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Committee on the Environment, Agriculture and Local and Regional Affairs

Conference on Nuclear Energy

STRASBOURG

25-26 November 2010

PROCEEDINGS

Strasbourg 2011

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OPENING SESSION

The Conference opened on Thursday 25 November 2010 at 2 pm.

with Mr Aleksei LOTMAN

Chair of the Committee on the Environment, Agriculture and Local and Regional Affairs, Parliamentary Assembly of the Council of Europe, Member of Parliament *(Estonia)*

in the chair

Welcome speeches

Mr Aleksei LOTMAN, I am very pleased to welcome you to the Council of Europe, the pan-European organisation of democracy and human rights.

I would like to begin by saying that the right to a healthy environment is a fundamental right – as has been stressed by the Parliamentary Assembly of the Council of Europe more than once. Energy, in particular nuclear energy, is therefore one of our areas of work and the Parliamentary Assembly has already produced various reports based on the activities of the Committee on the Environment, Agriculture and Local and Regional Affairs, which I have the honour of chairing. The most recent Council of Europe texts on the subject are a resolution on energy systems and the environment, presented in 2005 by Mr Bill Etherington (United Kingdom), a resolution on radioactive waste and protection of the environment presented in 2007 by Mr Alan Meale (United Kingdom), and a resolution on nuclear energy and sustainable development, presented in 2009 by Mr Etherington who took over from Vladimir Grachev (former member of the Committee, Russian Federation), who is present here today as an independent expert.

The Committee on the Environment believes that nuclear energy provides the opportunity to reduce the carbon footprint and greenhouse gas emissions of fossil fuels, but also stresses the need for the greatest possible caution in the management of radioactive material, particularly in view of the serious accidents that have taken place in the past. I am, of course, thinking of Chernobyl, which cost many lives, but also of other accidents. Safety issues must be taken into account as must problems such as the management of radioactive material, from extraction to storage. There is no single solution to nuclear fuel management. Moreover, nuclear energy is not sustainable in the same way as renewable energies given that uranium stocks are not infinite.

Priority must therefore be given to energy savings to reduce the carbon footprint and man's impact on the climate and to avoid squandering resources and producing waste.

In the current international context, we must focus our work on three main areas: energy security, sustainable development and the protection of the environment, which includes the reduction of greenhouse gases.

We will have tough choices to make and we need to consider all feasible choices. Although I am sceptical about nuclear energy, I am very pleased to open this conference, which will enable us to produce a report on the role of nuclear energy in future energy policies. I therefore trust that this conference will give us a clearer picture of what nuclear energy has to offer.

Mr Herbert REUL, Chair of the Committee on Industry, Research and Energy, European Parliament *(Germany)***.** Mr Chair, Ladies and Gentlemen, thank you for your invitation. I am pleased to be here as the spokesperson of the European Parliament and in particular of the Committee which I have the honour of chairing.

For several years now we have been studying the question of energy supplies, which is a matter of prime importance for Europe given the problems posed by energy security, the protection of the environment and the unwelcome rise in fuel prices. We have already held numerous hearing on the subject.

Europe wants to have abundant and cheap energy while at the same time limiting its impact on the environment and the climate. These are daunting challenges. Nobody has the answer to this complex problem, which requires a complex solution.

The European Parliament believes that Europe must not only rely on an energy mix but also make energy savings.

The European Union cannot dictate its member states' energy policy. However, it is responsible for safety issues, including waste management, an area in which we have consolidated European standards. The fact that the least incident at level 1 can be detected is proof of the effectiveness of warning systems, even if the drawback of such an announcement is that it may alarm the population. As for the elimination of nuclear waste, there are technical solutions to the storage of radioactive material. States have a wide range of policies: some try to recycle as much as possible, others, for example Germany, prefer to stock radioactive waste, which is a pity as it is better to recycle it. But the Germans have refused to take the necessary decisions. The European Commission has put forward courageous solutions and our committee will do its utmost to ensure that the requisite measures are taken.

Nuclear energy will doubtlessly remain a key element in meeting world demand. It also has certain advantages: it is inexpensive, readily available and safe, at least if we know how to manage safety issues and store nuclear waste. If we say yes to nuclear energy, we must also say yes to more research and development. A growing number of countries are resorting to nuclear energy because traditional energies are running out and because of the cost of developing renewable energies.

As energy policy-makers, we must ensure that energy does not become too costly, other wise we will create a new category of poor. We must therefore beware of raising energy prices to an unacceptably high level. I am pleased that you are debating this subject today. Europeans must have access to energy which is less inexpensive and more environment friendly.

Session 1

NUCLEAR SITUATION IN EUROPE AND THE REST OF THE WORLD

Mr Aleksei LOTMAN, Session Chairperson. You have heard introductions to today's subject by someone who believes in and someone who is sceptical about nuclear energy. I therefore conclude that it is necessary to have a carefully balanced energy mix.

Dr Atam RAO, Section Head of the Nuclear Power Technology Development Section, Division of Nuclear Power, International Atomic Energy Agency (IAEA), Vienna (Austria)

I am not a political leader but an engineer. I spent decades designing nuclear reactors for General Electric before coming to work for the IAEA.

Nuclear energy must be considered on a one-hundred year time horizon: some countries have been nuclear powers for many years while others are only now considering the possibility of nuclear energy. We need to consider the problem of

energy supply. There is no single solution. Coal is still the world's dominant fuel: China has increased its use of coal tenfold over recent years and India has chosen the same course.

Europe, the United States and Russia have been the driving forces behind technological innovation. Whether this will continue to be the case, I do not know. I also get the impression that, owing to the cost of production, there must be a genuine domestic market for nuclear energy.

When energy is mentioned, everyone thinks of China. The country's projected annual GDP is already measured in trillions of dollars and should be compared to the rise in GDP in the United States and India. In 2044, Chinese GDP will be double that of the United States while India's will have risen to the same level as the US. On the other hand, European GDP will scarcely change over the next forty years, while the GDP of the Association of Southeast Asian Nations (ASEAN) will grow to be equal to that of India.

What will happen in this part of the world once labour potential has been exhausted? Are there any lessons to be learned from demography?

Only one of the fifteen most densely populated countries in the world belongs to the European Union: the fourteenth, Germany. The situation with regard to generating capacity is quite different: the European Union, China and the United States are the main producers of electricity.

In which countries is the generation of electricity most likely to increase? Probably in those where the consumption per capita is relatively low today if we think a hundred years ahead. But the countries now at the top of the charts – the European Union, China, the United States, Japan and the Russian Federation – will also have to renew their generating capacity and will therefore continue to constitute a substantial market, in particular for the nuclear branch of the energy industry.

Developing countries need large amounts of energy and spend a large proportion of their GDP on energy, unlike West European countries, which spend only 3.5 % of their GDP on energy.

Of course energy costs also have an impact. In India, like elsewhere, renewable energies cost much more than fossil fuels and nuclear energy, which is why coal continues to be preferred in some countries such as Abu Dabi. In America, where costs are tending to drop, there are still challenges to be met, particularly with regard to solar panel installations.

There is a very high demand for water and electricity, in particular in the Middle East and North Africa. Invitations to tender for major contracts have just been issued in the United Arab Emirates. In Saudi Arabia demand for energy and water will rise threefold in the next thirty years. Nor should we forget that we need electricity to purify water. Will fossil fuels or nuclear energy be used to produce such electricity?

The IAEA has also noted that a growing number of countries intend to build nuclear reactors: sixty-five countries are now interested compared to fifty-one in 2008. But relatively few countries have actually launched projects. A reactor is being constructed in only one country which is not yet a nuclear power: Iran. Projects in Turkey and the United Arab Emirates are well advanced and a dozen other countries have decided in favour of nuclear energy. Of the newcomers interested in nuclear energy, thirty-five already have (relatively low) installed capacity, i.e. less than 5 gigawatts (GW), and therefore have a weak grid. They will therefore have to solve considerable problems if they want to introduce nuclear power. By 2030, some twenty newcomers should have nuclear power plants.

Most of the new power plants will be built in countries which already have nuclear installations and simply wish to increase the number of plants: Europe, the United States, Japan or Russia, which have retained and improved their nuclear know-how. Contrary to what we normally hear, not everything is happening in Asia. The United States and Germany, for example, have maintained their level of technological excellence and know-how.

Changes have however been noted. There are far fewer major suppliers than in the past: two in the United States compared to four previously, only one in Europe compared to four previously, plus three Japanese and one Korean. India will doubtlessly supply reactors in the future but the new suppliers are less numerous than those who have disappeared.

The newcomers have drawn on the best practices of traditional nuclear powers. The IAEA is concerned to ensure that these countries have learned the lessons of the past by respecting three stages: they should provide training for their clients to ensure they know everything they need to know, prepare them for taking on nuclear power and, finally, teach them to manage the nuclear plant themselves.

Some sixty reactors are being built and, despite standardisation, there are at least twenty-five different models. The country building the largest number of reactors is Russia – not only in the Russian Federation but throughout the world. China is building reactors mainly at home but is also planning to export them. The United States is in third position, with six reactors under construction, followed by Korea, France, India, Japan and Canada. In total, our Agency has counted sixty-one reactors currently under construction. But this figure is probably underestimated. In the United States, for example, we have not included work on existing sites, for example in South Carolina, and two power plants in Taiwan and at least one or two in China do not appear in our statistics.

France does not intend to build any further reactors but to replace the generation of reactors now reaching the end of their lifespan. China and India are at the other end of the scale. India plans to develop 650 GW capacity, a large proportion of which will consist of fast reactors. It intends to do everything in its power to avoid being dependent on uranium imports, which means it is necessary to give preference to fast breeder reactors, which are much more economic in terms of raw material. Fast reactors are obviously much more costly than the light-water reactors currently being used. The extra cost would be at least 30 to 50%.

What products will be developed in the future? What can we expect in terms of developments? In Silicon Valley, they often talk of "*killer apps"*, ie. applications that kill all competition, for example the Apple iPhone. According to professor Niall Ferguson, six factors have been decisive for the leadership of the West and these now apply to China: competition, scientific revolution, the rule of law and representative government, modern medicine, the consumer society and work ethic. At least the first two of these criteria can be applied to the nuclear branch. The United States is a market economy, science is developing quickly and the very large number of suppliers are obliged to constantly introduce new ideas to meet the expectations of consumers and of society as a whole.

In the nineteen seventies, the volume capacity of pressurised water reactors – the standard reactors currently in use – increased and, most importantly, it became easier to carry out maintenance work on nuclear power plants. This required more material, which explained the extra cost. However, companies then complained that the power plants were too big and too complicated. Consequently we now have passive nuclear power plants of a smaller volume than those used in the nineteen seventies. It is a somewhat like the development of the beetle: after increasing the dimensions of the basic model, Volkswagen reintroduced the original small format, without any decrease in quality or safety. Over recent years, the safety of nuclear power plants has been improved while individual units are simpler and less voluminous.

This trend will continue. In the long run power plants will be as simple if not simpler than those used in the nineteen seventies and, once inflation has been taken into account, they will be no more expensive. The IAEA keeps abreast of changes: at least six or seven models are being developed, in particular small reactors – for the time being India is the only country to have such reactors, on account of the restrictions to which it was subjected. Although fast reactors offer a solution for developing countries, most of them prefer options based on big power plants. As uranium supplies are limited, fast reactors provide a solution. A 500 GW fast reactor will doubtlessly be completed in India in 2012 and it should have five more by 2020.

