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Final Report

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LIST OF ACRONYMS

ALLEGRO	European Gas Fast Reactor Demonstrator Project
ASTRID	Advance Sodium Technological Reactor for Industrial Demonstration
BWR	Boiling Water Reactor
CCGT	Combined Cycle Gas Turbine
CEEC	Central and Eastern Europe Community
CIS	Commonwealth of Independent States
CO_2eq/kWh	Carbon dioxide equivalent per kilowatt hour
DEVCO	Directorate-General Development, European Commission
DG ECFIN	Directorate-General Economic and Financial Affairs, European Commission
DG ENER	Directorate-General for Energy, European Commission
DG CLIMA	Directorate-General for Climate Action, European Commission
DG RTD	Directorate-General for Research and Innovation, European Commission
EBRD	European Bank for Reconstruction and Development
EC	European Commission
ECA	Export Credit Agency
EIB	European Investment Bank
EMTN	Euro Medium Term Note
ESNII	European Sustainable Nuclear Industrial Initiative
ENEF	European Nuclear Energy Forum
ENPI	European Neighbourhood and Partnership Instrument
EU	European Union
FOAK	First of a Kind
FNR	Fast Neutron Reactor

FP7	The Seventh Framework Programme for Research and Development (2007 - 2013)
FSU	Former Soviet Union
GWe	Gigawatt electrical power
HLW	High Level Waste
IAEA	International Atomic Energy Agency
IFIs	International Financial Institutions
K2R4	Khmelnitsky 2 and Rovno 4
LFR	Lead- cooled Fast neutron Reactor
LILW-SL	Low and Intermediate Level Waste - Short-Lived
LILW-LL	Low and Intermediate Level Waste - Long-Lived
LMC	Lenders Monitoring Consultant
MYRRHA	Multi-purpose Hybrid Research Reactor for High-tech Applications
MOX	Mixed Oxide
MWe	Megawatt electrical power
NIP	Nuclear Illustrative Programme
NPP	Nuclear Power Plant
NSCI	Nuclear Safety Cooperation Instrument
OAPEC	Organisation of Arab Petroleum Exporting Countries
OPEC	Organisation of the Petroleum Exporting Countries
PHARE	Programme of Community aid to the countries of Central and Eastern Europe
PRIS	Power Reactor Information System
PWR	Pressurised Water Reactor
R&D	Research and Development
SFR	Sodium-cooled Fast Neutron Reactor
SNETP	Sustainable Nuclear Energy Technology Platform

SNRCU	State Nuclear Regulatory Committee of Ukraine
TACIS	Technical Assistance to the Commonwealth of Independent States
TSO	Technical Support Organisation
UO_2	Uranium Oxide
VLLW	Very Low Level Waste
VVER	Vodo-Vodyanoi Energetichesky Reactor – Russian designation for light water pressurised reactor
WEC	World Energy Council
WNA	World Nuclear Association

EXECUTIVE SUMMARY

This is the Final Report of the Ex-post Evaluation of the Euratom Loan Facility. The evaluation was commissioned by the Directorate-General Economic and Financial Affairs (DG ECFIN) in October 2010 and was undertaken by GHK Consulting in association with Pöyry Energy UK.

Background and Context

The Euratom Loan Facility was created in 1977 to provide long-term financing (in the form of loans) to 'projects relating to the industrial production of electricity in nuclear power stations and industrial fuel cycle installations' in EU Member States. The Facility was established in a context of rising oil prices and amid growing concerns about Europe's excessive dependence on energy imports. Following the Chernobyl reactor accident in 1986 (Ukraine), the scope of the Euratom Loan Facility was extended in 1994 to cover the financing of projects designed 'to improve the safety and efficiency of nuclear facilities' in certain third countries of the Central and Eastern Europe Community (CEEC) and of the Commonwealth of Independent States (CIS). The following third countries are currently eligible for Euratom Loans: Russian Federation, Republic of Armenia and Ukraine.

Financial support from the Euratom Loan Facility is limited to 20 per cent of the total project cost for Member States and 50 per cent of the cost of 'safety and efficiency' measures for third countries. Euratom loans are 'off-budget' operations which the European Commission finances 'back to back' by borrowing from the financial markets.

Since its inception, the Facility has provided long term loans in the order of EUR 3.4 billion to nuclear projects in the EU and its neighbouring countries:

- **Loans to EU Member States.** During the period 1977 to 1987, Euratom loans co-financed the construction of nine nuclear power plants; a uranium enrichment plant; and, a uranium reprocessing facility in five Member States namely, Belgium, France, Germany, Italy and the United Kingdom. The total loan amount of EUR 2,876 million has been fully repaid by the borrowers. No Euratom loans have been granted for investment projects in Member States since February 1987.

- **Loans to Third Countries.** Following the Council Decision of 1994 for third countries, the Commission has granted three Euratom loans: EUR 223.5 million for the safety upgrade of Kozloduy 5 and 6 (Bulgaria) in April 2000; EUR 212.5 million for the completion to an adequate safety level of unit 2 at Cernavoda (Romania) in March 2004 and USD 83 million for the safety upgrade of Khmelnitsky 2 and Rovno 4 (Ukraine) (K2R4) in July 2004.

The Facility is subject to a cumulative ceiling of EUR 4 billion. The amount currently available for new loans within this ceiling is EUR 626 million.

Purpose and Scope of the Evaluation

The overall mandate of this evaluation was to examine whether the scope, objectives and the limits fixed by the earlier Council Decisions on the Euratom Loan Facility (which date back to 1977 and 1994) remain relevant and appropriate in the present day context and in the foreseeable future.

The specific objectives of the evaluation were:

- To assess the functioning and achievements of the Euratom loan facility on the basis of loans granted so far; and,

- To determine the size and scope of a potential EU instrument for supporting the expected future financing needs of the nuclear sector**.**

The evaluation was based on a structured and systematic approach to analysing and triangulating evidence collected from a range of sources. The evaluation methodology comprised in-depth desk research and extensive consultations with the European Commission officials, national policy makers, loan beneficiaries, utility companies, industry representatives, legal advisors, banks and international financial institutions.

Findings and Conclusions of the Evaluation

The main findings and conclusions of the evaluation are as follows:

- The **underlying intervention logic of the Euratom Loan Facility remains valid** in the context of the EU's increasing dependence on energy imports; high and volatile oil prices; projected growth in electricity consumption within the EU; and, the need to cut greenhouse gas emissions to mitigate the impact of climate change.

- The **overall objectives of the Euratom Loan Facility are strongly aligned with the EU's policy objectives** relating to secure and affordable energy supply; climate change; job creation and economic growth; and, promotion of nuclear safety and security in third countries.

- The Euratom Loan Facility has **promoted and accelerated the development of the EU's nuclear energy sector** through direct financing of economically viable and environment friendly projects. It is estimated that Euratom loans co-financed 21 per cent of the total investment in new builds in the EU over the period 1977 to 2003.

- By enabling investment in the nuclear sector, the Euratom Loan Facility has contributed to the **decarbonisation and diversification of the EU's sources of energy supply**.

- A majority of the plants co-financed by Euratom loans are still in operation, generating **114,142 GWh of low carbon electricity annually** (representing circa 6 per cent of the EU's gross electricity generation and 12 per cent of nuclear electricity generation). In the absence of this **indigenous production capacity**, the EU would be importing an additional 10Mtoe of energy on an annual basis. Secondary benefits of the Facility include the **creation of 6,000 highly skilled jobs** at the plants under operation plus jobs and output creation in the wider economy through backward and forward linkages.

- The expansion of the geographic scope of the Euratom Facility in 1994 to CEEC and CIS was relevant and appropriate. Loans approved under the 1994 Decision directly **contributed to safety enhancements and promoted greater transparency of nuclear operations** in Bulgaria, Romania and Ukraine. Safety improvements financed by Euratom loans have helped bring the nuclear installations in these countries **in line with internationally recognised nuclear safety principles and standards**. Euratom lending was also crucial in **achieving wider reform in these countries** such as the creation and funding of decommissioning funds; reform of electricity tariffs; and, increase in the scale of nuclear insurance.

- The Facility has an **important 'signalling' effect** i.e. an EU endorsement of the project which provides a positive message to the market, Governments and the public about the project's economic and technological viability; and, a '**catalytic' effect** i.e. Euratom lending helps leverage financing from other sources.

- The Euratom Loan Facility provides loans on attractive terms to borrowers. The European Commission operates on a **non-profit basis** and passes on the benefits of its AAA/Aaa rating to its borrowers. The difference between the cost of capital raised on the market and the cost of the Euratom loan represents the **financial added value** of the Facility in the case of each project.

- As regards the financing needs of the nuclear sector, the evaluation identifies a **financing gap for new builds** and **large scale infrastructure for demonstration of next generation technologies.** Additional, exceptional financing needs (as yet hard to quantify) might also arise from **safety improvements**/ **upgrades** required as a result of the EU 'stress tests'.

- The amount available for new loans within the current ceiling is EUR 626 million. The **present resources and borrowing ceilings** for the Facility would not be adequate to meet the expected future demand for loans.

- The **financial management and implementation arrangements** for the Euratom Loan Facility have worked extremely well and there is evidence of them being effective: all loans within the EU have been **fully repaid**; there has been **no recourse to the EU budget guarantee** during the lifetime of the Facility; and, the Euratom Loan Facility has **delivered its stated objectives.**

- However, **some operational aspects of the Facility could be improved**. There is scope to enhance the visibility of the Facility and the processes relating to the procurement of external expertise could be streamlined.

Recommendations for the Future Orientation of the Facility

The recommendations of this evaluation are as follows:

1. **Continuity –** There is a strong argument, based on a market failure rationale, for the Euratom Loan Facility to continue supporting investment in new builds with the EU**.** The Euratom Loan Facility should also continue to support safety upgrades and the safe dismantling of nuclear installations in neighbouring third countries in order to minimise hazards to the health and safety of EU citizens.

2. **Scope** – The evaluation recommends a targeted use of the Euratom Loan Facility in future to address clearly identified financing gaps. The scope of the Euratom Loan Facility should therefore be adjusted to reflect the findings of the evaluation. While there is no longer a case for an EU level financial instrument to support investment in front-end fuel cycle facilities, the European Commission should consider making Euratom Loans available for safety upgrades and improvements within the EU. Financing of large scale research and development (R&D) infrastructure (such as commercial scale demonstration reactors) by the Euratom Loan Facility should also be considered in the absence of any corresponding EU instrument (provided the project sponsor can demonstrate the capacity to repay the loan on the basis of a credible business plan).

3. **Financial envelope** – The financial envelope for the Euratom Loan Facility should correspond to the anticipated financing needs of the sector. ‘Back of the envelope’ calculations indicate a new lending limit in the order of EUR 10 billion.
4. **Structure** – The Euratom Loan Facility should be restructured as a ‘revolving’ facility whereby loan repayments are recycled to support new lending (within the constraints of the financial envelope allocated to the instrument).
5. **Legal base** - The legal base should be amended to reflect the distinct intervention logics for investment in new builds (including demonstrator reactors) and safety upgrades/ improvements. It is recommended that these two purposes should be covered by two separate Council Decisions.
6. **Visibility and transparency** – DG ECFIN should improve the visibility and transparency of the Euratom Loan Facility through systematic dissemination of information regarding the Facility. The information package should reflect the needs of the different stakeholder groups notably, EU citizens, industry players and policy makers.
7. **Management processes** – DG ECFIN should be appropriately resourced so that it can continue to manage the Euratom Loan Facility in an efficient and effective manner. Additionally, appropriate framework contracts should be put in place to facilitate timely and efficient procurement of external expertise.

In addition, an Impact Assessment study should be launched by the European Commission to fully examine the costs and benefits of the proposed changes to the scope, size and structure of the Facility.

1 INTRODUCTION

This is the Final Report of the *'Ex-post Evaluation of the Euratom Loan Facility'*. The evaluation was commissioned by the Directorate-General Economic and Financial Affairs (DG ECFIN) in October 2010, within the auspices of the Framework Contract for the provision of external evaluation studies of an interim and ex-post nature (BUDG 06/PO/01 LOT No 3 - ABAC 101908). The work was undertaken by GHK Consulting in association with Pöyry Energy UK.

This report is a product of over eight months of discussions, reflections, interviews, literature review and desk research. It details the work undertaken and the evidence collected within the framework of this evaluation; sets out the conclusions reached in response to each evaluation question; and, makes a series of recommendations for the future orientation and structure of the Euratom Loan Facility.

1.1 Overview of the Euratom Loan Facility

The European Atomic Energy Community (Euratom) was created in 1957 for the purpose of promoting the development of nuclear energy in Europe by means of a common approach[1]. Article 172.4 of the Treaty allows for loans to be granted for the financing of research or investment in the nuclear sector. This article was first used in 1977, when the Euratom Loan Facility was created to provide long-term financing (in the form of loans) to *'projects relating to the industrial production of electricity in nuclear power stations and industrial fuel cycle installations'* in European Union (EU) Member States[2]. The Facility was established in a context of rising oil prices and amid growing concerns about Europe's excessive dependence on external sources of energy (and the impact that this could have on energy security).

In 1994, the scope of the Euratom lending instrument was extended to cover the financing of projects designed to improve the safety and efficiency of nuclear facilities in certain third countries[3] of the Central and Eastern Europe (CEEC) and of the Commonwealth of Independent States (CIS)[4]. This expansion in the scope of the Facility was driven by concerns regarding inadequate safety levels at nuclear installations in these countries following the Chernobyl (Ukraine) reactor accident in 1986.

The availability of Euratom loans for projects in third countries is, however, subject to the following conditions:

- Financing is only available for projects relating to nuclear power stations or installations in the nuclear fuel cycle which are in service, or under construction, or for

[1] Treaty establishing the European Atomic Energy Community (1957).
Available at: http://eur-lex.europa.eu/en/treaties/index.htm

[2] Council Decision 77/270/Euratom of 29 March 1977.
Available at: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:31977D0270:EN:HTML

[3] The term 'third countries' refers to non-EU countries.

[4] Council Decision 94/179/Euratom of 21 March 1994.
Available at: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:31994D0179:EN:HTML

the dismantling of installations where modification cannot be justified in technical or economic terms;

- The project should have received all the necessary authorisation at national level and in particular the approval of the safety authorities; and,
- The project should have received a favourable opinion from the European Commission in technical and economic terms.

Since 1994, the list of eligible third countries defined by the Annex to Decision 94/179/Euratom has been modified several times to take into account the accession of new Member States. The following third countries are currently eligible for Euratom loans: Russian Federation, Republic of Armenia and Ukraine.

Financial support from the Euratom Loan Facility is limited to 20 per cent (of the total project cost) for Member States and 50 per cent (of the cost of the 'safety and efficiency' measures) for third countries. Euratom loans therefore, require co-financing from other sources such as the internal cash flow of the operator; financial markets; export credit agencies (ECAs)[5]; commercial banks; national Governments; and, International Financial Institutions (IFIs) notably, the European Investment Bank (EIB) in EU Member States or the European Bank for Reconstruction and Development (EBRD)[6] in eligible countries outside the EU.

Euratom loans are 'off-budget' operations i.e. they are not financed directly from the general budget of the EU. Instead, for certain purposes, including the financing of Euratom loans, the European Commission is empowered to raise funds through debt capital markets either by issuing bonds (via its Euro Medium Term Note (EMTN) programme) or by issuing promissory notes. The proceeds are on-lend to the beneficiary on matching terms (amount, currency and payment date) apart from any deductions to meet the costs directly incurred by the European Commission. As a result, every outgoing payment in respect of the bond or promissory note issued by the European Commission is matched by an identical inflow from the beneficiary of the loan. In addition, the repayments are guaranteed by the EU budget.

The European Commission can borrow no more than the amounts for which it has received loan applications. Moreover, the cumulative borrowings of the European Commission are subject to a ceiling. The (cumulative) borrowing ceiling was originally fixed at 500 million European units of account, along with the following proviso: "*when the total value of the transactions effected reaches 300 million European units of account, the Commission shall inform the Council which, acting unanimously, shall decide on the fixing of a new amount as soon as possible*"[7]. The ceiling has been raised by various amendments of the Council

[5] It should be noted that Japan and Korea have set up vehicles for this purpose to assist penetration of their nuclear technology in European (and other) markets.

[6] EBRD's Energy Policy prohibits bank investment in the development of new nuclear power plants. However, the policy allows the bank to invest in safety measures at existing nuclear plants and to finance decommissioning. Source: http://www.ebrd.com/pages/sector/powerenergy/policy.shtml.

[7] Council Decision 77/271/Euratom of 29 March 1977.
Available at: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:31977D0271:EN:NOT

Decision 77/271/Euratom, the latest of which (Council Decision 90/212/Euratom of 23 April 1990[8]) increased it to EUR 4 billion (with the reporting threshold set at EUR 3.8 billion).

The amount currently available for new loans within the present borrowing limit is EUR 626 million. Owing to the fact that the Euratom Loan Facility is almost used up, on 6th November 2002, the European Commission approved proposals for the amendment of Decisions 77/270/Euratom and 77/271/Euratom. These proposals provide for:

- An increase in the borrowing ceiling by a further EUR 2 billion i.e. from EUR 4 billion to EUR 6 billion (with the reporting threshold set at EUR 5.5 billion)[9]; and,
- An expansion of the scope of admissible uses of Euratom loans[10].

Member States have not yet reached a consensus on these proposals. These proposals are still 'on the table' i.e. they have neither been approved nor rejected by the Council.

1.2 Aims and Objectives of the Evaluation

Against the above background, the overall objectives of this evaluation were:

- To examine the functioning and impact of the Facility on the basis of loans granted so far;
- To determine the future orientation of the Facility on the basis of an assessment of presently known and anticipated future financing needs of the nuclear sector.

To this end, the Terms of Reference contained eleven specific evaluation questions for this study to address. These were:

Relevance

- Q.1 To what extent are the objectives of the Facility still pertinent to the needs and problems (described inter alia in the recitals to the Council Decisions of 1977 and 1994), for which the Facility was designed to address?
- Q.2 To what extent are the objectives of the Facility pertinent to the needs and problems of current market circumstances and policies?

EU Added Value

- Q.3 To what extent have the expected benefits from EU intervention been attained?
- Q.4 What is EU added value of the Facility?
- Q.5 Some of the loan agreements included additional conditions. Would the results achieved with these imposed conditions have been equally attained in time and in quality had the Euratom loans including these covenants not been granted?

[8] Council Decision 90/212/Euratom of 23 April 1990.
Available at: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:31990D0212:EN:NOT

[9] COM(2002) 457 final.

[10] COM(2002) 456 final.

Coherence

- Q.6 To what extent has the division of tasks between the European Commission (DG ECFIN and other DG's), EIB and EBRD contributed to achieve the intended impact of the Facility?
- Q.7 Is the Facility coherent with other relevant EU policies and programmes? Are there any overlaps or contradictions?

Effectiveness

- Q.8 To what extent do the current management methods and their implementation achieve the objectives, ensure a high standard of service and how can they be improved?
- Q.9 Assessment of the effectiveness of the parameters of the Facility as laid down in the Council guidelines to achieve its objectives?

Efficiency and Delivery

- Q.10 To what extent are the Facility's objectives achieved at a reasonable cost?
- Q.11 Are present resources and borrowing ceilings for the facility appropriate? If not, what increase would be advisable?

1.3 Changes in the Evaluation Context

The evaluation was launched in a context of growing worldwide interest in nuclear energy as a response to climate change, oil price volatility and security of supply considerations. In recent years, there has been much publicised talk of a 'nuclear renaissance' referring to proposals and plans to build 474 new reactors worldwide by 2025[11]; the spread of nuclear energy to new markets in the Middle East (notably, oil rich countries such as the United Arab Emirates) and Southeast Asia (e.g. Vietnam); and, plans to develop new kinds of reactors and fuel-reprocessing techniques (e.g. Fast Neutron Reactor technologies). Within the EU, 53 reactors were at various stages of construction, planning and discussion at the end of 2010[12]. Moreover, recent months had seen some Member States re-evaluate the role of nuclear in their energy policies. Most notably, in September 2010 the German government agreed to extend the lifetime of the country's 17 reactors by 12 years on average; and, in January 2011, Italy's constitutional court ruled that a national referendum could be held to decide on the construction of nuclear power plants[13].

Events in Japan have however, instigated a fierce debate on the role of nuclear in the EU's energy mix and have prompted a few Member States to re-consider their policies (see also section 11 of the technical annex). On 11th March 2011, a nuclear emergency[14] was

[11] Source: World Nuclear Energy, Reactors Database, Reactor data as of 1st December 2010. Available at: http://www.world-nuclear.org/info/reactors201012.html

[12] *ibid*

[13] In 1987, Italians voted to abandon nuclear energy following the Chernobyl accident.

[14] Initially, rated as a level five crisis, the Japanese authorities raised their assessment of the crisis, on 12th April 2011, from level five to level seven– the highest level on the International Atomic Energy Agency scale and on par with the Chernobyl accident.

declared in Japan following damage to the Fukushima Daiichi facility (caused by a tsunami triggered by an earthquake measuring 9.0 on the Richter scale). In response to the crisis, some Member States immediately announced curtailment of their intended programmes, while others are progressing with their plans and looking at lessons that can be learned, to provide safe nuclear generation:

- The German government announced a three-month moratorium on lifetime extension of the country's 17 nuclear reactors and an immediate shutdown of the country's seven oldest nuclear plants for the duration of the moratorium[15];
- In the UK, the government launched an investigation into lessons that could be learned from the Fukushima crisis and how it could improve safety across its own nuclear reactor fleet[16];
- The Dutch government indicated its intention to push ahead with its plans for a new nuclear power plant (which it states, will incorporate the lessons learned from Japan)[17];
- The Italian government imposed a one-year moratorium on the construction of new nuclear plants[18]; and,
- At an EU level, the European Council called for a comprehensive and transparent risk and safety assessment ('stress tests') of all 143 nuclear reactors in operation in the EU albeit on a voluntary basis[19].

As far as the immediate reaction of major non-EU countries is concerned, Switzerland suspended plans to replace its ageing nuclear power plants[20]; China, which has 27 reactors under construction (with further 50 planned), stated that it will review its programme in the aftermath of Fukushima; while, Russia claimed that it would continue work on ten reactors that are in development[21]. Meanwhile, nuclear plant operators in the United States launched a self-imposed industry-wide assessment to verify and validate each plant site's

[15] Spiegel (2011) Germany to Reconsider Nuclear Policy: Merkel Sets Three-Month 'Moratorium' on Extension of Lifespans. 14th March. Available at: http://www.spiegel.de/international/world/0,1518,750916,00.html [accessed on 11 April 2011]

[16] Office for Nuclear Regulation (2011) Statement from HM Chief Inspector of Nuclear Installations on the implications of the Fukushima nuclear accident. 29th March. Available at: http://www.hse.gov.uk/nuclear/fukushima/statement-290311.htm [accessed on 11 April 2011]

[17] DutchNews.nl(2011) Cabinet to push ahead with nuclear plans. 14th April. Available at: http://www.dutchnews.nl/news/archives/2011/04/cabinet_to_push_ahead_with_nuc.php [accessed on 14 April 2011]

[18] World Nuclear News (2011) Italy announces nuclear moratorium. 24th March. Available at: http://www.world-nuclear-news.org/NP-Italy_announces_nuclear_moratorium-2403117.html?utm_source=World+Nuclear+News&utm_campaign=8f1173ff1a-WNN_Daily_24_March_20113_24_2011&utm_medium=email [accessed on 11 April 2011]

[19] Conclusions of the European Council, 24/25 March 2011. Available at: http://www.consilium.europa.eu/uedocs/cms_data/docs/pressdata/en/ec/120296.pdf [accessed on 5 April 2011]

[20] The Local (2011) Swiss suspend nuclear plans after Japan quake. 16th March. Available at: http://www.thelocal.ch/national/20110316_72.html [accessed on 24 March 2011].

[21] The Economist (2011) When the steam clears: The Fukushima crisis will slow the growth of nuclear power. Might it reverse it? 24th March. Available at: http://www.economist.com/node/18441163 [accessed on 24 March 2011].

readiness to manage extreme events[22]. In India, the Government ordered the Nuclear Power Corporation of India Limited to conduct an immediate review of its safety systems and security designs[23].

The recent events in Japan and subsequent developments around the world – which are briefly described above - have been important considerations in this evaluation. The evaluation takes account of the short-term financing needs that can be expected to arise from the crisis (i.e. enhanced safety measures and early closure of some nuclear power plants), whilst fully recognising that it would be premature and speculative to draw conclusions about the implications of Fukushima crisis for the long-term future of the nuclear industry at this stage.

1.4 Structure of the Report

The remainder of the report is structured as follows:

- Section 2 describes the overall methodological approach to the evaluation and the research tasks undertaken within the framework of this evaluation; it also discusses the strengths and limitations of the evidence collected from various sources;
- Section 3 details the findings and conclusions of the evaluation; and,
- Section 4 sets out the recommendations emerging from this evaluation.

The main report is supplemented by a Technical Annex which is structured as follows:

- Annex 1 presents the overall methodological framework for the evaluation;
- Annex 2 elaborates the intervention logic for the 1977 Decision;
- Annex 3 details the intervention logic for the 1994 Decision;
- Annex 4 provides a list of stakeholders interviewed for this evaluation;
- Annex 5 contains a reference and bibliography list;
- Annex 6 presents the case study report for Cernavoda;
- Annex 7 presents the case study report for K2R4;
- Annex 8 provides a comparative assessment of the Euratom Loan Facility and the US Guarantee Scheme;
- Annex 9 shows the detailed calculations underpinning an analysis of historical investment in the nuclear sector in the EU;

[22] Nuclear Energy Institute (2011) U.S. Nuclear Industry Will Learn Lessons From Fukushima, Industry Executive Testifies. 30th March. Available at: http://www.nei.org/newsandevents/newsreleases/us-nuclear-industry-will-learn-lessons-from-fukushima-industry-executive-testifies/ [accessed 6 April 2011].

[23] The Economic Times (2011) Additional safety features for India's nuclear plants: NPCIL. 14th April. Available at: http://economictimes.indiatimes.com/news/politics/nation/additional-safety-features-for-indias-nuclear-plants-npcil/articleshow/7978919.cms [accessed 14 April 2011].

- Annex 10 collates Eurobarometer survey data on EU citizens' opinions on safety and security aspects of nuclear energy; and,
- Annex 11 provides a snapshot of the immediate reaction of policy makers and industry following the accident in Japan as well as an update on recent developments.

2 THE METHOD OF APPROACH

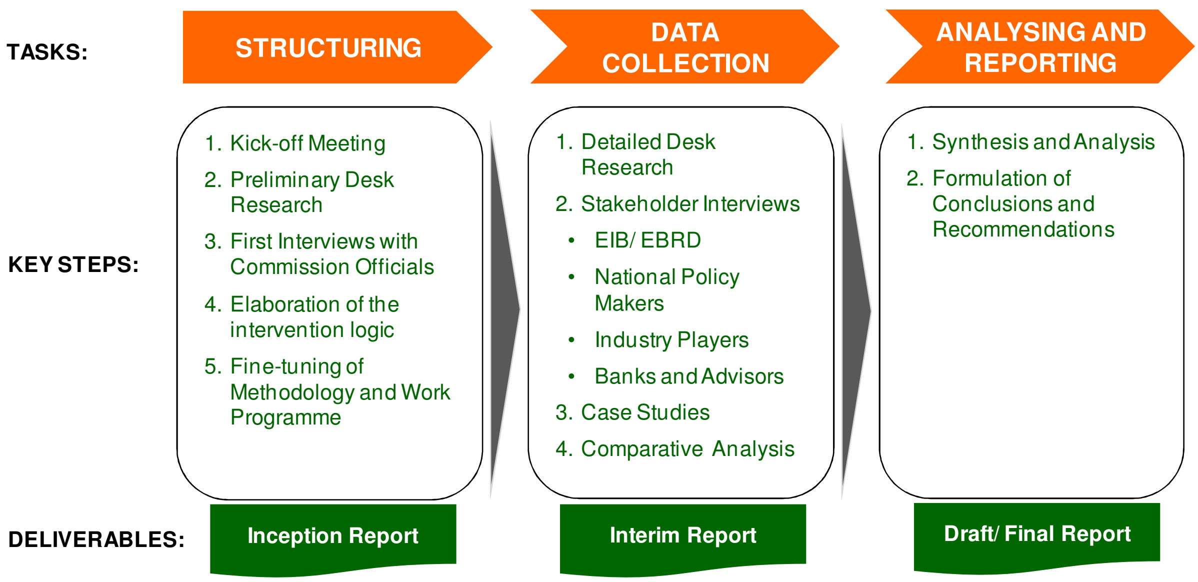
This section of the report describes the method of approach used to address the aims and objectives of the evaluation.

2.1 Evaluation Methodology

The evaluation methodology was based on a structured and systematic approach to collecting, analysing and presenting evidence. The overall methodological and analytical framework for the evaluation is presented in Annex 1; it sets out the judgement criteria and the research methods used to answer each evaluation question.

Figure 2:1 illustrates the work programme of the evaluation. It is followed by a description of the individual tasks undertaken.

