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to:	Mr Pierre de BOISSIEU, Secretary-General of the Council of the European Union
Subject:	Commission staff working paper EX ANTE EVALUATION accompanying the proposal for a Council decision concerning the Framework Programme of the European Atomic Energy Community for nuclear research and training activities (2012 - 2013)

Delegations will find attached Commission document SEC(2011) 204 final.

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COMMISSION STAFF WORKING PAPER

EX ANTE EVALUATION

Accompanying document to the

Proposals for a

COUNCIL REGULATION (Euratom)

laying down the rules for the participation of undertakings, research centres and universities in indirect actions under the Framework Programme of the European Atomic Energy Community and for the dissemination of research results (2012-2013)

COUNCIL DECISION

concerning the Framework Programme of the European Atomic Energy Community (Euratom) for nuclear research and training activities (2012 - 2013)

COUNCIL DECISION

concerning the specific programme, to be carried out by means of indirect actions, implementing the Framework Programme of the European Atomic Energy Community for nuclear research and training activities (2012 - 2013)

COUNCIL DECISION

on the specific programme, to be carried out by means of direct actions by the Joint Research Centre, implementing the Framework Programme of the European Atomic Energy Community for nuclear research and training activities (2012 to 2013)

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Ex-ante evaluation for the legislative package of Commission's proposals for Euratom research and training activities for 2012-2013

1. INTRODUCTION

This ex-ante evaluation accompanies the legislative package of Commission's proposals for the Euratom nuclear research and training activities (2012-13). It has been prepared in accordance with Article 21 of the Implementing Rules for the Financial Regulation (Commission regulation no. 2342/2002). This legislative package consists of the draft Council Decisions for the Framework Programme, Specific Programmes for direct and indirect actions and Rules for the Participation of undertakings, research centres and universities in actions under the framework programme and for the dissemination of research results. It will aim to continue supporting R&D actions in the nuclear field carried out under the 7th Euratom Framework Programme (2007-2011). The proposals will cover only two years (2012-13), in accordance with the current financial perspectives (2007-2013) and in line with the timeframe of the EU 7th Framework Programme (2007-2013).

The Directorates General (DGs) responsible for preparing this ex-ante evaluation are DG Research & Innovation and the Joint Research Centre (JRC). Work started in early 2010 and consultation with other Commission services was carried out through an inter-service group composed of representatives from the Secretariat General, DG Energy and the Joint Research Centre. The group was set up in May 2010 and met three times.

During its work on the ex-ante evaluation DG RTD and JRC used various sources, including

(1) Respective Euratom FP7 Interim Evaluations carried out by independent panels of experts

(2) A report of the European Fusion Development Agreement (EFDA) following an *ad-hoc* study group on the future of the Fusion R&D programme

(3) Input to the extension of FP7 and preparation of future research programmes from Euratom's Science and Technical Committee (STC)

(4) Input from the JRC Board of Governors

(5) Reports such as vision documents and strategic research agendas prepared by the Technology Platforms in nuclear field – Sustainable Nuclear Energy Technology Platform (SNETP), Implementing Geological Disposal Technology Platform (IGD-TP) and Multidisciplinary European Low Dose Initiative (MELODI).

2. THE NEED TO BE MET IN THE SHORT OR LONG TERM

2.1. Energy challenge

Following a proposal by the Commission[1], the European Council defined, at its March 2007 summit, an integrated policy for energy and climate change with three objectives: increased security of supply; competitiveness of European economies and availability of affordable energy; environmental sustainability whilst combating climate change. The resulting Energy Policy for Europe sets out a number of strategic energy policy objectives for 2020: (i) reduction in greenhouse gas emissions by 20% compared to 1990 levels; (ii) reducing primary energy use by 20% (through energy efficiency); (iii) increasing the level of renewable energy in the EU's overall mix to 20%; (iv) minimum target for biofuels of 10% of vehicle fuel. In addition, it sets out a vision for a low carbon society by 2050 in which greenhouse gas emissions must be reduced by 80% to 95% compared to 1990 levels[2].

Nuclear power is Europe's principal low carbon source of electricity. 151 reactors account for almost 1/3 of the electricity production, amounting to 2/3 of the low-carbon energy produced in the EU. This represents a saving of almost 700 million tons CO_2 per year[3], equivalent to that produced by all the cars in Europe. Nuclear power therefore plays a key role in limiting the EU's carbon emissions. In its Nuclear Illustrative Programme of October 2007[4] the contribution of nuclear power to the diversification and the security of energy supplies is recognised for a number of reasons, in particular the availability and distribution of nuclear fuel (natural uranium) and the limited impact of fuel price variations on plant operating costs. The role of nuclear is further underlined in the "Second Strategic Energy Review" published by the Commission in 2008[5]. More recently, in the Commission's Communication on "Energy 2020 - A strategy for competitive, sustainable and secure energy"[6] underlines the importance of nuclear safety and provisions of the Euratom Treaty in this respect, including safeguards of nuclear materials and detection of any illicit activities, especially in a scenario of increased recourse to nuclear power.

Major studies on future energy scenarios have been carried out by the European Commission[7], international organisations such as the IEA[8], NEA[9], IAEA, and industrial groups such as Eurelectric[10]. Forecasts for energy consumption suggest that electricity demand will increase, despite efforts to improve energy efficiency. However, the contribution of nuclear is expected to remain at current levels, in terms of electricity generated and as a percentage of the total generation capacity. The realisation of nuclear technology must also be carried out in such a way that civil nuclear material and technology is not diverted into

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1 Communication from the Commission "An Energy Policy for Europe", COM(2007)1
2 Council conclusions, 30 October 2009.
3 If nuclear capacity were replaced by a representative mix of alternative sources
4 Communication from the Commission "Nuclear Illustrative Programme", COM(2007)565
5 Communication from the Commission "Second Strategic Energy Review", COM (2008)781
6 Communication from the Commission "Energy 2020, A strategy for competitive, sustainable and secure energy", COM (2010)639
7 Energy Trends to 2030, http://ec.europa.eu/energy/observatory/trends_2030/index_en.htm
8 International Energy Agency World Energy Outlook 2010 and Energy Technology Perspectives 2010, IEA
9 Nuclear Energy Outlook 2008, Nuclear Energy Agency
10 "Power Choices, Pathways to Carbon-Neutral Electricity in Europe by 2050", Eurelectric, 2010

weapons programmes. This will become more important with nuclear expansion, especially in geographical areas not previously operating nuclear fuel cycle facilities.

For the civil use of nuclear energy, the public must be confident that nuclear materials are well protected against any use for illicit activities. These requirements call for strong and efficient safeguards, non-proliferation and nuclear security regimes.

Fusion is potentially a sustainable large-scale energy supply. It is inherently safe (in terms of accidents, waste and proliferation issues), carbon-free and has virtually inexhaustible and widely available fuel resources. The R&D challenges still to be met leave considerable uncertainty about the timescale on which commercial fusion power can be realised and the cost of fusion generated power, although some articles in peer reviewed journals[11] indicate a timescale of several decades after 2020 and an electricity cost likely to be competitive with other sources. Because of these uncertainties fusion is not usually included in the modelling of future energy scenarios, but it is firmly embedded in the energy research landscape, especially since the decision to proceed with ITER.

2.2. The SET-Plan and nuclear energy

Energy technologies play a central role in offering both competitiveness and sustainability in the energy sector while increasing security of supply. To help achieve the medium and long term objectives (2020 and 2050) the Commission proposed the Strategic Energy Technology Plan (SET-Plan)[12] which was endorsed by the Council on 14th March 2008 and adopted by the Parliament on 9 July 2008. The SET-Plan aims to accelerate the development and deployment of cost-effective low carbon technologies. Its main assumption is that no single form or source of energy will be able to provide a sustainable supply or to cover all energy needs in the coming decades. A broad portfolio of low-carbon energy sources and carriers needs to be investigated and developed. This includes *inter alia* wind, photovoltaic (PV), fossil fuels with carbon capture and storage (CCS), bio-energy, and nuclear energy, especially advanced reactors for increased sustainability. This broad portfolio and 'technology neutral' approach to future low-carbon energy supply has been underlined again in the conclusions of the European Council (4 February 2011) which agreed that the EU and its Member States will promote investment in renewables, safe and sustainable low carbon technologies and focus on implementing the technology priorities established in the SET-plan.

In the short term (2020) the SET-Plan supports research to reduce costs and improve performance of existing energy technologies, and encourages the commercial implementation of these technologies. For the longer term (2050) it supports development of a new generation of low carbon technologies. Both nuclear fission and fusion are identified in the SET-Plan as energy technologies which Europe must maintain, develop and deploy in order to meet its short and longer term energy objectives.

