



The European Nuclear Education Network - ENEN

The nuclear education in the regional and European context

BNS Evening Lecture 25th of April 2024: ENEN - The nuclear education in the regional and European context

Gabriel-Lazaro PAVEL

Executive Director

About ENEN

International non-profit association

STATUS:

The European Nuclear Education Network, ENEN, is an **international non-profit association** established under the Belgian law*.

HISTORY:

It was **originally established** as a non-profit association under the French Law, based in CEA-Saclay, France, in **2003**.

ENEN implemented an **international legal cross-border** restructuring, transferring its activities to Belgium, in **2018**.

LOCATION:

ENEN has **an office** situated in **Brussels**.

*Public registration: <https://kbopub.economie.fgov.be/kbopub/zoeknummerform.html?lang=en&nummer=0687994274&actionLu=Zoek>

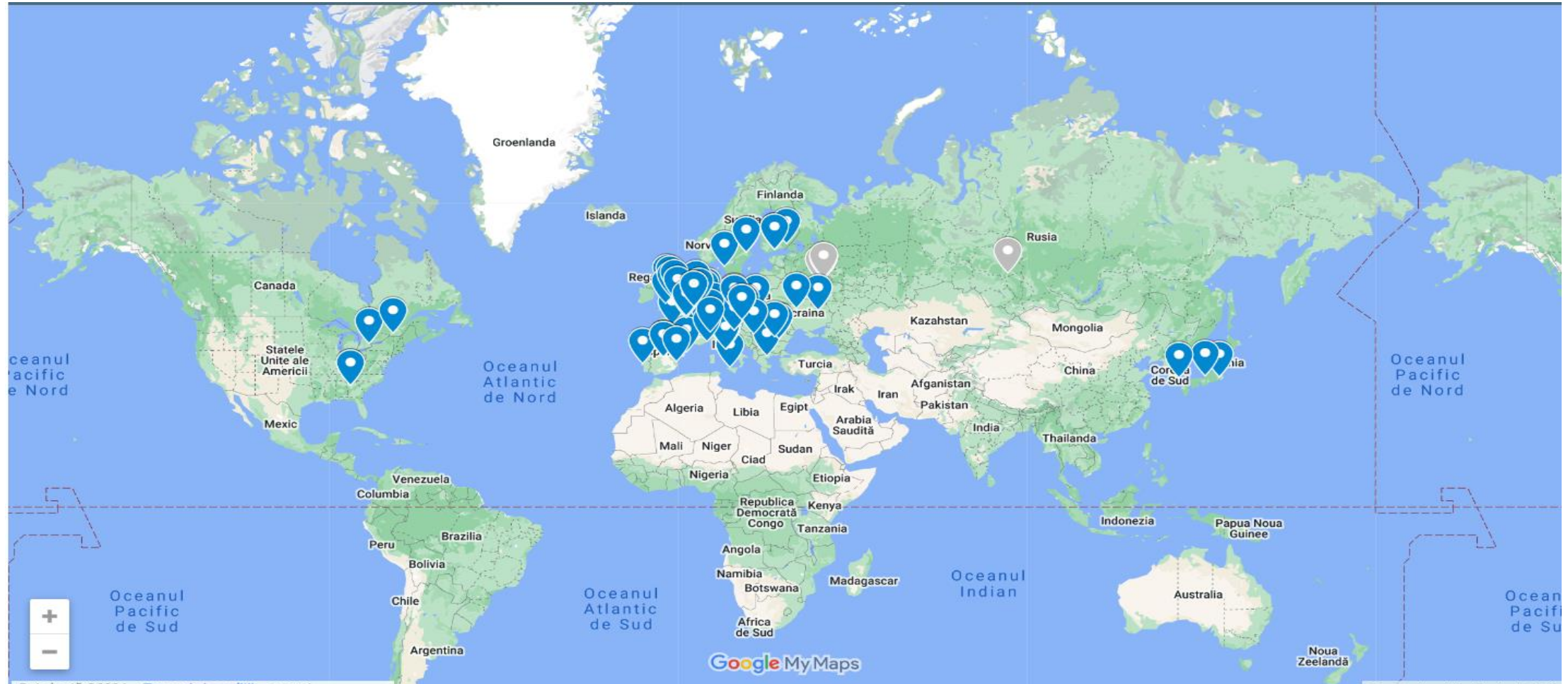
MISSION

The main objective is the **preservation** and further **development** of expertise in the nuclear fields by higher Education & Training:

- Promote and further develop the **collaboration** in nuclear education and training of students, researchers and professionals
- Ensure the **quality** of nuclear education and training
- Increase the **attractiveness** for engagement in the nuclear fields for students, researchers and professionals
- Promote **life-long learning** and career development at post-graduate or equivalent level

ENEN Members in 2024

+90 Members from 25 Countries:



Belgian Members

2	Belgian Nuclear Research Centre	SCK CEN	Mol
3	Ghent University	UG	Ghent
4	Katholieke Universiteit Leuven	KUL	Leuven
5	Université Catholique de Louvain	UCL	Louvain-la-Neuve
6	Université de Liège	ULG	Liege
7	Université Libre de Bruxelles	ULB	Brussels
8	Vrije Universiteit Brussel	VUB	Brussels
9	Westinghouse Electric Company	WEC	Brussels
10	Hasselt University	UHasselt	Hasselt

