

Fusion Knowledge Management Workshop

Strength of communities for knowledge capture and transfer

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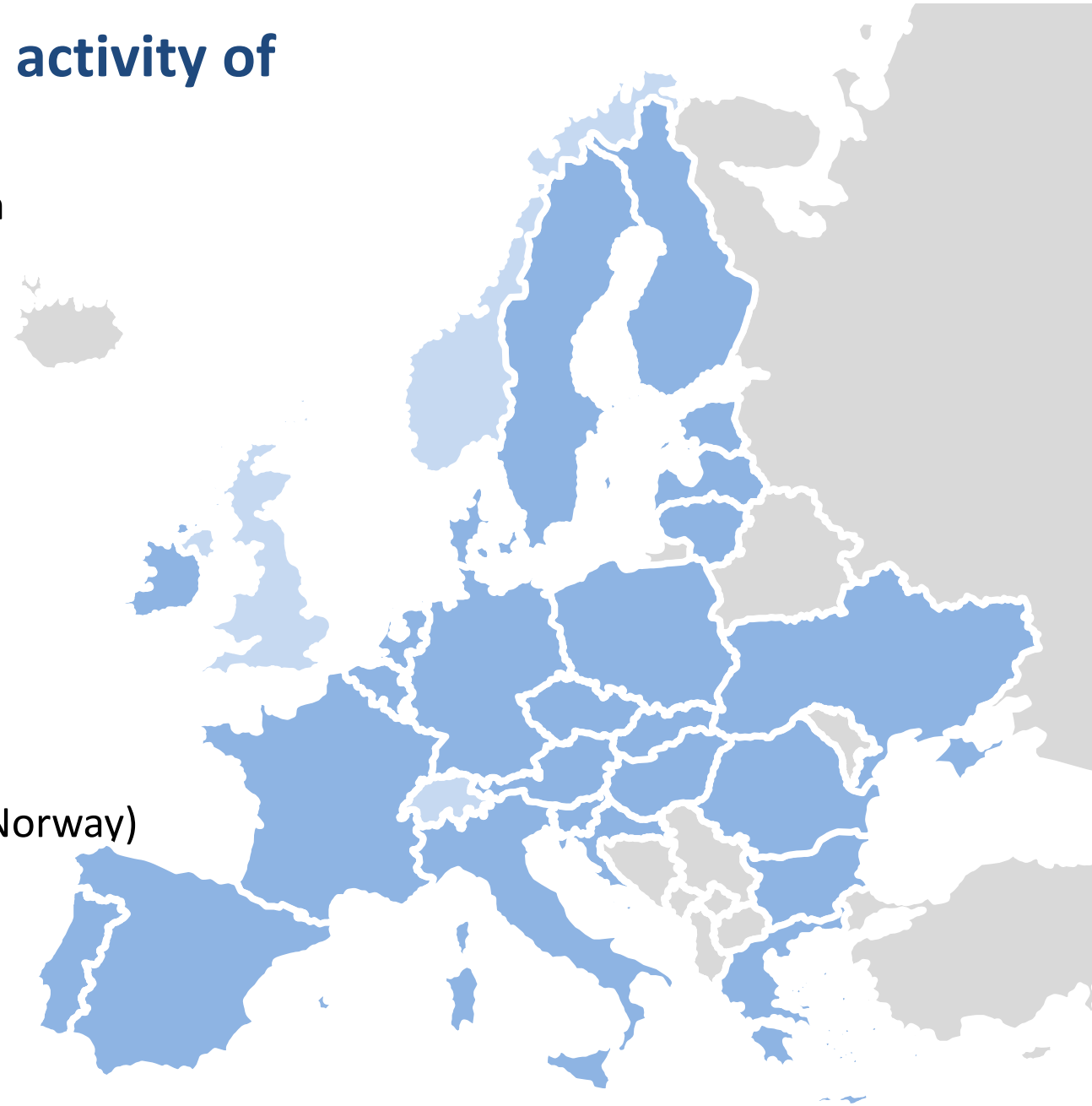
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Knowledge management is a core activity of the EUROfusion Consortium

EUROfusion coordinates Research & Development in nuclear fusion in Europe funded by the European Commission.