Regarding nuclear technology in particular, to meet the short term (2020) goals of the Energy Policy for Europe (EPE), the SET-Plan aims to *"maintain the competitiveness in fission technologies together with long term waste management solutions"*. To realise the longer-

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11 See for example "Revised assessments of the economics of fusion power", W.E. Han, D.J.Ward, Fusion Engineering and Design 84 (2009) 895–898

12 Communication from the Commission "A European Strategic Energy Technology Plan (Set-Plan). Towards a low carbon future", COM(2007)723

term EPE vision of a low carbon society by 2050, the SET-Plan states that the following milestones are to be reached by 2020: (1) c*omplete the preparations for the demonstration of a new generation (Gen-IV) of fission reactors for increased sustainability; and (2) complete the construction of the ITER fusion* facility and ensure early industry participation in the preparation of demonstration units. The European Sustainable Nuclear Industrial Initiative (ESNII), which is one of the six initial European Industrial Initiatives foreseen under the SET-Plan, was formally launched on 15 November 2010. ESNII will address the need for demonstration of Gen-IV Fast Neutron Reactor technologies, together with the supporting research infrastructures, fuel facilities and R&D work. The nuclear energy's milestones of the SET-Plan can be reached via research and development activities to be carried out by private and/or public sector in Europe. These R&D activities will address different challenges in fission and fusion, though some topics like development of nuclear-grade materials are cross-cutting. Finally, R&D should address some issues which are beyond scope of the SET-Plan, such as radiation protection and nuclear security (proliferation of fissile materials).

2.3. Main challenges in nuclear fission

(i) Challenges in the timescale of 2020

- **Plant lifetime management:** The current nuclear fleet in Europe is based mostly on Light Water Reactors (LWR) that have been in operation for about 20 years on average. Current plans in most EU Member States are to extend their lifetime on case-by-case basis beyond 40 years, and possibly beyond 50 years. Key R&D issues are related to meeting safety requirements for long-term operation focussing on ageing of structures, systems and components. Other important issues are ageing mechanisms, ageing monitoring and prevention and mitigation of ageing. Finally, research can address the performance of existing plants.

- **Geological disposal:** As indicated in the Commission's revised draft proposal for a Council Directive on the Management of Spent Fuel and Radioactive Waste[13], all EU Member States produce radioactive waste, which is generated by many beneficial activities including civil nuclear power and radioisotope applications in medicine, industry, agriculture, research and education. More than half of Member States have accumulations of spent nuclear fuel, or residues from the reprocessing of this fuel, as a result of the operation of nuclear power plants. The general principle is that those who benefit today from these activities should manage the resulting waste in a safe and sustainable manner. This is also the overwhelming view of European citizens[14], whose acceptance of nuclear energy is also strongly correlated to the implementation of solutions to safely manage nuclear waste. This is why implementing safe long-term management of this waste is specifically mentioned in the SET-Plan. Indeed, the R&D work carried out over last three decades has confirmed that deep geological disposal is the most appropriate solution for long-term management of spent fuel, high-level waste, and other long-lived radioactive wastes. This scientific consensus now needs to be turned into an engineering reality, and this will be the focus of attention over the coming decade.

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13 Proposal for a Council Directive on the management of spent fuel and radioactive waste, COM(2010)618, 3 November 2011

14 Special Eurobarometer 297: *Attitudes towards radioactive waste*, published in June 2008.

– **Nuclear safeguards and security:** Expansion of civil nuclear technology brings with it an increasing concern about the risk of accidents, nuclear non-proliferation and the threat of nuclear terrorism. The European Parliament made world-wide nuclear disarmament by 2020 a top-priority for the EU Member States. High priority is given to strengthening prevention measures at both the national and international levels, and establishing measures to ensure a rapid and coordinated response should these measures fail. The spread of nuclear material, technology and know-how already increases the risk of proliferation. The world-wide growth of nuclear power will require even greater safeguards which rely on profound knowledge and expertise.

(ii) Challenges by 2040 or beyond

– **Next generation fission systems:** Today's light water reactor technology uses less than 1% of the energy content of the mined uranium, which limits the sustainability of nuclear energy to a few decades because of the finite nature of the world's uranium reserves. By contrast fast neutron reactors will extract 50-100 times more energy from the same quantity of uranium, making nuclear much more sustainable. Furthermore, fast reactors will produce far less high-level long-lived waste, facilitating the management in future geological repositories. R&D challenges in fast reactors are needed to address cost competitiveness, enhanced safety and non-proliferation, requiring innovation both in reactor designs as well as fuel and fuel cycle technology. Though next generation fast neutron reactors are not expected to be widely deployed commercially before 2040, prototypes and demonstrators need to be designed and constructed in the next decade to enable sufficient return from experience before commercial deployment. In parallel, a broad-based programme of R&D is needed in key areas such as materials, numerical simulation and safety.

2.4. Main challenges in fusion energy

ITER, the next step in fusion R&D, is expected to demonstrate the feasibility of fusion power. The concentration of the majority of the funding on ITER is part of an evolution of the fusion programme that started during the ITER design phase and has recently accelerated as the needs of ITER have become more clearly defined and financial resources more scarce. The challenges for the Euratom Framework Programme in relation to ITER construction are not primarily concerned with R&D but involve issues of project schedule, cost containment and risk reduction in an international context. In parallel with this, a pioneering R&D programme is essential to building a demonstration power plant before 2040. The scientific and engineering challenges of fusion are major and require a research programme firmly focussed on this ultimate goal of fusion power plants.

The major challenges of ITER and fusion will not be resolved in the 2012-13 timeframe, but this period needs to be used to consolidate the programme strategy and to launch the activities for the next 10 years, i.e. in parallel with ITER construction, in order to ensure and enhance ITER's success and move towards the power plant goal as rapidly and as efficiently as possible. These major challenges are:

(i) Challenges in the timescale of 2020

– **Complete ITER construction**: the key challenges surrounding ITER's construction are procuring, testing and integrating the components, and launching the plasma device in

2019. These must be completed within the approved budget, while minimising the technological risks for the correct operation of the completed machine.

- **Secure ITER operation:** by expanding the knowledge base to maximise the scientific output of ITER. To achieve this, the programme must: (i) develop operational scenarios that will secure and even exceed the baseline performance, and (ii) ensure the rapid and efficient start up of ITER operation, and protect the investment in ITER by minimising the chances of unexpected technical problems that would delay exploitation or incur extra cost.

- **Prepare the ITER generation of researchers and engineers:** to ensure that Europe will have the human resources to exploit ITER in an international and competitive environment. Europe must cultivate future leaders of the ITER programme or it will risk ceding leadership in fusion research.

- **Lay the foundations for fusion power plants:** driving forward developments in physics and technology to ensure the design and construction of a demonstration fusion power plant as soon after ITER as possible. Position Europe so that it gains a significant share of the intellectual property of fusion power.

- **Involve industry more closely and promote innovation:** by integrating industry in the development of fusion power plant studies, enhancing the transfer of knowledge and creation of spin offs from the programme as well as developing the skills and capacities necessary for a European fusion industry of the future. The Commission has launched the formation of a Fusion Industry Innovation Forum as the first step towards meeting these challenges.

(ii) Challenges by 2040 or beyond

- **Fusion power:** Beyond ITER, which is an experimental reactor to study the physics and the technology needed for power generation, it is envisaged to construct a demonstration fusion reactor (DEMO) that can produce electrical power and be commercialised. Preparation for experiments in ITER are supported by a number of other smaller fusion experiments for specific studies and by major experimental facilities required to develop operating scenarios and address key physics issues for an efficient start up of ITER and for research towards DEMO. As a result of the experiences obtained by the operation of ITER, the physics of burning plasmas will be well known and valuable technological know-how will have been obtained. A parallel programme of technology activities for materials testing, technological validation, prototype development and fabrication methods is foreseen. Key technologies should be sufficiently developed and embedded in industry to have a final design and construction of a DEMO by 2050.

2.5. Other challenges in nuclear science and technology

There are also other challenges which concern radiation protection and skills in nuclear field:

- The growing use of radiation in medical diagnostic and therapeutic techniques is responsible for a significant rise in exposure to low doses. Further research is needed to determine the true risks emanating from such exposure, and to understand the emergence of latent cancers and vascular diseases at these low doses. This will lead to better regulation and an appropriate level of protection for the public and workforce in all industrial and medical uses of radiation. However, this scientific challenge is enormous, involving cutting edge research and an approach that must bring together experts from a wide range of disciplines, including radiation protection, radiobiology, molecular biology, genomics and epidemiology. Supporting basic and oriented research will be needed to keep the highest degree of understanding of key basic phenomenon.

– A particular focus must be given to provide support for education and training of present and future young scientists and engineers. As underlined by the Council conclusions[15], it is essential to maintain in the European Union a high level of training in the nuclear field. This effort is indispensable for (a) Member States wishing to continue to make use of nuclear energy for their energy; (b) for Member States wishing to begin using this energy source; (c) for Member States wishing to phase out the use of nuclear fission for electricity production and still facing the challenge of decommissioning nuclear facilities, and of managing radioactive waste and spent fuel; (d) for Member States which have not developed a nuclear power programme for energy production but which use nuclear technologies for other purposes (research, medical applications).

2.6. Innovation in nuclear field

Nuclear energy technology has special characteristics that affect the actors involved and the way innovation occurs: large up-front capital investments, large and complex facilities, special quality and safety requirements, and long R&D lead times. The fission sector has developed over 50 years into a mature industry and a major market. Nuclear innovation is stimulated by many factors including: (i) growing demand for affordable low-carbon electricity from citizens/industry, (ii) maintenance and reliability performance targets from the utilities, (iii) safety and emission standards set by public authorities, (iv) growing interest by industrial end-users in low carbon process heat, and (v) public policy intervention. The supply of innovative technologies is supported by public and private organisations (nuclear vendors and utilities) and involves technical safety organisations and regulators. Finance institutions are closely involved as nuclear is a very capital-intensive technology.