Figure 2:1 Work Programme



2.1.1 *Task 1: Inception (October to November 2010)*

This initial task laid the groundwork for primary data collection and subsequent analysis. The following steps were completed as part of the inception phase of the study:

Step 1.1 Kick off Meeting: A kick-off meeting was held in Luxembourg on 21st October 2010 to confirm the focus and scope of the evaluation.

Step 1.2 Preliminary Desk Research: Following kick-off, all key documentation and data relating to the Euratom Loan Facility, as well as wider literature on relevant topics (such as the financing needs of the nuclear sector, energy policy, energy demand etc.) was assembled and mapped. The purpose of this initial desk research was to enhance the study team's understanding of the Euratom Loan Facility; and, to determine the scale and scope of the information available for the evaluation. A thorough desk research meant that the second phase of the evaluation could focus on filling known gaps in evidence and on verifying the findings presented in the available material**.**

Step 1.3 First Interviews: A series of face to face interviews were conducted with relevant European Commission officials from DG ECFIN, DG ENER, DG CLIMA, DEVCO, DG RTD and DG Legal Services to understand the objectives and existing mechanisms of the Facility; its achievements to date; relevant policy developments; present day and anticipated future requirements in the area of nuclear energy; and, how the Facility might be re-orientated to meet these needs.

Step 1.4 Elaboration of the Intervention Logic: Following initial desk research and consultations with the European Commission officials, the study team developed two intervention logics for the Euratom Loan Facility (for the 1977 Decision and the 1994 Decision respectively). The idea behind developing an intervention logic is to make explicit the underlying hypotheses on how an intervention leads to intermediate and long-term outcomes, which can then be tested through a series of research tasks. An intervention logic thus, strengthens the scientific case for attributing subsequent change to the intervention.

Step 1.5 Fine-tuning of the Methodological Approach: Under this step, the evaluation methodology was refined to reflect the specific requirements of this assignment and to take account of the limitations in data availability (see section 2.2).

Inception Report and Meeting: Upon completion of this work, an Inception Report was submitted to the Steering Group on 10th November 2010. The Inception Report specified the work programme for the evaluation, elaborated the intervention logics for the Euratom Loan Facility and described the methodological and empirical approaches to be adopted for the remainder of the evaluation. An inception meeting took place on 26th November 2010 to discuss the Inception Report, following which a final version of the report was submitted on 1st December 2010.

The two key outputs of the inception phase were the 'Evaluation Matrix' summarising the overall analytical framework for the evaluation (presented in Annex 1); and, the intervention logics for the 1977 Decision (Annex 2) and 1994 Decision (Annex 3).

2.1.2 *Task 2: Data Collection (December 2010 to March 2011)*

This task involved primary and secondary data collection. The following research methods were used to collect quantitative and qualitative evidence for the evaluation:

Step 2.1 Detailed Desk Research: Documentation, data and literature assembled as part of step 1.2 (and additionally identified during the course of conducting first interviews with Commission officials) was systematically reviewed and analysed by the study team. Annex 4 provides a list of key documentary sources of evidence for this study.

Step 2.2 Stakeholder Interviews: Semi-structured interviews were conducted with a range of stakeholders notably, EIB/ EBRD, commercial banks, advisors to nuclear projects, industry representatives and national policy makers to explore: the drivers and barriers to investment in the nuclear sector; the financing needs of the sector; relevance of the Euratom Loan Facility in different market contexts and how the Facility could be adapted to meet these needs (if found to be relevant). In total, 42 stakeholders were consulted (see Annex 5 for a list of stakeholders interviewed in the context of this assignment).

Step 2.3 Case Studies: Two case studies were developed to examine the added value of Euratom Loans granted outside the EU; and, the contribution of this instrument to enhancing the safety of nuclear installations in third countries. The projects selected for the case studies were Cernavoda in Romania (Annex 6) and K2R4 in Ukraine (Annex 7).

Step 2.4 Comparative Analysis: The study methodology included a desk based comparative analysis of the Euratom Loan Facility with a similar instrument available outside the EU. The US Loan Guarantee Scheme was selected for this purpose. Other 'candidates' that were considered but discarded after a preliminary review, were the US risk insurance (Standby Support) and production tax credits; and, the Japanese/ South Korean export credit schemes. Instruments of this nature fall outside the remit of the EU and were thus considered to be of little interest and relevance to the study. The results of the comparative analysis can be found in Annex 8.

Interim Report and Meeting: A draft Interim Report was submitted on 31st January 2011 and a Steering Group meeting was held on 8th February 2011 to take stock of study progress and to discuss the first findings emerging from the fieldwork. A revised Interim Report - addressing the comments received from the Steering Group - was submitted on 18th February 2011.

2.1.3 *Task 3: Analysis and Reporting (March to May 2011)*

The final phase of the evaluation comprised the following tasks:

Step 3.1 Synthesis and Analysis: The quantitative and qualitative evidence collected during the earlier phases of the study was systematically analysed to derive well-triangulated answers to the evaluation questions.

Step 3.2 Conclusions and Recommendations: This step involved the formulation of evaluative conclusions regarding the relevance, efficiency, effectiveness, coherence and added value of the Facility on the basis of the judgement criteria developed during the inception phase of the study (see Evaluation Matrix in Annex 1). An internal brainstorming session was also organised to facilitate the process.

Draft Final Report: An early draft was submitted to the Steering Group for review and comments on 19th April 2011. A Steering Group meeting was held on 11th May 2011 to discuss the Draft Final Report. A validation workshop with key stakeholders also took place on the same day to test the emerging findings of the evaluation and to finalise the recommendations contained in the draft report. A second iteration of the Draft Final Report was submitted on 23rd May 2011, reflecting the feedback received from the Steering Group as well as the results of the validation workshop.

Final Report: This document constitutes the Final Report of the evaluation.

2.2 Strengths and Limitations of the Data Collected

The two main sources of information for this evaluation were: secondary information collected through desk research and primary information collected through stakeholder interviews. The following sub-sections critically review the quality of the information sources used and the validity of the data collected as part of this evaluation. It should be noted that while each method has its strengths and limitations, the two main research methods taken together complemented each other by enriching the evidence base and providing a basis for triangulation in the context of this evaluation.

2.2.1 *Desk Research*

The following existing documentation, data and literature were used for the evaluation:

- Legal bases such as the Euratom Treaty, 1977 Decision, 1994 Decision;
- EU Policies (currently in place, planned, or being considered);
- National energy policies and ambitions for nuclear sector;
- Listing of projects supported by the Loan Facility;
- Relevant working papers and proposals prepared by the Commission;
- The EU Nuclear Illustrative Programmes (NIPs) which provide information on the objectives adopted by Member States for nuclear power production and the investment required to achieve them;
- Relevant documentation, data and reports produced by International Energy Agency, World Energy Council, Nuclear Energy Agency. These institutes regularly publish detailed statistics and analysis on topics such as energy demand projections, energy mix, fuel prices, nuclear energy capacity etc;
- Literature on financing needs of the nuclear sector;
- Loan documentation (e.g. loan agreements, technical reports) relating to the loans granted outside the EU;
- Eurostat statistics on energy consumption, imports, carbon emissions etc;
- Press and journal articles; and,
- Websites of nuclear facilities that have been co-financed by Euratom loans.

[NB: Early on in the study, it was decided that there is little added value in retrieving documentation relating to loans granted under the 1977 Decision from the European Commission archives. Considering that the last loan within the EU was granted in 1987, the data would be out of date and thus, of little use and value in the context of this evaluation.]

The desk research was a rich source of background and contextual information; and, provided useful evaluation evidence. However, it only provided part of the evidence base for the evaluation; and it was necessary to update cross-check and complement the information collected from secondary material through other (primary) sources.

2.2.2 Stakeholder Interviews

The study methodology involved extensive consultations with a representative mix of stakeholders. The evaluation thus took into account the views of a diverse range of stakeholders, recognising their particular interests and perspectives by checking different accounts against each other (and against the evidence drawn from the desk research). Stakeholder interviews were an important source of information for the evaluation and the only source of information for some elements of the evaluation. Stakeholder interviews compensated for the gaps in information collected through desk research and provided additional insights about underlying issues relevant to the study. Stakeholder interviews were also used to corroborate the findings of the desk research. In some cases (e.g. evaluation question numbers 1 and 3) however, stakeholder interviews provided a limited basis for cross-validation. Non-availability of key interlocutors who were directly involved in the management and implementation of the Facility during the period 1977 to 1987, meant that the assessment of the relevance, added value and utility of the 1977 Decision was largely based on documentary evidence and views of wider stakeholders (who were not directly involved). Moreover, it was not possible to independently verify some of the assumptions and assertions made regarding the relevance and impact of the 1977 Decision due to lack of evidence. In such cases, the caveats associated with particular evaluative judgements and conclusions are explicitly stated in the report.

3 EVALUATION RESULTS

This section presents a synthesis of the evidence collected in response to each evaluation question and draws out the conclusions emerging from this analysis. It is organised around the core evaluation issues of relevance; EU added value; coherence; effectiveness; efficiency and delivery (and the specific evaluation questions contained therein).

3.1 Relevance

3.1.1 *Q.1 To what extent are the objectives of the Facility still pertinent to the needs and problems (described inter alia in the recitals to the Council Decisions of 1977 and 1994), for which the Facility was designed to address?*

There are two important considerations in assessing the relevance of an intervention:

- *The rationale for intervention*: as determined by an analysis of the needs, problems or issues that an intervention has been designed to address;
- *Demand for an intervention:* take-up of an intervention by its intended beneficiaries.

Since the *raison d'être* for the 1977 Decision is different from that of the 1994 Decision, the relevance of the Euratom Loan Facility is considered separately for the two Decisions.

Was the 1977 Decision relevant?

The intervention logic presented in Annex 2 demonstrates a logical link between a set of clearly identified needs and the objectives of the Facility. The main drivers for creating the Euratom Loan Facility in 1977 were:

- The 1973 oil price shock; and,
- The need to reduce reliance on energy imports.

In this context, the overall objective of the 1977 Decision was *'to reduce the Community's excessive dependence on external sources of energy and thus improve the terms on which energy is imported'*.

According to key informants, the Facility was 'hugely relevant' in the context of market conditions prevalent at the time, notably:

- Political desire and support for more self-sufficient sources of energy such as nuclear;
- Europe's growing demand for electricity;
- State-owned utilities operating in regulated electricity markets; and,
- Limited cross-border activity and liquidity in capital markets.

These are elaborated below.

Political desire and support for more self-sufficient sources of energy

By 1973, crude oil imports from Arab countries as a proportion of total energy consumption in Western European countries had risen to 45 per cent (from just 13.4 per cent in 1956)[24]. In the same year, the Organisation of Arab Petroleum Exporting Countries (OAPEC) announced an oil embargo against the US, the Netherlands and Portugal for their purported pro-Israeli stance thus disrupting supplies to a number of countries[25]. The embargo prompted the Organisation of the Petroleum Exporting Countries (OPEC) to quadruple the price of oil causing an energy crisis over the winter of 1973-74, followed by an economic shock. Oil prices remained volatile during the 1970s and 1980s (prices increased sharply during the 1970s, peaked in the early 1980s and have been falling gradually since 1980 - as shown in Figure 3:1). The 1973 oil crisis and continuing volatility prompted Community members to intensify their efforts to develop indigenous sources of energy particularly nuclear, in order to achieve security of energy supply.

Figure 3:1 World Oil Prices, 1970 - 1995

Source: European Commission (1995). Available at: http://www.eea.europa.eu/publications/GH-98-96-518-EN-C/page004.html

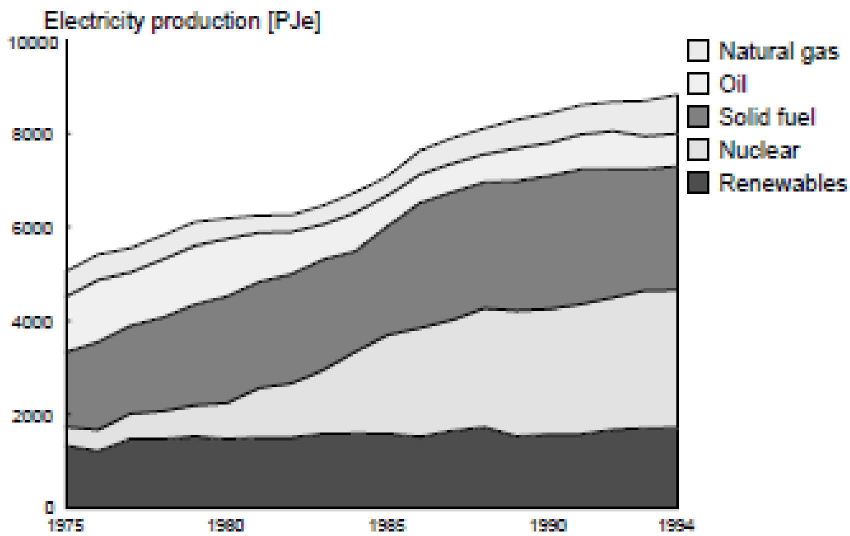
[24] Willenborg R., Tonjes C., Perlot W. (2004) Europe's oil defences.

[25] Of the nine members of the European Economic Community (EEC), the Netherlands faced a complete embargo, the United Kingdom and France received almost uninterrupted supplies (having refused to allow America to use their airfields and embargoed arms and supplies to both the Arabs and the Israelis), whilst the other six faced only partial cutbacks (source: Wikipedia)

Europe's growing demand for electricity

In 1977, the three main sources of electricity in Western Europe were solid fuel (hard coal and lignite), hydro power, and residual oil - altogether representing more than 80 per cent of electricity generation (Figure 3:2). There was limited possibility for hydro-power expansion and a new source of base load electricity generation was needed to meet Europe's (growing) demand for electricity[26] (see also Box 3.1 later in this section). At the time, nuclear technology was ready for commercial deployment and offered a viable, proven and indigenous source of electricity.

Figure 3:2 Electricity Production in Western Europe between 1975 and 1994 by Source



Source: Source: Ybema J.R., Lako P., Kok I., Schol E., Gielen D.J., Kram T. (1997) Historic developments in energy use in Western Europe 1970-1993 pp. 20
Note: Waste and biomass are included under solid fuels

State owned utilities operating in regulated electricity markets

In the 1970s and 1980s, electricity utilities in most EU countries were government owned[27] and backed by sovereign guarantees. Furthermore, utilities operated in a regulatory environment that permitted long-term investment i.e. they were guaranteed both future customers and high enough electricity prices to ensure a profitable rate of return. Under these conditions, utilities could '*recoup all investment costs, even when these were higher than planned*[28].

[26] During the period 1975-1985 average growth in electricity consumption in Europe was about 3 per cent per year. Source: Ybema J.R., Lako P., Kok I., Schol E., Gielen D.J., Kram T. (1997) Historic developments in energy use in Western Europe 1970-1993. Available at: http://www.ecn.nl/docs/library/report/1997/c97051.pdf

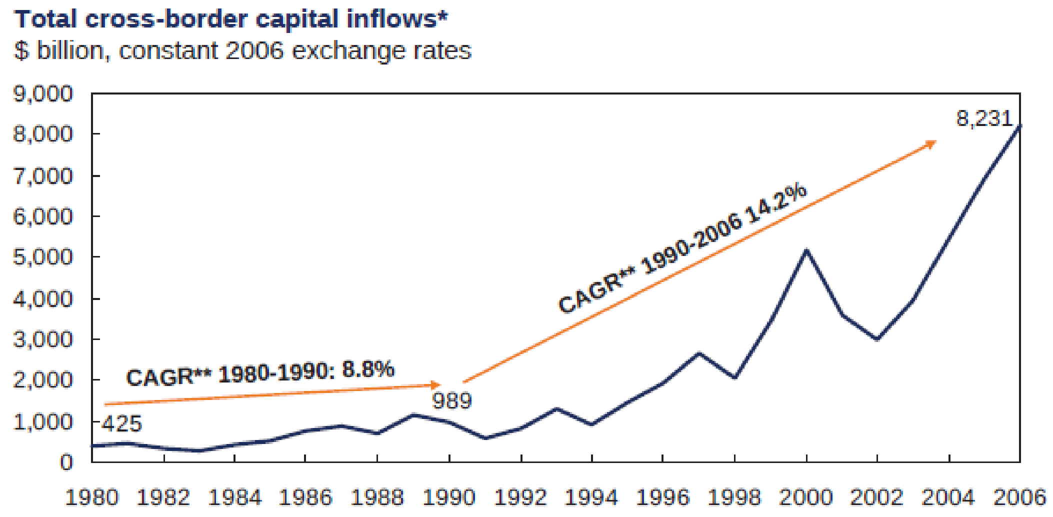
[27] OECD/NEA (2009) The Financing of Nuclear Power Plants pp.18

[28] *ibid*

Limited cross-border activity and liquidity in capital markets

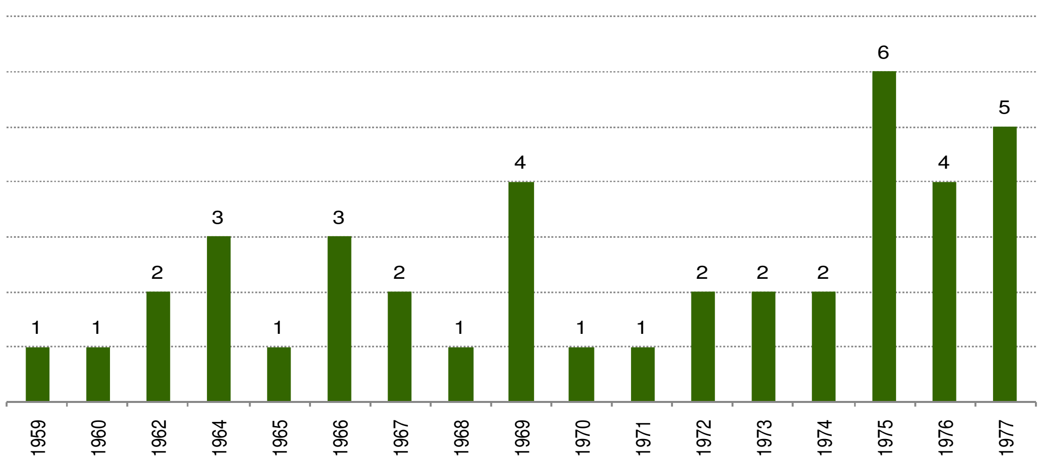
At the time cross border activity and liquidity in capital markets was relatively limited. As Figure 3:3 shows, global capital flows during the 1980s were less than half the levels seen in 1990s. Moreover, the capacity of commercial banks to appraise nuclear projects was also limited as nuclear was a relatively new technology with a limited track record of commercial operation - Figure 3:4 shows that only a few reactors had been brought online in the EU prior to 1977 on an annual basis. Besides, all the reactors in operation in the EU prior to 1970 were small (11MWe – 480 MWe) and many were prototypes. Large commercial reactors involving private sector investment came on-stream only in the 1970s in the EU.

Figure 3:3 Growth in Cross Border Capital Flows



Source: McKinsey Global Institute (2008) Mapping Global Capital Markets: Fourth Annual Report, January 2008, San Francisco

Figure 3:4 Number of Reactors brought Online in the EU*, 1954 - 1977

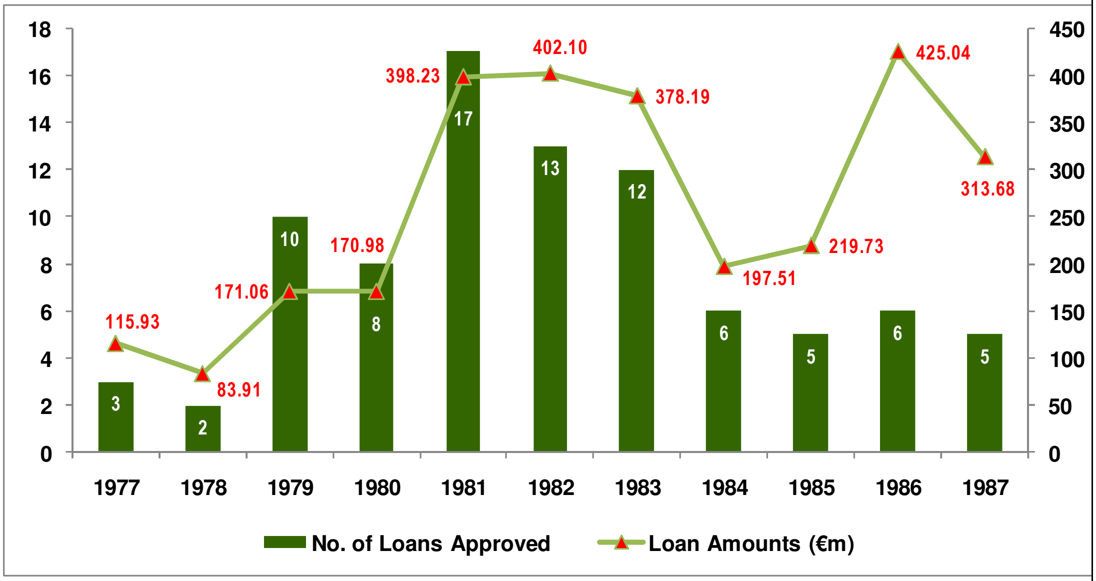


**During this period the following countries were members of the EU: BE, FR, LU, NL, IT, DE (six founding members), IE, DK, UK (the latter three joined the EU in 1973)*
Source: WNA Reactor Database; Advanced search by Commercial Operation Start, 1954-1977

In the above context, the Euratom Loan Facility (combined with EIB loans) was critical in accelerating and promoting investment in the nuclear sector. During the period 1977 to 1987, Euratom loans co-financed the construction of nine nuclear power plants (NPPs); a uranium enrichment plant; and, a uranium reprocessing facility – see Table 3:1 for details of individual loans.

Total lending of EUR 2 876 million was extended to projects in five EU Member States[29]: Belgium, France, Germany, Italy and the UK (Table 3:2 and Figure 3:5). Moreover, it should be noted that the actual demand for Euratom loans was higher than initially foreseen, as a result of which the cumulative ceiling was raised several times (from an initial level of EUR 500 million to its present level of EUR 4 billion).

Figure 3:5 Annual Volume of Loans Approved under the 1977 Decision



Source: GHK analysis of data provided by DG ECFIN, European Commission

[29] During the period 1977 to 1987, the following countries were part of the EU: BE, FR, LU, NL, DE, IT (six founding members); IE, UK and DK joined EU in 1973; GR joined in 1981; ES and PT joined in 1986. Only two Member States - who were pursuing a nuclear programme- did not make use of this Facility during this period (The Netherland's two reactors were constructed prior to the creation of the Facility in 1977; Spain's nuclear plants were constructed prior to its joining the EU in 1986) .

Table 3:1 Overview of Euratom Loans Approved under the 1977 Decision

Project Name	Member State	Description	Year	EIB Lending (mEUR)	Euratom Lending (mEUR)		
					Loan Amount	Cumulative Amount	Loan Reference
KKW Emsland	DE	Construction of NPP	1985	70.70	24.27	73.12	85002
			1986		24.58		86003
			1987		24.27		87005
KKW Mulheim-Karlich*	DE	Construction of NPP	1977	151.30	93.82	188.37	77001
			1978		46.01		78001
			1985		48.54		85001
Doel and Tihange	BE	Construction of NPP	1979	559.10	57.74	626.56	79003, 79008, 79010
			1980		67.21		80006, 80007, 80008
			1981		245.55		81001, 81002, 81005, 81006, 81007, 81008, 81009, 81010, 81011, 81012, 81015
			1982		76.47		82004, 82005, 82006, 82007
			1983		34.76		83001, 83010
			1984		98.48		84001, 84003, 84005
			1985		46.35		85005
Dampierre	FR	Construction of NPP	1980	51.40	42.96	42.96	80001
Belleville	FR	Construction of NPP	1982	153.90	122.14	167.14	82003, 82011
			1983		45.00		83002
Flamanville	FR	Construction of NPP	1983	215.70	32.36	177.13	83011
			1984		24.27		83012
			1985		13.90		84006
			1986		106.60		86006

Table 3:1 Overview of Euratom Loans Approved under the 1977 Decision

Project Name	Member State	Description	Year	EIB Lending (mEUR)	Euratom Lending (mEUR)		
					Loan Amount	Cumulative Amount	Loan Reference
Superphénix (NERSA)**	FR	Construction of NPP	1977	560.40	22.12	616.07	77002, 77003
			1979		71.97		79002, 79004, 79005, 79006, 79007, 79009
			1980		60.82		80002, 80003, 80004, 80005
			1981		119.13		81003, 81004, 81013, 81014, 81016
			1982		102.45		82002, 82008, 82012
			1983		38.83		83006
			1984		85.12		84002, 84004
			1986		115.63		86001, 86005
		Construction of Spent Fuel Storage (as part of NPP)	1987	72.70	71.60	71.60	87002
Montalto di Castro, Alto Lazio***	IT	Construction of NPP	1978	530.30	37.90	560.35	78002
			1979		41.16		79001
			1981		33.56		81017
			1982		43.12		82001
			1983		97.50		83004, 83007
			1985		100.58		85003, 85004
			1986		97.67		86002
			1987		108.86		87003, 87004
Torness	UK	Construction of NPP	1983	146.40	39.62	120.18	83008, 83009
			1986		80.56		86004
Tricastin	FR	Construction of Uranium	1982	123.40	57.93	123.79	82009, 82010, 82014

Table 3:1 Overview of Euratom Loans Approved under the 1977 Decision							
Project Name	**Member State**	**Description**	**Year**	**EIB Lending (mEUR)**	**Euratom Lending (mEUR)**		
					Loan Amount	**Cumulative Amount**	**Loan Reference**
		Enrichment	1983		65.86		83003, 83005
THORP, Sellafield	UK	Construction of Uranium Reprocessing	1986	137.90	108.95	108.95	87001
TOTALS				**2,773.20**		**2,876.22**	

Source: Data provided by DG ECFIN and EIB website (http://www.eib.org/attachments/strategies/eib_and_financing_of_nuclear_sector_en.pdf)
Notes: ECFIN data for Belgelectric loans does not, in all cases, permit allocation against particular projects. The loans appear to cover Doel I-IV and Tihange I - III. For Belegelectric Loans, ECFIN data shows a Euratom loan in 1985; not reflected in EIB data.
Detail for EdF (France) does not in all cases permit allocation against particular projects. Some guess/ interpretation has been made in the table. Loans to EdF have been allocated as follows: 80001 to Dampierre; 82003, 82011 and 83002 to Belleville; 83011, 83012, 84006 and 86006 to Flamanville
Additionally, following assumptions have been made:
Loan referenced 78002 and 79001 relates to Montalto di Castro
Loan referenced 83008 relates to Torness
Subtle differences in Cumulative loan amounts are observed; these might be due to exchange rate variations in the 2 datasets (EIB and ECFIN).
According to ECFIN data, the total value of Euratom loans granted is EUR 2,876.36 million whereas the total in the above table adds up to EUR 2,876.22 million. Again this difference could be due to exchange rate variations
**Plant shut-down in 1986 due to siting/ legal issues*
*** Plant shut-down in 1998; includes loans for construction of spent fuel storage*
****Indefinitely suspended/ cancelled (Italy abandoned its nuclear programme in post-Chernobyl referendum)*

Table 3:2 Loans Approved under the 1977 Decision

Project Type	Number of Loans						Amounts (€m)					
	Belgium	France	Germany	Italy	UK	Total	Belgium	France	Germany	Italy	UK	Total
Electricity production	27	33	6	11	3	**80**	626.75	1003.28	261.48	560.34	120.17	**2572.02**
Enrichment		5				**5**		123.79				**123.79**
Reprocessing					1	**1**					108.95	**108.95**
Waste storage		1				**1**		71.60				**71.60**
TOTAL	**27**	**39**	**6**	**11**	**4**	**87**	**626.75**	**1198.67**	**261.48**	**560.34**	**229.12**	**2876.36**

Source: GHK analysis of data provided by DG ECFIN, European Commission

During the period 1977 to 2000[30], 92 reactors were under construction in the EU, representing a generation capacity of 96 GWe. Assuming an average cost of construction of EUR 2.8 million per MWe (2007 prices)[31], the rough order of magnitude of investment in new builds is estimated to be EUR 269 billion. Of this investment, EUR 56 billion - or 21 per cent of the total investment in new builds - is estimated to have been co-financed by Euratom loans (see Annex 9 for detailed workings and assumptions)[32]. While, it is not possible to state with any degree of certainty whether this investment would have taken place (or not) in the absence of Euratom loans, given the increase in investment in the nuclear sector following the creation of the Euratom Loan Facility and its take-up by the industry, some of this investment may at least partially be attributed to the instrument (although, the level of attribution cannot be quantified due to lack of further evidence). This theory was corroborated by key informants who indicated that, in addition to direct financing of projects, the involvement of Euratom/ EIB (particularly, the EIB's appraisal process[33]) helped leverage funding from other sources (public and private) thus easing the overall financing constraint for viable projects. According to them, the 'signalling' effect of Euratom loans was (and still is) hugely important and not to be under-estimated. The overall opinion of the stakeholders was that the creation of the Euratom Loan Facility in 1977 helped the EU's new build programme maintain the momentum it had gained in 1975 – industry statistics show that construction of new builds in the EU peaked over the period 1975 to

[30] Year 2003 has been considered as the cut-off year for the analysis to avoid any confusion arising from the inclusion of new members of the enlarged Union (2004 onwards) which were previously covered by the1994 Decision.