NB: Belgium is a founding Member of ENEN

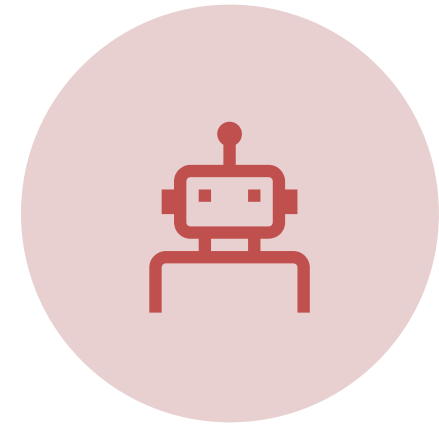
The Belgian Nuclear context



NUCLEAR EDUCATION

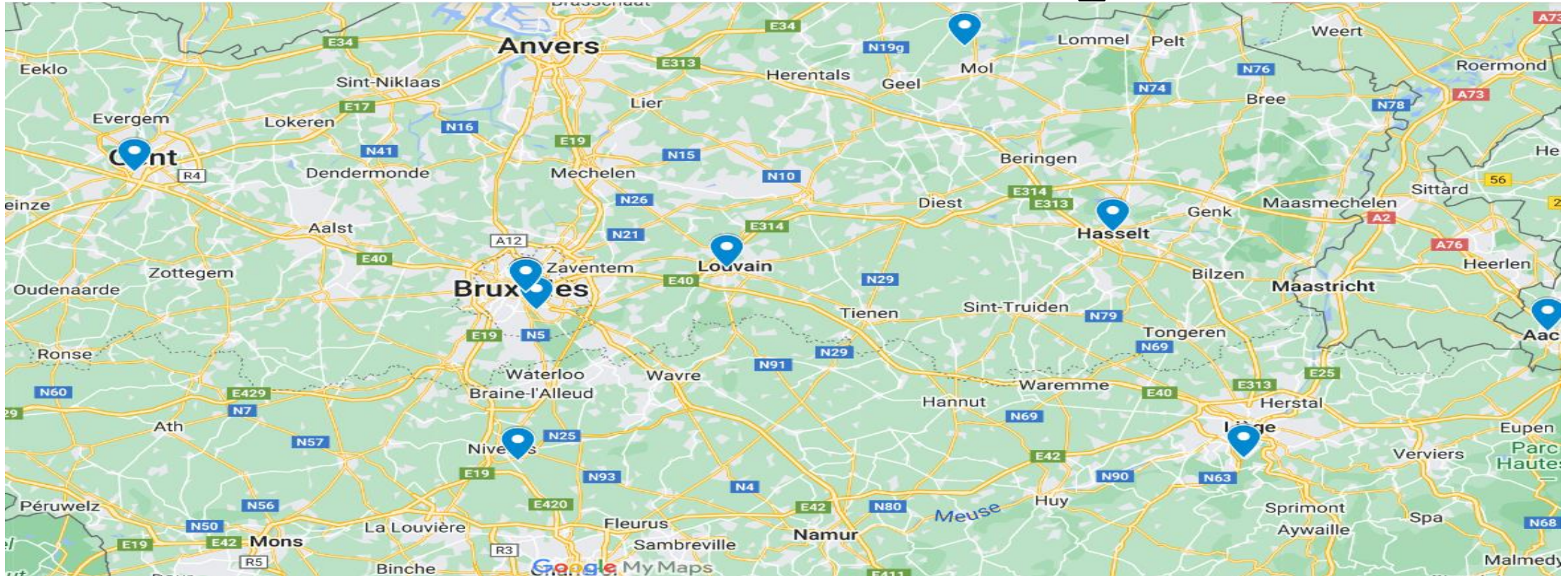


NUCLEAR RESEARCH



NUCLEAR
INDUSTRY/NPPS

Nuclear Education in Belgium



Belgium has a strong tradition of nuclear education, with several universities offering programs in nuclear engineering and related fields.

Belgian nuclear Research

Yesterday

- The SCK CEN at the forefront of Nuclear Research in Belgium and in Europe. Founded in 1952 under the name of Studiecentrum voor de Toepassingen van de Kernenergie (Research Centre for the Applications of Nuclear Energy)
- BR-1(1956R) BR-2(1961R) BR-3 (1962 1st electricity prod. Nucl. R.)

Today

- SMRs;
- MYRRHA;
- E&T Academy;
- HADES;
- Nuclear Materials (att. to medical radioisotopes);
- Advanced Nuclear Systems;
- Radiation protection;
- Space;
- Etc.

Belgian Nuclear Industry/NPPs

Plant name	Unit No.	Type	Model	Status	Capacity (MW)	Begin building	Commercial operation	Closed
SCK•CEN	1	PWR	Westinghouse (WH) BR-3	Decommissioned	10	1 Nov 1957	10 Oct 1962	30 Jun 1987
Tihange	1	PWR	Framatome 3 loops	Operational	962	1 Jun 1970	1 Oct 1975	(2025)
Tihange	3	PWR	Belgian firms plus WH 3 loops	Operational	1046	1 Nov 1978	1 Sep 1985	(2035)
Doel	1	PWR	WH 2 loops	Operational	445	1 Jul 1969	15 Feb 1975	(2025)
Doel	2	PWR	WH 2 loops	Operational	445	1 Sep 1971	1 Dec 1975	(2025)
Doel	4	PWR	Belgian firms plus WH 3 loops	Operational	1039	1 Dec 1978	1 Jul 1985	(2035) ^[13]
Tihange	2	PWR	Framatome 3 loops	Shut down	1008	1 Apr 1976	1 Jun 1983	31 Jan 2023 ^[14]
Doel	3	PWR	Framatome 3 loops	Shut down	1006	1 Jan 1975	1 Oct 1982	23 Sep 2022 ^[12]

Source: Wikipedia

Belgian Nuclear Industry/NPPs

- In late 2020 the Mr. De Croo's Government /coalition agreed the nuclear phase-out by 2025, with a "plan B" option to continue 2GW of capacity if by November 2021;
- After several internal political debates and due to external political situation, in 2022, the plan to replace nuclear with gas-powered facility was postponed;
- In March 2022, Belgium officially decided to postpone closing the two reactors Doel 4 and Tihange 3 by 10 more years
- In January 2023, an agreement was reached and Engie (existing NPP operator) agreed to continue to invest in the existing NPPs and the government would reduce the costs for discontinuation of the other plants and for nuclear waste.

Sources: Wikipedia; www.dw.com; www.iaea.org; www.bnsorg.be; www.world-nuclear.org;

International and regional context

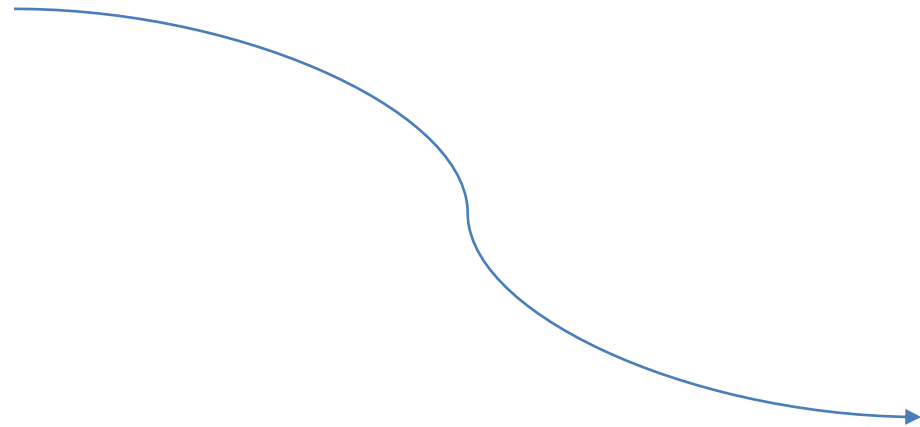
COP 28 (2023): “Nuclear Energy Makes History as Final COP28 Agreement Calls for Faster Deployment” (www.iaea.org): [...] “more than 22 countries to advance the aspirational goal of tripling nuclear power capacity by 2050”[...];

France, 2022. Mr. President Macron issued an ambitious program, to reach net-zero by 2050. The MATCH program showed a huge need for human resource in the coming year. Several strong actions were started and are in place.

