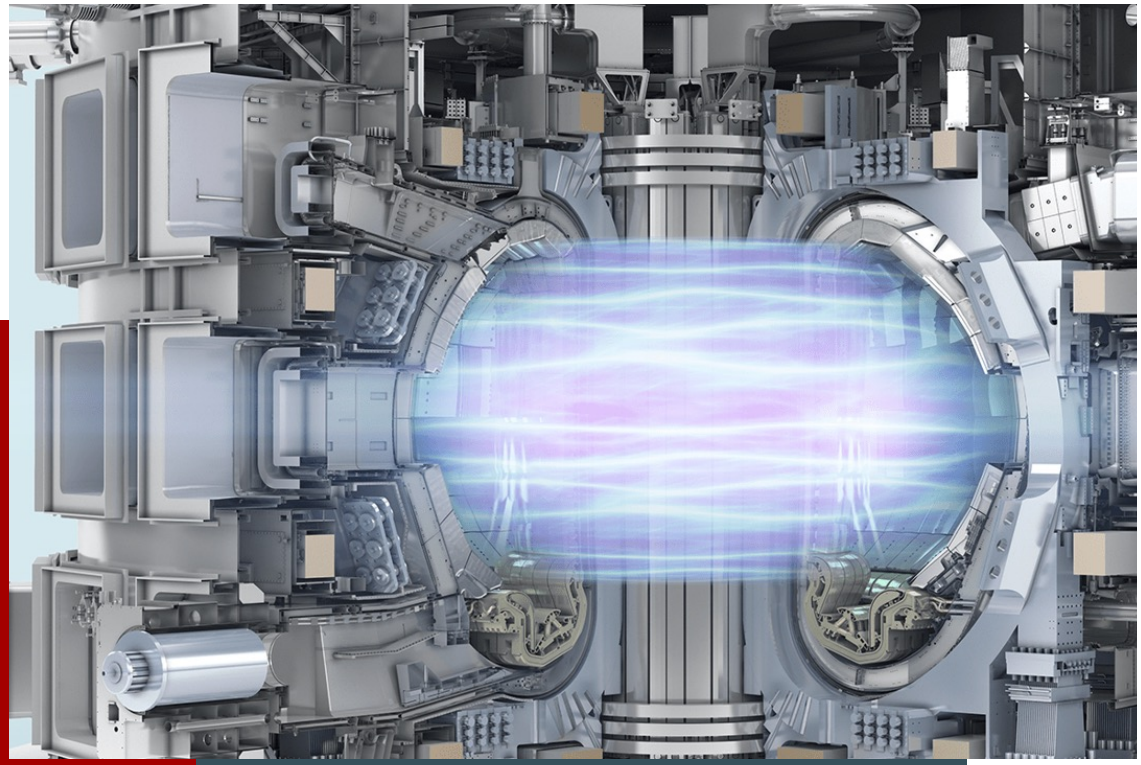
INPROCAP

Training 5 Practical training on innovation procurement for ILOs and BSO staff

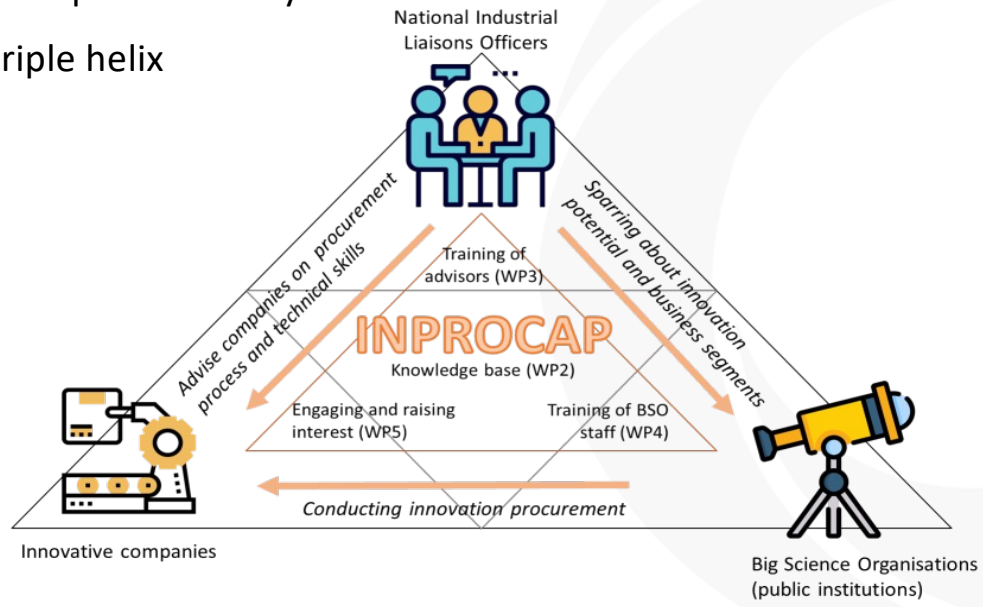


Welcome and agenda

Esther Davidsen, Danish Technological Institute

Objective of INPROCAP

- Build specialist advisory services on **in**novative **pro**curement amongst national Industrial Liaison Officers (ILOs) to Big Science Organisations (BSOs).
- Innovation procurement is an underused mechanism in the BSO value chain, has potential to transform BSO public spending into innovation for use in European industry
- Involve three main stakeholders in triple helix



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Four European Hubs - Seven Partners

European XFEL

EISCAT SCIENTIFIC ASSOCIATION

PEDAL CONSULTING

NWO

BigScience.dk

NATIONAL CENTRE FOR NUCLEAR RESEARCH ŚWIERK

CDTI

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RESULT: Start-ups and SMEs from all over Europe are motivated to participate in Big Science innovation procurement processes

Develop and implement a long-term sustainable advisory platform for innovation procurement processes in the Big Science innovation ecosystem)

ILOs perform specialist advisory services to the BSO public procurers on innovation procurement

Innovation procurement becomes a standard tool for the Big Science market,

- Involve 200 companies, mainly start-ups and SMEs
- Engage with 10 start-up environments and 10 supply chains in industry clusters and multipliers (PERIIA)
- Involve companies from at least 8 countries
- Initiate 10 small consortia to work on co-design of particular technological solutions for the BSOs.

- 40 ILOs participate in the training activities to empower their advisory function
- 5 BSOs integrate advice on innovation procurement from ILOs into ILO-forum meetings

- 3 instruction manuals (for BSOs, ILOs and companies) on how to conduct Big Science innovation procurement,
- 30 BSO staff members have gained innovation procurement capabilities,
- 5 BSOs show explicit effort to conduct innovation procurement.

Engage → Train → Implement

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Agenda for today

Time	Session	Key points
10:30-10:45	**Welcome**	• Introduction to INPROCAP project • Overview of the day's programme and learning objectives
10:45-11:15	**Recap: Innovation procurment Training Journey**	• Summary of modules: Needs Assessment, Market Analysis, OMC • Key takeaways and lessons learned
11:15-11:30	**Exercise: Designing an Open Market Consultation**	• Group work on realistic BSO scenarios, Design OMC strategy: objectives, formats, timeline
11:30-12:30	**Lunch Break**	
12:30-13:00	**Exercise: Designing an Open Market Consultation**	▪ Presentations of individual groups and discussion
13:00-13:45	**Experience with PCP – ARCHIVER project – Joao Fernandes, CERN**	• Real case from CERN practice, How PCP/innovation procurement was applied • Lessons learned and discussion
13:45-14:30	**Key Components of building a Business case**	• Why business cases matter for innovation procurement • Core components: problem, evidence, cost-benefit, risk, alignment
14:30-14:45	**Break 2**	
14:45-15:00	**Partner Perspective: Business case in practice – Manuel Moreno, CDTI**	• Practitioner perspective with real examples of building bussiness case for innovation procurement in Spain
15:00-15:50	**Exercise: Building a business case for BSO**	• Group work on real BSO cases, Develop business case outline: problem, evidence, approach, costs, risks • presentation
15:50-16:00	**Wrap-up, Key Takeaways, and Next Steps**	

