Council of the
European Union

Brussels, 28 March 2022
(OR. en)

7632/22

INTER-REP 50
RECH 157
ATO 19

COVER NOTE

Subject:	Medical radioisotopes production infrastructure in the EU: Powerpoint presentation (Research(atomique questions) WP meeting 28.03.2022)

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Medical radioisotopes production infrastructure in the EU

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Council WP on Research (Atomic Questions)

28 March 2022

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- Introduction of ESA activities
- EU Observatory for the supply of radioisotopes for medical use
- Radioisotopes in medicine
- Supply infrastructure in the EU (focus on Mo-99/Tc-99m)
- Research reactors challenges

Euratom Supply Agency (ESA)

Established by the **Euratom Treaty** to ensure **supply of nuclear materials** on the principle of **regular and equal access to sources of supply** for power and non-power use by means of a **common supply policy.**

Euratom Treaty Art. 52

Prerogatives

Diversification of sources of supply.

Acknowledges all contracts on services

Exclusive right to conclude contracts for the supply of nuclear materials

Right of option on Community-produced materials

Monitors the nuclear market

ESA operations, nuclear fuel market & nuclear energy developments

ESA findings & recommendations on supply and demand of nuclear fuels

ESA diversification policy & security of supply

Security of supply of medical radioisotopes

ESA Work Programme

EUROPEAN OBSERVATORY on the supply of medical radioisotopes

Euratom Supply Agency (ESA) together with the industry association Nuclear Medicine Europe (NMEu) co-chairs the European Observatory on the Supply of Medical Radioisotopes, **set-up in 2012**

With participation of

- Commission services (ENER, JRC, RTD, SANTE), European Medicines Agency (EMA)
- OECD Nuclear Energy Agency (NEA), International Atomic Energy Agency (IAEA)
- clinical end-users organization - European Association of Nuclear Medicine (EANM)
- industry represented by the NMEu association

EUROPEAN OBSERVATORY on the supply of medical radioisotopes

With objective to

- support secure and sustainable radioisotope supply across the EU
- ensure political visibility of the medical radioisotope supply issue
- identify any event likely to impact the radioisotope supply, including logistics and call relevant parties to take appropriate countermeasures
- promptly disseminate through agreed communication channels the enquired information regarding any possible supply disruptions
- establish periodic reviews of the radioisotope supply chain and capacities
- build a foresight overview of the supply and demand of radioisotopes at EU level
- to acquire the latest information on the development and implementation of new an alternative methods and technologies of medical radioisotope production

Meetings of the Observatory
(usually twice per year)

- Global Mo-99 producing research reactors scheduling
- Brexit/Covid-19 impact on the supply
- Possible inclusion of Lutetium-177 in the scope of the Observatory
- Status of the EC projects connected with the supply of medical radioisotopes
- Future supply outlook
- Updates from NMEu, IAEA, OECD/NEA and EANM
- As of March 2021, the Observatory has an updated Mission Statement and new Terms of Reference to better define its way of operating
- Next meeting scheduled for 29 June (Brussels) to mark 10-year anniversary

Reports produced by (or through) the Observatory

EUROPEAN OBSERVATORY on the supply of medical radioisotopes

Joint Observatory between the European Commission and AIPES
European Observatory for medical radionuclide supply

Working Group 3 (WG3)
Management of conversion from HEU to LEU and Target Production

Overview

Mo-99 is the most important radionuclide in nuclear medicine. It is used to produce Tc-99
generators which are used in more than 30 million diagnostic nuclear medicine procedures aroun
the world each year. Tc-99m is used in more than 100 different types of diagnostic nuclea
medicine procedures including evaluation of myocardial function, detection and staging of cance
brain disorders, infections and many other diseases. Accordingly, a stable and sustained supp
of Mo-99 must accompany the conversion process from the use of Highly Enriched Uranium (HEU
to Low-Enriched Uranium (LEU) to manufacture targets for irradiation in the nuclear reactor.

EUROPEAN OBSERVATORY on the supply of medical radioisotopes

Working Group 4 (WG4)

Capacity and Infrastructure Development

July, 2014

1. Overview

Radionuclides are used in nuclear medicine for the diagnosis and treatment of various diseases, such as cancer, cardiovascular diseases and brain disorders. Over 10,000 hospitals worldwide use radionuclides for the in vivo diagnosis or treatment of about 50 million patients every year, of which several million in Europe. Metastable technetium-99 (Tc-99m) is the most important radionuclide in nuclear medicine. It is used in more than 30 million diagnostic nuclear medicine procedures around the world each year, accounting for more than 20% of the global radiopharmaceutical market. Tc-99m is availed from its parent isotope Molybdenum-99 (Mo-99). The production of Mo-99 in large quantities is through the fission of Uranium-235, which is a complex process involving irradiation of uranium targets in

Tc 99 6.007 h 2.1·10⁵ a
Tc 100 15.8 s
Mo 98 24.39
Mo 99 65.976 h

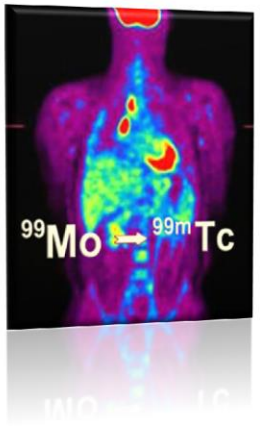
Report on the Security of Supply of Medical Radioisotopes

