Nuclear competence building: past and future of nuclear engineering education

si2021.eu

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20th BNEN MSc Academic year's opening, SCK-CEN Mol (BE), 13 September 2021

EU/Euratom Challenges, Opportunities, Impacts

- Safe and harmonised management of radioactive waste
- Enhanced safety of design and operation of existing and future reactors
- Lift uncertainty about health risks after low radiation dose due to industrial and medical applications
- Ensure transfer of knowledge to future generation in the field
- Integration of European research programming and implementation
- Challenges need to be addressed worldwide

Euratom Treaty, EU Directives, E&T is a safety requirement
Euratom Treaty (1957), Community research and training programme
EU Nuclear Installations Safety Directive (2009, 2014, art.7), EU Nuclear Waste Directive (2011, art.8), EU Basic Safety Standards Directive (2013, chap.4), IAEA Convention on Nuclear Safety (1994, art.11.2)

- Effective implementation of EU Research Area ERA in the field of nuclear fission, and exploiting the full potential of institutes, universities, industries and other organisations in these countries as regards their infrastructure, human resources and overall competences.

European Commission

BNEN, ENEN - European Nuclear Education Network

1999 BOLOGNA declaration on a 'European Higher Education Area' ECTS → mutual recognition of academic grades
2002 COPENHAGEN on 'Vocational Education & Training' ECVET → Lifelong learning and cross-border mobility
2010 and following EU Communication 'An agenda for new skills and jobs' → free movement of KNOWLEDGE together with PEOPLE, GOODS, CAPITAL AND SERVICES

- EFTS **Euratom Fission Training Schemes**, ECVET European Credit system for **Vocational Education** Training, **EU Master or PhD programmes, common qualifications, mutual recognition, mobility** of trainees/trainers and safety culture with an **EC contribution towards Euratom projects and a European Nuclear Education Network ENEN**

MSc EMINE – European Master in Nuclear Energy

- University, Res. Org., Industry, TSOs, Reg. Bodies,
  Master in Nuclear Energy, Nuclear safety **PWR, VVER**
  Nuclear Radiochemistry and fuel cycle
  Radiation Protection, Health physics, medical experts
  Waste management and geological disposal
  Access to **Key Infrastructures, Human Resources Observatory**

ecvet
European Credit system for Vocational Education & Training

European Commission

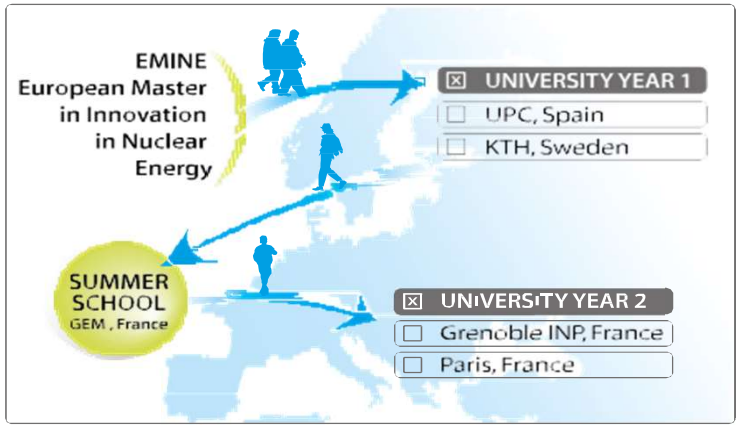
European Master in Nuclear Energy (EMINE)

In the framework of the **European Institute of Innovation and Technology – KIC InnoEnergy**.

Duration: 120 ECTS, over two years.

30 Scholarships per year

Language: English, **Face to face education**



MSc EMINE – European Master in Nuclear Energy

AREVA · endesa · KTH · GRENOBLE Management Technology & Innovation · EDF · UPC UNIVERSITAT POLITÈCNICA DE CATALUNYA BARCELONATECH