In sum, sixty one nuclear power plants are currently being built. Various messages are being sent out for the future, and there is no single solution. We do not claim to possess the truth. Each country must adopt its own strategy on the basis of common criteria: energy independence, geographical situation and the number of suppliers.

The meeting continued

with Mr Alan MEALE

Chairman of the Sub-Committee on Local and Regional Democracy, Committee on the Environment, Agriculture and Local and Regional Affairs, Parliamentary Assembly of the Council of Europe, MP (United Kingdom)

in the chair.

Mr Paul H. GENOA, Director, Policy Development, Nuclear Energy Institute (NEI), Washington DC *(United States)***.** The Nuclear Energy Institute defines nuclear policy in the United States. There are 300 nuclear reactors in the world and 104 of them are in the United States, which means that it has a vast nuclear programme.

The success of our nuclear programme is that of our nuclear power stations. They are efficiently managed and production is improving. Operations continue uninterrupted as licences are constantly renewed. Programmes for the management of waste nuclear fuel are undergoing a period of transition.

I would also point out that the American public's view of nuclear energy is improving as people are becoming aware that nuclear energy is better for the environment, and this also has an obvious impact in terms of political support.

Nuclear electricity is the least expensive in the United States – it costs two American *cents* per kilowatt-hour. Its price has also remained stable over the last fifteen years, unlike that of coal, gas and petrol. Moreover, although the 104 power stations only represent 10% of electricity producing plant, they supply 20% of the energy consumed in the USA.

The average capacity factor of our nuclear power stations is 90%, which makes them very competitive. In order to achieve 100% capacity, they would have to be used 365 days a year, which is impossible, particularly as fuel switching must be taken into account in the missing 10%. The increase in production since 1990 is equivalent to twenty-eight power stations. Supply has therefore greatly increased, particularly owing to the improved management of the power stations in operation. The quality of the components has also improved, for example pumps are now much more efficient and as a result production has increased by 5.6 GW over the past twenty years. We hope to raise this amount by a further 3.5 GW, the equivalent of ten new power stations.

We must also ensure that the lifespan of nuclear power stations is as long as possible: fifty-nine plants have obtained a sixty-year operating licence and all our nuclear power stations hope to obtain the same extension of their licences. The Department of Energy

hopes that, with the help of research laboratories, it will one day be able to extend these licences to eighty years, as what costs most is the construction of concrete and steel power plants. However, it will no doubt be necessary to change some of the components before the United States Nuclear Regulatory Commission accepts that a further extension of their service life is perfectly safe.

These 104 power plants represent 70% of the energy produced without any greenhouse gas emissions. The percentage of hydraulic energy has not increased, unlike wind energy, which nevertheless still represents a very low percentage. Very little use is made of solar or geothermal energy in the United States. Nuclear energy eliminates 647 million metric tons of greenhouse gases.

To appreciate this figure, account must be taken of the 700 million metric tons of greenhouse gases produced by the 137 million vehicles on American roads. In order to achieve the same savings as made by nuclear energy, it would be necessary to eliminate 125 million cars!

Some people claim that various stages of the production of nuclear energy produce $CO_{2:}$ the processing of uranium, the construction of nuclear power plants and the storage of waste. That is true but the amounts are very low compared to the lifespan of a nuclear power plant.

Moreover, the nuclear cycle does not include the emission of sulphur dioxide, mercury or other toxic substances.

It is important to calculate the cost of energy policies in order to compare the different practices with regard to the trading of greenhouse gas emissions. All the studies that have been carried out show that it is necessary to increase the proportion of nuclear energy to reduce emissions, which does not, however, mean that renewable energies should not be developed.

To ensure the safe management of nuclear power stations, we have introduced a nuclear security indicator, called *significant events*: a substantial decrease in major incidents has been noted. As for staff safety, it should be pointed out that the number of industrial accidents in the nuclear branch is lower than is observed in other types of energy production. The rate of exposure is not only lower than required by law but has even fallen below the fixed objectives. We have therefore succeeded both in raising the performance of nuclear power plants and in improving their safety.

For some fifty years now, spent nuclear fuel in the United States has been stored on site. Since 1982, the cycle of spent nuclear fuel has been governed by law: it must be stored and not re-used. Scientists agree on how spent nuclear fuel should be eliminated but there is no political resolve to implement their technical proposals. This year the American President took the, purely political, decision, to freeze plans for the Yucca Mountain nuclear waste storage site and we have decided to bring court proceedings against the Department of Energy. The President has therefore set up a commission to consider the possibility of recycling nuclear waste, which should publish its conclusions by the end of the year. We will then move on to the industrial stage.

Spent fuel must be safely stored: nuclear waste is stored passively, for at least a hundred years, in 125 ton containers, which could even resist an air-crash.

Particular attention must be paid to the economic and health conditions of the possible closure of existing sites and the creation of repositories, for which we already have the required funds. A tenth of a cent must be paid per kilowatt-hour produced in nuclear reactors and as a result 30 billion dollars have been funded by tax payers, 8 billion of which have already been used to evaluate the Yucca Mountain project. The commission set up by President Obama will probably advocate changes to current policy and we welcome this.

The United States now acknowledge that climate change and air pollution are a threat to society, and this is good news for the nuclear industry, which is now recognised to be ecologically favourable. Yvo de Boer, the former executive secretary of the UN Framework Convention on Climate Change has also acknowledged that it is impossible to do without nuclear energy if we want to eliminate greenhouse gases. One of the Nobel prize winners also pointed out in the fourth report of the convention that nuclear power plays a vital role. James Lovelock, who has written many books defending the environment acknowledges that nuclear energy is an essential tool for the future. Jared Diamond, who has also studied climate change in his books – perhaps many of you have read *Collapse* – comes to the same conclusion: we must make use of all the options, including nuclear energy. For Stewart Brand, also a defender of the environment, it is essential to develop four technologies, including nuclear power, to survive climate change. I also recommend that you read the work of David MacKay of Great Britain. He makes a full review of renewable energies and, with mathematical evidence, maintains that they are insufficient . Arguments must be supported by figures so as not to mislead the public, 75 % of whom are in favour of nuclear energy. We have been asking ourselves the same questions for twenty-five years. The fact is that 87% of Americans are in favour of renewing the operating licences of nuclear power plants as they think that nuclear energy is important for the future, 70% approve the construction of new reactors and 77% the construction of power plants on existing sites.

For the past two years, however, the global crisis has meant that Americans are experiencing the worst recession since the nineteen thirties and as a result the demand for electricity is dropping. Some nuclear power stations are going to be closed and others are slowing down their production. Despite this, electricity prices continue to be low.

Over recent years hydro-fracturing and other technologies have lead to the discovery of new natural gas sites and other energy sources. Their prices are low but will they remain so?

With regard to the building of new power plants, the supervisory authorities are currently examining thirteen licence applications for new reactors and three design certification applications. In the wake of 11 September 2001, safety criteria were substantially reviewed. By 2020, four new power plants should have been built.

We have adopted a new regulatory approval process to put an end to the long delay that previously existed between the two stages of the process: the time between the granting of the building licence and the granting of the operating licence could sometimes be from five to ten years while billions of dollars had already been invested. And, of course, it was the taxpayers who footed the bill! Now the operating licence has to be obtained before investors will invest in construction of the plant. Construction of the twenty-two reactors planned will therefore not begin until the operating licences have been obtained.

The low price of electricity obtained from nuclear energy is attracting companies such as Mercedes or BMW.

There has also been excellent co-operation between China and the United States, involving Chinese building technologies and the American approach to safety issues.

We are co-operating with public universities with a view to providing on-site vocational training for students. We have also renewed the nuclear component supply chain as, there had been no new constructions for thirty years. Given the recession, everyone is interested in these new job opportunities.

According to the National Research Council of the National Academies, the price of nuclear energy should remain competitive compared to renewable energies.

As regards the political standpoint, I would also point out that the only time that both democrats and republicans applauded President Obama was during his speech on the State of the Union in January 2010 when he said that he endorsed the building of nuclear power plants. There is therefore a consensus on nuclear energy. President Obama also spoke of low-interest loans and promised to triple the loan guarantees in the 2011 budget to cover 80% of nuclear power plan construction projects. At a training centre for workers in the electricity branch, he also said that one benefit of the construction of nuclear power plants would be to create jobs.

Nuclear energy is a unifying theme in the new Congress and the President will take this into account.

Steven Chu, our Energy Secretary and winner of the Nobel Prize in physics, is in favour of both large and small reactors. John Holdren, political advisor on science and technology, recently said that he thought the United States needed to stay at the cutting edge of nuclear technology for many years to come. Dr James Hansen, Director of the NASA Institute for Space Studies and expert on climate change, said that the challenges to be met were so great that nuclear energy had to be part of the energy mix. Moreover, two senators, a democrat and a republican, recently wrote a joint editorial in the *New York Times* aimed at placing the American nuclear programme at the heart of climate policy. Unfortunately too few people have given their backing to this programme to bring about the enactment of legislation.

Finally Bill Gates declared that, with a view to destroying nuclear weapons, he intended to invest in nuclear waste recycling. In answer to the question: “What do you think of nuclear energy?”, he replied: “I love nuclear”

Mr Peter FAROSS, Director of Nuclear Energy. With 143 reactors in operation in fourteen member states, Europe has the most dense network of reactors in the world. The majority of our member states use nuclear energy. France leads the field with fifty-eight reactors, followed by Germany, which has seventeen and Sweden ten. Denmark and Austria, on the other hand, do not have any reactors. I would point out that Europe is one of the only regions in the world to be involved in the entire nuclear cycle from the extraction of uranium to the storage of waste, including the processing of uranium.

There is still a gap between the European Union and China, which has only 13 reactors. However according to the IAEA, Chinese demand for electricity will rise threefold by 2035, which will lead to an increase in the number of its nuclear power stations. It is in Asia that the largest number of nuclear power plants will be built in the coming years.

The pace of construction has slowed down substantially in Europe, owing to policy rethinks in some member states. Germany has decided to extend the lifespan of its nuclear reactors. Italy is no doubt going to build nuclear power stations, while Sweden intends to maintain the status quo. A number of East European countries are preparing to have recourse to nuclear energy.

It should be borne in mind that 1.4 billion people on earth do not have access to electricity. The pace of development is no longer dictated by North America and Western Europe. The wind is now undeniably blowing from Asia: of the sixty-one new reactors under construction twenty-six are being built in China, which has become the main player on the market. In 2000, energy demand in China was less than half of that of the United States. Now the Chinese consume more energy than the Americans and in 2035 they will consume a fifth of all the energy in the world. China will also be world leader in the emission of greenhouse gases.

From a political standpoint, the European Union has always been in favour of steady and sustainable supplies of safe energy at a competitive price. The combination of the three factors – sustainability, security of supplies and competitive prices – mean that nuclear energy is a good option compared to fossil fuels as it does not emit any

greenhouse gases, the unit costs are relatively low and supplies are relatively secure as half of our uranium comes from three stable countries: Canada, the United States and Australia.

We have fixed target figures using the three twenties rule: a 20% increase in energy efficiency, a 20% reduction in CO_2 emissions and a 20% increase in the proportion of renewable energies. The two last-mentioned objectives are legally binding. In 2020 a fifth of our electricity production should be CO_2 free. In the long term, the aim is to reduce our carbon footprint. Particular efforts will have to be made in terms of energy because other branches will be unable to fall in line.