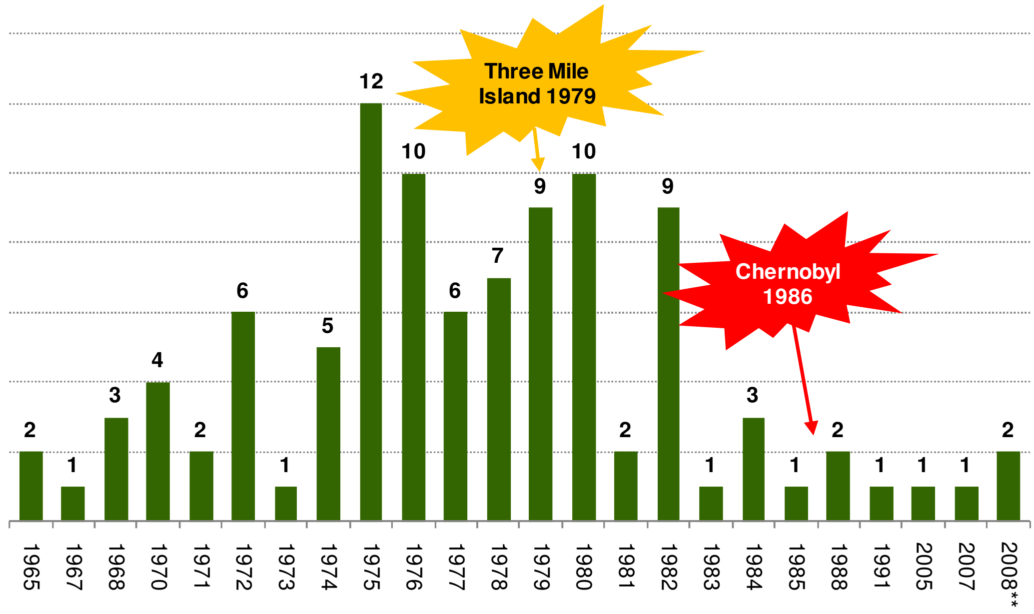
[31] This figure is derived as follows: data on costs of construction of the French reactor fleet is provided by Grubler (Grubler, A (2009) An assessment of the costs of the French PWR program 1970- 2000). An interim report. www.iiasa.ac.at/Admin/PUB/Documents/IR-09-036.pdf. Examination of Figure 3.2 of Grubler suggests an average figure of 14,000,000 FF(1998)/ MWe. Applying a conversion factor of 0.2 EUR(2007)/ FF(1998), produces the quoted average cost. Comparable information for other European construction has not been located; the French fleet is accepted as a suitable surrogate (to provide an indicative total investment magnitude) due to a) being a light water reactor, representing the majority of plants built; b) while other plants may be lower in cost (e.g. Russian origin), others (e.g. gas reactors) will be higher in cost; and, c) although the French example is for a fleet (constructed by Framatome), there were also relatively few other vendors, although construction may have been in several countries.

[32] The average co-financing rate is estimated to have been 5 per cent of the investment costs (the joint contribution from the EIB and Euratom loans, on average, accounts for 10 per cent of the investments costs of the projects receiving financing).

[33] Having established a high reputation as a careful evaluator and as a conservative bank with an excellent track record (only very few loans of the Bank have experienced difficulties) the Bank's appraisal process is perceived as a quality label.

1980 and then tailed-off (see Figure 3:6; see also Box 3:1 which provides some historical context). Given the time that has elapsed since the loans were last granted within the EU (1987), it is hard to independently verify stakeholders' assertions regarding the importance of the Facility at the time; but on balance, it would be reasonable to assume that the Facility made a positive contribution to the development of the nuclear sector in the EU.

Figure 3:6 Number of Reactors starting construction in the EU*, 1965 to present



Based on changing composition of the EU: BE, FR, LU, NL, IT, DE (1957 onwards), IE, DK, UK (1973 onwards); GR (1981 onwards); ES, PT (1986 onwards); AT, FI, SE (1995 onwards); CY, CZ, EE, HU, LV, LT, MT, PO, SK, SI (2004 onwards); BG and RO (2007 onwards); * Construction *of Mochovce 3 and 4 re-started in 2008*

Sources: WNA Reactor Database and IAEA Power Reactor Information System (PRIS)

Box 3:1 Historical Perspectives on the development of Nuclear Energy in EU Member States

In France, there was political commitment and strong desire to achieve energy independence, and to avoid a repeat of the oil shock. France had poor quality coal, limited possibility for hydro-power expansion and no domestic gas or oil resources. On the political front, there was cross-party support for nuclear energy. Electricity supply was effectively driven by the Government, with substantial public support. Électricité de France (EdF) was the main electricity supplier; it raised finance for its nuclear development from the public with government backing – including additional public placements for project overruns. The strong investment drive in nuclear, produced the present situation where 58 reactors generate some 70 per cent of the electricity used in France

German industrial development in the 19th century was fuelled by coal. Although, the use of coal declined in the 1970s and 1980s, East German brown coal remained important in the 1990s for electricity production, despite being a major source of air pollution. Oil and natural gas and hydro power were only a small source of electrical energy (but, were major energy sources for heating and manufacturing). German dependence on oil imports, the oil crisis of the 1970s, and a growing demand for energy shifted attention to the potential of nuclear energy. By the mid-1980s, 19 nuclear plants were supplying 36 percent of the electricity needs in West Germany, and more plants were in the planning stage. Following the Chernobyl' nuclear disaster in 1986, however, massive environmental protests stiffened public resistance to nuclear energy. Further construction of nuclear power facilities was halted for fear of accidents and lawsuits and because of the difficulties of disposing of the radioactive waste. Instead, West Germany embarked on a programme of energy savings, including increasing the efficiency of automobile engines and heating plants.

Other Member States using the Euratom Loan, Belgium and Italy, also had limited fossil fuel resources of their own and saw benefits in including nuclear in their energy mix.

The UK had developed its own nuclear programme in the 1950s around gas cooled reactors (GCRs), and later Advanced Gas Reactors (AGRs) in the 1970s. Around this time, natural gas was discovered in the North Sea, which offered cheaper electrical power supplies for the immediate future, and curtailed the nuclear programme in the UK (apart from construction of one PWR after a long public inquiry).

Was the 1994 Decision relevant?

Following the accident at Chernobyl (April 1986), the risks presented by nuclear facilities of Soviet design in Central Europe and the CIS became a source of major concern to the international community. Consequently, the International Atomic Energy Agency (IAEA) convened a special meeting of international organisations in August 1986. At that gathering, the Soviet Union provided a detailed description of the accident and the action being taken to deal with its consequences/ prevent a recurrence; it also sought international cooperation aimed at improving nuclear safety and operation. Subsequently, the IAEA began receiving requests for assistance with nuclear safety from countries operating or constructing Soviet-designed reactors. In response to these requests, the IAEA launched a programme, in September 1990, to evaluate the first generation of VVER-440 Model V230 reactors[34],. The programme's objective[35] was to help countries operating Model V230 reactors: (a) identify design and operational weaknesses; and, (b) to prioritise safety improvements. This programme was expanded in February 1992 to deal with later design VVER nuclear power plants (in particular, VVER-1000[36] under construction in Bulgaria, Czechoslovakia and Ukraine). By late 1994, the IAEA had reached international consensus on the major safety issues, ranked according to urgency and significance[37].

[34] VVER is the Russian version of the Pressurised Water Reactor (PWR)

[35] IAEA assistance focussed on identification of safety weaknesses in design and operation based on current international safety standards and practices; categorisation of safety issues according to their potential for degradation of the defence-in-depth safety concept; recommendation of the most effective safety improvements for reducing the overall risk of accidents; and, prioritization of recommended improvements for identified safety issues

[36] The VVER-1000 is a design that shares similarities with Western plants, in terms of design philosophy, design features and constructability. However, concerns remained about engineering design solutions, quality of manufacture, and reliability of equipment.

[37] The results of the safety evaluations conducted by the IAEA were published in 'Safety Issue Books' which became a reference for future improvements.

Concurrently, in recognition of the IAEA activities, the geographical scope of the Euratom Loan Facility was extended in 1994 to include select neighbouring third countries (from the CEEC and CIS)[38]. This expansion in the scope of the Facility was driven by:

- *Concerns regarding inadequate safety levels at nuclear installations in these countries following the Chernobyl reactor accident in 1986* – the Chernobyl accident demonstrated that an accident outside the EU could have both a direct (radiation fallout up to France) as well as an indirect impact on the EU (slowdown of the nuclear industry; reduced public acceptability of nuclear energy). Figure 3:7 illustrates the trans-boundary extent of Chernobyl radiation fallout; it shows the scale of the dispersal of radioactive material released from the accident as a result of the atmospheric conditions prevailing at the time of the release and thereafter.

- *Political developments* - the disintegration of the Soviet Union meant that the EU was able to conduct safety appraisals of nuclear installations in the Former Soviet Union (FSU) states and offer loans for safety upgrades.

Against this background, the overall objective of the 1994 Decision was *to eliminate hazards to the health and safety of EU citizens by investing in projects aimed at improving the 'safety and efficiency' of nuclear installations located in CEEC and CIS*. Annex 3 further elaborates the intervention logic for the 1994 Decision, showing the causal link between the outputs of the Facility (i.e. loans for safety improvements), intermediate outcomes (improved safety performance of nuclear facilities in neighbouring countries) and final impact (reduced likelihood and risk of nuclear accidents at these facilities).

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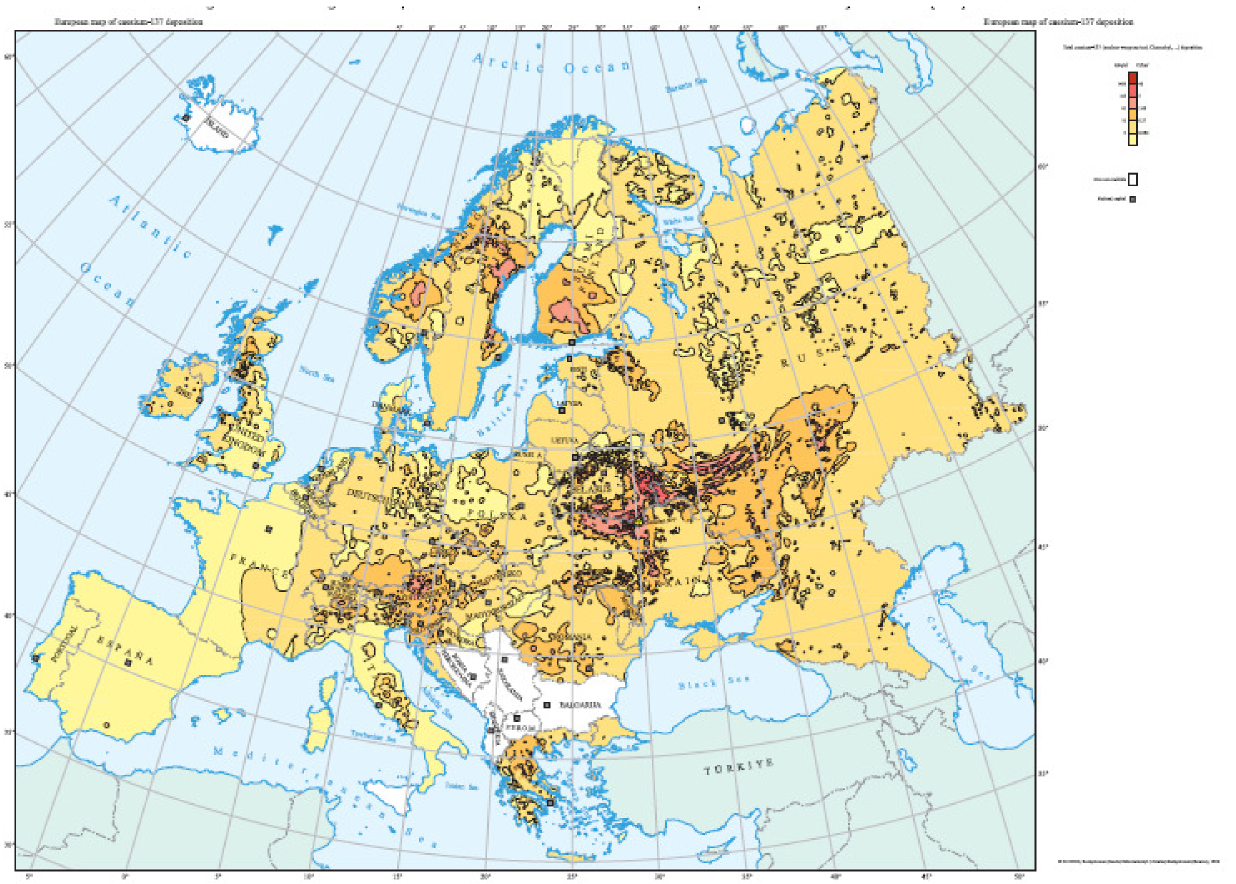
[38] Council Decision 94/179/Euratom of 21 March 1994

Figure 3:7 Surface Ground Deposition of Caesium-137 released in Europe after the Chernobyl Accident



Exposures and effects of the Chernobyl accident, Annex J of Sources and Effects of Ionizing Radiation, UNSCEAR 2000 Report to the General Assembly Vol. II page 464. Note: Caesium-137 is a long lived radioactive isotope, resulting from nuclear fission processes.

So far, the European Commission has granted three loans under the 1994 Decision:

Kozloduy units 5 and 6, Bulgaria – a loan of EUR 223.5 million was approved in April 2000 for the modernisation and safety improvement of Kozloduy units 5 and 6. The Euratom loan co-financed a number of improvements to the plant, notably:

- Additional measures to improve severe reactor accident management;
- Improvements to the instrumentation and control systems;
- Replacement of mechanical equipment of safety systems and electricity generating plant (turbine and balance of plant);
- Modernisation of electrical equipment and systems for reliable power supply;
- Replacement of monitoring and control systems with state-of-the-art digital control systems;
- Improvement of fire protection and seismic resistance;
- Mechanical and structural analyses of key nuclear components;
- Improvement of operational documents and maintenance means; and,
- Safety analyses including update of thermal-hydraulic analyses and production of a revised Safety Report.

Cernavoda unit 2, Romania – In March 2004, the European Commission approved a loan of EUR 212.5 million for unit 2 of Cernavoda to upgrade the safety levels of the reactor to internationally recognised safety standards and practices, including radiation protection standards.

Khmelnitsky 2 and Rovno 4, Ukraine – In July 2004, a loan of USD 83 million[39] was approved for a safety upgrade of Khmelnitsky 2 and Rovno 4 ('K2R4'). In 1995, Ukraine agreed to close the remaining units at Chernobyl by 2000 in exchange for assistance towards the modernisation of Chernobyl 4 shelter and for the development of the energy sector, including the completion of two new nuclear reactors, K2R4.

In the case of both Cernavoda and K2R4, safety improvements co-financed by Euratom loans focused on:

- Technology (reactor) upgrades, improving performance and reliability of process, inspection and safety systems and, changes to simplify maintenance requirements, reducing personnel radiation exposure;
- Technology (turbine and balance of plant) upgrades, improving efficiency and reliability of plant and therefore annual generation output;
- Modernisation, improving plant control, reliability and safety.

[39] The euro equivalent of the total loan disbursements was EUR 61.3 million.

- Technical studies to identify principal causes of nuclear or environmental risk and design/ installation of mitigation measures;
- Environmental studies associated with cooling water intake and discharge, to understand potential effects on the local aquatic biosphere;
- Provision of facilities for interim storage of nuclear fuel;
- Emergency actions and management.

The nature and scope of the safety improvements co-financed by Euratom loans are further elaborated in the case studies presented in Annex 6 (Cernavoda) and 7 (K2R4).

In the opinion of the stakeholders, the 1994 Decision (in conjunction with technical assistance from TACIS[40]/ PHARE[41] programmes) directly contributed to safety enhancements and promoted greater transparency of nuclear operations in Bulgaria, Romania and Ukraine. According to them, these safety improvements would either not have taken place at all or would have taken place over a much longer period in absence of Euratom loans. The following explanations were provided in support of this statement:

- Romania in particular, lacked the resources to undertake these safety improvements without financial support from the EU.
- In case of Bulgaria and Ukraine, the operators could potentially have generated the resources needed for the upgrades through electricity sales but, it would have taken them considerable longer (over ten years) to accumulate sufficient resources to fund the safety improvements. Euratom loans thus, considerably accelerated the implementation of safety upgrades in these countries.

[40] In 1991, following the collapse of the Soviet Union and the formation of the Commonwealth of Independent States or CIS, the European Commission launched the TACIS programme (Technical Assistance to the Commonwealth of Independent States) to support their transition towards a free market economy. One of the components of TACIS was the Nuclear Safety Programme – its purpose was to support nuclear safety improvements found necessary in the CIS countries. The TACIS Nuclear Safety Programme concentrated on Design Safety analysis, On-Site assistance to the Nuclear Power Plants with supply of equipment, Regulatory and licensing activities, Waste Management and contributions to international initiatives (Chernobyl Closure, Shelter Implementation Plan, (SIP), Nuclear Safety Account (NSA).

[41] Originally set up in 1989 to support the process of reform and economic and political transition in Poland and Hungary, the Programme of Community aid to the countries of Central and Eastern Europe (PHARE) became the financial instrument of the pre-accession strategy leading ultimately to the accession to the EU of the ten associated Central and Eastern European countries following the Essen European Council in December 1994. The PHARE Programme for Nuclear Safety had the same objectives as the TACIS Programmes.

Conclusions:
The Euratom Loan Facility was created in 1977 to promote investment in the nuclear sector with the overall aim of reducing the EU's dependence on energy imports. This global objective of the Facility was highly pertinent in a context of increasing import dependence, oil price volatility and rising demand for electricity in the EU. Furthermore, actual developments confirm the validity of the underlying intervention logic of the Euratom Loan Facility. The Facility accelerated and catalysed investment in the EU's nuclear sector by directly financing viable projects and by leveraging additional sources of funding through its 'signalling' effect. The Facility co-financed 21 per cent of the total investment in new builds in the EU over the period 1987 to 2003 and promoted investment in supporting infrastructure such as front-end fuel cycle facilities. Following the Chernobyl nuclear accident in Ukraine (1986), it was relevant and appropriate for the Euratom Loan Facility to be extended to neighbouring third countries to help improve the safety and efficiency of their nuclear installations. Euratom loans were instrumental in upgrading the safety levels of nuclear installations in Bulgaria, Romania and Ukraine thus, bringing them in line with internationally recognised safety standards and practices.

3.1.2 Q.2 To what extent are the objectives of the Facility pertinent to the needs and problems of current market circumstances and policies?

Table 3:3 provides an overview of the present day and anticipated future (short to medium term) investment and financing needs of the EU's nuclear sector, along with initial considerations on potential use of the Euratom Loan Facility for addressing these needs. It should be noted that it is beyond the scope of this evaluation to fully appraise the investment needs of the nuclear sector (and the financing gaps along the nuclear value chain) - such analysis would normally be undertaken as part of an Impact Assessment process.

Table 3:3 Drivers and Barriers to Investment in the Nuclear Sector, and the Scope for using the Euratom Loan Facility to fill Anticipated Financing Gaps[42]

Area of Investment	Drivers for Investment	Barriers to Investment	Is there a Financing Gap?	Can Euratom make a difference?
Research and Development	▪ The need to improve the safety, security and fuel efficiency of current technology ▪ To maintain the competitiveness and technological edge of the EU's nuclear sector in the global arena ▪ To meet expected rise in demand for medical isotopes[43] ▪ The need to replace ageing research reactors producing medical isotopes	▪ Scale of upfront investment – the cost of developing a commercial scale demonstration reactor ranges from EUR 1 billion to EUR 5 billion ▪ Long timescales for commercialisation (30 to 40 years) ▪ Inherent risky nature of R&D activities / uncertainty of commercial success ▪ Lack of steady stream of cash flows	**Yes** There is a need for strategic investment in nuclear research infrastructures. It is estimated that the ESNII project requires an investment of EUR 11 billion. There are no earmarked funds for this project in the EU budget. Although financing is more or less in place for the SFR prototype which will be hosted in France and will cost EUR 4 billion; sources of funds have not been identified for the remainder.	**Yes, potentially** R&D is typically not considered a bankable activity as it does not generate a stable/ predictable revenue stream until commercialisation. However, some commercial scale demonstration reactors might have the potential to generate revenue (i.e. by being connected to the grid). Overall, nuclear R&D investment should firstly be financed through grants, possibly Joint Undertakings (Article 45 of the Euratom Treaty) and other instruments. Euratom Loans could potentially be considered for the bankable aspects of large scale infrastructure (e.g. commercial scale demonstration reactor)

[42] Financing gap refers to a situation where a project is fundamentally viable/ bankable; but market financing is not available at all or not available on suitable terms due to the existence of market failures (such as information asymmetry).

[43] OECD/NEA (2010) The Supply of Medical Radioisotopes, Interim Report of the OECD/NEA High-level Group on Security of Supply of Medical Radioisotopes. Available at: http://www.oecd-nea.org/med-radio/reports/HLG-MR-Interim-report.pdf

Table 3:3 Drivers and Barriers to Investment in the Nuclear Sector, and the Scope for using the Euratom Loan Facility to fill Anticipated Financing Gaps[42]

Area of Investment	Drivers for Investment	Barriers to Investment	Is there a Financing Gap?	Can Euratom make a difference?
New builds	▪ Growing demand for electricity – even if significant energy efficiency measures are successfully implemented, EU's electricity consumption is expected to grow by 1 per cent per annum between 2010 and 2050[44] ▪ Security of energy supply – EU imports more than half (56 per cent) of its gross inland energy consumption; recent experience of disruptions of natural gas supplies from Russia; the EU27 trade deficit for energy (EUR 32.2 billion in January 2011[45])	▪ Scale and uncertainty of upfront investment and long payback period ▪ Highly risky nature of investment, with overall risk comprising: – Construction risk – Public acceptance – Political risk – Licensing and regulatory risk – Market risk ▪ Emergent events such as	**Yes** The investment required to deliver planned increases in generation capacity by 2030 (45 GWe to 70 GWe) is estimated to be in the order of EUR 150 billion to EUR 350 billion. It is highly unlikely that the utilities will make this investment unless electricity markets/governments provide sufficient assurances that they will get a secure and adequate return on their investment	**Yes** Euratom Loan Facility has the potential to add value for plants being built in smaller, new Member States where the utilities have less access to capital or the cost of capital is higher as compared to Western Europe (due to the size of the utility itself and the credit rating of the country concerned[46]). In such cases, the amount of the loan, the lower interest rate on Euratom lending (as the Commission can pass the benefits of its AAA/Aaa credit rating to borrowers) and the potential catalytic effect (i.e. attracting private sector financing) are likely to be important.

[44] Rega, N. (2010): Power Choices: Pathways to Carbon-neutral Energy in Europe by 2050. Eurelectric. Brussels, 2010.

[45] http://epp.eurostat.ec.europa.eu/cache/ITY_PUBLIC/6-15042011-AP/EN/6-15042011-AP-EN.PDF

[46] The availability and cost of capital depends in part on the credit ratings of both the country and the utility in question; countries with more stable economies tend to get easier access to capital at lower interest rates, as do utilities that have sounder finances. But the structure of the electricity industry is a factor as well. In countries that have traditional monopoly utilities, consumers effectively bear the project risk because any incurred costs are passed on—allowing for full-cost recovery.

Table 3:3 Drivers and Barriers to Investment in the Nuclear Sector, and the Scope for using the Euratom Loan Facility to fill Anticipated Financing Gaps[42]

Area of Investment	**Drivers for Investment**	**Barriers to Investment**	**Is there a Financing Gap?**	**Can Euratom make a difference?**
	▪ Supply of electricity at stable and predictable prices – oil price volatility affecting recovery ▪ Climate change (GHG emissions) – nuclear is a source of low carbon baseload electricity generation	Fukushima nuclear crisis ▪ Basel III regulatory requirements		Euratom financing may also bring some value to larger utilities operating in Western Europe, especially by providing a 'quality stamp' / EU endorsement (which would help leverage private sector financing) or addressing investment needs arising from multiple, concurrent projects
Safety enhancement of nuclear facilities	▪ Fukushima nuclear crisis – safety enhancements following the EU 'stress tests' ▪ Regulatory changes requiring enhanced safety and security standards	▪ Cost of backfitting/ safety upgrade vis-á-vis the cost of closure	**Yes, potentially** The scale of the financing gap cannot be quantified at this stage; it would depend upon the outcome of EU 'stress tests'	**Yes** Demand is expected to come from urgent upgrades/ improvements required as a result of reactions to 'force majeure' type events (e.g. natural disasters), policy or regulatory changes or compliance with new standards
Life extensions	▪ Ageing plants - the average age of 137 reactors presently in operation in the EU is about 27 years[47]	▪ Cost of investment ▪ Negative public perception regarding life	**No** According to the nuclear industry and the banks, lifetime	**No** There is no financing gap requiring EU intervention

[47] WNA Reactor Database [accessed on 15 April 2011].

Table 3:3 Drivers and Barriers to Investment in the Nuclear Sector, and the Scope for using the Euratom Loan Facility to fill Anticipated Financing Gaps[42]

Area of Investment	Drivers for Investment	Barriers to Investment	Is there a Financing Gap?	Can Euratom make a difference?
	▪ Preserving profitability (economic considerations life extensions versus closure) ▪ Lack of alternative low carbon technology to meet baseload electricity demand	extension	extensions can be financed by the capital markets as existing plants have an established track record and are revenue generating assets	
Nuclear fuel cycle (Uranium enrichment, fuel fabrication and re-processing)	▪ Planned increases in nuclear generation capacity within the next 15 years – estimates range from 45 GWe[48] to 62 GWe capacity[49] ▪ Rising prices and demand for uranium	▪ Scale of upfront investment ▪ Sensitive technologies with regard to proliferation ▪ Public perception relating to risk of proliferation	**No** The evaluation found no evidence of a financing gap	**No** There is no evidence of market failure(s) requiring EU intervention

[48] Pöyry (2011) National Supply Chain Capacity for Nuclear New Build – An Analysis of CH, FI,HU and UK. A presentation made by Philipp Elkuch and Matti Nummela at the European Nuclear Forum on 23 March 2011.

[49] 47 reactors are currently being planned/ proposed in the EU. WNA Website, Facts and Figures, World Nuclear Power Reactors & Uranium Requirements , dated 1 April 2011 (corrected 13/4). Available at: http://world-nuclear.org/info/reactors.html

Table 3:3 Drivers and Barriers to Investment in the Nuclear Sector, and the Scope for using the Euratom Loan Facility to fill Anticipated Financing Gaps[42]

Area of Investment	Drivers for Investment	Barriers to Investment	Is there a Financing Gap?	Can Euratom make a difference?
Decommissioning	▪ 58 reactors planned to be de-commissioned in the EU during 2006-2025[50] ▪ Fukushima nuclear crisis- resulting in earlier than anticipated closure/decommissioning of some nuclear plants	▪ Lack of a cash flow stream – decommissioning does not generate any revenues	**No** There is no financing gap; but there might be a shortfall in availability of funds for decommissioning in certain Member States	**No** Euratom Loan Facility is a conventional loan facility i.e. money is lent on the premise that it is repaid with interest. However, decommissioning is not a bankable activity; use of Euratom lending to fund decommissioning would create an unnecessary budgetary risk for the EU – see Box 3:2
Waste storage and disposal	▪ Growing quantities of waste	▪ Lack of an acceptable long term solution in many countries ▪ No cashflow – waste storage and disposal does not generate any revenues	**No, not in the short to medium term** EC policy requires Member States to make provision for the long term storage and management of radioactive wastes, including that from nuclear power generation, nuclear fuel cycle and subsequent decommissioning activities. The availability of finance to cover the	**No** Limited investment is expected in this area within the next 20 years. There might be a case to use the Facility for financing investment in waste storage and disposal facilities in the long term. However, it is not possible to scope out the financing requirements at this stage - a future evaluation of

[50] COM(2007) 794 final – EU decommissioning funding data.

Table 3:3 Drivers and Barriers to Investment in the Nuclear Sector, and the Scope for using the Euratom Loan Facility to fill Anticipated Financing Gaps[42]

Area of Investment	Drivers for Investment	Barriers to Investment	Is there a Financing Gap?	Can Euratom make a difference?
			costs of longer term waste storage and disposal facilities varies by country and is potentially area of funding shortfall	the Euratom Loan Facility should re-examine the issue.

Box 3:2 EU's Cash Flow Mechanism to ensure Timely Repayment of EU Borrowings

In the case of Euratom loans, the European Commission borrows money from the financial markets and on-lends it on matching terms to loan beneficiaries.

