

Nuclear resource utilization: safety, waste management and decommissioning

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European Commission's Joint Research Centre

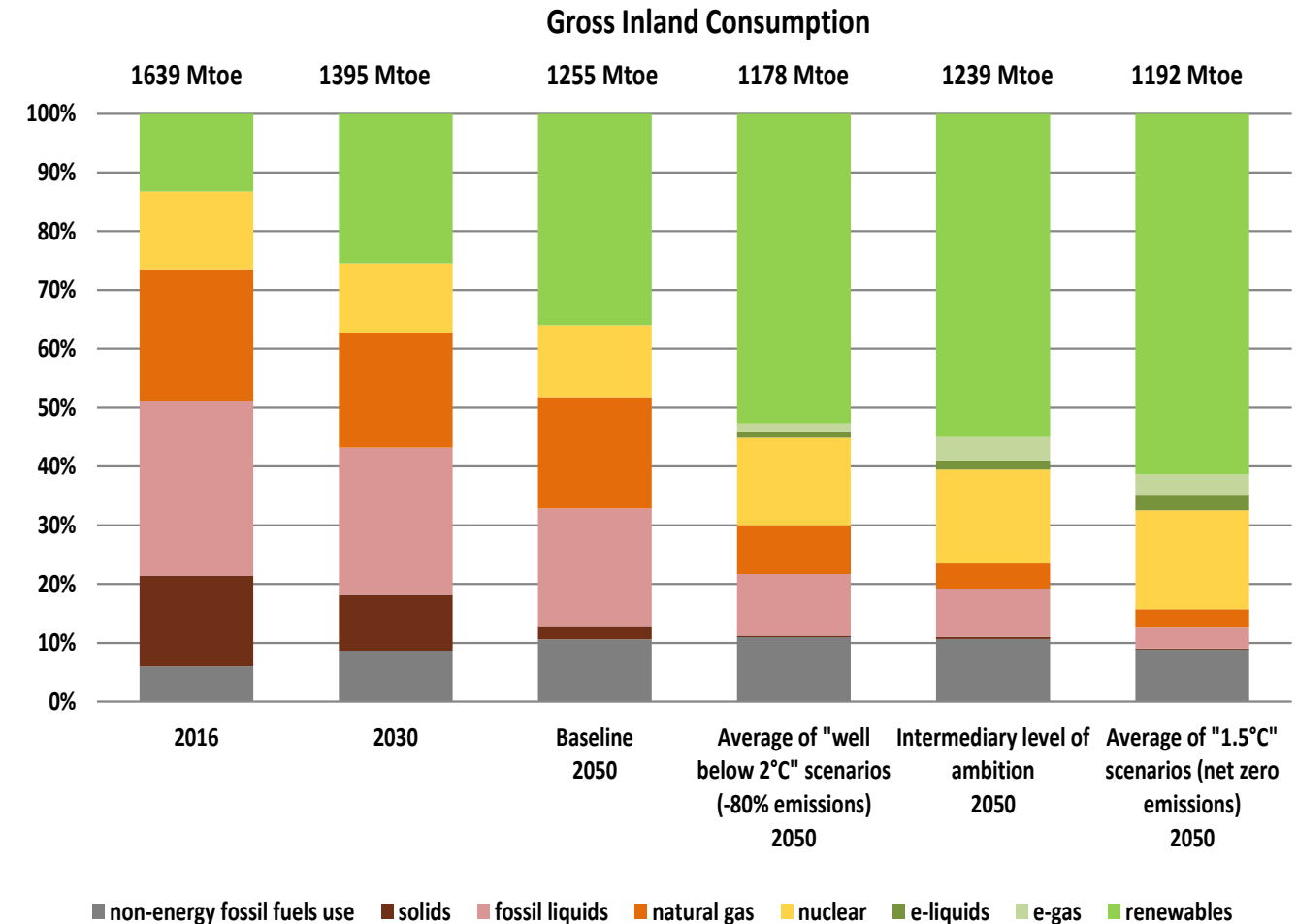
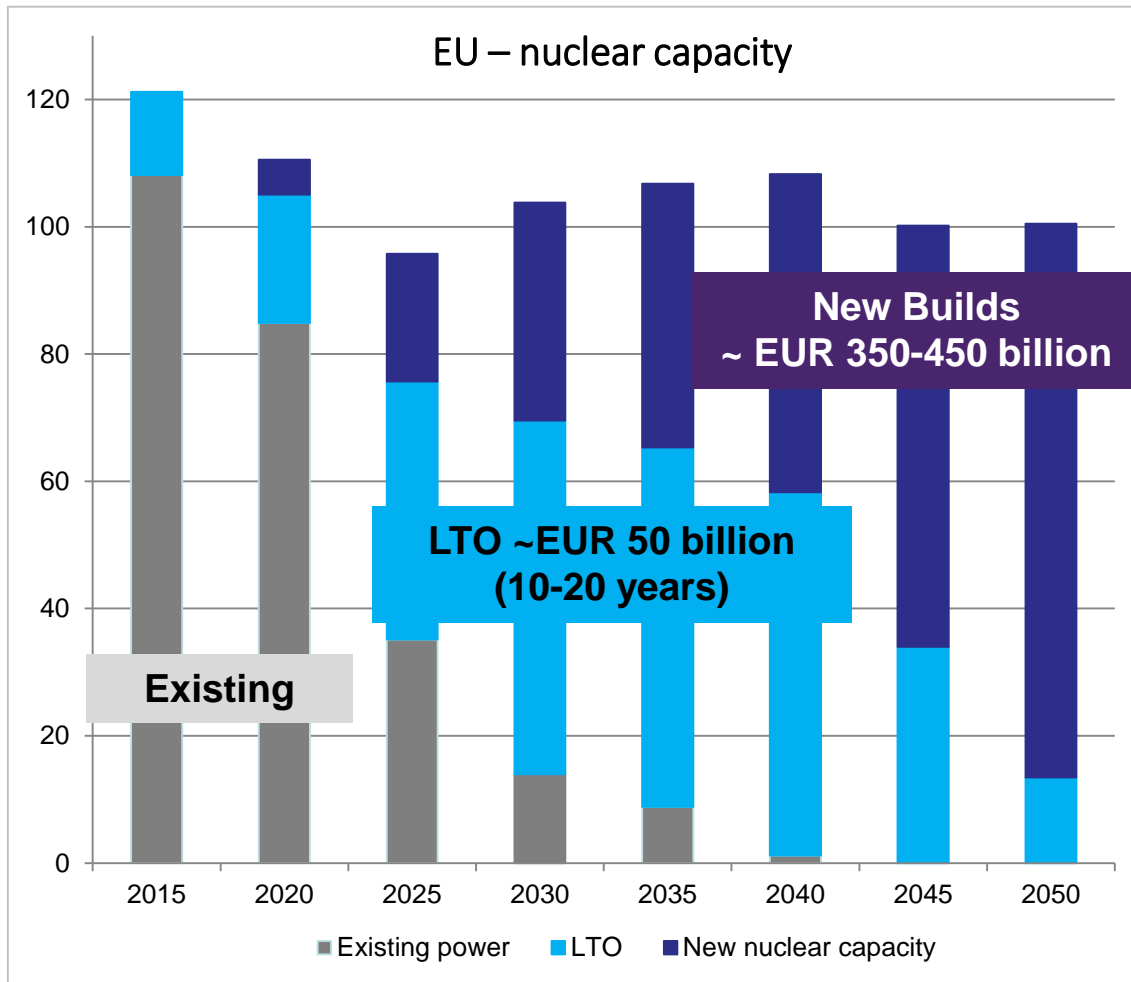
UNECE Nuclear Energy session, 24 September, 2020