Euratom Supply Agency

European Research Reactor
Position Paper
by
CEA, NCBJ, NRG, PALLAS, RCR,
SCK•CEN and TUM

15 June 2018

Radioisotopes in medicine

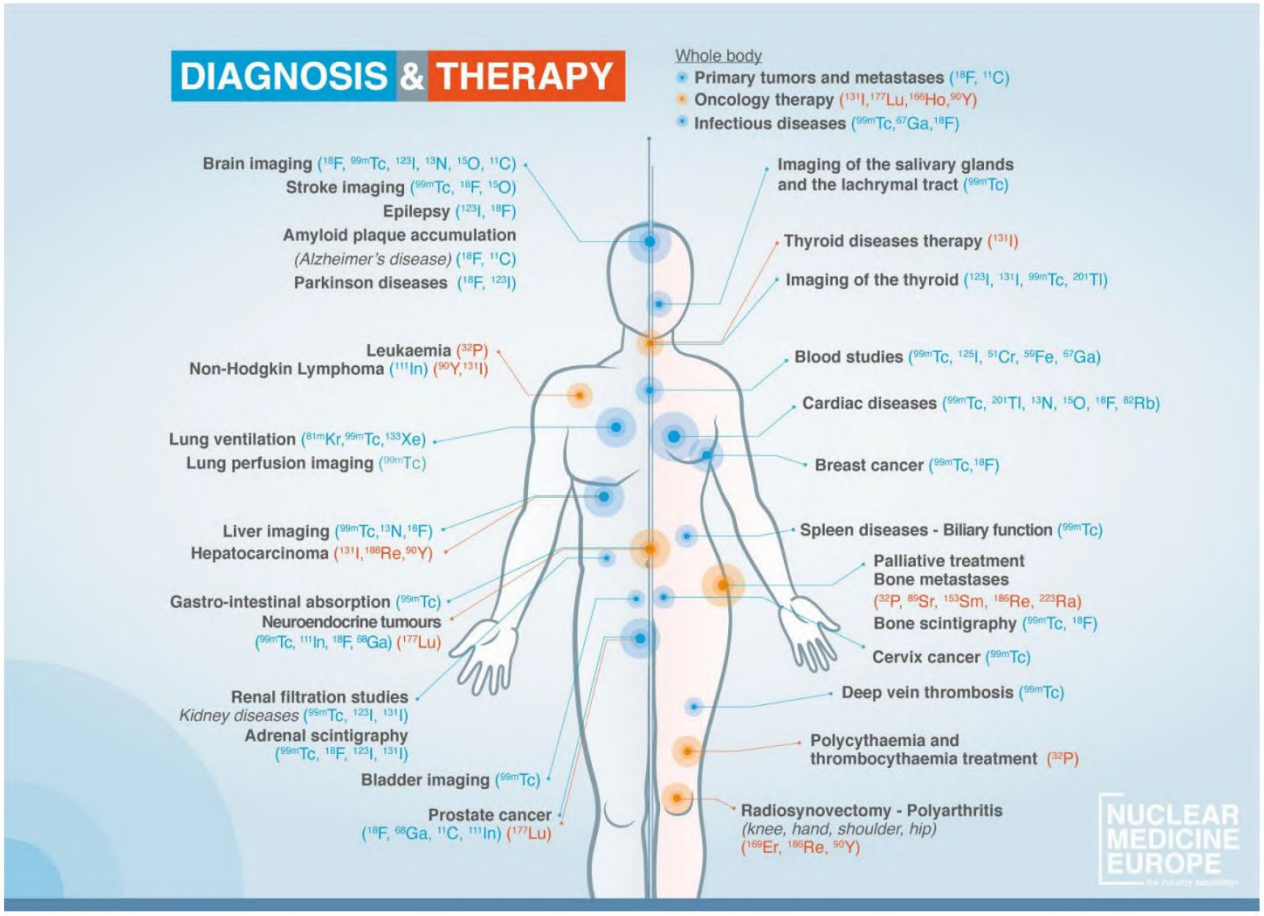


- Vital role in diagnosing cancer, cardiac conditions and other diseases
- Increasingly used for cancer treatments
- Over 10 000 hospitals worldwide use radioisotopes in about 100 different nuclear medicine procedures totalling almost **49 million medical procedures** each year
- In the EU alone, more than **1500 nuclear medicine centres** deliver about **10 million procedures** to patients each year
- Up to **65%** of nuclear medicine procedures are performed in **oncology**
- Molybdenum-99 (**Mo-99**) and its daughter product Technetium-99m (**Tc-99m**) - used in **80%** of all nuclear medicine diagnostic procedures