A cash flow mechanism has been put in place by DG Budget to ensure that the European Commission can meet its borrowing obligations (payment of interest + principal) on time. On the due date of the payment, the European Commission ensures that adequate funds are available (from the EU general budget) to make the payment. If the borrower (of the EU loan) pays on time, then there is no impact on the EU budget. However, in case the borrower defaults, then this would create a gap (at least a temporary one) in the EU budget.

In the first instance, the European Commission would try to recover the amounts from the defaulting borrower by calling upon the guarantees provided by the borrower. In case the recovered amounts are insufficient, the European Commission would have the following options: drawing upon the EU Guarantee Fund for External Actions (applies to loans extended to third countries only)[51] and/or redeployment of funds between budget lines (although it should be noted that there is no specific budget line for Euratom loans within the general budget).

The following sections elaborate upon the investment and financing needs outlined in Table 3:3.

3.1.2.1 Investment and Financing Needs: Research and Development (R&D)

Article 172 of the Euratom Treaty provides for financing of both research and investment projects in the nuclear sector. Historically, the Euratom Loan Facility has not been used to finance 'pure' research projects; although, it has previously been used to finance projects involving the commercialisation of research (for example, Euratom loans were used to finance Superphénix which was a leading edge, commercial scale demonstrator connected to the grid[52]).

As regards present day and expected future needs in the area of nuclear R&D, these can broadly be classified as follows:

- Large scale infrastructure for demonstration of next generation technologies;
- Smaller reactors for nuclear research and medical isotopes production.

These are briefly explained below.

[51] Euratom external lending (i.e. loans to non Member countries) is also covered by the EU Guarantee Fund for External Actions. In case the guarantee provided by the operator proves inadequate, the losses would ultimately be covered by the Guarantee Fund. The Guarantee Fund provides a 'liquidity cushion' – the resources of the Fund are used to repay the Community's creditors in the event of default by the beneficiary of a loan granted or guaranteed by the EU.

[52] The project was underpinned by EdF, Enel and some others. It thus had utility backing to underwrite financing. But, technical problems severely limited its operation, to the extent that modification costs exceeded future benefit and hence it had to be shut-down prematurely.

Large scale infrastructure for demonstration of next generation technologies

The EU is committed to the European Sustainable Nuclear Industrial Initiative (ESNII)[53] which aims to develop demonstration of Gen-IV Fast Neutron Reactor (FNR) technologies including the construction of a prototype of the sodium-cooled fast neutron reactor (SFR) technology (ASTRID project); experimental reactors to demonstrate alternative technologies such as lead-cooled fast reactor (MYRRHA project) and gas-cooled fast reactor (ALLEGRO Project); and, support other research infrastructures, fuel facilities and R&D work.

ESNII is a strategically important project for the EU's nuclear sector; the EU industry risks losing its technological edge if it does not invest in next generation technologies. Moreover, FNR technologies will be more efficient (50 to 100 times) than current technologies in the use of uranium and they will also address issues such as waste management and proliferation. According to the ESNII concept paper, FNR technologies '*are potentially able to provide energy for the next thousand years with the already known uranium resources*'[54].

Smaller reactors for nuclear research and medical isotopes production

Additionally, investment in research reactors is needed to address current issues relating to shortage of supply of radioisotopes for nuclear medicine[55] and the significant aging of existing research reactors producing medical isotopes. A recent Commission communication[56] highlights the challenges facing the EU in the use of nuclear technology for medical applications, including the urgent need to invest in research reactors and/or ^{99}Mo production facilities. It proposes the use of Euratom loans to support isotope production projects.

Historically, there were only five reactors that produced 90 to 95 per cent of the global ^{99}Mo supply: three in Europe (BR-2 in Belgium, HFR in the Netherlands and OSIRIS in France), one in Canada (NRU), and one in South Africa (SAFARI-1). All these reactors are over 43 years old - see Figure 3:8. Although there have been some recent additions to capacity (i.e. the MARIA reactor in Poland, which started producing ^{99}Mo for global distribution in February 2010 and the LVR-15 reactor in the Czech Republic, which started producing ^{99}Mo for global distribution in May 2010), there remain concerns regarding reliability of supply of medical isotopes due to the ages of the major producing reactors[57] and the fact that some of these reactors are expected to reach their end of life in the next six years. In parallel, the market demand for ^{99}mTc has continued to rise; although, there is a degree of uncertainty in the industry as to the scale of future demand for ^{99}Mo/^{99}mTc, with some supply chain

[53] ESNII Task Force (2010) A contribution to the EU Low Carbon Energy Policy: Demonstration Programme for Fast Neutron Reactors, A Concept Paper. Available at: http://www.snetp.eu/www/snetp/images/stories/Docs-ESNI/ESNII-Folder-A4-oct.pdf

[54] *ibid*

[55] The most widely used isotope in nuclear medicine is Technetium-99m (^{99}mTc), a decay product of Molybdenum-99 (^{99}Mo) . These isotopes are used in medical diagnostic imaging techniques which enable precise and accurate, early detection and management of diseases such as heart conditions and cancer, in a non-invasive manner.

[56] COM (2010) 423 final

[57] A consequence of ageing reactors is the increased occurrences of unexpected shutdowns at producing reactors and the need for extended shutdowns for planned maintenance work and possibly for unplanned maintenance. For example, in 2010 both the High Flux Reactor in the Netherlands and the OSIRIS reactor in France were scheduled to be down for extended maintenance periods.

participants expecting continued or increasing growth, while others predict growth to a saturation point then levelling off or even a decrease in demand.

Figure 3:8 Major Current 99Mo Producing Reactors

Reactor name	Location	Annual operating days	Normal production per week[a]	Weekly % of world demand	Fuel/targets[b]	Date of first commissionin
BR-2	Belgium	140	5 200	25-65	HEU/HEU	1961
HFR	Netherlands	300	4 680	35-70	LEU/HEU	1961
LVR-15[d]	Czech Republic	–	>600	–	HEU[e]/HEU	1957
MARIA[d]	Poland	–	700-1 500	–	HEU/HEU	1974
NRU	Canada	300	4 680	35-70	LEU/HEU	1957
OPAL	Australia	290	1 000-1 500	–	LEU/LEU	2006
OSIRIS	France	180	1 200	10-20	LEU/HEU	1966
SAFARI-1	South Africa	305	2 500	10-30	LEU/HEU[g]	1965
RA-3	Argentina	230	240	<2	LEU/LEU	1967

Source: OECD/ NEA (2010) op cit

Financing needs

There is presently a significant mismatch between the demand for and the supply of funds for nuclear R&D. It is estimated that the ESNII project requires a total investment of circa EUR 11 billion[58]. This includes an SFR prototype which will be hosted in France and is expected to cost EUR 4 billion (most of this investment is likely to come from the French government, though the nuclear industry, the EU and even possibly international partners are also expected to contribute). Public/private partnerships in one form or another, will constitute the principal means of funding the various infrastructures in ESNII though the size of the industrial contribution is likely to be limited as these technologies have very long lead times (on the basis that investment is made today, these technologies would be ready for commercial deployment around 2040).

In such a scenario, the Euratom Loan Facility could potentially be used to address the financing gap for large scale nuclear R&D infrastructure (such as commercial scale demonstration reactors). However, a major consideration in using the Euratom Loan Facility for financing R&D is that such projects are inherently risky and expected cash flows are highly speculative in nature (subject to realisation upon commercialisation, which itself is uncertain). Therefore, the use of Euratom loans for financing R&D investment - without corresponding collateral assurances from the sponsor (vendor, utility, developer and/ or state) - would create a budgetary risk for the EU. As with current nuclear power generation projects, investment and payback periods are long and, for demonstrator plants, increasing performance uncertainty (hence payback opportunity) deters loan investments (private and public). Superphénix is a case in point where the output was terminated after a few years of sporadic operation (although the Euratom loan was fully repaid).

[58] ESNII Concept Paper. Available at: http://www.snetp.eu/www/snetp/images/stories/Docs-ESNI/ESNII-Folder-A4-oct.pdf ; pp. 31.

Moreover, from the commercial banks' perspective, R&D is not considered a bankable activity for two reasons:

- R&D is not a 'typical' commercial activity. As a consequence, any revenue stream that is generated by an R&D project can only be considered secondary and intermittent by nature[59]. This is not compatible with a bank's traditional business, which is geared towards lending to 'commercial activities'.
- Banks would not normally accept First of a Kind (FOAK) risk[60] in the nuclear sector because of the specific characteristics of nuclear technology notably, technical complexity, high capital intensity and long payback period.

Other stakeholders however, put forward the following arguments in favour of extending the scope of the Euratom Loan Facility to cover R&D projects:

- *Revenue generation potential:* demonstrator reactors connected to the grid generate revenues; research reactors also have the potential to generate cash flow through the production of medical isotopes, for example. As Euratom loans would finance up to 20 per cent of the project costs (within the EU), an R&D project would only need to generate sufficient revenues to re-pay the loan amount.
- *The existence of market failures:* market failures such as incomplete and asymmetric information inhibit the provision of adequate financing or financing on suitable terms for investment in R&D projects.
- *Existing precedents*: there are examples of debt based instruments being used by the European Commission and the EIB to finance R&D. For example, the Risk Sharing Finance Facility (RSFF) is a debt based instrument which is available to companies or projects which can demonstrate the capacity to repay debt on the basis of a credible business plan. However, it should be noted that investment projects co-financed by the RSFF and the amount of financing provided by the instrument are of a considerably smaller scale as compared to the Euratom Loan Facility. RSFF could potentially be used to support smaller nuclear R&D projects - requiring investment in the order of some hundreds of millions euros (see Table 3:4 overleaf) - as it might be more suitable (in terms of scale of investment/ loan amount) than the Euratom Loan Facility[61].

On balance, there might be a justification for considering Euratom lending to support investment in large scale R&D infrastructure (such as commercial scale demonstrators) on the basis that this investment should firstly be financed through grants and other instruments; and, Euratom loans should only be considered for bankable aspects of the project. It is nonetheless important to remember that the Euratom Loan Facility is a conventional loan facility requiring repayment of the borrowed amounts (principal and interest) and not an instrument suited to supporting projects of a sub-senior credit quality.

[59] Research reactors operate on the basis of cycles, with a number of days of operating and then a period where the reactor is shutdown for refuelling, changing research project set-ups, regular maintenance, etc. In addition, some reactors do not operate the full year, depending on their research demands and available funding.

[60] This risk is typically borne by equity, not by debt.

[61] The amount of effort required to process a Euratom loan (due diligence, monitoring etc.) means that a loan amount of less than EUR 200 million is not likely to be cost effective (which implies a project cost of at least EUR 1 billion at a maximum intervention rate of 20 per cent).

Euratom, like the EU, enjoys a AAA/Aaa rating. This triple-A status is indispensable for the EU's ability to borrow from the capital markets on the finest terms. This is of utmost importance in the context of the EU's support to Member States and non-Member States for the purpose of addressing macroeconomic challenges (i.e. European Financial Stabilisation Mechanism, Balance of Payments, Macro Financial Assistance facilities) and cannot be jeopardised by making the Euratom Loan Facility to projects with sub-senior credit quality.

Table 3:4 Reported Costs of Planned Research Reactors which will be used for Medical Isotopes Production

Reactor	Country	Reported Cost (M EUR)	Purpose		
			Isotope Production	Research	Other
(1) Myrrha	Belgium	960	Potentially	√	Gen IV Demonstrator
(2) Pallas	Netherlands	500	√	√	
(3) Jules Horowitz	France	500	√	√	
(4) OPAL	Australia	300	√	√	
(5) ****	Jordan	120	√	√	Nuclear Training
(6) University of Saskatchewan	Canada	350 - 500	√	√	

Sources:

(1) http://www.world-nuclear-news.org/NN-Myrrha_announced_as_European_research_infrastructure-0112104.html
(2) http://www.pallasreactor.eu/home/veelgestelde-vragen-faq/
(3) www.world-nuclear-news.org/print.aspx?id_18584
(4) http://scott-ludlam.greensmps.org.au/content/question/open-pool-australian-lightwater-research-reactor
(5) www.koreatimes.co.kr/www/news/include/print.asp?newsIdx=56698
(6) www.canhealth.com/News1181.html

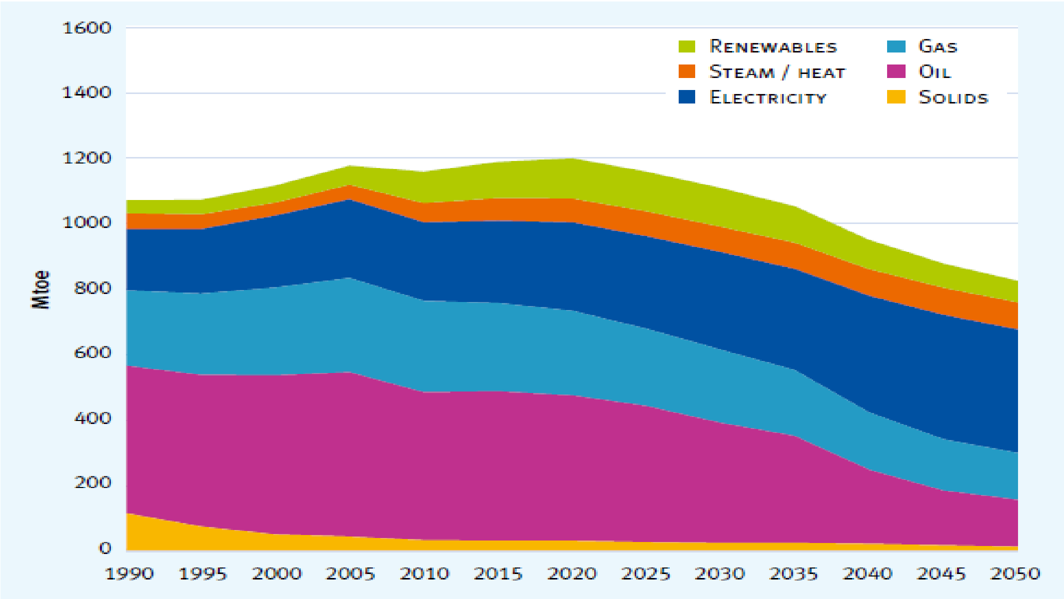
3.1.2.2 Investment and Financing Needs: New Builds

Drivers for investment in new builds

The main drivers for investment in new builds are as follows:

Rising demand for electricity – although final energy consumption in the EU is expected to fall in the future as a result of implementation of energy efficiency policies and measures (which would drive energy savings and cut overall demand); the demand for electricity is expected to grow as it becomes a major transport fuel (as plug-in hybrid and electric cars develop) – see Figure 3:9.

Figure 3:9 Final Energy Demand in Power Choices Scenario



Source: Rega, N. (2010): Power Choices: Pathways to Carbon-neutral Energy in Europe by 2050. Eurelectric. Brussels, 2010

Availability of energy at stable, predictable and competitive prices – energy costs represent between 1 per cent and 10 per cent of the costs of industrial production (excluding personnel costs) in the EU[62]. Energy/ electricity[63] prices therefore, have a significant impact on the growth trajectory and competitiveness of the EU economy. A range of independent studies[64] show full nuclear lifecycle costs, including decommissioning and waste management, to be competitive in relation to other sources (although the competitiveness of nuclear vis-á-vis other fuels is highly sensitive to cost of capital required by utilities to finance construction). Fuel costs represent a relatively small proportion of the total levelised electricity generating costs[65] for nuclear (Figure 3:10). As a result, the marginal costs of nuclear electricity tend to be low, stable and predictable, in contrast to those of fossil fuel

[62] DG Energy (2011) Background on Energy in Europe. Background Information for the European Council, 4th February 2011. Available at: http://ec.europa.eu/europe2020/pdf/energy_background_en.pdf

[63] Electricity represents circa 21% of the total energy consumption in the EU (source: Table 2.2.6 Final Energy Consumption, EU Energy in Figures 2010. Available at: http://ec.europa.eu/energy/publications/statistics/statistics_en.htm).

[64] See ENEF working group paper on Strengths and Weaknesses (dated 21st April 2010) for a summary of different studies. See also factsheet prepared by SNETP: *Is nuclear energy competitive?*. Available at: http://www.snetp.eu/www/snetp/index.php?option=com_content&view=article&id=80&Itemid=44

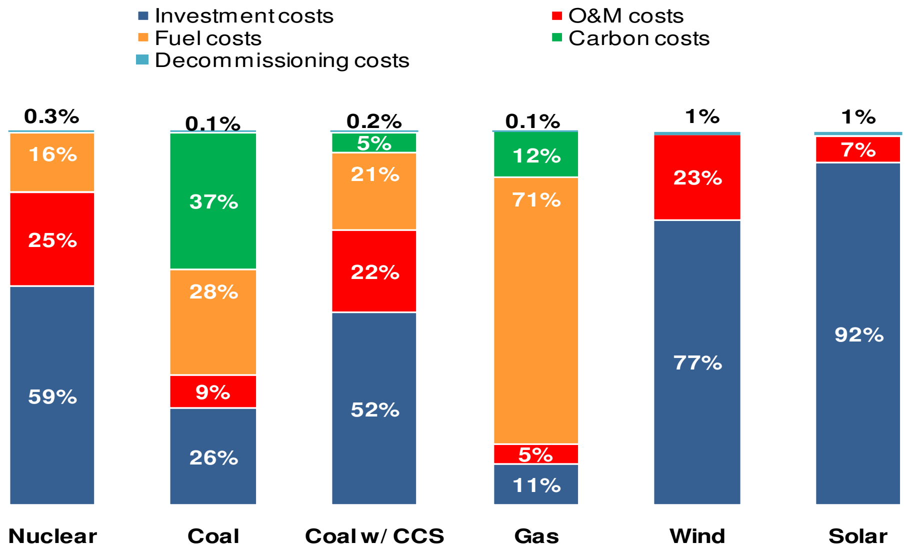
OECD/ NEA (2010) Projected Costs of Generating Electricity – 2010 Edition.

[65] Levelised cost represents the present value of the total cost of building and operating a power plant over an assumed financial life and duty cycle, converted to equal annual payments and expressed in real terms to remove the impact of inflation. Levelised cost reflects overnight capital cost, fuel cost, fixed and variable O&M cost, financing costs, and an assumed utilisation rate for each plant type (source: EIA).

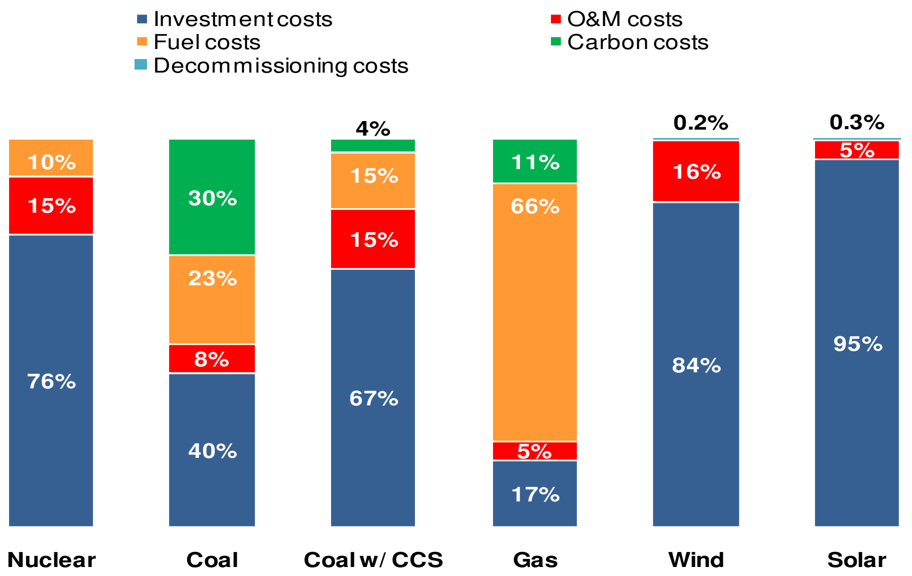
powered plants, where volatile fuel prices are an essential part of the electricity cost (Figure 3:11 shows the volatility observed in oil and gas prices over the period 2007 to 2010).

Figure 3:10 Approximate Breakdown of Levelised Electricity Generation Costs for Nuclear, Coal and Gas Fired Plants

5% Discount Rate

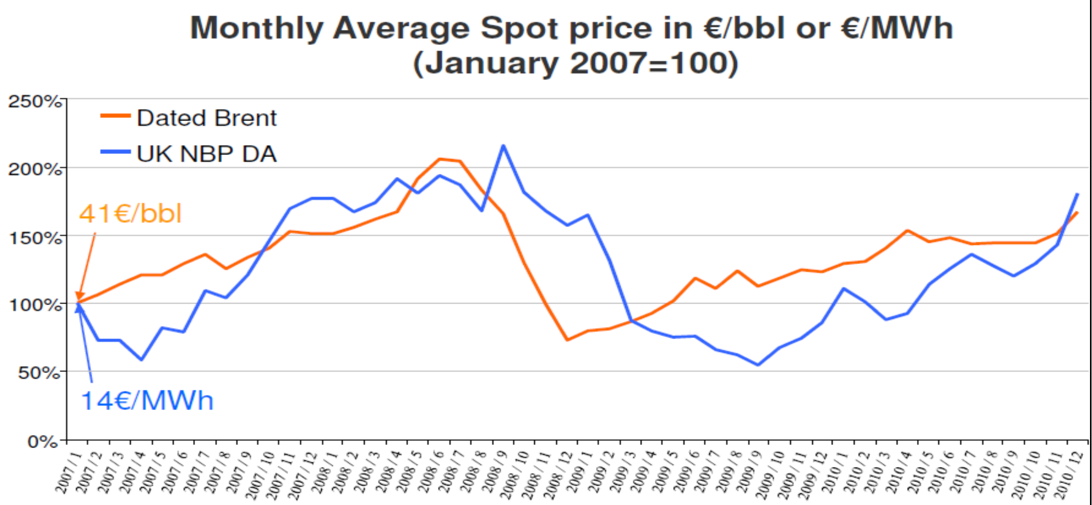


10% Discount Rate



Based on data from OECD (2010) Projected Costs of Generating Electricity – 2010 edition, pp.112
NB: Fuel costs for nuclear comprise the costs of the full nuclear full cycle including spent fuel reprocessing or disposal
Due to rounding off, figures for individual fuels do not always add up to 100 per cent

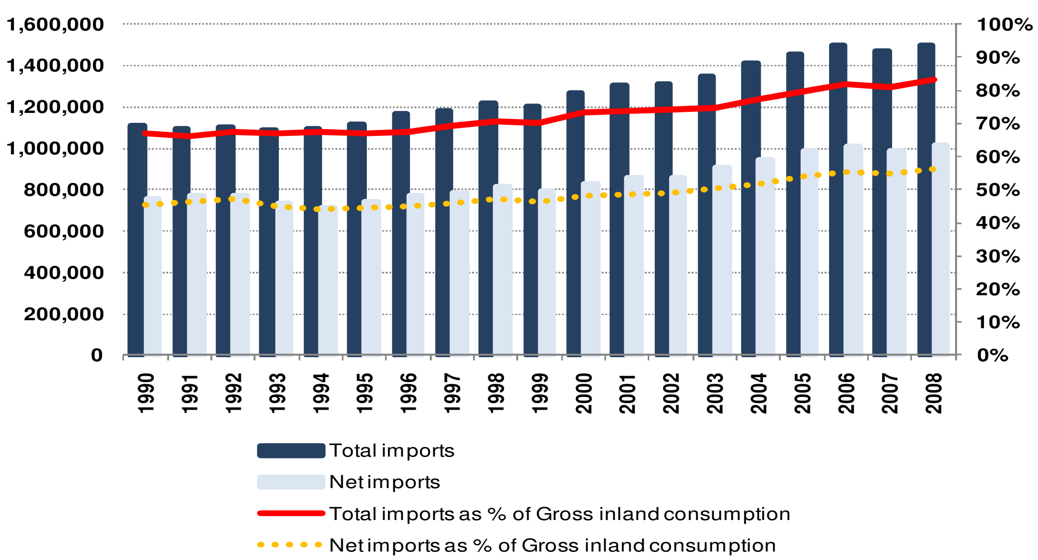
Figure 3:11 Trends in Oil and Gas Price, 2007 - 2010



DG Energy (2011) Background on Energy in Europe. Background Information for the European Council, 4th February 2011. UK NBP DA refers to National Balancing Point for the sale and purchase and exchange of UK natural gas

Security of energy supply – the EU is increasingly reliant upon imports to meet its energy demands (Figure 3:12). EU's net energy import dependency rose from 46 per cent in 1990 to 56 per cent in 2008.

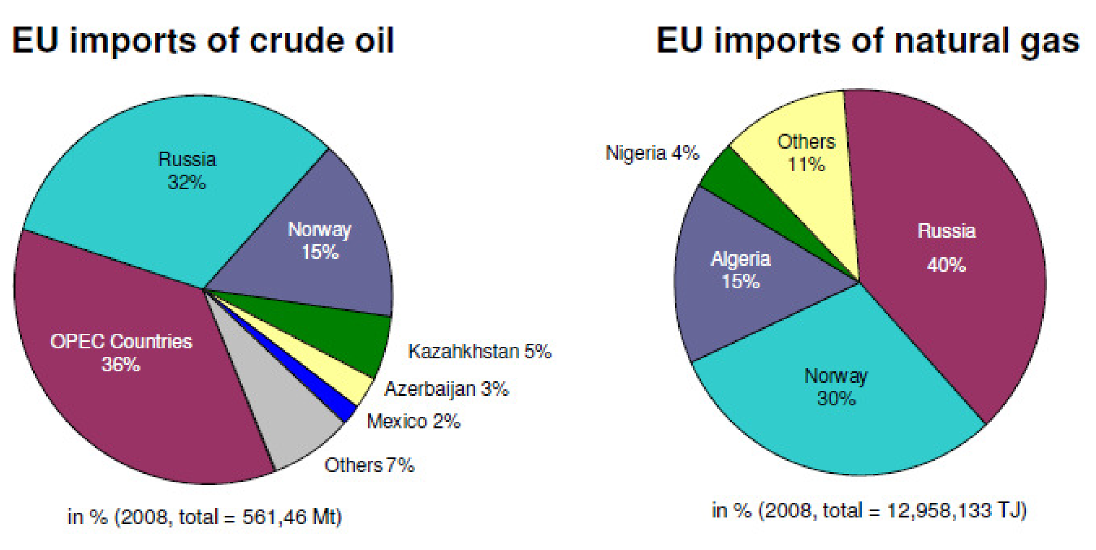
Figure 3:12 EU Energy Imports, Thousands Tonnes of Oil Equivalent, 1990 to 2008



Data Source: Eurostat

Moreover, the EU is reliant on a few suppliers for its oil and gas imports (Figure 3:13). Nuclear energy can reduce EU's dependency on imported fuels, particularly from politically unstable regions by providing a large scale, reliable source of base load electricity[66].

Figure 3:13 Sources of the EU's Oil and Gas Imports, 2008



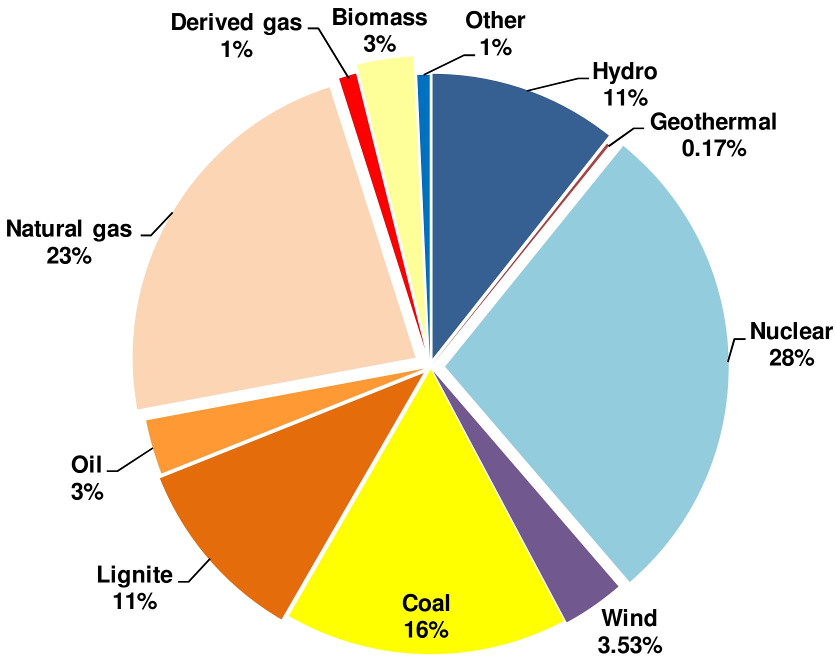
DG Energy (2011) op cit.