The fusion energy sector is in its infancy and high-tech industry has to learn-by-doing and gain appropriate skills and manufacturing capabilities. First steps need to be taken now at EU level to prepare this new industry and associate it to the programme evolution. The high technology industry involved in the construction of large-scale research fusion infrastructures, such as ITER and W7-X are keen to be involved in the fusion technology. They welcome the positive impact on their skills base and the possibility to re-use the new innovative manufacturing processes for other products and services[16]. The situation is similar to other big science research where more than 1/3 of industrial contracts yield new products and services according to CERN[17].

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15 Conclusions on the need for skills in the nuclear field, 2891st Competitiveness (Internal Market, Industry and Research) Council meeting, Brussels, 1 and 2 December 2008

16 Commission's survey (2009) of companies involved in upgrade and construction projects in fusion

17 Technology transfer and technological leaning through CERN's procurement activity, E. Autio, M. Bianchi-Streit, A. Hameri, CERN, Geneva 2003 (http://cdsweb.cern.ch/record/680242/files/p1.pdf)

3. THE ADDED VALUE OF EURATOM COMMUNITY INVOLVEMENT IN NUCLEAR R&D

Public support of research is justified in a variety of circumstances, including large scale, long term endeavours, matters concerning public safety and security, a low probability of a near term economic return ("market failure"). Research in radiation protection is an example of activity where public support is essential, since there is no industrial / private sector to speak of that can exploit such research on a commercial basis, but the research is nonetheless needed in order to adequately protect the public and the workforce. An example of market failure is in advanced nuclear technology, where commercial deployment is too far in the future for the nuclear sector to justify the economic, regulatory and political risks of investing now. The justification for public sector support for fusion research is its firm focus on the future public benefit of having a further option in the energy mix, but on a timescale for deployment too long for there to be, at present, significant investment by industry.

The Euratom Treaty is the legal basis underpinning R&D by the Euratom community. It enables research coordination and cooperation. Article 1 stipulates that it "it shall be the task of the Community to contribute to the raising of the standard of living in the Member States and to the development of relations with the other countries". Article 2 stipulates that "in order to perform its task the Community shall, as provided in the Treaty promote research and ensure dissemination of technical information". For this purpose "the Commission shall be responsible for promoting and facilitating nuclear research in the Member States and for complementing it by carrying out a Community research and training programme" (Article 4). The Nuclear Safeguards activities for current nuclear fuel cycle systems contribute to the implementation by the Commission services of chapter 7 of the Euratom Treaty and by the IAEA of the Non-Proliferation Treaty. To fulfil these obligations, nuclear material measurements, modelling skills for processes and equipment, advanced sealing and verification technologies, scientific and technical support from trusty and independent laboratories, and dedicated consultancy services are needed by the safeguards authorities (DG ENER and IAEA).

Because the research competence is not exclusive to Euratom, the principle of subsidiarity applies. In order for Community action to be justified, the principle of subsidiarity must be respected. This involves assessing two aspects.

Firstly, it is important to ensure that the objectives of the proposed action could not be achieved by Member States in the framework of their national systems (necessity test). This relates to the scope and size of the required research activities. Clear economies of scale may exist when R&D efforts are pooled on a European scale. European research funding allows Europe to benefit from transnational research teams, bringing together the best expertise in Europe to meet ambitious goals.

The second aspect to consider is whether the research serves Community aims and whether the benefits will be widely spread across the Member States. In the case of nuclear energy, with potential cross-border impacts, the need for Member States to work collectively together is clear, especially in areas that will lead to improved practices and/or regulation applicable in all Member States, and in areas where the rewards will only appear in the long term.

Public financial support for much nuclear research is more effective at a European level than at a national level for several reasons:

– Critical mass: Some nuclear research activities are of such a scale and complexity that very few Member States could provide the necessary financial resources or personnel, and hence need to be carried out at an EU level. For example, where a large research capacity is needed and resources must be pooled to be effective, or where complementary knowledge and skills are needed (such as inter-disciplinary fields like plasma physics, material science etc);

– Access to common research facilities such as JET and the fusion programme's High Performance Computer;

– Participation of smaller Member States: doing large nuclear R&D projects at European level brings in valuable contributions from the smaller Member States who otherwise might be left out;

– Improving skills and technology capabilities: Research teams wishing to develop their capabilities in specific fields can participate in top trans-national teams, benefit from learning and synergies, and so become recognised global leaders and centres of excellence;

– Leverage on private and public investment: Through EU research schemes, private companies and public research bodies can collaborate with foreign partners at a scale not possible at national level, which induces them to invest more of their own funds than they would under national funding schemes;

– Dissemination of results: It is more efficient to disseminate the results of research at an EU level - to users, industries, firms, citizens, etc. – leading to a better use of research, and creating a larger impact than would be possible only at Member State level;

4. THE OBJECTIVES TO BE ACHIEVED

The Euratom Framework Programme is one of the building blocks of Europe 2020 and the Innovation Union. It promotes competition for scientific excellence and fosters innovation in the nuclear energy field to tackle challenges in energy and climate change strategy. The programme will contribute to the "Innovation Union" flagship by supporting pre-commercial research and facilitating technology transfer process between academia and industry and to the "Resource efficient Europe" flagship by greatly increasing the overall sustainability of nuclear energy. By putting emphasis on training in all its activities, boosting competitiveness in the current nuclear industry and creating a new sector of high-tech industry for fusion energy in particular, the Euratom programme will lead to growth and new jobs in a wide range of disciplines.

The current proposal addresses in detail just the 2-year period 2012-13, but the activities remain fully consistent with the key milestones for technology development in the nuclear field over the next decade as laid out in the European Strategic Energy Technology Plan (SET-Plan).

The Euratom Framework Programme for 2012-13 , covers the same scientific & technical and strategic objectives and using the same funding schemes of current FP7 programme (2007-2011). Nonetheless, the programme has evolved over the last 5 years, and must take into account results of recent research and the new policy context and research landscape in Europe. Regarding policy, the most significant development has been the adoption and endorsement of the SET-Plan as part of a broad portfolio approach to addressing future energy challenges.

The broad objectives for the Euratom Framework Programme for the years 2012-13 are:

– in the area of fusion energy research, to develop the technology for a safe, sustainable, environmentally responsible and economically viable energy source;

– in the area of nuclear fission and radiation protection, to enhance the safety performance, resource efficiency and cost-effectiveness of nuclear fission and other uses of radiation in industry and medicine; and to enhance nuclear security (nuclear safeguards, non-proliferation, combating illicit trafficking and nuclear forensics)

4.1. Indirect actions in the area of nuclear fission and radiation protection

In the area of nuclear science and technology, the last 3 years have seen the launch of key technical forums that bring together all key nuclear research and industrial stakeholders across Europe. These are the Technology Platforms in Sustainable Nuclear Energy and Implementing Geological Disposal (SNETP and IGDTP) and the joint programming initiative MELODI – the Multidisciplinary European Low-Dose Initiative. All three have come together around agreed visions for future R&D in their respective field, and all have defined, or are defining, Strategic Research Agendas (SRA) and Deployment Strategies, to be implemented by sharing members' resources in the respective platforms. Both SNETP and IGDTP are closely aligned with the objectives of the SET-Plan.

The Euratom strategy in FP7 (2007-11) has already adapted to this new landscape by focusing on areas defined in the SRAs. This approach needs to be maintained in the 2-year prolongation, and extended to ESNII, the European Sustainable Nuclear Industrial Initiative, which is one of the six initial European Industrial Initiatives foreseen under the SET-Plan, and one of the pillars of SNETP's SRA. ESNII was formally launched at the Belgian Presidency's SET-Plan Conference in Brussels on 15-16 November 2010.

Within the programme's five priority areas, the specific objectives are:

– **Geological disposal** – Implementation-oriented research and development activities on all remaining key aspects of deep geological disposal of spent fuel and long-lived radioactive waste and, as appropriate, demonstration of the technologies and safety, and to underpin the development of a common European view on the main issues related to the management and disposal of waste.

– **Reactor systems and safety** – Research to underpin the safe operation of all existing reactors (including fuel cycle facilities). This research must take into account new challenges such as life-time extension and the development of new advanced safety assessment methodologies (both the technical and human element). Further research to assess the potential, the safety and waste-management aspects of future reactor systems, in the short and medium term, thereby maintaining the high safety standards already achieved within the EU and considerably improving the long-term management of radioactive waste. Research on partitioning and transmutation and/or other concepts aimed at reducing the amount and/or hazard of the waste for disposal.

– **Radiation protection** – Research, in particular on the risks from low doses, on medical uses and on the management of accidents, to provide a scientific basis for a robust, equitable and socially acceptable system of protection that will not unduly limit the beneficial and widespread uses of radiation in medicine and industry.

– **Infrastructures** – Supporting the availability of, and cooperation between, research infrastructures necessary to maintain high standards of technical achievement, innovation and safety in the European nuclear sector, such as material test facilities, underground research laboratories, radiobiology facilities and tissue banks,.

– **Human resources and training** – Supporting the retention and further development of scientific competence and human capacity (for instance through joint training activities) in order to guarantee the availability of suitably qualified researchers, engineers and employees in the nuclear sector over the longer term.

4.2. Indirect actions in fusion energy

The construction of ITER in Europe has brought about a fundamental change in the environment in which the European fusion research programme operates. However, the FP7 objectives were framed in the context of extensive negotiations with the other international partners which were taking place and the decision to proceed with ITER (the international agreement was signed in November 2006). The FP7 objectives are therefore already well adapted to the needs of the period 2012-13.

