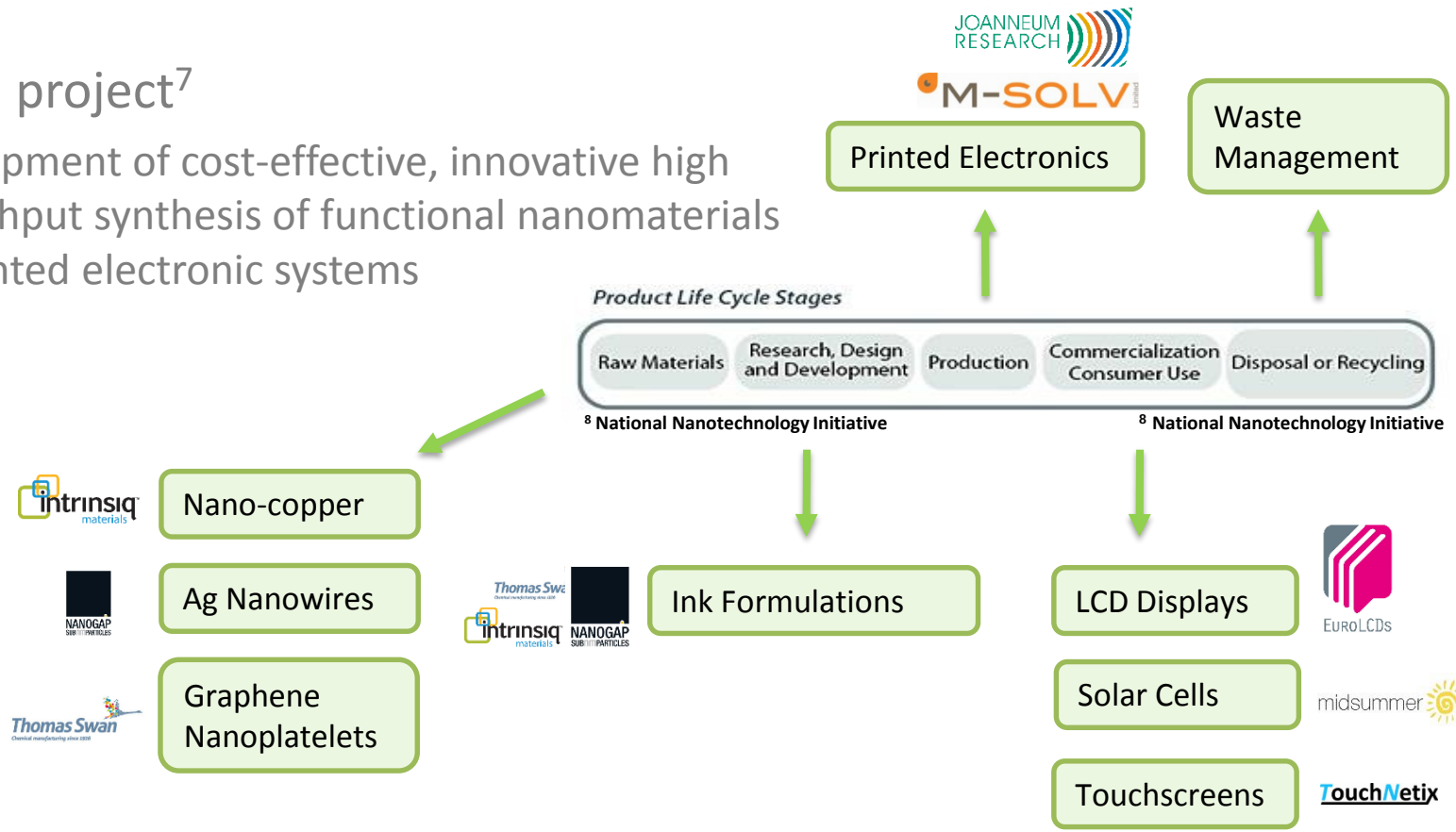
# Putting Knowledge into Practice

- Integration of the safety strategy in an industrial innovation process
- INSPIRED project[7]
  - Development of cost-effective, innovative high throughput synthesis of functional nanomaterials for printed electronic systems




[7] http://www.nano-inspired.eu/
[8] National Nanotechnology Initiative. "Environmental, health and safety research strategy." 2011

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# STEP 1: Preliminary Safety Assessment

- **Input**
  - Demand-driven questionnaire
    - Evaluation of workplace-/process-related sources of nanomaterials, safe practice and control measures, maintenance, waste management
  - Company visit
    - Interviews with health and safety managers, worker, technicians
    - Itemization of relevant processes into single process steps
- **Output**
  - Workflow-diagrams