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Welcome & Introduction

- ❑ **Interactive elements:** Mentimeter polls and quizes
- ❑ **Recording:** Yes, available afterward
- ❑ **Questions:** Use chat function or raise hand

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Learning Objectives

By the end of this training, participants will be able to:

- ✓ **Recall and apply** key concepts from Needs Assessment, Market Analysis, and Open Market Consultation modules
- ✓ **Design an OMC strategy** — selecting appropriate formats, drafting targeted questions, and ensuring equal treatment
- ✓ **Understand CERN's practical experience** with PCP and innovation procurement through a real case study (ARCHIVER)
- ✓ **Identify the core components** of a business case for innovation procurement — problem definition, market evidence, cost-benefit analysis, risk assessment, and strategic alignment
- ✓ **Develop a business case outline** for a real BSO procurement scenario through collaborative exercise

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Today´s speakers

Jozef Kubinec, Keennovate

- Innovation procurement expert
- INPROCAP trainer responsible for trainings manual and ILOs and BSO staff innovation procurement trainings
- Member of CERIS – Community for European Research and Innovation for Security
- Ministry of Interior Slovakia procurement experience
- SHIELD4CROWD, PROTECT, PCP WISE, SHIELD PCP, multiple EU projects

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Today´s speakers

João Fernandes, CERN

- is a senior CERN staff member with nearly two decades of experience driving innovation in ICT
- Technical coordinator of *H2020 HNSciCloud*, establishing a federated cloud platform for data-intensive science across the *GÉANT* network.
- Led the award-winning *H2020 EOSC ARCHIVER* project on hybrid cloud services for scientific data analysis, storage, and long-term preservation.
- Contributed to CERN's next-generation computing model, including cloud-based quantum services and heterogeneous computing, via the *CERN Quantum Technology Initiative* and *Next Generation Triggers*.
- Since January 2026: CERN Engineering Department, *Information Management group (EN-IM)*, leading a team supporting mission-critical digital engineering applications for 5,000+ specialists.

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Today´s speakers

Manuel Moreno Ballesteros, CDTI

- is an aeronautical engineer and has a degree in physical sciences.
- He works at the CDTI.
- He is the Spanish liaison for Spain (ILO) in particle physics at CERN, the ESRF, and the ILL, and a member of the Spanish delegation to the Finance Committee of CERN and the ESRF
- He will present the examples of PCP conducted by CDTI and also methodology how they analyse ideas for future PCPs.

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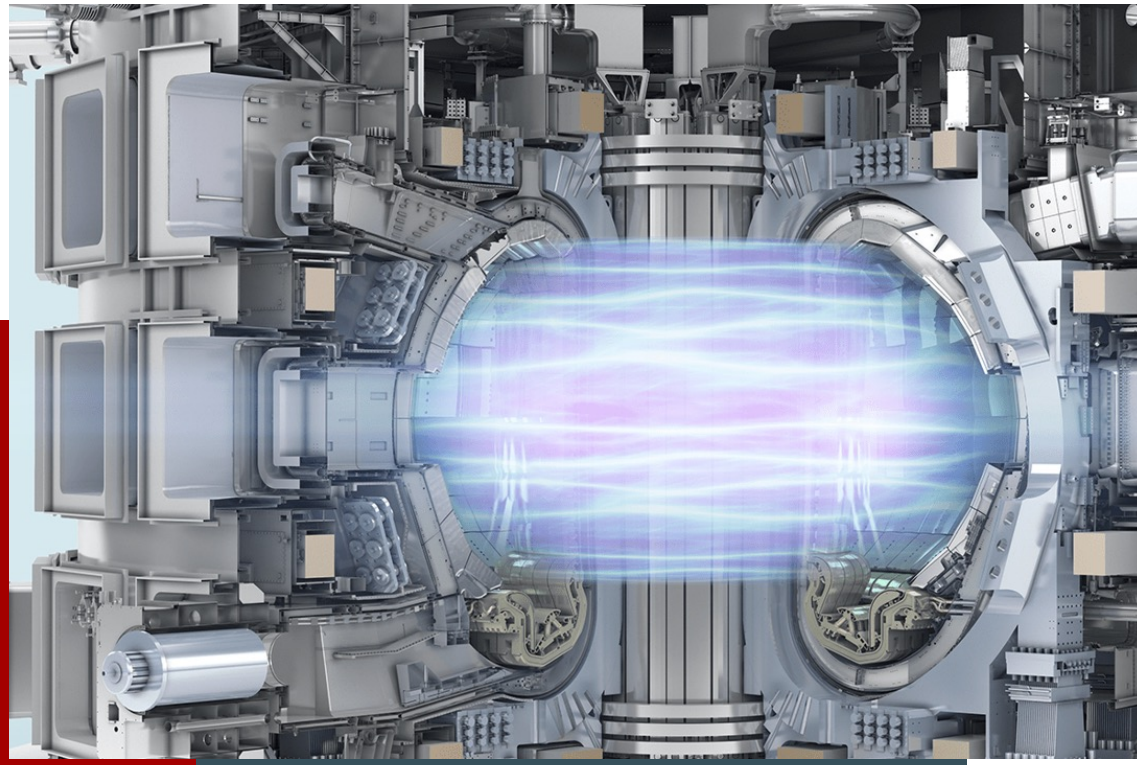

RECAP: Innovation Procurement Training Journey

Expectations from training

What are your expectations from Training?

Go to .....Mentimeter.com
Use code..... **4598 6826**

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Expectations from training

Which module from the INPROCAP training journey do you feel most confident about?

- Needs Assessment
- Market Analysis (SOTA)
- Open Market Consultation
- I need a refresher on all of them

Go to .....Mentimeter.com

Use code.....**4598 6826**

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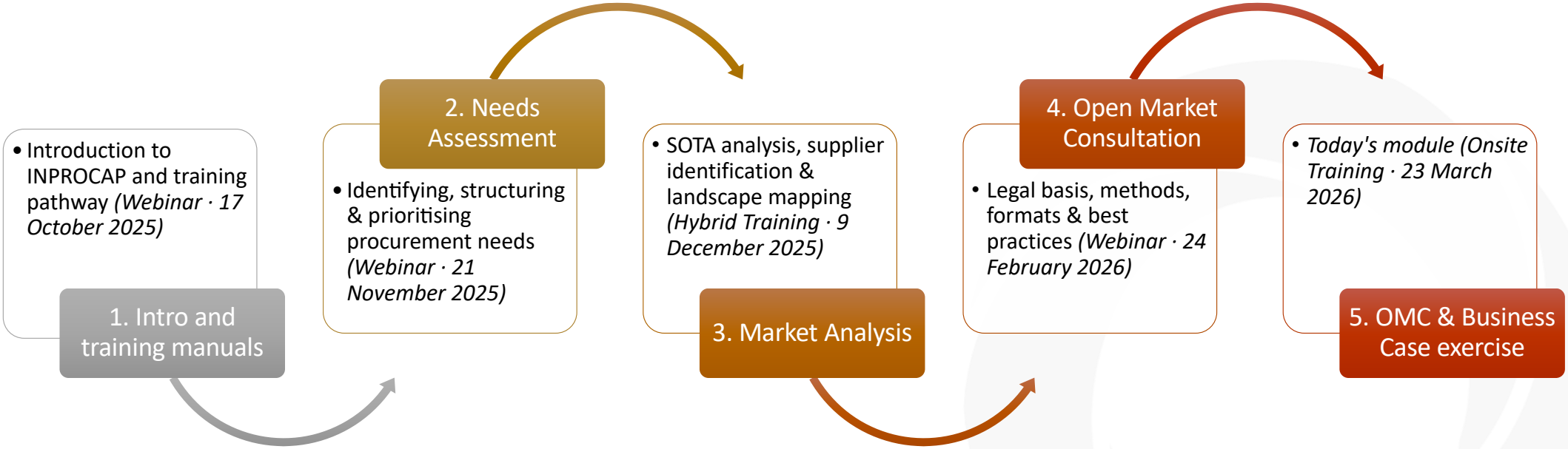
The INPROCAP Training Pathway



