COMMENTS OF **FINLAND** to the
ISSUES PAPER No. 10

[…]

Introduction

The European civil nuclear power sector is an established industry generating 27% of all electricity consumed in the EU and contributing to competitiveness, security of energy supply and limitation of CO_2 emissions as part of the EU's 2020/2030/2050 energy and climate policy objectives. In its Energy Union Communication[1], the Commission stated that *"putting the EU at the forefront of smart grid and smart home technology, clean transport, as well as clean fossil fuel and the world's safest nuclear generation, is central to the aim of turning the Energy Union into a motor for growth, jobs and competitiveness",* and that *"the EU should also ensure that it maintains technological leadership in the nuclear domain, including through ITER, so as not to increase energy and technology dependence"*.

Fourteen EU MS currently operate nuclear power plants (NPPs), though all MS benefit through the electricity grid from nuclear-generated electricity and have an interest in ensuring the safety of operating NPPs no matter where they are located. In addition, all MS benefit from the use of ionising radiation in industry and medicine and have accumulations of radioactive waste from either the nuclear power sector, research and/or medical and industrial applications.

In the European Commission's Energy roadmap 20 50[2], all scenarios include continued reliance on nuclear power, though the ageing of the existing fleet implies an increasing role for long-term operation (LTO) as well as the growth in decommissioning and related waste management activities. The projection in the latest Nuclear Illustrative Programme (PINC)[3] shows that after an initial decline in EU nuclear generation capacity up to 2025, the trend is reversed by 2030 with new reactors connected to the grid together with extensive LTO of the existing fleet. After a slight increase, the capacity then remains stable at between 95 and 105GWe until 2050, by which time approximately 80-90% of installed capacity would be new build. The PINC figures not only underline the significant investments in new build, but also in LTO of existing plants that will play a crucial role in bridging the gap between now and the availability of the new plants.

At the global level, the Energy Technology Perspectives (ETP2015)[4], in the scenario limiting increase in average global temperature to 2°C, assume that world nuclear capacity will more than double to 930GWe by 2050, with nuclear power then representing 17% of global electricity production. Moreover, the Paris COP21 Agreement on Climate Change, 12 December 2015, emphasised the need to limit the increase in the global average temperature to well below 2°C above preindustrial levels.

The EU legislative framework has been significantly strengthened in recent years: a Council Directive on the management of spent fuel and radioactive waste was adopted in 2011, followed by a revised Basic Safety Standards Directive in 2013 and a revised Nuclear Safety Directive in 2014 (more details in Annex 1). This represents the most advanced legally binding and enforceable regional legal framework on nuclear safety and related issues anywhere in the world. In addition,

1 COM(2015)80 final, 25/02/2105 (http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=COM%3A2015%3A80%3AFIN)
2 COM(2011)885 final, 15/12/2011; Publications Office of the EU, 2012, ISBN 978-92-79-21798-2
3 'Programme indicatif nucléaire communautaire', or 'Nuclear Illustrative Programme presented under Article 40 of the Euratom Treaty for the opinion of the European Economic and social Committee', C(2016)177, 04/04/16
4 IEA Energy Technology Perspectives 2015 (http://www.iea.org/etp/etp2015/) and the joint IEA / NEA Technology Roadmap for Nuclear Energy (https://www.oecd-nea.org/pub/techroadmap/)

there are a number of relevant Strategic Research Agendas, Deployment Strategies, roadmaps and/or coordinated research programmes prepared by or under the auspices of a range of key stakeholder groups, technology platforms and international bodies (refer to Annex 1 for an exhaustive list).
Furthermore, actions were already summarised in the input to the SET-Plan integrated roadmap discussions in 2014, and key elements are presented in Annex 2.

In addition, the timely supply of educated and skilled talents is essential element leading to the success of the SET plan. Long-term consolidation and strengthening of the nuclear Education,

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Training and Knowledge Management (EKTM) activities in the EU and its member countries is therefore in the forefront if the EU strategic goals in the nuclear power sector.

The targets in the present document are consistent with the research and policy base as listed in the annexes. In addition to the targets themselves, a number of important cross-cutting challenges are also listed. The targets concern primarily the energy sector, though non-energy applications such as supply of radiopharmaceuticals, use of radiation in medical practices and related health effects of low doses, are also important and are closely linked, particularly as regards research infrastructure and availability of irradiation facilities (refurbishment / construction of research reactors).