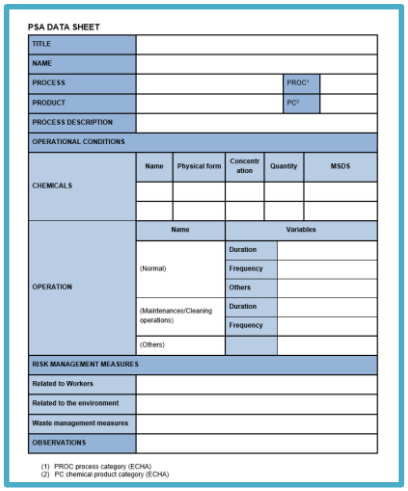

"INdustrial Scale Production of Innovative nanomateRials for printEd Devices"

H2020-NMP-2014-2015/H2020-NMP-PILOTS-2014

EC Grant Agreement Number: 646155

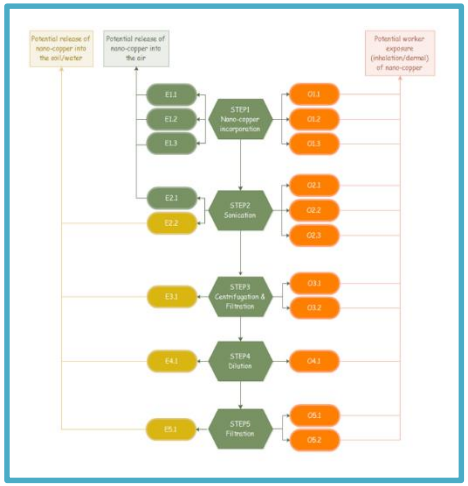
INSPIRED

Questionnaire for Consortium Partners


PSA DATA SHEET

| | | | | | | |
|---|---|---|---|---|---|---|
| TITLE | | | | | | |
| NAME | | | | | | |
| PROCESS | | | | PROC[1] | | |
| PRODUCT | | | | PC[2] | | |
| PROCESS DESCRIPTION | | | | | | |
| OPERATIONAL CONDITIONS | | | | | | |
| CHEMICALS | Name | Physical form | Concentration | Quantity | MSDS | |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| OPERATION | Name | | Variables | | | |
| | (Normal) | | Duration | | | |
| | | | Frequency | | | |
| | | | Others | | | |
| | (Maintenances/Cleaning operations) | | Duration | | | |
| | | | Frequency | | | |
| | (Others) | | | | | |
| RISK MANAGEMENT MEASURES | | | | | | |
| Related to Workers | | | | | | |
| Related to the environment | | | | | | |
| Waste management measures | | | | | | |
| OBSERVATIONS | | | | | | |

(1) PROC process category (ECHA)
(2) PC chemical product category (ECHA)



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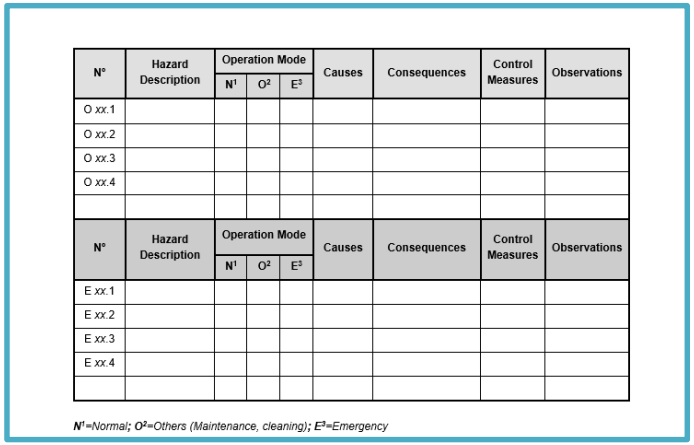
# STEP 2a: Hazard Assessment

- **Collection, collation and evaluation of…**
  - Toxicological and ecotoxicological data (dose-response studies, case studies, peer reviewed data)
  - Material safety data sheets
  - Occupational and environmental benchmark limits (e.g. PNEC, DNEL)

# STEP 2b: Exposure Assessment

- **Pinpointing relevant key scenarios**
  - Occupational exposure scenarios
  - Environmental exposure scenarios



| N° | Hazard Description | Operation Mode | | | Causes | Consequences | Control Measures | Observations |
|---|---|---|---|---|---|---|---|---|
| | | N[1] | O[2] | E[3] | | | | |
| O xx.1 | | | | | | | | |
| O xx.2 | | | | | | | | |
| O xx.3 | | | | | | | | |
| O xx.4 | | | | | | | | |
| | | | | | | | | |
| N° | Hazard Description | Operation Mode | | | Causes | Consequences | Control Measures | Observations |
| | | N[1] | O[2] | E[3] | | | | |
| E xx.1 | | | | | | | | |
| E xx.2 | | | | | | | | |
| E xx.3 | | | | | | | | |
| E xx.4 | | | | | | | | |
| | | | | | | | | |