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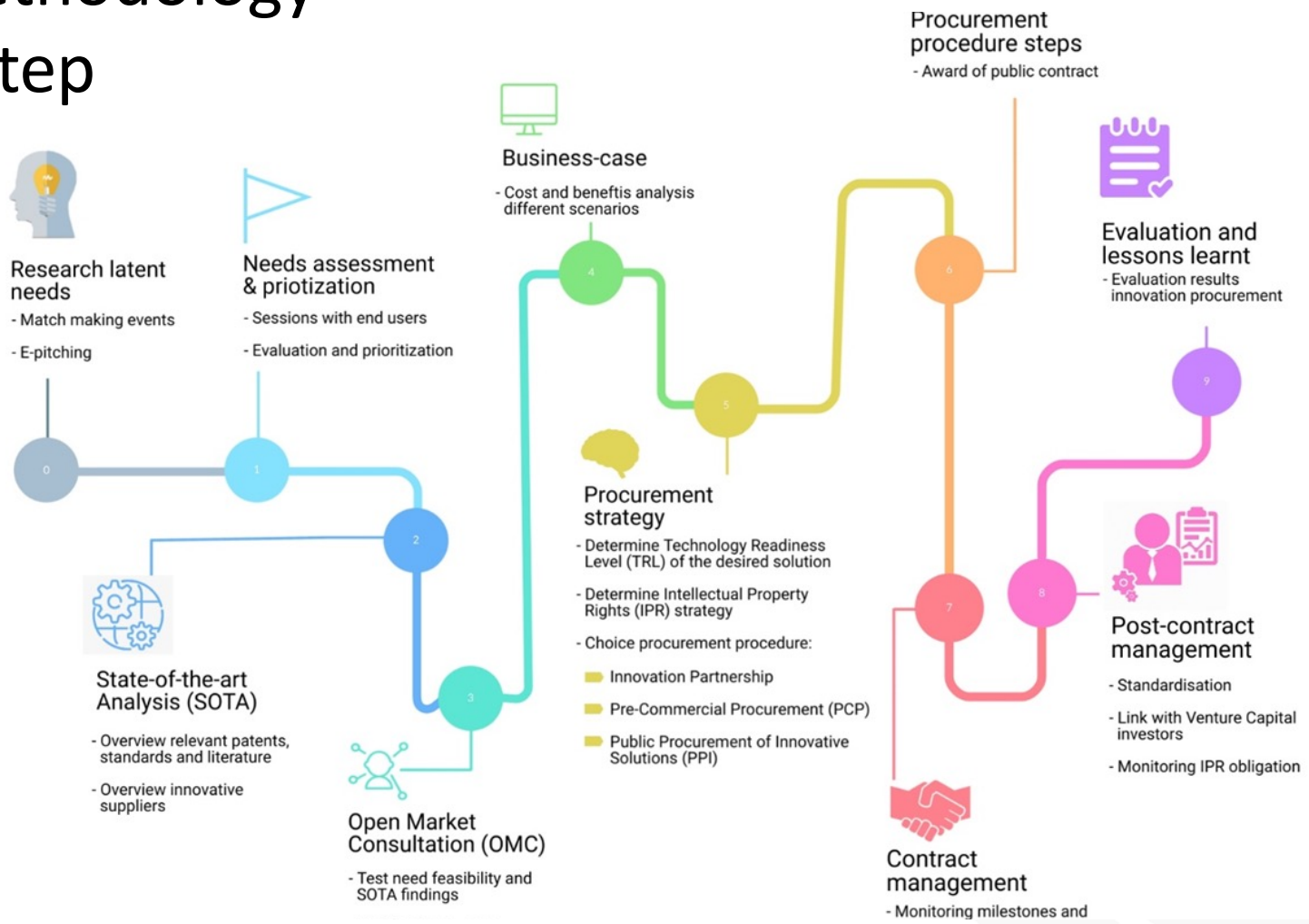
EAFIP Methodology step-by-step



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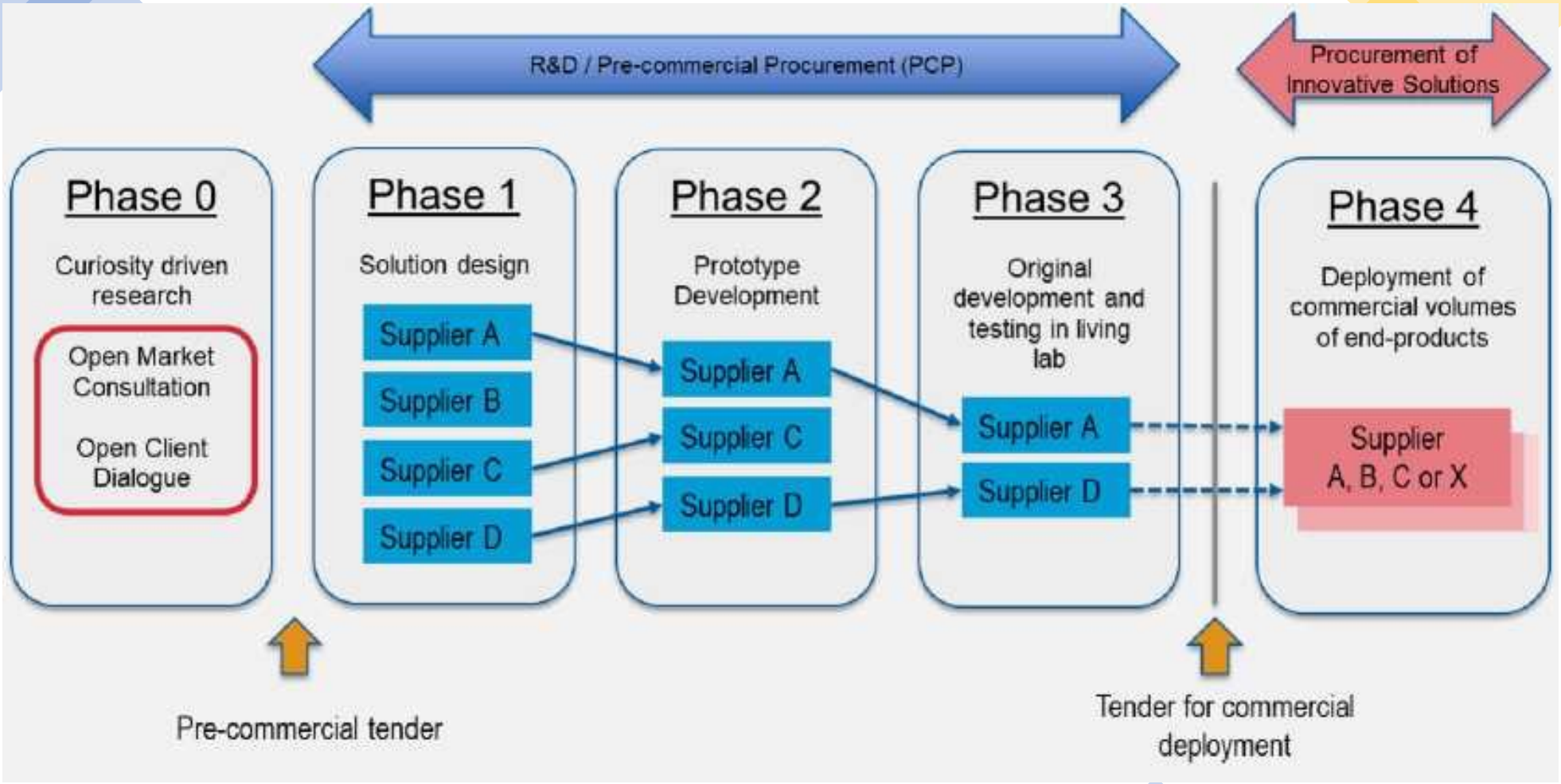
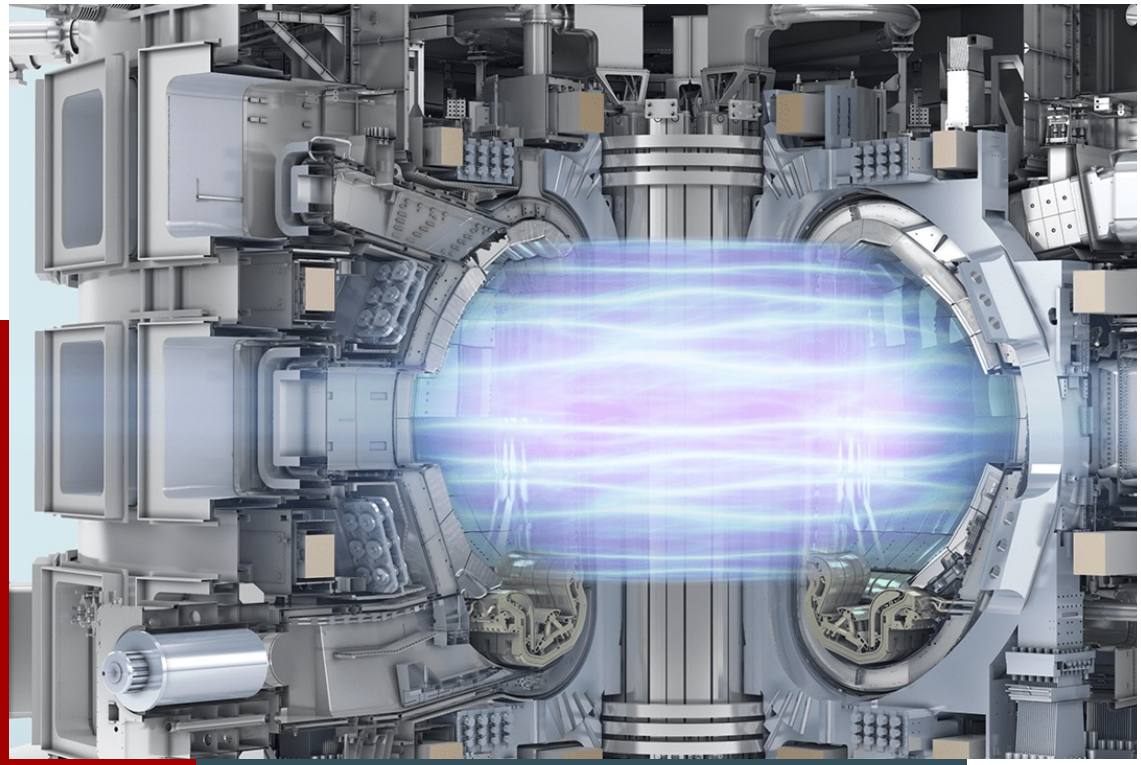
WHAT IS INNOVATION PROCUREMENT?