On 10 November, the European Commission presented a new strategy for competitive, sustainable and secure energy. We have added five criteria: efficient use of energy, to achieve the non-binding objective; an integrated energy market offering competitive prices to both business enterprises and private individuals; maintaining technological leadership, in particular in low-carbon technologies; and strong international partnerships to reduce CO_2 emissions.

From the standpoint of all of these criteria, we cannot do without nuclear energy. We therefore intend to enhance security throughout the nuclear industry. We are seeking practical solutions to the problem of nuclear waste. We want to harmonise liability regimes, which are currently governed by three systems: some countries follow the Paris convention, others the Vienna convention and the remainder have not acceded to any convention. The problem is to harmonise production licences so that it is not necessary to reinvent the wheel every time a nuclear power station is built, as that can be very costly. Work was carried out to certify Areva's Finnish 1,600 metric gigawatt EPR, for the one in Flamanville, and also for the unit under consideration in the United Kingdom. This is possible for big countries but definitely not for small countries.

We intend to persuade as many international stakeholders as possible to accept these binding objectives with regard to safety and waste management. To this end we are co-operating closely with the IAEA and are establishing bilateral partnerships all over the world in the framework of the EURATOM agreements, with countries such as Australia, Canada and Russia.

In the early 2020s, we therefore hope to be producing two thirds of our electricity without CO_2, 20% of which should be produced from renewable sources. In terms of electricity generation, that would mean that 33 to 35% of carbon-free electricity would be produced from renewable sources. In order to achieve 33%, either carbon must be captured and stored (but these techniques have not been approved in Europe, despite pilot projects), or nuclear power must be developed.

In this context, the European Union is responsible for defining the most sophisticated and most demanding legal framework possible in terms of security and non-proliferation. We want to help all countries in the world to achieve these objectives, in particular those which are considering beginning to construct nuclear reactors. We have therefore established two bodies: the European Nuclear Energy Forum, to facilitate an open exchange, free from taboos, and to hear the arguments of civil society, industry, researchers and political leaders for and against nuclear energy and ENSREG, the Nuclear Safety Regulators Group), a high-level group made up of the supervisory authorities responsible for safety regulations and waste management, both in countries which already have nuclear generators and in non-nuclear countries.

If Europe wishes to rely on nuclear power to forge ahead, it obviously needs to convince the public. The "eurobarometer" surveys which we regularly conduct point up two vital points: safety and waste management.

In June we took a major step forward in ensuring nuclear safety when the twenty-seven member states unanimously adopted new legal instruments. The proposals were submitted to the European Parliament and were approved by over five hundred MEPs.

Proceedings can now be instituted against any country which acts in breach of these binding legal measures. The aim is to reinforce member states' responsibility. We have enhanced the powers of independent supervisory authorities, which must be given the means to take action. Safety can never be taken for granted, it must be continuously improved. Member states have a duty to inform the public with the greatest transparency and involve civil society in the monitoring process.

The other major problem is waste management. The public is divided into two almost equal parts: 44% of Europeans are in favour while 45% are against nuclear power, whereas the percentage of those in favour in the United States is 75%. But 62% of Europeans would be in favour if nuclear waste was properly managed. It is therefore necessary to have sound legislation in this field. At an international conference on access to civil nuclear energy, held in Paris in early March, President Barroso announced that the European institutions would take a legislative initiative by the end of the year. This promise was kept: on 3 November 2010, the European Commission adopted a revised proposal for a directive on the management of spent fuel and radioactive waste. To my great surprise, the press response to Mr Günther Oettinger's presentation was more than favourable, even on the part of those who are not known to be enthusiastic supporters of nuclear energy.

We intend to apply the most demanding regulations possible to radioactive waste and spent fuel. Although the first nuclear power station was linked to the grid over fifty years ago, in 1956, we still do not have a permanent storage site and the same applies to the rest of the world. We want this situation to change; the twenty-seven members must act. Irrespective of whether or not they have nuclear power stations, they all have nuclear waste, industrial or medical waste or waste from research centres. We need to have a Community framework obliging member states to put forward national programmes describing exactly what they intend to do with their nuclear waste. They should also submit to the Commission precise inventories and a calendar of proposed actions, with estimates and, where necessary, requests for funding.

The Council of Ministers and the European Parliament will now have to study the question and take a decision. Once the directive is adopted, we will at last have put an end to a situation where we were sitting back doing nothing. France and Sweden already have very ambitious waste storage programmes and the first permanent storage sites should come into operation by 2020 or 2025. Deep underground burial - the solution advocated by scientists - will doubtlessly be chosen.

Session 2

NUCLEAR IMPACT ON CLIMATE CHANGE

with ***Mr John PRESCOTT***

Vice-President of the Parliamentary Assembly and First Vice-Chair of the Committee on the Environment, Agriculture and Local and Regional Affairs, Parliamentary Assembly of the Council of Europe, Member of the House of Lords *(United Kingdom)*

in the chair.

Mr John PRESCOTT,. Climate change means that nuclear power must be given a more important role in future, no matter what other sources of electricity are used. But politics sometimes overshadows scientific facts.

It would perhaps be more convenient to entrust consideration of the problem of waste management to a new body, like the Obama commission. Scientists consider long-term waste management a priority as it has an important impact on the environment and climate change. In my own country, we have for the last decade been asking ourselves what should be done to process nuclear waste. It is an expensive business. Energy producers are expected to bear the cost of decommissioning nuclear power stations. But is it preferable to place the burden of waste management costs on the producers or the tax-payers?

Well-to-do countries are asking the economic tigers, the rapidly developing countries, to introduce low-carbon policies. However the only solution, apart from renewables, is nuclear energy.

Dr Hans-Holger ROGNER, Head of the Planning and Economic Studies Section, Department of Nuclear Energy, International Atomic Energy Agency (IAEA), Vienna (Austria). There are four messages that I would you to take away with you. Nuclear energy is good for the climate; it can make a substantial mitigation contribution in any serious long-term mitigation strategy; it is not a quick-fix solution; and it requires non-partisan policy support. We also hope that the private sector's participation in all major projects will steadily increase, and that requires stable political discourse. Irrespective of the party in power, nuclear energy must be included in the energy mix. What remains to be decided is what proportion of the total energy production it will represent and that will depend mainly on economic considerations.

At the IPCC and at the Sustainable Development Committee, in New York and in Cancun, the measures to which priority was given to limit climate change have always been improving energy efficiency, using renewable energies, reducing deforestation and making technological progress. The latter expression does not use the word "nuclear" on purpose but actually entails several technologies: clean fossil and CCS (carbon-capture and carbon-storage) technologies and the new generation of nuclear reactors.

There are emissions throughout the entire energy chain, from extraction to waste management. But the figures differ considerably from one branch to the next and every new cycle of innovation and fresh investment brings about further improvements. The results are therefore much better than in 1990, particularly where fossil fuels are concerned.

Nuclear energy is a very low carbon technology. It produces between 2 and 6 grammes of carbon per kWh, which are mainly the result of extraction, the construction of nuclear plant and the transport of nuclear waste. These figures, which are provided by the IAEA, have been corroborated by numerous other studies.

Nuclear energy has considerable potential to mitigate climate changes. In 2008, the global electricity supply was 20,000 Terawatts, produced mainly from coal, oil, natural gas, nuclear power, hydrology and biomass. The nuclear branch already produces one out of every seven kWh in the world.

Nuclear power is a tried and tested technology, which has indeed already helped to mitigate the effects of carbon emissions on the climate. The number of megatons of carbon saved shows that nuclear energy exceeds the objectives of the Kyoto protocol. According to a study by the World Bank, once all the factors have been taken into account in the equation, including energy security and air pollution, nuclear energy can lead to a reduction that will even result in negative costs. The nuclear record is all the more positive given that if it were not used it would be necessary to use coal instead. The nuclear sector even makes the greatest contribution to the mitigation of carbon pollution.

However, it will not offer a solution from one day to the next. It takes decades before a nuclear power plant comes into operation. It takes between ten and fifteen years to move from the drawing board to excavation, then a further ten years between when the shovel first hits the ground and the first electron is fed into the grid.

But we have to escape the electricity ghetto. Nuclear-related technologies can be used for urban heating, desalination, to refine oil, for oil sand processing, etc.

No technology is perfect but some are doubtlessly better than others. All technologies entail risks and have an impact on the environment. We should not discuss a particular technology in isolation but consider all the options on an equal footing. The uranium cycle is neither good nor bad as such, it all depends on what we do with it. A kWh produced by a wind turbine does not always cost the same because the wind is not always of equal force and sometimes does not blow at all and the accumulators required are expensive.

Past experience has also taught us that we should not rush into the future with our eyes glued to the rear mirror. In order to take well-informed decisions, we should of course learn from past experience but it is most important to look ahead and not put all our eggs in the same basket.

There is no technique making it possible to produce energy without waste and the amount of toxic waste produced by nuclear energy is no more than that produced by solar energy. Moreover, nuclear waste management is governed by stringent regulations whereas other energy industries are not subject to such strict legislation.

Nuclear energy helps secure energy supplies and it is easier to forecast production costs, for, apart from nuclear liability, most externalities are already internalised. The only thing that uranium can be used for is to feed nuclear power plants, whereas there is considerable competition for oil. Moreover, there are potential synergies between nuclear energy and other intermittent sources of energy and its sustainability is weak. Apart from the man-made assets, in other words the nuclear plant, account must also be taken of immaterial aspects: the environment, human capital, know-how and the political, religious and cultural context, all have an impact on sustainability.

The first period of Kyoto commitments, with its flexible mechanisms, did not unfortunately take nuclear power into consideration. But we need a very long term commitment as there are no returns on investment before at least ten to fifteen years. In Copenhagen, nationally appropriate mitigation actions were established and the nuclear option was excluded. In the forthcoming negotiations in Mexico, it will be necessary to re-discuss the nuclear option, as some countries have already proposed.

It has also been said that nuclear projects do not fulfil the additionality requirement, as nuclear energy is already the least expensive energy option. Admittedly funding will no doubt be an obstacle, but other energy industries also require high initial investment.

If investors are currently rather reluctant, it is because they are not convinced of the long-term nature of the commitment and hesitate when confronted with the initial expense. The 2007 and 2008 scenarios for calculating the profitability of electric power stations in 2017 and 2018 were based on an explosion in energy costs. But the problem of volatile energy prices also exists in the other energy branches, perhaps to an even greater extent than in the nuclear branch.

Other problems concern maintenance, safety standards, waste and the risk of proliferation. Nevertheless nuclear energy cannot be ignored if we are serious about protecting the climate. What remains to be done is to make it acceptable to the public, although there will never be unanimity on the subject.

There are obviously substantial differences between countries in terms of energy needs, alternatives, financial options and preferences. How can we quantify the respective risks of an oil spill, a mining disaster and a nuclear accident? How can we quantify the different options with regard to the price of electricity, air pollution, employment and dependence on exports? Each country uses a *mix*. Nuclear energy is not a miracle solution, it is not a universal panacea, all options are worth considering.

The IAEA has prepared a reference scenario, based on a ceiling of 450 ppm atmospheric CO2 concentrations, a level which is compatible with a global temperature increase of no more than two degrees. This would require a reduction of 13.8 gigatons of CO_2 by 2030.

Mr Serge GAS, Head of External Relations and Public Affairs, OECD Nuclear Energy Agency *(France)***.** As early as 2007 the Intergovernmental Panel on Climate Change estimated that nuclear energy was very will placed in terms of CO_2 emissions.