KIT · Grenoble INP · ParisTech · cea · VATTENFALL

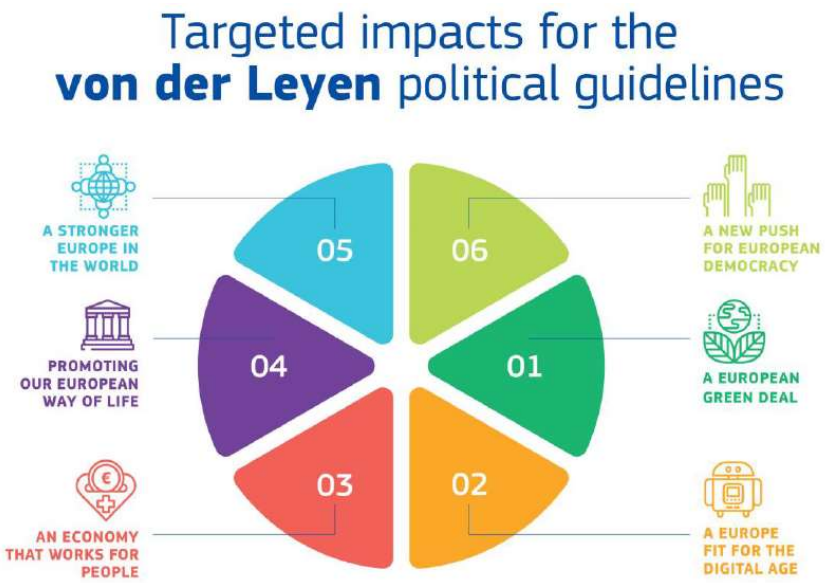
European Commission

Capitalising all initiatives

- Under Euratom, **EC should promote and facilitate EU Nuclear safety R&D** in **MS, cooperation IAEA, NEA, GIF**
- **ETIPs** Technology Platforms are industry led to promote R&D and demonstration of EU fission technologies
- **EU fora** supporting nuclear policy, promoting stakeholders dialogue and safety improvements
- **ENEF** from 2007 and WG Transparency, risks and opportunities
- **ENSREG** from 2007, stress tests peer reviews
- **SNETP** composed of **NUGENIA, ESNII and NC2I** pillars
- **SET-Plan** Key action n.10 on nuclear fission and fusion
- **IGDTP** on geological disposal, and **EJP EURAD**
- **MELODI** with NERIS-TP, EURADOS and Alliance
- **ENEN** European Nuclear Education Network, **EHRO-N**
- **INCO** structured dialogue on R&D policy and priorities

Contribution from nuclear to EU policies and SDGs

EC President von der Leyen Priorities



UN Sustainable Development Goals

Affordable energy reduces poverty (SDG1) and inequality (SDG10), and supports health (SDG3), education (SDG4), industry (SDG9) and economic growth (SDG8)

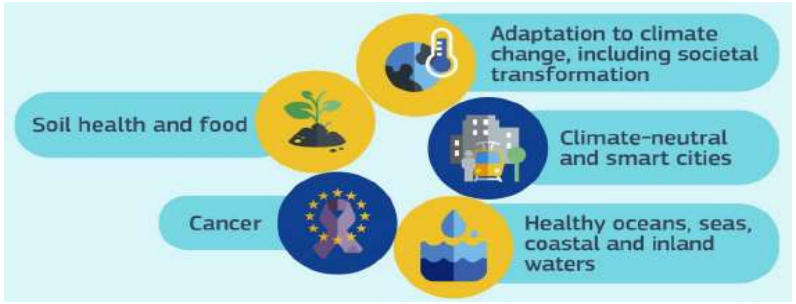
Energy for all fosters peace, justice (SDG16), and partnerships (SDG17)

Sustainable energy is crucial for climate action (SDG13), ecosystems (SDG14, 15), agriculture (SDG2), water (SDG6, 14), and reducing waste (SDG12)

Reliable energy is essential for industry (SDG9), agriculture (SDG2), health (SDG3) and education (SDG4)

Modern energy supports clean communities (SDG11), health (SDG3), and gender equality (SDG5)

Horizon Europe Missions



Research and Innovation

fuel EU's **scientific and technological excellence** and the strengthen the European Research Area (ERA)

tackle policy priorities, including **green and digital transitions** and Sustainable Development Goals

boost Europe's **innovation uptake, competitiveness** and **jobs**

Science & technology | **Society** | **Economy**

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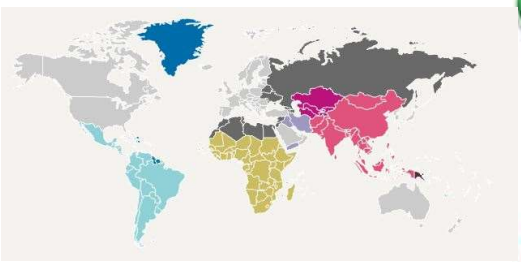
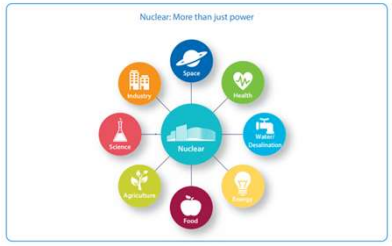
2021-27 Overview of unifying activities EC RTD-JRC-ENER-INTPA



Complementing EU Nuclear Safety and Decommissioning (LT, BG, SK) implemented by DG **INTPA** and **New JRC** Decommissioning Programme

Safeguards & security – specific to **JRC**



RTD-JRC

Improving the safety of nuclear systems; including nuclear reactor and fuel safety as well as emergency preparedness, decommissioning

Contributing to the development of solutions for the **nuclear waste management** and for **NPPs decommissioning**, including final geological disposal as well as partitioning and transmutation

Fostering the development and sustainability of **nuclear expertise** and increasing excellence in the **nuclear science base** for standardisation.

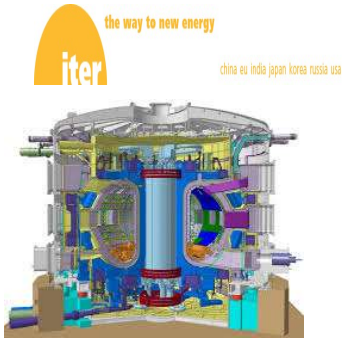
Supporting **radiation protection** and the development of **medical applications of radiation**, including the secure and safe supply and use of radioisotopes

Moving towards demonstrating the feasibility of **fusion as a power source**, laying the foundations for future fusion power plants by developing materials, technologies and conceptual design; and promoting innovation and industrial competitiveness.

Ensuring the availability and use of **research infrastructures** of pan-European relevance.

Improving **nuclear security**, including: nuclear safeguards, non-proliferation, combating illicit trafficking, and nuclear forensics.

Supporting the **policy of the Union** on nuclear safety and security.