Innovation procurement refers to any procurement that has one or both of the following aspects:

- **buying the process of innovation** – research and development services with (partial) outcomes
- **buying the outcomes of innovation**

*the EC definition of Innovation Procurement


R&D / Pre-commercial Procurement (PCP)
Procurement of Innovative Solutions
Phase 0
Curiosity driven research
Open Market Consultation
Open Client Dialogue
Phase 1
Solution design
Supplier A
Supplier B
Supplier C
Supplier D
Phase 2
Prototype Development
Supplier A
Supplier C
Supplier D
Phase 3
Original development and testing in living lab
Supplier A
Supplier D
Phase 4
Deployment of commercial volumes of end-products
Supplier A, B, C or X
Pre-commercial tender
Tender for commercial deployment



Module: Needs Assesment

Concept of unmet need

Innovation procurement starts with an "**unmet need**"

"a requirement or set of requirements that public procurers have now or (preferably) one that public procurers will have in the future, that current products, services or arrangements cannot meet, or can only do so at excessive cost or with unacceptable risk."*

**Department for Business Innovation & Skills: "Delivering best value through innovation. Forward Commitment Procurement. Practical Pathways to buy Innovative Solutions", UK Innovate*

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Concept of unmet need

An unmet need is:

- Described in terms of **outcomes**, not technologies

Example:

❌ "We need AI-powered software"

✅ "We need to reduce client response time from 48h to 4h"

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Examples of methodologies to identify needs

- Voice of the Client/Customer
- 5 step-by-step approach
- WIBGIF (wouldn’t it be great if…)

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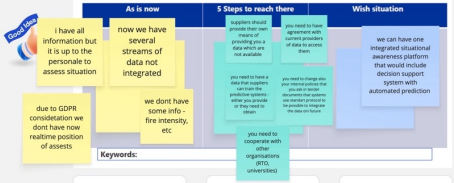
STEP 1

Describe the ideal situation

STEP 2

"As is" and "wish situation"



Describe the situation now

Indicate 5 steps to get from as i...

What is your ideal situation i...

Write some keywords for a...

STEP 3

New grid

Describe your use case	endusers: firefighters, Crises mamangment units, volunteers, citizens
Main functions:	• provide one operational picture • prediction module for resource managment, deploy managment • categorize the eevent and how it can possibly develop - wildfire category 4, • it should be possible to use it also trainings
Input:	• general data either owned by public buyer or publicly available
Output:	• one platfro that integrates all the data
When:	• it is important to have this platfrom during the crises
Where:	• deployed in the control room or in the filed,

STEP 4

New grid

Functions	**Performance**
retrieve data	**refresh rate - 10 sec? but maybe for satallite data it might not be possible**
integrate data sources in one platfrom	**updated every 10 seconds**
store data	**securely stored in the EU/premises of public buyer**
analyse and sort	• **assessment of current data and predict the future scenarios** • prediction of need for deployment of resources

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Key Takeaways – Needs Assessment

✅ **Start with the problem, not the solution** — define what you need before exploring the market
✅ **Use functional specifications** — describe desired outcomes, not prescriptive technical requirements
✅ **Involve end-users early** — procurement teams alone rarely capture the full picture
✅ **Prioritise strategically** — not every need justifies innovation procurement; focus resources where impact is highest
✅ **Document the rationale** — a well-recorded needs assessment becomes the audit trail for every downstream decision

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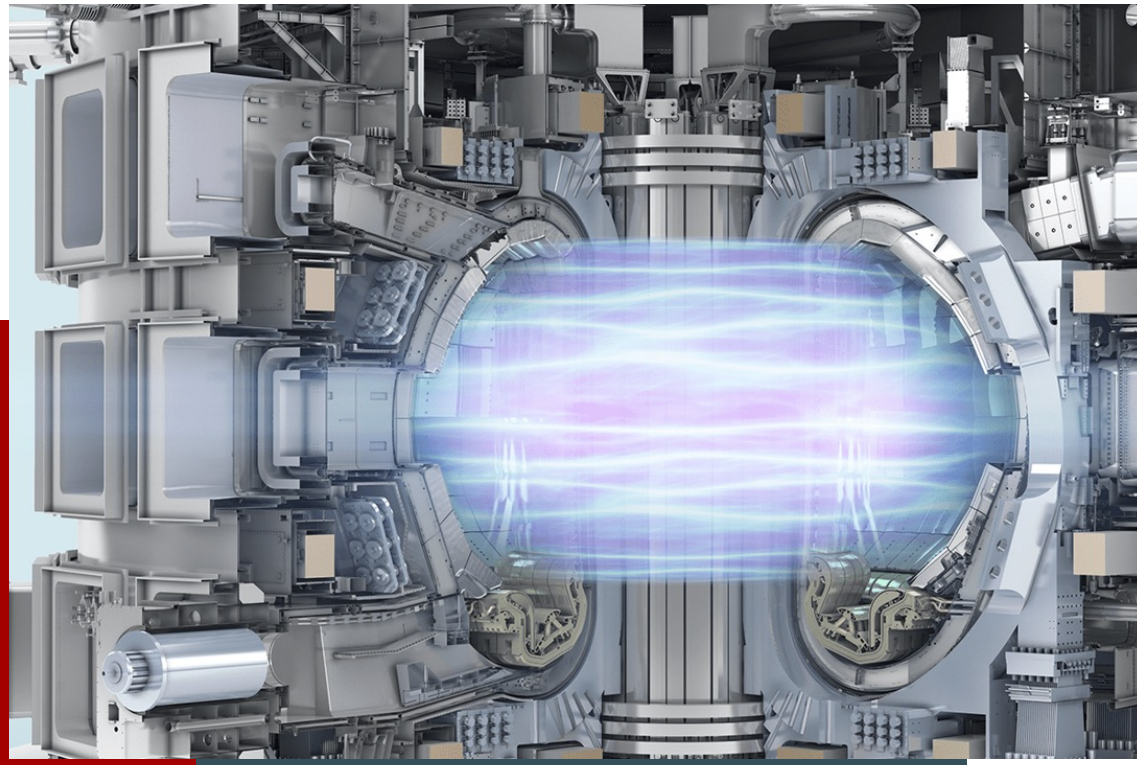

Module: Market analyses

The innovation procurement challenge

Knowing What Exists vs. What Needs Development

- **The core question:** Can the market already solve your problem?
- **Market maturity determines procurement approach:**
  - Solution ready (TRL 7-9) → Public Procurement of Innovation (PPI)
  - Needs R&D (TRL 4-6) → Pre-Commercial Procurement (PCP) or Innovation partnership
- **Without market analysis:** You choose the wrong instrument, waste resources, face legal challenges
- **With market analysis:** Informed decisions, better specifications, competitive bids

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What is SOTA?