The overall objective remains "To develop the knowledge base for, and to realise ITER as the major step towards, the creation of prototype reactors for power stations that are safe, sustainable, environmentally responsible, and economically viable". This entails:

– **The realisation of the ITER machine** as a joint international research infrastructure within the approved scope and schedule. EU objective, as host, is to maintain a leading role in site preparation, the ITER Organisation's management and staffing, and general technical and administrative support. As an ITER Party, the Community objective includes the construction of equipment and installations, support to the project during construction and the management of R&D activities in support of ITER construction carried out in the Fusion Associations and European industries.)

– **R&D in preparation of ITER operation** to consolidate ITER project choices. Preparation for a rapid start-up of ITER operation, reducing significantly the time and cost needed for ITER to achieve its baseline objectives. This will include assessment of specific key technologies for ITER operation through the completion and exploitation of the JET Enhancements (first wall, heating systems, diagnostics) and the exploration of ITER operating scenarios by means of targeted experiments on JET and other facilities, and coordinated modelling activities.

– **Technology activities in preparation of DEMO**, with the objective of developing the key technologies and materials required for the licensing, construction and operation of the DEMO power plant.

– **Human resources, education and training** aiming at ensuring adequate human resources and a high level of cooperation within the programme, both for the immediate and medium term needs of ITER, and for the further development of fusion.

– **Technology transfer processes** which have the short term objective of ensuring that innovation and technological progress created in the programme is transferred to industry swiftly, so that European industry becomes more competitive.

4.3. Direct actions in nuclear safety and security

The overarching goal is to provide customer driven scientific and technical support to EU policy related to nuclear energy. In particular, the nuclear activities of the JRC aim to satisfy the R&D obligations of the Euratom Treaty and support both the European Commission and Member States in the fields of safeguards and non-proliferation, waste management, safety of nuclear installations and fuel cycle, radioactivity in the environment and radiation protection. To fulfil this goal, knowledge and skills need to be updated continuously to provide the cutting edge scientific expertise required for nuclear reactor safety and nuclear security. Furthermore, the JRC will further strengthen its role as a European reference for the dissemination of information, training and education for professionals and young scientists, ensuring that Europe's leading scientific position in the nuclear field is preserved and reinforced, and that the necessary competent workforce of scientists and operators is available in the future to implement, monitor, evaluate and assess current and new nuclear programmes. The safe and reliable operation and maintenance of all nuclear installations and laboratories located in the JRC's nuclear sites and related management of the operational waste from their exploitation will remain a high priority objective.

The JRC's specific objectives are:

(1) Nuclear Waste Management and environmental impact

– Nuclear waste management: strengthening the knowledge base of relevant processes during dry storage of spent fuel and in the near-field of the final repository (from the waste/waste package to the geological barrier); in the field of partitioning and transmutation, contribution to demonstration of efficient processes and safe operation of fuel fabrication and partitioning facilities at laboratory scale, based on aqueous and dry techniques.

– Basic research and applications: remaining at the forefront of actinide physics, chemistry and nuclear reference data, with the main goal of providing world-class experimental results and opening its facilities to scientists from universities and research centres; in the field of nuclear data, production of internationally required data and safe operation of the Van de Graaff and GELINA accelerators; in medical applications, supporting the development of targeted alpha therapy, focusing on alternatives for the production of alpha emitters and the radio-biological testing of radio-labelled bio molecules, assessing their efficiency and feasibility.

– Monitoring radioactivity in the environment: development of analytical techniques and production of the corresponding reference materials; development of real-time systems to collect, validate, map and report on environmental radioactivity in Europe.

Nuclear Safety

– Nuclear reactor safety: maintaining competences in design and operational nuclear safety for EU and Russian designed power plants in order to provide valuable technical support to the other policy making Commission DG's in nuclear safety related legislation/projects/issues, to the EU regulatory bodies and technical support organisations in the interpretation and dissemination of events occurring in nuclear power plants.

– Nuclear fuel cycle safety for the present generation of reactors: development of current and evolutionary fuel cycle trends and concepts for fuels operating in Gen II and III reactors; fuel rod safety assessment during in-pile operation through state of the art post irradiation examination techniques; modelling applications.

– Safe operation of advanced nuclear systems: giving support to the implementation of the Sustainable Nuclear Energy Technology Platform (SNETP) deployment strategy, to further coordinate the Euratom participation in GIF, remaining a major Euratom contributor to the GIF knowledge and data base build-up in the field of advanced fuels, safety assessments and qualification of innovative materials.

Nuclear Safeguards and Security

– Nuclear safeguards: development of verification and detection, containment and surveillance technologies, advanced and innovative measurement methods for nuclear materials, production of required nuclear reference materials, organisation of inter-laboratory comparisons, and provision of training, in particular for IAEA and Commission inspectors; related to the "Additional Protocol", strengthening of the capability for detection of undeclared nuclear activities, enhancement of the spectrometric methods towards high resolution, high sensitivity and reliability.

– Combating illicit trafficking of nuclear materials including forensic analysis: establishment of an integrated nuclear security concept for prevention, detection, and response to scenarios of undeclared activities. This includes establishment and implementation of the European Security Training Centre at the JRC, based upon a robust and high quality scientific background in terms of personnel and equipment.

5. THE POLICY OPTIONS AVAILABLE

The proposal for the Euratom Framework Programme will aim to continue support for R&D actions in nuclear field carried out under the 7th Euratom Framework Programme (2007-2011). The proposal will cover only two years (2012-13), in accordance with the current financial perspective (2007-2013) and in line with the timeframe of the EU 7th Framework Programme (2007-2013). There are three policy options for Euratom all of which should be based on the Commission Staff Working Document "Towards a robust management and governance of the ITER project"[18] and the available/planned budget (including the Commission's proposal to amend the financial perspective[19]).The variable factors behind each option are the cost increase of Euratom's contribution to ITER, the need to ensure continuity of fusion research programme parallel to the ITER construction, and the need to support implementation of SET-Plan in nuclear energy.

In this section, three policy options representative of the range of scenarios for the Euratom Framework Programme are presented, together with the planned activities and immediate results. Long term impacts are discussed under section 6.

5.1. Option 1 – Same level of Euratom R&D and no additional funding for ITER

The Euratom Framework Programme is extended to cover 2012-13 with the budget envelope provided in the current financial perspective. The Commission's proposal to amend the financial perspective to provide additional funding for ITER[20] is not adopted. The funding for indirect R&D actions in fission and radiation protection would remain at the same level as during the last 5 years, while the appropriations for fusion R&D would be similar to the average level of Euratom contribution to fusion research during FP7. Regarding direct actions in nuclear safety and security to be implemented by the Joint Research Centre, the draft appropriations proposed for 2012-13 also follow the budget provided under FP7 (2007-2011).

Activities to be implemented and expected results:

Fission and Radiation Protection: Under this scenario, the 'fission' programme will be able to co-fund in 2012-13 a limited number of projects in all key research areas (radioactive waste management, nuclear systems & safety, radiation protection, training actions, related cross-cutting topics). As in Euratom FP7 (2007-2011) there will be flexibility in the annual budget that allows the allocation of funds to be tailored, taking into account the strategic, scientific and technical needs of a particular time. This flexibility also enables results of ongoing projects to be taken into consideration in the annual work programmes. At present, it is expected that, following the annual calls for proposals and evaluations, approximately 20 additional projects will be launched each year. Some of these will be in support of SET-Plan aims and objectives presented in Section 2.2 above. In nearly all cases, there will be a focus on key research topics identified in the Strategic research agendas (SRAs) emerging from SNETP, IGDTP and MELODI. Such an approach will enable even more effective use of

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[18] SEC(2010) 1386

[19] Proposal for a decision of the European Parliament and of the Council amending the Interinstitutional Agreement of 17 May 2006 on budgetary discipline and sound financial management as regards the multiannual financial framework, to address additional financing needs of the ITER project, COM(2010) 403

[20] COM(2010) 403

Framework Programme funds, since these SRAs promote joint programming of research and commit a broad range of organisations including industrial players (except in the case of MELODI, where only public research funding is available) and those responsible for implementing national programmes. This level of activity in the 'fission' programme is considered the minimum possible in view of the objectives laid down in the SET-Plan regarding nuclear energy and radioactive waste management, and in particular the requirements of ESNII in coming years. Though the Euratom FP is unlikely ever to be able to make large financial contributions to actual construction of large demonstrator facilities, which are the focus of ESNII, Euratom can and should be an important player in the allied cross-cutting research programme that is also foreseen under ESNII. The current ESNII Concept Paper, endorsed by the SET-Plan Steering Committee, estimates that €1B will be required over 10 years for the accompanying R&D programme, to be carried out largely in new or upgraded research infrastructures. Much of this effort will be on safety-related aspects of next generation nuclear systems, advanced modelling and numerical simulation techniques, pre-commercial and pre-normative R&D in general, for example in materials science, and in related all-important training and knowledge management activities, all of which are areas where the Euratom FP has a clear role to play. Though these activities will often continue till 2020 and beyond, many must nonetheless begin in earnest now and are often based on current Euratom research projects and actions.