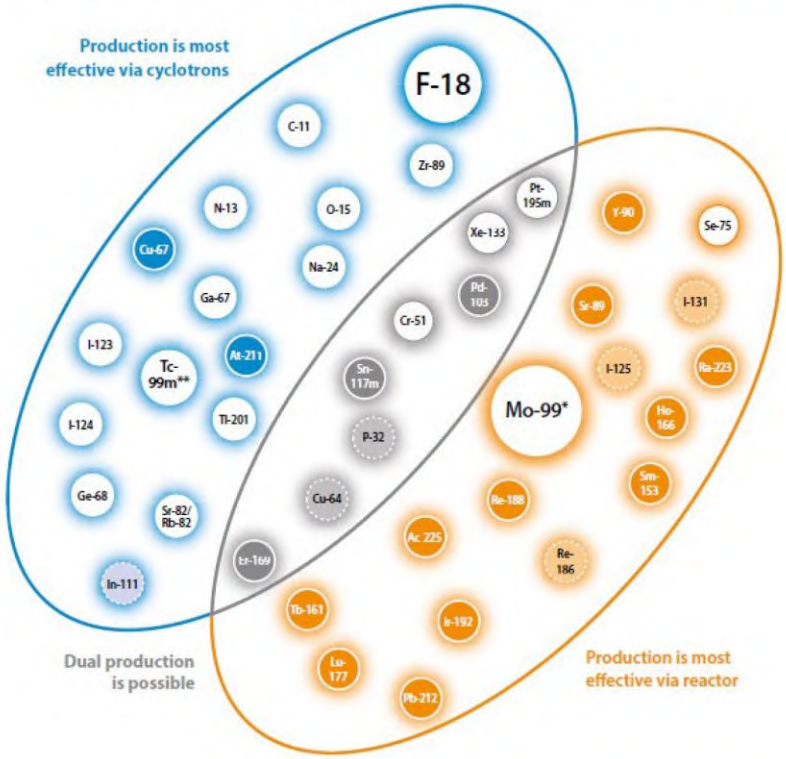
Medical radioisotopes

- **EU:** unique supply network - innovative technology developments - strong clinical research commitment -> a **central role in the nuclear medicine domain**
- **EU**: leading supplier of medical radioisotopes to the world market, with a market share of more than **60%** for some of the most widely used radioisotopes
- Main source of radioisotopes - **research reactors**, with several other technologies that use cyclotrons or linear accelerators in use or under development
- The different radioisotopes and production technologies rely on highly specialised supply chains, which often extend across countries and continents and involve **24/7 “just-in-time” delivery**

Medical radioisotopes: use

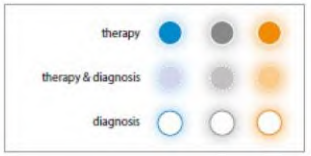


Medical radioisotopes: production



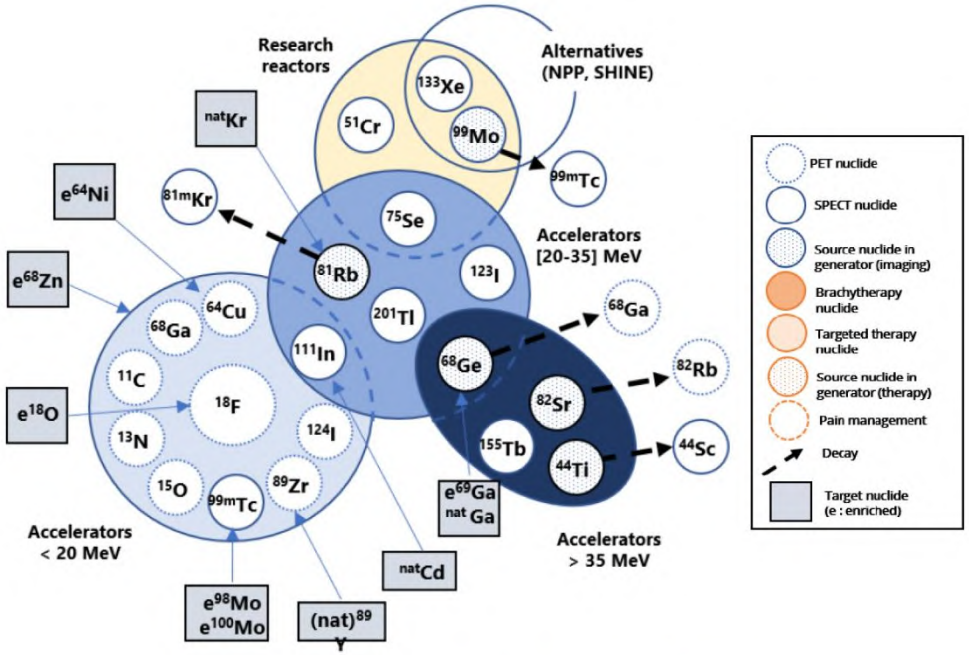
* Various production routes for Mo-99 are being examined.