All the scenarios envisaging a reduction in greenhouse gas emissions forecast that the proportion of nuclear energy used will rise by some 10 percentage points by 2050, ie. from 14 to 24 %. These projections may seem to be very ambitious but the studies of the OECD Agency for Nuclear Energy show that the proportion of nuclear energy in the energy mix may indeed rise by 10 percentage points by 2050 if we resume building nuclear power plants at the same rate as in the nineteen seventies.

Dr Hans-Holger ROGNER. I agree!

Mr John PRESCOTT, Session Chairperson. Science requires us to ration energy because there is no energy *mix* which will allow us to reach our objective. By 2050, the economy will have grown by 400%. At the same time we need to reduce greenhouse gas emissions by a quarter. That will be difficult. We will have to invest in clean technologies to capture carbon, for India, China and other countries will continue to be heavily dependent on oil and coal for several decades.

We must look at the problem not from an economic but from an ethical standpoint: every country must reduce the amount of greenhouse gases it produces but developing countries face specific circumstances and it is also necessary to take account of the number of inhabitants: the United States produce 20 tons of greenhouse gases per person compared to 6 tons in China, 10 or 11 in Europe, 5 in India and 2 in Africa. There is no technology which can solve this problem for us.

Can we rely on nuclear energy to produce less CO_2? Do you think that the discussions will continue in this direction during the next stage in the negotiations?

Dr Hans-Holger ROGNER. Given the positions taken by the different parties, I fear that we will not secure any results in the coming weeks. Our political leaders always seek to find institutional arrangements without getting to the heart of the problem, in other words binding agreements quantifying the efforts that need to be made. We must make concrete progress. The texts have been under examination for eighteen months

but without any outcome. The problem needs to be solved at a higher level, that of the Heads of State and Government.

The work done by numerous institutions and NGOs proves that viable technologies are already available.

Mr John PRESCOTT, Session Chairperson. We mustn't repeat the error of Copenhagen! It's ridiculous - it took four years to prepare Kyoto, so a four-day meeting will not be enough to solve the problem. The Kyoto framework set a deadline: 2012. In Cancun, states should follow the example set by the European Union: given that the deadline is not far off, we need another agreement. We shouldn't expect the United States, China or Japan to take the lead, but should aim for a non-binding, voluntary agreement, as stated in the appendix to the Copenhagen documents. The negotiations must be given time to establish and reinforce confidence in the system. If demands are too high, the risk is that no progress will be made at all. So let us try to take a small step for mankind and not a giant one, as they tried to take in Copenhagen in 1997.

Dr Hans-Holger ROGNER. There is no need to take research any further as we can do even better, we can move forward from the economic standpoint with the technologies already at our disposal. Waiting and holding up the process is not the right approach. It is possible to manage matters more efficiently. Even if climate change does not turn out to be a genuine threat, we will have taken positive action by improving the profitability and safety of the nuclear industry.

Mr Mathieu CAREY, journalist at the International Nuclear Communication Network (NetNuc) *(Belgium)***.** In view of the emissions produced by industry, why has there not been stronger international pressure in favour of high-pressure reactors?

To what extent do you think that awareness of climate change has altered the public's attitude to nuclear energy?

Dr Hans-Holger ROGNER. Fossil energy was not expensive enough. It was not so much Chernobyl as the exorbitant interest rates, the existence of excess capacity in the industrialised world and the liberalisation of markets which lead to a certain rationalisation, towards what was immediately achievable and inexpensive. It was only when the price of fossil fuels soared that further consideration was given to nuclear energy. Moreover, you can be sure that the price of fossil fuels will soon start rising again!

Mr John PRESCOTT, Session Chairperson. In the United Kingdom, the two coalition parties did not agree on the subject and therefore the new government had to work out a new nuclear scenario. Finally, the only scenario possible would be not to allocate public subsidies to the nuclear industry. We'll see! The UK was planning to secure 25% of its energy production from nuclear energy, and now it's only 13%. This branch continues to be important in combating climate change because it is only possible to rely on renewable energies up to a point. The public is beginning to understand this. Otherwise, one day, it will be necessary to cut off electricity supplies!

Since 1980, certain disasters - Three Mile Island in the United States and Chernobyl in the URSS, for example - have no doubt had an impact on public opinion. But the public understands that nuclear energy is now safer and that we rely on it to avoid climate change.

Ms Francine JOHN-CALAME, Member of Committee on the Environment, Agriculture and Local and Regional Affairs, Parliamentary Assembly of the Council of Europe, National Councillor (Switzerland). You said that it was impossible to have confidence in wind energy because the wind was unreliable. On the other hand, does nuclear energy not lack flexibility given that nuclear power stations have to be in operation day and night? What can be done to overcome this lack of flexibility?

Dr Hans Holger ROGNER. It is true that, from an economic standpoint, it is essential to the continue producing nuclear energy. Nevertheless, it is becoming easier and easier to monitor changes in demand and to adjust production accordingly, in particular in France. It is also true that nuclear energy will never be able to cover all our needs, or it will be necessary to have a larger number of small reactors. Nuclear energy must serve as the basic source of supply.

Moreover, why should nuclear energy not also be used for desalination or for producing hydrogen, which does not emit any greenhouse gases?

Mr Serge GAS. You said that a change in lifestyle would be necessary to curb climate change, which raises the question of an international agreement on limiting greenhouse gas emissions. The competitiveness of low-carbon or no-carbon energies depends on a carbon tax which cannot be levied at international level without an international agreement.

Mr John PRESCOTT, Session Chairperson. I agree with you, but this issue must be addressed in Cancun. Rapidly growing economies will refuse such a tax because their growth relies mainly on coal.

Changes must take place in the richest countries. 100 billion dollars are apparently necessary to adapt electric grids to solar energy. Changes are already taking place. Let us not be fixated with the 2012 deadline! We must not give up. Public opinion and events evolve more quickly than governments.

Even in Germany, they have realised that they need a balanced energy mix. The ecologists will understand in the long run. In the United Kingdom the liberals will also understand. Common sense will win the day.

Ms Francine JOHN-CALAME. At no point has anyone mentioned geothermal energy: it is systematically forgotten!

The Council of Europe also ought to talk about energy per capita. It would be better to do so from an ethical standpoint, particularly given the expected rise in energy consumption in China in the coming years.

Mr John PRESCOTT, Session Chairperson. Mr Genoa mentioned geothermal energy.
I would also mention that not enough is done to insulate houses. Economic arguments are always given priority. People are *a priori* in favour of solar energy but in the United Kingdom where the return on investment in solar energy is very long, people obviously hesitate. Although public subsidies are necessary, the decision lies with the consumers.

Dr Hans Holger ROGNER. Geothermal energy and tidal power can be used to produce electric energy.

Given that Europe and America bear historical responsibility for pollution and the emergence of an unbridled economic model, they will never be able to convince developing countries that their warnings are well-founded if they do not show the way. Transferring technologies and know-how would help these countries to move towards energies other than carbon energies.

Mr John PRESCOTT, Session Chairperson. The Chinese Prime Minister once told me that he would refuse to impose a ceiling on his country's coal consumption but that he would accept energy efficiency objectives. But that would come to the same thing given that China is becoming increasingly urbanised and will develop the same way as our own countries.

Ms Biruté VÉSAITÉ, Member of the Committee on Economic Affairs and Development, Parliamentary Assembly of the Council of Europe *(Lithuania)***.** Reference has been made not only to new large capacity nuclear power plants but also to new generations of reactors which could meet the energy needs of a large city. Can you give us more information on this?

Mr Paul H. GENOA. Plans to build small reactors have been developed in the United States in particular. Water-cooled reactors could be more easily and more rapidly constructed. However, the basic technology is identical for large and small reactors.

At any rate, it has always taken between ten and twenty years to obtain operating licences, whatever designers say; we still haven't been able to bring these new reactors into operation even if they are more simple to construct. The road between theory and practice is long!

Moreover, the technology of these "rapid" reactors still requires further improvement. It will be a long time before they are approved.

Ms Édith WENGER, Head of the biodiversity working group, Committee on Territorial Sustainable Development of the Council of Europe Conference of INGOs *(France)***.** According to your presentations, it is possible to say that nuclear energy is efficient in combating climate change.

However, how sustainable is this type of energy, given that uranium resources are limited, apart from in Nigeria and Australia? Will these limited quantities be sufficient if the nuclear industry is developed throughout the world?

It is also impossible, given the cost, for poor countries to invest in nuclear energy. Not to mention that there is more sun than uranium in tropical countries!

Dr Hans Holger ROGNER. Uranium resources are perfectly sufficient, particularly as uranium exists in different forms: for example the uranium that is dissolved in the oceans. Japanese researchers have shown that uranium could be produced from seawater at a price equivalent to that of energy in 2007. The only problem is that of concentrations. But it is totally mistaken to claim that there is not enough uranium in the world.

A few years ago it was claimed that nuclear energy had no future and that uranium exploration had stopped. The OECD published a brochure on uranium, which only referred to the known uranium deposits. However, uranium can even be found in phosphate rocks or in coal. The Chinese extract uranium from coal ash. Nor should we forget recycling, which would allow us to gain a further fifty or sixty years. It is not the problem of uranium that is critical but that of the cost of extraction and recycling.

As regards poor countries, nuclear energy is definitely too expensive. However the least expensive option is not solar energy but biomass.

Mr PERRAUDIN Jean- Claude, **Responsible for the European Affairs, French Atomic Energy and Alternative Energies Commission (CEA)** *(France)***.** Uranium can be found everywhere in the world. The problem is the cost of mining it. Fourth generation generators, which have not yet been mentioned, will take us from a time horizon of 100 years to 5,000 or 6, 000 years!

Dr Hans Holger ROGNER. I agree. And a resource with a time horizon of several centuries is a sustainable resource. Moreover, 200 years from now, we will have improved nuclear technology even further. I trust in human genius. Nuclear energy is a sound technology.

Session 3

Nuclear power and the economy

with ***Mrs Biruté Vésaité***

member of the Committee on Economic Affairs and Development of the Parliamentary Assembly of the Council of Europe and member of parliament (*Lithuania*) *in the chair*

Mrs Biruté Vésaité,). Nuclear energy is currently experiencing a renaissance, because fossil-based energy resources are in limited supply and, despite the economic crisis, prices are rising. As part of our political responsibilities we are naturally concerned that our fellow citizens have affordable energy. Many Europeans live below the poverty line and this affects their energy requirements. There are households that cannot afford to spend a large part of their income on electricity and heating.

Nuclear energy does not cause substantial carbon emissions. After hydroelectricity it is the least expensive energy source. It therefore undoubtedly has a future.

Dr Ralf Güldner, President of FORATOM, Vice-Chair of the Board of Management, E.ON Kernkraft GmbH, (*Germany*)**.** FORATOM is the Brussels-based trade association for the nuclear energy industry in Europe and represents sixteen national associations. We are made up of 800 undertakings, including large nuclear plants but also companies concerned with mining, processing and enrichment, and the engineering and dismantling of nuclear power plants.

FORATOM is recognised by the European institutions as the official spokesperson for the nuclear energy industry . It sets out to present the relevant issues to these institutions, to the relevant decision makers and to the public at large. It maintains contacts with intergovernmental organisations, the International Atomic Energy Agency (IAEA), the Organisation for Economic Co-operation and Development (OECD), the European Union and the scientific community.