ITER: The cost increase of the ITER project was the subject of in-depth assessment in the Commission Communication "ITER status and possible way forward"[21]. In the business-as-usual scenario, Euratom's contribution to ITER would be limited. Such a budget would require key procurements to be delayed beyond 2013. The resulting substantial delays would not allow the Community to implement the project according to the schedule agreed in July 2010 (ITER baseline). Euratom would therefore not fulfil its obligations under the ITER agreement. In the longer term, any delay in ITER construction and exploitation would have an impact on the realisation of the SET-Plan and on the European long term vision of a low carbon society in 2050.

Fusion R&D programme: The level of appropriations would be used to maintain a minimum research programme in fusion. The Commission, with the support of a high-level expert group, is currently assessing the role of JET in this programme. Depending on the level of funding dedicated to ITER this policy option could have very serious disadvantages because insufficient funds for the fusion programme would compromise the Joint European Torus Facility (JET) and the EU's global reputation. JET could face closure, resulting in redundancies of around 500 staff, the money recently spent on upgrading it would be wasted, and its contribution to ITER would be negligible. The ability of the EU to lead the ITER project during and beyond construction could be seriously damaged. The credibility of the European Union as the coordinator of European fusion research could be lost both in Europe and worldwide. It is clear that leadership in the development of fusion would move to Asia, since the Korean prime Minister made very supportive comments about fusion in his key note address to the recent IAEA fusion energy conference in Korea. At the same time, in China it is reported that 2000 PhDs in plasma science have graduated last year.

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21 Communication from the Commission "ITER status and possible way forward", COM(2010)226, SEC(2010)571

Direct actions in nuclear security and safety: The JRC will continue to act as a reference centre for unbiased robust science, supporting independent policy making, in key areas of nuclear energy and nuclear security, satisfying the R&D obligations of the Euratom Treaty and supporting both the European Commission and Member States in the fields of safeguards and non-proliferation, waste management, safety of nuclear installations and fuel cycle, radioactivity in the environment and radiation protection.

Knowledge and skills need to be updated continuously to provide the cutting edge scientific expertise required for nuclear reactor safety and nuclear security. Furthermore, the JRC will further strengthen its role as a European reference for the dissemination of information, training and education for professionals and young scientists, ensuring that Europe's leading scientific position in the nuclear field is preserved and reinforced, and that the necessary competent workforce of scientists and operators is available in the future to implement, monitor, evaluate and assess current and new nuclear programmes. The R&D component will remain the key aspect in the nuclear programme justifying the added value of the JRC. Another essential aspect is the need of independent and reliable research and assessment in a controversy context in which public acceptance, policy concerns and nuclear industries are strong components.

Nuclear Waste Management and environmental impact will cover R&D work and relevant data on fuel cycle (back-end); development of optimised waste management and final repositories; development of closed fuel cycles and recycling techniques to reduce the long-term waste burden; development, implementation and training of tools to improve the exchange of information on environmental radioactivity in the EU MSs (routine and emergency conditions), according to the underlying EU legislation (EURATOM, Chapter III, art. 35, 36 and 39); maintaining expertise in environmental monitoring (sampling-measurement) by performing international intercomparison exercises; underpinning science in chemistry and physics of the actinide elements, nuclear materials research and pre-normative and exploratory research; health impact and medical uses of radiation sources and radioisotopes, becoming increasingly important with emerging new technologies; non nuclear applications of nuclear materials and techniques.

Nuclear Safety will address current nuclear policy and innovative systems (Innovative safety concepts both in nuclear reactor and nuclear fuels, targeting at harmonised guidelines on operational safety issues; plant safety assessment; operational feedback and event analysis; performance standards and codes for current and new materials, and for conventional and advanced fuel safety concepts, fabrication of prototype nuclear materials, determination of their properties, safety and performance analyses and improved nuclear data for reduced modelling and simulation uncertainties of reactor core and fuel cycle parameters

Nuclear Security, Safeguards and Non-Proliferation will include three main pillars in the domain, prevention (includes a full set of nuclear safeguards tools and techniques, including running of on-site laboratories for DG ENER and an extensive R&D support programme to the IAEA), detection, response (includes nuclear forensics analysis and response plans). They will cover improved and new methods and technology development (in Non Destructive and Destructive Analyses, Mass/volume determinations, Containment and surveillance, sealing, particle analysis etc), forensics analyses and response in case of seized materials; detection technologies for nuclear and radiological security; nuclear materials accounting and control statistical analysis; production and certification of reference materials, reference measurements and inter-laboratory comparisons; - Operations and process modelling and monitoring; development of methodologies for Gen IV proliferation resistance analysis and safeguards by design.

5.2. Option 2 – No additional funding but priority given to ITER

The Euratom Framework Programme is extended to cover 2012-13 with the budget envelope provided in the current financial perspective. The Commission's proposal to amend the financial perspective to provide additional funding for ITER[22] is not adopted. In order to give priority to ITER the funding for fusion R&D, the indirect R&D actions in fission and radiation protection would be reduced to a very low level, but direct actions in nuclear safety and security to be implemented by the Joint Research Centre would remain at the same level as in option 1.

Activities to be implemented and expected results:

Fission and Radiation Protection:

Most of nuclear research and training activities in Europe would be carried out only on the basis of existing national programmes. The leverage effect of the Euratom FP on national and industrial programmes would be lost at a time when SET-Plan activities should be starting in earnest. Euratom FP support to complement key EU policy initiatives in nuclear safety (EU Directive adopted in 2009) and radioactive waste management (Directive to be adopted this year) would no longer be possible. Bilateral and multilateral links between research and industrial organisations in Europe would be seriously curtailed with consequences for the realisation of the European Research Area in this field.

ITER: The limited additional appropriations coming from the fusion and fission research programme would still not be sufficient to launch the necessary procurements in the 2012-2013 timeframe. The delay in construction compared to the schedule agreed by the members of the ITER International Organisation, which foresees the start of operation of the facility in 2019, would be almost as severe as in option 1. Such delays would necessarily increase the total costs for the period of ITER construction, because of the running costs of the ITER Organization and F4E.

Fusion R&D programme: The level of appropriations would be insufficient to maintain a minimum viable research programme in fusion. The detailed impacts of a low level of budget would be:

– Closure and termination of the JET facility - Exploitation of the JET facility would be limited to 2012 as the largest part of available funding would be used to cover the termination expenditures, mainly on staff and operational waste, currently estimated at 45 Million GBP. In accordance with the JET agreement, the host of the facility, the Culham Centre for Fusion Energy, will cover costs of the facility's decommissioning.

– Termination of the Contracts of Association and EFDA – Within this budget envelope, Euratom would not be able to maintain the support to the fusion Associations: the Contracts of Association and EFDA would terminate at the end of 2011. But the training activities and the mobility of researchers might continue to be supported at a low level.

[22] COM(2010) 403

– Cessation of R&D activities in support of ITER – Closure of JET in 2012 and the termination of the Contracts of Association at the end of 2011 would mean the integrated fusion programme would practically cease to exist. The ability of the EU to lead the ITER project during and beyond construction would be brought into question.

Direct actions in nuclear security and safety: see option 1

5.3. Option 3 –Same level of Euratom R&D and budget increase for ITER

The Euratom Framework Programme would be extended to cover 2012-13 with the budget envelope provided in the financial perspective and additional funds foreseen in the Commission's proposal to amend financial perspective in order to provide additional funding for ITER[23]. The funding for fusion would maintain a minimum-sized EU coordinated research programme. The funding for indirect R&D actions in fission and radiation protection and direct actions in nuclear safety and security to be implemented by the Joint Research Centre would remain at the same level as in the option 1.

Activities to be implemented and expected results:

Fission and Radiation Protection: see option 1

ITER: The construction of ITER in Cadarache, France, will continue in 2012-13. The schedule for ITER construction agreed by the members of the ITER International Organisation foresees the start of research in November 2019. In 2012-13, the European Joint Undertaking 'Fusion for Energy' will carry on procurement activities concerning key European components of the ITER facility.

Fusion R&D programme: This policy option is a "bridge to the next research programme (beyond 2013)". EU funding in 2012 and 2013 is minimal, around the same level of Euratom contribution to fusion research in 2011. A bridge to the next research FP will have no impact on the EU's contribution to ITER outlined in the schedule agreed between ITER Parties, and would be part of the requested reduction of the European contribution to the ITER construction costs over its lifetime. In this scenario, a much reduced EU-coordinated fusion research programme would be maintained in 2012-13 through activities which, if followed by adequate funding in the next research FP, would protect the European investment in ITER and make sure that Europe, its research community and its industry, will reap the full benefit of the research at ITER. Depending upon the outcome of the assessment carried out with the support of a high level group of experts JET may continue to operate during 2012-13 and to close during the following research FP. The Fusion Associations would continue to work together under very tight financial constraints, focussing on preparing the operation of ITER, but very limited activities in power plant physics and technologies would be funded. This funding does not undermine the schedule and baseline of ITER, nor affects the full EU contribution to its construction costs. In fact, it will allow vital mitigation of risks and cost containment activities for ITER to continue.

Direct actions in nuclear security and safety: no change from option 1.

