EUA-EPUE
European Platform of Universities in Energy Research & Education

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EUA-EPUE Response to SET-Plan Consultation

Key Action No. 10: Nuclear

BACKGROUND

This response provides the perspective of the European Platform of Universities in Energy Research & Education (EUA-EPUE) to the consultative process on the European Strategic Energy Technology Plan (SET Plan) - Key Action No. 10 - Nuclear.

EUA-EPUE responds to the consultation from the perspective of the universities' role in society. Universities constitute a significant part of the research capacity in Europe. At the same time, they educate the highly skilled work force of our societies. We consider therefore that setting up the SET-Plan projects with ensured integration of innovative research with education, including industrial partners, will provide a high pay-off towards achieving the energy system transition, which is a major objective of the SET Plan and the European Union.

RESPONSE

Proposed targets in Nuclear

For the main expected outcome: To make specific recommendations on the priorities/targets proposed in the issues paper(s)

- Do you agree with the targets set in the issue paper?
- Do you think that the level of ambition is correct?
- Are there any standing issue(s) in the way to reaching the proposed targets/priorities?

It may be useful to understand the broader context in which these targets/priorities need to be achieved. If possible, we suggest that the following is addressed as well:

- *What are your specific recommendations on prioritising R&I activities on these issues (and building where appropriate on relevant existing initiatives)?*
- *Who are the best placed actors to implement the targets/priorities (Industry, EU, Member States, regions, groups of countries/organisations/etc.)?*

Nuclear, perhaps more than any other technology, elicits strong opinions. Presently there is no convergence of Member States governments' policies regarding the development of the nuclear field in the EU. For the successful future development of the technology, it is therefore vital to engage with the general public, including those who may hold skeptical views in this topic.

Universities constitute a significant part of the nuclear education and research capacity in Europe. Steady support for appropriately educated and highly skilled workforce in the nuclear field is therefore essential, while ensuring scholastic independence.

The cooperation effort between universities, in particular the technology universities, with industry and research institutes in nuclear research for technology development should also be mentioned.

This should be maintained and encouraged as it places university research at the core of the developments in the nuclear sector and supports dissemination activities. It is crucial to point out that, to ensure that this role is properly fulfilled, the university sector should have access to long-term financial support while preserving institutional independence in research and education.

When developing and taking advantage of disruptive technologies (whether these lie in Small Modular Reactors (SMRs), closed fuel cycles, inherently safe designs or elsewhere), it can be observed that its future remains uncertain. Hence, highly educated youngsters may significantly contribute to carrying the ideas of nuclear research forward and to this regard, universities could have a role in encouraging these activities. It can finally be acknowledged that the demand for competent workforce requires integration of education activities with research in order to disseminate new research knowledge. This can ultimately contribute also to industrial innovation.

1. Proposed targets in Nuclear: 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, implementation by MS of all actions to improve nuclear safety as follow-up to the stress tests7;
- optimisation of NPP operation as a function of predicted demand, and integration with more intermittent suppliers in evolving electricity grids;
- observance of strict non-proliferation regime and physical protection of nuclear materials and facilities.

a) The target should be formulated in a more coherent manner considering the fuel cycle from uranium or mining to waste processing and disposal. There are several specific *safety* elements to be considered for each stage, including the manufacturing and construction of equipments. Non conformities and lack of corrective actions at the manufacturing stage may seriously impact, not only the plant operation, but also construction schedules with economic problems down the road (as it was the case in Finland).
b) *Safety* and *security* are priorities that should also include Radioactive Waste Management (RWM). Recent circumstances linked to terrorist threats have raised the concerns on the use of active

materials as a weapon. This is partly recognised when "observance of strict non-proliferation regime and physical protection of nuclear materials and facilities" is mentioned in the target, but should be more clearly stated in the general formulation of the target. Anti-nuclear terrorism is a very important activity and should therefore be emphasised, including the institutional communication and cooperation requirements. Moreover, a related issue to nuclear *security*, and only partly overlapping with the discussion on 'nuclear energy' is the issue of research reactors and the potential *security* and *safety* issues associated with them. The issue paper should recommend working towards a dedicated target to harmonise the *security* and *safety* issues of research reactors, as for instance a ban of Highly Enriched Uranium (HEU) use for research reactors.

c) Nuclear *safety* is heavily regulated both at the EU level, which is a unique example of a functioning regional and multilateral nuclear safety regime, and at the global level (i.e. International Atomic Energy Agency (IAEA) conventions and guidelines). The same regional approach could be put in place for nuclear *security* as well. The need for such governance is rather high, as it has been repeatedly emphasised in the series of Nuclear Security Summits in Washington D.C., Seoul, The Hague and most recently again in Washington D.C.[1] It is recommended that the EU takes the lead on nuclear *security* matters adopting relevant legislation in the field, which could be based as a first step on the agreements reached at the Nuclear Security Summits.