** The direct production of Tc-99m via accelerators is being examined.

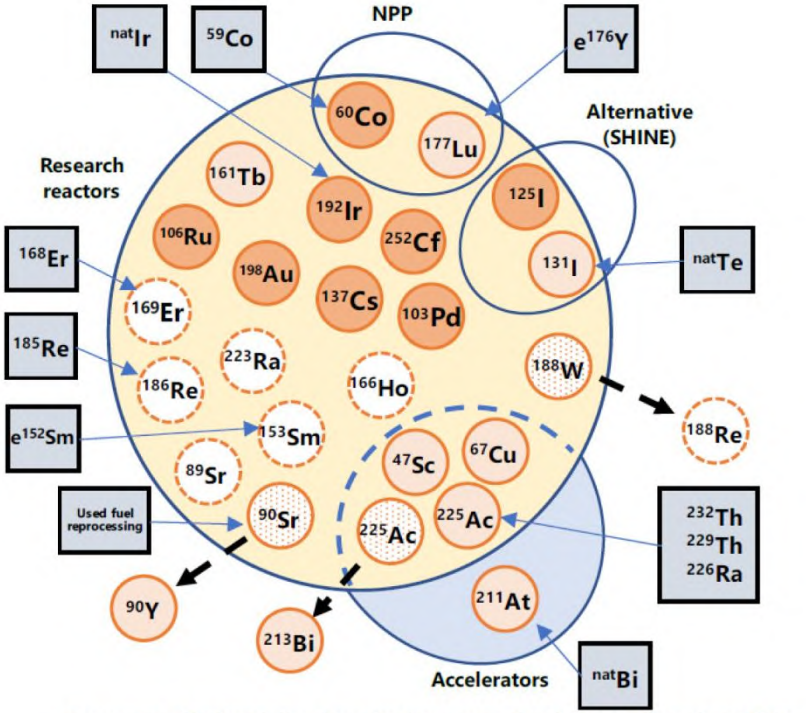


Co-ordinated approach to the development and supply of radionuclides in the EU, Final report, 29/10/2021

Medical radioisotopes: production



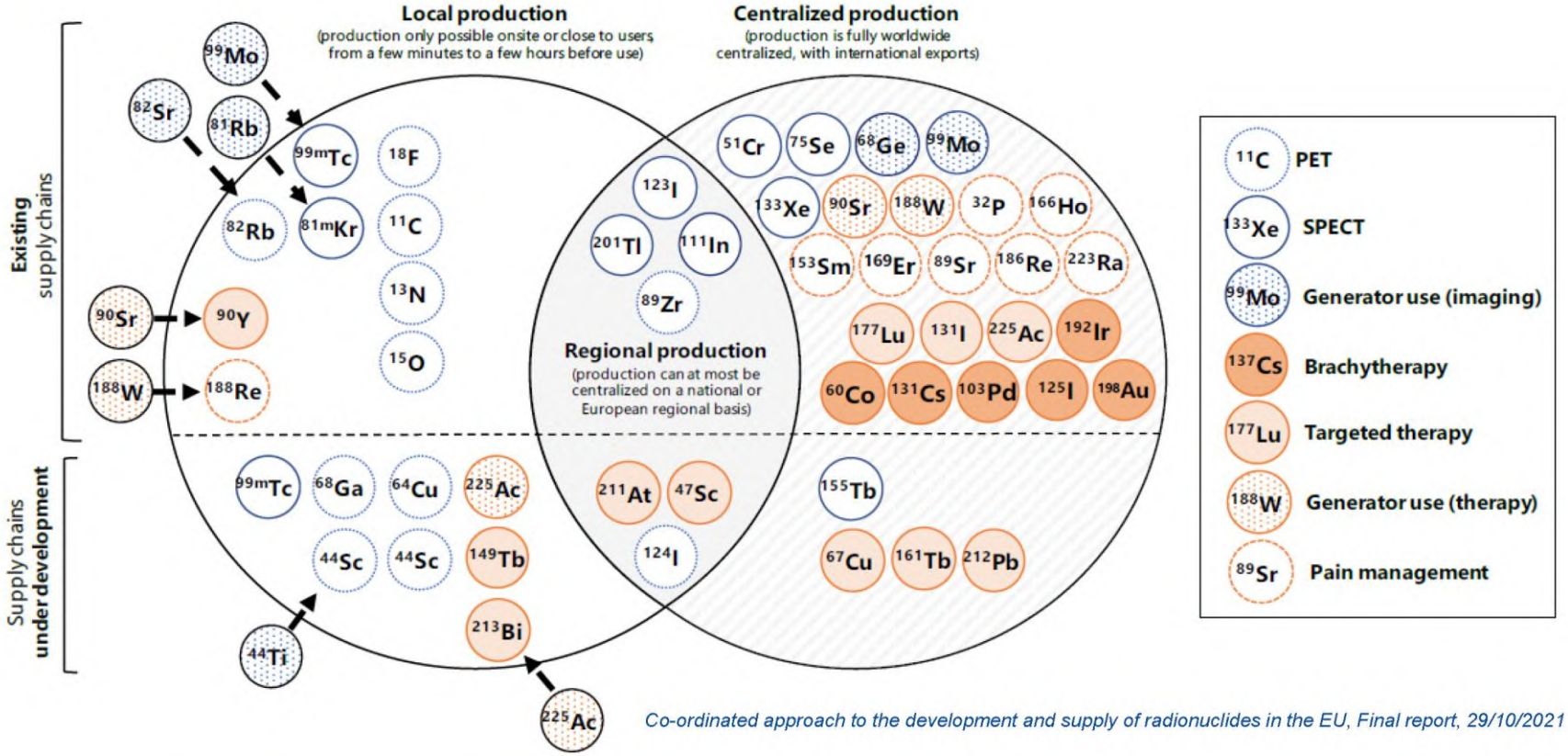
Summary of industrialized production routes for imaging radionuclides