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[23] Additional funds foreseen in the Commission's proposal to amend the financial perspective. Ibidem, COM(2010) 403

6. THE RESULTS AND IMPACTS EXPECTED, IN PARTICULAR ECONOMIC, SOCIAL AND ENVIRONMENTAL IMPACTS, AND THE INDICATORS AND EVALUATION ARRANGEMENT NEEDED TO MEASURE THEM

6.1. Impacts of limited funding for ITER (option 1 and 2)

A budget for Euratom contribution to ITER limited to the appropriations foreseen for this purpose in 2006 does not allow the Community to implement projects according to the schedule agreed in July 2010 (ITER baseline) and prevents the Euratom Community from fulfilling its legal obligations under the ITER agreement. The Joint Undertaking 'Fusion for Energy' would need to postpone some key procurements beyond 2013. It will result in the substantial delay of the start of the ITER exploitation.

The possible impacts include: (1) loss of credibility of the European Union, (2) additional cost for Euratom as the host for ITER (additional running costs for ITER IO and F4E), and (3) compensation to other parties in the ITER agreement.

6.2. Results and impacts of ITER construction according to the baseline agreed in July 2010 (option 3)

The realisation of the ITER machine as a joint international research infrastructure will continue within the approved scope and schedule and is the highest priority of the fusion programme. The objectives of reaching burning plasma conditions at 500MW of fusion power over 400 seconds, with an amplification factor of 10, and of controlling plasma discharges well beyond this duration at reduced fusion power are essential for building an electricity producing demonstration reactor (DEMO). In addition to its scientific objectives, ITER will contribute to DEMO by testing technologies impossible to test on present-day fusion devices.

The objective of the Community as the host of the project is to maintain a leading role in site preparation, the ITER Organisation, management and staffing, plus general technical and administrative support. The objectives of the Community as an ITER Party include construction of equipment and installations, support of the project during construction and the management of R&D activities in support of ITER construction carried out in the Fusion Associations and European industries.) Almost 50% of the budget for construction of ITER will be spent in Europe to provide the components "in-kind" to ITER by F4E. The scale and complexity of components requires a constant flow of information and transfer of technologies between industry and research associations. This will involve key enabling technologies and a wide variety of sectors. Fusion for Energy will have an extremely important role of bringing together the scientific knowledge of laboratories and the practicality-based thinking and management of industry.

Joint Undertaking 'Fusion for Energy' procurement activities since 2007 have already given a huge boost to high-tech sector, paving the way for existing and future industries consortia. Major European companies are already joining forces to respond to the calls for tender launched by F4E in challenging science and engineering areas. As a result, the industry will gain new skills and manufacturing capabilities. Technological progress will also produce spin-off results in other sectors which are difficult to predict today.

Fusion for Energy has placed many industrial contracts already for the construction of ITER. These first contracts are large and therefore limited in scope for SMEs but already 7% of the contracts have been placed with SMEs. This is not including the many service contracts that have been awarded for which there is a significant number of SME participation. At present F4E is reviewing these contracts to gauge the exact involvement of SMEs in the activities of F4E. For the future procurement contracts, SME participation is expected to increase due to the smaller size and higher technology content of the contracts. To encourage the participation of SMEs, F4E is developing a policy whereby a certain percentage of SME are included in the call for tender for contracts under a certain threshold, as well as contractual requirements on main suppliers to include SME subcontracting with favourable conditions such as payment schedules etc.

This way the Community will stay a leader in the field and be in the forefront for next steps in the development of technology for a demonstration power plant, while gaining valuable experience in combining the worlds of laboratories and industries

The scientific and technological results from ITER operations will only start to appear after ITER first plasma planned for the end of 2019. A staged exploitation mode for ITER is foreseen to gain gradual experience in the operation of this device, which is of a completely new nature compared with previous experiments. However, a great deal of scientific or technical information can be reached before reaching full performance, including information having an important impact for the design of DEMO.

6.3. Results and impacts of termination of fusion R&D programme (option 2)

As discussed in section 5, the near zeroing of the budget under option 2 would result in the de facto termination of the integrated European fusion programme and the abandoning of its long term aim of demonstrating fusion power. The closure of JET would be irreversible (mothballing is not a viable option) and the withdrawal of support given to the Associations would rule out all fusion R&D, and undermine the priority status given to ITER. Associated with this would be a substantial loss of expertise and training activities from fusion research. Even if funding were to be restored in the following research FP, the ability of the programme to support ITER and to work towards its long term aims would be seriously impaired. Lack of expertise would leave Europe in a very weak position for the future exploitation of ITER, which will certainly involve competition with our international partners, and Europe would not be able to capitalise on the results of ITER.

6.4. Results and impacts of prolongation of fusion R&D programme (option 3)

Option 3 would provide just enough funding in 2012 and 2013 to bridge the gap to the next research programme (beyond 2013) and keep the momentum of the programme going towards its long term objectives. A Working Group of the Consultative Committee for the Euratom Specific Research and Training Programme in the Field of Nuclear Energy (Fusion - CCE-FU) has identified the objectives and deliverables for the fusion programme over the period of ITER construction. The objectives are (i) securing ITER operation by expanding the existing knowledge base; (ii) preparing the ITER generation to ensure that Europe will have the human resources to exploit ITER in an international and competitive environment; and (iii) laying the foundations for fusion power plants by driving forward the significant physics and technology developments that are required.

Achieving objectives (i) and (ii) will have a significant and direct impact on the efficient operation of ITER. It will be a unique experiment, its operation posing first-of-a-kind challenges ranging from the need to have pre-planned high performance operating scenarios guaranteed not to damage the machine, through the maximisation of operational efficiency in view of the substantial operating costs, to the creation of a effective ways for a geographically spread, multi-national group of researchers to work together in a unified team. The integrated fusion programme, and especially the experience of the collective exploitation of JET, will put Europe in a strong position to take the leading role in meeting all these challenges.

All three objectives are important for Europe to be able to benefit from the success of ITER and to be able to move on to the following stage of fusion development: the demonstration power plant. The body of expertise created in Europe, both in industry and the research community, by working for ITER will provide immediate technology transfer benefits. Steps will continue to be taken at EU level in 2012 and 2013 to prepare the European industry to meet fusion technological challenges and mobilize relevant stakeholders, in particular through the Fusion-Industry Innovation Forum. On a longer timescale, the ITER-generated expertise in industry and the research community, together with the physics and technology developments in parallel to ITER, will provide the essential basis for demonstration power plants.

6.5. Results and impacts of a very low funding for the fission & radiation protection programme (option 2)

Under this option a very low level of funding could mean that only small coordinated actions could be launched in fission and radiation protection research. The Euratom 'fission' programme would not be in a position to contribute to reaching Europe's long-term energy targets and to address societal concerns in areas such as nuclear safety, radioactive waste management and use of radiation in industrial and medical practices. For example Euratom would not be able to support topics identified in respective Strategic Research Agendas of the technical forums SNETP, IGDTP and MELODI. In particular Europe would lose an important added value in the form of the leverage on national and industrial programmes. Finally Euratom would not fulfil Council requests to undertake actions for maintaining knowledge and competence in Europe, including in Member States without civil nuclear power programmes but who have to regulate nuclear research and medical activities and/or who decide to develop nuclear power.

6.6. Results and impacts of maintaining the fission & radiation protection programme (options 1 and 3)

The overall aim of the Euratom 'fission' programme is to contribute to reaching Europe's long-term energy targets and to address societal concerns in areas such as nuclear safety, radioactive waste management and use of radiation in industrial and medical practices. The activities carried out in the programme are intended to maximise impacts in these areas over the longer term for the greater benefit of the maximum number of EU citizens.

However, the 'fission' programme has limited financial means for 2012-13 – so the emphasis is on ensuring funding is allocated as effectively as possible in all thematic areas of the programme. This is achieved by concentrating on topics identified in respective SRAs of the technical forums SNETP, IGDTP and MELODI (provided these topics are also within the scope of the Euratom FP) and relying on the catalytic effect to maximise the leverage on national / industrial programmes. In the period 2007-2010, this leverage has been >100%, i.e. the combined total costs of all FP7 projects to date is more than double the Euratom contribution over these 4 years. This Euratom seed money is particularly effective in projects in more cross-cutting fields (including nuclear safety), or where the research is largely pre-commercial and a broad cooperative approach is required across Europe in order to ensure critical mass.

In any scientific field, impacts of individual research projects, or whole lines of research, may become apparent only after several years. In the nuclear sector the timescales can be even more protracted; we are only now seeing these impacts in the case of research carried out in Euratom FP4. For example, the research on geological disposal completed some 10-15 years ago is now feeding through as an element in actual implementation programmes in the most advanced Member States; similar situations are apparent in aspects of research on nuclear installation safety, and even longer timescales may be apparent in research on advanced nuclear systems, since such systems will not be deployed commercially for decades.

However, in addition to adding to the knowledge base in key fields, Euratom FP6 & FP7 have had a more immediate restructuring effect on the fission research landscape in Europe; these positive impacts will continue in 2012&13 and will contribute, along with the actions undertaken by the technical forums, to establishing the European Research Area in the nuclear field. In this process of facilitating effective cooperation in Europe, Euratom research also ensures the all-important development of a common European view in key scientific and technical issues, and forges a clear link with the Commission's policy initiatives in areas such as nuclear safety (new Directive came into force in 2009) and radioactive waste management (new Directive proposed by the Commission in Oct. 2010) and radiation protection (new Communication on medical applications of ionising radiation adopted by the Commission in Aug. 2010). Effective links with the nuclear safety regulatory authorities, through such forums as ENSREG (European Nuclear Safety Regulators Group), are an important part of this overall approach.