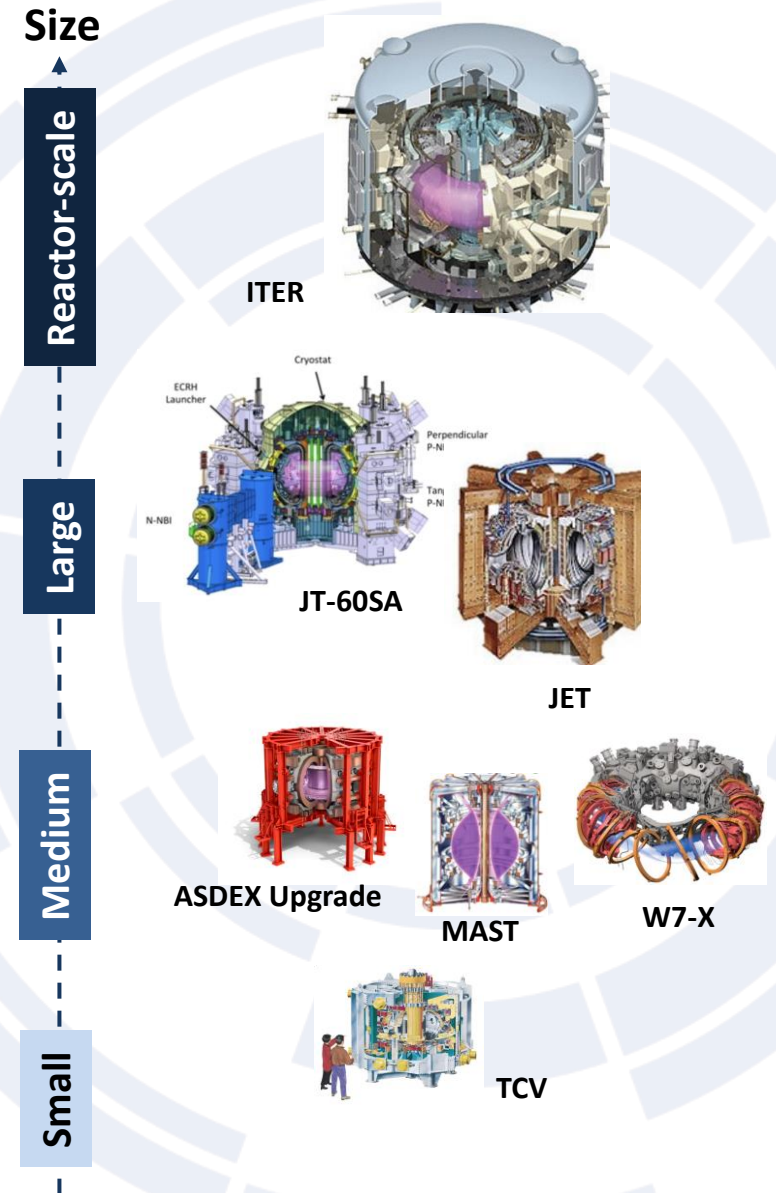
- 26 + 3** Countries
- 28** Research Institutes (members)
- 168** Affiliated entities (universities, laboratories)
- 3** Associated partners (UK, Switzerland, Norway)
- 1000+** MSc and PhD students
- 4000+** Fusion scientists, engineers and support staff