Mrs. President Ursula von der Leyen at the Nuclear Energy Summit: [...]” nuclear technologies can play an important role in clean energy transitions[...] Innovation in nuclear technologies [...] lifetime extensions for existing nuclear plants[...] industry’s ability to deliver on time and on budget[...] Most pathways to net zero keep a place open for nuclear power. In the IEA’s 2050 scenario, e.g. nuclear capacity more than doubles by 2050[...]

Human Resources in nuclear

- Existing “producers” of HR will face difficult times in coping with demand;
- Collaboration (local; regional; international) is the key answer to fulfill the need



ENEN's findings: HR needs (EU)

Task-Force	Sub-sector	2023			Needed recruitments horizon 2035							
		Workforce			Retirement compensation			For growth				Total
		Direct jobs	Indirect jobs (supply chain)	Total Nuclear sector	Direct jobs	Indirect jobs (supply chain)	Sub-total	Growth rate Hypothesis	Direct jobs	Indirect jobs (supply chain)	Sub- total	
TF1.1	Industry (Utilities)	80	80	160	20	20	40	0,10	8,0	8,0	16,0	56,0
	Industry (Fuel)	50	60	110	13	15	28	0,10	5,0	12,0	17,0	44,5
	Industry (Engineering)	30	51	81	8	13	20	0,10	3,0	25,5	28,5	48,8
	Industry (Transport & others)	10	19	29	3	5	7	0,10	1,0	9,5	10,5	17,8
TF1.1 perimeter		170	210	380	43	53	95		17	55	72	167
TF1.2	R&D (indd Research reactors)	20	15	35	6	3	9	0,10	2,0	1,5	3,5	12,5
	Safety (Regulators+TSOs)	5	5	10	1,5	1,5	3	0,15	0,8	0,5	1,3	4,3
	Waste & Decommissioning	25	35	60	7,5	10,5	18	0,10	2,5	3,5	6,0	24,0
TF1.2 perimeter		50	55	105	15	15	30		5	6	11	41
TF1.3	Medical Physicists	10	2	12	4	0,6	4,6	0,08	0,75	0,15	0,90	5,5
	Radio pharma & Radio chem	1	1	2	0,35	0,25	0,6	0,50	0,50	0,50	1,00	1,6
	Space & Environment	0,3	0,3	0,6	0,09	0,06	0,15	0,05	0,02	0,02	0,03	0,2
TF1.3 perimeter		11	3	15	4	1	5		1	1	2	7
Total WP1 perimeter		231	268	500	62	68	130		24	61	85	215

Hypothesis 2.5% per year recruitments for retirement compensation

Initial considerations 1/2

- There are currently 109 reactors in operation within EU27+UK perimeter;
- Volatile environment: some countries decide to start a nuclear program or upgrade the existing one; some intend to maintain the current reactor fleet; some intend to close some or all nuclear power plants;
- Assessment of human resources and skills' needs at the horizon of 2035 maintaining the same perimeter;
- Provided we consider that indirect jobs are in majority in the supply chain (ratio indirect/direct for 2023 = 1.16 from our modelling approach).

Initial considerations 2/2

- Several scenarios were considered;
- We have assumed roughly ten new nuclear power plants to be built in an “average” 10% growth scenario;
- Various analysis models were used (literature review; direct contacts through developed questionnaires; extrapolations based on existing know how; etc.)
- Direct and indirect jobs were considered;
- Retirement based on existing know-how;
- Despite its major contribution in EU strategy, the ITER project and more generally fusion programmes were not taken in consideration.
- ...

What industry wants/needs? Case study: SMRs

Results obtained in TANDEM project

According to the results of the survey, the following **job categories** will be required for the construction and operation of SMRs:

All engineering disciplines	All technician disciplines (electrician, welders, etc)
Large project management & project control disciplines (including cost control & planning)	Nuclear safety and physics
Licensing, permitting and procurement	Operations management (procedures instructions, practices etc)
Information technologies	Digitisation
Waste management	Chemistry

What industry wants/needs? Case study: SMRs

Results obtained in TANDEM project

HARD SKILLS	SOFT SKILLS
Nuclear safety	Problem-solving and analytical skills
Nuclear security & safeguards	Organisational ability
Licensing	Excellent spoken and written communication skills
Components	Ability to visualise complex processes
Electrical	Creativity and persistence in work activities
Civil	Ability to order information logically and clearly so others can follow their lead and instructions
Construction	Accountability
Welding	Teamwork
Non-Destructive Examination	Questioning attitude
Project management	Work Autonomy
Maintenance and inspections	Adaptability
Planification and cost estimation	Resilience
Mathematical and computer skills	

What ENEN provides together with Members

ENEN Activities

- **ENEN-original activities**

- For students at Master Level:
[EMSNE](#) : European MSc in Nuclear Engineering
- For students at Ph.D. Level:
Annual [ENEN PhD Event & Prize](#)
- Co-organisation of NESTet conference
- Global networking
- Facilitating discussion between member institutions

- **Activities executed by ENEN**

- Coordination of projects, most of them being financed by the EU
- Organization of Education and Training courses
- Dissemination and Communication activities
- Support of mobility of students

The R&D is carried out by ENEN members, not ENEN itself.

