# From IRGC Framework and sample applications (ERRAs) to Emerging Risk Management Framework (ERMF)

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# The task setup

- Problem:
  1. In SP1: Analyze and compare ERRAs, extract common features
  2. In SP2: Find the backbone of the theoretical solutions labeled “iNTeg-Risk approach”
  3. In SP3: Apply the “iNTeg-Risk” approach to cases/companies NOT having participated in SP1 and SP2
  4. In SP4: Have the communication and application baseline
- Solution proposed here:

  Apart from other elements of the overall solution proposed in the DoW, develop the framework for emerging risks
- Expected results:

  Have a tool(s) for comparative analysis of current ERRAs, analysis of new ones and possible providing solutions/advices for new cases based on the existing ones.

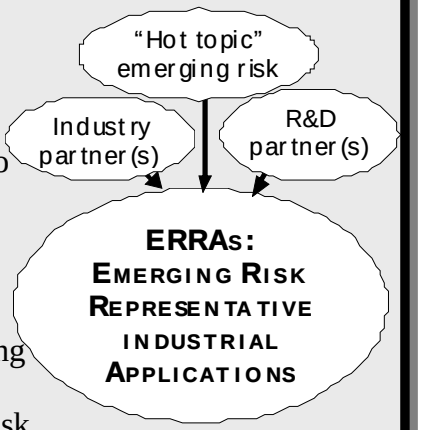
# ERRAs

**ERRAs:** Emerging Risks Representative (industrial) Applications are significant examples of applications related to industrial safety (emerging risks). Solutions for the these single, specific problems related to emerging risks should allow to capitalize upon and, by generalizing the solutions, build the common European approach to emerging risk.

# iNTeg-Risk: One framework fits all…

- … is it realistic?
- "New Technologies" in iNTeg-Risk used also as a synonym for "applications"
- In iNTeg-Risk:
  The 17 ERRAs
  … divided in 4 groups
  A. New (production) technologies
  B. New materials and products
  C. New technologies & production networks
  D. New policies

**ERRAs:** Emerging Risks Representative (industrial) Applications are significant examples of applications related to industrial safety (emerging risks). Solutions for the these single, specific problems related to emerging risks should allow to capitalize upon and, by generalizing the solutions, build the common European approach to emerging risk.




Each ERRA is a triplet containing: (a) one significant emerging risk related issue/topic, (b) one or more industrial partners concerned by the above emerging risk(s), and (c) one or more R&D partners having proven excellence in providing solutions for the above emerging risk(s). They also provide the test-bed for the developed integrated methods, tools and the whole system..

*iNTeg-Risk Box "ERRAs"*

# Overview of all ERRAs in iNTeg-Risk

| | |
|---|---|
| **A** | **EMERGING RISKS - NEW TECHNOLOGIES** |
| **A1** | CO2 capture and sequestration, both technical risks and governance risk |
| **A2** | Insurance and re-insurance aspects of emerging risks including the security-related (HSSE) emerging risks of new technologies |
| **A3** | Emerging risks related to the industrial use of automated and un-manned surveillance of industrial infrastructure |
| **A4** | Liquid Natural Gas (LNG) regazification in sensitive areas on-shore and offshore |
| **A5** | Safety and security of underground hubs with interconnected transportation services and shopping centers |
| **B** | **EMERGING RISKS - NEW MATERIALS AND PRODUCTS** |
| **B1** | Public health and medical issues related to monitoring of emerging risks in production, storage and transport of nano-materials on industrial scale in small and medium enterprises (SMEs) |
| **B2** | Emerging risks related to advanced storage technologies for hazardous materials (including H2) |
| **B3** | Emerging risks related to development and use of advanced engineering materials, composite materials |
| **C** | **NEW PRODUCTION - TECHNOLOGIES & PRODUCTION NETWORKS** |
| **C1** | Challenges to safety posed by outsourcing of critical tasks – in oil, gas, petrochemical and construction industries |
| **C2** | Remote operation in environmentally sensitive areas |
| **C3** | On-line risk-monitoring and assessment of emerging risks in conventional industrial plants – monitoring of risks beyond the design/regulatory basis |
| **C4** | Atypical, one-of-the-kind major hazards/scenarios (post-Buncefield implications) and their inclusion in the normal HSSE practice |
| **C5** | Security of energy supply and related emerging risks |
| **D** | **EMERGING RISKS - RELATED POLICIES** |
| **D1** | Definition of KPIs emerging risks for selected industry case studies, including CSR aspects of emerging risks |
| **D2** | Integrated approach on emerging risks related to the implementation of European safety legislation on SME´s and its application on companies working in Distributed Energy Resources (DER) |
| **D3** | Emerging risks related to interaction between natural hazards and technologies at community level |
| **D4** | Emerging risks related to hazardous substances, impact on public health and relations with REACH and GHS |

# iNTeg-Risk: TECHNOLOGIES…

A. **New (production) technologies**
B. New materials and products
C. New technologies & production networks
D. New policies


| Nr | Name | Responsible Partner |
|---|---|---|
| **A** | **EMERGING RISKS - NEW TECHNOLOGIES** | **UNIBO (CONPRICI)** |
| A1 | $CO_2$ capture and sequestration, both technical risks and governance risk | HSE-HSL |
| A2 | Insurance and re-insurance aspects of emerging risks including the security-related (HSSE) emerging risks of new technologies | Swiss Re |
| A3 | Emerging risks related to the industrial use of automated and un-manned surveillance of industrial infrastructure | GDF |
| A4 | Liquid Natural Gas (LNG) regasification in sensitive areas on-shore and offshore | D'Apollonia |
| A5 | Safety and security of underground hubs with interconnected transportation services and shopping centers | VSH Hagerbach |