Targets

1. Maintaining a high level of safety and security

The priority is maintaining a high level of safety and security (current fleet, LTO, new-build). This involves organisational, operational and regulatory aspects, as well as further research & innovation, the latter often depending on the availability of research infrastructures of pan- European relevance. Relevant targets are:

- by August 2017, transposition by MS of the Nuclear Safety Directive, followed by timely realisation of the new 'Nuclear Safety Objective' through a clear schedule for implementation;

- by 2020, availability of conclusive research findings on (i) ageing of structures, materials and components (LTO of NPPs and extended spent fuel storage) and (ii) more robust and accident- resistant designs (passive systems, accident-tolerant fuels, improved containment designs and protection strategies);

- by 2020, a clear view on the future needs _of trained workforce and on how to meet these needs. Explore and utilize possible synergies with ETKM activities in the complementary targets;

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- by 2020, implementation by MS of all actions to improve nuclear safety as follow-up to the stress tests

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- optimisation of NPP operation as a function of predicted demand, and integration with more intermittent suppliers in evolving electricity grids in order to assure the technical and economical capability of NPP operation to load follow and the reduction of operation and maintenance costs

. - observance of strict non-proliferation regime and physical protection of nuclear materials and facilities

It is recommended to add a new target

2. Security of power supply

Undisturbed electricity supply js a prerequisite for functionality of the modern society

- secure the economic use of nuclear power as an important part of the weather- dependent renewable (wind and solar) power system without extensive investments for power storage. Securing low carbon energy supply by new builds based on the current technologies.

3. Radioactive waste management and decommissioning

- In line with obligations under the spent fuel / radioactive waste Directive in particular, MS are putting in place and carrying out national programmes, including necessary research. Key target is, by 2030, the operation in Europe of the world's first deep geological repositories for spent nuclear fuel and/or heat-generating high-level radioactive waste.

- By 2030, the development of a world-leading decommissioning sector, building on the EU's safety culture and know-how in waste management.

4. Advanced and innovative fission reactors

Towards 2050 the availability of designs offering increased uranium resource efficiency and lower long-lived waste production may become attractive for utilities. Furthermore it is crucial to take, into account the increasing requirement for more flexible energy sources and recent MS initiatives in this regard small modular reactors (SMR) and co-generation plants may develop on a shorter timescale:

- research and development for licensing practises of SMRs
- licensed SMR design(s) available in the EU by 2025, with operating plant(s) by 2030;
- evaluate the capability and advantages of SMRs for load follow operation and to replace fossil energy production in current and future energy systems
- at least one Generation-IV demonstrator fast reactor operating in Europe by 2030, including associated fuel cycle facilities (pilot fuel fabrication and processing plants). This is late already!

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5. Fusion

Successful ITER construction and operation in line with agreed baseline, and progress to fusion electricity in line with European roadmap and EUROfusion Joint Programme (see Annex 1 - targets to be further developed following publication of revised ITER baseline and revised European roadmap).

- How is this related to the SET Plan schedule?
- Explore and utilize possible synergies in ETKM activities in nuclear fission

Cross-cutting challenges

To achieve the above top-level targets, and to enable nuclear to remain a safe and competitive option in the future energy mix, a number of cross-cutting challenges need to be addressed that also involve concerted efforts amongst stakeholders and MS, in particular:

- **stable / predictable long-term investment conditions**, which for new build means the availability of appropriate financing schemes such as contracts for difference, an effective supply chain and a more appropriate carbon price[5];
- **diversification of nuclear fuel supplies**, in line with the objectives outlined in the Energy Union Communication (see footnote 3) and the European Energy Security Strategy Communication[6];

it is recommended to split the bullet on trained workforce in two parts to acknowledge different-approaches needed for the successful education and training of engineers/scientists and vocational training and some editorial:

- Stable/predictable education and training of scientists, engineers and other skilled workers benefitting from strengthened national programmes, funding through ERC, MSCA or ERASMUS+ grants, and coordination at the EU level by technology platforms and professional associations such as ENEN,
- Stable/predictable availability of a trained workforce, e.e. benefitting from the European Credit System for Vocational Education and Training (ECVET)

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- **harmonisation of licensing rules and standards**, including mutual recognition by regulatory authorities, streamlining of design approval and harmonised classification schemes;
- ensuring **synergy between safety, security , safeguards and, operability;**

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- **standardisation of reactor codes**, enabling a common reference to be established between all actors involved in the design, construction and licensing of nuclear facilities;
- a favourable **socio-political environment**;
- availability of **state-of-the-art research infrastructures** (in particular for materials research, including irradiation facilities, research reactors, hot cells, etc.);
- Secure funding for research and innovation in Europe, e.g. from the Euratom budget
- availability of **all potential EU funding options,** e.g. innovFin, EFSi (European Fund for Strategic investments), ESI F (European Structural and investment Funds) and possible Euratom loans, with established mechanisms such as ESFRi remaining important in the setting-up of collaborations between MS in the development of new research infrastructures.