Read more on www.enen.eu

**E&T in
nuclear**



**Radio Prot &
Safety for
NRAs**

**Leadership
for safety**

**More nuclear
E&T
opportunities**

**Radio
chemistry**



T&T



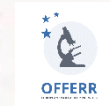
**Research
facilities**

**Flow Induced
Vibrations**

**Access to
infrastructure**

**Fuel
recycling**

Safeguards



**SMRs &
energy mix**

**Reactor
Physics**

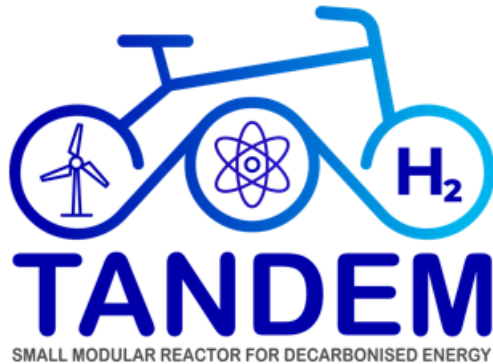
SMRs

**Research
Reactors**

**Radio-
Isotopes**

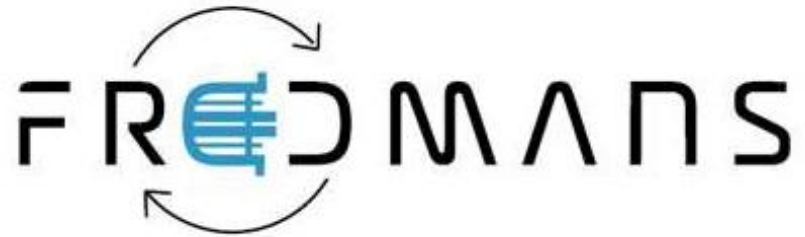


Tandem



- Research and Innovation
- 17 Partners from 8 countries
- Assess the safety compliance of SMRs to be integrated in the future European energy mix
- Provide guidance in a deployment perspective for future integration of SMRs and AMRs into well-balanced hybrid energy systems
- Foster enabling environment for development of hybrid energy systems based on SMRs and AMRs

FREDMANS



- 17 Partners from 11 countries
- Research and Innovation
- Fuel recycle and experimentally demonstrated manufacturing of advanced nuclear solutions for safety
- FREDMANS aims to increase safety and efficiency in both nuclear power production as well as the recycling of spent fuel.
- Mobility fund available

Go Viking



- Research and Innovation
- [18 Partners from 9 countries](#)
- The GO-VIKING project aims at improving the current state-of-the-art of fluid induced vibrations knowledge and analysis concerning the following global targets: improve overall NPP safety, enhance plant reliability in long-term operation and power uprate programs, reduce staff exposure, design components that are less susceptible to FIV, and increase the regulatory acceptance.
- The GO-VIKING consortium gathers expertise from research, industry and technical safety organisations

SECURE

SECURE

- Research and Innovation
- 17 Partners from 10 countries
- The SECURE project aims to make a major contribution to the sustainability of medical isotope production and its safe application in Europe;
- To remove critical barriers along the production of its selected alpha and beta emitting isotopes that restrict a sustainable production;
- Develop a framework of guidance and recommendations that enables exploring the full clinical potential of alpha and beta particle therapy and its safe application

Joint European Canadian Chinese development of Small Modular Reactor Technology

The ECC-SMART is oriented towards assessing the feasibility and identification of safety features of an intrinsically and passively safe small modular reactor cooled by supercritical water (SCW-SMR), considering specific knowledge gaps related to the future licensing process and implementation of this technology.

The main objectives of the project are to define the design requirements for the future SCW-SMR technology, to develop the pre-licensing study and guidelines for the demonstration of the safety in the further development stages of the SCW-SMR concept including the methodologies and tools to be used and to identify the key obstacles for the future SMR licensing and propose strategy for this process .

GRADUATE EDUCATION ALLIANCE FOR TEACHING THE PHYSICS AND SAFETY OF NUCLEAR REACTORS

The GRE@T-PIONEER project aims at developing a specialized education in reactor physics and nuclear reactor safety for PhD and Post-Doc students, for nuclear engineers, and taken as advanced courses for MSc students.

The education will encompass both **theory and hands-on training exercises**, the latter heavily relying on the use of research/training reactors and of computer-based modelling environments.

Sets of educational materials will be created.

The covered topics will allow the students to fully comprehend all the methods and corresponding approximations used for modelling the behavior of nuclear reactor cores, from the generation of nuclear cross-sections to the response of a reactor during a transient.

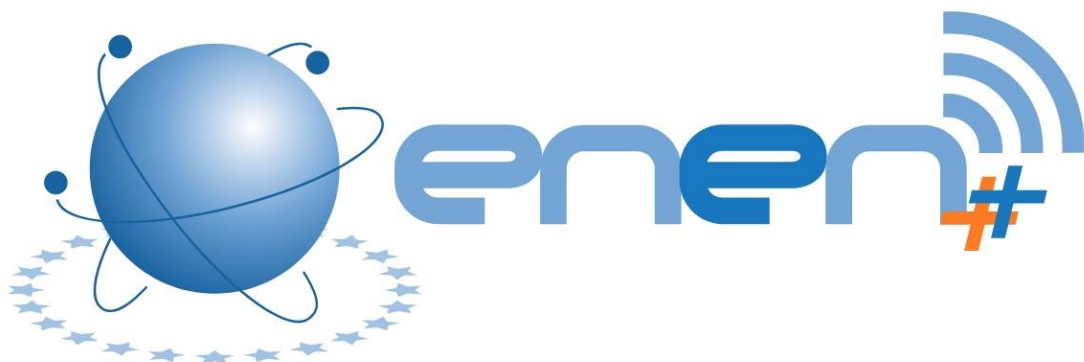


OFFERR

- 15 Partners from 10 Countries
- Access to research infrastructures for scientists
- Support for research activities
- Design of research programs
- Mobility scheme in conjunction with ENENplusplus