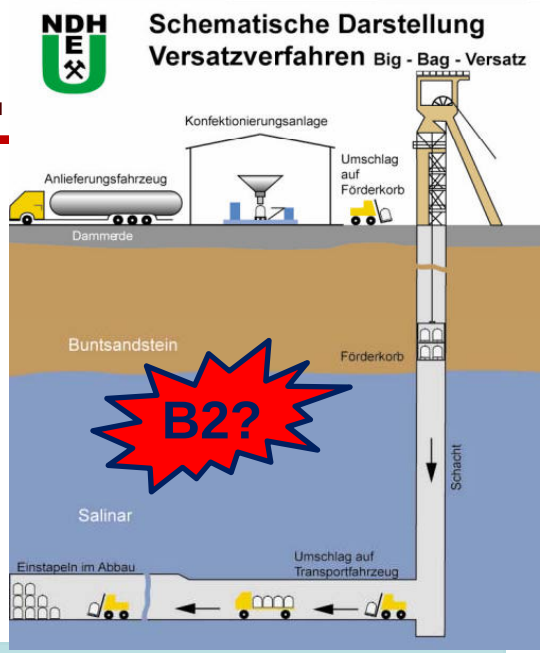
# iNTeg-Risk: TECHNOLOGIES..

A. New (production) technologies

**B. New materials and products**

C. New technologies & production networks

D. New policies




| Nr | Name | Responsible Partner |
|---|---|---|
| **B** | **EMERGING RISKS - NEW MATERIALS AND PRODUCTS** | **EU-VRi** |
| B1 | Public health and medical issues related to monitoring of emerging risks in production, storage and transport of nano-materials on industrial scale in small and medium enterprises (SMEs) | Novineon |
| B2 | Emerging risks related to advanced storage technologies for hazardous materials (including $H_2$) | BAM |
| B3 | Emerging risks related to development and use of advanced engineering materials, composite materials | KMM-VIN |

# iNTeg-Risk: TECHNOLOGIES…

A. New (production) technologies
B. New materials and products
**C. New technologies & production networks**
D. New policies


| Nr | Name | Responsible Partner |
|---|---|---|
| **C** | **New technologies & production networks** | **SINTEF** |
| C1 | Challenges to safety posed by outsourcing of critical tasks – in oil, gas, petrochemical and construction industries | DTU |
| C2 | Remote operation in environmentally sensitive areas | SINTEF |
| C3 | On-line risk-monitoring and assessment of emerging risks in conventional industrial plants – monitoring of risks beyond the design/regulatory basis | BZF |
| C4 | Atypical, one-of-the-kind major hazards/scenarios (post-Buncefield implications) and their inclusion in the normal HSSE practice | HSE-HSL |
| C5 | Security of energy supply and related emerging risks | JRC |

# iNTeg-Risk: TECHNOLOGIES…

A. New (production) technologies
B. New materials and products
C. New technologies & production networks
**D. New policies**

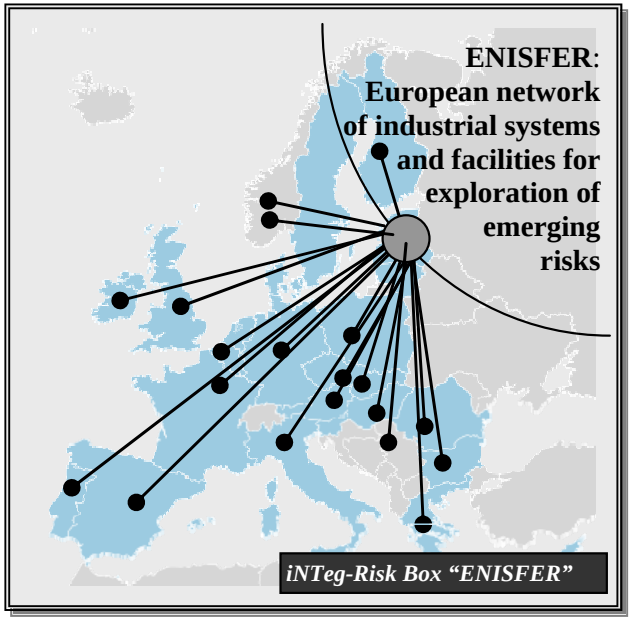

| Nr | Name | Responsible Partner |
|---|---|---|
| **D** | **EMERGING RISKS - RELATED POLICIES** | **R-Tech** |
| D1 | Definition of KPIs for emerging risks for selected industry case studies, including CSR aspects of emerging risks | DNV |
| D2 | Integrated approach on emerging risks related to the implementation of European safety legislation on SMEs and its application on companies working in Distributed Energy Resources (DER) | LEIA |
| D3 | Emerging risks related to interaction between natural hazards and technologies at community level | INERIS |
| D4 | Emerging risks related to hazardous substances, impact on public health and relations with REACH and GHS | RIVM |

# iNTeg-Risk: TECHNOLOGIES…

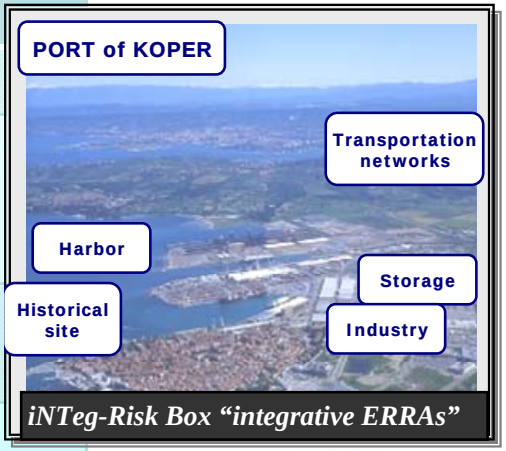
A. New (production) technologies
B. New materials and products
C. New technologies & production networks
D. New policies

Verification:

- Integrative ERRAs
- Catalogue of installations (ENISFER)
- A “yet-to-be-defined” additional verification case (competition)

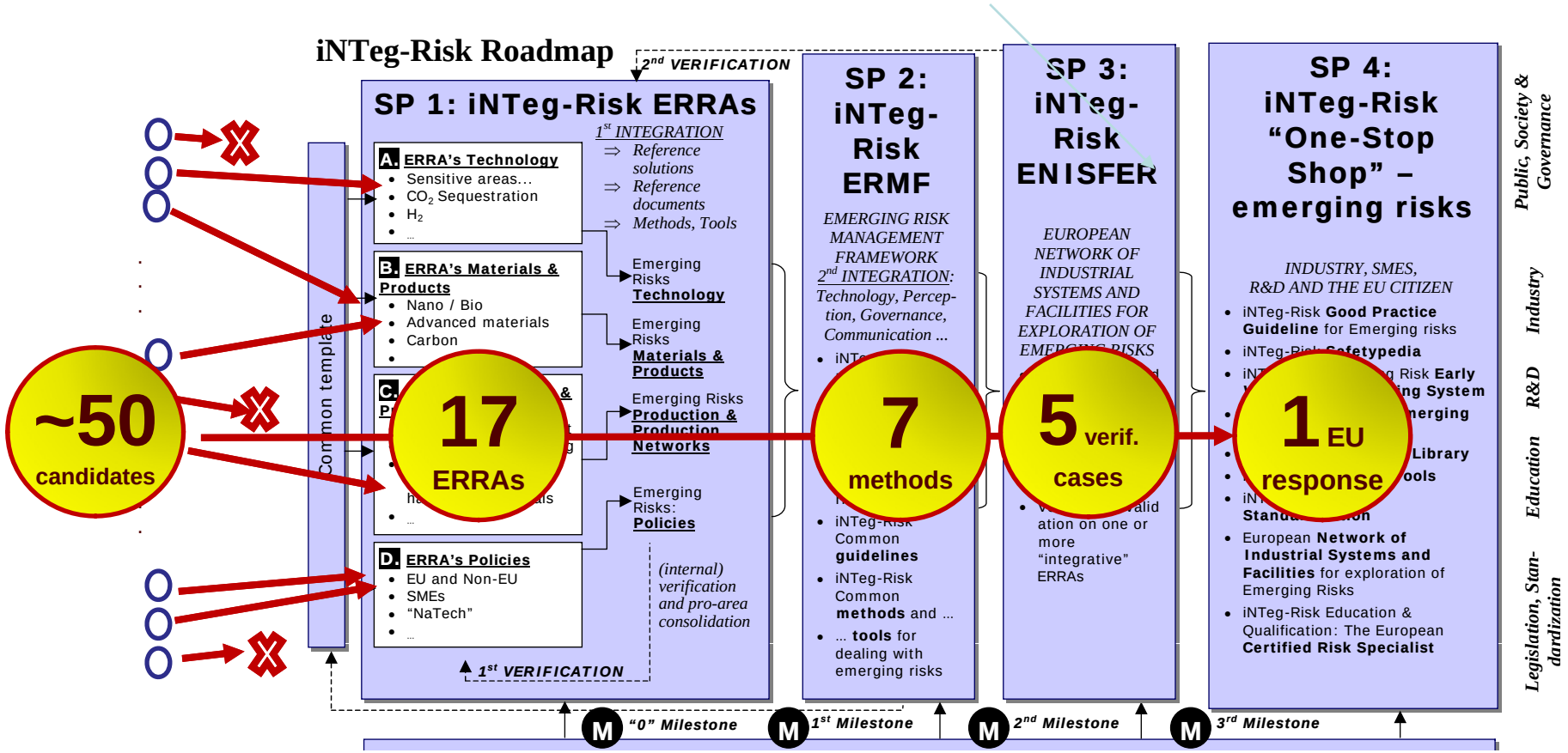



| Nr | Name |
|---|---|
| **SP3** | **Verification ERRAs** |
| I1 | Integrative ERRA #1 for the validation of emerging risk assessment and management tools in the Industrial zone (NaTech – Nature-Technology interaction) of area of Mantova |
| I2 | Integrative ERRA #2: Harbor zone (industry + transport networks) of Luka Koper |
| I3 | Integrative ERRA #3: Industrial zone (mixed industry) of Pančevo-South |