Reactors are currently under construction in Finland, France, Slovakia and Romania. Others are planned in a whole series of countries. Poland is anxious to find a replacement for coal and will soon join the European nuclear club. Italy is reversing its policy of the 1980s. Other countries, such as Germany, plan to extend the life of their reactors. Sweden is considering the establishment of new units on existing sites, and since the change of government, the United Kingdom once more supports the nuclear industry.

If the nuclear industry is to maintain its share of overall energy production, we will need to build new reactors and extend the life of existing ones. This is what is happening in the Netherlands, Spain and Belgium. Similarly, after much political debate Germany has also decided to extend the life of certain nuclear plants by either eight or fourteen years, depending on whether they came into production before or after 1980. This should increase production by 1 800 terawatts. The other side of the coin will be a heavy levy to pay for renewable energies, in the form of a federal nuclear tax.

There are three components to European policy: competitiveness, security of supply and sustainable development. I wish to focus on the economic aspects.

Nuclear energy is financially viable and competitive. Construction costs are, admittedly, very high but operating, maintenance and raw material costs are lower than for other forms of energy. We can rely on an operational life of sixty years. Even when CO2 emissions are taken into account, nuclear power is acknowledged to be the least expensive for the majority of basic production.

The European sector also employs half a million people and each new plant creates 400 permanent jobs directly and 300 among the sub-contractors. The nuclear industry also guarantees employment to firms that are highly labour intensive. I therefore fail to understand the hostile attitude of German trade unions, which by refusing to agree to their industries being nuclear powered pose a threat to employment.

There are three main components of costs: construction, operation and maintenance, and fuel, which represent respectively 60, 25 and 15 % of the total. The sector is therefore highly insensitive to fluctuations in uranium prices. Even if its price doubles, this only has an effect of a few percentage points on the cost of electricity generation. It should also encourage the exploitation of new uranium deposits.

According to the OECD, in many cases nuclear plants have the most profitable life cycle. This takes account of the price of fuels and of a tonne of CO_2. The discount rate is the critical factor. Whether it is 5 or 10%, nuclear energy retains its competitive edge in each of the three regions of the world considered.

Nuclear energy internalises a significant part of its costs. Nevertheless, there are still external costs in terms of environmental impact and security of supply, which vary according to the energy source. However, the risk of terrorism is not taken into account.

FORATOM and its members fully support recent European Union initiatives and are working hard to secure their success. We are particularly interested in the activities of the European Nuclear Energy Forum (ENEF), which come under three categories: opportunities, risks and transparency. Two working groups have been established to look at opportunities, focussing respectively on competitiveness and financing models.

A report to the ENEF meeting in Bratislava early this year looks at production costs, safety, emissions, health impacts, accident risks and waste disposal problems over the entire life cycle, in the light of existing technologies. The various scenarios draw on the knowledge and experience of the relevant stakeholders – the nuclear industry, NGOs, governments and the scientific community. We plan to update this report regularly. Unfortunately, the views of ecological NGOs are not well represented, as they withdrew from ENEF in May 2009. We hope that these environmental activists will soon rejoin us.

Nuclear fuel costs are below those of gas and coal. It is reasonably priced and there are no great risks attached. Security of supply is assured and we are well placed in terms of greenhouse gas emissions. There are very few accidents in the workplace. The risks are therefore well under control. The costs take account of the whole life cycle, including those of dismantling plant. This energy source is certainly not completely renewable, but the recycling possibilities opened up by fast-breeder technology offer considerable opportunities for the future.

Radioactive waste is limited in volume but it remains active for a long time and needs to be stored in safety. Sweden and Finland have decided to establish long-term storage sites by 2011. Germany should shortly be storing its initial consignments of low and medium radioactive waste.

Briefly, then, the European Union should continue to support the development of the nuclear industry.

The main sources of financing are the electricity supply companies but there are several possible models. For example, the Finnish EPR model encourages the main electricity consumers to invest in such stations, as they already did for the first two stages of the Olkiluoto plant. In return for their contributions, these shareholders can use or resell a certain proportion of the production.

France uses more traditional means of financing, most of which comes from EDF, the main producer and distributor. France has also established the Exeltium model, which includes major electricity consumers.

All these arrangements must take account of the Commission's carefully drawn up competition rules. EURATOM provides loans and financing may also come from the European Investment Bank. These financial institutions generally receive an overall sum and then allocate the amounts concerned.

The American model was presented yesterday.

If safety is guaranteed, financing should be possible. Given the amounts required to build new plant, the nuclear option can only be envisaged by countries and undertakings with a good credit rating on the financial markets and considerable capital resources.

One of the key issues is the extent to which the public accept nuclear power. New investment calls for a stable political and legal framework. On the other hand, the industry must show that it is capable of bringing projects on line within the agreed deadlines and budgets. We also need long-term plans for waste management and storage. Contacts between electricity suppliers and consumers may need to be improved. Regulators must make sure that all the branches of production enjoy a "level playing field". Finally, investment in human capital is critical.

Quite apart from new plant, which will not increase production capacity before 2020, existing stations must be kept in service for longer if nuclear energy is to maintain its position in the long term. This will also help to reduce CO_2 emissions. A European consensus is needed. I believe that electricity companies are now fully agreed on the need for integrated production and greater long-term harmonisation of conditions for long-term operation.

According to Eurobarometer in 2010, 70% of Europeans think that nuclear energy reduces our dependence on fossil fuels. More than 50% think that the nuclear option must be maintained and that nuclear energy can be managed completely safely, though opinions do differ from one country to another.

The nuclear option would be more acceptable to the public if a viable solution could be found to radioactive waste management. On average, 40% of Europeans are currently opposed to nuclear power, but would be willing to accept it if the problem of waste were resolved. Convincing European legislation on safety and waste is essential. There is also a need for greater transparency. The nuclear industry must be more open. Operators have to convince the public that safety will always be their number one priority.

Mrs Biruté Vésaité, Chair of the session. The Lithuanian public strongly support nuclear energy but unfortunately it has not been possible to maintain the Ignalina plant in operation. The result has been a 25% rise in the price of electricity. We are also currently establishing storage sites but this will take a great deal of time.

Prof. Riita Kyrki-Rajamäki, Lappeenranta University of Technology *(Finland)***.** Lappeenranta is a small university in eastern Finland, whose courses have always included a combination of technology and business administration. It has about 5 000 students of 45 nationalities. We have a particular interest in nuclear engineering, including an experimental thermal hydraulics laboratory, but we are interested in all aspects of nuclear power, including the economics. We also have facilities for VVER and PWR modelling.

In the early 1990s, the Scandinavian countries - Denmark, Finland, Norway and Sweden - start to deregulate their wholesale electricity markets, by moving towards liberalisation and then integration. In 1996, Norway and Sweden established Nord Pool,

an electrical power exchange. They were joined by Finland in 1998 and Denmark in 1999. In 2002, spot market operations were organised as a separate company, Nord Pool Spot, which now has some 300 participants and an annual trading volume of about 250 twh.

The aim is to standardise prices across Europe, since its generating capacity is very interconnected. Nord Pool Spot, which is the most standardised energy market in Europe, also trades with Germany and Estonia.

Nuclear energy accounts for more than half Sweden's electricity production and a little less than a third in Finland. Denmark makes the greatest use of fossil fuels, just ahead of Finland.

In the Nordic countries, coal and gas prices are fairly unimportant elements of electricity production. In the medium term, energy prices vary according to hydro reservoir water levels, particularly in Norway, where hydroelectricity represents a large part of the market. Finland imports more than its exports, particularly from Russia. Denmark imports from Germany but also exports to it.

Short-term fluctuations are significant, because of bottlenecks in transfer capacity. Over a twenty-four hour period average prices may be accompanied by very high peaks - around € 1 000 per megawatt (MW) hour in winter - when the entire capacity is used.

In the Nordic market, electricity prices are determined by the relative costs of hydroelectricity, combined heat and power for industry, nuclear power, district heating and coal and gas turbine powered production. The price has risen now that 80% of carbon emissions are reflected in energy prices.

Hydroelectricity is the least expensive source. The Finnish government is considering how to tax nuclear energy to ensure that it benefits less from its low rate of CO_2 emissions.

We have measured how the cost of carbon dioxide generation in the atmosphere is reflected in the price of different forms of energy.

The Nordic countries' nuclear capacity has declined in recent years because governments are tending to place more emphasis on renewable sources and to connect up their respective systems. For example, Fingrid is contributing to the construction of EstLink, in Latvia. We also want to co-operate with Sweden.

My university has carried out a study of costs according to energy source. Coal is too expensive while at € 50 per MW hour nuclear energy is the only truly viable source. It is clearly not economical to invest more in other sources. In contrast, improved connections with the countries of southern Europe would have an impact on prices, the level of investment that we need and the amount of energy available for the south.

To be worth investing in new capacity, € 52 per MW hour must be the maximum cost. Nuclear energy is the only one to meet this condition. However, there are many programmes under way to make alternative energy sources more attractive. In the mean time though, of the options that do not generate carbon dioxide, nuclear energy is the most cost beneficial.

Half of the cost of building stations is related to safety. I consider it essential that safety standards be clearly laid down and respected and that they are applied uniformly, so that investment costs do not vary from one unit to another. The treatment of waste and, eventually, decommissioning, also require investment. Harmonisation can only be beneficial since it will reduce both planning costs and construction times.

The new Olkiluoto reactors will not come into service until 2012 at the earliest for unit 3 and 2020 for unit 4. An additional unit may perhaps be necessary ten years later.

Meanwhile a building permit has already been drawn up for a site close to Helsinki, which currently uses fossil fuels for district heating for its million inhabitants.

The Finnish Mankala model is based on the principle of a non-profit making enterprise. Shareholders are each entitled to a fraction of the energy produced corresponding to their shareholding, with no notion of profit. Such undertakings are not confined to the nuclear sector, indeed hydroelectric stations were the first to apply the principle. Costs are allocated according to shareholdings and no one has the power to set prices or costs. Sales are at cost price, something the European Commission is scrutinising. The system is extremely beneficial because it enables small players to invest in large nuclear projects, with the assurance, in exchange, of being supplied with energy. It also makes financing easier as risks to and from each company need not be accounted for. Finally, the return on capital is two to three times higher than that offered by traditional businesses and the interest rates on loans are significantly more attractive.

The Finnish government has publicly announced that in the case of CO_2, the polluter-pays principle is too favourable to hydroelectric and nuclear power. It intends to increase taxes on nuclear energy, which is quite incompatible with the EU commitment to reducing CO_2 emissions and cleaner forms of production. Moreover, the taxation of a single energy form is contrary to the EU free trade principle. We shall very shortly see what the Finnish government decides.

The price of nuclear energy means that it is extremely competitive on open markets. Imports and exports are very dynamic. Finally, increases in the individual capacities of each plant and in national capacity make this market still more attractive and lucrative.

Mrs Biruté Vésaité, Chair of the session. The principle is to serve the population at large. I believe that two Baltic states that are somewhat isolated - Lithuania and Latvia - are potential future allies of Nord Pool Spot. Since Ignalina was withdrawn from service much of our imported power has come from Russia, which has enabled us to reduce electricity prices.

Professor Dr Ing. Alfred Voss, Institute of Energy Economics and the Rational Use of Energy, University of Stuttgart, (*Germany*). I wish to consider the competitiveness of nuclear energy from three standpoints, those of power station operators and distribution companies, of the relevant macroeconomic data and of sustainable development, ecology and the climate.