Challenges

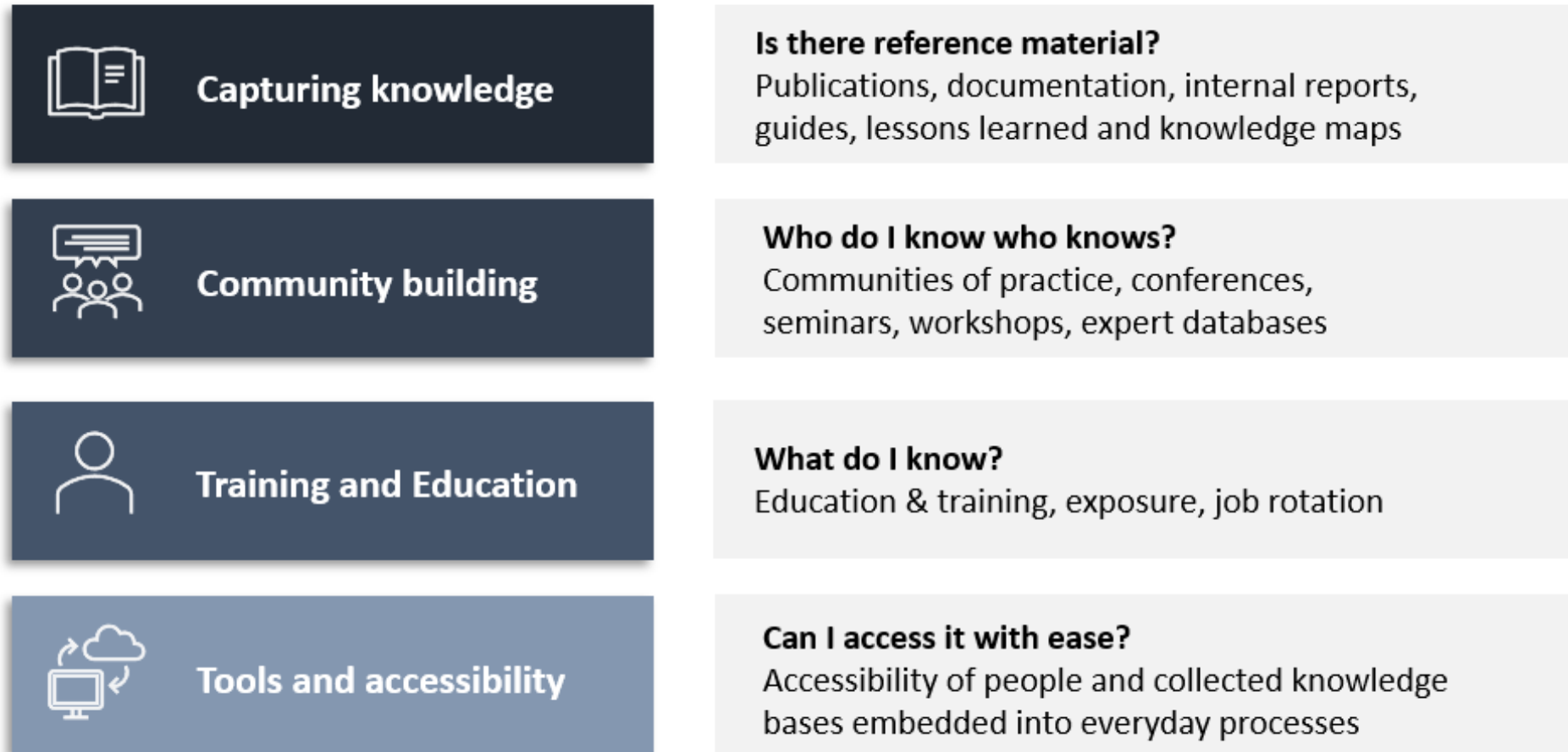
- **Distributed teams** across Europe, strong international collaborations, retiring experts, JET legacy
- **Multi-cultural** international projects with in-kind contributions, transfer knowledge to new project & Japan
- **Nonlinear rise of complexity of operations with the size** of the device
- **Long time scales (decades)** leading to generational gap between design, construction and operation.
- **Commercialisation** of fusion research requires training more early and mid-career experts, higher movement between institutes, private sector and industry
- Culture change from academic research to industry