Euratom is a nuclear research and training programme, and the impacts in the latter field are already being felt following a number of key activities in recent years, including the establishing of a number of Euratom Fission Training Schemes. The political dimension to such issues as availability of competences and know-how in this field has already been addressed in the EU Council Conclusions of December 2008, in which the role and impacts of the Euratom FP were clearly mentioned. Again, Euratom influence is in providing a catalyst and initial seed money, but also a framework for change and a Community-wide vision. Training and knowledge management have become a focus of the activities of SNETP and other Europe-wide nuclear stakeholder initiatives, such as the European Nuclear Energy Forum (ENEF).

In conclusion, and in view of this long-term nature of the research in most nuclear fields, the importance is to maintain continuity research and related competences and to ensure that the R&D contribution is in line with the evolving Community strategy / policy, as represented by the SET-Plan (low-carbon energy policy / strategy) or under the Euratom umbrella (i.e. nuclear safety, radioactive waste management / radiation protection). The potential benefits for the Community as a whole will be maximised if this coherence can be maintained, and this can be best achieved by working closely with SNETP, IGDTP and MELODI for as long as these forums continue to be effective and work efficiently. To date, the establishing by the research community of the above technical forums, and cementing the relationship with the SET-Plan, especially the launch of ESNII, represent the most tangible success of the Euratom FP. Euratom's contribution to this process remains crucial over the coming years if we are to capitalise on its success in the longer term.

6.7. Conclusions of assessment

Following assessment of options presented in the section 6, it is concluded that option 3 (budget increase for ITER and continuation of fusion, fission and radiation protection R&D programmes) would enable the Community to address the medium (2020) and long term (2040) R&D challenges and to reach SET-Plan objective of low carbon society by 2050.

6.8. Indicators and evaluation arrangement for the preferred option

For the monitoring and evaluation it is proposed that, like in the past, the Commission would assess the execution of the Euratom Framework Programme through the following indicators:

ITER construction:

– Number of milestones met by Joint Undertaking Fusion for Energy (F4E).

– Number of procurement contracts launched and research grants awarded by the Joint Undertaking 'Fusion for Energy'

– Number of new industrial consortia formed to deliver ITER components and technology

Fusion research:

JET

– Number of scientific publications on JET

– Number of operational days devoted to experimental campaigns

– Number of professional person days of Association staff at JET for campaigns

EFDA coordinated activities

– Completion of deliverables under EFDA Task Agreements

– Implementing Agreement for Power Plant Physics and Technology activities

– Number of fusion researchers and engineers trained for the needs of ITER and the programme)

Associations

– Planning & monitoring of Associations' programmes by the Steering Committees

– New Association Work Programmes

Mobility Agreement

– Level of researcher mobility in fusion R&D

High Performance Computer

– Number of proposals and allocation of CPU time to the Associations

Indirect actions in Fission and Radiation protection:

Indicators have already been laboriously developed and endorsed as part of the RTD Annual Management Plan, and these will be maintained (and improved if necessary) during the period 2012-13 (see list below). In view of the 'business-as-usual approach', no major changes are considered necessary.

In brief, the indicators include:

– Coverage of areas being granted highest priority in the Specific Programme for indirect actions.

– Percentage of proposals which successfully addressed the criteria of scientific and/or technological excellence (based on the consensus report for research projects established by the evaluators to rank the proposals)

– Percentage of projects which generate one or more patent application (in the field of nuclear fission and radiation protection, the intellectual property acquired during the project implementation could result in patent applications not only during the lifetime of the project and Euratom Framework Programme, but also in the 10-15 years after the end of the project).

– Percentage of the projects which have fully achieved their objectives and technical goals and have even exceeded expectations.

– Percentage of proposals which successfully addressed the criterion of dissemination and use of project results.

– Percentage of projects showing evidence that they will produce significant scientific, technical, commercial, social or environmental impacts.

– Percentage of projects with publications in peer reviewed journals.

– Percentage of projects which generate one or more patent application

– Percentage of industrial participation in the projects (Excluding Radiation Protection)

Direct actions in waste management, nuclear safety and security (JRC)

The JRC has put in place a system of evaluation support activities, ranging from the monitoring of achieving objectives, through to a Periodic Action Review, which assesses the set of JRC research projects (called "actions") in terms of achieved policy impact and scientific output once a year using an elaborated indicator-based methodology.

Regarding policy support, the JRC determines:

– the number of deliverables (productivity indicator), and

– the number of occurrences of a tangible impact at the level of policy makers using a list of pre-defined criteria (impact indicator).

Scientific output is measured through:

- the number of publications in peer reviewed journal articles (productivity indicator), and
- the number of joint publications with external research organizations (for measuring the degree of cooperation with top class institutes).

In 2011, the JRC will develop a system to assess the impact of its scientific publications.

- Training and education results and impact will be assessed on the basis of:
- the number of PhD-Thesis performed at JRC premises
- the number of visiting scientific researchers (PhD, Post-docs and visiting scientists)
- the number of hours of training modules delivered multiplied by the respective number of participants.

Regarding the evaluation arrangements, the Commission will continually and systematically monitor the implementation of the Euratom Framework Programme and its specific programmes and regularly report and disseminate the results of this monitoring. In accordance with the article 173 of the Treaty on the functioning of the European Union and article 11 of the Euratom Treaty, the Commission publishes annual reports. These reports are accompanied by a Commission Staff Working Document, which provides more detailed reporting and by Statistical Annexes. Following the completion of the Framework Programme, the Commission will launch, not later than two years after its completion (2015) an external evaluation by independent experts of its rationale, implementation and achievements. The Commission will communicate the conclusions of this evaluation, accompanied by its observations, to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions.

7. THE MOST APPROPRIATE METHOD OF IMPLEMENTATION FOR THE PREFERRED OPTION

The following management modes are envisaged. The funds will be managed in a centralised direct management system and by indirect management through a body set up by the Communities (Fusion for Energy, a Joint Undertaking situated in Barcelona). Several control methods are applied as for FP7, including ex-ante control measures and randomly selected biannual ex-post verifications in the framework of the internal control scheme. Moreover, the requirement for audit certificates and the performance of regular independent external audits help to ensure sound financial management, including regularity and legality of the transactions performed.

Fission and radiation protection: The 'fission' programme during 2012-13 will continue on the basis of annual calls for proposals, covering most if not all thematic priority areas and committing most if not all of the annual budget. This system has been applied successfully for the years 2007-2011. By setting call deadlines in April and evaluations in May, the time taken to process the proposals and grant funds ("time to grant") has been reduced to 240 days which is about as efficient as could be expected. If simplifications are introduced for the Euratom 2012-13 programme, then the time to grant may be even quicker.

Fusion R&D programme: Substantial changes to funding mechanisms (and their associated governance provisions) are not envisaged. These mechanisms are the Contracts of Association, EFDA (the European Fusion Development Agreement, under which there are Implementing Agreements for JET and the High Performance Computer for Fusion), the JET Operating Contract and the Agreement on Staff Mobility. They are interconnected, so any substantial change to one would have important consequences for the others. The integrated nature of the fusion programme is largely due to the success of these mechanisms, and any adaptation of them should be done in consultation with the actors and stakeholders in the programme. Such adaptations could be considered as part of preparations of research programme after 2013.

ITER: In its Staff Working Paper "Towards a robust management and governance of the ITER project"[24] the Commission examines and addresses the way in which the Member States, F4E, and the Commission itself fulfil their responsibilities under the ITER agreement. The overall goal is the successful construction of ITER in accordance with the technical requirements, within the agreed schedule and with the resources fixed to that end. To this aim, an adequate project management, including cost containment and risk management (technical, industrial, financial, legal) must be at the core of the ITER implementation at all levels. The Staff Working Paper provides an overview of the possible measures for improvement of governance and management at the European level (Joint Undertaking 'Fusion for Energy') and level of the ITER International Organisation.

The ITER project is conducted under the terms of an International Agreement[25] between Euratom, represented by the Commission, and 6 other Parties - People's Republic of China, India, Japan, Republic of Korea, the Russian Federation, the United States-, which was signed in Paris in November 2006 and entered into force in October 2007. The Agreement established the ITER Organization (IO) with full international legal personality to be responsible for the joint implementation of the ITER project. According to the International Agreement, each Party provides its contribution to IO through an entity called Domestic Agency (DA). The IO is responsible for the construction and performance of the machine (including design and assembly of the components, and quality and safety requirements), while the Parties are committed to providing various components and systems. At EU level, the Euratom contribution to ITER is managed through the European Joint Undertaking for ITER – "Fusion For Energy" (F4E), established as the European "DA" by the Council in March 2007[26] and based in Barcelona. Community funds advanced through the Euratom Framework Programme represent about 80% of the European contribution to the ITER project and the Commission is ultimately accountable for the use of these public resources. The European Parliament is responsible for giving budgetary discharge to the European Joint Undertaking for ITER.

24 Commission Staff Working Document "Towards a robust management and governance of the ITER project",
SEC(2010) 1386, 9 November 2010

25 Agreement on the Establishment of the ITER International Fusion Energy Organization for the Joint Implementation of the ITER Project. OJ L 358, of 16.12.2006, p.62

26 OJ L 90, 30.3.2007, p. 58.

8. THE INTERNAL COHERENCE OF THE PROPOSED PROGRAMME OR ACTIVITY AND ITS RELATIONS WITH OTHER RELEVANT INSTRUMENTS

Indirect R&D activities to be supported by the proposed Euratom Framework Programme are within the scope of the Strategic Energy Technology Plan (SET-Plan), which has been endorsed by the European Council. The programme also takes account of major EU policy documents such as Communications on Europe 2020 and Energy 2020.