*N[1]=Normal; O[2]=Others (Maintenance, cleaning); E[3]=Emergency*

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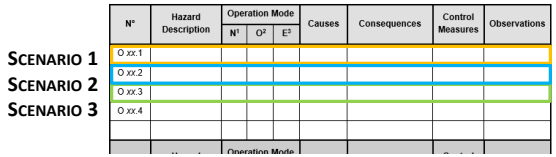
# STEP3: Risk Characterisation & Prioritisation

- Identified exposure scenarios are linked to ECETOC TRA® (Targeted Risk Assessment) tool[9]
  - Preferably used (NANoREG[10], NSC[11]) considering REACH/ECHA relevant aspects




**STEP 1** Identification of the Substance

**STEP 2** Physico-chemical Properties

**STEP 3** Risk Assessment

**INPUT DATA**

- Substance Name
- CAS. No.

- Molecular weight
- Vapour pressure
- Partition coefficient
- Biodegradability

[9] ECETOC. "Targeted Risk Assessment User Guide for the integrated tool TRAM." 2014
[10] http://www.nanoreg.eu/
[11] http://www.nanosafetycluster.eu/

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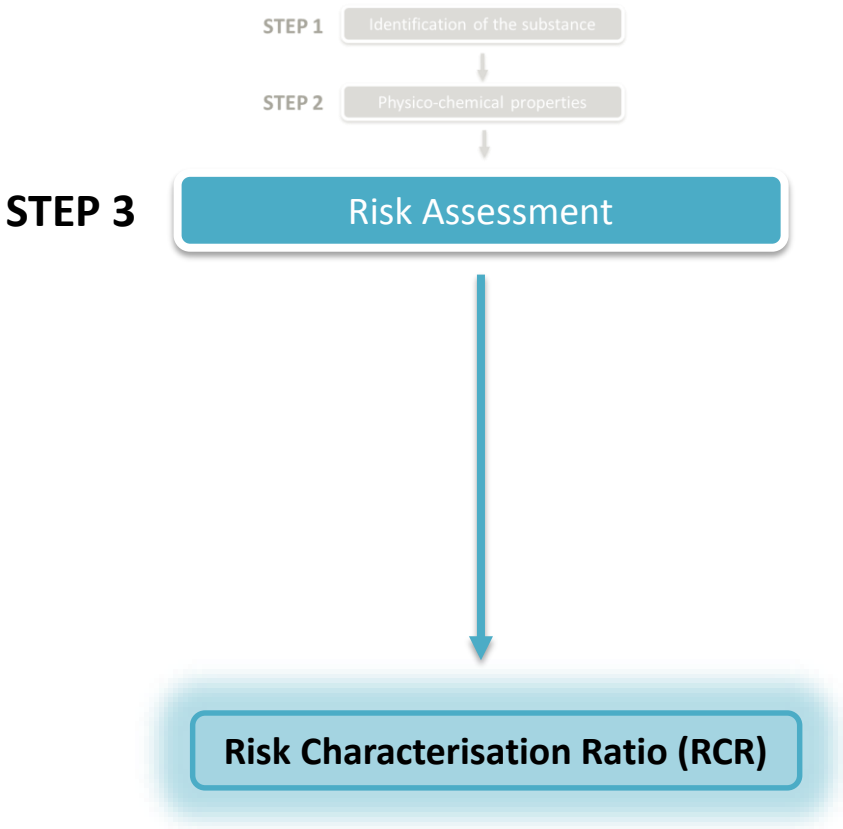
# STEP 3: Risk Characterisation & Prioritisation




## INPUT DATA

**OCCUPATIONAL**
- **PROC**[12] (process release category)
- **DNEL** (derived no effect level)

**ENVIRONMENTAL**
- **ERC**[12] (environmental release category)
- **PNEC** (predicted no effect level)

**OVERALL**
- Operational activities
- Risk management measures
- Material characteristics (physical form, weight fraction)

## OUTPUT DATA

**RCR ≥ 1**
**HIGH**
risk potential

**RCR < 1**
**LOW**
risk potential

[12] European Chemical Agency. "Guidance on information requirements and chemical safety assessment." 2012

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# Impact & Benefits of the Nanosafety Approach

- The presented approach…
  - creates a company-oriented library of **critical hotspots** associated with initial exposure estimates
  - helps to **enhance the safety level** and/or improve the performance of existing exposure monitoring systems/risk management strategies
  - aids to design-out uncertainties and potential risks at the earliest possible and/or feasible stage → **safe-by-design**
  - will support industry with a **clear safety framework**, based on the review of regulatory aspects to gain **regulatory preparedness**

# Thank you for your Attention!

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