EU's climate change targets – nuclear accounts for 28 per cent of the gross electricity generation within the EU (Figure 3:14); but, only 1 per cent of the GHG emissions from electricity generation (Figure 3:15). CO_2 emissions from the full nuclear cycle are low (ranging from 5g CO_2eq/kWh to 15g CO_2eq/kWh). NPPs produce no direct CO_2 emissions (as there is no combustion; heat is generated by fission of uranium or plutonium). Most emissions occur indirectly from NPP construction; fuel cycle activities (uranium mining, enrichment and fuel fabrication), decommissioning (which according to some estimates[67], accounts for 35 per cent of the lifetime CO_2 emissions), and includes emissions arising from dismantling the nuclear plant and the construction and maintenance of waste storage facilities.

[66] For further information see factsheet prepared by SNETP: *How does nuclear contribute to security of supply?*. Available at: http://www.snetp.eu/www/snetp/index.php?option=com_content&view=article&id=80&Itemid=44

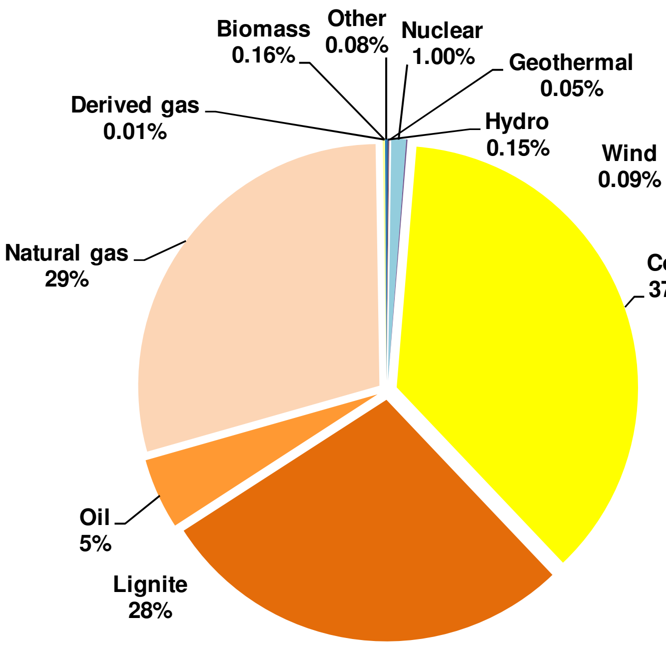
[67] Carbon Footprint of Electricity Generation. Available at: http://www.parliament.uk/documents/post/postpn268.pdf

Figure 3:14 Gross Electricity Generation by Energy Source (%), 2008



Data sourced from Eurostat

Figure 3:15 Electricity Generation Related Lifecycle GHG Emissions by Source (%), 2008



Source: GHK Analysis. Estimated as follows: Gross electricity generation by energy source X applicable emission factor

The following emission factors have been used:

Lifecycle GHG emissions (gCO2eq/kWh)

Hydro	6
Geothermal*	122
Nuclear	15
Wind	11
Coal**	950
Lignite**	1100
Oil	637.5
Natural gas	530
Derived gas	6
Biomass	21
Other***	45

Source: SEC(2008) 2872 Commission Staff Working Document accompanying the Second Strategic Energy Review

** Based on data for Italian plants. The actual range was from 4 g/kWh to 740 g/kWh with the weighted average being 122 g/kWh. Source: IPCC (2008) The possible role and contribution of geothermal energy to the mitigation of climate change*

***Lower end of the scale taken. Source: Weisser (2007) A guide to life-cycle greenhouse gas (GHG) emissions from electric supply technologies*

**** Assumed to be solar*

Job and Output creation – the nuclear sector makes a significant contribution to the EU economy in terms of both, output and employment. In 2008, the European energy market was worth around EUR 620 billion[68] (or 5 per cent of the EU GDP); on a pro-rata basis[69], the nuclear sector's direct contribution to the EU economy in 2008 (by way of electricity sales) can be estimated to be in the order of EUR 87 billion or 0.7 per cent of the EU GDP. The nuclear sector also contributes indirectly to the economy through backward linkages (purchases from suppliers) and supply of electricity to other sectors of the economy. In terms of job creation, a factsheet produced by FORATOM[70] states that the Europe's nuclear industry currently employs around 500,000 people, including those in the supply chain.

Job creation by the nuclear industry occurs over three distinct phases.

During the pre-construction phase: These jobs are created in anticipation of a new nuclear plant construction. The companies in the supply chain, which provide equipment and services, start gearing up to meet expected demand. Companies start expanding existing manufacturing facilities and engineering centres or building new ones. Virtually all of these are high-quality skilled craft and engineering jobs. A UK study[71] estimates that a modern

[68] The Internal Energy Market – Time to Switch into Higher Gear, Non-paper. Available at: http://ec.europa.eu/energy/gas_electricity/legislation/doc/20110224_non_paper_internal_nergy_market.pdf

[69] i.e. 14 per cent which is the share of nuclear in the EU's gross inland energy consumption. Source: SEC(2008) 2871, Volume II

[70] The socio-economic benefits of nuclear energy, dated March 2010. Available at: http://www.foratom.org/download-center/doc_view/4074-fact-sheet-socio-economics-of-nuclear.html

[71] Cogent (2010) Next Generation Skills for New Build Nuclear, Renaissance Nuclear Skills Series: 2

new build (twin unit plant) will create over 500 highly-skilled jobs during this phase (Figure 3:16).

During the construction phase: Overall, construction, taken together with electrical, mechanical and site preparation, typically accounts for 60 per cent of the employment during a new build programme. According to a US study[72], an average nuclear plant employs 1,400 to 1,800 people during construction, with peak employment reaching as high as 2,400 construction workers. The estimates provided in the UK study are not too dissimilar - it estimates that an average new build has the potential to create over 2,000 direct construction jobs (Figure 3:16). Additionally, construction of a new nuclear power plant also provides a substantial boost to suppliers of commodities like concrete and steel and manufacturers of hundreds of plant components. Supplying these materials and components creates even more jobs in the economy.

During the operations phase: These jobs are created when the new plants start commercial operation. According to the US evidence cited above, an average nuclear plant employs 400 to 700 people for 40 to 60 years. These jobs pay approximately 35 per cent more than average salaries in the local area. The UK study estimates that operation and maintenance of a new build will create just over 800 full time equivalent (fte) jobs per year (these include operations, HQ function and supply chain) (Figure 3:16); and that 75 per cent of these jobs will be created directly by the nuclear operator, while 25 per cent of these jobs will be in the supply chain. Total employment, for a single reactor, peaks close to 2,500 ftes approximately midway through the timeline (Figure 3:17).

Figure 3:16 Estimated Employment Potential of the UK's 16 GWe New Build Programme

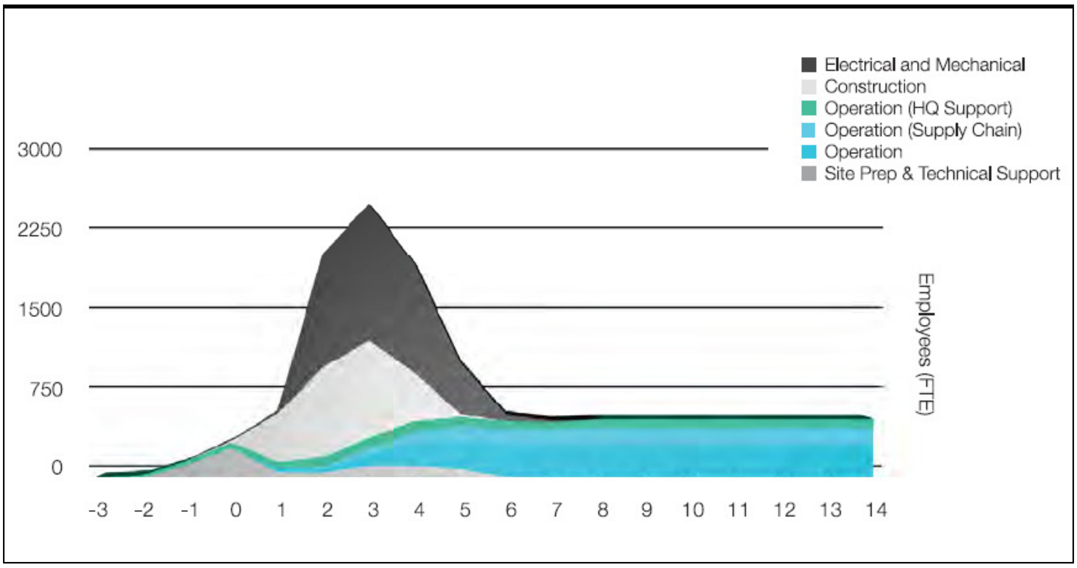
16 GWe (new)	6 Twin-Unit Stations	Station (twin unit)	Construction[a] (twin unit)	Manufacture (twin unit)	Operation (twin unit)
Person years	110,000 - 140,000	21,200	13,000 60%	3,200 15%	5,000[b] 25%
Timeframe of build	13 years	6 years	6 years	6 years	6 years
Employment – pn yrs per GWe	6,000	7,571[c]	4,643[c]	1,143[c]	1,786[c]
Employment - fte p.a.	10,000[d]	3,533[d]	2,167[d]	533[d]	833[d]

Source: Cogent (2010) Next Generation Skills for New Build Nuclear, Renaissance Nuclear Skills Series: 2.
Notes: (a) Here 'Construction' includes site preparation and electrical and mechanical jobs; (b) thereafter 1,000 fte pa for 60 years or 60,000 person years; (c) uses a hypothetical EPR+AP1000 station; (d) 'Person Years' divided by 'Timeframe'; e based on nuclear operator data; f estimated contribution to peak from sector that is highly globalised
Manufacturing covers the provision of civil engineering items, major nuclear items, and the non-nuclear sections of the generating plant (termed the 'balance of plant')
The workforce required to build, operate and maintain each new nuclear power station may vary

[72] NEI (200X) New Nuclear Plants: An Engine for Job Creation, Economic Growth. Available at: http://www.nei.org/resourcesandstats/documentlibrary/newplants/whitepaper/new-nuclear-plants-an-engine-for-job-creation-economic-growth

according to the design of the station or the requirements of individual operators. The above table is based on a common model for all reactor types.

Figure 3:17 Workforce Profile of a Nuclear Reactor



Source: Cogent (2010) Next Generation Skills for New Build Nuclear, Renaissance Nuclear Skills Series: 2.

The permanent jobs at a nuclear plant and its supply chain also create additional jobs in the local area to provide the goods and services necessary to support the nuclear plant workforce (e.g., car dealers, retail shopping, food service, etc.). Moreover, an average nuclear plant generates millions of euros in taxes. These tax payments support schools, roads and other national and local infrastructure.

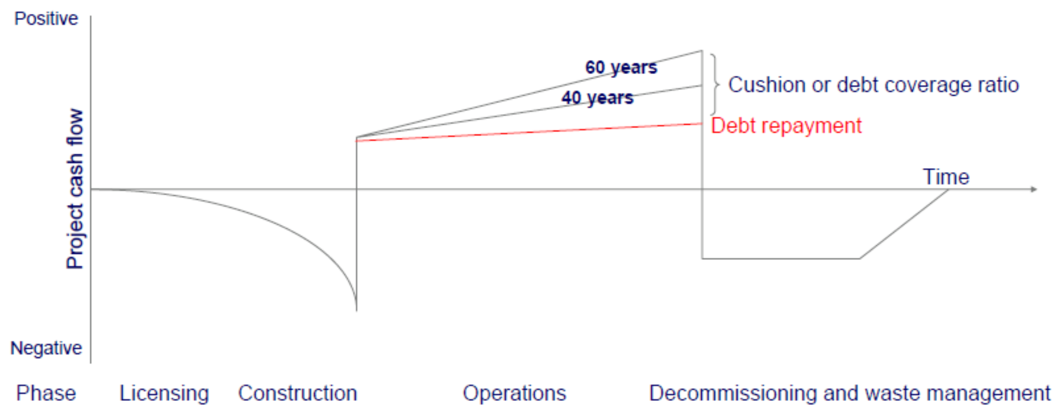
Barriers to investment in new builds

However, despite the economic, environmental and social benefits outlined above, the cost and availability of financing remains a key barrier to investment in new builds. Nuclear thus, represents a classic case of market failure where the market does not incorporate externalities such as environmental, security of supply and social costs and benefits in its investment decisions (leading to under-investment in the sector).

NPPs require huge upfront investment and have a relatively long payback period (Figure 3:18 illustrates the cash flow profile of a typical nuclear plant over its lifetime). A 1,000 MWe new build can cost anywhere between EUR 3 billion to 5 billion[73] (costs are likely to rise as a result of additional safety requirements following the Fukushima crisis) and it can take 20 to 30 years to recoup investments or repay loans for NPP construction.

[73] It is difficult to establish average costs precisely as each reactor is unique or has specific design features. Costs are influenced by factors such as site issues, country location, licensing requirements etc.

Figure 3:18 Illustrative Life Cycle Cash Flow for a Nuclear Power Plant



Source: Pr-conditions for Financing Nuclear Power, A Presentation by Mr Alexander Alting von Geusau, ING Wholesale Banking, November 2006

Moreover, the capital cost of nuclear plants are higher and their construction periods longer than other technologies. Construction cost of nuclear plants is circa 2x those of coal plants and 4x those of Combined Cycle Gas Turbines (CCGTs). Design, construction and operation period of a nuclear power plant is >70 years compared to gas plants of <35 years and coal plants of <50 years[74] (see also Table 3:5).

Table 3:5 Costs and Timeframes for Constructing Power Plants using Alternative Technologies

	Coal	Gas	Wind	Nuclear
Overnight construction costs (USD/KWe)	900 to 2,800	520 to 1,800	1,900 to 3,700	1,600 to 5,900
Overnight construction costs (EUR/KWe)*	643 to 2,000	371 to 1,286	1,357 to 2,643	1,143 to 4,214
Construction time	appx. 4 years	2 to 3 years	1 to 2 years	5 to 7 years**

Based on data from OECD (2010) Projected Costs of Generating Electricity – 2010 edition
**calculated using an exchange rate of 1EUR = 1.4 USD*
***OECD/ NEA (2009) The Financing of Nuclear Power Plants*

[74] Citibank (2009) *op cit.*

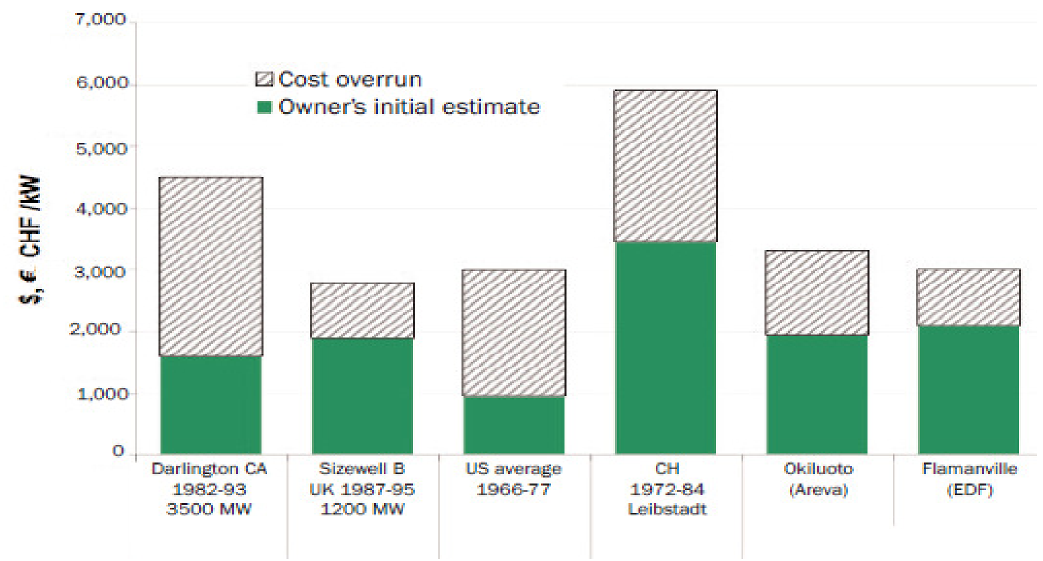
In addition to the overall scale of investment in new builds being high, the risk of investment is also high. Potential investors and lenders are put-off by the following risks (which are amplified by the specific characteristics of nuclear technology i.e. high capital intensity and long lead time in construction):

Political risk – low public acceptability of nuclear energy gives rise to political risk i.e. the risk of change in government policy[75] in response to popular public sentiment. 45 per cent of the EU citizens are 'fairly opposed' or 'totally opposed' to energy production by nuclear power stations[76]. The level of public acceptance varies hugely across EU Member States – ranging from 17 per cent in Austria to 87 per cent in Bulgaria. Low public acceptance stems from concerns regarding proliferation and lack of clear solutions for radioactive waste management and decommissioning (see Annex 10).

Planning/ development risk (also referred to as licensing/ regulatory risk) – the controversial nature of nuclear energy (low public acceptance and lack of political support) often results in extended planning procedures. Moreover, there are uncertainties associated with the timing of the licensing process, the risk of not obtaining a license, unreasonable delay/ failure in renewing operating or other permits and of new regulation being introduced requiring significant changes to design and/ or technology;

Construction risk – the risk of cost over runs and delays. There are many examples of NPPs taking longer than expected to construct with correspondingly large cost over runs (Figure 3:19);

Figure 3:19 Cost overruns in North America and Europe



Source: Pöyry (2010) Nuclear capital costs: fashion or fission? New Power, Issue 21, October 2010. Available at: *http://ilexenergy.com/pages/Documents/Other/NuclearCapitalCostsFashionOrFission.pdf*

[75] Changes in government policy can *inter alia* result in additional regulatory requirements, higher taxation, abandonment of construction or premature closure of operating plant.

[76] Attitudes towards radioactive waste - Fieldwork February – March 2008 - Publication June 2008 - Special Eurobarometer 297.

Market risk – nuclear power stations have high fixed costs and relatively low variable costs; their cash flows and profitability are therefore, particularly sensitive to the price at which they sell their electricity. Market price of electricity is based on a merit order curve i.e. it is set at the highest marginal cost or the most expensive electricity that needs to be called to meet demand. In practical terms, nuclear power plants are price takers; as the market price is usually set by CCGT/ coal. Fossil fuel prices are volatile by nature which in turn makes electricity prices unpredictable which creates a cash flow risk for the operator (uncertain prices imply uncertain revenues). In such a scenario, nuclear plant operators would be able to recoup their variable costs; but, might not be able to recoup fully their fixed costs. The economics of nuclear are therefore, highly sensitive to the price of electricity (and uncertainty related to carbon pricing and demand growth projections i.e. slower than expected economic recovery). A further key risk, especially in liberalised markets, is competition from substitutes. Several interviewees highlighted the following factors as giving rise to uncertainty regarding the size of the long term market for nuclear power: (a) strong political support for energy efficiency/ renewables development, especially wind (and the lack of level playing field for nuclear in terms of policy support); (b) continued growth of CCGT to provide stand-by generating capacity; (c) recent trend towards the decoupling of oil and gas prices; (d) and, recent projections on availability of non-conventional gas (such as shale gas).

Operational risks – the risk of lost output due to reactor non-availability or accidents on site and/ or during transportation of waste.

The above risks affect both the availability and cost of capital for new builds. At present, there are limited options for market financing of new builds (see Box 3:3). Most notably, limited recourse (including project) finance[77] is not available for new builds due to the specific characteristics of nuclear projects (capital intensity of these projects and high perceived risks). For the same reasons, 100 per cent equity or internal financing of new builds is also highly unlikely. Some combination of debt and equity (from public and/or private sources) is generally required to finance new builds. However, the availability of equity financing is constrained by the fact that the scale of investment requires participation of multiple investors[78] (typically via a consortium or joint venture) and there is a limited pool of investors with the resources and the inclination to invest in new builds. Moreover, there are practical challenges to putting in place a consortium of strategic investors (as demonstrated by the experience with Visaginas in Lithuania). In this context, it should be noted that the Mankala model has limited wider replicability due to a lack of critical mass of large industrial users in a number of Member States. Furthermore, there are practical challenges to finding industrial consumers with common interests (such as compatibility of timing of investment cycle) and managing the risks of such a consortium (e.g. the risk of delocalisation, of closure in case of mergers, etc.).

[77] Non-recourse or limited recourse financing, for example, offers no recourse collateral to lenders except the future income and assets of the project itself.

[78] Generally, equity investment would come from the developer/ utility, potential customers, state or other strategic investors.

Box 3:3 Financing Structures of Nuclear Reactors under Construction in the EU

There are presently four reactors under construction in the EU: Olkiluoto-3 in Finland; Flamanville-3 in France; and, Mochovce units 3 and 4 in Slovakia. This box provides an overview of the financing models that have been adopted for these reactors.

The Mankala Model: Olkiluoto-3

The investment cost of Olkiluoto-3 is being financed through buyer's credit (17 per cent of the total financing); bilateral loans (10 per cent); equity (20 per cent); subordinated shareholders loan (5 per cent); and, revolving credit (44 per cent)[79].

Olkiluoto-3 shareholders have formed a Mankala company[80] i.e. several large industrial electricity consumers have jointly invested in Olkiluoto-3 through their TVO joint venture. The shareholding is distributed as follows[81]:

- PVO is the largest shareholder with 60.2 per cent of the Olkiluoto 3 equity;
- Fortum, a partly state-owned utility, owns 25 per cent of Olkiluoto 3 shares;
- 8.1 per cent of Olkiluoto 3 shares are owned by Oy Mankala AB, a fully owned subsidiary of Helsingin Energia (a utility owned by the city of Helsinki); and,
- The remaining Olkiluoto 3 shares are with Etelä-Pohjanmaan Voima Oy EPV (6.6 per cent), a regional energy procurement company owned by 21 local utilities, which are principally municipally owned.

TVO shareholders have injected subordinated debt and equity corresponding to 25 per cent of the financing requirement. External debt financing represents 75 per cent of the investment cost. Majority of debt financing is direct commercial financing of TVO through a quasi-corporate facility (i.e. it is financed on the balance sheet of TVO); TVO also has access to some short term credit facilities. Part of the debt (EUR 610 million) is guaranteed by the French export financing agency.

[79] Financing structure of Olkiluoto-3 as of December 2008. Source: 'Workshop on Economics and Financing of Nuclear Power', A presentation made by Lauri Piekkari, Vice President and Treasurer, Teollisuuden Voima Oyj. IAEA, Vienna, 11 February 2009.

[80] The Mankala concept was developed in 1943 when several Finnish forest products companies pooled resources to develop power supplies for their pulp or paper mills. It is a widely used business model in the Finnish electricity sector, whereby a limited liability company is run like a non-profit-making co-operative for the benefit of its shareholders. Teollisuuden Voima Oyj (TVO) and Pohjolan Voima Oy (PVO) are the best known Mankala companies in Finland. Both are owned by various companies in the Finnish pulp and paper industry and municipalities / municipally owned local utilities.

The Mankala model's main objective is '*to produce electricity for the joint owners at the lowest possible cost. This can be achieved by producing the energy by themselves or by functioning as a procurement company and buying the energy from associated companies*'. The owners gain electricity in proportion to their ownership at the cost price. The owners can either use the electricity to satisfy their own needs or sell it on the market or electricity exchange.

[81] IAEA (2007) Energy Policies of IEA Countries, Finland, 2007 Review. This information has been updated with inputs from Pöyry.

Balance sheet financing by large utility: Flamanville-3, Mochovce units 3 and 4

'On-balance sheet' finance is the only sort of finance available to most companies and consists of borrowing or raising equity against the assets of the company as a whole. EDF, a state owned national utility (the French government owns 84.49 per cent of the company's shares) with an asset base of EUR 240.56 billion[82], is financing most of the investment cost of Flamanville-3 from its current revenues and balance sheet. Enel, the largest Italian electricity utility[83], has a 12.5 per cent stake in Flamanville 3 and will contribute proportionately to the investment costs[84].

Operating cash flow of the developer (Slovenské Elektrárne, member of Enel group) is the key source of financing for Mochovce units 3 and 4; supplemented by a multi-purpose loan facility, secured by corporate cash flow[85].

The following factors contribute to scarcity of debt capital for the development of new builds:

- *Limited number of players in the market*: on the supply side, there are only 124 or so commercial banks active in this sector worldwide[86]. Following Fukushima, it is highly likely that some banks which are presently active in the nuclear sector, might exit from this sector altogether. On the demand side, only well-capitalised utilities have the capacity to raise 'on-balance sheet' financing for new builds. According to experts, five utilities in Europe have the capacity to finance NPPs on their balance sheet, namely: EdF, GdF-Suez, Enel, E.On and RWE.
- *Basel III Framework:* under the proposed Basel III framework[87], long-term lending will require more capital to back it. As a result, commercial banks' capacity to take big tickets in loans will be greatly diminished in future.

Overall, the view of the industry, banks and experts is that it would be crucial to address the risks previously described, in order to unlock private investment in the sector. There is a collective role for both the public and private sector to play in this regard (see Table 3:6). While it is generally accepted that the bulk of the risk lies with the industry, public support is considered necessary for mitigating risks which are beyond the industry's control or are too large.

Discussions with utilities, banks and experts suggest that construction risks are the most significant from an investor's or lender's perspective as the (perceived) residual risk remains high even after mitigating measures have been put in place[88]; thus, affecting the supply and

[82] Consolidated Financial Statements as of 31st December 2010. Available at: http://shareholders-and-investors.edf.com/fichiers/fckeditor/Commun/Finance/Publications/Annee/2011/2010EDFGroupComptesConsolides_va.pdf

[83] Enel has an asset base of EUR 53.77 billion (as of 2010). Source: 2010 Annual Financial Report, pp.68. Available at: http://www.enel.com/it-IT/doc/report2010/110518_Bilancio_Enel_SpA_31122010_en_def.pdf

The Italian government owns 31.2 per cent of the company's shares. Source: http://www.enel.com/en-GB/investor/shareholders/ [Accessed on 1st Jun 2011].

[84] EPR Technology: Fact Sheet. Available at: http://www.sni.enel-edf.com/en-GB/doc/quaderno_epr_en.pdf [accessed 31st May 2011].

[85] *Lessons learned from completion of nuclear power plant EMO 3,4* – A presentation by Juraj Chren, Centrel Business Development Manager - Slovenské Elektrárne. Geneva, November 24, 2010. Available at: http://www.unece.org/energy/se/pp/clep/ahge6/07.2_Chren.pdf

cost of capital. According to them, targeted measures to reduce financing costs or even direct financing (unsubsidised) of construction phase would assist in getting projects 'off the ground'. It was also mentioned that any direct lending during the construction phase could be refinanced through the market when the NPP commences operations (thus reducing loan tenor and risk).

Table 3:6 Key Nuclear Risks and Potential Mitigation Measures

Risk category	Primary risk taker(s)	Potential mitigating measures
Political risk	Owners Government	Clear and sustained government policy support *(Responsibility: Government)* Commitment to solutions for waste management and decommissioning *(Responsibility: Industry and Government)*
Regulatory and licensing risk	Owners Government	Efficient, predictable and effective regulatory systems *(Responsibility: Government)*
Construction risk	Vendors and other contractors Owners	Risk-sharing between parties e.g. turnkey contracts *(Responsibility: Industry)* Improvement in construction times *(Responsibility: Industry)* Establishment of track-record to address FOAK risk *(Responsibility: Industry)*
Market risk	Owners	Suitable carbon pricing/trading arrangements *(Responsibility: Government)* Price certainty and long term off-take contracts e.g. through formation of excelsium consortium[89] of energy intensive users; feed-in tariffs policy[90] *(Responsibility: Industry and Government)*

[86] Nuclear-banks (2010) http://www.banktrack.org/download/nuclear_banks_no_thanks_/100526_nuclear_banks_briefing_gp.pdf

[87] Basel III raises the core capital ratio from 2% currently, to 7% (although there are "buffers" that allow for flexibility in this number). This means that if a bank has EUR 2B of capital, it can currently make a maximum EUR 100B of loans. In future, it must either increase its capital to EUR 7B, or else cut its lending to EUR 28B (because EUR 2B divided by 7%).

[88] Olkiluoto 3 and Flamanville-3 experience with construction delays and cost over-runs, has further reinforced investor's/ lender's concerns regarding construction risk, particularly for FOAK technology.

[89] long term contracts for purchase of electricity at pre-determined prices.

[90] A policy mechanism designed to accelerate investment in low carbon electricity generation. Feed-in tariffs typically include three key provisions: (a) guaranteed grid access; (b) long-term contracts for the electricity produced; and, (c) purchase prices based on the cost of generation.