The direct actions to be carried out by JRC aims to build on the Strategic Research Agenda (SRA 2009) of the Sustainable Nuclear Energy Technology Platform (SNETP), the Implementing Geological Disposal of Radioactive Waste Technology Platform (IGDTP) and other instruments for stability and global security such as EU CBRN Action Plan (June 2009), EU New Dual Use Regulation (May 2009), EU Council Decision on New Lines for combating proliferation of WMD (Dec 2008).

9. THE VOLUME OF APPROPRIATIONS, HUMAN RESOURCES AND OTHER ADMINISTRATIVE EXPENDITURE TO BE ALLOCATED WITH DUE REGARD FOR THE COST-EFFECTIVENESS PRINCIPLE

In the following section, the budget for the preferred option 3 is explained. The proposal for Euratom Framework programme is of limited duration and will be in force from 1st January 2012 until 31st December 2013. Financial impact is expected from 2012 until 2016.

The programmatic content of the two year period 2012-13 is a direct continuation of Euratom FP7, with strong continuity in the activities and outcomes. In all areas except ITER construction the proposed appropriations are consistent with the corresponding figures for FP7, and there is therefore a similar cost-effectiveness. The cost of ITER construction has been the subject of extensive analysis and the present appropriation proposals are considered to represent the most cost-effective way of achieving the aims within a regime of strict cost containment[27]

Commitment figures:

	2012 *Million euro*	**2013** *Million euro*	**Total** *Million euro*
Fission R&D	54,105 €	55,839 €	109,944 €
Fusion R&D and ITER	1.129,274 €	936,965 €	2.066,239 €
Administration	74,054 €	76,817 €	150,871 €
Total indirect R&D actions	**1.257,433 €**	**1.069,621 €**	**2.327,054 €**
JRC operational expenditure	9,895 €	10,252 €	20,147 €
JRC administrative expenditure	104,648 €	108,421 €	213,069 €
Total direct R&D actions	**114,543 €**	**118,673 €**	**233,216 €**
Total for direct and indirect actions	**1.371,976 €**	**1.188,294 €**	**2.560,270 €**

[27] Communication from the Commission "ITER status and possible way forward", COM(2010)226, SEC(2010)571

Payment figures:

	2012 *Million euro*	2013 *Million euro*	2014 - 2016 *Million euro*	Total *Million euro*
Fission R&D	34,600 €	35,000 €	40,344 €	109,944 €
Fusion R&D and ITER	401,822 €	863,164 €	801,252 €	2.066,239 €
Administration	74,054 €	76,817 €	- €	150,871 €
Total indirect R&D actions	**510,476 €**	**974,981 €**	**841,596 €**	**2.327,054 €**
JRC operational expenditure	4,650 €	8,972 €	6,525 €	20,147 €
JRC administrative expenditure	104,648 €	108,421 €	- €	213,069 €
Total direct R&D actions	**109,298 €**	**117,393 €**	**6,525 €**	**233,216 €**
Total for direct and indirect actions	**619,774 €**	**1.092,374 €**	**848,121 €**	**2.560,270 €**

Human resources:

		Year **2012**	Year **2013**
Establishment plan posts (officials and temporary agents)			
X 01 01 01 (Headquarters and Commission's Representation Offices)		-	-
XX 01 01 02 (Delegations)		-	-
XX 01 05 01 (Indirect research)		**190**	**190**
10 01 05 01 (Direct research)		**566**	**566**
External personnel (in Full Time Equivalent unit: FTE)			
XX 01 02 01 (CA, INT, SNE from the "global envelope")		-	-
XX 01 02 02 (CA, INT, JED, LA and SNE in the delegations)		-	-
08 01 04 *yy*	- at Headquarters	-	-
	- in delegations (F4E)	**239**	**239**
08 01 05 02 (CA, INT, SNE - Indirect research)		**40**	**40**
10 01 05 02 (CA, INT, SNE - Direct research)		**166**	**166**
Other budget lines (specify)		**-**	**-**
TOTAL		**1,201**	**1,201**

There is no extra need for staff in spite of the increase of the budget in 2012 and 2013.

10. THE LESSONS LEARNED FROM SIMILAR EXPERIENCES IN THE PAST

In 2009 two panels of independent experts carried out the interim evaluation of direct and indirect actions under the Euratom FP7 (2007-2011). More recently, the Euratom Scientific and Technical Committee (STC) produced its ex-ante opinion on orientations for Euratom Framework Programme (2012-13), which also provided an initial reflection on Euratom research programmes beyond 2013.

Regarding the indirect actions in fission and radiation protection, the report of the panel fully supports the establishing of Technology Platforms / Joint Programming Initiatives in line with ERA (European Research Area) and SET-Plan goals, which is a growing focal point of the calls for proposals, and considers that the Euratom FP7 'fission and radiation protection' programme is on track to meet its objectives in all research activities.

The panel recommended that the EU should alter the balance of the fission research programme to be able to better reflect the priorities agreed by all stakeholders, as formulated by the Technology Platforms and Joint Programming initiatives, particularly with respect to the increasingly important field of advanced and more sustainable reactor systems (also prioritised under the SET-Plan). Very similar conclusions and recommendations are reflected in the Euratom STC opinion. In addition, previous ex-post evaluations of the Euratom FP5 and FP6 fission programmes have demonstrated the effectiveness of the research carried out in these programmes, the restructuring effect of the new funding instruments introduced in FP6, and the importance of developing the technology platforms to ensure longer term strategic impacts in Europe.

Regarding the indirect actions in fusion research, the panel expressed its conviction that the potential of fusion is so great that it should be actively pursued. The costs, timescale and project risks inherent in the development of fusion are great – so much so that it is unlikely that any European Member State could contemplate undertaking it alone. The panel believes that the fusion research coordinated under European Fusion Development Agreement is well focussed and managed and is essential to support ITER.

The fusion programme has also been the subject, in 2009,, of an in-depth examination by a high level panel of nine European and non-European experts[28]. The Fusion Facilities Review panel was charged with the tasks of developing " a vision of the R&D required to make fusion energy production ready for commercial exploitation" and defining "the facilities needed to support the envisioned R&D". With regard to the programme, the panel concluded that:

During the period of ITER construction the key strategic R&D emphasis should be on supporting ITER construction and preparation for operation, and preparing DEMO design, simultaneously carrying out long-term R&D;

During the following decade the focus must shift towards preparing for DEMO construction, based on ITER and the accompanying R&D;

ITER and DEMO must be complemented by long-term strategy for human resources to guarantee a future workforce with adequate skill and expertise.

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[28] "R&D Needs and Required Facilities for the Development of Fusion as an Energy Source" - Report of the Fusion Facilities Review Panel - October 2008.

The panel also prioritised the present and possible future facilities in the programme according to their benefits, costs and risks in relation to ITER and DEMO.

On the basis of these conclusions, the Commission launched a dialogue with all the Fusion Associations on how their programmes could and should be adapted, and which facilities should continue to receive Community support. These dialogues have taken on an increased urgency in view of the serious budget constraints during the last two years of FP7, which may continue in 2012-13. The process of adaption will continue into that period.

The ITER project is inherently complex but it provides enormous potential for sustainable energy. The FP7 Interim Evaluation panel considered ITER an essential step towards the commercial realisation of fusion energy and if Euratom is to pursue fusion energy it must be adequately funded. The panel was critical of the existing structure of the ITER project because it believes that it has not been and is not effective, and may still fail to deliver even at the higher costs and longer timescales presented during the review. On the basis of this review the Commission has strived to have a more focused leadership at the ITER organisation to secure a positive outcome within the limits set by the adopted baseline. It also requires a more streamlined international management structure with fewer and/or better interfaces implemented according to the best practice either from the construction of nuclear power plants or large international projects. Changes of management will take place during the last years of FP7 but continued monitoring, verification of planning and quality of the deliverables will continue in 2012-2013.

A separate panel of external experts carried out an interim evaluation of direct actions under Euratom FP7. It evaluated the rationale and relevance of the programme, the implementation of the programme (its governance), the achievements and performance level (at macro-level). The panel made a positive evaluation of the achievements and performance of the JRC nuclear programme, with the three broad recommendations specifically focusing on the governance and management structure of the programme:

Governance of the programme should be improved through the better management structure and distribution of responsibilities, enhanced customer consultation and reduction of bureaucratic burden;

Present work and future proposals should be based on a vision and strategy linked to Strategic Research Agendas of the technical forums such as SNETP, and through a definition of a 10 to 20 year outlook for JRC's research facility infrastructure;

JRC programming, planning and reporting should be improved.

In response to these recommendations, a series of actions are being undertaken in JRC and will be implemented as proposed, namely:

a series of actions regarding governance and management, as well as planning and reporting;

the development of a nuclear safety and security specific strategy taking into account the recommendations of the report.

It should be noted that since the beginning of 2011, a new structure has been put in place in the JRC, defining 7 Thematic Areas (nuclear R&D being one of them), with a Lead Director who has the responsibility of the programme definition and follow-up of its implementation.