

# European citizens' opinions towards radioactive waste: an updated review<sup>1</sup>

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## Summary

The Eurobarometer is a major policy instrument that enables citizens' views to be taken into account in the framing of Community policies and initiatives. The 2005 survey on radioactive waste highlighted the central importance of taking decisions and finding more acceptable management solutions, especially in order for nuclear energy to be a real option for the public. The survey underlined the relatively low level of knowledge on this issue and highlighted major gaps in the perception of risk. Citizens also wanted to be involved in decisions and acknowledged the role to be played by the EU in this field.

## 1. INTRODUCTION

Europe currently faces two major challenges in the energy sector: to guarantee security of supply without increasing external dependence and to take appropriate measures for preventing climate change, in line with international commitments signed up to by the EU and the Member States. Both issues need to be tackled in an appropriate manner at European level so as to avoid the problems becoming even greater in the years to come.

Given the impossibility of European self-sufficiency in energy, there needs to be a contribution by all sustainable sources to the energy mix in a scenario of a less energy-intensive economy and more efficient consumption. In this context, it is not the responsibility of the Commission to tell Member States which energy resources they should use. However, the Commission can create a level playing field for all sources and to highlight the extent to which each of them fulfils the three criteria set out in the 2006 Commission Energy Green Paper<sup>3</sup>, namely sustainability, competitiveness and secure supply.

Nuclear energy, although considered a "less than perfect energy option"<sup>4</sup>, has clear advantages with respect to climate change and by contributing as an indigenous source to security of energy supply in Europe.

But public confidence in nuclear energy depends on the issue of managing the radioactive waste generated in nuclear power plants (NPPs). For political, social, technical and economic reasons, this matter is rather complex. So far, with few exceptions, most European countries have not decided on the management approach to be followed with regard to spent nuclear fuel, which is temporarily stored pending an eventual solution.

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<sup>1</sup> Document prepared for the presentation in the Conference « Local competence building and public information in nuclear territories » organised by the Group of European Municipalities with Nuclear Facilities (GMF), held in Cernavoda (Rumania) on 5<sup>th</sup> and 6<sup>th</sup> April 2006.

<sup>2</sup> The views expressed in this paper are those of the authors and do not necessarily reflect those of the European Commission

<sup>3</sup> COM(2005) 105 final "A European Strategy for Sustainable, Competitive and Secure Energy"

<sup>4</sup> COM (2000) 769 final

The development of safer and sustainable long-term management solutions, based on the substantial reduction of the volume and the danger of radioactive waste, should be accompanied by efforts to secure greater involvement of the public in decision-making processes on the use of radioactive waste.

Knowing the opinions and attitudes of European citizens on this subject is a necessary first step towards establishing Community and national strategies to support and stimulate public debate. It is in this context that the 2005 Eurobarometer on radioactive waste was launched.

## 2. EUROBAROMETER 2005

Since 1973 the Commission has conducted periodic surveys, known as Eurobarometers, in order to ascertain the opinions and attitudes of European citizens on major issues related to health, culture, technology, the environment, etc. On the specific issue of radioactive waste, two previous surveys were published in 1999<sup>5</sup> and 2002<sup>6</sup>, both limited to the EU-15 Member States.

The third Eurobarometer survey on radioactive waste (EB 227, Wave EB 63.2) was conducted in February and March 2005. In all, 25 000 citizens of EU-25 were interviewed, making an average sample of 1 000 persons per country.

The main objective of this survey was to enable conclusions to be drawn from the different points of view expressed and at the same time to serve as a policy instrument aimed at bringing decision-making processes closer to the citizens. As such, it should be useful as a means of drawing conclusions about Community initiatives:

- either in order to shape new ones,
- or to check whether other initiatives already launched are still backed by the public.

Academic sociological conclusions may also be drawn from the survey, but they are not the specific subject of this paper. Also, since the previous Eurobarometer was addressed to the citizens of EU-15, it is difficult to establish trends for more than a few of the issues.

The structure of the questionnaire is shown in Figure 1. Three questions were aimed at determining European citizens' attitudes towards **nuclear energy**. The other 12 questions, focusing on the subject of **radioactive waste**, were grouped under four main headings:

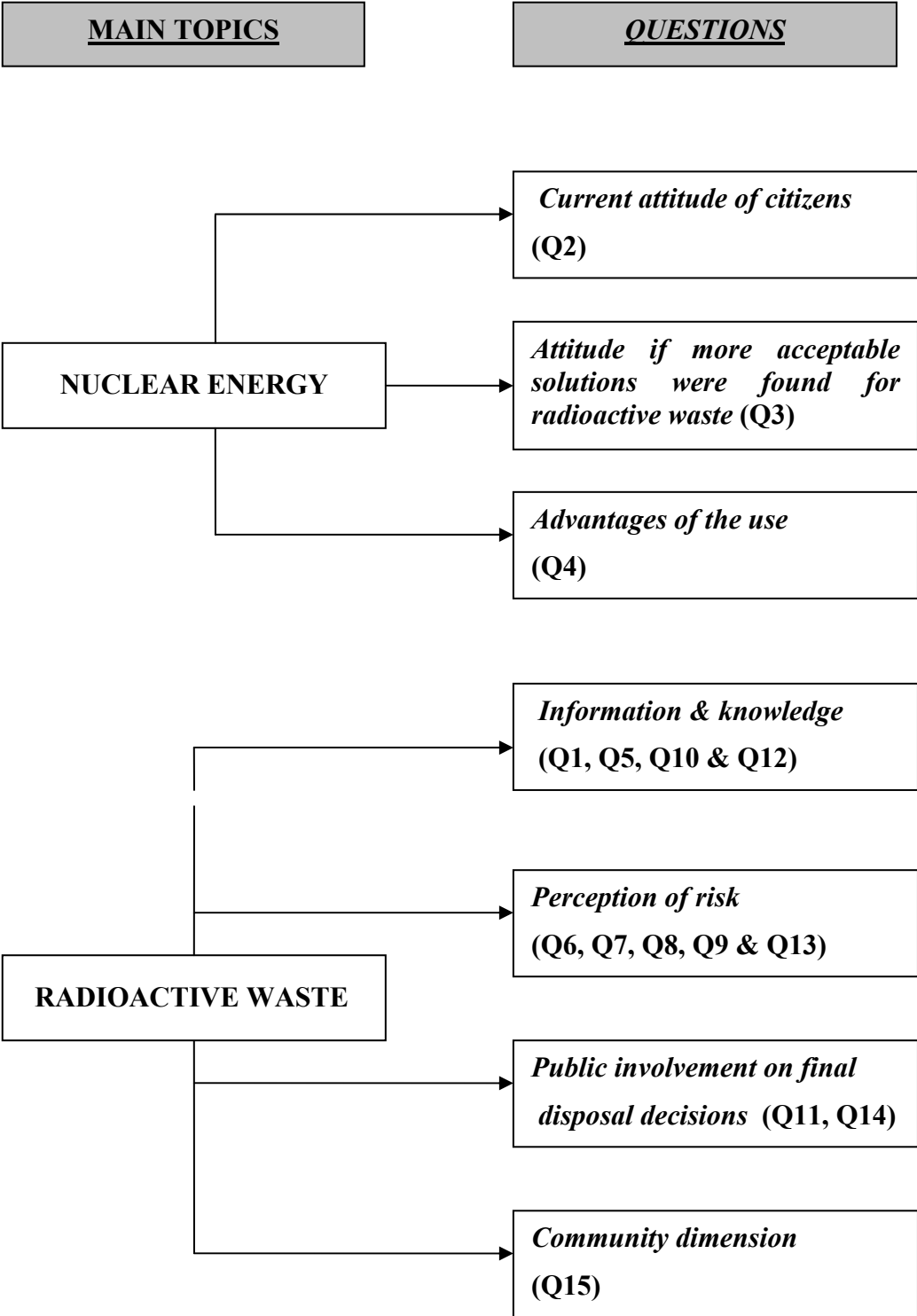
- Information and knowledge
- Risk perception
- Public involvement
- Community dimension

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<sup>5</sup> EB 122 Wave 50 carried out in October/November 1998 and published in January 1999

<sup>6</sup> EB 165 Wave 56.2 carried out in October/November 2001 and published in April 2002

**FIGURE 1.- QUESTIONNAIRE STRUCTURE**



This paper, which follows the structure of the questionnaire, assesses the 2005 Eurobarometer results, which can be found at the following web site address:

[http://europa.eu.int/comm/energy/nuclear/waste/doc/2005\\_06\\_nuclear\\_waste\\_en.pdf](http://europa.eu.int/comm/energy/nuclear/waste/doc/2005_06_nuclear_waste_en.pdf)

### 3. ATTITUDES TOWARDS NUCLEAR ENERGY

***Finding solutions to the radioactive waste issue is key to determining the attitude of European citizens to nuclear energy***

- **Six out of 10 citizens acknowledge the benefits of the use of nuclear energy** as regards diversification of energy supply, reducing dependence on oil and lowering greenhouse gas emissions (Q4).
- There have clearly been **substantial improvements** in EU-15 (EU Member States before the 2004 enlargement) citizens' knowledge of the potential benefits of the use of nuclear energy: in 2001, just 41% of them acknowledged the advantage of producing fewer greenhouse gas emissions, whereas in 2005 this figure had risen to 62%.
- Nevertheless, **only 37% are in favour** of the use of nuclear energy, compared to **55% who are opposed** (Q2).
- However, if the issue of radioactive waste were considered as resolved, 38 % of those who are opposed to the use of nuclear energy would change their opinion (Q3).