Outline

- **Nuclear Energy in the EU**
- **Nuclear legal framework**
 - Objectives
 - Main elements
 - Specific elements
- **Nuclear skills and competences**
 - Research and Innovation
 - Education, training, and knowledge management
 - Nuclear Research infrastructures
- **Conclusions**



Nuclear Energy in EU 2050 Strategy



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>

Legal framework

Directive 2014/87/Euratom on nuclear safety (amending directive 2009/71):

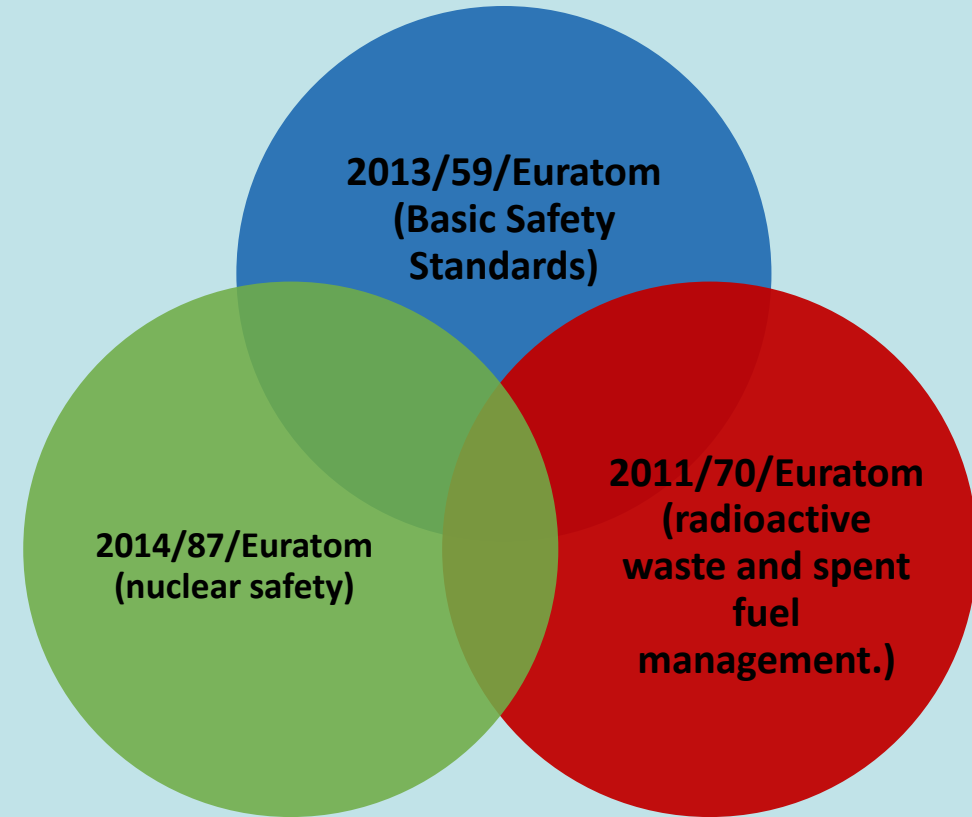
To maintain and promote continuous improvement of nuclear safety and its regulations

Directive 2011/70/Euratom on safe and responsible management of spent fuel and radioactive waste:

To ensure the responsible and safe management of radioactive waste and spent fuel to avoid imposing undue burdens on future generations

Directive 2013/59/Euratom on basic safety standards (radiation protection):

To protect the workers, the public and the environment from the dangers arising from ionising radiation.



Legal framework / Main elements

Independence of REGULATORY AUTHORITIES from undue influence in their regulatory decision making and ensures:

- sufficient enforcement capacities, financial resources, staffing with necessary qualifications, Participate in the definition of the nuclear safety requirements, Verification and inspection

TRANSPARENCY, includes Information on nuclear safety aspects, operational aspects, exposition to radioactivity, incidents, new facilities. Responsibility of the license holder and the competent regulatory authority according to national legislation and international legislation, Efficient involvement of the public in the decision-making process

EXPERTISE AND SKILLS. Education and training of the staff (This complements additional requirements of sufficient number of skilled and competent staff in the license holders' organisations and in the regulatory authority).