Fusion – specific to **RTD** (EUROfusion) and **ENER** (F4E Joint Undertaking for the construction of ITER)

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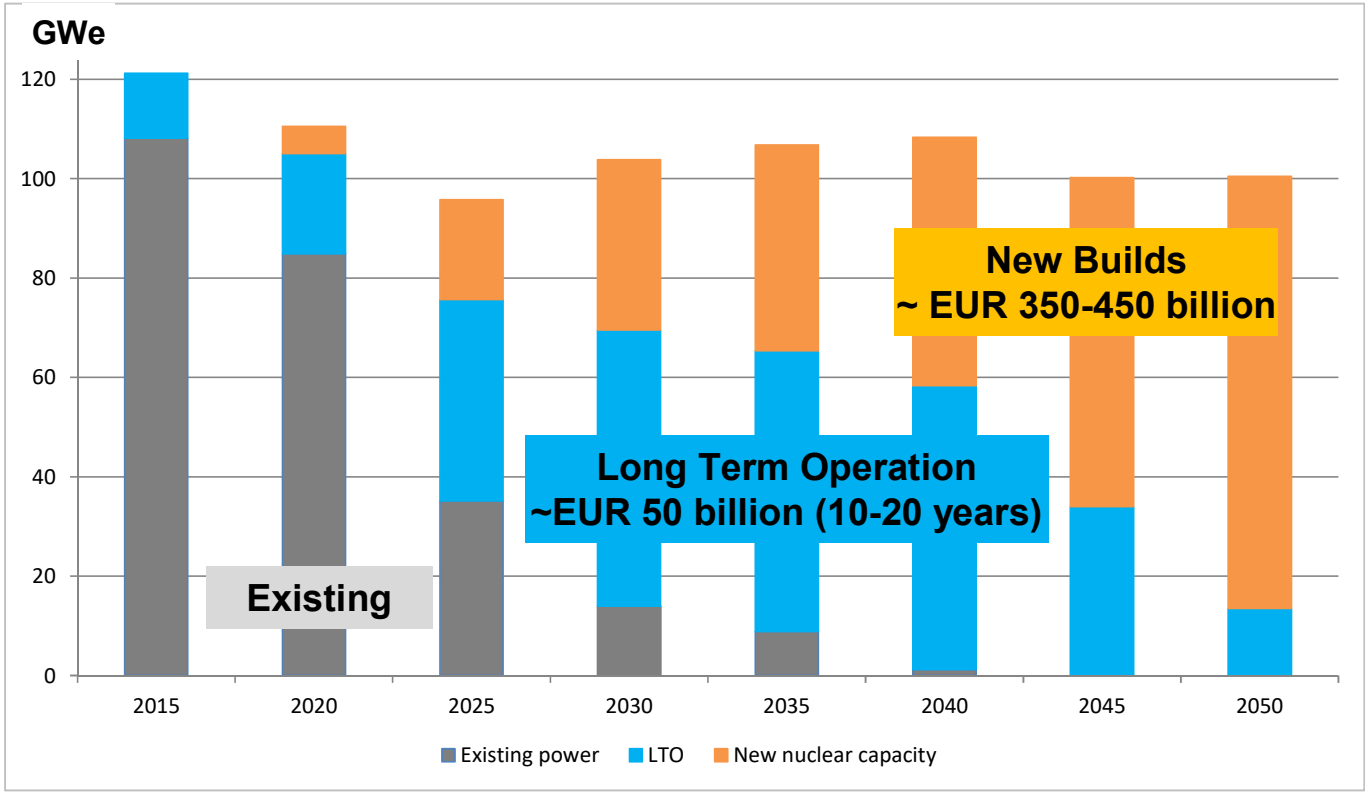
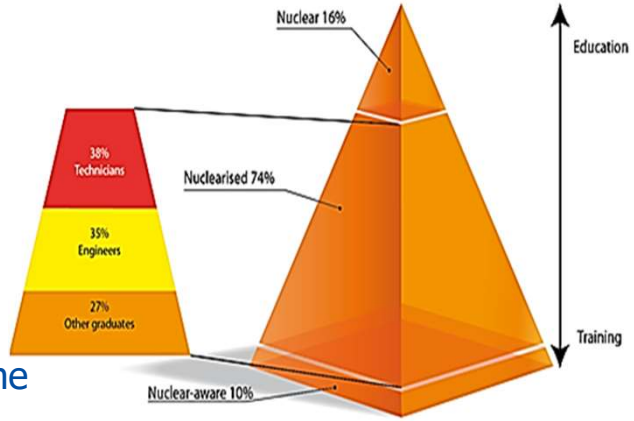
EU Nuclear Electricity Generation (PINC 2017) and 2050 strategy