Operational risk	Owners Vendors and other contractors Insurance companies	Use of proven design and equipment *(Responsibility: Industry)* Use of experienced contractors/ skilled operators *(Responsibility: Industry)* Availability of adequate insurance *(Responsibility: Industry)*

Adapted from OECD/ NEA (2009) The Financing of Nuclear Power Plants

As regards the potential role of the Euratom Loan Facility in addressing the financing gap for new builds, two main conclusions emerged from the detailed discussions held with banks and utilities:

- The financing of new builds can be expected to be particularly challenging in countries/ regions (e.g. Bulgaria, Hungary) with relatively low sovereign ratings; where a limited numbers of plants will be built; where sponsors may have low credit standing; and, where capital markets are relatively less liquid as compared to Western Europe. In these countries, the Euratom lending instrument might have a dual role to play: in filling the financing gap as well as in catalysing investment (through its signalling effect).
- There are some doubts about the longer term profitability of new builds (in absence of strong political support and favourable electricity market conditions such as CO_2 price certainty or a fixed-price off-take contract for the output) even in the more 'mature' markets (such as Western Europe) which have well resourced utilities and relatively liquid capital markets (although Fukushima crisis and Basel III framework are likely to result in reduced availability of capital even in these countries). Here, the Euratom Loan Facility might have an important signalling role to play, particularly when other investors/ lenders are hesitant to get on board. In this context it was suggested that Euratom loans could be granted to sponsors while the plant is in construction, which could later be refinanced by market loans (when the plant starts operation). This would fill a gap in availability of finance for construction of new builds.

3.1.2.3 Investment and Financing Needs: Safety Upgrades

There are 137[91] reactors operating in the EU, of differing 'generation' and plant age. The majority of these plants are 'Generation II' reactors, the original designs of which contain deficiencies against 'modern standards' embodied in the more recent plants (Figure 3:20).

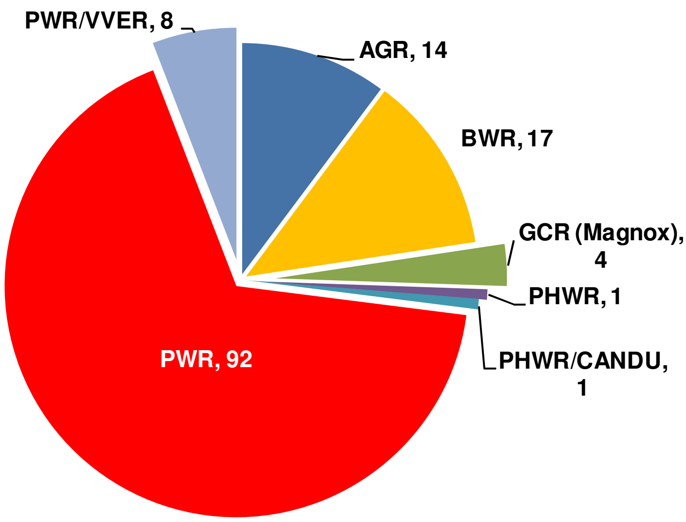
It is standard practice for plants to undergo a periodic safety review (normally decennial), providing operators and regulators the opportunity to increase safety levels to agreed standards and technology developments. Many (Western nuclear power plants) have been subject to plant improvements/ upgrades under continuous improvement (e.g. 'lessons learned') and periodic safety review/ licensing. In France, a major upgrade programme

[91] Based on WNA data. To note that the European Commission press release states that there are 143 reactors in the EU. European Commission Press Release: After Fukushima: EU Stress tests start on 1 June. IP/11/640. Brussels, 25 May 2011. Available at: http://europa.eu/rapid/pressReleasesAction.do?reference=IP/11/640&format=HTML&aged=0&language=EN&guiLanguage=en [Accessed on 1st June 2011]

followed the Blayais flooding event in 1999. Elsewhere, plants have been systematically upgraded (e.g. seismic enhancements) in accordance with risk based cost-benefit decisions.

However, nuclear accident events (e.g. Chernobyl and currently, Fukushima) and industry lessons learned, may change or challenge the agreed baseline for adequate safety, with an attendant requirement for specific, rather than standard periodic reviews and upgrades of nuclear plants. EU nuclear regulators are currently examining the safety of operating plants in relation to the lessons learned from Fukushima, with findings due to be reported by the end of this year[92].

Figure 3:20 Operating Reactors by Type of Technology (EU)



Data sourced from WNA Reactor Database [accessed on 15 April 2011]

Safety upgrades for western nuclear plants have historically been financed directly by the operator, with a business case based on future generation revenues. In some cases, there may not be an economic case for upgrade, resulting in plant closure (e.g. early VVER-230 plants).

If the EU 'stress tests' identify a significant and pressing need for safety upgrades/ improvements, then there might be a case for using the Euratom Loan Facility to support this investment. For example, there might be a need to draw upon the Euratom Loan Facility to finance safety upgrades/ emergency fixes of reactors that cannot be shut-down immediately. Additionally, there might be a need to invest in safety improvements in other segments of the nuclear value chain e.g. fuel production facilities. Typically, safety enhancements are regarded as bankable projects and the utilities would normally be able to finance these without public intervention. However, nuclear projects requiring safety upgrades as a result of the post-Fukushima 'stress tests' could potentially be perceived as 'riskier' projects by the commercial banks, resulting in a higher cost of finance (which might

[92] EU Stress Tests Specifications. Available at: http://ec.europa.eu/energy/nuclear/safety/stress_tests_en.htm

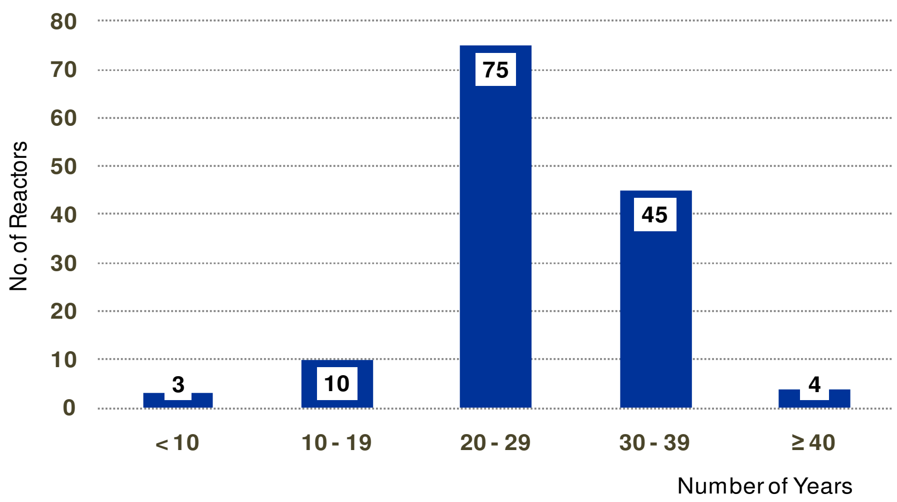
render safety upgrades/ improvements uneconomical). In such cases, Euratom lending could be used to ease the financing constraint for safety upgrades/ improvements which are urgently needed.

The nature of upgrades that will be required as a result of the 'stress tests' is not known at this stage and, could involve substantial costs (e.g. seismic upgrade or civil works such as increased flood protection barriers is expensive and extensive) and/ or more modest costs for local enhancement of systems (e.g. adding seals around doors or to penetrations). The full scale of investment that might be needed, can only be determined upon completion of the 'stress tests'.

3.1.2.4 *Investment and Financing Needs: Lifetime Extensions*

A significant proportion of EU reactors will reach 40 years in the next few years (Figure 3:21) but, it may be economically justified to extend their lifetime. How many of the 49 reactors aged 30 years or above, will undertake life extension is a matter for the plant owners/ operators to decide on the basis of political and commercial factors.

Figure 3:21 Age Distribution of Operating Reactors in the EU



Data sourced from WNA Reactor Database [accessed on 15 April 2011]

The financing needs for life extension will vary from plant to plant, in part determined by earlier investment and operating and maintenance practices. IAEA case studies suggest that a figure of EUR 400 million is not untypical for a major upgrade involving replacement of major components (e.g. Steam Generators). However, Euratom loans are not expected to be used for this purpose as banks are generally willing to lend for lifetime extensions (lifetime extensions are considered bankable because operating plants have an established track record and revenue stream).

3.1.2.5 *Investment and Financing Needs: Nuclear Fuel Production*

Practically all commercial power reactors use uranium oxide fuel (UO_2), which is usually enriched to various levels depending on the reactor technology. Some types of reactor use 'natural uranium'. Nuclear fuel technology continues to advance, in terms of 'burn-up' (the amount of energy used per unit mass) and also via the introduction of recycled uranium and plutonium in certain countries.

The fuel production process begins with the extraction of uranium from mined ore (predominantly outside of Europe), and conversion into a transportable product. This product still contains some impurities and prior to enrichment has to be further refined. Conversion plants exist in the EU and elsewhere around the world – EU plants (in France and UK) represent approximately 30 per cent of global conversion capacity.

Large commercial enrichment plants are in operation in the EU, the USA and Russia with smaller plants located elsewhere[93]. EU plants provide approximately 30 per cent of the worldwide enrichment capacity, with surplus capacity over forecast demand of some 20 per cent in 2015 . Enrichment accounts for almost half of the cost of nuclear fuel production and about 5 per cent of the total cost of electricity generated.

The uranium enriched product requires additional processing to form UO_2 powder, which undergoes several further treatments before processing into a fuel pellet. During this stage. other ingredients may be added (e.g. to prolong the life in the reactor). The finished pellets are loaded into a metal tube (or cladding) thus forming a fuel rod which is sealed at both ends. Multiple rods are arranged in a grid assembly as the final fuel bundle which is inserted into the reactor.

Mixed Oxide (MOX) fuel is used in about 30 reactors in Europe[94] and in 2009, started being used in Japan. The ingredients for MOX fuel are depleted uranium left over from enrichment and plutonium oxide from a reprocessing plant. A MOX fuel plant will blend these products to form a fuel rod similar to the manufacturing process for UO_2 pellets, above. Performance of MOX plants to date has been mixed, with plans to grow existing capacity to accommodate future needs of utilities to optimise use of their fuel stocks. MOX feedstock requires nuclear chemical reprocessing plants which are available in the UK and France, with additional plants planned for the USA and Japan.

Annual demand for nuclear fuel fabrication services are about 7,000 tonnes of enriched uranium, increasing to about 9,700 tonnes by 2015, and around 3,000 tonnes for natural uranium reactors. Requirements for fuel fabrication tends to grow roughly in line with the growth in nuclear generating capacity and additionally, affected by changes in utilities' reactor operating and fuel management strategies. There is little direct coupling between the uranium mining, conversion and enrichment markets and that of fuel fabrication. The market for fuel fabrication has become increasingly competitive and several suppliers now compete to supply different fuel designs across the world. Fuel rod production capacity in the EU is approximately 30 per cent of world capacity, with overall capacity considerably in excess of demand.

Capital costs of a new uranium enrichment facility are in the order of EUR 2 billion to EUR 3 billion[95] (plus a further EUR 1 billion for a fuel fabrication plant). Cost of a MOX cycle is

[93] World Nuclear News, Uranium Enrichment, www.world-nuclear.org/info/inf28.html

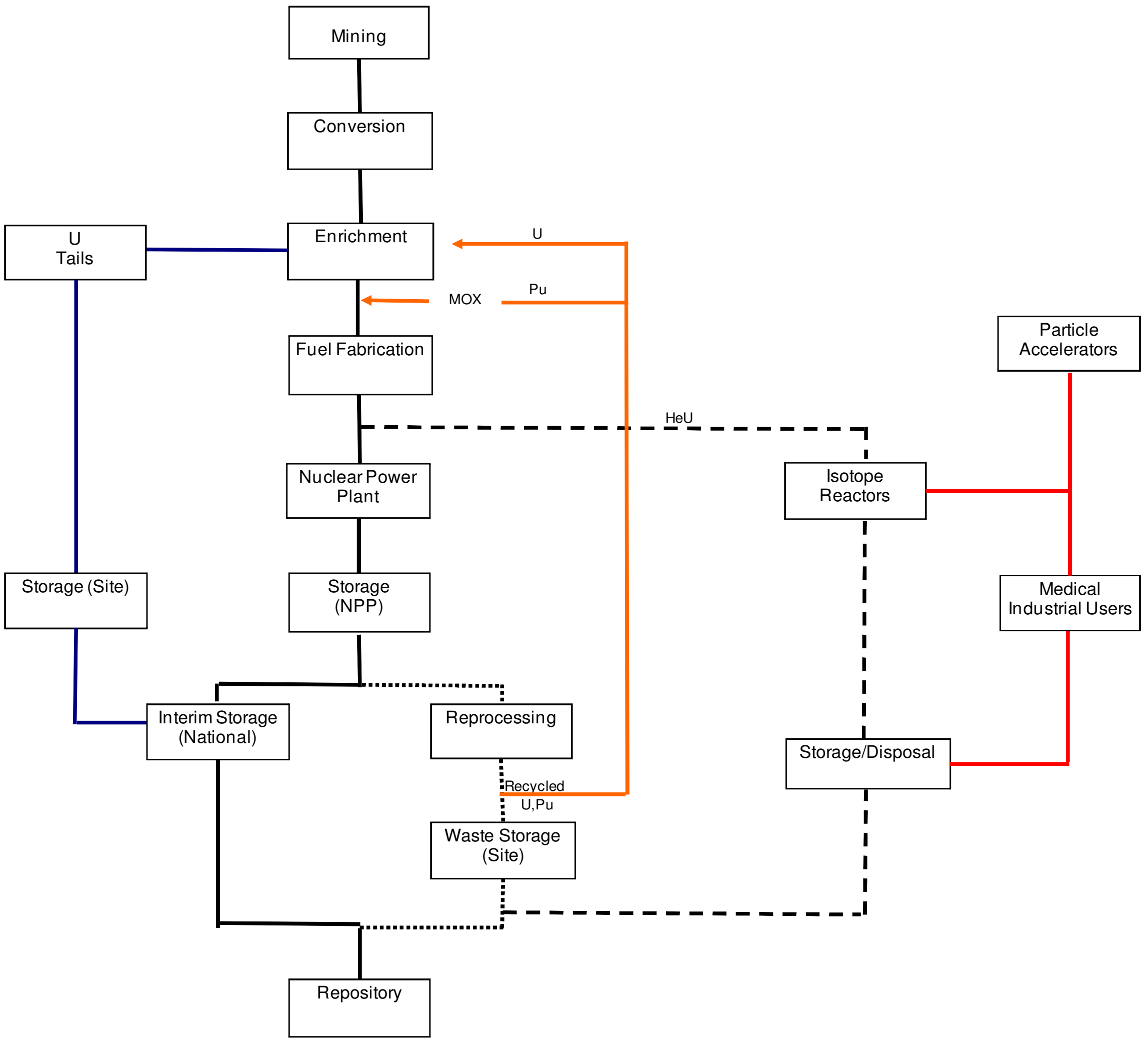
[94] *Ibid*, Mixed Oxide Fuel, www.world-nuclear.org/info/inf29.html

[95] www.world-nuclear.org/info/inf28.html Uranium Enrichment.

reported to be circa EUR 700 million, assuming that the supply of plutonium is already available. Construction of a reprocessing plant could be a further EUR 10 billion[96].

The strength of the nuclear fuel supply market and the nature of long term supply contracts for the constituent processing facilities means that commercial finance for fuel production facilities is available to companies. The study team found no evidence of market failure(s) in the financing of fuel production facilities and therefore, no case for the continued use of Euratom Loan Facility for this purpose. Nuclear fuel production and fabrication is clearly an integral component of the nuclear generation value chain (Figure 3:22), and thus was relevant to the objectives of the market in the 1970s, but does not require support in the future.

Figure 3:22 Nuclear Front-End and Back-End Fuel Cycle



Source: Pöyry

[96] www.cbo.gov/ftpdocs/88xx/doc8808/11-14-NuclearFuel.htm CBO Testimony, Costs of Reprocessing versus Directly Disposing of Spent Nuclear Fuel, November 14, 2007.

3.1.2.6 Investment and Financing Needs: Decommissioning

All power plants have a finite life beyond which it is not economically feasible to operate them. Early nuclear plants were designed for a life of 25 or 30 years, and many reaching this time have had their lives extended. Newer plants are designed for 40 to 60 years operating life. At the end of its life, a power plant needs to be decommissioned, decontaminated and demolished so the site is available for other uses. For nuclear plants, decommissioning includes removal of spent nuclear fuel and stored radioactive waste, clean-up of radioactivity and progressive dismantling of the plant.

National policy will determine the decommissioning approach and timing. Immediate dismantling and early site release reduces the amount of time for 'care and maintenance' and management of radioactive (and any other hazardous) material. Immediate dismantling is also preferable from a purely practical point of view – dismantling requires good knowledge of the plant and by deferring it, there is a risk that this knowledge might be lost. Conversely, delayed dismantling allows radioactive decay (thus reducing the radiation hazard during dismantling). In both cases, fuel can be removed from the reactors reasonably easily and quickly and placed in secure storage, and similarly for stored radioactive wastes produced during operation.

The 'polluter pays' principle applies to de-commissioning and the operator or owner is responsible for bearing the decommissioning costs. The cost of decommissioning varies by reactor type and by size, as well as the sequence and timing of the overall programme (deferment tends to reduce cost of dismantling, but incurs increased storage and surveillance costs). A 2003 OECD survey[97] reported costs by reactor type, generally in the range USD 250 – 500/ kWe for water reactors, and as much as USD 2,600/ kWe for some early UK gas reactors. While the overall cost for decommissioning is significant, it is low in comparison with the lifetime productive output and repayment of capital costs accumulated during construction (and any safety or performance modifications during operation).

Approaches to the financing of decommissioning costs vary from country to country, the most common being:

- *Prepayment* – money is deposited in a separate account before the plant begins operation. Funds are only available for decommissioning purposes and amortise over the operational period;
- *Sinking Fund* – this is built up over a number of years from a tariff on electricity generating costs. Funds amortise over the operating period. This is the most common approach; or,
- *Surety fund, letter of credit, or insurance* – purchased by the utility to guarantee that decommissioning costs will be covered even if the utility defaults.

The estimated funding shortfall will depend on provisions made by governments/ operators for decommissioning liabilities and whether a plant is shut down before the end of its planned lifetime (and the size of accumulated decommissioning funds). The cost of decommissioning a typical LWR is estimated to be EUR 400 million per plant[98]. Costs for

[97] OECD/ NEA 2003, Decommissioning Nuclear Power Plants – policies, strategies and costs.

[98] It should be noted that decommissioning costs remain uncertain due to limited experience and data in this field. In some studies , decommissioning costs are assumed to be15 per cent of the construction costs. For example, OECD (2010) Projected Costs of Generating Electricity – 2010 edition, pp.43.

new Member States (Bulgaria, Lithuania and Slovakia) are higher than this value; although they receive decommissioning grants from the EU (financial assistance from the EU to the three Member States until the end of 2013 is estimated to be EUR 2 847.78 million[99]).

However, it should be noted that the decommissioning phase itself does not generate any revenue or capital return; on the other hand, it entails cash outflows to pay for decommissioning equipment and activities. Decommissioning is therefore, not a bankable activity and as such, it cannot be financed through a conventional loan facility such as the Euratom Loan Facility.

3.1.2.7 Investment and Financing Needs: Waste Storage and Disposal Facilities

All parts of the nuclear fuel cycle produce some radioactive waste (albeit very small in comparison to other toxic and hazardous waste resulting from industrial activities). The cost of managing this material during operation and on-site after shut-down/ closure is normally raised as part of the cost of electricity.

The volumes and nature (especially radioactivity) of wastes produced varies by reactor type, operating and maintenance practices and the length of time in storage. Some wastes are suitable for shallow land burial and are not held on-site for any significant period. Other wastes are conditioned and held in interim storage until such time that a longer term disposal solution is available. Used nuclear fuel is usually stored on-site for a period to allow cooling and radioactive decay before either further storage or transport for reprocessing (to recover unused uranium and plutonium for re-use in nuclear fuel production).

Long term waste management and disposal strategies vary from country to country (see Box 3:4). To date there has been no practical need for final radioactive waste repositories for higher activity wastes, until warranted by the volumes of waste held in store. Some countries are more advanced than others in their research and development of a national repository. Most countries have repositories or at least storage facilities for lower level wastes.

Box 3:4 Long term waste management and disposal strategies of EU Member States

Where spent fuel is not to be reprocessed, the normal management option is an extended period of storage, at least 30 years, followed by deep geological disposal. Currently two Member States, Finland and Sweden are actively pursuing this option. However in a majority of the Member States, a definitive spent fuel policy does not exist, other than arrangements to ensure a safe extended period of storage (50 – 100 years). Whatever the management route chosen, the only disposal option for HLW[100] / spent fuel is deep

[99] European Parliament (2011) Report on the efficiency and effectiveness of EU funding in the area of decommissioning nuclear power plants in the new Member States (2010/2104(INI)). Available at: http://www.europarl.europa.eu/sides/getDoc.do?type=REPORT&reference=A7-2011-0054&language=EN

[100] Radioactive wastes are normally categorised according to the content and quantities of radioactive products. See Commission Recommendation of 15 September 1999 on a classification system for solid radioactive waste, 1999/669/EC, Euratom.

VLLW is very low level radioactive waste that require a lower degree of containment and isolation than that provided by engineered surface and near-surface repositories (see below), and may not even be radioactive under the relevant national legislation, such that material can be released without further restriction.

geological disposal. Although most states are committed in principle to this option, it is likely that by 2025 only three states will have operational deep repositories for HLW / spent fuel; Finland, France and Sweden.

Beyond this group of states only Belgium has an underground laboratory, with notional dates for construction (2025) and operation (2040) of a repository. In the UK, the Nuclear Decommissioning Authority's current planning assumption is that a repository will be ready to accept HLW by 2040. For the remaining Member States target dates for operational repositories are from around 2050 onwards. Generally the work carried out in this latter group of countries has been rather limited, even as regards setting out a procedure for the various steps towards a repository.

Source: SEC(2008) 2416 final/2

The arrangements for financing waste management and disposal vary between countries. Generally speaking, there are three main approaches:

- *Balance Sheet* – sums to cover anticipated costs are included on the plant owner's balance sheet as a liability. The company needs to monitor its provisions to ensure that sufficient funds are available when needed;
- *Internal Fund* – payments are made into a special fund held and administered by the plant owner. While rules may vary, some countries allow the fund to be reinvested in the assets of the owner, subject to adequate securities and investment returns; or,
- *External Fund* – payments are made to a fund that is held outside the company that owns the plant, often by government or a group of trustees. Some countries only allow the fund to be used for its intended purpose while others allow companies to borrow against this fund to reinvest in their business.

Thus, the provision of funding for waste management (including the construction of on-site storage facilities) during operation is quite clear - it is provided by the utility as normal business.

Looking further along the waste management value chain, estimated costs for construction of a repository vary considerably, and could amount to EUR 10+ billion by the time they are built. Until such time, radioactive waste will need to be stored in bespoke interim stores, costing perhaps hundreds of millions of euros each. These costs exclude operating and maintenance costs, and are indicative.

The availability of finance to cover the costs of longer term waste storage and disposal facilities varies by country and is potentially an area of funding shortfall . Some countries might not have accumulated sufficient funds by the time the development of a repository is

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LILW-SL means short-lived low and intermediate level radioactive waste; waste that is contaminated with radionuclides with half-lives of less than 30 years and for which there is negligible heat generation from radioactive decay. Disposal is in engineered or near-surface repositories (in operation today).

LILW-LL or long-lived low and intermediate level radioactive waste, also produces negligible thermal power but has a concentration of long half-life radioactive nuclides above the limit for classification as short-lived waste. Disposal would normally take place in deep geological repositories.

HLW means high-level waste, and refers to waste for which the thermal power must be taken into consideration during storage and disposal. Most HLW results from the direct disposal of Spent Fuel (SF), or from the reprocessing of SF, in the form of vitrified residues.

required. Disposal is normally the responsibility of the national government (or an Agency thereof), with available finance derived from utilities (balance sheet) or dedicated funds.

However, in reality limited investment is expected in this area in the next 20 years (as indicated in Box 3:4). There may be a case to use the Euratom Loan Facility for financing investment in waste repositories for HLW in the longer term. Some consultees suggested that future waste repositories might be operated on a commercial basis, either as a quasi-state enterprise or as a full private sector activity. Precedents exist in various Member States for private operation of existing waste stores (e.g. for LILW-SL Wastes), but for a limited period of time, with ultimate site liability remaining vested with the state. Storage of wastes at these facilities is charged to the producer. Conceivably therefore, construction of a repository for long term storage of LILW-LL and High Level (Spent Fuel) Waste could be commercialised, with cost recovery from operation of the facility over subsequent years (in a manner, and risks, not dissimilar to new nuclear generating capacity). Investor appetite for development of a repository (as opposed to State driven) has not been tested as part of this project, but could be included in future evaluation of the Euratom Loan Facility.

3.1.2.8 Continuing Relevance of the 1994 Decision

Table 3:7 shows that there are a number of VVER reactors in operation (or planned) in neighbouring countries. For the safety and security of EU citizens, it is important that these reactors meet internationally recognised safety standards and principles. The underlying intervention logic for the 1994 Decision therefore, remains valid. There is overwhelming consensus among stakeholders regarding the need to support safety improvements outside the EU. In this context, EBRD officials mentioned that the Bank is unlikely to finance safety upgrades in transition countries without Euratom co-financing.

As regards the anticipated scale of demand emanating from third countries, it should be noted that a loan request from Energoatom (Ukrainian utility) to apply K2R4 type safety upgrades to its entire nuclear fleet is already in the pipeline. There is however, likely to be limited additional demand for Euratom loans from third countries. Armenia and Russia are unlikely to apply for Euratom loans (for political and economic reasons) although this possibility cannot be entirely excluded.

Table 3:7 Remaining VVERs in Neighbouring Countries

Site	VVER Reactor Variant (Successive Generation)				Comments
	440-230	440-213	1000	1200	
Armenia					
Metsamor	1 (S)				
	1				
Russia					
Balakovo			4		
Kalinin			3		
Kola	2	2			
Leningrad				2 (C)	
Novovoronezh		2	1	2 (C)	
Volgodonsk			2	2 (C)	
Turkey					
Akkuyu				4 (P)	
Ukraine*					
Khlmelnitskiy			2	2 (C)	K2 safety upgrade completed
Rivne		2	2		R4 safety upgrade completed
South Ukraine			3		
Zaporizhzhia			6		

Source: Pöyry Analysis; Legend: (S) – Shutdown/ Decommissioning; (C) – Under Construction; (P) – Planned. Note: As previously stated, three of these countries are presently eligible for Euratom Loans namely, Armenia, Russia and Ukraine. Moreover, planned reactors in third countries are not entitled to support from the Euratom Loan Facility.

Conclusions
The key conclusions emerging from the above evidence and analysis are as follows: ▪ The market lacks the capacity and information to accurately appraise and price the risk of investment in new builds. There is therefore a strong argument, based on market failure rationale, for the Euratom Loan Facility to continue supporting investment in new builds within the EU. ▪ There is evidence of a financing gap in the case of large-scale nuclear R&D infrastructure (such as commercial scale demonstration reactors). ▪ Additional, exceptional financing needs might also be expected to arise from safety improvements/ upgrades required as follow-up to the EU 'stress tests'. Although safety improvements/ upgrades within the EU have historically been financed by the owner/ operator, there might be instances in future where the market is reluctant to finance viable safety upgrades due to high perceived risks and reputational concerns. ▪ There is no evidence of a financing gap in the case of life extensions and decommissioning is not considered a bankable activity. As such, the use of Euratom Loan Facility for these purposes cannot be justified. ▪ Financing needs may arise in future for investment in waste storage and disposal solutions. However, given the current uncertainty in this area, this evaluation cannot provide definitive conclusions regarding the use of Euratom Loan Facility for this purpose. This issue could be usefully examined through a future evaluation of the Euratom Loan Facility. ▪ The underlying intervention logic for supporting safety upgrades/ safe decommissioning outside the EU remains valid, although there is likely to be limited demand for Euratom loans from third countries in future.

3.2 EU Added Value

3.2.1 *Q.3 To what extent have the expected benefits from EU intervention been attained?*

The primary driver for creating the Euratom Loan Facility in 1977 was to reduce the EU's dependence on energy imports. Collectively, the nine plants directly financed by the Euratom Loan Facility, generate approximately 114,142 GWh of electricity on an annual basis (which represents circa 6 per cent of the EU's gross electricity generation and 12 per cent of nuclear electricity generation). In absence of this indigenous production of electricity, the EU would be importing an additional 10Mtoe of energy on an annual basis[101]. Moreover, as previously mentioned (section 3.1.1), the main benefit of the Euratom Loan Facility has been its role in accelerating and promoting investment in the nuclear sector. By enabling investment in new builds, the Euratom Loan Facility has contributed to the growth of nuclear in the EU's energy mix. The share of nuclear in Europe's electricity generation has grown from approximately 5 per cent in 1973 (Table 3:8) to 28 per cent in 2008 (according to

[101] GWh output has been converted into Mtoe using IAEA online until convertor: http://www.iea.org/stats/unit.asp

Eurostat data presented in Figure 3:14)[102]; whereas, the share of oil has declined from 25 per cent to 3 per cent over the same period.