Combining the responses to questions Q2 and Q3, it appears that **a majority of European citizens (58%) would be in favour** of the use of nuclear energy, **while 31% would remain opposed**, if the issue of radioactive waste were considered to have been resolved (Figure 2)

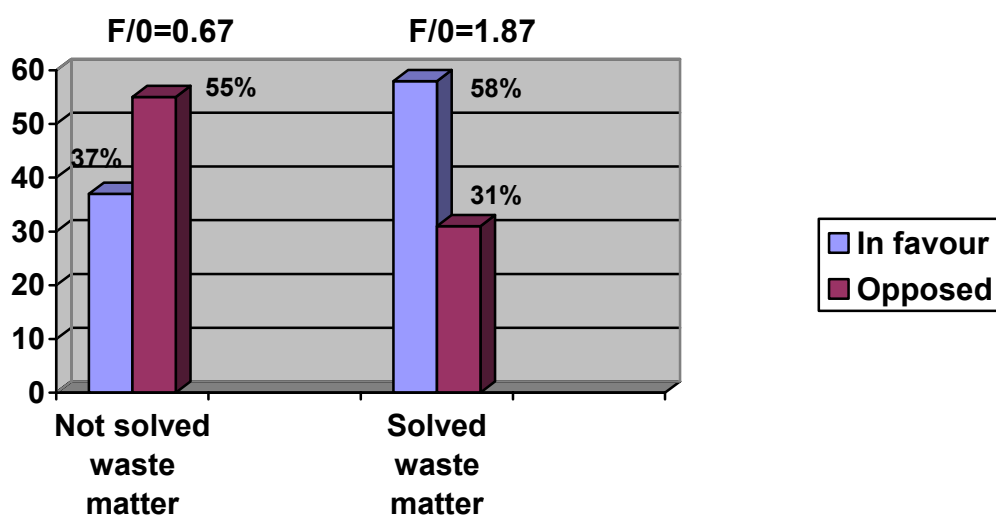


Figure 2. - Attitudes towards nuclear energy strongly depends on finding solutions for the matter of radioactive waste

## 4. INFORMATION AND KNOWLEDGE ABOUT RADIOACTIVE WASTE

### 4.1. Information and current knowledge

*It appears that there is not enough information about radioactive waste: a finding which is confirmed by the current level of knowledge on this issue, which may be considered as average as far as the nature of radioactive waste is concerned and low as regards its management.*

- **Three out of four citizens in the EU do not feel that they are well informed (Q1).** Looking at EU-15 only, the percentage of citizens who consider themselves well informed has increased from 20% in 2001 to 25% in 2005.
- Non-Governmental Organisations (NGOs) and independent scientists are **the most trusted sources** of information (Q12).

#### 4.1.1. Knowledge about the nature of radioactive waste

As regards the **nature of radioactive waste (Q5)** correct answers to specific questions made up only 53% on average; the most significant incorrect answers were in response to the following statements:

- (1) “**All radioactive waste is very dangerous**” (eight out of 10 citizens agreed)

Radioactive waste is generally categorised according to how hazardous it is, which depends essentially upon the activity level expressed in Becquerel (Bq) per unit of volume or mass, and the time taken to return to an activity level close to that of the original mineral.

Material included in the category of **short-lived, very low-level waste** has a life span of less than 30 years. Its activity ranges from 1 to 100 Bq/g (i.e. comparable the granite ground activity – 8 Bq/g). This kind of waste usually comes from the decommissioning of nuclear installations, as it is normally handled without particular shielding and is disposed of or recycled after a number of years.

On the other hand, the activity of the material considered as **long-lived high-level waste** is more than 100.000 times greater than that of short-lived, very low-level waste. It typically comes from the spent fuel generated in nuclear power plants, which represents a small volume of all radioactive waste, but contains 99% of the total radioactivity. Its handling requires shielding and permanent isolation from the human environment and most of these materials need long-term cooling followed by special disposal practices. The life span to reach the level of natural radioactivity is more than 300 000 years.

The level of knowledge on this question, which could strongly influence the perception of the risk, has not changed in the last two Eurobarometers for EU-15 citizens.