d) *Safety* concerns should not only be related to potential accidents with release of radioactivity but also cover other aspects such as economic impacts and public stress (which is obviously different from the technological safety). This may trigger political decisions or processes leading to the complete shutdown of Nuclear Power Plants (NPPs) with an increase of the vulnerability of baseload cover (as in the case of Italy), digitisation, cybersecurity issues, and other consequences. It should also be stressed that the target makes no direct mention of cyber security. This is a widespread concern across developed societies and a relevant concern for nuclear. The university sector may be well placed to address these issues, considering that it requires a systemic approach to tackle generic issues.

e) Regarding the mentioned target "by 2020, availability of conclusive research findings on (i) ageing of structures, materials and components (Long-Term Operation (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)", it should be mentioned that while on one hand, there is relevant experience regarding item (i) on ageing of structures, materials and components, on the other hand, item (ii) on more robust and accident-resistant designs would require more effort by the Members States and the EU.

f) Finally, there is a need to better understand the impact of large-scale load of NPPs, as a result of increasing renewable energy inputs into the electricity grid. The research should focus also on the introduction of SMRs as a way to optimise the operation of NPPs in a higher volatility system. Large reactors must operate in base load nominal regimes due to well-known processes (e.g. Xenon 'poisoning'), in order for several small reactors to provide more flexibility and adaptability to renewable volatile regimes. Models for these system operations may be very useful and should be developed in conjunction with the present changes in operational challenges.

[1] See also (Bunn 2013). Bunn, M. 2013. "Strengthening Global Approaches To Nuclear Security." In . Vienna: - International Atomic Energy Agency. ttp://belfercenter.ksg.harvard.edu/files/strengtheningglobalsecurity.pdf.

2. Proposed targets in Nuclear: 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.

a) The main concerns in relation to this target regard *safety* uncertainties in relation to the direct disposal of spent fuel and hence more research is needed, especially for geological disposal facilities in fractured hard rock and clay geologies. It should also be mentioned that research is needed concerning the issue of *security* and non-proliferation safeguards.

b) As regards to waste management, this includes not only the geological repositories but also the low and medium radioactive waste deposits. Moreover, considering that decommissioning and or operational life extension becomes important at the present age of NPPs in the EU, waste from decommissioning should be given more relevance. Also, the issue of spent fuel pool at the NPP should be analysed especially in relation with vulnerabilities linked to short-term events (e.g. Fukushima-Daiichi) and to long-term ones (e.g. accumulation of spent fuel) which require temporary storage deposits of spent fuel and/or transfer to dry casks.

c) The general area of radioactive waste management is not solely concerned with deep geological disposal. Longer term ambitions related to Gen IV and closed cycles (as mentioned in the 'Cross-cutting challenges' below) are also relevant and worth mentioning here. The successes of Sweden and Finland are the result of the long-lasting participatory approaches. Similar approaches could be recommended for other EU Member States who have not adopted yet this approach or are in earlier stages of their disposal plans.

d) There are many Member States that have fairly limited long-lived waste, either because they have one or two power plants or because they only operate (or have operated) research reactors and other nuclear research facilities. This is why there is an ongoing discussion between several nuclear waste management organisations in the EU and at the global level. To this regard, it is worth mentioning the activities of the European Repository Development Organization Working Group ERDO-WG3. As a general comment to this target, it is recommended that a reformulation of the target may be needed in order to investigate the correct level of ambition by 2030. It is worth mentioning that the latest Waste Framework Directive[4] allows for such multilateral collaboration but does not foresee dedicated targets.

e) In order to ensure the possibility to build geological waste deposits, the management of financial resources and dedicated funds for the investment in such repositories is crucial. A general EU policy should be envisaged to encourage Member States` investments in the field.

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[3] www.erdo-wg.eu

[4] Directive 2008/98/EC of the European Parliament and of the Council of 19 November 2008.

f) It is recommended that support to the industrialisation of partitioning and transmutation of long-lived radionuclides to reduce the radiological burden of disposal facilities is envisaged, considering that it is important to demonstrate that radioactive waste is not a long-term issue.
g) Robotics and potentially radiation tolerant opto-electronics are disruptive technologies with important applications in decommissioning. It is relevant mentioning that both of these areas are experiencing a surge in the activities of the university sector.

3. Proposed targets in nuclear: 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, and taking 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:

- licensed SMR design(s) available in the EU by 2025, with operating plant(s) by 2030;
- at least one Generation-IV demonstrator fast reactor operating in Europe by 2030, including associated fuel cycle facilities (pilot fuel fabrication and processing plants).

a) Given the fast penetration of SMR design, there is a need to design licensing procedures that would not hamper the construction cycle of such reactors. Moreover, research into EU designs such as Advanced Lead Fast Reactor European Demonstrator (ALFRED), and gas-cooled SMRs should be accelerated, considering that these produce less high level radioactive waste compared to Light-Water Reactor (LWR) versions. This would also contribute to complementing the many designs developed in the United States.
b) The issue of licensing of reactors (SMRs or other reactors) is crucial. This is mainly a pan-governmental issue, therefore the EU should have an important role in addressing this. The current requirement for distinct Generic Design Assessments (GDA) in each Member States is one of the major hurdles to negotiate for future nuclear development. This is mentioned in the cross-cutting challenges section of this input paper and also relates to the provision of stable and predictable investment conditions. Based on these considerations, it is recommended that the issue of harmonisation of licencing becomes a separated target.
c) The target concerning the Gen-IV demonstrator reactor requires more effort by Member States and the EU as compared for instance to the Jules Horowitz Reactor (JHR), which is a comparatively modest test reactor. To this regard, the university sector could encourage discussions on the nature of the reactor, its design and test facilities for this and related materials work (e.g. fusion).
d) It is recommended that appropriate consideration is given to research on Thorium cycles, which is already under scrutiny in various European and non-European countries.