ENEN2plus

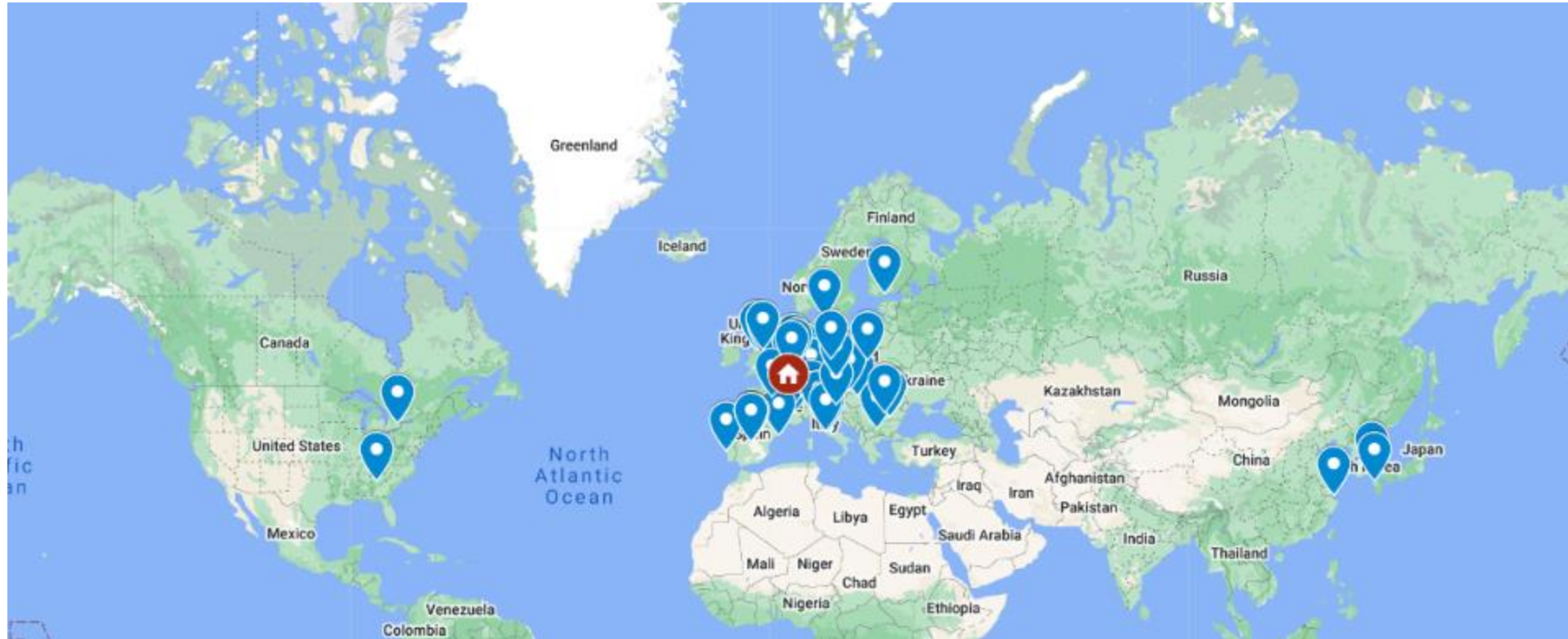


- 51 Partners from 3 continents
- Based on the former ENENplus
- Targeting to strengthen the nuclear education at a whole
- Mobility fund of 2.5 Mil EUR
- Knowledge hub to be developed
- developed VET programs

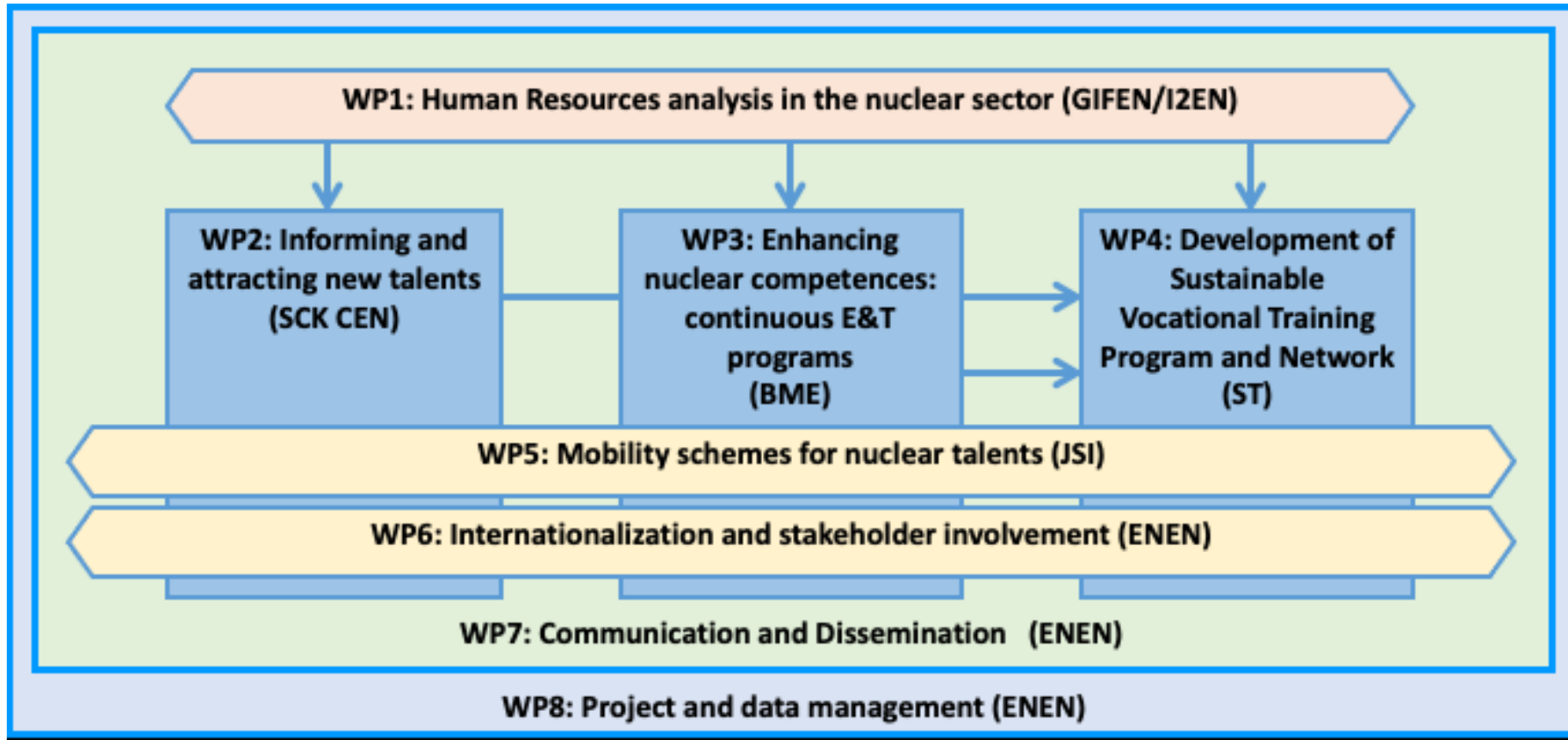
All actions started->

- In-house actions on specific nuclear topics
- Mobility fund of 2,5 M EUR

ENEN2plus : 51 partners - 3 Continents



Project structure



Mobility scheme for nuclear talents

WP No.	Work Package Title	Lead Partner	Short Name	Person Months	Start Month	End Month
WP1	Human Resources analysis in the nuclear sector	38	GIFEN-I2EN	46	1	18
WP2	Informing and attracting new talents	9	SCK CEN	43.5	1	48
WP3	Enhancing nuclear competences: continuous E&T programs	7	BME	128.5	1	48
WP4	Development of Sustainable Vocational Training Program and Network	8	ST	66.5	1	48
WP5	Mobility schemes for nuclear talents	10	JSI	22	1	48
WP6	Internationalization and stakeholder involvement	1	ENEN	78	1	48
WP7	Communication and Dissemination	1	ENEN	12	1	48
WP8	Project and data management	1	ENEN	44	1	48
				Total	440.5	