- (2) “**Radioactive waste is produced in similar quantities to other dangerous waste**” (one citizen in two)

The total amount of **radioactive waste** produced in the EU-25 (current EU Member States) is about 40.000 m<sup>3</sup> per year, which corresponds to 90 cm<sup>3</sup> per person (equivalent to half a glass of wine). Within this general amount the figures corresponding to the most hazardous materials are (per year):

- Long-lived low-level waste: 3.000 m<sup>3</sup>, equivalent to **7 cm<sup>3</sup> per person**
- High-level waste, vitrified: 240 m<sup>3</sup>, equivalent to **0.5 cm<sup>3</sup> per person**
- Spent fuel: 2.400 tonnes, equivalent to **5 g per person**

These figures are very small compared to the 36 million tonnes of **toxic waste** produced in EU-15 in the year 2000, equivalent to **100 kg per person**

The level of EU-15 citizens' knowledge on this issue improved substantially in the period 2001 to 2005, as the **ratio of right/wrong answers** to this question rose from 0.4 to 1.

#### 4.1.2. *Knowledge about the management of radioactive waste*

Concerning the **management of radioactive waste (Q10)** the average of correct answers to specific questions was slightly lower (44%); the most significant incorrect answers concerned the following statements:

- (1) **“Radioactive waste is currently buried deep underground at special disposal sites”** (six EU citizens out of 10)

In 2005, of the EU countries only Finland had decided on the management strategy to be followed for high-level radioactive waste (spent fuel): namely deep underground disposal. A road map provides for the repository not to come into operation until after 2020. Until that date no EU Member State will have disposed of high-level radioactive waste.

- (2) **“Radioactive waste is sent to other countries for (final) disposal”** (one EU citizen out of two)

Current practices in the EU show that no country wants to bury radioactive waste from abroad, especially high-level waste. On the contrary, national laws try to prevent such a possibility.

- (3) **“Radioactive waste is dumped at sea”** (35% of EU citizens)

Dumping of high-level radioactive wastes has never been allowed under the London Convention of 1972 on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter. Since 1983 a moratorium on the dumping of low-level radioactive wastes was in place until 1994, when this ban was extended to all types of radioactive waste.

## **4.2. Influence of information and knowledge about radioactive waste on the acceptance of nuclear energy**

*Citizens from EU-15 Member States, who are better informed and have more up-to-date knowledge about radioactive waste and nuclear energy, display more positive attitudes towards the use of nuclear energy.*

Different sets of variables representing Member States' average values were compared using the Pearson correlation method in order to obtain information about the strength and nature of relationships between them. Comparisons shown in the tables below highlighted substantial differences between the answers from EU-15 and EU-10 (new Member States after the 2004 enlargement). In general, possible causal relationships (shown in shading) are thought to be likely for r absolute values above 0.7.

### *4.2.1. Level of knowledge*

#### *(a) Advantages of and support for the use of nuclear energy*

Table 1.- Correlation between the acknowledgement of the advantages of using nuclear energy and its acceptance (Q2 vs. Q4)

Member States	In favour of nuclear energy		
	<i>Diversification of energy sources</i>	<i>Reduce dependence on oil</i>	<i>Produce less greenhouse gases</i>
EU – 25	+ 0,875	+ 0,791	+ 0,876
EU – 15	+ 0,835	+ 0,869	+ 0,927
EU – 10	+ 0,919	+ 0,777	+ 0,853

As might be expected, there are strong indications of a positive relationship ( $r > 0.8$ ) between the acknowledgement of the advantages of the use of nuclear energy and the level of acceptance of this energy source. This relationship is clearly seen in all EU Member States.

#### *(b) Level of knowledge and support for the use of nuclear energy*

Table 2.- Correlation between actual knowledge about nuclear waste and acceptance of nuclear energy (Q2 vs. Q1, Q5, Q10, Q7, Q6)

Member States	In favour of nuclear energy		
	<i>Feels well informed</i>	<i>Actual knowledge (nature)</i>	<i>Actual knowledge (management)</i>
EU – 25	+ 0,568	+ 0,623	+ 0,718
EU – 15	+ 0,727	+ 0,856	+ 0,779
EU - 10	+ 0,362	+ 0,488	+ 0,619

EU-15 Member States' attitudes seem to be more in favour of the use of nuclear energy when their citizens:

- Feel better informed about radioactive waste issues
- Have a higher actual knowledge of the nature of radioactive waste
- Have a higher actual knowledge of management techniques

#### 4.2.2. *Clustering of Member States*

The percentage breakdown of citizens who support nuclear energy in each Member State (Q2) as a function of their average level of knowledge about radioactive waste (average of Q5 and Q10 answers) is reported in Figure 3.

An initial conclusion that can be drawn from the analysis of the data is that **EU nuclear countries<sup>7</sup> show a significantly higher level of support for nuclear energy compared to EU non-nuclear countries** (51% versus 37%).