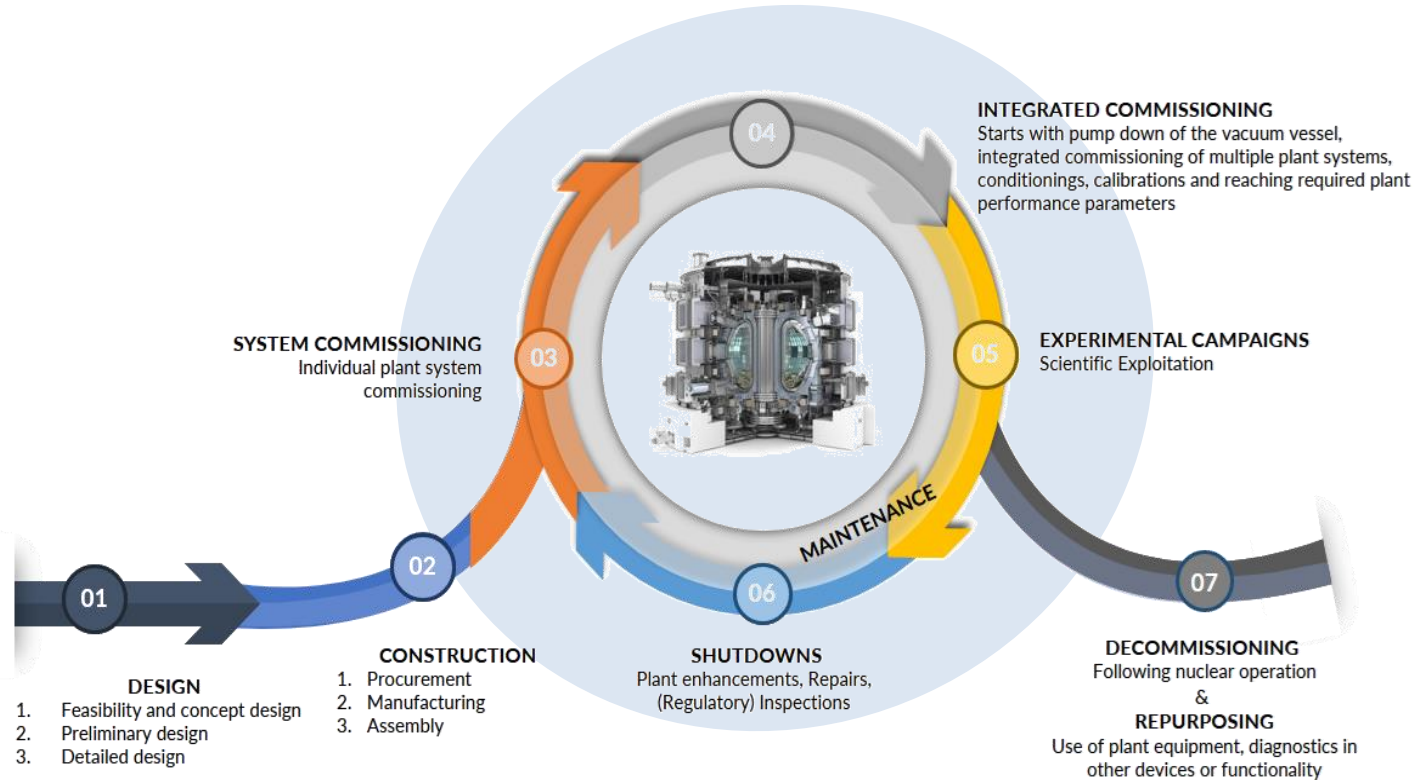
The EUROfusion Knowledge Management Framework

THE EUROFUSION KNOWLEDGE MANAGEMENT MODEL





Need more focus on operations



Delays due to commissioning and operations can take weeks, months to years to recover.

- Sharing experience & lessons learned, training can reduce operational delays and training times.

ITER started system commissioning of its first plant systems.

Operational complexity of devices increases with their size.

- JET: ~50 roles with ~500 staff.
- Training: few months to a year, some roles take 4-10 years.
- Training is often on the job, shadowing an experienced operator.



Capturing knowledge

- **ITER Engineering Design Handbook** - project launched this year in collaboration with ITER to capture design decisions and engineering considerations.
 - **Textbook on tokamak operations** – follows the joint operations course, in collaboration with IAEA.
 - **Publication on Operations** – Since 2021, we have a special issue in PPCF focusing on capturing commissioning and operational experience.
 - **MSc and PhD thesis repository** on our publication pinboard.
- + Individual capture of engineering and operational information at the laboratories (JET, MAST-U, ...)

High level overview

1. PREFACE
2. ACKNOWLEDGEMENTS
3. INTRODUCTION
4. TECHNICAL CHALLENGES IN FUSION AND THE ROLE OF ITER
5. ITER CHRONOLOGICAL HISTORY
6. PROJECT GENESIS & EVOLUTION (1983-2021)
7. ITER DESIGN EVOLUTION & TECHNOLOGY MATURATION
8. THE MAKING OF ITER
9. THE ANATOMY OF THE ITER PLANT
10. KEY LESSONS LEARNED SO FAR
11. WHAT COMES NEXT?
12. LOOKING BEYOND ITER
13. CONCLUSIONS
14. APPENDICES
15. GLOSSARY AND ABBREVIATIONS
16. BIBLIOGRAPHY