# From 50 sample cases to one “EU response”

**Project preparation** **Project execution**



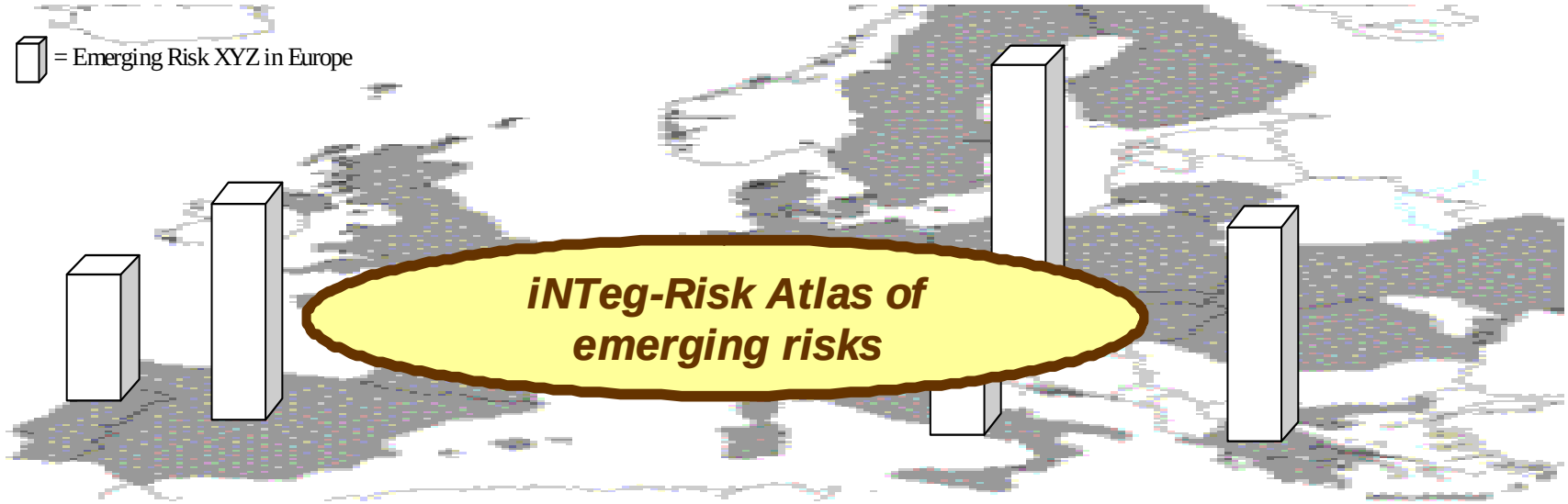

~ 50 “Emerging Risk” Candidate applications

17 ERRAs

~ 7 Main Methods

~ 1 EU “response to emerging risks”

# Examples of a planned iNTeg-Risk solutions: iNTeg-Risk Atlas of Emerging Risks



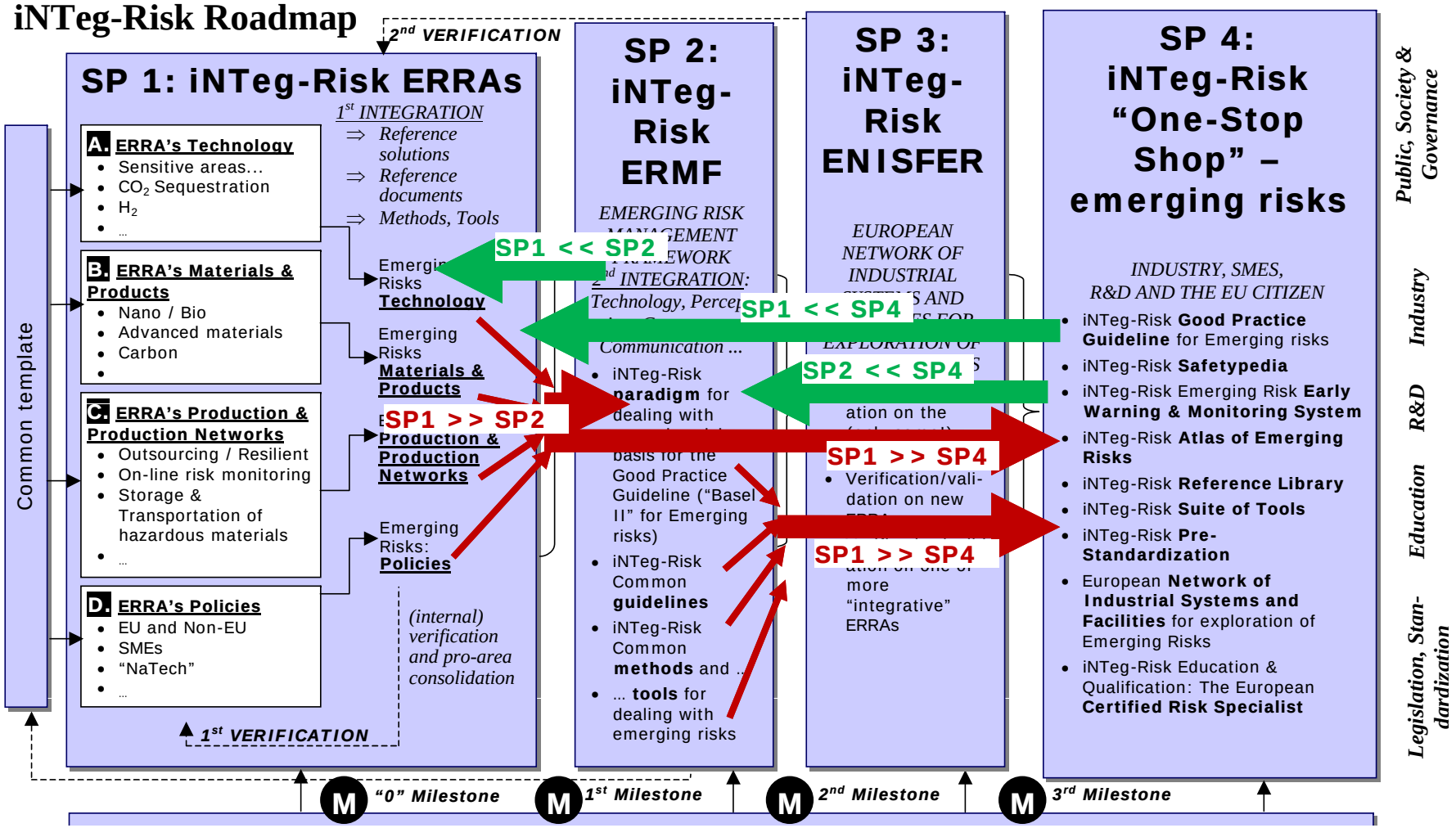

- **Early Warning & Monitoring System** (the network of approved iNTeg-Risk sentinels in charge of signaling the emerging risks and providing advice on them Europe-wide)
- **iNTeg-Risk Atlas of Emerging Risks** (providing on-line maps with current level of emerging risks in different European countries/regions – relaying on the Safetypedia and the Monitoring System);
- **Catalogue of European Industrial Systems and Facil**ities for exploration of Emerging Risks
- **iNTeg-Risk Suite of Tools** (providing access and recommendations to both the tools developed in INTeg-Risk and the relevant validated tools from other sources)