Target: support 1.000 learners with over 2,5 million EUR

Possible contribution to the nuclear community

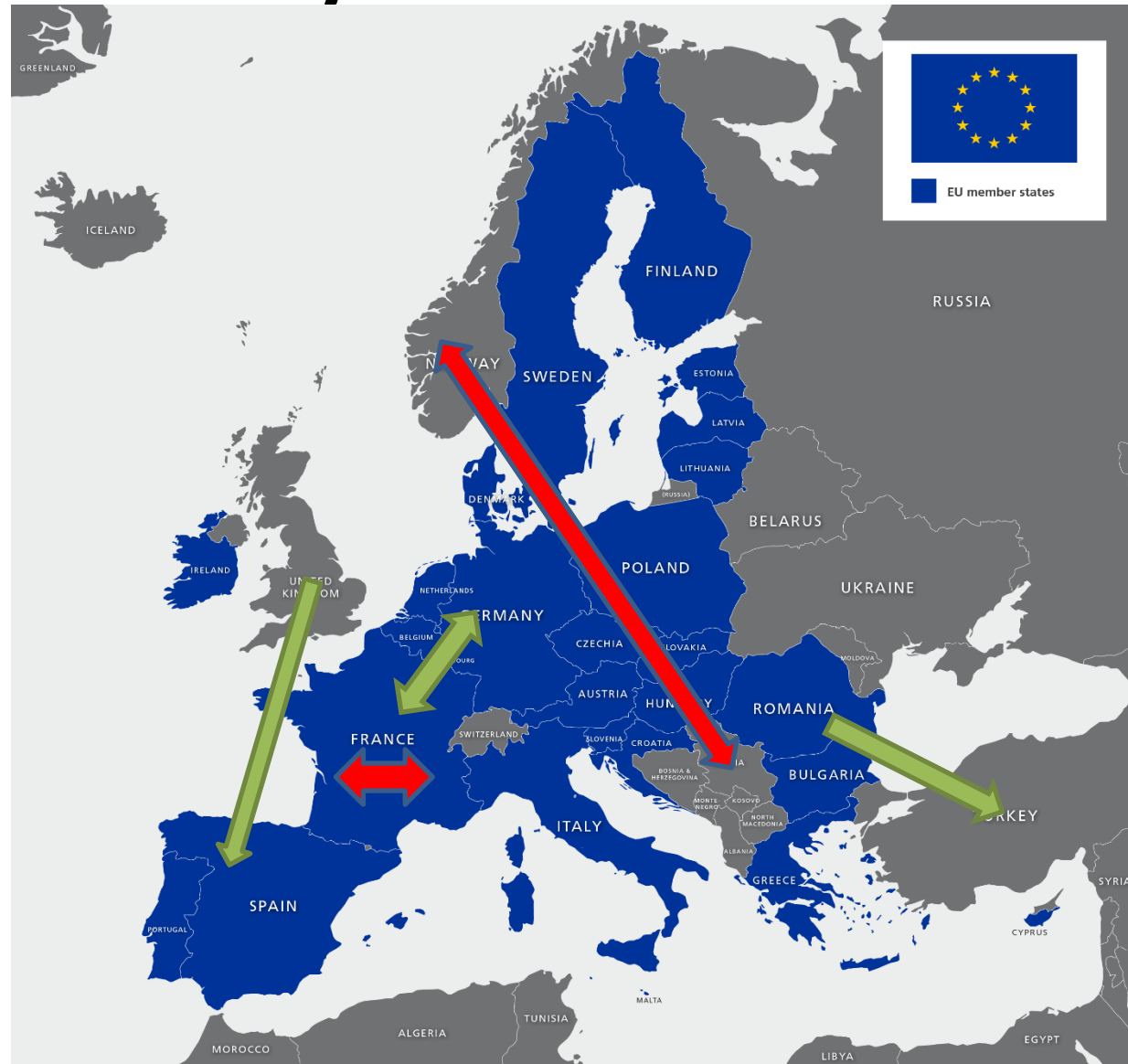
Mobility Manual

- support for attendees to participate to developed actions/experiments;
- > increased number of researchers;
- > increased number of experiments/E&T actions;
- > increased knowledge, skills and competences;
- > independent on geographical distribution of attendees;
- > EU participation is encouraged;
- > must respect Mobility Manual requirements.

Mobility rules - 1

Mobilities

Not mobilities



26.04.2024

Picture credits: [European Union \(EU\) Definition | Forexpedia™ by BabyPips.com](#)

Mobility rules – 2 (Groups of learners eligible to receive the ENEN# mobility grants)

Groups of mobility beneficiaries	Individual applications	Group applications
High-school pupils	No	Yes
High-school teachers	No	Yes
B.Sc. students (interested in pursuing a master education and/or a career in the nuclear fields)	Yes	Yes
M.Sc. students in nuclear interested in extracurricular experience and/or academic exchange such as the EMSNE certification by ENEN.	Yes	Yes
Ph.D. students in nuclear interested in academic and research exchange, access to research infrastructures and cooperation with Euratom research projects.	Yes	Yes
Post-docs in nuclear interested in academic and research exchange, access to research infrastructures and cooperation with Euratom research projects.	Yes	Yes ³
Early career professionals (preferable up to 10 years of experience), interested in changing their careers to nuclear and/or building up their life-long learning on nuclear topics.	Yes	Yes ³

Project expected outcomes

Detailed analysis of HR needs, gaps and perspectives for nuclear industry, research centres, waste management, safety operators and non-power applications of nuclear

Match of the **nuclear industry needs** with **academic and research offer**

Enhanced competences of BSc, MSc, PhD and researchers with support of a generous **mobility program**