Legal framework / Specific elements.

NUCLEAR SAFETY OBJECTIVE.

- Nuclear installations designed and operated to avoid accidents, and should they occur, avoid large early releases.
- New build vs. Already operating plants (continuous improvement of safety)

NATIONAL PROGRAMME FOR SPENT FUEL AND RADIOACTIVE WASTE MANAGEMENT

- Member States shall implement (and maintain updated) its national programme covering all types of spent fuel and radioactive waste from generation to disposal.
- Includes national policies, principles, plans, inventory, cost estimation, key performance indicators, etc.

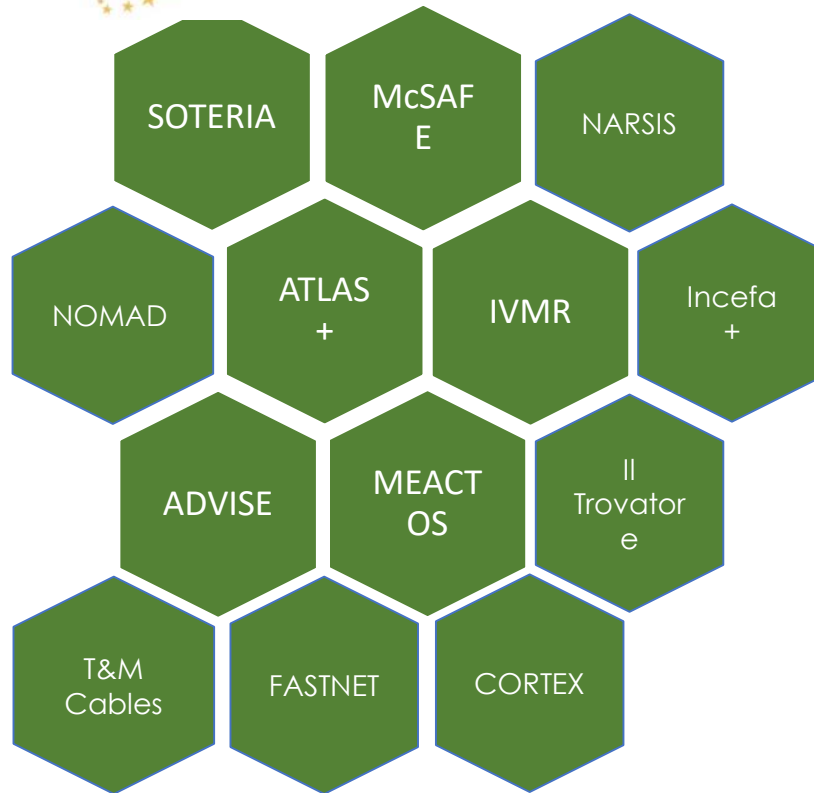
Research and Training Programmes

Specific objectives of the Euratom Research and Training Programme 2014-20

- **safety** of nuclear systems;
- safe, longer term solutions for the management of ultimate **nuclear waste**, including final geological disposal as well as partitioning and transmutation;
- development and sustainability of nuclear **expertise and excellence** in the Union;
- supporting **radiation protection** and development of medical applications of radiation, including, inter alia, the secure and safe supply and use of radioisotopes;
- promoting **innovation** and industrial competitiveness;
- ensuring 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, safeguards and security