- The SOTA (prior art analysis + IPR search) **identifies products, services, standards, patents, and publications** to define the TRL of relevant solutions.

- Once the needs of the public procurers have been identified, a SOTA Analysis should be conducted to confirm whether the **identified need(s) are indeed "unmet" needs.**

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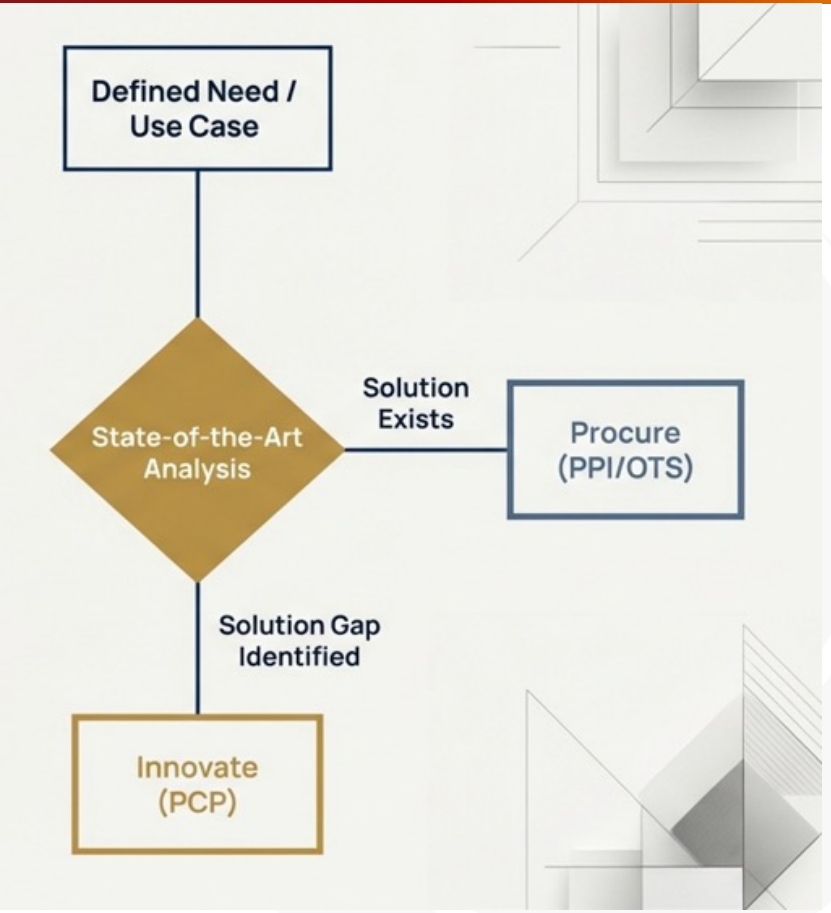
Why SOTA Analysis is a cornerstone

- If the solutions exists, there is no need to spend our money and effort to reinvent the wheel
- It determines whether a viable solution already exists in the market.
- This single process dictates the project's entire procurement path: either we buy an existing solution efficiently, or we invest in developing a new one.



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Two pillars of Market Intelligence

SOTA is a synthesis of two distinct but complementary activities that provide a complete view of the market

Prior art Analysis

A systematic search of the public domain to discover what is already available or in development.

- Existing products
- Ongoing product developments
- Services
- Academic publications

IPR Search

A targeted search of national and international patent databases to understand the intellectual property landscape.

- Identify key R&D players
- Avoid infringing on existing patents
- Understand who owns the foundational technologies in a given field

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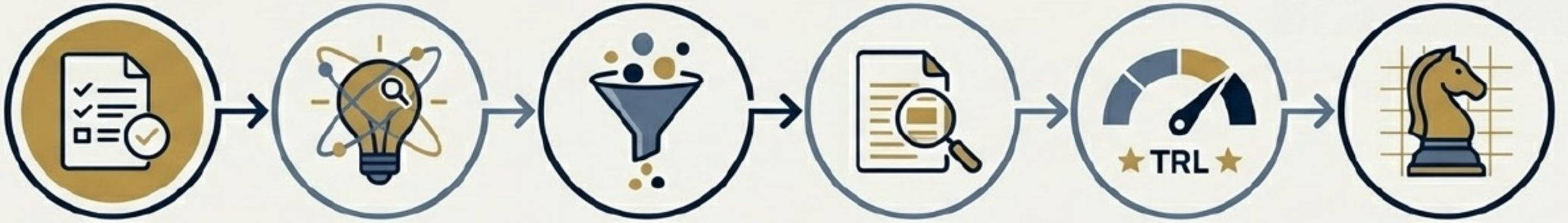

1 Define Needs

Start with clearly defined Use Cases and requirements.

2 Develop Keywords

Brainstorm and refine a comprehensive set of search terms with domain experts.

3 Search & Filter

Systematically scan patent and publication databases (e.g., using the IPlytics platform) with the defined keywords.

4 Analyze & Shortlist

Review abstracts to narrow down thousands of initial results to a manageable number of highly relevant patents and publications.

5 Assess TRL

Collaborate with domain experts to assess the Technology Readiness Level (TRL) of the shortlisted solutions.

6 Interpret & Strategize

Analyze the findings to determine the market landscape and define the optimal procurement strategy.

What the Data Tells Us: Three Scenarios for Strategic Action

Scenario 1: All Needs Met	Scenario 2: Some Needs Met	Scenario 3: No Needs Met
A solution (or combination of solutions) exists that fully addresses the defined need.	Existing technologies address some, but not all, of the core needs. There is a clear innovation gap.	The analysis reveals no existing patents or products that address the core need. This is “white space.”
Strategic Action: Procure. This could be an COTS solution from one supplier or a PPI to integrate multiple existing technologies.	**Strategic Action:** Innovate via Pre-Commercial Procurement (PCP) targeting mid-range TRLs (e.g., TRL 5-6).	**Strategic Action:** Innovate via Pre-Commercial Procurement (PCP) targeting early-stage R&D (e.g., TRL 3-4).
Risk: Low (for COTS), but watch for vendor lock-in. High (for PPI), due to the complexity of integrating solutions from multiple patent holders.	**Risk:** Moderate. Requires R&D to bridge the gap between existing components and the desired final solution.	**Risk**: Low. Because there are no incumbent patent holders, the risk of infringement is minimal, offering maximum freedom to innovate.