Fusion Education and Learning Hub – make fusion education globally accessible

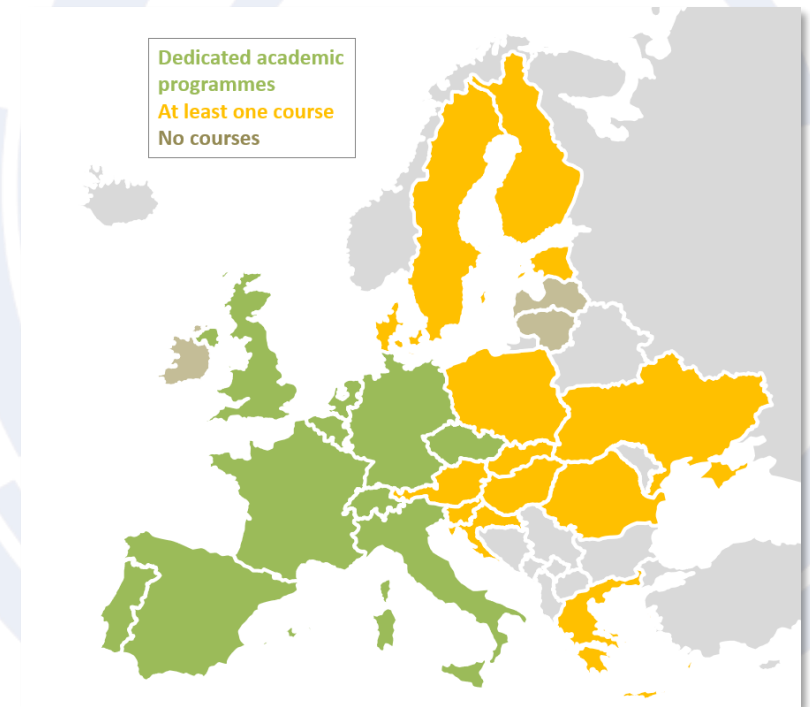
Annual education programme surveys indicate the lack of availability of courses dedicated to fusion across Europe.

1. Make fusion education and training available and accessible across Europe and worldwide to students, new starters & as continuous education for current staff.
2. Provide comprehensive fusion curriculum, a wide range & variety of topics from introductory to advanced level.



The **Fusion Education and Learning Hub (FuEL)** will host a comprehensive curriculum of online university courses and training material widely accessible across Europe and worldwide.

- Recorded university and training courses
- Massive online learning style courses (MOOCs)
- Live online academic lectures
- Database of practical exercises, (Capstone) projects with solutions
- Development of new courses in scarce and important competency areas.