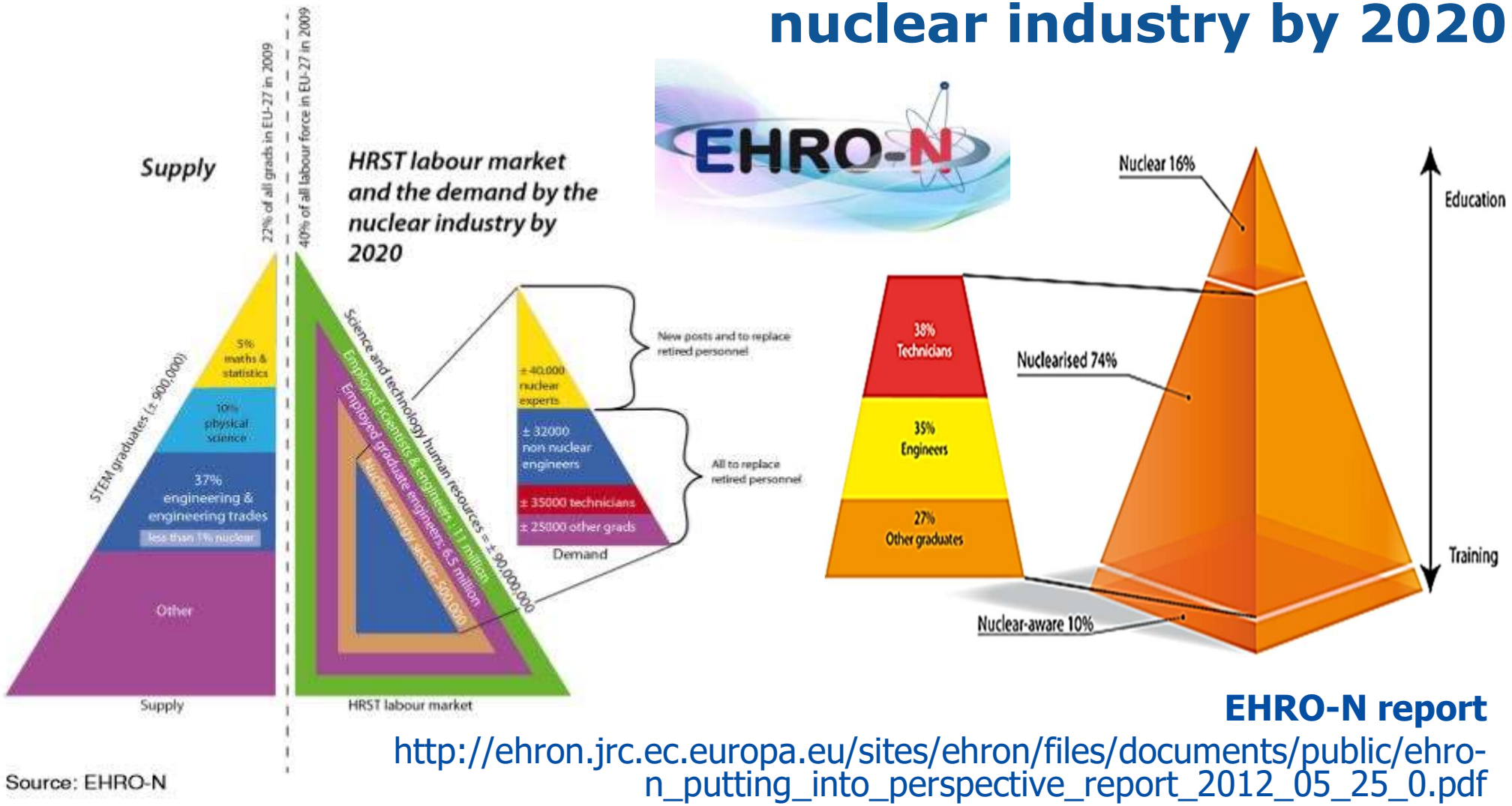
Other important aspects with respect to HR requirements for nuclear experts at a European scale are the experts employed by the regulatory bodies, their technical support organizations, and in nuclear research, education, and training.



PINC - EU Nuclear Illustrative Programme
https://ec.europa.eu/energy/en/news/commission-presents-nuclear-illustrative-programme
2050 Long-term strategy
https://ec.europa.eu/energy/en/topics/energy-strategy-and-energy-union/2050-long-term-strategy