Figure 3 also highlights the following:

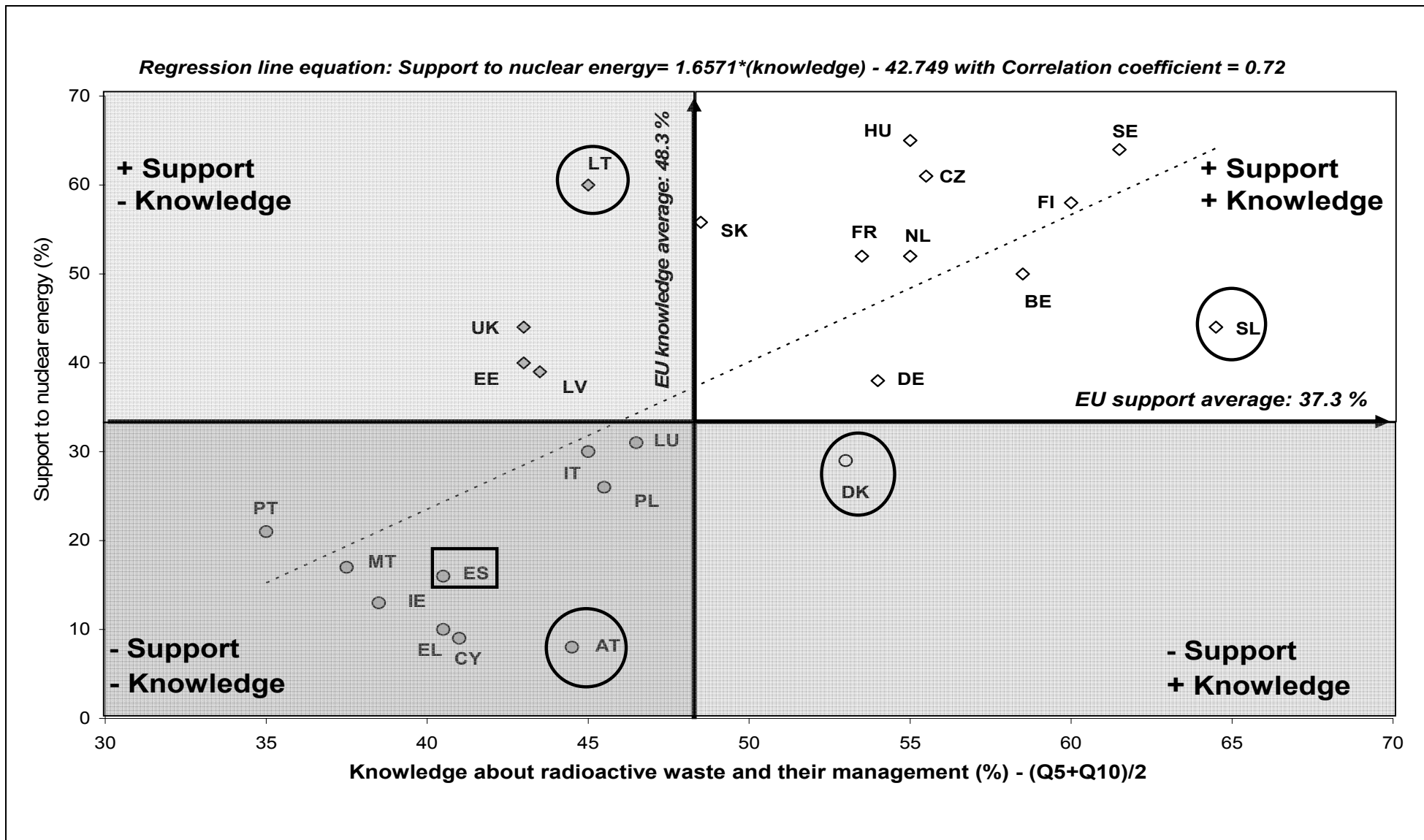
- All Member States in the top right quadrant (actual knowledge and support above EU average values) are **nuclear countries**. Slovenia shows the highest level of knowledge but its support for nuclear energy is far below EU average trend.
- On the other hand, all Member States in the bottom left quadrant (actual knowledge and support below EU average values) are **non-nuclear countries**, with the exception of Spain. The Member State with the lowest acceptance level in the EU is Austria.
- Actual knowledge of the three Baltic Countries and the UK (top left quadrant) is below the EU average, but their **support for nuclear energy is above the EU average**; the main support comes from Lithuania, which produces more than 70% of its electricity from nuclear energy.
- Finally, it is also worth mentioning that Denmark (bottom right quadrant) is the only country with an actual knowledge higher than the EU average and, at the same time, an **acceptance level that is lower than the EU average**.

Further dedicated studies of citizens' attitudes in each of these five countries (Slovenia, Spain, Austria, Lithuania and Denmark) could provide a sociological picture of the reasons for such deviations in EU average behaviour.

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<sup>7</sup> 13 in total: Spain, Germany, Slovenia, UK, Belgium, France, Netherlands, Slovakia, Finland, Lithuania, Czech Republic, Sweden and Hungary.