# iNTeg-Risk Atlas of Emerging Risks


Incidents/problems in CO2 plants…

Risk perception problems related nanotechnologies…

# Bottom-up vs. Top-down in iNTeg-Risk




**Delivery of data, facts, commonalities …**

**Requirements, formats, queries …**

# ERIs
# Emerging Risk Issues
# (within an ERRA!)

# ERIs

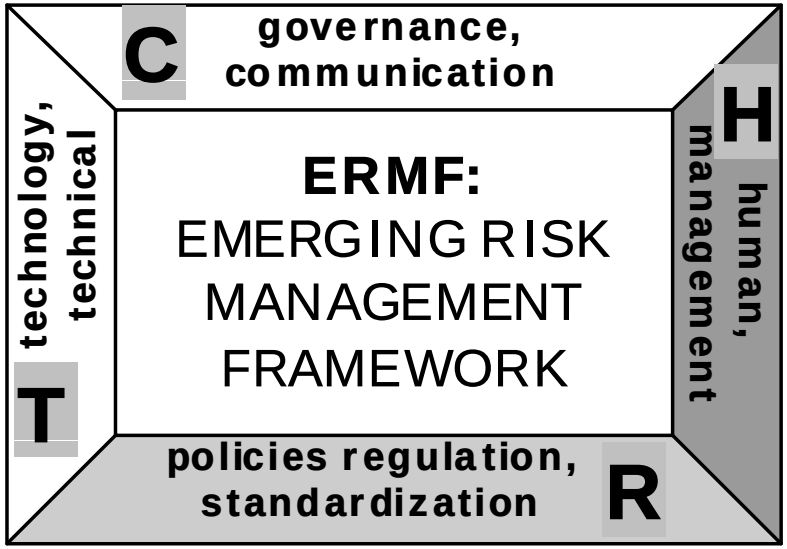
- Each ERRA is a triplet containing:
  a) At least one significant emerging risk related issue/topic (=ERI!)
  b) One or more industrial partners concerned by the above emerging risk(s), and
  c) One or more R&D partners having proven excellence in providing solutions for the above emerging risk(s).

  ERIs within ERRAs should also provide the test-bed for the developed integrated methods, tools and the whole system..

# The framework - ERMF

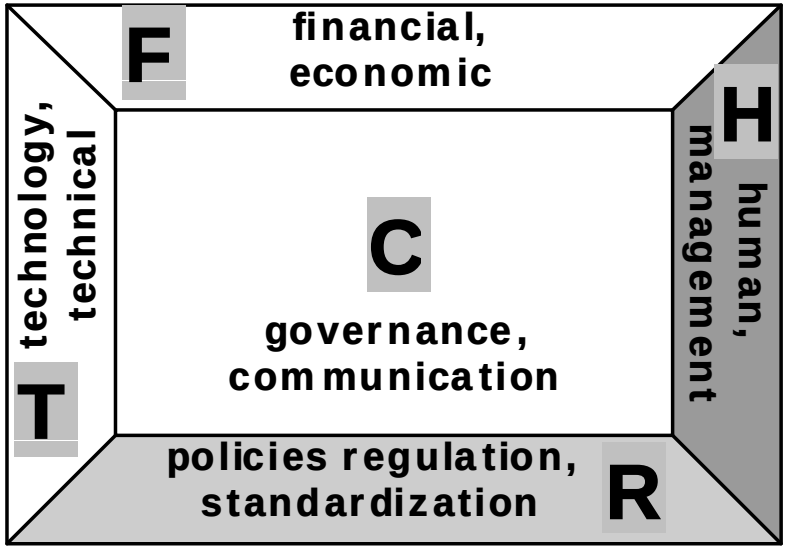
# ERMF – current representation

- Emerging Risk Management Framework (ERMF) is the Risk Management Framework developed in Shape-Risk project and formalized in the iNTeg-Risk proposal covers the 4 following dimensions for emerging risk management:
  1. Technical / technological (T)
  2. Human / management (H)
  3. Governance / communication (C)
  4. Policies / Regulations / Standards (R)



# ERMF – Proposed update!

- Emerging Risk Management Framework (ERMF) is the Risk Management Framework developed in Shape-Risk project and formalized in the iNTeg-Risk proposal covers the 4 following dimensions for emerging risk management:
  1. Technical / technological (T)
  2. Human / management (H)
  3. Governance / communication (C)
  4. Policies / Regulations / Standards (R)