Power station operators must reckon with several simultaneous options and ensure that they are always profitable, by taking a comprehensive approach. They have two main possibilities, namely to commission new reactors or to extend the lives of existing ones, bearing in mind investment already made and likely future costs.

At the start of the year, the IAEA examined the production costs of nuclear, coal fired, gas fired and wind powered stations in 21 OECD member countries over their entire life cycle, including plant that would come into service in the middle of the decade.

With an interest rate of 5%, nuclear power was fairly well placed. With an interest rate of 10%, it became less economical, as did other energy sources, particularly renewable ones such as wind power. Local costs also have to be taken into consideration.

A comparison has been made between different types of power station that will be in operation in Europe in the coming years, namely nuclear, coal or lignite fired, gas fired, on-shore and off-shore wind powered and solar powered. The base assumptions were that nuclear plant would come into service in the middle of the next decade, there would be a slight increase in the price of fossil fuels, power stations would operate for 7 500 hours per year and CO_2 would be costed at € 20 a tonne.

Nuclear and lignite are at about the same level, coal is a little more expensive and gas a little more expensive still, even in the case of modern gas-powered plants. Production

costs using renewable energy sources, particularly photovoltaic (PV) solar energy, are much higher.

Production costs using fossil fuels also rise considerably if the imputed price per tonne of CO_2 increases from € 20 to 40. The cost of production based on fossil fuels, and thus the economics of the nuclear option, are therefore heavily dependent on the level of the ecotax.

Cost structures vary greatly. For the nuclear, wind powered and solar options, capital costs are considerable, whereas CO_2 mainly impacts on coal, gas and lignite.

Major variations in the price of raw materials, interest rates or taxes would obviously modify the results.

If CO_2 is costed at € 20 per tonne, the nuclear option becomes the most economical at or above 6 400 hours of operation per year. Below this level, other sources may be more viable. The relevant figures change somewhat if the cost of CO_2 rises to € 40. The more expensive it is, the greater the advantage for nuclear power, even for non-permanent full capacity use.

The cost of nuclear-generated electricity ranges from € 2 500 to 4 000 the MW, but the price of fuels, which is source of great uncertainty, may rise by 40 %. Nuclear power is much less affected by such volatility than other energy sources, including renewable ones.

Nuclear energy is a good means of reducing CO_2 because it does not entail any additional costs. To reduce CO_2 emissions by one tonne requires an investment of € 70 to 80 in the case of wind power and up to € 300 for solar power. Investing in new nuclear power stations is therefore undoubtedly an interesting option.

The very high marginal costs are determined by the length of time that nuclear power stations are in use. In practice, they operate practically continuously, which enables them to reap significant benefits. Given the purchasing and enrichment costs, and above all the cost of waste processing, the fuel cycle is fairly expensive: € 5 to 10 per MW hour. Nevertheless, even if the price of the raw material doubled, the cost of the fuel cycle would only increase by about € 15 per MW hour. The variable costs are therefore much higher for other energy sources.

Income linked to electricity sold, which permits a return on investment, is higher. Account must also be taken, if appropriate, of the need to modernise plant to maintain and extend its operational life. The additional cost, estimated at a further € 500 per KW, does not pose a threat to the sector's viability.

From the standpoints of macroeconomics and sustainable development, consideration must be given to the efficiency of energy resource use, which has become a key notion.This means that the impact on the environment and all the external, or "social", costs have to be quantified. This is how we determine which options are most compatible with sustainable development. We have therefore carried out an analysis of resource use from the very start of construction to the total dismantlement of a power station, in other words the overall cost, including the ecological footprint. Construction implies energy use, waste disposal and fuel preparation, which is then imputed to each useable kWh .

Photovoltaic solar energy is very dear since it requires massive resources. The extraction and transport of coal use a great deal of energy. Nuclear energy, in contrast, is generally well placed. More non-energy raw materials, such as steel, copper and bauxite, are required to build a wind-powered or photovoltaic generator than a nuclear one, which explains the high final cost.

In the case of CO_2, SO_2 and NOx over the whole life-cycle of a production unit, traditional thermal power stations are very poorly placed and the impact of photovoltaic plant is by no means negligible, with additional health consequences. Fossil fuel generators have a particularly high cost in terms of number of years of life lost, mainly attributable to fine particulate emissions, whereas nuclear and wind-powered energy have much more positive outcomes.

In the case of coal and lignite, the remaining external costs are significant, because of their impact on the climate, even though this does depend on the price per tonne of CO_2. They are very low for nuclear and wind-power, and a little higher for solar energy. At all events, once again fossil fuels are the least well placed.

Consolidating all these costs leads to a macroeconomic cost that is fairly comparable to the gross cost.

There are several possible scenarios for combating climate change. Under the reference scenario, which is now two years old, Belgium, Germany and Spain, which had intended to eventually abandon the nuclear option, will develop renewable energy sources and continue with the moderate use of nuclear power. The second scenario provides for a sixty year extension of nuclear power stations and the introduction of an effective climate policy. Bear in mind that the European Union wanted a 30% reduction in greenhouse gas emissions between 1990 and 2020 and a 75 % reduction between 1990 and 2050. We also start from the premise that the technology will advance, growth will average 1.8% per year and oil prices will continue to rise.

Between now and 2030, total consumption of primary energy will barely change but the fossil fuel share will decline. In the reference scenarios, the contribution of nuclear energy would remain more or less stable, at least with an effective climate protection policy. Imports of fossil fuels would fall from 57 to 47% of total requirements. More interestingly, not only fossil fuels, particularly coal and lignite, but also natural gas would account for a diminishing proportion of net electricity production. Coal, lignite and gas-fired power stations would have to be fitted with CO_2 capture and storage facilities. In the second scenario, renewable energy sources would not play a large part. The reference scenario gives an average increase in costs of 50%, but much less in the event of a highly effective climate protection.

The annual system costs for Europe would fall by € 27 billion if reactor life was extended and even by € 72 billion in the event of optimum climate protection. Over the period 2010-2030, the cumulative energy cost saving would be € 329 billion in the first scenario and nearly € 700 billion in the second.

I have to emphasise that these are not precise figures but merely orders of magnitude that offer indications for Europe.

Mrs Edith WENGER, Head of the biodiversity working group, Committee on Sustainable Territorial Development of the INGO Conference of the Council of Europe *(France)***.** It has been said and repeated that the nuclear kWh is the least expensive, although Professor Voss has somewhat qualified this statement.

What exactly are the external costs? I would draw attention to the additional costs associated with the safety of the extraction and transport processes, construction of generators, security of maintenance operations, which operators now contract out, reprocessing of spent fuels and management of radioactive waste.

The recent return to Germany of radioactive waste reprocessed in La Hague in France raises the issue of the cost of nuclear energy since this required a special train accompanied throughout its journey by a helicopter, thus causing greenhouse gas emissions, and the stationing of police officers on both sides of the line every fifty metres over a stretch of 1 800 kilometres, not to mention security measures on board

the train and the monitoring of demonstrators. Are these additional costs included in the external costs of nuclear generation?

This is the question that is asked by a public that finds it difficult to accept nuclear energy when it is still the subject of an imposed policy that is shrouded in secrecy, be this in connection with defence or with extending generator life.

Finally, are the costs of marketing and of water for cooling purposes included in the externalities?

Professor Voss. The external costs are ones that are not taken into account in existing balance sheets but are borne by society. Balance sheets do not at present include environmental costs such as the emission of pollutants, CO_2 or radioactive isotopes. This is why we have developed methods to quantify these external constraints, particularly damage to the environment caused by elements that are harmful to materials or health. We have given them a monetary value per kWh. They are all included.

The cost of transporting fuel rods to Germany, in trains that currently require protection because of the protests they arouse, has not been taken into account. But is this really an external cost? Wind farms also give rise to protests and thus additional expenditure, which have not been included in the reckoning.

Dr Ralf Güldner. The costs of transport and final storage of nuclear waste are already met by the industry under the polluter pays principle. We have thus already made most of the expenditure on Gorleben and it would be a mistake to terminate the scientific studies for political reasons.

What do you mean by marketing costs?

As far as transport is concerned, it is true that the pay of police officers who protect convoys while respecting the right of peaceful protests is not taken into account. However, such forms of transport are relatively rare. Moreover, Professor Voss's figures clearly highlight the limits of these additional costs, which are linked to attempted illegal acts.

Mr Gilbert Moritz, Baden Württemberg energy group, EnBW, *(Germany)***.** How do you distinguish between communication and lobbying? What sort of European communication strategy is possible to make nuclear energy more acceptable, since reports that are favourable to it are rarely published?

Dr Ralf Güldner. Since the smallest nuclear incident has major repercussions, we are committed to maximum transparency with all the organisations concerned.

We are reliable operators. German reactors have 93% availability, which shows that they function transparently.

Dr Romana Jordan-Cizelj, member of the European Parliament *(Slovenia).* Doctor Güldner, you have spoken of European harmonisation. Should the extension of generator life be a European matter?

Also, what form should a nuclear tax take?

Finally, nuclear waste is exported to Russia, and a train load of radioactive waste has just crossed my country, Slovenia. What are your views on this, since the draft directive would ban such shipments?

Dr Ralf Güldner. There are some 140 power stations in Europe in 15 member states, which have their own regulatory bodies and apply their own criteria for managing radioactive waste or extending reactor life. The EPR has been certified in Finland and

France. An EPR project is being discussed in the United Kingdom, which would be the subject of special approval, whereas in the United States there is just one regulator. It would be necessary to harmonise security measures at European level, since national regulators are the final arbiters at local level. American operators would also penetrate the European market if the rules were harmonised.

Like the European Commission, we are categorically opposed to exports of radioactive waste. If operators in different countries used their resources in common to build a site, it would be possible to share the risks and costs.

The waste to be shipped from Germany to Russia comes from a former Russian site in East Germany. Radioactive waste may be treated in a country other than the country of production but at the end of the day each country has to recover its waste.

Session 4
Education and training in the nuclear field

with Dr Romana Jordan-Cizelj,
member of the European Parliament
in the chair

Dr Romana Jordan-Cizelj, Chair of the session. The development of nuclear energy has ceased to progress since Chernobyl, even though it can offer solutions in terms of competitiveness, sustainable development and security of supplies. References to a renaissance of nuclear power are therefore hardly surprising.

However, this twenty-year pause, which the nuclear sector found difficult to cope with, has left us today with a shortage of trained staff. Hence the need to attract young people into the industry and the importance of this conference.

Professor Joseph SAFIEH, Study Director, National Institute of Science and Nuclear Techniques, France; President of the European Nuclear Education Network (*France*) When we talk about "human resources" we are also talking about training and experience. The European network, which is more than nine years old, aims to meet the needs of the nuclear industry and research laboratories, with a particular concern for the functioning of reactors in complete safety.

The ENEN project was launched in January 2002 as part of the Fifth EURATOM Programme.

European policy makers had decided to gradually phase out nuclear power and reduce the number of reactors, which meant that fewer and fewer students were choosing this option. Qualified teachers were not replaced when they retired and universities were offering an ever diminishing number of courses in this field. Everything had to be reinvented to ensure the safety of existing facilities and prepare for the future.

A European nuclear engineering project was established to preserve nuclear knowledge and expertise, ensure that nuclear disciplines were included in higher education and establish qualifications in accordance with the Bologna declaration, which aims to secure student mobility in Europe via the transfer of credits. The three objectives are to harmonise education programmes, determine at European level what an engineer in the nuclear field needs to know to qualify for a masters, particularly by harmonising best practices, and ensure that the standard of programmes is maintained by means of quality assurance.