European Commission

HR STEM labour market and the demand by the EU nuclear industry by 2020

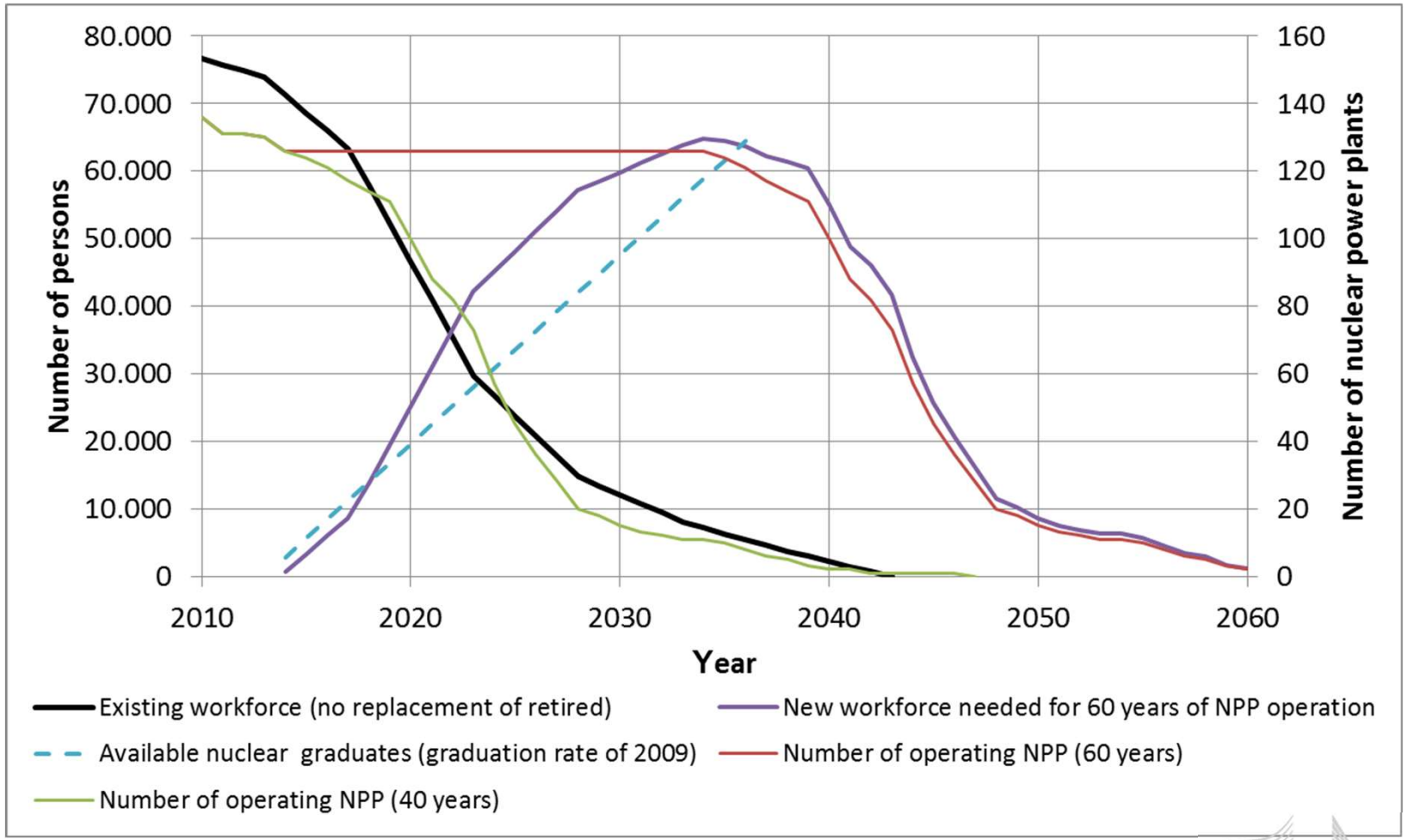


Source: EHRO-N

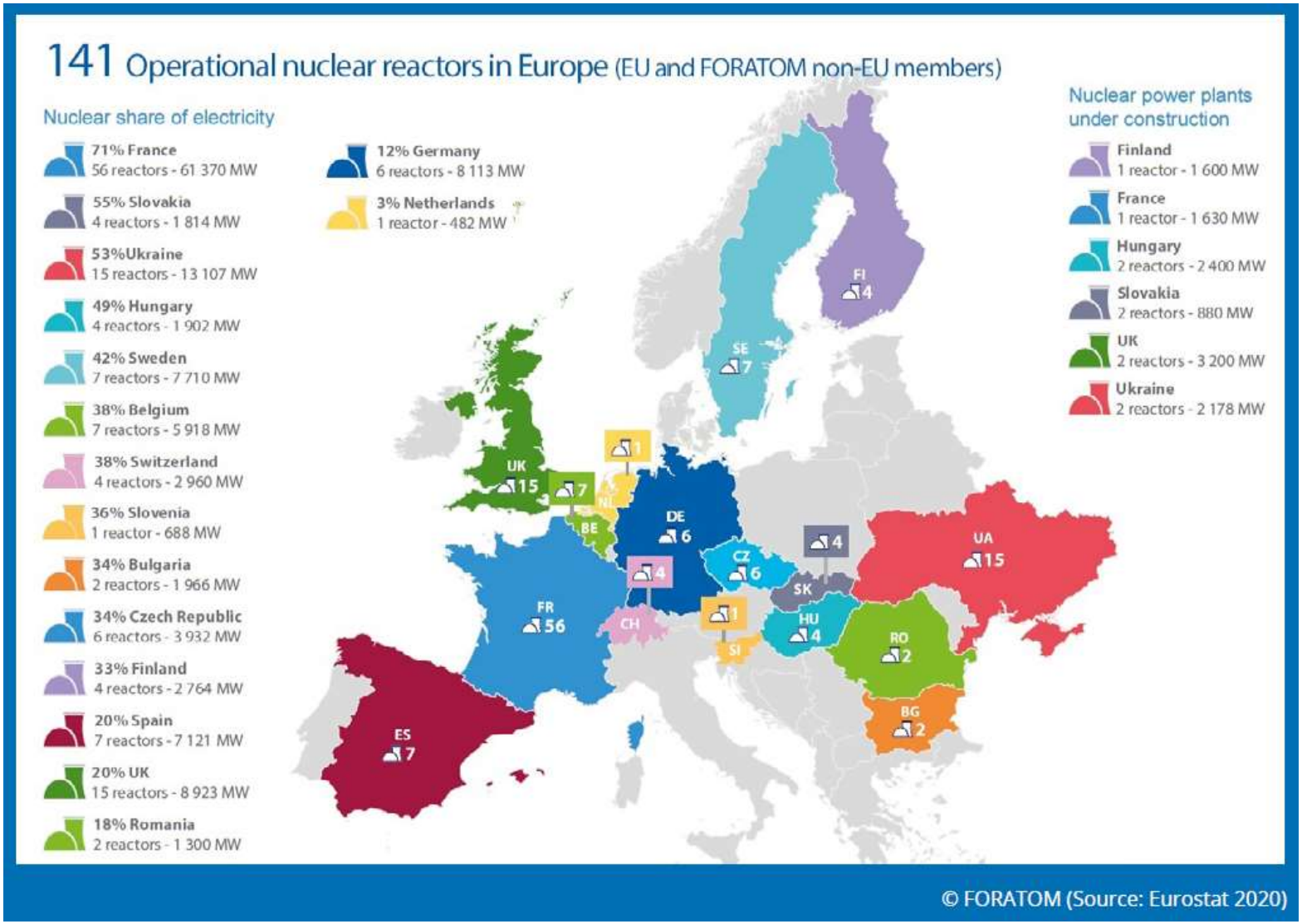
EHRO-N report

http://ehron.jrc.ec.europa.eu/sites/ehron/files/documents/public/ehro-n_putting_into_perspective_report_2012_05_25_0.pdf