# IRGC Framework

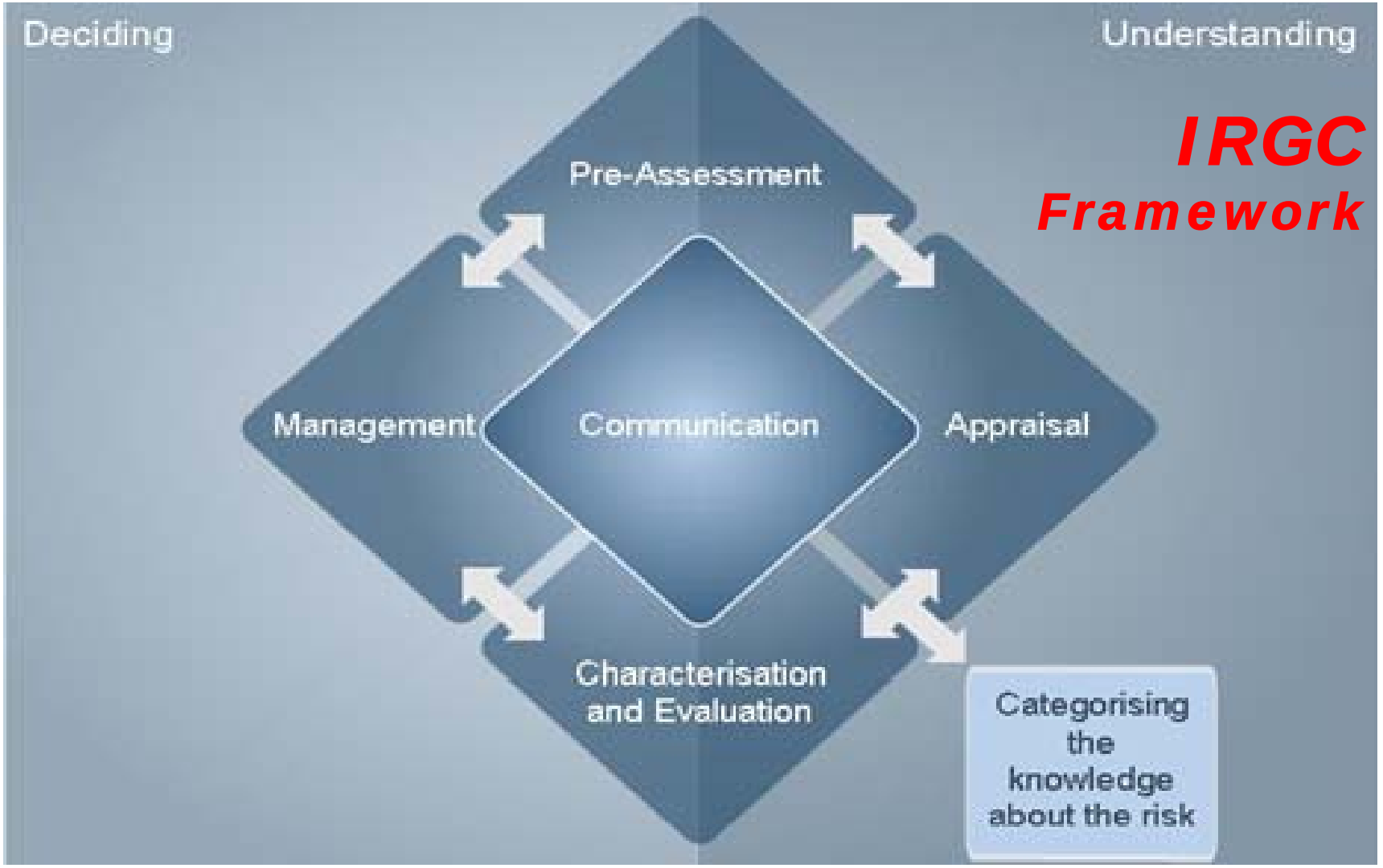
The IRGC framework risk process, or risk handling chain breaks down into three main phases:

1. **Pre-assessment**
2. **Appraisal**
3. **Management**

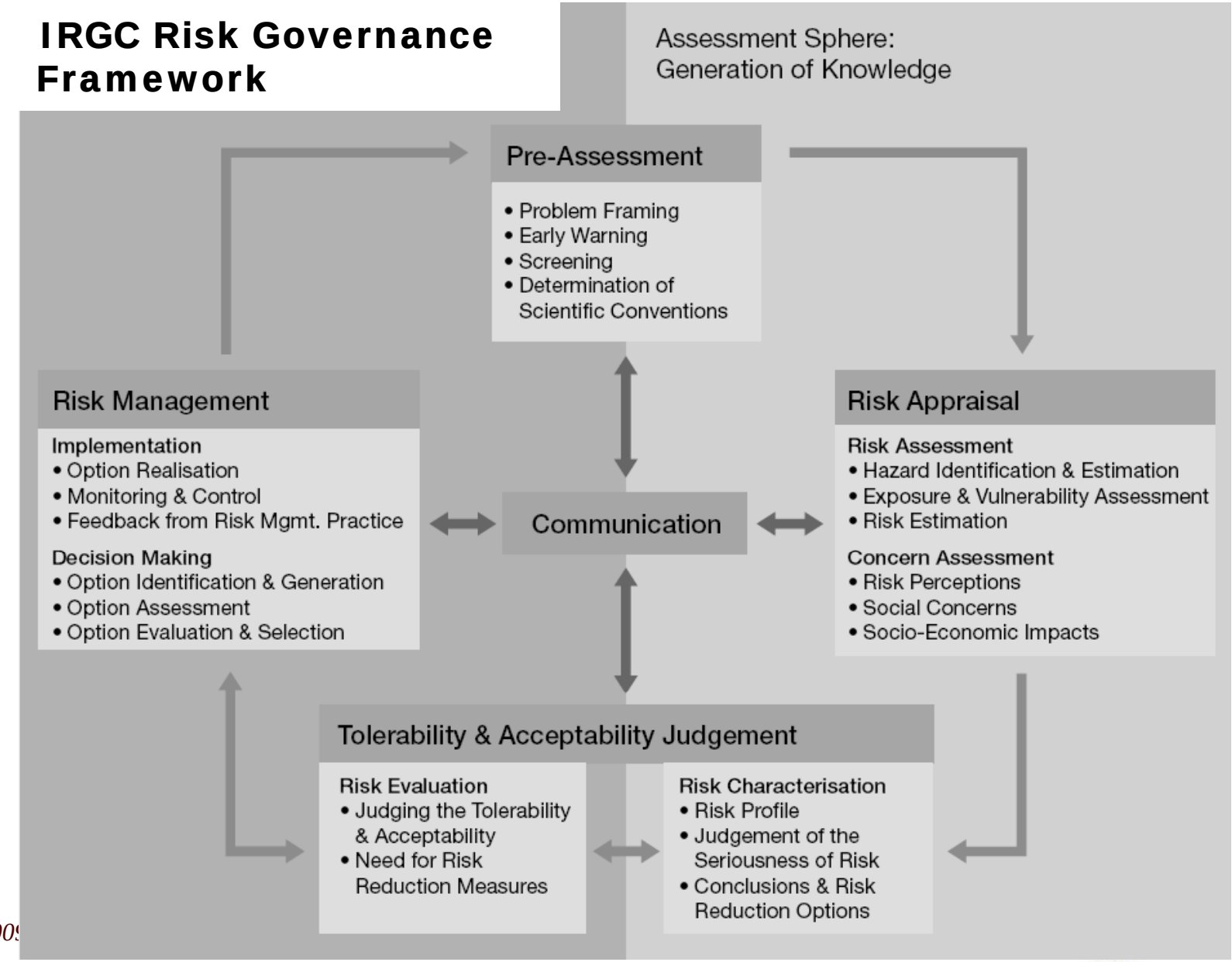
A 4. phase, comprising the **Characterization and Evaluation** of risk, is placed between the appraisal and management phases and can be assigned to either of them thus concluding the appraisal phase or marking the start of the management phase. The risk process has **Communication** as a companion to all phases of addressing and handling risk and is itself of a cyclical nature.