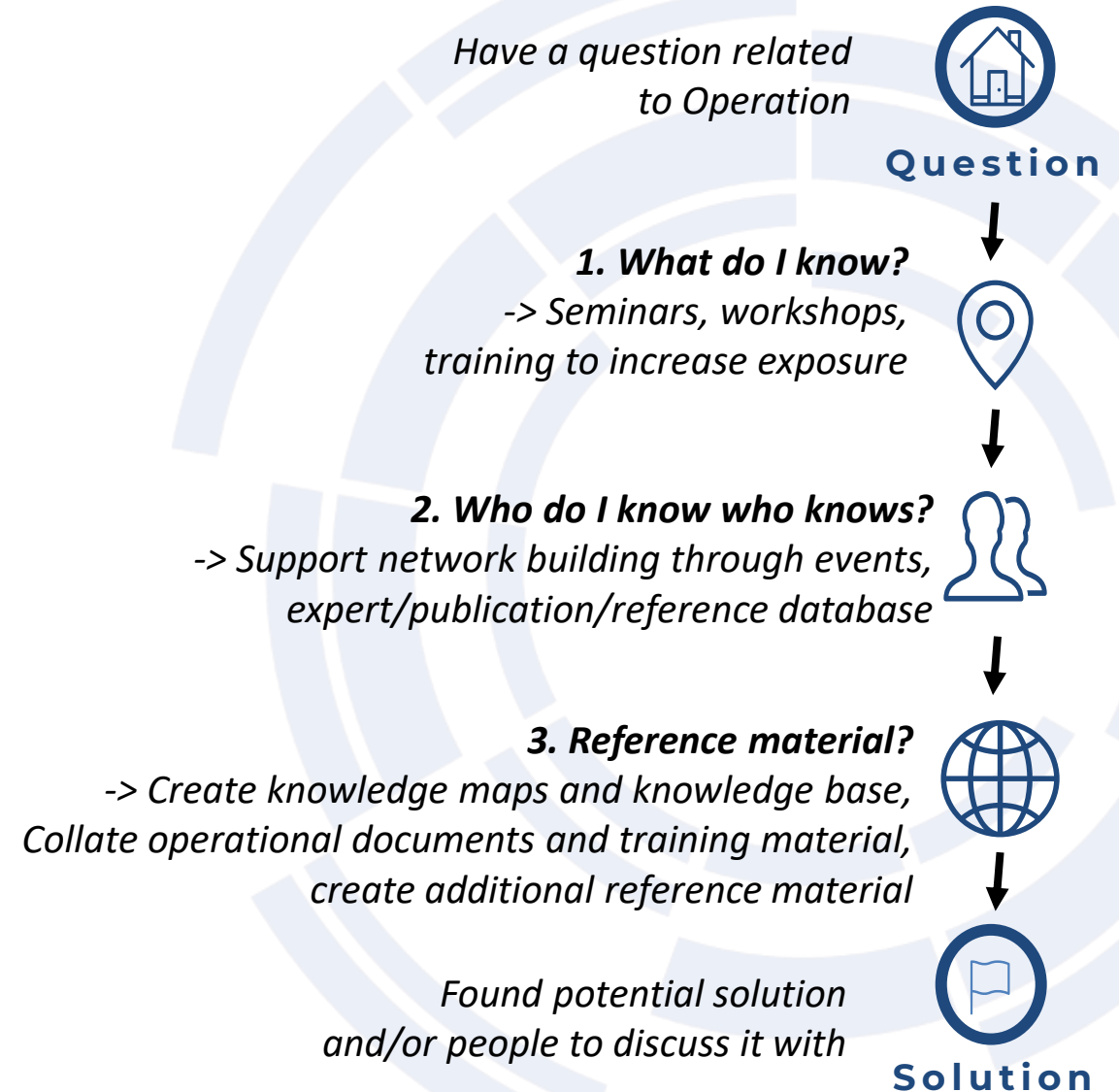




Communities - EUROfusion Operations Network

The [EUROfusion Operations Network \(EON\)](#) organizes **workshops, seminars and training on dedicated operational topics** open to all EUROfusion (and Broader Approach) experts:

- facilitate stronger connection between the operational teams to share operational experience
- develop joint understanding and identify best practices based on multi-machine experience
- improve commissioning, fault identification and resolution, operational reliability and performance
- identify opportunities for joint studies.
- support development and training of operators
- create a joint knowledge base encouraging recording/publication of experience and know-how.
- contribute to the EUROfusion preparation for the (integrated) commissioning and operation of ITER.





Pilot communities of practice

Two communities of practice focusing on heating systems to learn, consult, collaborate, support recruitment ...

- **Run by the community:** 10-20 teams across Europe + guest collaborators. Panel consisting of 1 representative from each team + 2 early career representatives -> organize local teams, define schedule and programme
- **Inclusive:** invite all experts in Europe and Japan (physicists, engineers, technicians, students, ...) + invited external experts (ITER, Fusion for Energy)
- **Relevant:** addresses current problems and questions from existing or future devices
- **Heavily discussion-focused:** 50% discussion time. Focus on practical, tacit knowledge.
- **Flexible:** seminars are recorded for future access
- **Regular:** 2-hour seminars every 1-2 months, 65 - 85 participants
 - **Overview talks** focusing on individual teams
 - Structured discussion on a **dedicated topic** with short presentation from each device (protection systems, conditioning, diagnostics, common issues)
- **Expert list, resource/publication database,**
- **Offers/exchange of spare components,** work with suppliers, joint collaborations
- **Joint European training programme for new operators**



Integrated approach and the strength of communities

EUROfusion Operations Network

P2. Create a community of practice

- Organized through a panel with 1 representative from each European team + early career representatives
- Recorded, regular online seminars open to all European experts
- Focus on current, community needs

P4. Create expert registry and knowledge base

- List of experts with their competence, interest and contact
- List of publications, internal reports, commissioning/operational procedures

P3. Training courses

- Develop training courses based on the joint experience

P1. Capture knowledge into written form and videos

- Publish on commissioning/operational experience – lessons learned, best practices, improve physics/engineering understanding
- Video capture of processes and practices
- Manuals and textbook

P4. Tools to make access to knowledge base easier

- Develop AI-enhanced tools to embed knowledge base into everyday processes and training.



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Reports:

Download our reports at <https://euro-fusion.org/eurofusion/roadmap/> or pick-up hardcopies of the following reports in Garching:

- **European Research Roadmap to the Realisation of Fusion Energy**
- **EUROfusion Human Resource Survey and Workforce Development Report**
- **EUROfusion Knowledge Management Strategy**