Table 3:8 OECD Europe - Electricity Production and Consumption (TWh)

	1973	1980	1990	2000	2005	2007	2008
Gross Production	**1626.1**	**2059.9**	**2652**	**3229.9**	**3523.7**	**3618.2**	**3636.2**
Nuclear	74.4	230.4	782.2	934.6	980.6	925.3	921.8
Hydro	350.1	426.7	463.3	571.2	524.8	533.2	554.2
Geothermal	2.5	2.7	3.6	6.2	7.1	9.5	9.9
Solar	0	0	0	0.1	1.5	3.8	7.5
Tidal, wave, ocean	0.6	0.5	0.6	0.6	0.5	0.5	0.5
Wind	0	0	0.8	22.3	70.9	105.3	120.1
Coal	663.1	887.2	1010.9	953.6	989.5	1012	934.1
Oil	409	363.7	203.2	179	135.2	107.5	103.8
Gas	120.4	137.9	166.6	512	720.4	811.9	868.8
Other combustibles*	6	10.8	20.7	49.1	86.1	106.8	113.1
Other (e.g. Fuel cells)	0	0	0.1	1.2	7.1	2.4	2.4
Total Consumption	**1412.6**	**1799.4**	**2317.3**	**2792.6**	**3077.5**	**3173.6**	**3199.8**
% share of nuclear:							
in production	*5%*	*11%*	*29%*	*29%*	*28%*	*26%*	*25%*
in consumption	*5%*	*13%*	*34%*	*33%*	*32%*	*29%*	*29%*
% share of oil:							
in production	*25%*	*18%*	*8%*	*6%*	*4%*	*3%*	*3%*
in consumption	*29%*	*20%*	*9%*	*6%*	*4%*	*3%*	*3%*

*Source: IEA (2010) Electricity Information, 2010 Edition, Part IV, pp.59; *Combustible renewable and waste*

Additionally, nuclear power plants co-financed by the Euratom Loan Facility are delivering a range of secondary benefits (Table 3:9):

- *Supply of low carbon electricity* – each year, the use of these power plants to generate electricity avoids emissions in the order of 15 to 108 million tonnes of CO_2 (depending on the alternative power generation technology used)[103].
- *Creation of highly skilled jobs in the EU* - Euratom co-financed NPPs currently employ almost 6,000 highly skilled technicians and workers.

Furthermore, due to non-availability of data, it has not been possible to fully quantify the knock-on effects of the Euratom Loan Facility arising from:

[102] According to the IEA data presented in Table 3:8, the share of nuclear in electricity generation is 25 per cent (2008). This data pertains to OECD Europe which includes EU Member States plus Iceland, Norway, Switzerland and Turkey.

[103] The lower end of the range is based on the assumption that the nuclear generation capacity would be replaced by CCGT (for which an emissions factor of 145 kg CO_2/ MWh has been used). The higher end of the range is based on the assumption that the nuclear gene that the nuclear generation capacity would be replaced by coal - Circulating Fluidised Bed Combustion (for which an emissions factor of 960 kg CO_2/ MWh has been used).

- Backward or supply chain linkages – output and job creation in businesses which supply intermediate inputs such as materials, equipment etc.; and,
- Forward linkages – impact on other economic sectors which use the electricity generated by these plants.

Table 3:9 Electricity and Employment Outputs of Euratom Financed NPPs

Member State	NPP	Unit	Current Status	Operation Start Year	Currently Anticipated Year of shutdown	Currently anticipated total years of operation	Original Net Capacity Mwe	Current Net Capacity Mwe	Average Annual Output (GWe.h)	Jobs FTE (a)
Germany	Emsland	Emsland	Operating	1988	2036	48	1,242	1,329	10,445	300
	Muelheim-Karlich	Muelheim-Karlich	Shut down	1986	N/A	N/A	1,219			
United Kingdom	Torness	Torness unit A	Operating	1988	2023	35	645	600	3,733	500
		Torness unit B	Operating	1989	2023	34	645	605	3,839	
Italy	Montalto di Castro	Montalto di Castro-1	Suspended	N/A	N/A	N/A	982			
		Montalto di Castro-2	Suspended	N/A	N/A	N/A	982			
Belgium	Doel	Doel-1	Operating	1975	2025	50	392	433	2,880	940
		Doel-2	Operating	1975	2025	50	392	433	2,892	
		Doel-3	Operating	1982	2022	40	890	1,006	7,214	
		Doel-4	Operating	1985	2025	40	1,000	1,039	7,169	
	Tihange	Tihange-1	Operating	1975	2025	50	870	962	6,650	940
		Tihange-2	Operating	1983	2023	40	902	1,008	7,215	
		Tihange-3	Operating	1985	2025	40	1,020	1,046	7,754	
France	Belleville*	Belleville-1	Operating	1988	2028	40 (60)	1,310	1,310	7,927	800
		Belleville-2	Operating	1989	2029	40 (60)	1,310	1,310	8,169	
	Dampierre**	Dampierre-1	Operating	1980	2020	40 (60)	890	890	5,583	1,500
		Dampierre-2	Operating	1981	2021	40 (60)	890	890	5,430	
		Dampierre-3	Operating	1981	2021	40 (60)	890	890	5,676	
		Dampierre-4	Operating	1981	2021	40 (60)	890	890	5,563	
	Flamanville***	Flamanville-1	Operating	1986	2026	40 (60)	1,330	1,330	7,850	850
		Flamanville-2	Operating	1987	2027	40 (60)	1,330	1,330	8,152	
	Super-Phenix	Super-Phenix	Shut down	1986	N/A	N/A	1,200			
						Totals	**21,221**	**17,301**	**114,142**	**5,830**

Sources: Data transmitted by FORATOM and extracted from PRIS database; (a) Power plant respective websites [accessed 31st May 2011]: *Emsland : http://www.rwe.com/web/cms/contentblob/77498/data/10036/emsland-2-engl-pdf.pdf* *Torness: http://www.british-energy.com/documents/Torness_Spring_2010_LR%5B1%5D.pdf* *Doel: http://www.electrabel.com/whoarewe/nuclear/keyfigures_doel.aspx* *Tihange: http://www.electrabel.com/whoarewe/nuclear/keyfigures_tihange.aspx* *Belleville: http://energie.edf.com/nucleaire/carte-des-centrales-nucleaires/centrale-nucleaire-de-belleville/presentation-45853.html* *Dampierre: http://energie.edf.com/nucleaire/carte-des-centrales-nucleaires/centrale-nucleaire-de-dampierre/presentation-45887.html* *Flamanville: http://energie.edf.com/nucleaire/carte-des-centrales-nucleaires/centrale-nucleaire-de-flamanville/presentation-45740.html*
** 680 EDF staff, 800 including service providers*
***1200 EDF staff, 1500 including service providers*
****650 EDF staff, 850 including service providers*

As far as the 1994 Decision is concerned, the following benefits are noted:

- Improvements in safety and security culture in recipient countries (Bulgaria, Romania and Ukraine);
- Creation of commercial opportunities for EU firms - the guidelines to the 1994 Decision stipulated the condition of close cooperation with at least one Community enterprise in the implementation of the project;
- Establishment of de-commissioning funds – the setting up of de-commissioning funds were conditions precedent in the loans extended to Romania and Ukraine. Prior to the Euratom loan, no decommissioning funds were in place in these countries; and,
- Reform of electricity sector in the borrowing country – where applicable, loans included conditions precedent relating to the reform of the domestic electricity sector.

Case studies in Annexes 6 and 7 provide further detail.

Conclusions
A majority of the plants co-financed by Euratom loans are still in operation, generating 114,142 GWh of low carbon electricity annually. In the absence of these plants, the EU would be importing an additional 10Mtoe of energy on an annual basis. The Euratom Loan Facility has thus, delivered its main intended benefit i.e. reduced dependence on energy imports. Secondary benefits of the Facility include the creation of 6,000 highly skilled at the plants under operation. The non-quantifiable benefits of these plants include job and output creation in the wider economy through backward and forward linkages. Outside the EU, the Euratom Loan Facility has contributed directly to safety enhancements and promoted greater transparency of nuclear operations in Bulgaria, Romania and Ukraine. Safety improvements financed by Euratom loans have brought nuclear installations in these countries in line with internationally recognised nuclear safety standards.

3.2.2 Q.4 What is EU added value of the Facility?

The Euratom Loan Facility (1977 Decision) exists to finance nuclear power production in EU Member States. The Facility was created out of a treaty promoting the development of nuclear energy. This clarity of purpose – promoting nuclear production – is distinctive. There is general consensus among all groups of stakeholders that the non-financial added value of the Facility arises in two ways:

- **Signalling effect.** Euratom lending to a project has been seen as an endorsement of the project, providing a positive message to banks, suppliers and other providers of finance, Governments and the public about the project's economic and technological viability.

- **Catalytic effect.** Euratom lending has provided leadership within the financial community, encouraging other banks to participate in financing projects, and often perceived as being the first to understand and accept certain project risks.

While the EIB has usually been involved whenever Euratom has provided finance, it is the role of Euratom as the entity with a clear mission to promote nuclear power that is seen by stakeholders as the most important and influential.

The Euratom Loan Facility also has a financial added value from the perspective of the borrowers. The cost of Euratom Loans is relatively low as compared to commercial loans. This is because the European Commission with its 'AAA/ Aaa' credit rating can borrow from the financial markets on favourable terms; and when it on-lends, it operates on a non-profit basis charging only its cost of funding and expenses incurred in connection with the preparation, negotiation, entry into, execution and implementation, monitoring or advertising of the Loan. The financial added value of Euratom lending can be significant considering that: (a) not all Member States or utilities have a 'AAA/ Aaa' rating; and, (b) the high perceived risk of nuclear projects among commercial banks and other private lenders (resulting in a high risk premium).

Outside the EU, Euratom loans (1994 Decision) and EBRD lending has been instrumental in:

- The creation and funding of de-commissioning funds in Romania, Bulgaria and Ukraine;
- Wider reform of the electricity sector in Ukraine;
- Increase in the scale of nuclear insurance.

A detailed examination of loans to Romania and Ukraine was carried out as part of the evaluation and reported as case studies in Annex 6 and 7. The main findings of the evaluation as regards the added value of these loans are elaborated below:

Romania

The Loan Agreement included the following undertakings:

18.1 Regulated Tariff: The Borrower shall monitor and report to the Lender the planned evolution of the Regulated Tariff.

The reform and evolution of the electricity sector of Romania was partly influenced by the accession negotiations and commitments with the European Commission on the Energy Chapter (2002 – 2004). Evolution and plans for liberalisation are continuing.

Inclusion of this undertaking in the Loan Agreement reinforced the importance attached to the progress and completion of the electricity market reform, and encouragement of competition.

18.2 Fuel Storage: The Borrower shall take all necessary measures to ensure that the fuel (including spent fuel) is stored safely, whether on Site or elsewhere.

At the time of negotiating the loan for upgrading unit 2, provision for spent fuel management was limited to on-site wet storage for approximately ten years. There was an approaching need for additional fuel storage capacity until such time that long term radioactive waste management facility is available.

The loan condition provided a lever for the design and implementation of interim nuclear fuel storage facilities for continued operation of the reactors. Interim (dry) storage[104] is now operational, using a modular format, enabling additional capacity to be added as the need arises.

18.3 Decommissioning Fund: The Borrower shall contribute to the Decommissioning Fund (i) in accordance with Applicable Laws, and (ii) in compliance with the European Community law as and when applicable.

Since 1996, legislation regarding the safe decommissioning of nuclear facilities in Romania had requested the creation of a fund for decommissioning and radioactive waste management, with obligations for each radioactive waste producer to contribute to the fund. The first reactor at Cernavoda commenced operation in 1997, but no financial contributions had been set aside (attributed to non-payment of electricity bills by numerous large, state-owned industrial enterprises which significantly reduced the revenue streams of electricity producers). The decision to complete unit 2 provided an opportunity, via loan conditions, to ensure that liabilities of the new nuclear power plant were addressed from the outset; the creation of additional unit(s) also has a beneficial effect on the contribution required from the first unit, providing confidence that suitable funds will be available when the reactors eventually shut down.

The loan condition provided a means to ensure that unfinanced liabilities did not escalate and, by aiding completion of the second unit, changed the financing burden for unit 1. Decommissioning funding schemes and regulations are now enacted such that future obligations for nuclear decommissioning and radioactive waste management of Cernavoda operations will be satisfied.

In addition, under Schedule 6, the following aims are identified:

- Implement safety recommendations in the Nuclear Safety Evaluation Report;
- Implement environmental recommendations in the Environmental Progress Report:
  - Seismic design;
  - Revised Safety Analysis;
  - Cooling Water Intake Studies (entrainment, thermal effects);
  - Sewage Treatment;
  - Emergency Control Centre;
  - Spent Nuclear Fuel Storage;

[104] www-ns.iaea.org/downloads/rw/conventions/fourth-review-cycle/tm-paris/session%202/Romania-sorescu.pdf, Romania's Waste Management Overview.

– Permits and Authorisations;

– Environmental and Emergency Plans.

The completion of these modifications and upgrades reduced the safety and environmental threat, to the on-site workforce and general public in Romania and in a trans-boundary context, posed by the nuclear power plant. It is outside the scope of this study to report upon the absolute change in calculated risk resulting from the modifications made using Euratom/ EIB funding.

Ukraine

The Loan Agreement included the following undertakings:

18.22 Borrower's Electricity Tariff: The Borrower shall:

18.22.1 strictly adhere to the Tariff Methodology and diligently seek adjustments to the Tariffs from the NERC through the Tariff Methodology, so as to ensure that Tariffs are at a level so as to ensure revenue for the Borrower adequate to permit all operating costs, capital expenditures and costs associated with nuclear safety to be fully recovered from the Tariff, including, without limitation, the following costs: (i) expenditures for ordinary operating costs, including maintenance; (ii) financing costs; (iii) expenditures for safety upgrades, reconstruction, modernisation and lifetime management costs, including the full implementation of the Upgrade Package for existing units; (iv) contributions to the Decommissioning Fund; (v) costs associated with radioactive waste management and spent fuel treatment; (vi) expenditures for nuclear insurance contributions; and (vii) capital expenditures related to all NPP units;

18.22.2 not seek or implement any changes to the Tariff Methodology, without the consent of the Lender;

18.22.3 (a) promptly upon its becoming aware that an adjustment to the Tariff is required to ensure compliance with Clause 18.22.1, provide the Lender with notice of its intention to seek a Tariff adjustment, (b) provide the Lender with a copy of any proposal submitted to the NERC requesting a Tariff adjustment and (c) promptly notify the Lender of any change to the Tariff which is approved by the NERC, including description of the changes to each component of the Tariff and an explanation of any such changes;

18.22.4 charge a Tariff at the rate agreed with the NERC and diligently pursue the collection of all amounts owed to it pursuant thereto; and

18.22.5 diligently implement and adhere to the Ministry of Fuel and Energy Letter, including, without limitation, increasing its civil liability insurance for nuclear damage from SDR50 million to SDR150 million by 31 December 2004.

As common with many Central and Eastern Europe countries formerly of the Soviet Union, electricity prices were set by the state at a level that did not reflect true operating costs or provision for future liabilities. In providing a loan to a non-member country, the European Commission (and the EBRD) would not wish to subsidise other markets at the expense of the European industry, at the same time wishing to realise benefits (to populations in the Ukraine and neighbouring Member States) of safety and efficiency improvements.

The conditions attaching to the loan provided a means to accelerate market reform in Ukraine to align with European policies for competition in the energy market. The sub-clauses are self-evident in protecting the objectives of the market reform and implementation of an agreed tariff methodology.

Sub-clause 18.22.5, encouraged Ukraine to develop suitable levels of insurance to comply with international conventions, which required reinsurance with Western European nuclear insurance pools to achieve the necessary level. This process was ongoing when the Loan was being negotiated and was an important condition of future nuclear safety risk/ liability management. Including this in the loan ensured that suitable provision was concluded within a short timeframe.

18.23 Electricity Sale: The Borrower shall not enter into any agreement for the sale of electricity outside the wholesale electricity market unless (i) such agreement is on commercial terms no less favourable than those in place in connection with the sale of electricity to the wholesale electricity market, and (ii) the Borrower shall, prior to entering into such agreement, have submitted to the Lender a summary of the principal commercial terms thereof.

This condition maintained the objective in Clause 18.23 to maintain a suitable tariff for electricity produced by the nuclear power plants to be sufficient to provide for operational needs and liabilities.

18.25 Decommissioning Fund and Overall Radioactive Waste and Spent Fuel Plan: The Borrower shall from the Availability Date, establish and maintain a Decommissioning Fund in accordance with the provisions of Annex 3 and shall make monthly payments into such Decommissioning Fund in an amount as it is agreed with the LMC will enable the Borrower to implement the Overall Radioactive Waste and Spent Fuel Plan.

Existing Ukraine legislation did not require accumulation of funds for decommissioning of nuclear power plants, and thus there was no guarantee that future nuclear and radiological liabilities would be effectively managed (and financed). As part of the negotiations for, and conditions of the loan, a draft law (now enacted) was prepared to provide legal settlement of financial and economic obligations that arise in relation to cessation of operation and commencement of decommissioning, and ensure efficient accumulation and utilisation of money from the Decommissioning Fund.

The loan conditions were an important driver to the early creation of the formal requirement for the Decommissioning Fund, and importantly, visibility of initial operation during the tenure of the loan.

In addition the Loan Agreement documentation identifies the following aims

The post start-up modernisation measures comprises the Works currently being considered, and entails approximately 70 measures at each plant that address nuclear safety deficiencies, both generic to the VVR1000 reactors and specific to K2 and R4 individually. The post start-up modernisation measures are planned to be implemented over the first three annual unit shutdowns. The first refuelling shutdown is planned for summer 2005.

The letter from the Ministry of Fuel and Energy details the following objectives:

- Elimination of design drawbacks of the power unit(s);

- Detailed safety analysis of the operating units with utilization of modern methodologies and approaches, based on existing international practice (the results of the detailed safety analyses provide the basis for determination of the priority safety measures);
- Improvement of operational standards:
- Measures targeted at accident prevention (operational experience and feedback, personnel training, development of manuals for operation and maintenance);
- Measures with respect to accident management and mitigation of their consequences;
- Improvement of safety culture;
- Implementation of the quality assurance system;
- Improvement of radiation protections standards for the personnel and population;
- Improvement of fire safety; and,
- Operational reliability improvement of equipment, lifecycle replacement of equipment.

The completion of these modifications and upgrades reduced the safety and environmental threat, to the on-site workforce and general public in Ukraine and in a trans-boundary context, posed by the nuclear power plant. It is outside the scope of this study to report upon the absolute change in calculated risk resulting from the modifications made using Euratom/ EBRD funding. The timescale for the works (3 years for the majority of the upgrades) meant that the upgrades were probably implemented as soon as was reasonably practicable, while minimising disruption to electricity supply in Ukraine.

Conclusions
The Euratom Loan Facility provides loans on attractive terms to borrowers. The European Commission operates on a non-profit basis and passes on the benefits of its 'AAA' rating to borrowers. The difference between the cost of capital raised on the market and the cost of the Euratom loan represents the financial added value of the Facility. The added value of the Euratom Loan Facility is more than purely financial. Within the EU, the non-financial added value of the Euratom Loan Facility arises from its signalling and catalytic effect. Outside the EU, the Euratom Loan Facility has financed safety improvements and contributed to the creation and funding of de-commissioning funds; achievement of wider reform of the electricity sector in Ukraine; and increase in the scale of nuclear insurance.

3.2.3 Q.5 Some of the loan agreements included additional conditions. Would the results achieved with these imposed conditions have been equally attained in time and in quality had the Euratom loans including these covenants not been granted?

The following additional conditions were identified for loans granted to Bulgaria, Romania and Ukraine[105]:

Bulgaria:

The loan required the complete and definitive closure - at a date specified in the Loan Agreement - of units 1 to 4 of the Kozloduy NPP.

Romania:

In agreeing to the Euratom loan, in addition to commercial terms and conditions for security and repayment, the Loan Agreement also stipulated additional conditions to ensure the safety of all nuclear units in Romania:

- Regulation of the electricity tariff for electricity produced by the plant;
- Contributions to a Fund to cover decommissioning of the plant; and,
- Provisions for safe storage of spent nuclear fuel and other operational radioactive waste.

Ukraine:

As a condition of the Euratom/ EBRD loans, additional conditions were stipulated to ensure the safety of all nuclear units in Ukraine. These conditions were targeted at raising sufficient funds (based on an agreed tariff-setting methodology promoting the smooth functioning of Ukraine's wholesale electricity market) to provide:

- Recovery of nuclear safety costs of modernisation of K2R4 and safety upgrades of the other operational nuclear power units in Ukraine, using K2 and R4 as the benchmark;
- Safe storage of nuclear fuel and radioactive wastes associated with nuclear generation;
- An internationally agreed nuclear liability and insurance regime;
- A decommissioning fund and overall radioactive waste and spent fuel plan; and,
- Independence of the State Nuclear Regulatory Committee of Ukraine (SNRCU), with adequate funding and resources to enable regulation in accord with international nuclear regulatory principles and practice

The evaluation team is of the view that these changes would have taken place eventually, due to international peer group pressure; and, conditions for accession to the EU and compliance with EU legislation (in the case of Romania and Bulgaria). However, it would be

[105] It has been clarified by the Steering Group that this question relates to loans approved under the 1994 Decision only.

reasonable to assume that the attachment of these conditions to the loans, accelerated development of the outcomes with corresponding enhancement of nuclear safety in these States in the short term (for safe operation of the plants) and in the long term (finance for decommissioning and management of spent fuel and radioactive waste).

Conclusions:
The loans to nuclear installations in Bulgaria, Romania and Ukraine contained special conditions relating to wider reform of these countries' nuclear and/ or electricity sector. These reforms would have taken place regardless of the conditions attached to Euratom loans, albeit over a longer timeframe.

3.3 Coherence

3.3.1 *Q.6 To what extent has the division of tasks between the European Commission (DG ECFIN and other DG's), EIB and EBRD contributed to achieving the intended impact of the Facility?*

The Euratom Loan Facility is managed and implemented by the European Commission. As the Euratom loans are normally co-financed by the EIB (within the EU) and the EBRD (loans to third countries), the European Commission conducts joint appraisals with these institutions. The three organisations use the same information and coordinate the due diligence process; however, each organisation makes a decision in accordance with its own decision making procedures. Nonetheless, loan conditions and decisions are closely coordinated so that the three organisations don't arrive at different conclusions. Within the European Commission, relevant DGs (such as DG ENER and DEVCO) are consulted as part of the inter-services consultation process.

Figure 3:23 overleaf depicts the loan appraisal and management process. For the 1977 Decision, the following process was followed:

- Loans were granted using normal banking criteria. The economic and financial appraisal of the loans was carried out by the EIB for a fee. The EIB due diligence also covered certain technical aspects of the project that were pertinent to the financial/ economic appraisal.

- No additional technical appraisal was required as the loans were granted on the condition that the project had obtained all necessary regulatory and safety approvals from relevant Member State authorities. Moreover, the investment projects requesting a loan must have previously communicated this investment under the terms of Article 41 of the Euratom Treaty and received a positive view from the European Commission.

- The European Commission also took account of publicly available information relating the project in making its investment decision.

A slightly different process was followed for the 1994 Decision. In addition to the approval of the national regulators and safety authorities, the European Commission took into account the technical inputs (including an assessment of the environmental aspects of the project) provided by the TACIS group of national experts[106] and an external technical support organisation (TSO). Additionally, in accordance with the Guidelines for the 1994 Decision

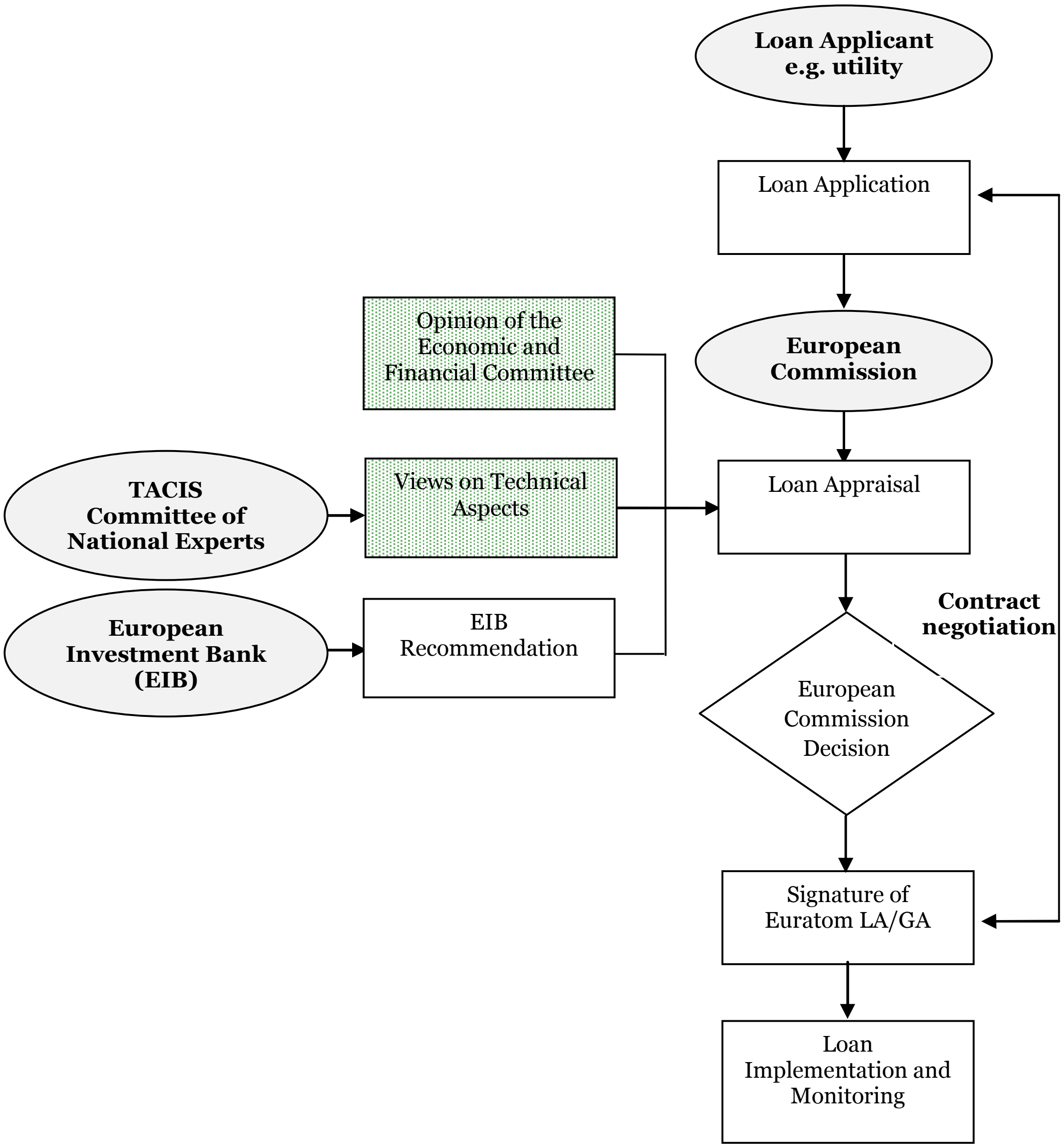
[106] Now succeeded by the INSC Committee.

(point 3.2 on page 10), the European Commission also took into account the opinion of the Economic and Financial Committee on the balance of payments and external debt situation of the borrowing country. As with the 1977 Decision, the economic and financial appraisal was conducted out by the EIB on behalf of the European Commission for a fee.

The evaluation found no evidence to suggest that the division of tasks between the European Commission, EIB and EBRD has impeded the successful delivery of the Facility. The Facility has operated successfully. There have been no bad debts or safety issues. The money that was lent within the EU has been repaid along with the costs and expenses incurred by the European Commission in managing the Facility[107].

[107] It should be noted that loans disbursed under the 1994 Decision have not been fully amortised as yet.

Figure 3:23 The Euratom Loan Appraisal Process



NB: Steps highlighted in green only apply to loans granted under 1994 Decision

Conclusions
There is effective division of tasks between the European Commission (DG ECFIN and other DG's), the EIB and the EBRD.

3.3.2 Q.7 Is the Facility coherent with other relevant EU policies and programmes? Are there any overlaps or contradictions?

The following sub-sections provide a brief overview of relevant EU policies and programmes.

3.3.2.1 Overarching Policy Framework

Europe 2020 Strategy

The Europe 2020 strategy, launched in 2010, is the successor to the Lisbon Agenda. It provides an overarching strategic framework for EU action over the period 2011 to 2020. The overall aim of the strategy is to turn the EU into a 'smart, sustainable and inclusive' economy delivering high levels of employment, productivity and social cohesion[108]. The success of Europe 2020 will be benchmarked against a range of headline targets:

- Meeting the 20-20-20 climate/energy target (including an increase to 30 per cent of emissions reduction if the conditions are right);
- Raising the employment rate to 75 per cent of the working age population i.e. aged 20-64 years (presently this figure is around 69 per cent on average);
- Investing 3 per cent of the EU's GDP in R&D;
- Improving education levels by reducing school drop-out rates to less than 10 per cent and by increasing the share of 30-34 years old having completed tertiary or equivalent education to at least 40 per cent; and,
- Promoting social inclusion by aiming to lift at least 20 million people out of the risk of poverty and exclusion.