Regarding the exploitation and development of major research infrastructures, including demonstrator facilities, the European fusion research programme (implemented by EUROfusion) has shown the **effectiveness of joint programming** based on a detailed and resource-loaded roadmap,

6 For recent information on cost of nuclear electricity, from new-build Generation-III / III+ and LTO Generation-II, refer to, for instance, (i) William D. D'haeseleer *"Synthesis on the Economics of Nuclear Energy"***, Study for the European Commission, DG Energy, Contract N° ENER/2012/NUCL/SI2.643067, November 27, 2013 (https://www.mech.kuleuven.be/en/tme/research/energy environment/Pdf/wpen2013-14.pdf) and (ii)** *Energy Technology Reference Indicator projections for 2010-2050* **(https://setis.ec.europa.eu/publications/irc-setis- reports/etri-2014).**

7 COM(2014)330 final, 25/5/2014 (http://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX:52014DC0330&qid=1407855611566)

with clear milestones and deliverables, a risk register, coordinated use of and access to all priority facilities and centralised programme management.

Finally, though the achieving of the above targets will contribute significantly to maintaining European technological leadership in a number of areas, in line with the objective stated in the Energy Union Communication, it will not be easy for Europe to retain leadership in all areas, especially in view of the increase in nuclear generating capacity in the rest of the world. This underlines the importance of international cooperation, especially in areas such as development of advanced and innovative reactors.

Annex 1

Nuclear R&I: overview of current legal and policy framework

Euratom acquis

Apart from Title II, Chapter 1 'Promotion of Research' of the Euratom Treaty, and in particular Article 7 on Community research and training programmes, there is an extensive Euratom acquis with potential implications for the SET-Plan, the most relevant being:

Euratom Directives

- Council Directive 2009/71/Euratom of 25 June 2009 establishing a Community framework for the nuclear safety of nuclear installations, as amended by Council Directive 2014/87/Euratom;
- Council Directive 2011/70/Euratom of 19 July 2011 establishing a Community framework for the responsible and safe management of spent fuel and radioactive waste;
- Council Directive 2013/59/Euratom of 5 December 2013 laying down basic safety standards for protection against the dangers arising from exposure to ionising radiation;
- Council Directive 2006/117/Euratom of 20 November 2006 on the supervision and control of shipments of radioactive waste and spent fuel.

International cooperation (Euratom as signatory and/or represented by the European Commission)

- GIF International Framework Agreement (extended by 10 years on 26 February 2015, Euratom accession currently in the process of being extended) https://www.gen- 4.org/gif/jcms/c 9342/framework-agreement;
- the Convention on Nuclear Safety and the related 2015 'Vienna Declaration' (http://www-ns.iaea.org/conventions/nuclear-safety.asp);
- the Joint Convention on Safety of Spent Fuel Management and Safety of Radioactive Waste Management (http://www.iaea.org/Publications/Documents/Conventions/iointconv.html);
- The Convention on Physical Protection of Nuclear Material (CPPNM), ratified by Euratom in December 2015 following ratification by all MS;
- in fusion, the ITER agreement (https://www.iaea.org/sites/default/files/publications/documents/infcircs/2007/infcirc702.pdf). the Broader Approach with Japan, and a number of Implementing Agreements under the auspices of the IEA;
- Euratom bilateral Cooperation Agreements with key international partners in the nuclear domain (fission and/or fusion); and
- the OECD Nuclear Energy Agency (OECD/NEA, https://www.oecd-nea.org/) and the International Atomic Energy Agency (IAEA, https://www.iaea.ore/). involving participation in standing committees, working groups, etc.

Euratom Treaty provisions referring to nuclear safeguards

- Title II Chapter 7 on the Euratom system, its implementation and the Commission's role *Euratom*

Treaty provisions referring to financing / implementation of projects and joint initiatives

- Title II Chapter 4, Art. 40-44, on investments (which includes the provisions for the PINC);
- Title II Chapter 5, Art. 45-51, on ioint undertakings;

- Art. 172 on Euratom loans (secondary legislation currently under review).

In addition, outside the Euratom acquis, there are broader cooperation initiatives on Energy, such as the EU-US Energy Council, in which technology working groups also cover fission / fusion aspects, as well as EU legislation on environmental impact assessment, strategic environmental assessment and public participation in decision-making (Aarhus Convention, http://www.unece.org/ env/pp/welcome.html), all of which are applicable to nuclear projects. ESFRI, the European Strategy Forum on Research Infrastructures (http://ec.europa.eu/research/infrastructures/index en.cfm? pg=esfri), remains an important EU forum for the development of major infrastructure projects, including in the nuclear field, though the tailor-made ERIC (European Research Infrastructure Consortium) legal framework remains unavailable in the case of nuclear projects. Financing mechanisms such as EFSI (European Fund for Strategic Investments) and ESIF (European Structural and Investment Funds) remain in theory available for nuclear projects, though the ESIF is limited to nuclear R&D facilities since the construction or decommissioning of NPPs cannot be supported.