Summary of industrialized production routes for therapeutic radionuclides

Co-ordinated approach to the development and supply of radionuclides in the EU, Final report, 29/10/2021

Medical radioisotopes: production



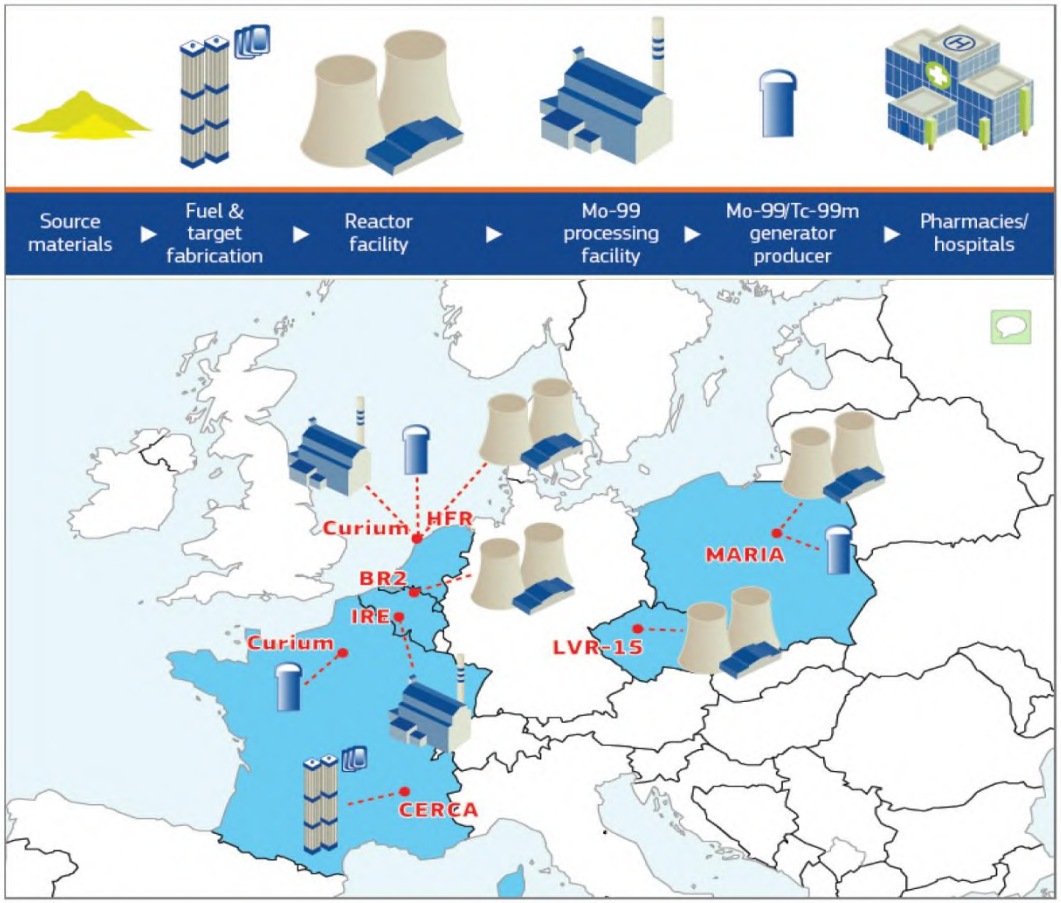
Co-ordinated approach to the development and supply of radionuclides in the EU, Final report, 29/10/2021

Summary of existing/future supply chains to be secured, according to their supply models: local, regional or centralized

Mo-99/Tc-99m Supply infrastructure (EU)