NOTE: The clear sequence of phases and steps offered by this process is primarily a logical and functional one and will not always correspond to reality.

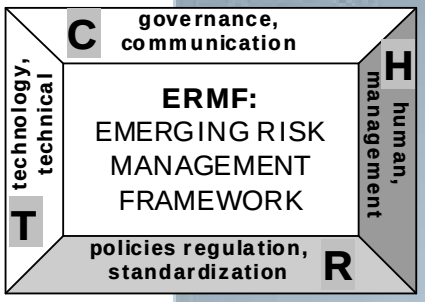
# IRGC Framework



# IRGC Framework - detailed



# Combining the two solutions - general

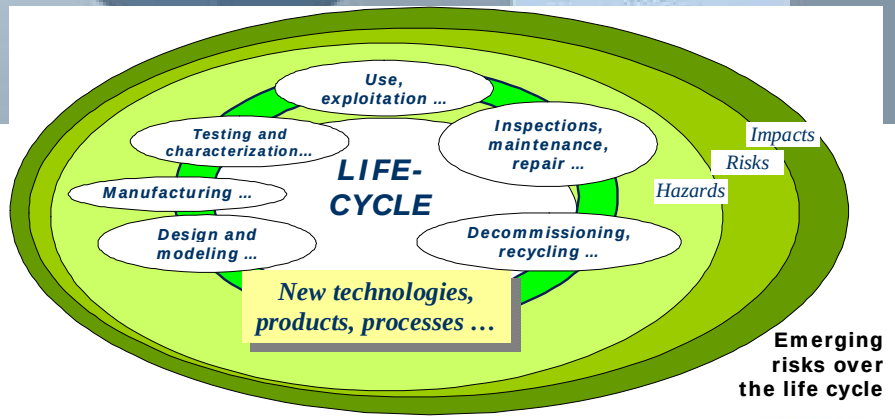






***iNTeg-Risk solution*** *based on:*

- ***common framework*** *based on*
  - *IRGC and*
  - *Shape-Risk solutions*
- ***common language*** *(UML of emerging Risks, UML - Unified Model Language)*
- ***CMMI*** *(Capability Maturity Model Integration)*
- ***Life Cycle Analysis*** *(LCA)*
- ***common metrics*** *(based on KPIs) – Key Performance Indicators*
- ***common tools***




**Emerging risks over the life cycle**

# Combining the two solutions - practical

| 1. OVERVIEW MATRIX | | | | | |
|---|---|---|---|---|---|
| Title of the ERRA: | | | | | |
| Particular Emerging Risks Issues (ERIs) within this ERRA | ERMF | IRGC | | | |
| | | Pre-Assessment | Risk Appraisal | Tolerability; Acceptability Judgment | Risk management |
| ERI#1:..... | [T] Technology, technical: | e.g. LEVEL 2 | e.g. LEVEL 1 | e.g. LEVEL 2 | e.g. LEVEL 1 |
| ERI#2:..... | [C] Governance, communication: | e.g. LEVEL 1 | e.g. LEVEL 3 | e.g. LEVEL 3 | e.g. LEVEL 3 |
| ERI#3:..... | [H] Human, Management: | e.g. LEVEL 3 | e.g. LEVEL 1 | e.g. LEVEL 3 | e.g. LEVEL 2 |
| ERI#*n*:..... | [R] Policies, regulation, standardization: | e.g. LEVEL 1 | e.g. LEVEL 2 | e.g. LEVEL 3 | e.g. LEVEL 1 |

| LEGEND: Criticality of risk issues for iNTeg-Risk | |
|---|---|
| LEVEL 3 | Risk issues are not covered/explored (e.g. information and data not available). |
| LEVEL 2 | Risk issues are poorly covered/explored (e.g. information and data exist but are insufficient). |
| LEVEL 1 | Risk issues are well covered/explored. |

| 2. CRITICALITY OF SINGLE ERRIs | | | | |
|---|---|---|---|---|
| Level of Probability for each ERI | HIGH | **e.g. ERI #1** | | |
| | MEDIUM | | **e.g. ERI #2, ERI #4** | **ERI #5** |
| | LOW | **e.g. ERI #3** | | |
| | | LOW | MEDIUM | HIGH |
| | | Level of Consequence for each ERI | | |