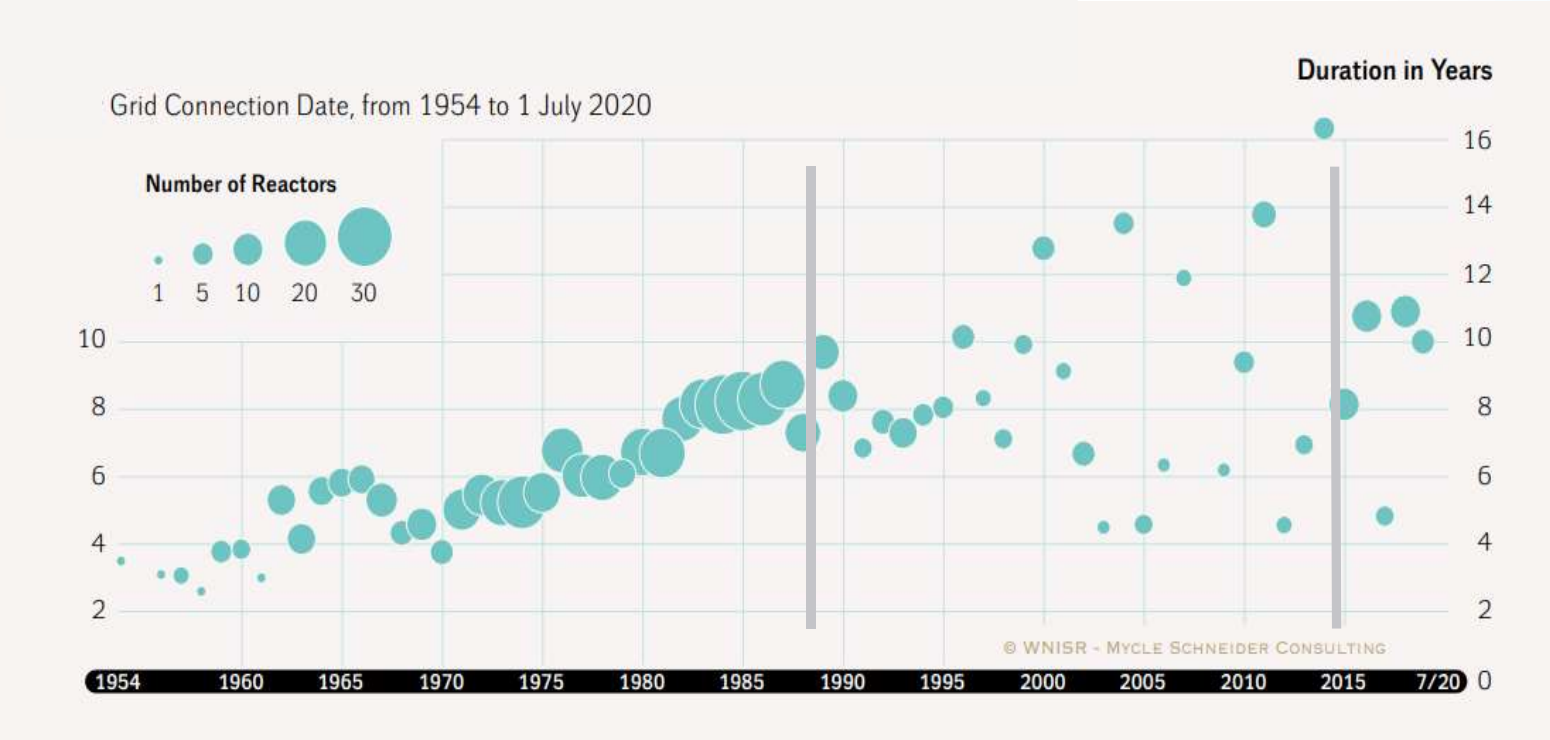
Nuclear Workforce in EU (2012)



European Commission


141 Operational nuclear reactors in Europe (EU and FORATOM non-EU members)
Nuclear share of electricity
71% France
56 reactors - 61 370 MW
55% Slovakia
4 reactors - 1 814 MW
53%Ukraine
15 reactors - 13 107 MW
49% Hungary
4 reactors - 1 902 MW
42% Sweden
7 reactors - 7 710 MW
38% Belgium
7 reactors - 5 918 MW
38% Switzerland
4 reactors - 2 960 MW
36% Slovenia
1 reactor - 688 MW
34% Bulgaria
2 reactors - 1 966 MW
34% Czech Republic
6 reactors - 3 932 MW
33% Finland
4 reactors - 2 764 MW
20% Spain
7 reactors - 7 121 MW
20% UK
15 reactors - 8 923 MW
18% Romania
2 reactors - 1 300 MW
12% Germany
6 reactors - 8 113 MW
3% Netherlands
1 reactor - 482 MW
Nuclear power plants under construction
Finland
1 reactor - 1 600 MW
France
1 reactor - 1 630 MW
Hungary
2 reactors - 2 400 MW
Slovakia
2 reactors - 880 MW
UK
2 reactors - 3 200 MW
Ukraine
2 reactors - 2 178 MW
FI 4
SE 7
UK 15
7
1
NL
BE
DE 6
4
CZ 6
4
SK
UA 15
FR 56
CH
1
SI
HU 4
RO 2
BG 2
ES 7
© FORATOM (Source: Eurostat 2020)

Average Annual Construction Times



Sources: WNISR, with IAEA-PRIS, 2020

Euratom Call 2021-22 Overview Schedule

Event	Date
Drafting and Programme Committee WP2021-22	**02/2020 – 02/2021**
Adoption Euratom 2021-25.....	**05/2021**
Euratom WP2021-22 publication	**07/2021**
Submission Call open.....	**07/2021**
Deadline	**7/10/2021**
Evaluations	**10 – 11/2021**
Negotiations/Finalisation of Grants	**01 – 05/2022**
Grant Agreement signature.....	**06/2022**
First projects launched	**06/2022**