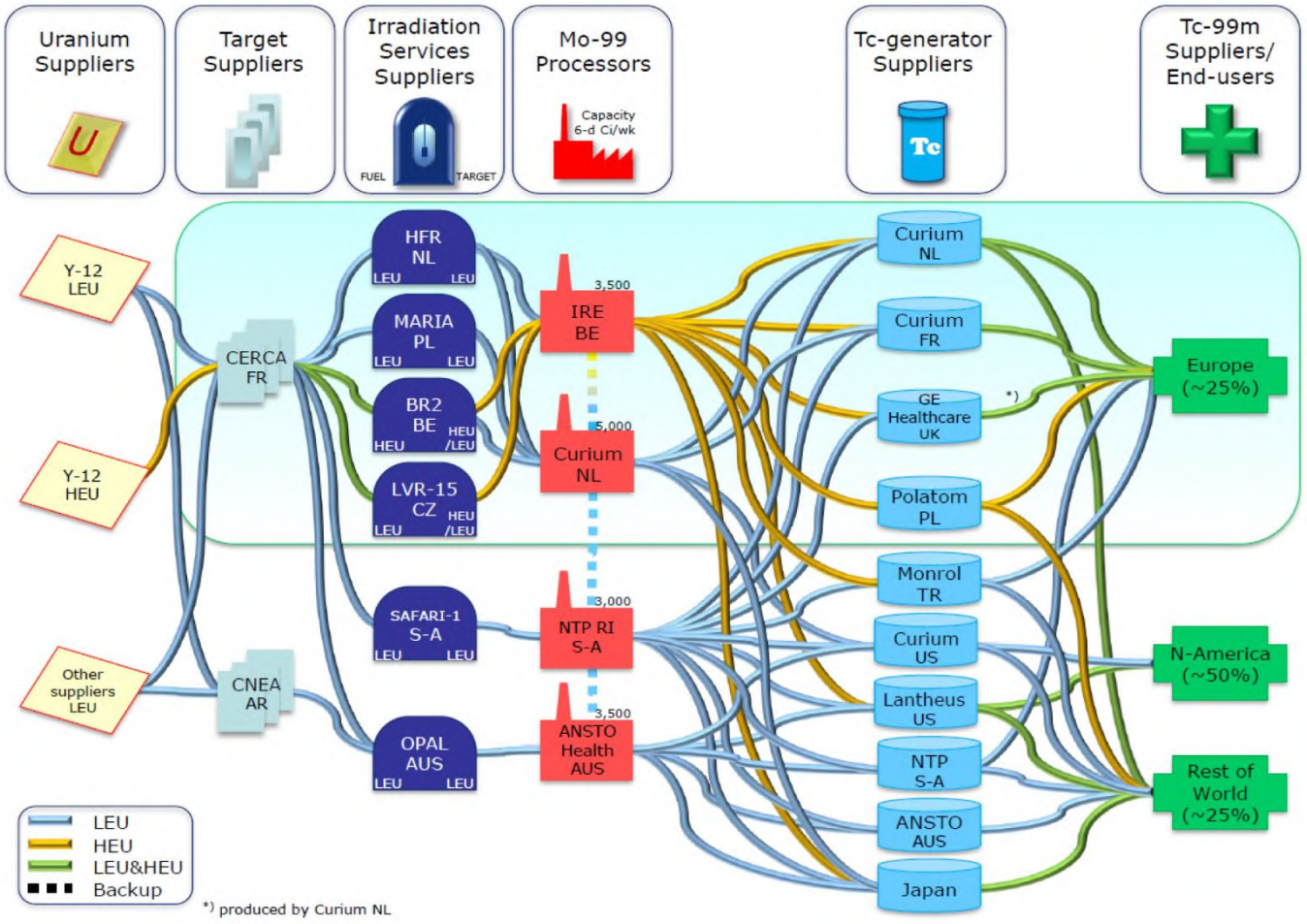
Unique regional network

(inc. all supply chain actors)



60% of global market share

Mo-99/Tc-99m Supply infrastructure (world)



Research reactors challenges

Age factor

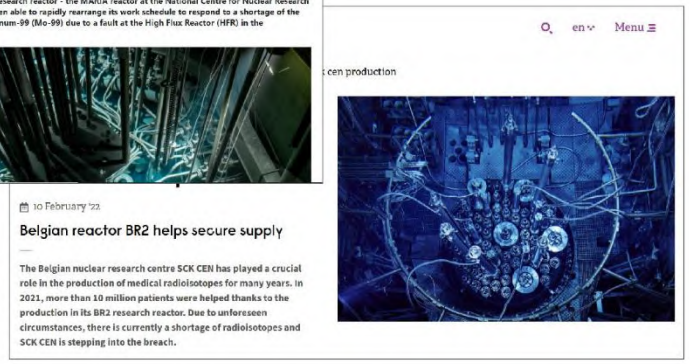
Major current Mo-99 producing reactors in the EU

Reactor name	Location	Annual operating days	Normal production per week	Weekly % of world demand	Date of commissioning	Estimated end of operation
BR-2	Belgium	140	5 200	25-65	1961	2036
HFR	Netherlands	300	4 680	35-70	1961	2024
LVR-15	Czech Republic	-	+600	-	1957	2028
MARIA	Poland	-	700 – 1 500	-	1974	2035

[6]Nuclear Medicine Europe data

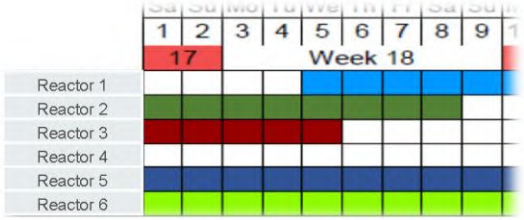
Future production facilities:

- FRM-II (Germany)
- JHR (France)
- MYRRHA (Belgium)
- PALLAS (Netherlands)