Key Takeaways – Market Analysis

✅ **SOTA analysis is your evidence base** — it proves whether existing solutions can meet the need
✅ **Look beyond your usual suppliers** — cross-sector and cross-border search reveals hidden capabilities
✅ **Map the maturity landscape** — distinguish between ready-to-buy solutions and those requiring R&D
✅ **Identify gaps** — the gap between what exists and what you need is the justification for innovation procurement
✅ **Keep it updated** — markets evolve; a static analysis loses value quickly

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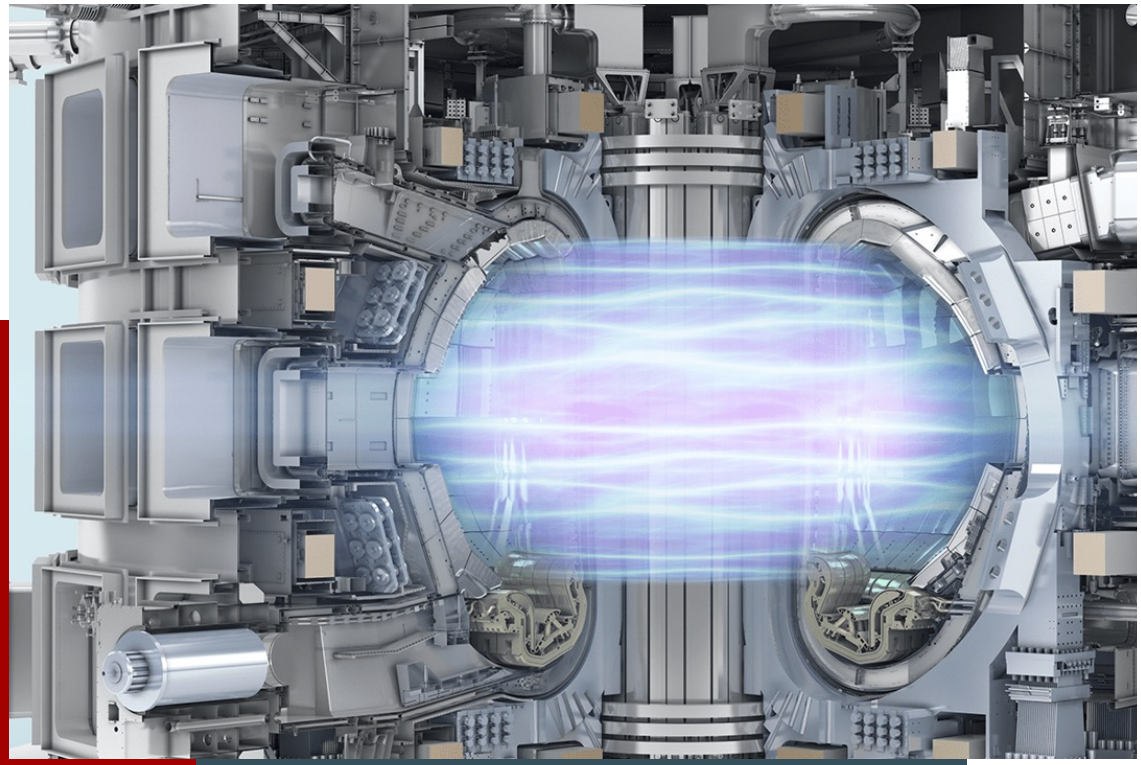

Module: Open Market Consultation

Open Market Consultation

Formalised dialogue between the contracting authority and other entities (economic operators, suppliers or independent experts), aiming to obtain answers to how the contracting authority's problems can be solved

What is Open Market Consultation ?

Definition & context

- A **structured dialogue** between a contracting authority and the market **before** launching a procurement procedure
- Allows the procurer to gather intelligence on available solutions, capacities, and pricing
- Not a procurement procedure itself — it is a **preparatory step**
- Applicable to all types of procurement, but **especially valuable** for innovation procurement where requirements are uncertain

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OMC fundamentals

- **OMC ≠ tender:**
  - Consultation is pre-procurement, non-binding, exploratory
- **When to conduct:**
  - After State of the art Analysis, before finalizing tender documents
- **Typical timeline:**
  - 6-12 weeks from announcement to completed analysis
- **Who is responsible?:**
  - Depends on the organisational structure of organisation:
    - in some technical department (responsible for pre-procurement, for example of XFEL)
    - In some procurement team

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Purpose and Benefits of OMC

Benefit	What it means in practice
Validate market capabilities	Confirm that solutions exist (usual PP) or there are not solutions that can adress all needs (Innovation procurement)
Refine technical specifications	Avoid over-specification or under-specification by learning what the market can deliver
Build market awareness	Signal upcoming opportunities early → more competitive tenders
Identify innovative solutions	Discover approaches the procurer did not know about
Assess supplier interest & capacity	is a sufficient supplier base for competition?

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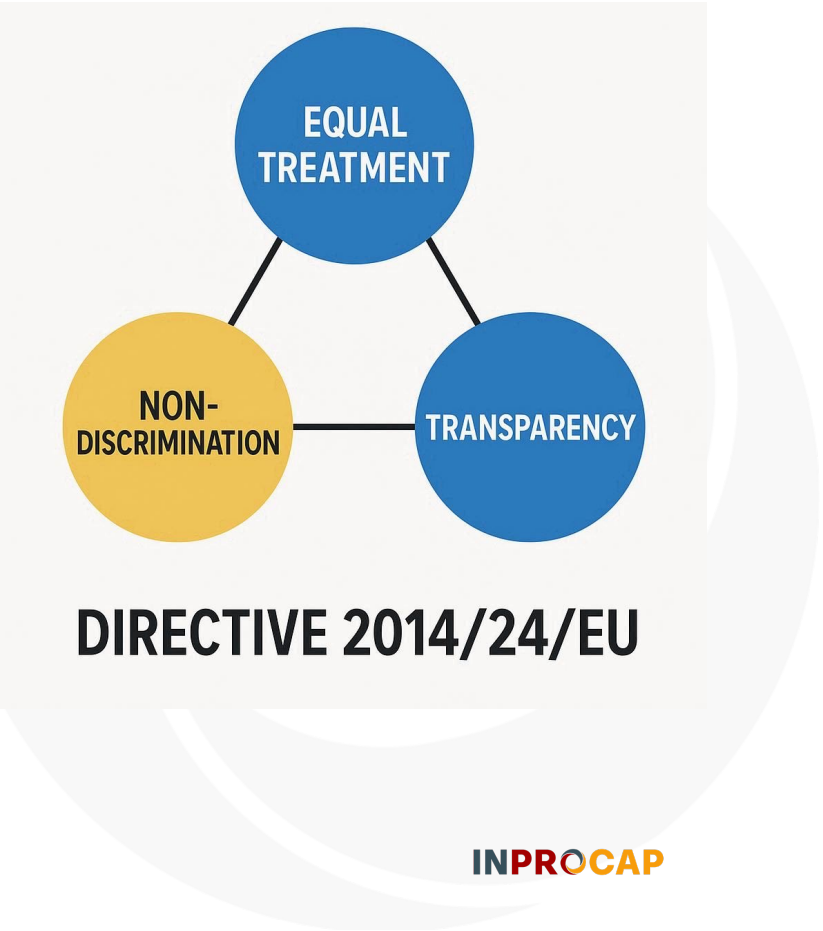
Basic principles

When organising a Open Market Consultation what should always be kept in mind is **that the process must comply with the principles of equal treatment, non-discrimination and transparency stated in the directive 2014/24/EU.**



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OMC Formats and Methods

Traditional formats:

Physical meetings: In-person sessions at your facility

- Pros: Best for technical discussions, relationship building
- Cons: Limited geographic reach, expensive, time-consuming

Site visits: Suppliers see operational environment

- Pros: Suppliers understand context better, better proposals
- Cons: Security/confidentiality concerns for BSOs

Digital formats (increasingly common):

Online webinars: Presentation + Q&A

- Pros: Broad reach, cost-effective, easy to record
- Cons: Less personal, technical difficulties

Questionnaires/surveys: Structured data collection

- Pros: Standardized responses, easy to analyze, documented
- Cons: Low response rates, limited dep

Innovative formats:

- **Prototype demonstrations:** Suppliers show working solutions
- **Hackathons:** Competitive problem-solving events
- **Innovation challenges:** Prize-based idea competitions
- **E-pitching sessions:** Suppliers pitch solutions (5-10 min each)
- **Hybrid approaches:** Combine multiple formats for best results