Research Programme : Safety of Generation II/III

13 Euratom ongoing projects



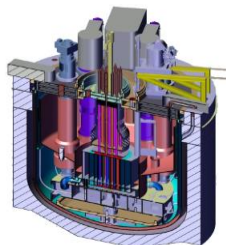
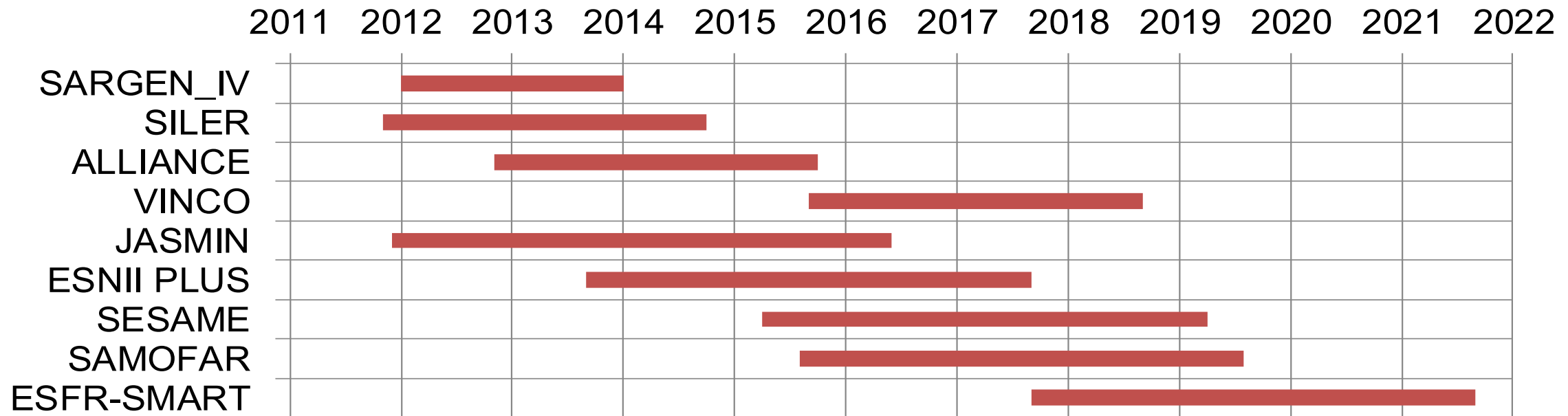
The projects have received funding from the European Union's Horizon 2020 research and innovation programme

- **SOTERIA** (CEA): Safe LTO of LWR (Degradation of RPV and RVI, follow-up project of FP7 projects PERFORM60 & LONGLIFE); **(JRC participation)**
- **Mc Safe** (KIT): High-Performance Monte Carlo Methods for SAFETY Demonstration – From Proof of Concept to realistic Safety Analysis and to Industry-like Applications **(JRC participation)**
- **INCEFA+** (AMEC): INcreasing Safety in NPPs by Covering gaps in Environmental Fatigue Assessment. **(JRC participation)**
- **IVMR** (UJV): Management Strategy of In-Vessel Melt Retention in existing and future NPPs **(JRC participation)**
- **ATLAS +** (VTT): Advanced Structural Integrity Assessment Tools for Safe Long Term Operation
- **MEACTOS** (CIEMAT): Mitigating EAC Through Optimisation of Surface condition **(JRC participation)**
- **ADVISE** (EDF): Advanced Inspection of Complex Structures
- **NOMAD** (IZFP): NDE System for the inspection of operation-induced material degradation
- **T&M CABLES** (EDF): European Tools and Methodologies for an efficient ageing management of nuclear power plant cables
- **Il Trovatore** (SCK-CEN): Innovative cladding materials for advanced accident-tolerant energy systems **(JRC participation)**
- **CORTEX** (IRSN): Non-Intrusive Core Monitoring Techniques Relying on Inherent Reactor Dynamics
- **FASTNET** (IRSN): Fast Accident Source Term tools for Emergency Centers **(JRC participation)**
- **NARSIS** (CEA): New Approach to Reactor Safety Improvements

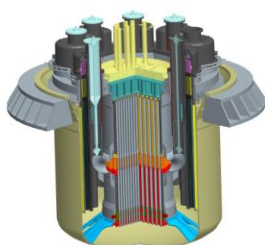
Research Programme: Safety of Generation IV



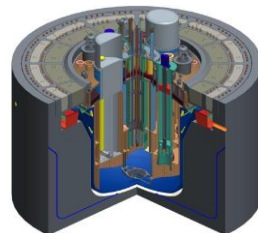
Since late 2011, EU framework programs supported **nine projects** on these systems.