4. Proposed target in Nuclear: 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).

a) Regarding the target on fusion, it can be mentioned that there will be a migration of activity to ex-vacuum technology work (fusion blankets, other plant, tritium processing, etc). These are nascent technologies to whom the university sector may contribute to.
b) Fusion has a high profile amongst the student population. Effort could be devoted to focusing beyond ITER (efficient large-scale production of electricity from fusion) and towards DEMO (generating significant amounts of electricity over extended periods) [5].
c) It is worth mentioning that the Wendelstein 7-X, a stellerator fusion reactor, became recently operational[6] in Germany.

5. New proposed target from EUA-EPUE in Nuclear: Specialists

New target proposed based on the potential loss/migration of competent personnel in the nuclear field due to biased MS policies.

a) In the present years there is a biased attitude regarding the development of nuclear energy in the EU Member States. Germany is on a complete shutdown trajectory while other countries are considering construction of new plants. This may lead to a downsize of the job market for the nuclear field that would result in less students interested in the domain and later on in a loss or migration of specialists. These might have relevant consequences in terms of required competences that may trigger important safety and security issues. Thus, a dedicated target on the preparation of the necessary competent personnel for the nuclear field, as an important prerequisite to maintaining a high level of security and safety, is proposed.
b) European universities may have a leading role in correlating their programmes in a coherent manner and cooperate with the industry and the research centers in order to ensure the level of competence needed in such a strategic field as the nuclear one. Some relevant aspects, to which universities may contribute to, are reported below:
   - Investigating on the opportunity to set up a unified sillabus for the nuclear engineering teaching in the EU universities;

[5] http://ec.europa.eu/research/energy/euratom/index_en.cfm?pg=fusion&section=iter-future
[6] http://www.ipp.mpg.de/16900/w7x

- Encouraging the correlation between planned needs of the industry with the university teaching, in order to target the appropriate number and study field of Masters and PHD students .
- Promoting the development of research networks associated with the big laboratories in and outside the EU.

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 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;
- 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 Communication9;
- availability of a trained workforce, including the education and training of scientists, engineers and other skilled workers, e.g. benefitting from a European Credit System for Vocational Education and Training (ECVET) but also ERC, MSCA or ERASMUS+ grants;
- 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 and safeguards;
- 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 conducive socio-political environment;
- availability of state-of-the-art research infrastructures (in particular for materials research, including irradiation facilities, research reactors, hot cells, etc.);
- availability of all potential EU funding options, e.g. InnovFin, EFSI (European Fund for Strategic Investments), ESIF (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.

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a) It is relevant mentioning that while licensing is often used as a synonym of permissioning, the exact form of licensing depends upon the legal framework in the Member States. Moreover, while on one side it may be possible to harmonise the concept of licensing, on the other side, harmonising "technical and engineering standards" might be more easily feasible. In this framework, IAEA standards, as well as national and internal engineering standards, such as the American Society Of Mechanical Engineers (ASME) do already exist.
b) The concept of "mutual recognition" should be further researched. While on one side, compliance with the Convention on Nuclear Safety of IAEA[7] should ensure mutual recognition of the national regulatory frameworks, on the other side implementation is difficult because legal frameworks (e.g. to licence the construction and/or operation of a NPP) differ among countries. It is therefore recommended that the codes of IAEA are correlated to the particular requirements of the EU Member States by making an in depth research on the specific differences, in order to converge towards a basic acceptance procedure.
c) Moreover, the concept of "streamlining design approval" should also be investigated. Indeed, it is legally difficult for one Member State to automatically accept the design of a NPP that has been "accepted" by another Member State. In the United Kingdom for instance, the regulator does not "accept a design". It is for the licensee to demonstrate that the design is safe and risks have been reduced to as low as reasonably practicable. It is the licensee that is legally responsible for safety and he should prove this to the regulator who can ultimately decide on permissioning the licensee to commence construction.
d) An important topic for future research is the evaluation of the costs of nuclear *safety* and *security*. These externalities should not be considered as subsidies for the NPP but be included in creative financial schemes. It is recommended that these schemes have to be agreed with Member States and correlated within the Euratom financing. The European Commission can have a final monitoring role on the evaluation of the costs of nuclear *safety* and *security*.

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[7] http://www-ns.iaea.org/conventions/nuclear-safety.asp