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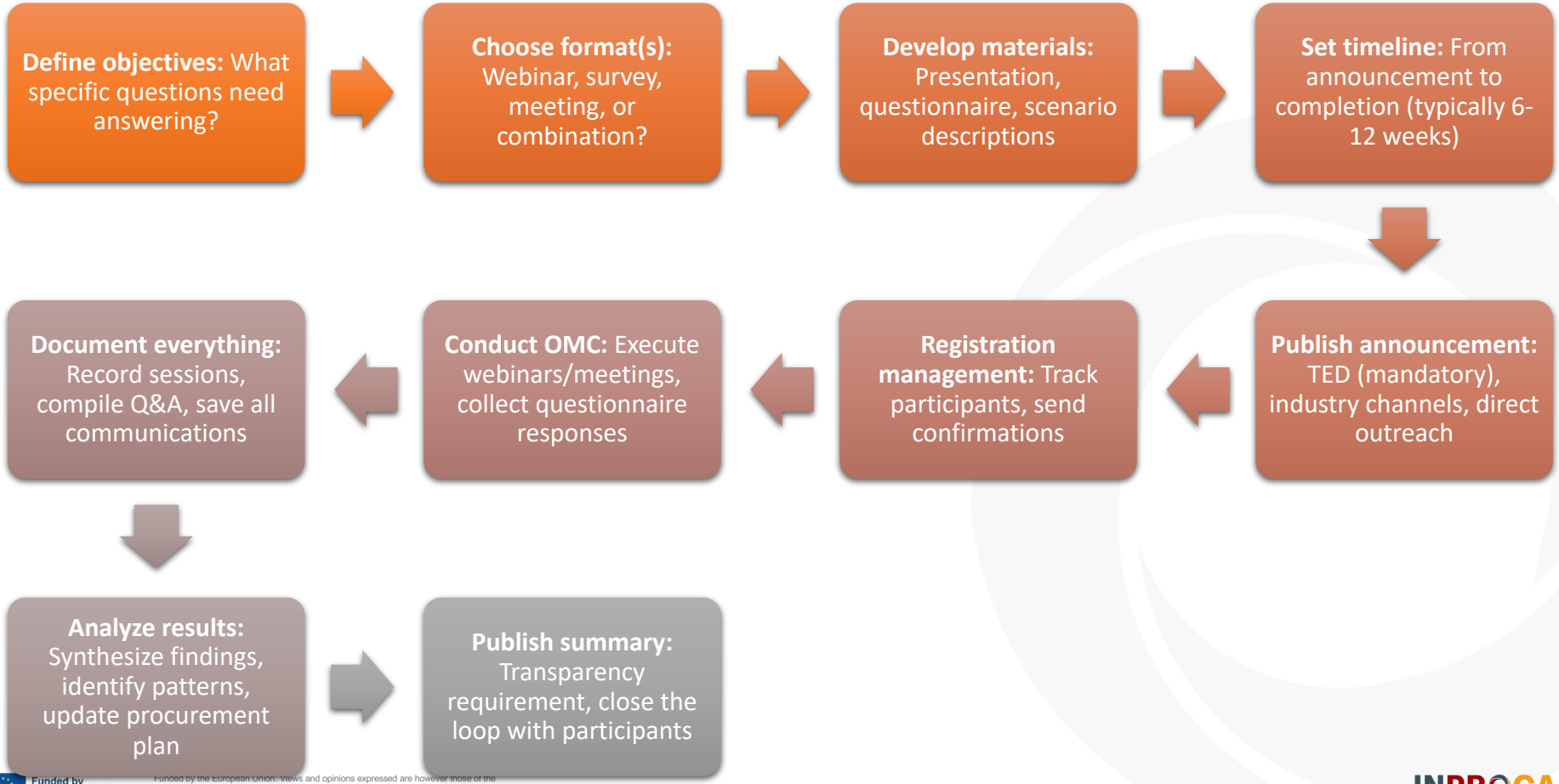
10 step process



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Planning

- ❑ **Timing:** Start early — ideally 6 months before the expected tender publication
- ❑ **Objectives:** What do you need to learn from the market?
  - ❑ Technical feasibility?
  - ❑ Cost benchmarks?
  - ❑ Potential supplier pool size?
- ❑ **Target audience:** Who should participate?
  - ❑ Established suppliers in the sector
  - ❑ Innovative SMEs and start-ups
  - ❑ Industry associations and clusters
  - ❑ Academic and research institutions
- ❑ **Internal alignment:** Ensure procurement, technical, and legal teams agree on scope and approach

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Preparing right questions

The quality of your OMC depends on the quality of your questions. Design a **structured question set** that covers your key knowledge gaps.

Key questions to ask

- ❑ **Company Details**: The basic information (company name, location, email, etc.) to understand the demographic and geographic distribution of respondents.
- ❑ **PCP Challenge and Requirements**: The questions that probe the market's familiarity with the challenge, current solutions, and potential innovations they can offer.
- ❑ **Technical feasibility** — Can your solution meet [requirement]? What is the TRL? What are the main risks?
- ❑ **Market maturity (SOTA)** — How many comparable solutions exist? What differentiates yours?
- ❑ **Timeline & capacity** — Realistic delivery timeline? Can you deliver?
- ❑ **Miscellaneous**: Allows open-ended responses for suggestions, concerns, or alternative proposals.

Tip: Send questions in advance — give suppliers **at least 2 weeks** to prepare. Combine a written questionnaire (RFI) with follow-up workshops.

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Execution

- **Facilitation tips:**
  - Use a structured agenda with clear questions
  - Allow enough time for suppliers to prepare (minimum 2–4 weeks notice)
  - Use 1-to-1 meetings for sensitive topics, group sessions for general market intelligence
- **Documentation:**
  - Record all interactions (minutes, recordings with consent)
  - Use standardised templates for consistency
  - Note both explicit answers and implicit signals
- **Engagement:**
  - Publish a Prior Information Notice (PIN) on TED / national portals
  - Use ILOs, industry networks, clusters, and BSO supplier databases
  - Be proactive — reach out, don't just publish and wait

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Analysis and Report

- **Identify patterns:**
  - What did most suppliers agree on? Where did they diverge? What surprised you?
- **Validate assumptions:**
  - Were your initial requirements realistic? Does the market offer alternatives you hadn't considered?
- **Document conclusions** in OMC report
  - Findings, recommendations, and their link to procurement strategy
  - Publish the OMC report, not include sensitive information

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Key Takeaways – Open Market consultation

Key Takeaways — Open Market Consultation

✅ **OMC is a strategic tool, not a formality** — it shapes your procurement strategy

✅ **Choose the right format for your goal** — RFIs for broad scoping, one-to-one meetings for depth, industry days for awareness, hybrid onsite/online workshops

✅ **Ask specific, well-structured questions** — vague questions yield unusable answers

✅ **Equal treatment is non-negotiable** — all potential suppliers must receive the same information

✅ **Use OMC outputs as evidence** — feed findings directly into your business case

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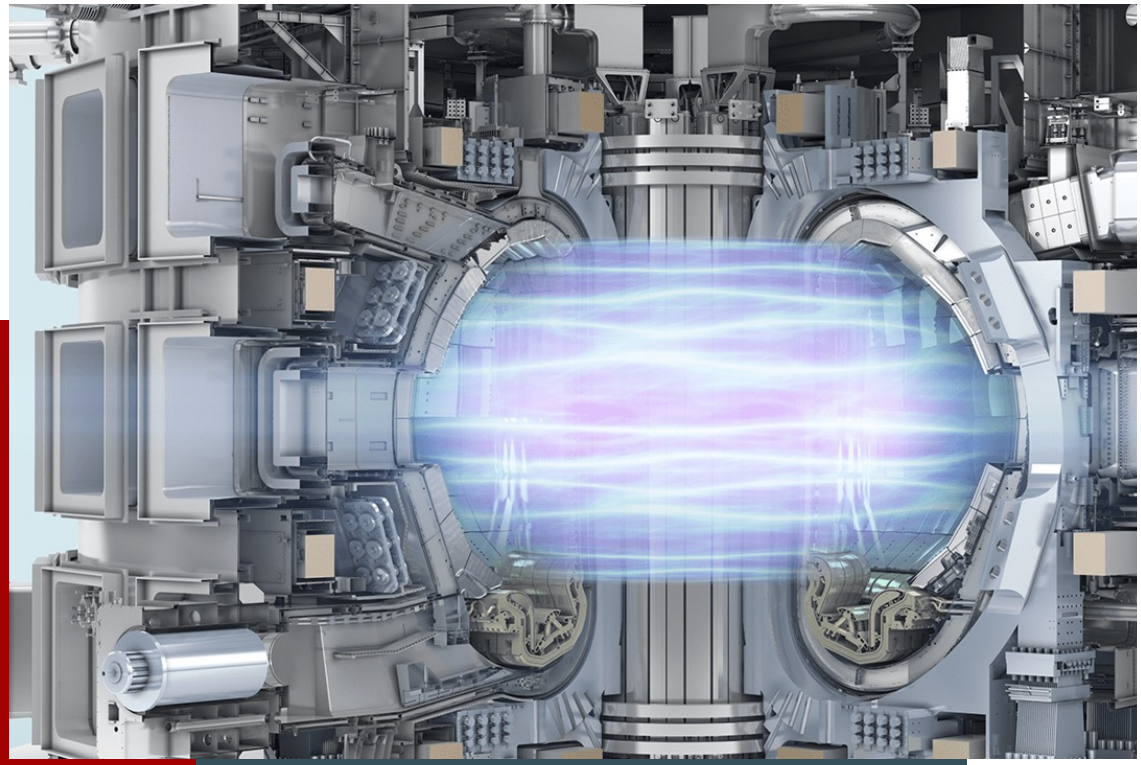