**Figure 3: Level of support to nuclear energy as a function of the level of general knowledge about radioactive waste and their management**



## 5. PERCEPTION OF THE RISK OF RADIOACTIVE WASTE

### 5.1. General

*EU citizens perceive all the activities associated with radioactive waste as highly risky, although in some cases there are clear gaps in the perception of actual relative risk.*

- The **construction of a disposal site for radioactive waste close to their homes** raises two main concerns among citizens (Q13),
  - The possible effects on the environment and health (53 % of those consulted)
  - The risk of radioactive leaks during operations (28 % of those consulted)
- There are **gaps in the perception of risk linked to radioactive waste**, mainly on the following issues

#### ➤ **Storage (Q6)**

**“The storage of low-level radioactive waste represents a high risk”** (7 citizens out of 10)

Standing two metres away from a lorry filled with low-level radioactive waste for one hour would give a person less radiation than if he/she took a return flight from Paris to Buenos Aires.

#### ➤ **Transport (Q7)**

**“The transport of low-level radioactive waste is one of the things that represent a high risk”** (7 citizens out of 10)

More than 1 million packages of radioactive material are transported each year, primarily for use in medicine, research and industry. Exposures of members of the public are trivial and represent only a minute fraction of the relevant dose limit.

In addition, when transporting low-level radioactive waste the risks to the community of exposure to dangerous levels of radiation are negligible. The waste in the truck emits low levels of radiation and is also sealed in steel drums and transported in containers that are designed to remain intact in an accident

#### ➤ **Recycling of non-contaminated material (Q8)**

**“Recycled non-contaminated materials coming from the nuclear industry cannot be used for any purpose”** (44 % of EU citizens)

No comments are needed

### 5.2. Risk perception and support for nuclear energy

*A lower level of knowledge about radioactive waste seems to lead to a higher perception of the risk, resulting in less support for the use of nuclear energy.*

Table 3.- Correlation between level of knowledge (Q5 & Q10) and support for nuclear energy (Q2) as regards the perception of the risk (Q6 & Q7)

Member States	Actual knowledge				Support for nuclear energy	
	Nature		Management			
	<i>Transport is high risk</i>	<i>Storage is high risk</i>	<i>Transport is high risk</i>	<i>Storage is high risk</i>	<i>Transport is high risk</i>	<i>Storage is high risk</i>
EU – 25	- 0,568	- 0,560	- 0,488	- 0,407	- 0,506	- 0,434
EU – 15	- 0,773	- 0,729	- 0,675	- 0,600	- 0,747	- 0,756
EU - 10	- 0,140	- 0,165	- 0,133	- 0,061	- 0,192	- 0,040

Again, for EU-15 Member States it appears likely that

- the lower the actual knowledge about the nature of radioactive waste, the higher the perceived risk associated with the transport and storage of such material;
- the greater the citizens' perception of the risk associated with the transport and storage of radioactive waste, the lower the support for the use of nuclear energy.

## 6. PUBLIC INVOLVEMENT IN DECISIONS ABOUT FINAL DISPOSAL

### 6.1. Participation in decision-making processes

*Citizens almost unanimously believe that decisions for solving the problem should be taken now. On the other hand, they also consider that they should be directly involved in decisions about the construction of underground disposal sites.*

- The current general lack of decisions on the final disposal of highly radioactive waste demonstrates to EU citizens **“that it is politically unpopular to take decisions about the handling of any dangerous waste”** (8 out of 10 EU citizens) (Q11.1)
- **“A solution for highly radioactive waste should be developed now and not left for future generations”** (9 out of 10 EU citizens) (Q11.2).
- In the hypothetical case of an underground disposal site for radioactive waste being built near their home, respondents said that they would like to **be directly consulted and participate in the decision-making processes** (6 out of 10 EU citizens); this was a considerably higher proportion than for any other option involving delegation to other bodies (NGOs, authorities, etc.) (Q14).

### 6.2 Opinion about final disposal operations

*There is a lot of scepticism among citizens concerning current management solutions; deep underground disposal is the most acceptable solution, but only to less than half of those interviewed.*

- The perception that **deep underground disposal is the most appropriate solution** for the long-term management of these materials is accepted by 45% of respondents, whereas 38% disagree (*Q11.4*).
- EU citizens are fairly unanimous (8 out of 10) in highlighting existing doubts about current management procedures, since “**there is no safe way of getting rid of highly radioactive waste**” (*Q11.3*).

## 7. COMMUNITY DIMENSION

*There is a very broad consensus among EU citizens concerning the European dimension of radioactive waste, supporting Community intervention in fostering the setting up of management approaches and of harmonised and consistent practices, monitored by the EU.*

Approximately 9 out of 10 EU citizens agree with the following three statements (*Q15*):

- “It is high time for each European Member State to **fix a deadline for setting up management approaches** for their waste”.
- “Since management of radioactive waste may have effects beyond national borders, **harmonised and consistent practices should be found**”.
- The European Union should be able to **monitor national practices and programmes**”.