ASTRID



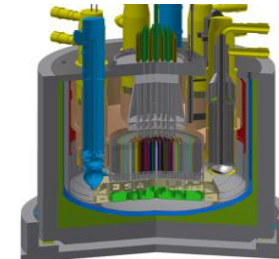
ALFRED



MYRRHA



ALLEGRO



ESFR



SEALER



MSFR

Research Programme: Waste management / Decommissioning



Modern Spent Fuel Dissolution and Chemistry in Failed Container Conditions



H2020-NFRP-2016-2017-1
Development of Solutions
for the Management of
Radioactive Waste

Topic NFRP 6
R&I issues for the first-of-the-
kind geological repositories

RIA

JRC contribution:
Study of the matrix stability in
aqueous solution of different
oxide fuels containing additives
(Cr, Al and Pu) in order to
elucidate structural effects on
the radionuclide release



European Joint Research
Programme on Radioactive Waste
Management



H2020-NFRP-2018
Radioactive waste management

Topic NFRP-2018-6
European Joint Research
Programme in the management
and disposal of radioactive
waste
COFUND (European Joint
Programme)

JRC contribution:
Verification of nuclear waste
inventories in irradiated
nuclear fuel using innovative
non-destructive detection
methods
Assessment of the response of
nuclear fuel during extended
interim storage to mechanical
solicitations
Knowledge Management



Improved Nuclear Site
characterisation for waste
minimisation in Decommissioning
and Dismantling operations under
constrained EnviRonment



H2020-NFRP-2016-2017-1
Development of solutions for
the management of radioactive
waste

Topic: NFRP-7
Research and innovation on the
overall management of
radioactive waste other than
geological disposal
RIA

JRC Contribution:
Leading WP2 – *User*
requirements & validation and
WP7 – *Dissemination &
Exploitation*.
JRC is also involved in the
implementation of the other
WPKs.



In-situ metrology for
decommissioning nuclear facilities



The European Metrology
Programme for Innovation and
Research (EMPIR)
EMPIR Call 2016
Field: Environment

JRC contribution:
The scientific contribution of
JRC is concentrated in WP3
which concerns
characterization of two
measurement stations for up
to 400 litres waste containers
constructed in Area 40 of the
JRC Ispra site. The stations
include a passive/active
neutron station and a
tomographic gamma-ray
station



StakeHolder-based Analysis of
REsearch for Decommissioning

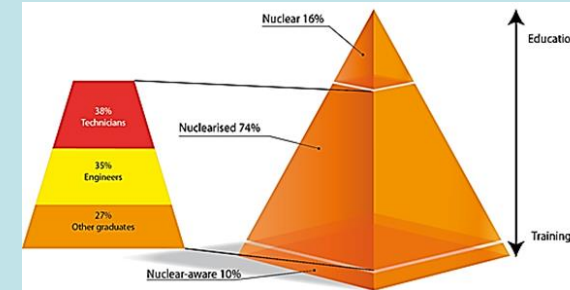
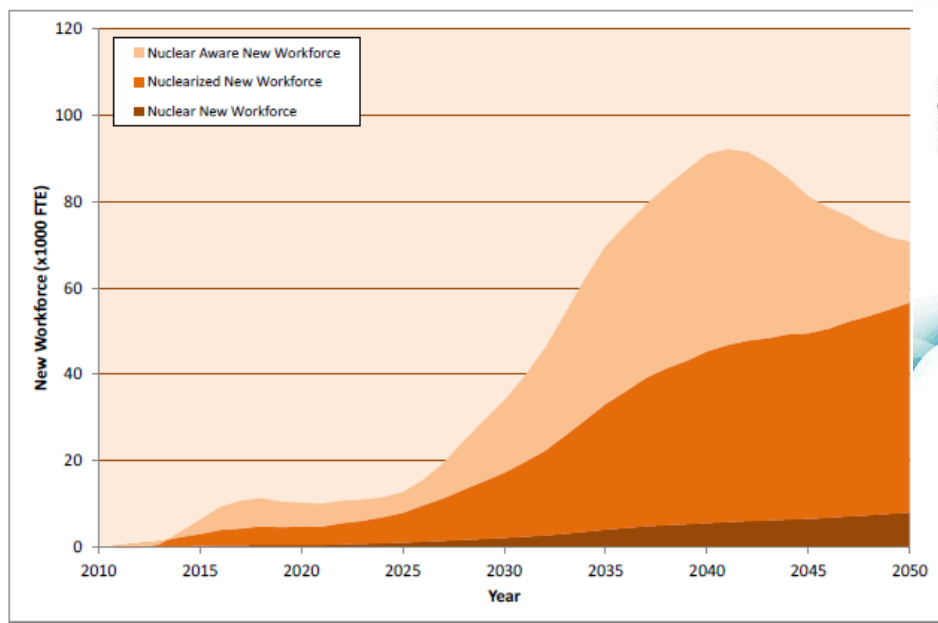