The project has been formalised through the European Nuclear Education Network (ENEN), which is not confined to energy matters but also extends to nuclear medicine and risk management.

ENEN was inaugurated on 22 September 2003 at the Luxembourg FISA conference, under the auspices of the French associations law of 1901.

Its aims are to preserve and develop expertise in the nuclear field through higher education and training, promote and develop collaboration in nuclear education and the training of students, researchers and professionals, make the nuclear sector more attractive for students and promote a high standard of life-long learning.

To that end, we support universities through the establishment of networks, which facilitates student exchanges through the mutual recognition of credits.

The co-operation extends to exchanges of information and academic staff, and also includes the nuclear industry, their regulatory bodies and research centres.

The network has 56 members in 18 European countries, but we are not confined to Europe. We have an agreement with the IAEA, and we co-operate closely with the European Nuclear Society and South Africa, particularly North-West University, and with the Moscow physics engineering institute and the Tokyo institute of technology. We have an agreement with the Japanese atomic energy agency and provide continuing training in Russia with a network of Russian universities. We are also studying the possibility of co-operation with Canada.

Like any association, we have an organisation chart, which includes a general assembly, board of governors and numerous committees - on teaching, economic questions, research, doctorates, training and industrial projects.

The general assembly decides on the next year's programme approved by the board. Two action plans are adopted with the aid of two transversal committees, on quality assurance and knowledge management.

Agreement was reached with the Commission under the sixth framework programme on the Neptuno project, from January 2004 to June 2006. ENEN has also established a European masters degree in nuclear engineering. Our emphasis has been first on teaching and then on practical training in the form of training sessions and pilot courses for the industry. We have now extended our courses to include knowledge management.

The ENEN II project lasted from October 2006 to March 2009, enabling us to progress from engineering *stricto sensu* to the study of radiation and nuclear waste storage.

Master of Science in Nuclear Engineering is the qualification earned by all the students who satisfy the conditions. They must spend three months in another European country and obtain various credits. The Commission then gives them the ENEN certificate, which is recognised by all 58 members of the association. Three students were awarded it in 2005 and 25 this year. It is now the industry's responsibility to open its doors to them.

The ENEN members are also very active at national level in establishing new engineering masters degrees to meet the needs of the industry. In Switzerland, the Federal institutes of technology, EPF Lausanne and ETH Zurich, have co-operated to establish, in 2008, a new MSc course taught in English, with alternating semesters in Lausanne and Zurich.

The national institute of nuclear science and techniques (INSTN), which is attached to the French atomic energy commission, and the University of Paris-Sud-Orsay are co-

operating in the establishment of a nuclear engineering masters taught entirely in English.

EDF and Areva have been involved since 2009. With the assistance of INSTN and Orsay, we have been able to pursue our efforts in five French universities to establish a second masters year that will also include reactor design, operation and decommissioning and the fuel cycle. The courses are in English even though half the students are French.

I cannot mention all the networks and co-operative ventures established under ENEN auspices, which also include doctoral and post-doctoral courses. The PhDs will specialise in one of nine subjects taught. There are also paying courses under the ENEN label for young professionals in the nuclear industry who want still further training in nuclear engineering.

Many European countries also offer training courses under the ENEN label, that are too numerous to mention.

Finally, ENEN has published numerous works and CD-ROMs, including one for the general public.

We are also working under the auspices of EURATOM's 7th framework programme on four projects: ENEN III on nuclear engineering, which Areva has joined, ENETRAP II on radiation protection, PETRUS II on waste management and disposal and TRASNUSAFE on nuclear safety culture. We also have three bilateral co-operation agreements. One is between the European Union and Japan on the mutual recognition of degrees. A number of European students are already preparing theses in Japan while two Japanese students have placements in European research centres and a third is following courses in Europe. We have another co-operation agreement with Russia and one with China is currently being developed.

Professional training credits must also be transferable. This is more difficult than in a university setting because of the need to assess knowledge and skills at the end of the course.

The European Council of 1 and 2 December 2008 adopted conclusions that referred explicitly to ENEN.

Mr Jean-Claude Gauthier, Director of the European Nuclear Energy Leadership Academy (ENELA), Munich (*Germany*)

ENELA is a European institute operating on behalf of all the partners of the nuclear community to ensure that Europe offers leadership in this area. Our aim is to provide links between the technology and the science. The academy's headquarters are in Munich.

It was the brainchild of six major European companies: Areva, AXPO AG, EnBW, E.ON Kernkraft GmbH, Urenco Limited and Vattenfall AB.

We have strong support from the European Commission which we would like to see reflected in financial terms.

It is not a company academy. We want to secure movement in Europe by opening up to new partners.

ENALA first saw the light of day at an early meeting of FORATOM and was intended to identify education and training needs and propose solutions. It is not designed to replace existing training arrangements. We are a post-university institute offering a high level of professional training. We want to train tomorrow's middle and senior managers and attract high quality specialists from other sectors into the nuclear industry so that it

can benefit from their experience. We aim to give them the necessary additional training. We are also concerned with generation replacement since there is a shortage of personnel in the 35-45 age group. Since the young persons who are currently being trained will not become fully operational for another ten years, ENELA aims to fill this gap through the rapid training of specialists. Meanwhile, young people now know that the industry has interesting careers to offer them.

We also want to encourage greater awareness of the importance of nuclear issues and to develop networks.

ENELA targets three main groups. The first comprises young graduates and professionals with high potential, whether or not that have the relevant masters. We aim to "nuclearise" them. We are also aiming at young graduates and professionals in civil and mechanical engineering and lawyers. We help them enter the nuclear industry by offering the necessary additional training to fill posts throughout the sector, from power stations to supervisory bodies.

We are also looking for the industry's future middle and senior managers. These are people who already have five to ten years' professional experience and have been seen as having potential. We want to offer them the eventual prospect of major responsibilities in the industry.

Finally, we are targeting opinion formers and policy makers, by offering them - to plagiarise Woody Allen - "everything they always wanted to know about nuclear energy, but were afraid to ask". Since these are the people who will be making decisions about the industry we want to educate them.

We have three training programmes.

The first – "Management" – is for new graduates and young professionals. It lasts four months and is supplemented by a six-month internship. It concerns technicians, communication and finance specialists, lawyers and economists.

The second programme – "Leadership" – is for people with high potential. They meet for one week a month over a six-month period and meet all the nuclear energy stakeholders. They have to complete “homework” on specific issues. The programme lasts seven weeks and includes the geopolitics of energy, technical data on power stations, the fuel cycle from uranium extraction to the management of waste, security, legal and international aspects of nuclear energy, economic issues, communication and management.

Finally, we will shortly be establishing an ENELA Conference Cycle for opinion formers and other leaders, two days a month for six month. The first day will comprise lectures and the second interactive visits to offer these decision makers factual information on nuclear energy.

We have also recently signed a co-operation agreement with Munich technical university to strengthen the technical content of out training.

We have our own premises, with two lecture theatres and numerous meeting rooms for group work.

Mr Serge Gas, Head of external and public relations, OECD Nuclear Energy Agency (NEA), *(France)*. How many students do the European Network and ENELA train each year?

Mr Jean-Claude Gauthier. To maintain the level of interaction with staff, there is a maximum of 20 to 25 students per class. However, courses may be repeated over the year to include more participants.

Professor Joseph Safieh. Each country determines its own needs in the nuclear sector. Studies have shown that some 1 200 students need to be trained each year. Three hundred a year are awarded a masters in nuclear engineering.

Mrs Christine Marin, Member of the Parliamentary Assembly's Committee on Environment, Agriculture and Local and Regional Affairs, member of parliament (*France*). I am delighted to hear that nuclear energy has such a bright future. As a member of parliament, I have the good fortune to have Areva in my constituency.

Are courses planned on the EPR?

Professor Joseph Safieh. Nuclear engineering is an applied subject. After the theory we have to move on to practical training. One of the distinctive features of nuclear engineering is that courses have to be given by industrial experts to explain the functioning of nuclear power stations and their components.

Young professionals also require continuing training.

Mrs Claude Fischer, President of Confrontations Europe *(France)*. I strongly welcome the important work of ENEN and ENELA to fill the gaps in scientific and technical training and continuing training in this field.

How does ENEN work with the Mediterranean countries, which need to develop their nuclear energy.

Also, what languages are ENELA courses taught in? Is the sole use of English not an impediment to the more open training that you are seeking?

Professor Joseph Safieh. For historical reasons, INSTN, which is a member of ENEN, is responsible for collaboration with Tunisia. The Tunisian project is relatively advanced, even though the country has not yet taken a final decision. We are currently training a third wave of ten engineers. In two years, Tunisia will thus have 50 trained engineers, which should enable it to open its first power station in 2025.

There are long-standing and frequent exchanges with research centres and universities in Morocco. Co-operation with Algeria is more difficult but the first courses for professionals, financed by the International Agency, started a month ago.

Mr Jean-Claude Gauthier. ENELA's courses are in English. We are polyglot and therefore English speaking. English is the common language.

Session 5

Nuclear safety and waste management

with ***Mr Alan Meale***

Chair of the Sub-Committee on Local and Regional Democracy, Committee on the Environment, Agriculture and Local and Regional Affairs, Parliamentary Assembly of the Council of Europe, MP *(United Kingdom)*
in the chair

Mr Alan Meale, MP, We were repeatedly told this morning that radioactive waste is dangerous, which means that it must be treated with great care.

Since the early 2000s, we have been moving towards a comprehensive approach to the issue. Waste classified as intermediate is normally stored on the surface or at low depths. This is not the case with the 60 000 tonnes of highly radioactive and thus very dangerous spent fuel, which has to be buried at great depth in sites that are capable of resisting climatic factors and are geologically suitable. Reprocessing also generates waste. Despite declarations of intent, the relevant policies have still not been harmonised.

I have visited numerous sites of variable standard. The fact is that we still have no permanent solution. Nor must we neglect the ethical dimension of the policy.

Mrs Ute Blohm-Hieber, Head of the Nuclear Energy, Transport and Waste Management Unit, European Commission. The European Commission has recently presented proposals for a directive on radioactive waste management. I want to speak about the safety culture in this area.

The Commission considers that those who profit from nuclear energy must manage its waste, the polluter pays principle. Failure to make any proposals would be to court disaster.

Various sorts of radioactive waste are to be found in all the member states, even if they do not have nuclear power stations. There are also medical and industrial waste and waste from research.

There are two main categories of waste: waste with a relatively low level of radioactivity over time and waste whose radioactivity has to be measured in millennia. There are two disposal options: at or near the surface for the first category, at great depth for the second. In fact, at present we only have intermediate solutions. Several scenarios already exist for waste that will become inoffensive within the next 300 years but we have none for very long-term radioactive waste. There is also a lack of political will to deal with the matter because it is far from popular. Finally, as well as a lack of technical and scientific knowledge there is an absence of financing. In other words, it's an ostrich policy, in which the burden is passed on to future generations, who will have to sort it out.

It should be added that failing to provide for the management of this waste offers nuclear energy a competitive advantage over other sources of electricity.

Finland is one of the good pupils since it is likely to have a permanent disposal site by 2020. Sweden and France have taken the first steps. You are aware of the particular situation in Germany, where the moratorium has delayed a choice.