EC Funding and Tenders portal https://ec.europa.eu/info/funding-tenders/opportunities/portal/screen/home

Horizon Europe and Euratom Info Days https://www.horizon-europe-infodays2021.eu/

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Euratom 1-16 (Fission) and Other Actions (Fusion and others)	EUR million EC contr./prop	Total Budget (indicative)	Proposals (indicative)
1 Safety of operating Nuclear Power Plants and Research Reactors (RIA).....	**3.0**	**18.0**	**6**
2 Safety of advanced and innovative nuclear designs and fuels (RIA).....	**3.0**	**13.5**	**4**
3 Multi-recycling of spent nuclear fuel from Light Water Reactors (RIA).....	**3.0**	**3.0**	**1**
4 Advanced structural materials for nuclear applications (RIA).....	**8.0**	**8.0**	**1**
5 Safety of High Temperature Reactors (RIA).....	**3.0**	**3.0**	**1**
6 Harmonization of licensing procedures, codes and standards Fi/Fu (RIA).....	**2.5**	**2.5**	**1**
7 Development of tritium management in fusion and fission facilities (RIA).....	**3.0**	**3.0**	**1**
8 Towards an aligned harmonized regulatory framework RWM and DECOM (CSA)...	**3.0**	**3.0**	**1**
9 European Partnership for research in radiation protection (COFUND).....	**30.0***	**30.0***	**1**
10 Safe use and reliable supply of therapeutic radionuclides (RIA).....	**3.0**	**3.0**	**1**
11 Cross-sectoral synergies and new applications of nuclear technologies (IA).....	**2.0**	**10.0**	**5**
12 European Facility in Nuclear Research (CSA).....	**9.0**	**9.0**	**1**
13 Towards a European nuclear competence area (CSA).....	**7.0**	**7.0**	**1**
14 Socio-economic issues related to nuclear technologies (CSA).....	**1.5**	**1.5**	**1**
15 Support to Euratom National Contact Points (CSA).....	**0.25**	**0.25**	**1**
16 Support to the Sustainable Nuclear Energy Technology Platform (CSA).....	**0.6**	**0.6**	**1**
Other Actions: GIF, FISA2022/EURADWASTE'22 ...Eurofusion (COFUND **537***)....		**0.7 .. 537 (fusion)**	**1**
Overall Euratom Fission 2021-22 Call indicative budget (* include budget from years 2023-25 fission (20), fusion (343))		**99.6 (fission)**	**29**

https://ec.europa.eu/info/funding-tenders/opportunities/portal/screen/home

Other Actions

- **Nuclear Innovation Prize (OA-03)** – to encourage European researchers to pursue excellence across a broad range of nuclear sciences and technologies. https://ec.europa.eu/info/research-and-innovation/funding/funding-opportunities/prizes/nuclear-innovation-prize_en

- **MSCA Postdoctoral Fellowships in research fields covered by the Euratom Programme 2021-2025 (Other Action OA-06)** – contribution to development of nuclear competences in the EU by provision of MSCA fellowships in fission and fusion research https://ec.europa.eu/info/funding-tenders/opportunities/portal/screen/opportunities/topic-details/horizon-msca-2021-pf-01-01

- **FISA2022 and EURADWASTE'22 Conference (OA-08)** – presentation and discussion of progress and key achievements of the latest Euratom projects

- **Other Actions: external expertise (OA-04), ex-post and interim evaluation (OA-05), contribution to GIF (OA-07), communication actions (OA-10), support for Ukraine NCP (OA-11).**

European Commission

Mark your calendar - FISA2022 / EURADWASTE'22

François de La Rochefoucauld's assertion that "everything happens in France" is as true now as it was 350 years ago – global culture, fashion, food and football all have a distinct French accent.

Next
FISA2022
…(May/June, tbc)

https://www.consilium.europa.eu/en/council-eu/presidency-council-eu/
http://europa.eu/european-union/eu60_en

Thank You!

TILLSAMMANS
SEDAN 1957

LE CHÉILE
Ó 1957

FLIMKIEN
MILL-1957

SAMEN
SINDS 1957

INSIEME
DAL 1957

I FÆLLESSKAB
SIDEN 1957

ЗАЕДНО
ОТ 1957

SKUPAJ
OD 1957

JUNTOS
DESDE 1957

ÜHESKOOS
AASTAST 1957

ENSEMBLE
DEPUIS 1957

JUNTOS
DESDE 1957

TÖGETHÉ®
SINCE 1957

GEMEINSAM
SEIT 1957

ÎMPREUNĂ
DIN 1957

TOGETHER®
SINCE 1957

ΌΛΟΙ ΜΑΖΊ
ΑΠΟ ΤΟ 1957

EGYÜTT
1957 ÓTA

SPOLU
OD 1957

DRAUGE
NUO 1957-ŲJŲ

RAZEM
OD 1957

YHDESSÄ
VUODESTA 1957

MĒS KOPĀ
KOPŠ 1957. GADA

SPOLEČNĚ
OD 1957

European Commission

Publications – CORDIS (EC R&D Information Service)

View all H2020 Euratom projects summaries
and public deliverables on CORDIS
https://cordis.europa.eu/

H2020 Euratom projects (All)
https://cordis.europa.eu/search?q=contenttype=%27project%27%20AND%20(programme/code=%27H2020%27%20OR%20programme/code=%27H2020-Euratom%27)%20AND%20(%27euratom%27)&p=1&num=100&srt=Relevance:decreasing

… Latest relevant projects summaries !