## 8. SUMMARY OF CONCLUSIONS

In general, European citizens

- feel that they are not satisfactorily informed. This is consistent with the medium-to-low level of their actual knowledge about radioactive waste.
- demonstrate a relatively low level of acceptance of nuclear energy (37% in favour vs. 55% against), which changes substantially (58% in favour vs. 31% against) if the problem of radioactive waste could be resolved.
- demonstrate that a higher level of knowledge lowers the perception of the risk, leading to a higher level of acceptance of nuclear energy.
- are sceptical about the availability of a safe method of disposing of highly radioactive waste, with deep underground disposal being seen as the most appropriate solution but one which only has the support of less than half of EU citizens.
- feel that there is a major gap between the perception of the risk associated with radioactive waste issues and the actual risk.
- want solutions to be found now and want to be involved in the decision processes.
- support EU intervention in matters relating to radioactive waste.
- confirm an increase in their actual knowledge about radioactive waste and are slowly beginning to show a more positive attitude towards the advantages of nuclear energy.

## 9. COMMUNITY INITIATIVES

In line with working practices laid down in the Commission Governance White Paper<sup>8</sup>, the Directorate-General for Energy and Transport (DG TREN) has paid a great deal of attention to transparency and to the participation of stakeholders and citizens' organisations in the definition of Community strategies and initiatives in this area. To this end, the Eurobarometer on radioactive waste makes it possible to periodically canvass public opinion in order to take these opinions into account.

A prime issue highlighted by the 2005 Eurobarometer is that citizens' opinions are in line with a Community legislative initiative on this matter which was included in the **Nuclear Package 1** proposed by the Commission in 2002 and amended in 2004<sup>9</sup>. Citizens acknowledge the need for prompt decisions on drawing up national waste management plans and establishing harmonised and consistent practices, which should be monitored at Community level, as recommended in the Nuclear Package. These legislative initiatives are still under discussion and might be re-formulated.

Also according to citizens' opinions, any initiative at Community level should take into account **two main needs** underlined in this opinion poll:

- (a) **Bridging the gap that exists in the public mind between knowledge and perception of the risk associated** with radioactive waste, and encouraging public participation in the decisions.

Under the Euratom Framework Programme for Research and Training, the Commission currently supports societal research actions dealing with knowledge acquisition, public participation and risk perception.

DG TREN also supports:

- Studies focused on assessing and validating methodologies about public participation in decision-making processes.
- The activities of main stakeholders, such as the European association of municipalities with nuclear facilities (GMF) aimed at identifying and benchmarking existing good practices as regards processes of public information and participation in decisions.

- (b) **Develop more acceptable management approaches**, based on criteria of security of supply, sustainability and competitiveness.