European nuclear research and broader policy framework

Within the European Commission, a number of services have a policy and/or implementation role as regards nuclear safety, security and safeguards / technology and related research issues, namely ENER.D, RTD.G and JRC.

The Euratom Scientific and Technical Committee (STC), the highest level technical committee under the Euratom Treaty and constituted by experts nominated by MS ad personam, provides opinions and policy guidance to the European Commission on a range of technical nuclear-related issues.

The European Nuclear Energy Forum (ENEF, https://ec.europa.eu/enerev/en/events/2015-european-nuclear-energy-forum-enef-plenary-meeting) is a pan-European forum set up to examine transparency issues, opportunities and risks of nuclear energy. The European Economic and Social Committee (EESC, http://www.eesc.europa.eu/) also supports a dialogue with civil society on nuclear safety. The European nuclear industry trade association, European Atomic Forum of industry (FORATOM, http://www.foratom.org/) also publishes technical and policy-related documents covering the full range of nuclear sector issues.

Recently, the European Parliament in its resolution of 15 December 2015 on *Towards a European Energy Union* (2015/2113(INI)) has also made important references to nuclear power (see para 143145 at http://www.europarl.europa.eu/sides/getDoc.do?pubRef=-//EP//NONSGML+TA+P8-TA-2015-0444+0+DOC+PDF+V0//EN).

Relevant European platforms, stakeholder groups, etc. involved in R&D and/or related coordination include:

- the Sustainable Nuclear Energy Technology Platform (SNETP, http://www.snetp.eu/). which is the overarching nuclear systems and safety platform encompassing three main pillars related to safety and performance of Generation-II & -III reactors (NUGENIA, http://www.nugenia.org/)· Generation-IV fast reactor demonstrators (ESNII, http://www.snetp.eu/esnii/)₁ cogeneration of electricity and process heat (NC2I, http://www.snetp.eu/nc2i/) together with cross-cutting research activities and supporting research infrastructures;
- the Implementing Geological Disposal Technology Platform (IGDTP, http://www.igdtp.eu/) focusing on R&D needed to ensure safe geological disposal of spent fuel and high-level heatgenerating waste;
- the Multidisciplinary European Low Dose Initiative (MELODI, http://www.melodi-online.eu/). the

platform coordinating the multidisciplinary research on effects of low doses of radiation;

- the European Energy Research Alliance - Joint Programme on Nuclear Materials (EERA-JPNM, http://www.eera-jpnm.eu/) which coordinates public sector research on nuclear materials;
- the European Technical Safety Organisations Network (ETSON, http://www.etson.eu/). which has links with SNETP but also has its own position paper on safety of Generation-II & -III reactors;
- the Western European Nuclear Regulators Association (WENRA, http://www.wenra.org/) which is leading in the definition of technical nuclear safety standards;
- the European Nuclear Safety Regulators Group gathering together high-level representatives of EU nuclear regulatory bodies (ENSREG, http://www.ensree.eu/):
- NERIS, the European Platform on Preparedness for Nuclear and Radiological Emergency Response and Recovery (http://www.eu-neris.net/):
- EURADOS, the European Radiation Dosimetry Group (http://www.eurados.org/):
- the European Radioecology Alliance (http://www.er-alliance.eu/): and
- in the case of magnetic confinement fusion, the European roadmap to fusion electricity (https://www.euro-fusion.org/eurofusion/the-road-to-fusion-electricity/) has been agreed by all national labs and institutes in Europe and provides the basis for the EUROfusion Joint Programme (https://www.euro-fusion.org/).

Enen and fusion to be listed similarly as the rest.Joint initiatives also exist in the area of nuclear education and training, the most important being the European Nuclear Education Network (ENEN, http://www.enen-assoc.org/) and FuseNet, the Fusion Education Network (http://www.fusenet.eu/). Observatories have also been established in two key areas:

- the European Human Resources Observatory for the Nuclear Sector (http://ehron.irc.ec.europa.eu/): and
- the European Observatory on the Supply of Medical Radioisotopes http://ec.europa.eu/euratom/observatory radioisotopes.html.

The above are complemented by international initiatives:

- the Generation-IV International Forum (GIF, https://www.gen-4.org/) the international body overseeing global cooperation in pre-conceptual design research on Generation-IV systems: and
- Nuclear Innovation 2050 (httpy/www.oecd-nea.org/ndd/n^OSO/), an initiative of the NEA (Nuclear Energy Agency), that is mapping current nuclear fission R&D programmes and infrastructures, defining R&D priorities to foster innovation, enhancing the long-term contribution of nuclear fission in a low-carbon future, and evaluating potential opportunities for cooperation to implement these priorities.

In the field of nuclear safeguards and security, we can mention:

- ESARDA (European Safeguards Research and Development Association), considered as the unique network of national research organisations together with the European Commission:
- The European Nuclear Security Regulator Association.