H2020-NFRP-2018
Decommissioning and
environmental remediation

Topic NFRP-2018-6
Development of a roadmap for
decommissioning research
aiming at safety improvement,
environmental impact
minimisation and cost
reduction
CSA

JRC Contribution:
Leading the WP1 -
Infrastructure for SHARE
implementation:
methodologies and tools and is
involved in the implementation
of the others SHARE work
packages

Education, training and knowledge management



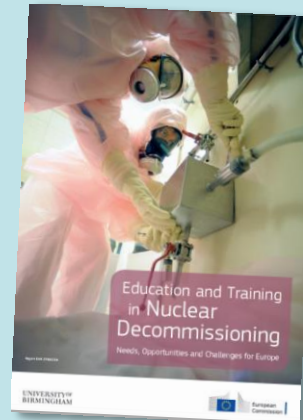
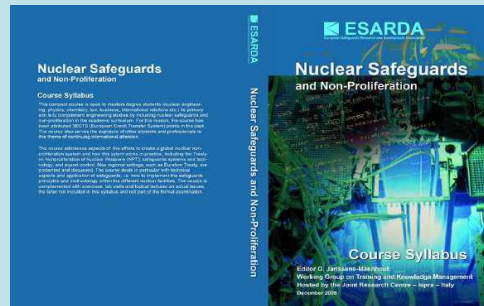
Pilot Project on knowledge management in the area of nuclear safety (TOPIC: Materials ageing)

Aims at developing a concept of a knowledge management (KM) method and tool to improve the sharing and availability of Euratom and third parties research results for the European nuclear safety research community.