# Combining the two solutions - practical

**+ KPIs!**

**+ do it for:**

1. **Status**
2. **Work to be done**
3. **Results**

| 5. RESULTS MATRIX | | | | | | |
|---|---|---|---|---|---|---|
| ERMF | | | IRGC | | | |
| Emerging Risk Issues (ERI) | | KPI (Key Performance Indicator) | Pre-assessment | Risk Appraisal | Tolerability; Acceptability Judgment | Risk Management |
| **[T]** Technology, technical (screening using available methodologies e.g. QRA, HAZOP, AMDEC etc.): | ERI 1: | KPI 1: | | | | |
| | ERI 2: | KPI 2: | | | | |
| **[C]** Governance, communication (screening internal and external communication strategies): | ERI 3: | KPI 3: | | | | |
| | ERI 4: | KPI 4: | | | | |
| **[H]** Human, Management: (screening using available methodologies e.g. OHSAS 18001): | ERI 5: | KPI 5: | | | | |
| | ERI 6: | KPI 6: | | | | |
| **[R]** Policies, regulation, standardization (screening following regulations in place and standard procedures):90 | ERI 7: | KPI 7: | | | | |
| | ERI *n*: | KPI *n*: | | | | |

# Sample implementation of the matrix (A1)

**$CO_2$ capture and sequestration, both technical risks and governance risk**

Particular Emerging Risks Issues (ERI)within this ERRA

ERI # 1:
Characterization of the severity of a massive release of $CO_2$.

ERI # 2:
Risk informed decision making process to be clearly defined.

ERI # 3:
Security of the $CO_2$ storages: the legal status of $CO_2$ still needs to be defined.

ERI # 4:
Clear policy and standards throughout Europe.

# Sample implementation of the matrix (A1)

## $CO_2$ capture and sequestration, both technical risks and governance risk

| OVERVIEW MATRIX | | | | | |
|---|---|---|---|---|---|
| Title of the ERRA: A1 $CO_2$ capture and sequestration, both technical risks and governance risk | | | | | |
| Particular Emerging Risks Issues (ERI) within this ERRA<br>ERI # 1: Characterization of the severity of a massive release of $CO_2$.<br>ERI # 2: Risk informed decision making process to be clearly defined.<br>ERI # 3:Security of the $CO_2$ storages the legal status of CO2 still needs to be defined.<br>ERI # 4:Clear policy and standards throughout Europe. | ERMF | IRGC | | | |
| | | Pre-Assessment | Risk Appraisal | Tolerability & Acceptability Judgment | Risk management |
| | [T] Technology, technical: | LEVEL 3 | LEVEL 2 | LEVEL 3 | LEVEL 3 |
| | [C] Governance, communication: | LEVEL 2 | LEVEL 2 | LEVEL 3 | LEVEL 3 |
| | [H] Human, Management: | LEVEL 3 | LEVEL 2 | LEVEL 2 | LEVEL 2 |
| | [R] Policies, regulation, standardization: | LEVEL 3 | LEVEL 3 | LEVEL 3 | LEVEL 3 |

| LEGEND: Criticality of risk issues for iNTeg-Risk: | |
|---|---|
| LEVEL 3 | Risk issues are not covered/explored (e.g. information and data not available). |
| LEVEL 2 | Risk issues are poorly covered/explored (e.g. information and data exist but are insufficient). |
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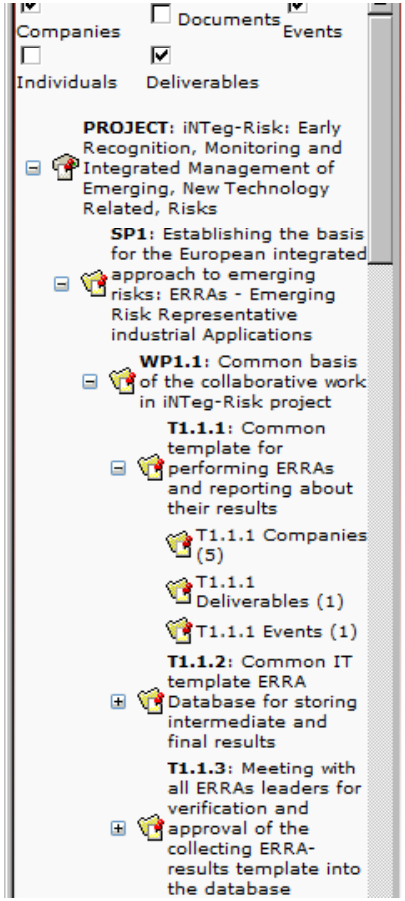
# Sample implementation of the matrix (A1)

## $CO_2$ capture and sequestration, both technical risks and governance risk




**STATUS MATRIX**

| ERMF | | | IRGC | | | |
|---|---|---|---|---|---|---|
| Emerging Risk Issues (ERI) | | KPIs | Pre-assessment | Risk Appraisal | Tolerability & Acceptability Judgment | Risk Management |
| [T] Technology, technical (screening using available methodologies e.g. QRA, HAZOP, AMDEC etc.): | Definition of risk scenarios | To be defined : could be related with generic criticality (based of number of scenarios, expected number of hazard sources, expected consequences and frequency of main scenarios) | The problem is already well framed. Broad contours of risk scenarios are defined<br>Massive gas emanation on the ground : from a well or from a surface equipment<br>Contaminated water resurgence on the surface:<br>Explosion of (presumed large) storage vessel<br>The list of main generic risk scenarios should be completed<br>Generic criticality of the scenarios should be defined. | Precise definition of accident scenarios needs to be done.<br>Already relatively well known for traditional transport and storage<br>To be defined more precisely for geological storage | Lack of precise definition of accident scenarios makes tolerability and acceptability judgment difficult | Definition of risk reduction options is based on the initial definition and understanding of risk scenarios |

See more details under http://www.integrisk.eu-vri.eu/ma/ProjectExplorer.aspx?lan=230&tab=70&itm=72&pag=72

# Conclusions

- Combine coordinate with the template activities (this part yet to be included into the ERRA templates – in particular the ERIs)
- Adapt the database specifications to the needs of the framework
- Start looking for the CBR aspects (case based reasoning) and use of clustering techniques