European Commission

Conferences' Proceedings FISA 2019 / EURADWASTE '19 … available!

Publications Office of the European Union

FISA 2019 Proceedings
https://op.europa.eu/en/publication-detail/-/publication/9cfc43f8-cbc7-11ea-adf7-01aa75ed71a1/language-en/format-PDF/source-140481060

EURADWASTE '19 Proceedings
https://op.europa.eu/en/publication-detail/-/publication/fe1b968b-cbc8-11ea-adf7-01aa75ed71a1/language-en/format-PDF/source-140505052

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edp open

EPJ N Nuclear Sciences & Technologies

EPJ N Topical issues https://www.epj-n.org/

- **TOPICAL Edition** https://www.epj-n.org/component/toc/?task=topic&id=1234
- **AWARDS Selection** https://www.epj-n.org/component/toc/?task=topic&id=1169

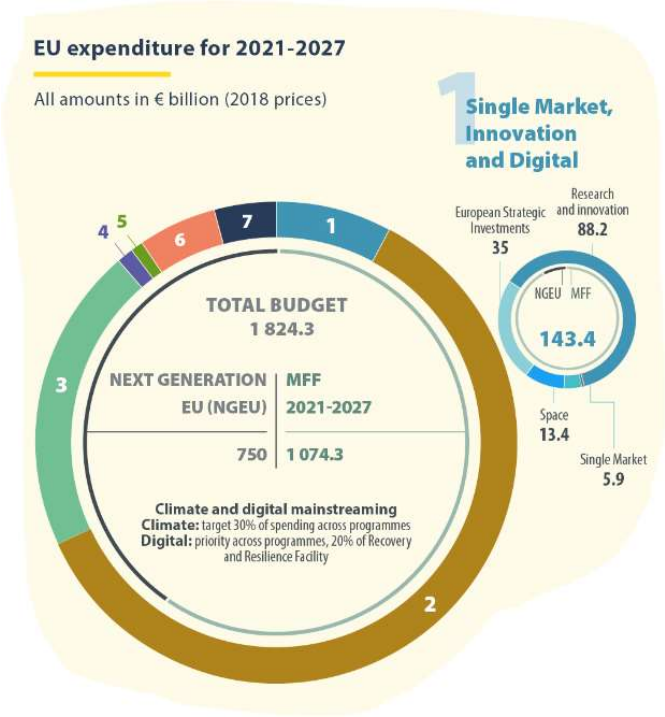
romania2019.eu

Romanian Presidency of the Council of the EU in 2019 Conferences http://fisa-euradwaste2019.nuclear.ro/

FISA 2019 Presentations http://fisa-euradwaste2019.nuclear.ro/fisa/

EURADWASTE '19 Presentations http://fisa-euradwaste2019.nuclear.ro/euradwaste/

2021-27 Horizon Europe EUR 95.5 & Euratom EUR 1.98 Billion



Euratom Research and Training * Complementing Horizon Europe**	*(7 years)* *EUR 1,980 million*	**(5 years)** **EUR 1,380 million**
Indirect RTD		
• Fusion R&D	*809*	**583**
• Fission R&D Safety and radiation protection	*370*	**266**
Direct JRC		
• Fission Safety and safeguards	*802*	**532**

ITER (a dedicated EC Regulation, 7 years)	**EUR million**
	5,610

EU Council regulation Horizon Europe https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32021R0695&qid=1630764388794
Euratom Research and Training https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=uriserv:OJ.LI.2021.167.01.0081.01.ENG
ITER and F4E https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32021D0281&qid=1630764683246
… Complemented by EI-INSC https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32021R0948&from=EN
Decom NADP LT https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32021R0101&qid=1630767059180
Decom NADP SK, BG, and Decom JRC https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32021R0100&qid=1630767174312
And CBRNE Risk Mitigation Centres of Excellence https://europa.eu/cbrn-risk-mitigation/index_en

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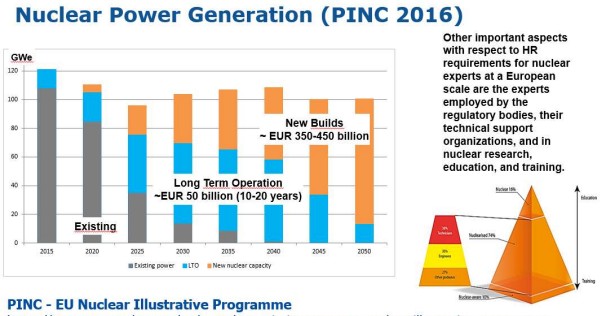
EU/EURATOM Fission RTD Work Programmes

~ 20%

Waste Management and Geological disposal

- Decommissioning



~ 40%

Reactor systems

- Safety of existing nuclear installation (Gen II-III)
- Advanced nuclear systems for increased safety (Gen-IV)
- Partitioning, Transmutation and closed fuel cycle
- Cross-cutting aspects (e.g. fuels, materials, simulation, nuclear data)
- Other applications (e.g. cogeneration, support to Research Reactors)

~ 20%

Radiation protection

- Non-power applications

~ 20%

Research infrastructures

Training and mobility

Cross-cutting INCO

Grand Total:

Euratom Fission RTD ~ 50 Mi€ / Year

Euratom Fission JRC ~ 50 Mi€ / Year

Total ~ 10 % EU Public&Private Fission R&D

European Commission