Education, training and knowledge management

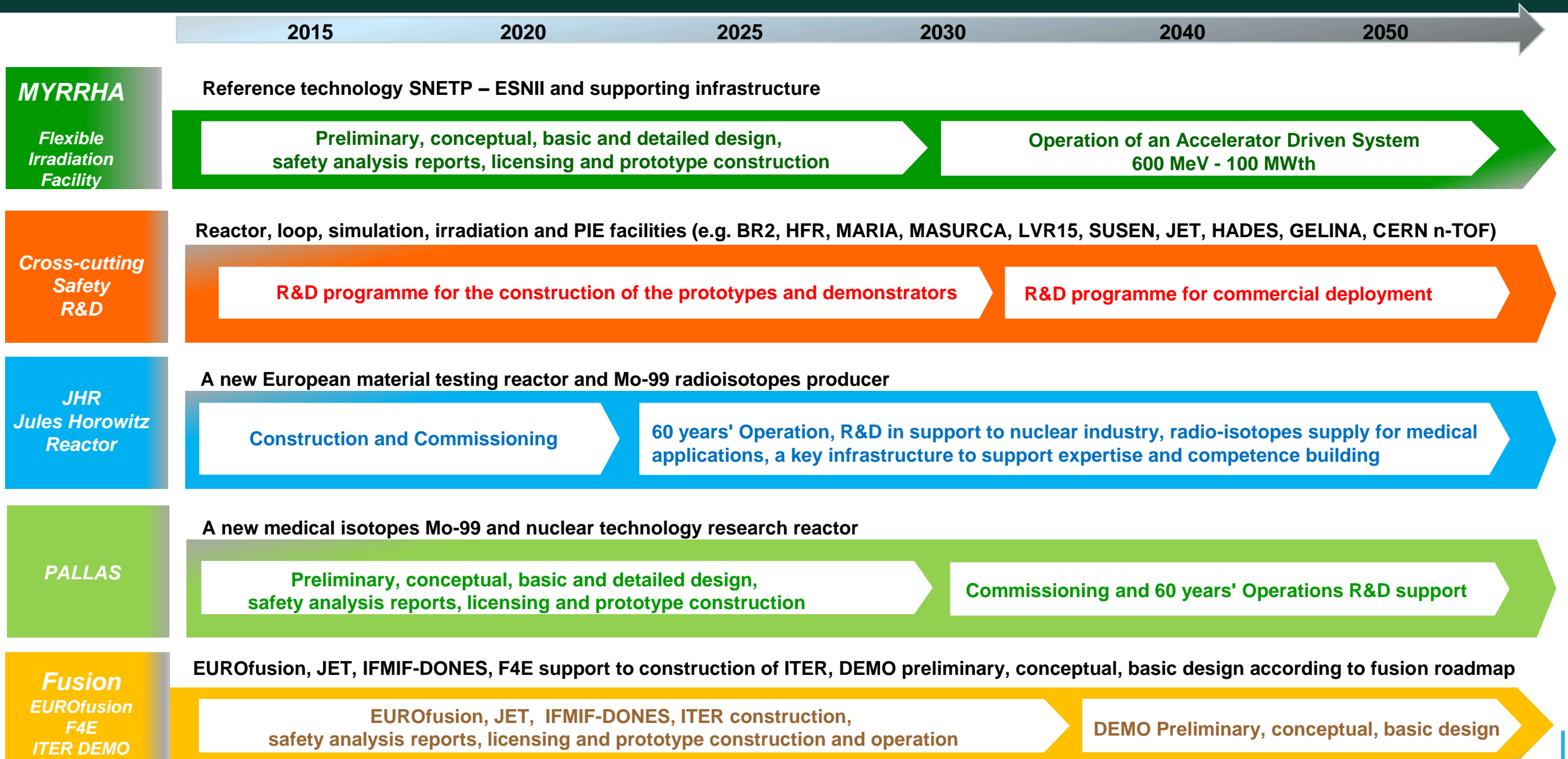
- Nuclear safety
- Nuclear security
- Nuclear data measurements
- Decommissioning and waste management
- Nuclear safeguards and non-proliferation

European Learning Initiatives in Nuclear Decommissioning and Environmental Remediation (ELINDER)



International summer school
radioactive waste management
and decommissioning

The Strategic Energy Technology (SET) Plan (Nuclear Research Infrastructures)



Open access to research infrastructure

Open access to JRC nuclear research infrastructure.

Aims at supporting mobility of EU researchers, facilitating the use of JRC unique nuclear laboratories.

JRC offers third party scientists free of charge access to its nuclear research installations.

Financial support available for researchers to (travel and subsistence)

Ongoing (Call ends 30/9)

<https://ec.europa.eu/jrc/en/research-facility/open-access>

Nuclear data

Tandem accelerator

Surface science multi-probe station

X-ray diffractometer in a glove-box

GELINA neutron time-of-flight facility

Underground low-level radioactivity lab in HADES

^{237}Np Mössbauer spectrometer

solid state NMR

Conclusions

Nuclear resources are aiming at :

- highest standards of safety, security, waste management and non-proliferation.
- maintaining technological competence in the nuclear domain, so as not to increase energy and technology dependence
- pursuing the world's safest nuclear generation, in order to contribute for growth, jobs and competitiveness

Implies:

- Developing and maintaining the most advance legal framework
- Continued efforts and investment on:
 - Research, development and innovation
 - Training, education, and knowledge management
 - Nuclear research experimental infrastructure.
- International Cooperation