Coordination of the research reactor maintenance schedules

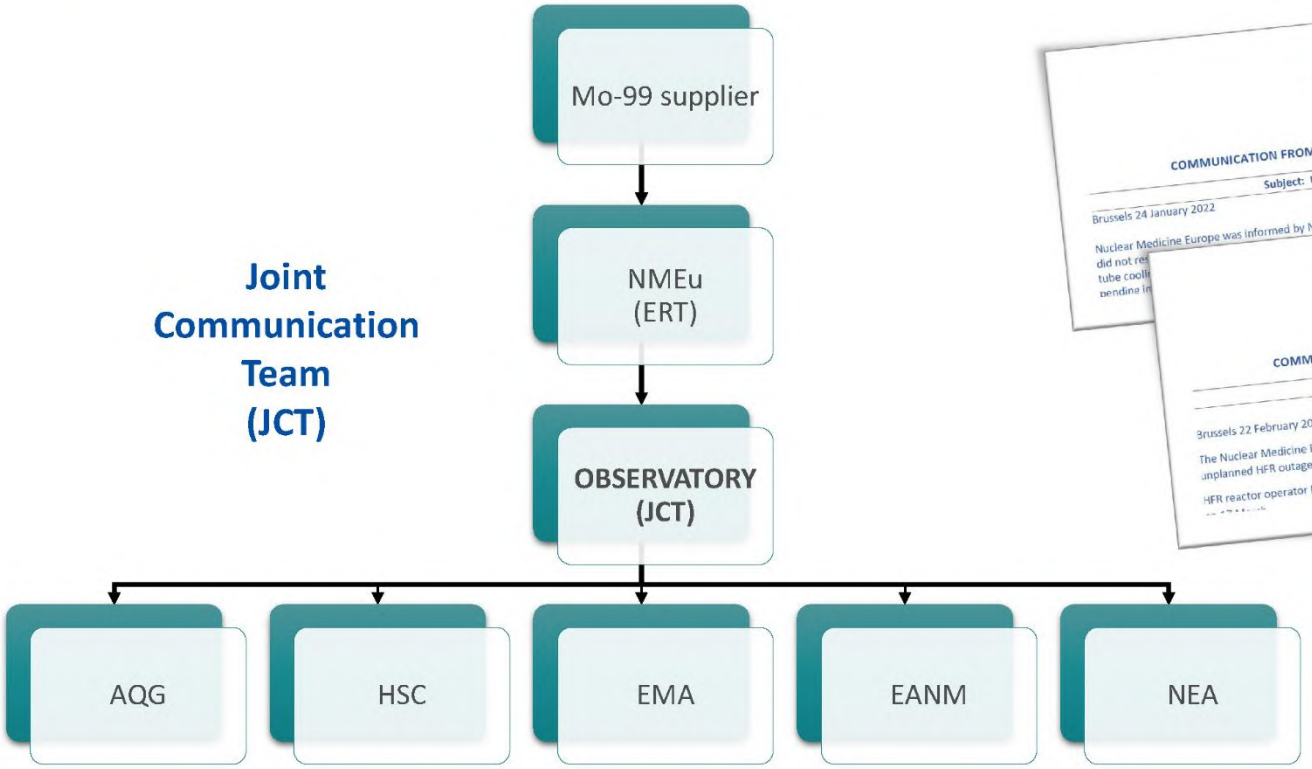
- Voluntary participation of the operators
- **Emergency Response Team (ERT)** to monitor production and supply issues
  - research reactor operators
  - Mo-99 processors
  - Mo-99/Tc-99m generator manufacturers



- Continuous monitoring to identify potential shortages of Mo-99 and draw up mitigation action plans involving all stakeholders

Communication to the stakeholders

Joint Communication Team (JCT)




NUCLEAR MEDICINE EUROPE

COMMUNICATION FROM THE NMEu EMERGENCY RESPONSE TEAM (ERT)

Subject: Unplanned Outage of the HFR Reactor

Brussels 24 January 2022

Nuclear Medicine Europe was informed by NRG, the operator of the HFR reactor in Petten, Netherlands, that the HFR

NUCLEAR MEDICINE EUROPE

COMMUNICATION FROM THE NMEu EMERGENCY RESPONSE TEAM (ERT)

Subject: Update on HFR Reactor Outage

Brussels 22 February 2022

The Nuclear Medicine Europe Emergency Response Team held a call on 21 February 2022 on the unplanned HFR outage that resulted in cancellation of the planned HFR first operating cycle of 2022.

HFR reactor operator NRG informed Nuclear Medicine Europe of continued progress in efforts to return HFR to servic

Research reactors challenges

HEU ➡ HALEU conversion

NSS 2010 - 2016

HERACLES-CP

Our first H2020 project, focused on a sound scientific understanding of the irradiation behaviour of UMo and advancing production techniques for dispersion fuel. Running from 2015 to 2019.

READ MORE

LEU FOREvER

The second project, aiming on advancing production technology for dispersion and monolithic fuels and paving the way for high density U_3Si_2 fuels. Engineerd in a way, that HPRRs and MFRs will profit altogether. Running 2017 to 2021.

READ MORE

EU-QUALIFY

The third project, aiming on advancing production technology for dispersion and monolithic fuels and paving the way for high density U_3Si_2 fuels. Engineerd in a way, that HPRRs and MFRs will profit altogether. Running 2017 to 2021.