3.3.2.2 EU's Energy Policy Framework

Energy Policy for Europe (2007)

In January 2007, the Commission published its first Strategic Energy Review (SER) [109] along with a number of supporting documents underpinning some of the proposals in the SER. The first SER identified the following priorities for action:

- Increasing EU-wide energy security;
- Enhancing sustainability; and,
- Fostering competition in EU's internal energy market.

The main proposals in the first SER included objectives to reduce greenhouse gas emissions within the EU and internationally; targets for renewable energy and biofuels; ways to improve the functioning of the internal electricity and gas market; the need to strengthen the EU's Emissions Trading Scheme; priorities for action to improve energy efficiency based on the EU's Energy Efficiency Action Plan of October 2006; a commitment to increase by 50

[108] European Council Conclusions, 17 June 2010, Brussels. Available at: http://ec.europa.eu/eu2020/pdf/115346.pdf

[109] COM(2007) 1 final

per cent EU spending on energy-related research; and plans to encourage construction of 12 demonstration plants for carbon capture and storage.

With respect to nuclear energy, the first SER noted the right of individual Member States to determine their energy mix; but stressed that nuclear power production must be considered as an option to reduce CO2 emissions:

'It is for each Member State to decide whether or not to rely on nuclear electricity. However, in the event that the level of nuclear energy reduces in the EU, it is essential that this reduction is phased in with the introduction of other supplementary low-carbon energy sources for electricity production; otherwise the objective of cutting GHG emissions and improving security of energy supply will not be met.'

The SER also highlighted the economic benefits of nuclear energy in terms of its price competitiveness (vis a vis other low carbon alternatives) and potential market opportunities for European firms arising from projected increases in nuclear power capacity worldwide:

'...nuclear energy is one of the cheapest sources of low carbon energy that is presently produced in the EU and also has relatively stable costs.'

'In the current energy context, the IEA expects the world-wide use of nuclear power to increase from 368 GW in 2005 to 416 GW in 2030. There are therefore economic benefits in maintaining and developing the technological lead of the EU in this field.'

Finally, it underscored the need to include nuclear waste management and decommissioning issues in future Community work in this area.

In March 2007, the European Council endorsed the first SER along with a political commitment to achieving at least a 20 per cent reduction of greenhouse gases by 2020 compared to 1990.

Integrated Package for Energy and Climate Change (2008)

In January 2008, the European Commission proposed an integrated package for energy and climate change. This 'climate and energy package'[110] was agreed by the European Parliament and Council in December 2008 and became law in June 2009. The Package contains the following mandatory targets, collectively referred to as the 20-20-20 and 10 per cent targets:

- Greenhouse gas (GHG) emissions to be cut by at least 20 per cent from 1990 levels;
- Energy consumption to be reduced by 20 per cent of projected 2020 levels by improving energy efficiency;
- Renewable energy sources to be increased to comprise of 20 per cent of the EU's final energy consumption; and,
- Biofuels usage to be increased by ensuring it represents at least 10 per cent of overall EU transport petrol and diesel consumption.

[110] COM(2008) 30 final

The integrated package reiterates the right of individual Member States to determine their energy mix and to decide whether or not to rely on nuclear energy.

EU Energy Security and Solidarity Action Plan (2008)

In November 2008, the Commission tabled its second SER which focused on energy security and proposed an 'EU Energy Security and Solidarity Action Plan'[111]. The Action Plan identified five priority areas:

- Infrastructure needs and the diversification of energy supplies;
- External energy relations;
- Oil and gas stocks and crisis response mechanisms;
- Energy efficiency; and,
- Making the best use of the EU's indigenous energy resources.

In a document accompanying the second SER, "Update of the Nuclear Illustrative Programme", the Commission indicated that over the next 10-20 years the majority of nuclear power plants in the EU would reach the end of their originally designed lifetimes. By 2020 the share of nuclear energy in power generation would decrease significantly if no decisions were made about new investments. It highlighted that decisions about lifetime extension, new investments or replacement needed to be made urgently in light of the EU CO2 reduction objective.

The proposals made by the Commission in its Second SER were endorsed by the Energy Council in January and February 2009, the European Parliament and the Spring European Council.

Energy 2020: A strategy for competitive, sustainable and secure energy (2010)

Launched in November 2010, 'Energy 2020'[112] defines the EU's energy priorities for the next ten years and sets out the actions to be taken in order to achieve 20 per cent energy savings by 2020; to achieve a pan-European integrated; to deliver secure, safe and affordable energy to EU consumers and businesses; to successfully bring new high performance, low-carbon technologies to the European markets; and, to build strong international partnerships in pursuit of common goals.

The strategy acknowledges the contribution of nuclear energy and highlights the actions that need to be taken in order to ensure safe nuclear generation in Europe and worldwide:

'The contribution of nuclear energy, which currently generates around one third of EU electricity and two thirds of its carbon-free electricity, must be assessed openly and objectively. The full provisions of the Euratom Treaty must be applied rigorously, in particular in terms of safety. Given the renewed interest in this form of generation in Europe and worldwide, research must be pursued on radioactive waste management technologies and their safe implementation, as well as preparing the longer term future through

[111] COM(2008) 781 final

[112] COM(2010) 639 final

development of next generation fission systems, for increased sustainability and cogeneration of heat and electricity, and nuclear fusion (ITER)' - COM(2010) 639 final

The strategy specifies the following actions with respect to nuclear energy:

- Enhancement of the legal framework for nuclear safety and security through the mid-term review of the Nuclear Safety Directive, the implementation of the Nuclear Waste Directive, the redefinition of the basic safety standards for the protection of workers and the population and a proposal for a European approach on nuclear liability regimes. The Communication also calls for action to promote greater harmonisation of plant design and certification at the international level (Action #2 under Priority 3);

- Implementing the SET Plan (see Box 3:5) without delay, including the European Industrial Initiative on nuclear fission (Action #1 under Priority 4); and,

- Promoting legally binding nuclear-safety, security and non-proliferation standards worldwide (Action # 4 under Priority 5).

The Council conclusions[113] on 'Energy 2020' further highlight the importance of developing the infrastructure needed to support indigenous production of energy, including nuclear energy.

Box 3:5 The Strategic Energy Technology Plan (SET-Plan)

In 2008, the European Council endorsed[114], following a proposal by the Commission[115], the European Strategic Energy Technology Plan (SET-Plan) as a strategy to accelerate the development and large scale deployment of low carbon technologies that draws upon the current R&D activities and achievements in Europe. The plan was presented alongside two studies providing an overview of energy research capacities in EU member states.

The SET-Plan objectives for nuclear energy are the following:

- Maintain the safety and competitiveness of today's technologies (facilities and reactors); and,

- Develop a new generation of more sustainable reactor technologies (GEN-IV fast neutron reactors with closed fuel cycles).

In order to foster the development of key energy technologies at European level, the SET-Plan established large scale programmes such as the European Industrial Initiatives (EIIs) that bring together industry, the research community, the Member States and the Commission in risk sharing and public-private partnerships. Six priority technologies were identified as the focal points of the first EIIs: wind, solar, electricity grids, bioenergy, carbon capture and storage and sustainable nuclear fission.

The nuclear EII (called 'European Sustainable Nuclear Industrial Initiative' or ESNII)

[113] See also Council conclusions on Energy 2020: A Strategy for competitive, sustainable and secure energy, dated 28th February 2011. Available at: http://www.consilium.europa.eu/uedocs/cms_data/docs/pressdata/en/trans/119518.pdf

[114] http://www.eu2008.si/en/News_and_Documents/Council_Conclusions/February/0228_TTE1.pdf

[115] COM(2007) 723, SEC(2007) 1510, SEC(2007) 1511

focuses on the development of technologies for Fast Neutron Reactor (FNR) systems with closed fuel cycle (Generation-IV nuclear reactors), with demonstration phases relying on the construction (by 2020) and operation of technology prototypes in Europe (2020- 2040) together with maintaining competitiveness in fission technology and provide long-term waste management solutions.

In October 2009, the Commission presented concrete proposals to implement the Strategic Energy Technology Plan (SET – Plan)[116]. Working together with stakeholders, the Commission has drawn up Technology Roadmaps 2010-2020 for the implementation of the SET-Plan.

A Roadmap for moving to a competitive low carbon economy in 2050 (2011)

In March 2011, the Commission adopted the roadmap[117] for moving to a competitive low carbon economy which sets out the key elements for shaping EU's climate action. The view is that innovative solutions are required to mobilise investments in energy and industry, for example. The roadmap will be used as a basis to develop sector specific policy initiatives. According to the roadmap, the power sector has the biggest potential for cutting emissions. It can almost totally eliminate CO2 emissions by 2050. Electricity will come from renewable sources like wind, solar, water and biomass or other low carbon sources such as nuclear. The share of these clean technologies could increase rapidly from the present 45 per cent to circa 60 per cent by 2020 and almost 100 per cent by 2050.

3.3.2.3 Industrial Policy

The overall aim of the EU's industrial policy is to increase growth and jobs; while reducing resource and energy use; and greenhouse gas emissions[118]. At the same time, the 2010 Integrated Industrial Policy acknowledges that the competitiveness of European industry depends *inter alia* on security of energy supply. In this context, Section 3.1.2 highlighted how the nuclear sector makes a direct contribution to growth and jobs in the EU; as well as an indirect contribution through the supply of electricity at stable prices and by reducing EU's dependence on energy imports.

3.3.2.4 External Policy

The European Neighbourhood Policy (ENP) was formally adopted in 2004 and was underpinned by a Strategy Paper[119] detailing how the EU could work more closely with its neighbouring countries. Its broad objective is to foster partnership and cooperation with the EU's closest neighbours[120] with a view to enhance prosperity, stability and security in the region. It aims to promote good governance and social development in Europe's neighbours through closer political links; partial economic integration; support to meet EU standards; and, assistance with economic and social reforms.

[116] COM(2009) 519. See also: The European Strategic Energy Technology Plan (SET-Plan) - COM(2007) 723 and SEC(2007) 1510.

[117] COM(2011) 112 final

[118] COM(2010) 614 final

[119] COM (2004) 373 final

120 This ENP framework concerns states, namely Algeria, Armenia, Azerbaijan, Belarus, Egypt, Georgia, Israel, Jordan, Lebanon, Libya, Moldova, Morocco, Occupied Palestinian Territory, Syria, Tunisia and Ukraine. Source: http://ec.europa.eu/world/enp/policy_en.htm

The ENP relies primarily on bilateral agreements to achieve its objectives. Concretely, the EU and the ENP partners identify together the needs and reforms desirable, and then agree, in an Action Plan, on a set of priorities to be implemented. The EU allocates funds following a conditionality approach: the amount of financial support – and other benefits such as access to internal markets - vary depending on the degree of commitment to common values and the extent to which the targets set in the action plans are achieved. Since 2007, the ENP financial instrument is called the European Neighbourhood and Partnership Instrument (ENPI)[121]; it replaces existing EU financial assistance (such as TACIS or MEDA).

In the field of the nuclear sector, the need for approximation to EU safety standards in neighbouring countries was made clear after the Chernobyl reactor accident in 1986. It has since been one of the objectives pursued by the EU in its policy with neighbouring countries, to which both the ENPI and the Euratom Loan Facility contribute.

The two main financial instruments used to promote nuclear safety outside the EU are the Nuclear Safety Co-operation Instrument (NSCI) and the Euratom Loan Facility. The NSCI replaces the TACIS Nuclear Safety Programme[122]. The NSCI has a budget of EUR 524 million for 2007-2013. The NSCI is based on three new principles: joint implementation, more active involvement of all stakeholders and co-financing. One main element offered by INSC is the assistance to and cooperation with all countries outside the EU no longer limited to CIS as it was with TACIS.

Its aim is to finance actions in the following priority areas:

- Improving nuclear safety, particularly in terms of regulatory framework or management of nuclear plant safety (design, operation, maintenance, decommissioning);
- The safe transport, treatment and disposal of radioactive waste;
- The remediation of former nuclear sites and the protection against ionising radiation given off by radioactive materials;
- Emergency preparedness (accident prevention as well as reaction in the event of an accident); and,
- Promotion of international cooperation in the field of nuclear safety.

3.3.2.5 EU Programmes: The Seventh Framework Programme for Research and Development

Within the EU, the Facility, in theory, complements the Seventh Framework Programme for Research and Development (FP7). FP7 supports Member States' national programmes in the area of nuclear technology:

[121] Council Regulation N° 300/2007 of 19 February 2007 establishing an Instrument for Nuclear Safety Cooperation. OJ L 81, 22.3.2007, p. 1. Available at http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2007:081:0001:0010:EN:PDF

[122] http://ec.europa.eu/europeaid/how/finance/nsci_en.htm

- Fusion energy research – which aims to develop the knowledge base for the International Thermonuclear Experimental Reactor (ITER[123]) and its implementation; and,

- Nuclear fission and radiation protection – this strand covers radioactive waste management; radiation protection (working in particular on improving the benefits of medical uses of radiation versus risk of exposure); nuclear systems and safety. In this latter field, FP7 co-funds R&D in this broad area and coordinates activities with SNETP (Sustainable Nuclear Energy Technology Platform) in order to maximise effectiveness.

The European Commission does not have the mandate or the budget under FP7, to fund the construction of next generation nuclear research reactors[124]. The European Commission's approach therefore, has been to facilitate shared-cost actions in a broad range of activities which are of interest to a number of Member States. With respect to research infrastructure, the main focus of FP7 is to facilitate access to existing infrastructure and facilities (as FP7 does not have a budget that is large enough to fund significant construction work directly). The Euratom Loan Facility could potentially be used to finance commercial scale demonstration reactors (as discussed in section 3.1.2) which would provide the infrastructure for future research activities (supported through future framework programmes). The European Commission is also trying to facilitate training and knowledge management through the framework programmes with the aim of developing the skills and competence of the workforce in the nuclear sector. Any future project, co-financed by the Euratom Loan facility, would potentially benefit from such activities.

Table 3:10 Overview of Findings on Coherence

EU Policy Framework/ Programme	**Coherence between Euratom Loan Facility and EU Policy/ Programme**
Europe 2020 Strategy	By promoting investment in nuclear energy generation, the Euratom Loan Facility directly contributes to the achievement of the 20-20-20 target. Indirect contribution arises from creation of jobs and increased investment in R&D by the nuclear sector.
Energy Policy Framework	The Euratom Loan Facility contributes to the following objectives of the EU's energy policy: • Security of supply through indigenous energy production; • Generation of low carbon electricity; • Availability of electricity at stable and predictable prices;

[123] An international research project which involves the development of the world's largest and most advanced experimental tokamak nuclear fusion reactor at Cadarache in the south of France. For more information, please refer to: http://www.iter.org/

[124] The budget available under FP7 is c. EUR 50 million per year.

	• Promoting nuclear safety in third countries.
Industrial Policy	The Euratom Loan Facility directly contributes to the overall policy aim of job and output creation; It also helps maintain the competitiveness of the EU industry through provision of secure and affordable electricity;
External Policy	The Euratom Loan Facility has been instrumental in improving nuclear safety in neighbouring countries ;
FP7	There is a potential for complementarity between FP7 research activities and the use of Euratom Loan Facility (if it is used to finance the development of commercial demonstration reactors) – but it is yet to be tested as the Euratom Loan Facility has not been used in the EU since 1987.

Conclusions
The objectives of the Euratom Loan Facility are fully aligned with the EU's policy objectives relating to climate change, security and diversification of energy supply, creation of jobs and competiveness of the EU industry. Additionally, the Euratom Loan Facility is also coherent with the EU's external policy objective of promoting nuclear safety and security outside the EU.

3.4 Effectiveness

3.4.1 *Q.8 To what extent do the current management methods and their implementation achieve the objectives, ensure a high standard of service and how can they be improved?*

The framework for the management of Euratom loans is based on relevant treaties and legal basis as well as on the European Commission's internal procedures and co-operation with the EIB. The management of Euratom loans involves the following process:

Initial approach to the European Commission: the loan applicant (usually a utility) approaches the European Commission with a request for Euratom Loan[125].

Examination of project: the appraisal procedure is launched by DG ECFIN. This involves an information session with the beneficiary, relevant Commission services (DG ENER, ENV, DEVCO) and the EIB. The parties agree the strategy to be followed, including studies to be carried out and their financing. In case of loans to Member States, potential co-financing of the project by the EIB is also discussed at this stage.

Appraisal: the appraisal process elaborated in section 3.3.1 is followed.

[125] Prior to this, the applicant should have declared the proposed investment to the European Commission in line with Article 41 of the Euratom Treaty; and, obtained a positive opinion from the European Commission.

Decision: DG ECFIN makes a decision in agreement with other relevant DGs.

Contract signature: following approval, DG ECFIN coordinates the preparation and signature of the Loan Agreement and the Guarantee Agreement (the latter only applies to third countries).

Verification of conditions precedent by DG ECFIN**.**

Loan disbursement: the procedure to be followed for disbursement of the different tranches is defined in the corresponding Loan Agreement. The following steps are followed for the disbursement of each loan tranche:

- The Borrower issues a Request for Funds in accordance with the Loan Agreement.
- Preparation of a Checklist for Disbursement to keep adequate track of the process.
- Verification of requirements according to the Loan Agreement.
- If acceptable, DG ECFIN issues the Acceptance Notice to the borrower.
- DG ECFIN evaluates the situation of the market so as to meet the conditions requested by the borrower and prepares the borrowing transaction.
- DG ECFIN issues the Confirmation Notice to the borrower with the terms of the funding.
- The funds are raised from the market and transferred back to back to the borrower.
- The Checklist for Disbursement is completed and filed.

Monitoring: The European Commission monitors the loan from the signature of the loan Agreement until the loan is fully repaid. Monitoring requirements (including the different (technical and financial reports to be provided by the borrower) are defined in the corresponding Loan Agreement. On that basis, DG ECFIN prepares a *Summary Reports Table* reflecting the different reports and the dates when they are expected to be provided; and a *Monitoring Checklist template* for each type of report, indicating the different conditions that need to be verified for each report in accordance with the corresponding Loan Agreement. These two documents are updated by DG ECFIN every time a new report is received from the borrower. Any contractual changes, waivers, specific requests etc. are considered by DG ECFIN on a case by case basis.

Closure and ex post evaluation: no action specified.

While there is no evidence to suggest that the above process has hindered the effective implementation of the Euratom Loan Facility; the evaluation identifies the following issues as requiring further action:

- *Visibility of the Facility* – there is little publicly available information on the Euratom Loan Facility. Indeed, a number of utilities and banks consulted in the context of this assignment, were not even aware of its existence. It is important that potential beneficiaries are aware of the existence of the Facility and have access to sufficient information relating to the Facility (e.g. eligibility conditions, application process). This would reduce the information search costs for potential applicants.

- *Dissemination of information on the implementation of the Facility* – DG ECFIN should systematically disseminate information on how the Facility has been used and its benefits. This would promote greater transparency and address any misconceptions about the Facility (arising from lack of information). The present evaluation is one aspect of such dissemination activities.

- *Procurement of external expertise* - the European Commission has a budget line to procure external expertise to support its due diligence work (i.e. EIB recommendation, technical and legal assistance) but, there are no framework contracts in place to enable DG ECFIN to respond quickly to these demands. In absence of appropriate framework contracts, DG ECFIN presently relies on the support of other DGs to contract these services on its behalf[126]. Additionally, for project monitoring, DG ECFIN imposes on the borrower, the obligation to contract a Lenders Monitoring Consultant (LMC). DG ECFIN reserves the right to approve the LMC, its Terms of Reference and its contract. Presently, the LMC reports to the Lender but, is contracted by the Borrower. Direct contracting of LMCs by DG ECFIN would help ensure the independence of these contractors (with respect to the borrowers). DG ECFIN should have a budget line and appropriate framework contracts so that it can procure requisite legal and technical support during the due diligence and monitoring phases of the projects. This would help improve efficiency and management of the Facility.

Conclusions
The management and implementation arrangements for the Euratom Loan Facility have worked well and there is evidence of them being effective: all loans have been repaid and the Facility has delivered its stated objectives. However, going forward, there is scope to improve the following: (a) external information package relating to the Facility; and, (b) internal procedures for procurement of external expertise.

3.4.2 Q.9 Assessment of the effectiveness of the parameters of the Facility as laid down in the Council guidelines to achieve its objectives?

The main parameters of the Facility are its focus; scope; geographic coverage; co-financing rate; structure; loan tenor; and, legal basis. Each of these is considered below.

Focus of the instrument: the key issue here is whether there should be a single instrument at an EU level to support investment in low carbon technologies (nuclear and renewables) so as to provide a level playing field for all technologies. While in theory and from a policy point of view, the idea of a single instrument is appealing; there are practical barriers to implementing this idea successfully. For example, nuclear energy falls under the scope of the Euratom Treaty; while any instrument designed to support other low carbon technologies would fall under the scope of the Lisbon Treaty. While it is technically possible to create a single instrument that operates under a dual legal base; it would be practically difficult to manage and administer such an instrument (for example, the Euratom Treaty requires unanimous decision making; whereas the Lisbon Treaty only requires a qualified majority). Furthermore, discussions with banks clearly indicate that the Euratom Loan Facility's exclusive focus on nuclear is important; and any changes which might dilute its signalling effect for the nuclear sector should not be made without good reason/ impact assessment.

[126] In order to avoid launching competitive tenders every time a request for a loan is received, as this can result in long delays and a disproportionate amount of effort.

Scope of the Facility: the findings of the evaluation (section 3.1) suggest that the scope of the Euratom Loan Facility needs to be fine-tuned in order to reflect present day and anticipated future financing needs of the nuclear sector. According to the evidence and analysis presented in earlier sections, there is no longer a case for an EU level financial instrument to support investment in front-end fuel cycle facilities; on the other hand, the scope of the Euratom loans could be used to address potential financing gaps in the area of safety upgrades/ improvements within the EU.

Geographic coverage (MS and neighbours, wider global, etc): presently, three countries are eligible for Euratom loans under the 1994 Decision (Ukraine, Armenia and Russia). The NSCI which replaces TACIS is now available to all countries outside the EU (it is no longer limited to CIS as it was with TACIS); and there might be a case for extending the coverage of the Euratom Loan Facility likewise. Besides, a significant accident at a nuclear facility would have a huge impact on public acceptance and investor confidence in the EU regardless of its location (as demonstrated by the Fukushima nuclear accident); and on that basis, safe operation of nuclear facilities across the world, would be in the EU's interest. However, considering the EU's limited resources, it would not be feasible to extend the geographic coverage of the Euratom Loan Facility. The Facility should therefore, maintain its focus on the presently eligible list of countries.

Co-financing rate: financial support from the Euratom Facility is currently limited to 20 percent for Member States (for new builds) and 50 percent for third countries (for safety and efficiency improvements). Discussions with banks and utilities suggest that a maximum co-financing rate of 20 per cent for new builds is sufficient. However, if on the basis of the findings of the evaluation, the scope of the Euratom Loan Facility is extended to provide financing for safety upgrades within the EU, then the same co-financing rate (maximum 50 percent) should apply to Member States as well as third countries. The evaluation found no justification for discriminating between EU Member States and third countries with respect to the financing of safety upgrades.

Structure of the Facility: while it is not possible to change the basic character of the instrument within the text of the Treaty (i.e. change from loan to equity based instrument)[127]; it would be possible to change the structure of the Facility from one that is based on 'cumulative lending limits' to a 'revolving' facility (i.e. loan repayments are recycled to support new lending within the constraints of the overall size of the Facility). The underlying rationale for having a cumulative lending limit is not obvious. On the contrary, a revolving facility would contribute to greater efficiency (as it would avoid the need to prepare new proposals every time the cumulative ceiling is reached).

Loan tenor: appendix II of the OECD Arrangement envisages 18 years of repayment for export credits, in addition to which some time is also to be provided for the construction period. Typically, an export credit would, therefore, have a total tenor of, say 24 or 25 years (6 or 7 years of construction + 18 years of repayment). In this context, the all-in tenor of a Euratom loan would ideally be 25 years in order to match the maturity of an export credit.

Legal basis: the evaluation clearly demonstrates that there are significant differences in the underlying intervention logic for investment in R&D and new builds as compared to safety

[127] A loan guarantee instrument would not be feasible as it would have budgetary implications (i.e. amounts would have to be provisioned within the EU General Budget to reflect the risk of lending backed by the guarantee scheme).

upgrades. On that basis, it would be advisable to introduce this distinction within the legal basis by creating separate Decisions for the two broad uses of Euratom loans.

Conclusions:
Some adjustments to the scope, co-financing rate, structure and legal basis of the Facility would make it more responsive to present day and anticipated future needs of the sector.

3.5 Efficiency and Delivery

3.5.1 *Q.10 To what extent are the Facility's objectives achieved at a reasonable cost?*

Euratom Loans are 'off-budget' operations which the Commission finances 'back to back' by borrowing from the financial market i.e. the Commission raises the corresponding funds from the capital markets, either by issuing securities under the Euro Medium Term Notes programme, or through a promissory note; and on-lends the proceeds on a 'back-to-back' basis (i.e. same terms) to beneficiary undertakings. Moreover, the European Commission is legally obliged to fully recover its costs relating to the lending (e.g. appraisal, monitoring etc) from the borrower. According to official records, the loans granted to projects within the EU have been fully repaid and loan repayments relating to external loans are on track. The loans have so far, not resulted in any cost or burden to the tax payer. Section 3.2.1 demonstrates the Facility has successfully delivered its stated objectives. This implies that the Facility's objectives were achieved at no cost to the tax payer.

Conclusions:
The Facility is a highly efficient form of intervention because it is implemented on a commercial basis and targets financially viable projects. Moreover, it has achieved its objectives without imposing a cost on the EU tax payer.

3.5.2 *Q.11 Are present resources and borrowing ceilings for the facility appropriate? If not, what increase would be advisable?*

There are a number of different estimates of future (up to 2030) new builds in the EU, ranging from 45 – 70 GWe. Assuming a capital cost of EUR 3 billion to EUR 5 billion per MWe, this equates to investment needs in the range of EUR 135 billion to EUR 350 billion. A detailed bottom up analysis of likely investment in the sector (see Annex 9 for details), yields a more precise figure of EUR 184 billion. Assuming an average co-financing rate of 5 per cent for Euratom Loans (which is the average co-financing rate for projects historically financed by the Facility) , the rough order of magnitude of demand for Euratom loans is estimated to be EUR 9.2 billion.

Additionally, demand may arise from projects relating to safety improvements (both within and outside the EU). However, it is not possible to determine the likely scale of this demand until the results of the EU safety reviews (and in some cases, national safety reviews) are known.

Conclusions:
Demand for future Euratom lending is likely to arise from new builds and possibly, from safety upgrades. The Facility is presently subject to a ceiling of EUR 4 billion. The amount currently available for new loans within this ceiling is EUR 626 million. The present resources and borrowing ceilings for the Facility will not be adequate to meet the expected demand for loans.

4 RECOMMENDATIONS

The following recommendations emerge from the ex-post evaluation of the Euratom Loan Facility:

1. **Continuity –** There is a strong argument, based on a market failure rationale, for the Euratom Loan Facility to continue supporting investment in new builds with the EU**.** The Euratom Loan Facility should also continue to support safety upgrades and the safe dismantling of nuclear installations in neighbouring third countries in order to minimise hazards to the health and safety of EU citizens.

2. **Scope** – The evaluation recommends a targeted use of the Euratom Loan Facility in future to address clearly identified financing gaps. The scope of the Euratom Loan Facility should therefore, be adjusted to reflect the findings of the evaluation. While there is no longer a case for an EU level financial instrument to support investment in front-end fuel cycle facilities, the European Commission should consider making Euratom Loans available for safety upgrades and improvements within the EU. Financing of large scale research and development (R&D) infrastructure (such as commercial scale demonstration reactors) by the Euratom Loan Facility should also be considered in the absence of any corresponding EU instrument (provided the project sponsor can demonstrate the capacity to repay the loan on the basis of a credible business plan).

3. **Financial envelope** – The financial envelope for the Euratom Loan Facility should correspond to the anticipated financing needs of the sector. 'Back of the envelope' calculations indicate a new lending limit in the order of EUR 10 billion.

4. **Structure** – The Euratom Loan Facility should be restructured as a 'revolving' facility whereby loan repayments are recycled to support new lending (within the constraints of the financial envelope allocated to the instrument).

5. **Legal base -** The legal base should be amended to reflect the distinct intervention logics for investment in new builds (including demonstrator reactors) and safety upgrades/ improvements. It is recommended that these two purposes should be covered by two separate Council Decisions.

6. **Visibility and transparency** – DG ECFIN should improve the visibility and transparency of the Euratom Loan Facility through systematic dissemination of information regarding the Facility. The information package should reflect the needs of the different stakeholder groups notably, EU citizens, industry players and policy makers.

7. **Management processes** – DG ECFIN should be appropriately resourced so that it can continue to manage the Euratom Loan Facility in an efficient and effective manner. Additionally, appropriate framework contracts should be put in place to facilitate timely and efficient procurement of external expertise.

In addition, an Impact Assessment study should be launched by the European Commission to fully examine the costs and benefits of the proposed changes to the scope, size and structure of the Facility.