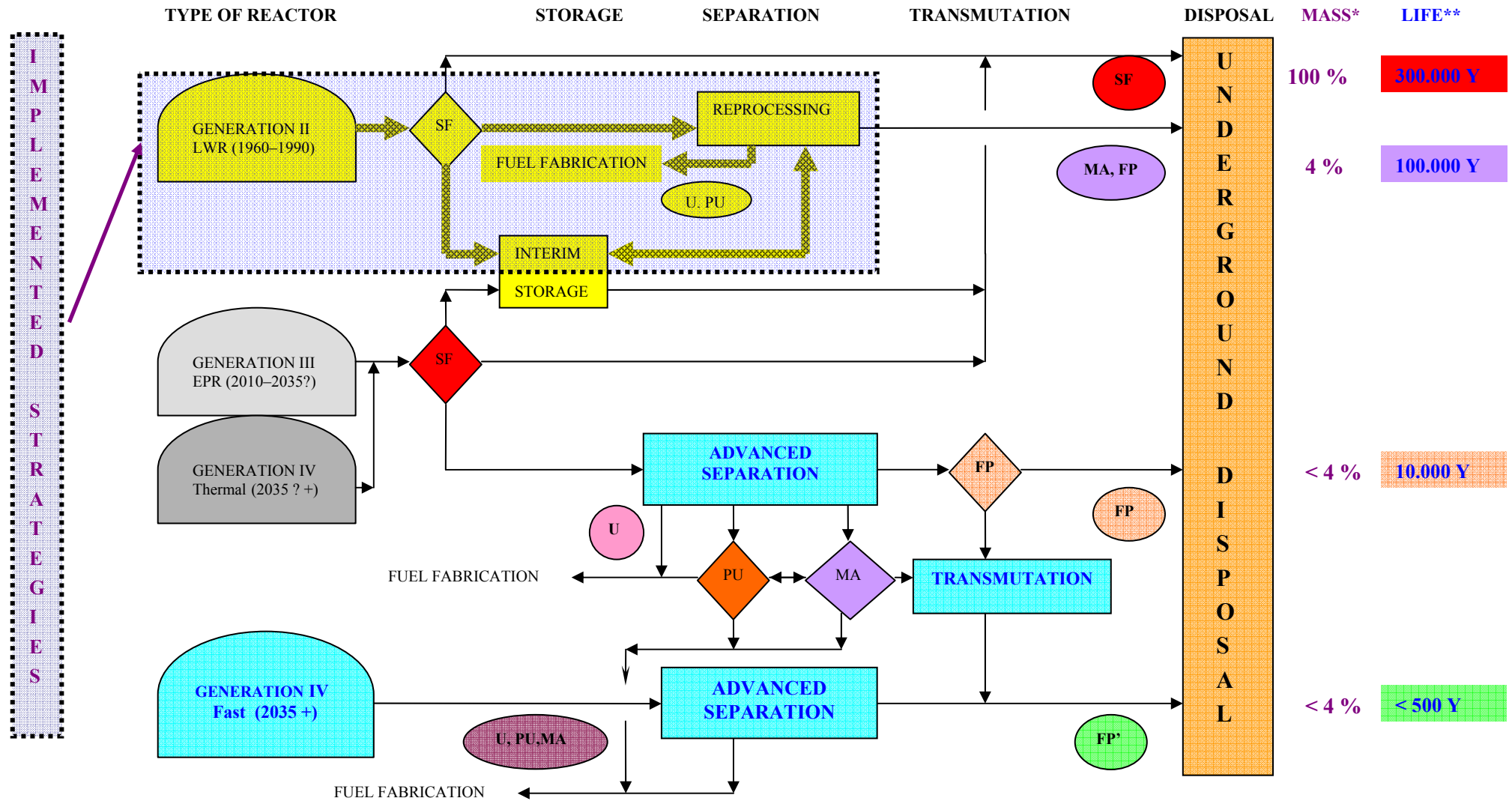
On top of the factors to satisfy these criteria should be placed **technological development**, for which different options appear as shown in Figure 4. The figure summarises in a schematic manner possible spent fuel management possible scenarios, ranging from a direct disposal of irradiated fuel (open cycle, piling-up of waste, no re-use of remaining fuel inside the waste) to the expected advanced reprocessing together with new generation reactors (closed cycle, reduced waste generation, re-use of valuable fuel inside the waste).

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<sup>8</sup> COM(2001) 428 final of 27.7.2001 "European Governance. A White Paper"

<sup>9</sup> COM(2004) 526 final of 8.9.2004. Amended proposal for a Council Directive (Euratom) on the safe management of the spent fuel and radioactive waste

**Figure 4: Spent Fuel Management Strategies**



LECTURE.:	SF (SPENT FUEL);	U (URANIUM);	PU (PLUTONIUM);	MA (MINOR ACTINIDES);	FP (FISSION PRODUCTS);	FP' (TRANSMUTED FISSION PRODUCTS)
% Mass:	100%	95%	1%	0.2%	< 4%	< 4%

\* AMOUNT OF DISPOSED WASTE COMPARED TO ORIGINAL SPENT FUEL

/ \*\* TIMEFRAME TO DECAY TO THE ACTIVITY OF NATURAL URANIUM

Research activities carried out at laboratory scale have shown the potential of technologies reducing the activity and volume of nuclear waste, leading to long-term safer management options more acceptable to the public. Moreover, the implementation of such technology at large scale will enable to transform the spent fuel into raw material for fresh nuclear fuel, contributing to security of supply in a sustainable and proliferation-resistant manner.

As a complement to the research activities carried out under the Euratom Framework Programme, DG TREN is fostering the establishment of a public-private partnership (Joint Undertaking) for the implementation of **demonstration facilities**. These would include advanced separation and transmutation technologies, to scale-up the laboratory promising technologies.

This initiative is also likely to be a **major instrument at the European level** for:

- knowledge acquisition and management, fostering innovation in the nuclear sector
- communication, to better make the case to European stakeholders and the public for the technical feasibility of safer and more sustainable management approaches
- supporting national decision-making processes about waste management and so nuclear energy.

The implementation of these initiatives would be a real step forward in finding acceptable solutions for the management of radioactive waste. It would also make a decisive contribution in order for nuclear energy to be considered as a real option in national energy mixes, for those Member States that wish to use this energy source.

Early in 2006, the US Administration announced the Global Nuclear Energy Partnership, or GNEP, as part of President Bush's Advanced Energy Initiative. Among the aim this ambitious initiative, which is completely in line with the DG TREN proposal, is the demonstration of advanced reprocessing technologies beyond the laboratory environment, and the construction of a pilot advanced burner reactor.