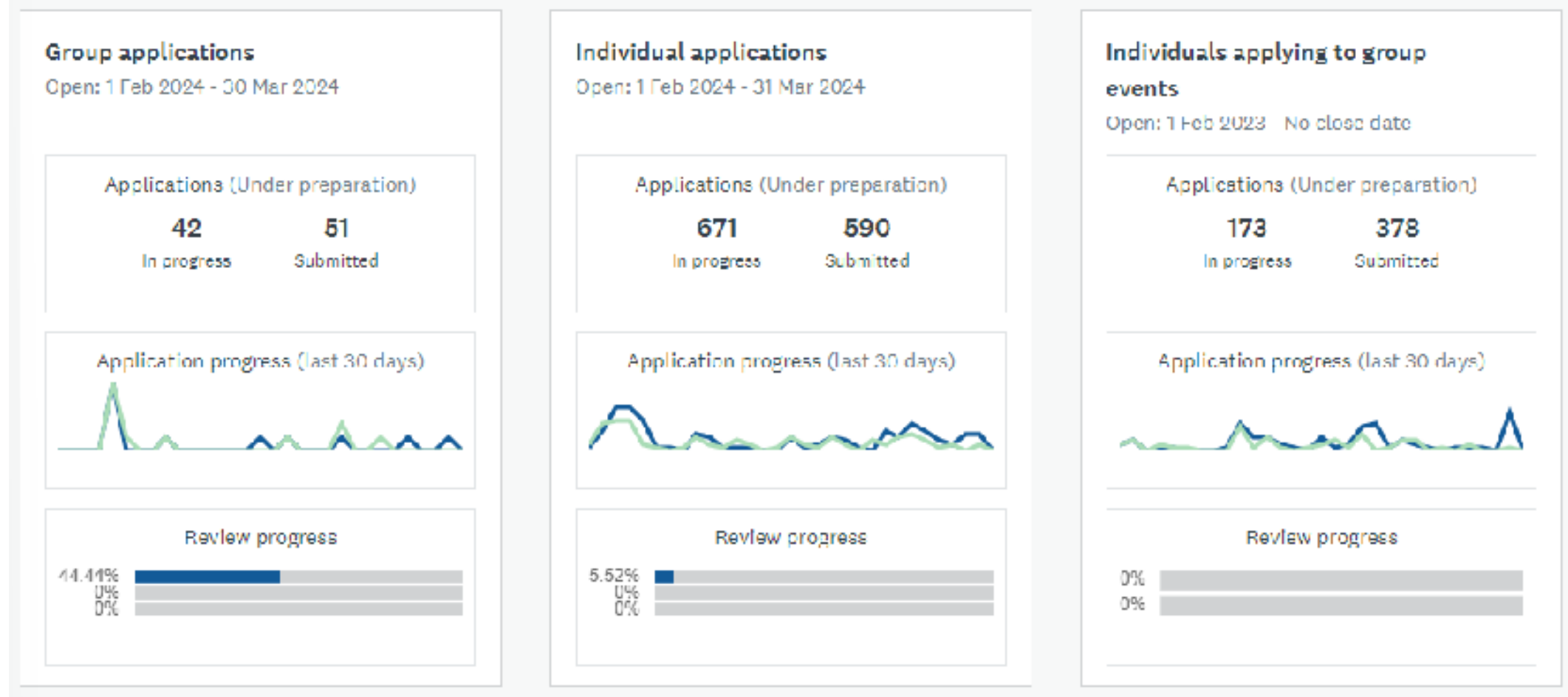
Better awareness of job offers and perspectives for graduates

Access to truly World class classic and online **education**

Attraction of passionate **young generation** to the nuclear field

Development of a **VET program** implemented into a **centralized hub**, a single point entry for educational materials, job offers, internships, thesis work