READ MORE

HERACLES-CP
Grant agreement ID: 661935

Closed project

Start date 1 June 2015 — **End date** 29 February 2020

Funded under
H2020-Euratom-1.8.
H2020-Euratom-1.4.
H2020-Euratom-1.1.

Overall budget
€ 6 349 673,11

EU contribution
€ 6 349 673,11

Coordinated by
TECHNISCHE UNIVERSITAET MUENCHEN
Germany

LEU-FOREvER
Grant agreement ID: 754378

Start date 1 October 2017 — **End date** 31 March 2022

Funded under
Euratom

Total cost
€ 6 923 147,50

EU contribution
€ 6 598 148,25

Coordinated by
COMMISSARIAT A L ENERGIE ATOMIQUE ET AUX ENERGIES ALTERNATIVES
France

EU-QUALIFY
Grant agreement ID: 945009

Start date 1 October 2020 — **End date** 30 September 2024

Funded under
Euratom

Total cost
€ 9 044 296,25

EU contribution
€ 7 798 926

Coordinated by
STUDIECENTRUM VOOR KERNENERGIE / CENTRE D'ETUDE DE L'ENERGIE NUCLEAIRE
Belgium

https://heracles-consortium.eu/horizon2020.php

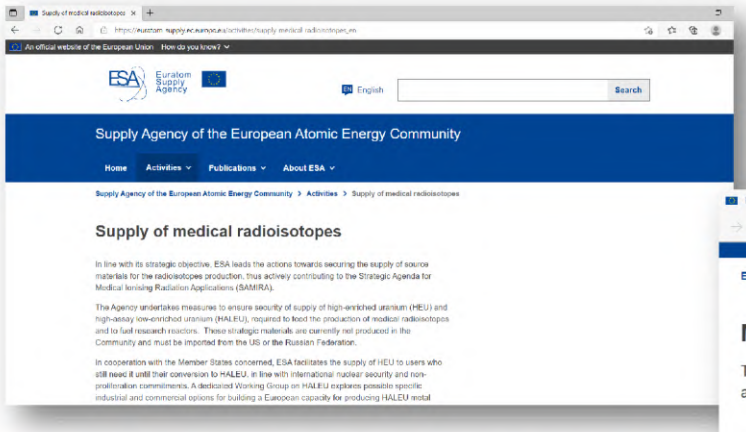
Supply of High-Enriched Uranium (HEU) for European Research Reactors

- ESA continues cooperating with the US DoE/NNSA to ensure the supply of HEU for the use of European research reactors by means of transferring excess HEU to the US in exchange in order to minimize the amounts of HEU
- MoU between US DoE/NNSA and ESA
  - Signed in 2014
  - Review of balance of material annually
  - Revised and signed in February 2021 with agreement to
    - Take into account the withdrawal of UK from the EU
    - Maintain the material balance sheet
    - Continue annual reviews
    - Carry out the next review of MoU after three years
- Next review meeting scheduled for May 2022

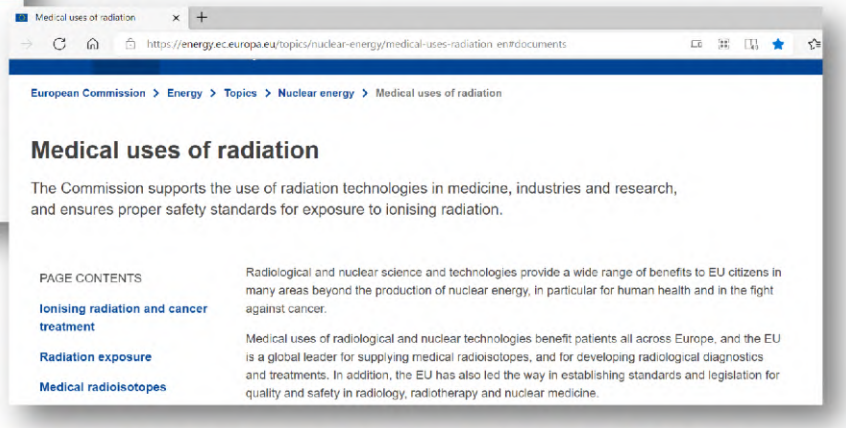
Supply of High-Assay Low-Enriched Uranium (HALEU)

- ESA Advisory Committee's WG on European Supply of low-enriched (19.75%) uranium
  - Set up in 2012 with a report in 2013
  - 2nd mandate in 2018 -> revised assessment of the report in 2019
  - 3rd mandate
    - kick-off meeting in April 2021
    - to explore the necessary conditions, including European public and private sector and specific industrial and commercial options, and to facilitate preparation of the possible construction in Europe of a HALEU metal production capacity responding to the EU needs for the research reactors fuel and medial radioisotopes production.
  - Draft report expected for 12 May ESA Advisory Committee meeting

For more information, studies and reports



https://euratom-supply.ec.europa.eu/activities/supply-medical-radioisotopes_en



https://energy.ec.europa.eu/topics/nuclear-energy/medical-uses-radiation_en#documents

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Thank you

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