OMC: Exercise

Based on real challenges from the Lund AIMday Big Science Technology event

OMC exercise

Each group receives one challenge scenario.

Online:

- Group 1 – Scenario A
- Group 2 – Scenario B
- Group 3 – Scenario C

Onsite:

- Group 4 – Scenario D
- Group 5 – Scenario E
- Group 6 – Scenario F

Your task is to design a complete **Open Market Consultation (OMC) strategy** for your assigned case:

1. **Objectives** — What specific questions do you need the market to answer?
2. **Format** — Which OMC method(s) would you use? *(online/physical meetings, questionnaire, demos, etc.)*
3. **Timeline** — When would you conduct the OMC in your procurement timeline?
4. **Key Questions** — Draft **3–5 critical questions** to ask potential suppliers
5. **Risk Mitigation** — How will you ensure equal treatment and avoid conflicts of interest?

⏱️ **Time: 15 minutes for group work - 3 minutes per group for presentation**

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OMC Exercise

- **Only one member from group fill in the handout in google forms**

- **When filling out the form:**
  - **Scan QR code**
  - **Write your group number**
  - **Choose the given scenario from drop down menu**
  - **Fill in questions**
  - Only **one submission per group** — the coordinator submits on behalf of the team

- **Coordinator submits** the Google Form

- **Prepare a short presentation** (3 min) covering:
  - Your chosen OMC format and **why**
  - Your **top 3 questions** for suppliers
  - How you handle **equal treatment**

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INPROCAP

Scenarios

Scenario	A: AI-Enhanced Quality Assurance	B: Cost-Efficient Antenna Panel Production	C: Scalable Time-of-Flight Detection System
BSO	European Spallation Source (ESS)	European Southern Observatory (ESO)	FAIR/GSI
Context	ESS is transitioning its Integrated Management System (IMS) from the project phase to long-term operations. Quality assurance documentation must be easily searchable, accurate, and consistently applied across projects and departments. Current systems lack intelligent search, cross-referencing, and document consistency checking capabilities.	Sub-millimetre radio telescopes like ALMA require parabolic reflector antennas with extreme surface accuracy (RMS deviation < 5–10% of operating wavelength). Future upgrades (ALMA2040) require at least a 3-fold increase in total antenna collecting area (~6,500 m² currently), making cost-effective antenna design and manufacturing critical.	The FAIR facility needs a Time-of-Flight (ToF) system for large apertures (40 cm diameter) at beam intensities too high for conventional scintillator-based detectors. Other accelerator facilities face similar challenges, creating significant market potential for a reliable and scalable solution.
Requirement	An AI-based solution that can perform qualitative document reviews, assess consequences of document changes in a large document structure, identify compliance gaps by comparing internal processes to regulatory frameworks, and support role-based task management. The solution must integrate with existing documentation systems.	Novel antenna design and manufacturing concepts that reduce normalised production costs to substantially less than 25% of current ALMA antenna costs (~120 k€ per effective m² at 3 mm wavelength). Target total collecting area: 20,000 m². Primary reflector diameter range: 10–30 m. Solutions may include off-set parabolic configurations, additive manufacturing, or 3D metal printing of precision panels.	A commercially viable Cherenkov-based ToF detector system with large aperture capability, suitable for high-intensity beams. The system should include a mechanism for constant liquid exchange in the radiator material. Manufacturing methods and materials must enable commercial production at scale.
Challenge	The transition from project to operations involves challenges in documentation, role assignments, and regulatory compliance. No off-the-shelf AI tools are optimised for the specific context of a large research facility's quality management system. The solution must handle scientific, technical, and administrative documentation simultaneously.	Current production methods (CNC milling) are expensive and generate significant waste. The required surface precision is extreme, and scaling production while reducing costs demands fundamentally new manufacturing approaches. Drive system costs must be factored in to find the optimal reflector diameter.	Existing prototypes (tested at GSI) demonstrate feasibility but are not production-ready. No commercial supplier currently offers such a system. The transition from laboratory prototype to commercially manufacturable product requires identifying the right technologies, materials, and value chain partners.

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Scenarios 2

Scenario	D: PFAS-Free Cooling System Transition	E: Data-Driven Legionella Treatment in Cooling Towers	F: arge-Scale Carbon Fibre Vacuum Chambers for Neutron Experiments
BSO	FAIR/GSI	CERN	European Spallation Source (ESS)
Context	Upcoming EU regulations on PFAS and F-gases will restrict or ban many refrigerants currently in use. FAIR and GSI's complex infrastructure relies on large-scale, highly reliable cooling systems where the choice of refrigerant has major implications for system design. Replacing refrigerants later is difficult and costly.	CERN operates water-based cooling systems at 40–55 °C — a temperature range optimal for recovering waste heat but also favourable for Legionella growth. Current treatment relies on chemical biocides and is not data-driven, leaving room for optimisation in terms of reducing unnecessary maintenance stops, chemical usage, and environmental impact.	The HIBEAM/NNBAR experiment at ESS requires a 200 m long high-vacuum chamber with a 2 m diameter experimental section. Traditionally, beryllium is used for such chambers due to its low atomic mass and high particle transparency, but it is toxic, expensive, and difficult to machine — with no willing local suppliers.
Requirement	A comprehensive risk assessment of existing and planned installations, evaluation of PFAS-free and low-GWP refrigerant alternatives, and a strategic roadmap combining regulatory compliance, sustainability (including waste heat recovery and energy optimisation), and operational reliability. Solutions must be scalable across multiple cooling systems.	A measurement system and ecological population model to enable adaptive, AI-based Legionella treatment strategy. The solution should predict Legionella risk, optimise chemical dosing based on actual conditions, and reduce both costs and environmental impact while ensuring safe operation at flow rates exceeding 150 m^3/h — entirely without chemical additives if possible.	A large-scale vacuum chamber (2 m diameter, 6 m length experimental section) manufactured from carbon or carbon fibre composites, compatible with ultra-high vacuum (UHV) conditions. The solution must ensure structural integrity, vacuum tightness, and minimal wall thickness while maintaining performance. Vacuum-compatible coatings or surface treatments must be applicable without traditional baking methods.
Challenge	Different refrigerants require significant changes to system design, making later replacements difficult. The facility must balance regulatory compliance, environmental sustainability, operational reliability, and cost. Knowledge of natural refrigerant-based alternatives for large research infrastructure applications is limited.	Conventional chemical mitigation carries environmental and operational drawbacks. No existing commercial system combines real-time monitoring, predictive modelling, and adaptive dosing for Legionella control in large-scale research infrastructure cooling towers. Technologies of interest (UV-LED, ultrasonic, antimicrobial surfaces, hydrodynamic cavitation) have not been validated at this scale.	Manufacturing carbon fibre structures at this scale that meet UHV requirements is unproven. Key unknowns include outgassing behaviour of composite materials, scalable joining techniques for UHV applications, and surface treatment compatibility. No commercial supplier currently offers such a product for particle physics applications.

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OMC Exercise

Group presentations and discussion:

- Each group presents 3 minutes summary

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THANK YOU

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