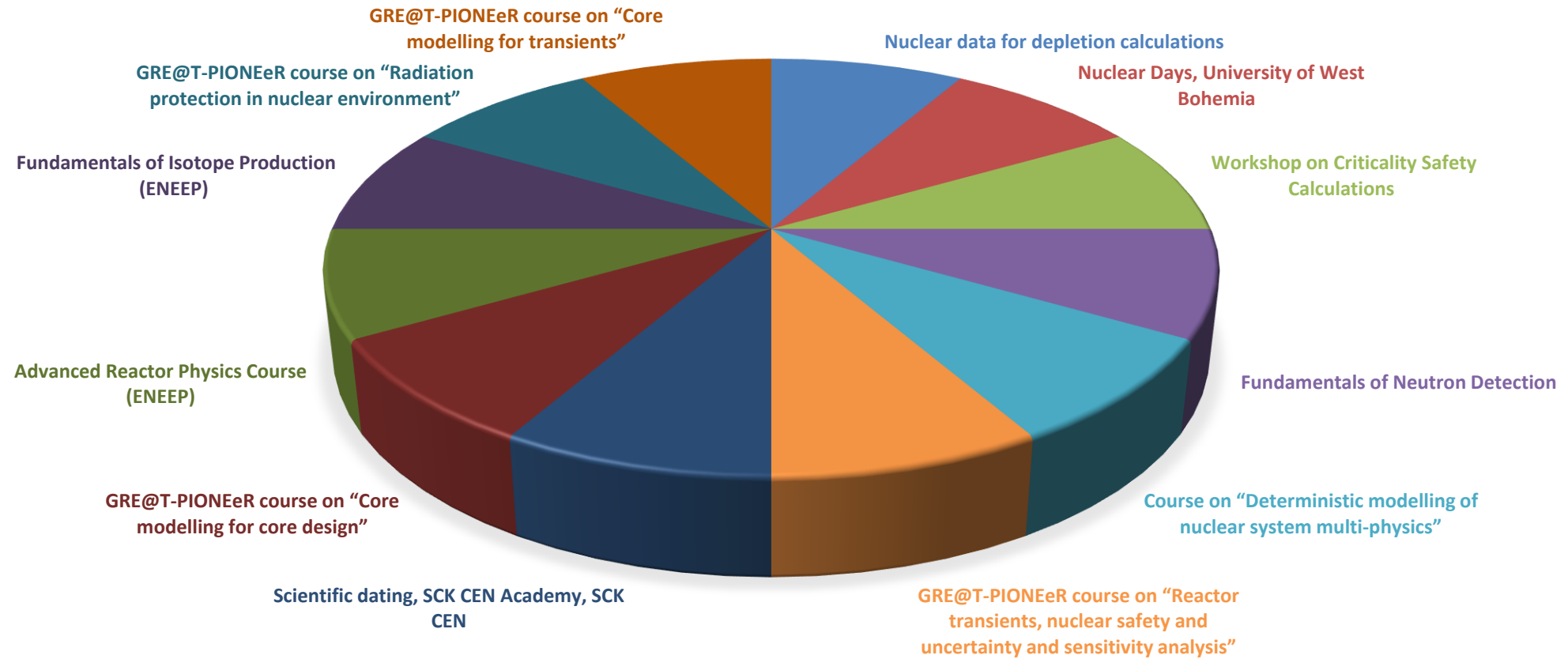
Project results on 27.02.2024



26.04.2024

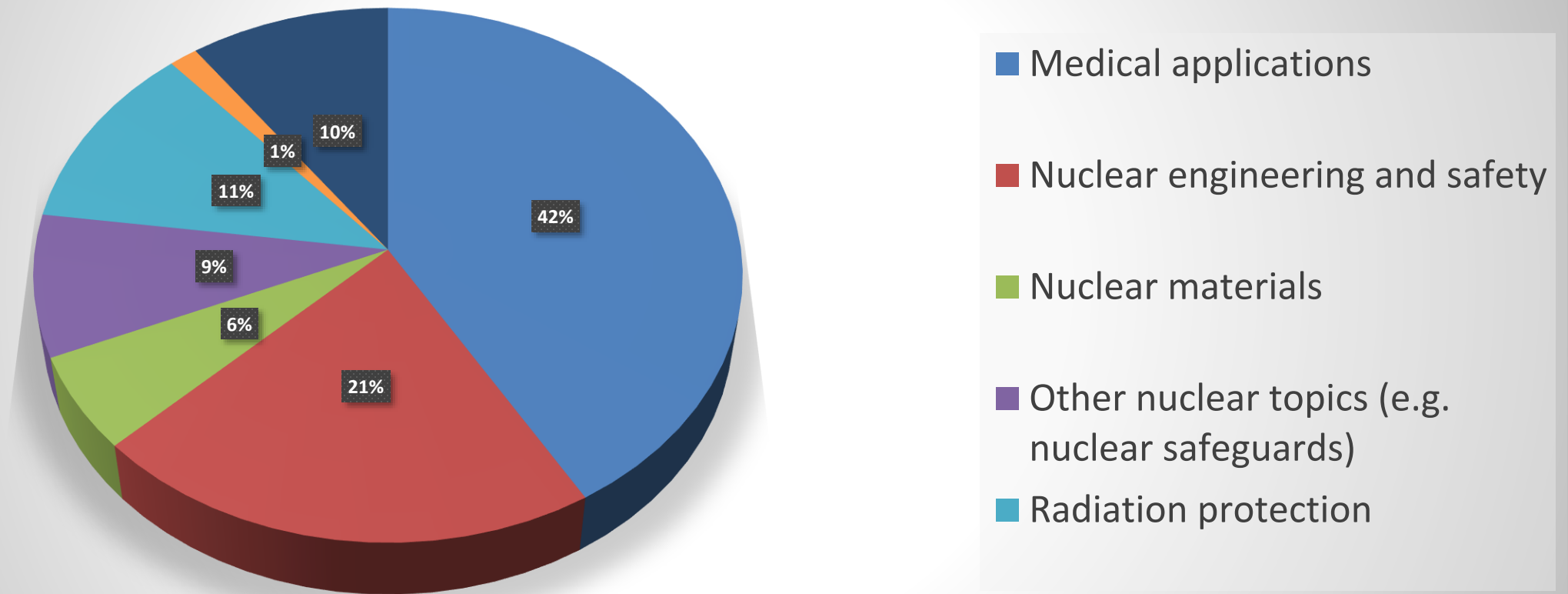
Project results

GROUP TOPICS



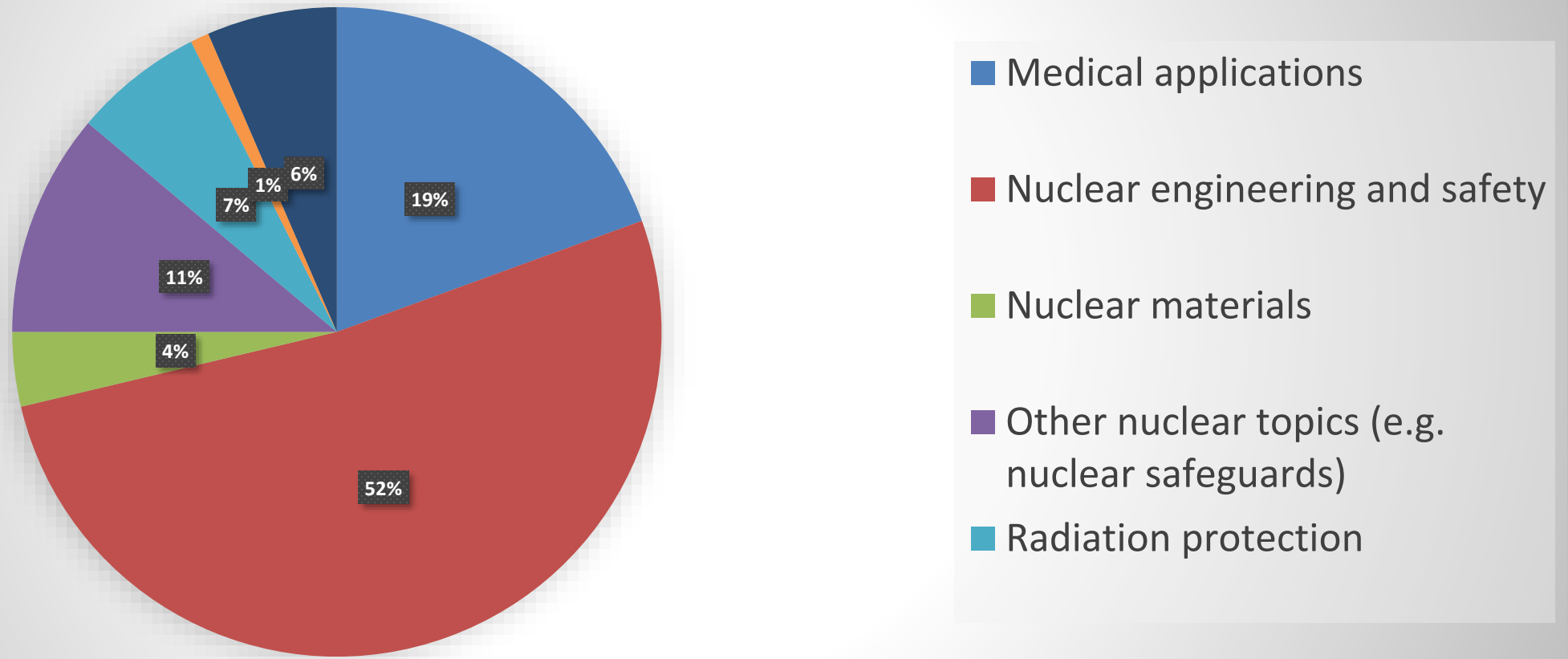
Female funding distribution

Females in nuclear



Male funding distribution

Males in nuclear



To sum-up

Check for updates here: [ENEN2plus Project – European Nuclear Education Network](#)

The [Mobility platform](#) used for funding requests is operational

The [Mobility handbook](#) used for mobility rules is public



Thank you for your attention



Gabriel-Lazaro PAVEL
gabriel.pavel@enen.eu