The Commission has two ways of acting, namely legislation and promoting dialogue and awareness.

From the standpoint of dialogue, ENEF has prepared a roadmap on the disposal of radioactive waste in geologically suitable sites. ENSREG, the safety regulator group, has gathered information for use in proposed legislation. Meanwhile, the IGD-TP (Technology Platform for Implementing Geological Disposal) has been asked to demonstrate the feasibility of geological disposal by 2025.

The Commission itself produces regular situation reports on existing quantities of waste and its location. The last one was in 2008.

In June 2009, Commission adopted its Directive on the Safety of Nuclear Installations and on 3 November it produced a revised proposal for a Council Directive on the management of waste. There is other legislation, particularly Article 37 of the EURATOM Treaty and the Treaty on the Functioning of the European Union, but nothing to permit the proper long-term management of waste. We therefore intend to fill this gap.

The directive will make the IAEA safety standards legally binding. In contrast, the rules of the Joint Convention are legally binding, but not enforceable because they are too imprecise.

Discussions have taken place in ENEF and ENSREG. The European Council and Parliament and the Economic and Social Committee have encouraged us to continue along this path.

According to Eurobarometer surveys, more than 50% of European citizens think that European legislation on the subject would be very useful. A substantial majority of the rest think that national measures are inadequate and that binding measures are needed. The main challenges facing the directive are lack of transparency, the absence of a clear solution for waste disposal and inadequate participation of the public.

We have also carried out an impact study, which is obligatory before any legislative proposals. Three options were considered: do nothing, simply make IAEA safety standards and the Joint Convention legally binding and enforceable or go further. The first two options are inadequate. As part of its national plan, each member state must seek a permanent solution. There is also the issue of civil society participation, which is essential if the process is not to fail. Finally, there must be no distortion of competition and the burden must not be left to future generations.

The directive would establish very strict and binding standards for the management of radioactive waste and irradiated spent fuel, and would apply to all civilian waste. European Union member countries would also be forbidden to export their waste. On the other hand, several European countries could co-operate among themselves. Let me repeat, to be effective the European level must be based on solid national policies.

Moreover, the new generations of plant will have to produce less waste.

We also have to take account of interdependence. It will be necessary from the outset to consider the nature of sites to ensure that they are fully suitable. The form of management must guarantee long-term safety, which according to IAEA standards means 1000 years or more for certain types of waste. The principle of maximum safety of passive storage is set down in black and white in the draft directive.

Steps must also be taken to guarantee the independence of regulatory authorities to avoid any conflicts of interest. The directive will be very clear on this point.

We also need skilled personnel, which implies proper training, a subject dealt with in the directive alongside that of finance. Reliable storage is impossible without adequate funding.

As I have already announced, the national programmes will be the operational heart of the system. European Union member states will be required to produce detailed inventories of radioactive waste and develop technical proposals at all stages, particularly after the closure of reactors. Storage sites must also be just as safe after their closure. All these constraints call for research and development, but we should not wait for all the answers before we take any action. We have to define each party's responsibilities, draw up a timetable, assess the costs and – I repeat – provide the necessary financing.

The member states will notify us of their national programmes, which we will review. Under the Joint Convention, reports are already required every three years. We will prepare our own report for the European Council and Parliament. We also plan to introduce peer review every ten years.

Let me finish by quoting Seneca: "It is not because things are difficult that we do not dare; it is because we do not dare that they are difficult." With the directive, we hope that every member states will dare.

Mr Jukka LAAKSONEN, Director General of the Nuclear Safety Authority in Finland (STUK) and Chair of the Western European Nuclear Regulators' Association (WENRA) and of the European Nuclear Safety Regulator Group (ENSREG). (*Finland*) Much nuclear waste ends up in poor countries, yet countries with nuclear power stations or research units have been rare to act. Most are content to wait.

The main purpose of the directive is to make sure the principal member states take action. Radioactive waste is a problem now and national authorities have responsibility for its safety.

Spent fuel bundles removed from reactors are highly radioactive and need to be isolated from the environment for a very long time. We also produce 200 to 400 m^3 of low and intermediate level waste, which only needs to be isolated from the environment for a few hundreds of years.

So far no permanent global solution has been found to the storage of highly irradiated fuels, with 70% in interim storage and 30% reprocessed. For more than 15 years, many countries have operated permanent disposal facilities for low and intermediate level waste. The entire life cycle of nuclear fuels therefore needs to be planned to protect the environment and human beings from any radiation, since storage can only be a temporary solution. We have to master new techniques to find a safe alternative since it has to be recognised that, whatever the current or future technologies to manage highly radioactive waste, they will never eliminate it totally.

When it is removed from a reactor, uranium is 400 000 times more radioactive than when it was extracted from the mine. The radioactivity diminishes over time. It is only 7 000 times more radioactive after 40 years, 100 times after 500 years, 15 times after 10 000 and finally regains its original radioactivity after 250 000 years.

Underground storage technology requires us to avoid any contact between radioactive material and groundwater. This means that geological barriers are effective but inadequate and technical barriers remain necessary, so the permanent solution draws on both.

New disposal models should be operational in Finland within the next fifteen years. Our country has a comprehensive approach to nuclear energy, including radioactive waste management, and is based on the following principles: not leaving the burden to future generations, managing our nuclear waste without foreign support and making the process transparent to the public and open to international expert assessment. Moreover, no definitive solution should include the retrieval of radioactive waste, even though such retrieval must remain possible. The deadlines must also be respected.

Finally, in 1994 the Finnish parliament decided not to export any more nuclear waste, whether to Russia or elsewhere. Nor is the import of foreign nuclear waste permitted.

In 1983, the government adopted a strategic three-stage licensing process for waste disposal sites, involving public acceptance and a local authority right of veto, and construction and operating licences that take account of technical safety considerations. Parliament approved the decision in principle in 2000 by 159 votes for, 3 against and 39 abstentions. Research and development programmes have been established, including ones on safety requirements. The regulatory authorities must also monitor the process and annual revisions are provided for to take account of technological advances.

There is a clear definition of each party's role and responsibilities, with the main responsibility resting with the waste producer. Alongside government and parliament, local authorities have an important role in the granting of licences because the law requires municipalities to have the support of the local population. They also have access to all relevant information. The regulatory body monitors safety with the assistance of the International Atomic Energy Agency in Vienna. Technical support and expertise is available. There is a financing system based on a state nuclear waste management fund and the polluter pays principle. Generators of nuclear waste are obliged to present annual estimates of the future cost of managing their existing waste including spent fuel disposal and plant decommissioning.

A laboratory is currently under construction on the Onkalo site to confirm the underground rock characteristics established by research. It should be completed in 2012. The Olkiluoto disposal site, with radioactive waste stored in canisters, should come into operation in 2020. The canisters will be buried 500 metres underground. The five kilometre tunnel should be completed in March 2011. The final disposal site will have several shafts.

I would conclude by stating that the IAEA safety requirements are consistent with the principles of radioactive waste management.

Nils Bøhmer, Bellona Foundation *(Norway)***.** Bellona is a Norwegian NGO founded after Chernobyl in Oslo in 1986. It has offices in Russia, the United States and Brussels.

The nuclear option is claimed to be critical for reducing CO_2 emissions, but we are not convinced. We think that fossil fuels will predominate until 2020, or even 2050. So to achieve the CO_2 objectives by 2050, it will be better to develop carbon capture and storage (CCS) techniques, rather than relying on nuclear power, which will only permit a reduction of some 10 % in CO_2 emissions. Nuclear energy will not save the planet or the climate. It must simply be one part of the energy mix.

Our particular objective is to defend the quality of the waters of the Baltic and Barents Seas, which are important fishing grounds. We are therefore very concerned about what is happening in north-west Russia. When the fish that is caught only contains 0.23 Bq/ kg 137 Cs, it can be considered very pure from a dietary standpoint. This is a very low concentration of radioactivity.

However we have noticed that the main source of pollution in the Barents Sea since the 1970s has been the British nuclear plant at Sellafield. This is still the case despite British accession to the OSPAR Convention, which provides for near zero release of radioactive substances by 2020. Given the current reprocessing capacity in the United Kingdom, we think it unlikely that it will be able to honour this commitment. The only reason why emissions are falling is that the plant is no longer operating at full capacity. Reprocessing units have been shut down but the plant still holds, on sufferance, an enormous stock of unprocessed radioactive waste. We are therefore very pessimistic.

When we started our activities rumours were rife that radioactive waste was being stored in the Barents Sea. The region has a large number of radioactive sources, particularly power stations. Russia's Arctic zone contains more than 10 000 civil radioactive sources and there is a considerable quantity of radioactive waste, which is not always stored according to western standards. Nor should we forget the 25 nuclear submarines in active service in the Barents Sea. Everyone remembers the Kursk drama. In recent years, with aid from the international community the Russian Federation has withdrawn the oldest submarines from service. This represents some hundred reactors, whose fuel rods have had to be stored.

The storage unit in Andreeva Bay, 45 kilometres from the Norwegian border, is also a cause for worry. Waste should be stored there for a maximum of five years. Yet the spent fuel from 90 nuclear submarine reactors is still stored there on an interim basis.

Moreover, in response to the economic crisis, the United Kingdom has reduced its financing of operations at the site and there is no solution on the immediate horizon. Those concerned are increasingly being left to deal with the problem themselves.

In the end, the independence of Russia's regulatory bodies needs to be strengthened.

Mr Peter Wikberg, Research Director, Swedish Nuclear Fuel and Waste Management Company (SKB), *(Sweden).* From 2020 or 2025, until 2075 or 2079, Sweden intends to store radioactive waste from its twelve reactors, 12 000 tonnes in total, in the Forsmark site.

In accordance with the timetable, the licence application will be submitted in March 2011 and construction should start in 2015.

We are currently reckoning on a life-span of nuclear plants of between 50 and 60 years. We still therefore have 20 to 30 years to deal with the question of radioactive waste processing.

The tunnels are dug as and when needed. The storage areas represent 2 km^2. We will dig down 400 or 500 metres.

One of the best ways of dealing with the problem is to consider what basis should be used to assess the safety of radioactive waste management.

In fact, the time horizons are very long and it is difficult to know what will happen in more than 1000 years' time. We therefore have to consider various scenarios and make our calculations in the light of all possible consequences.

In 1976 the Swedish government asked us for data to show that radioactive waste could be stored completely safely. The studies, which started immediately, showed that burying it in granite strata 300 metres deep could be a good solution, though only if we mastered the technology of the canisters, particularly the risk of corrosion.

In 1984 Swedish government declared itself satisfied with the studies carried out - KBS 1, 2 and 3. Following KBS 3 it was convinced of the feasibility of the disposal project, which took all the geological and human parameters into account. The spent fuel bundles would be placed in copper canisters with cast-iron insert and buried 400 metres down.

CLAB, in the centre of the country, is an interim storage site where all waste will be deposited until a permanent site is available. It is first necessary to build a plant to place the radioactive waste in canisters. In Sweden it is transported by boat as the sites are close to the coast.

KBS 3 was launched to acquire the necessary knowledge to build a permanent repository and anticipate CLAB's long-term closure. Safety assessments are necessary

at all stages of the procedure, which is difficult given the gaps in our present-day knowledge and the fact that we have to determine storage safety over 100 000 years. The preliminary and final studies are due for completion by March next year.

We now have the necessary knowledge to obtain the approval of the authorities and the environment court but our work on the management of radioactive waste will have to be continually updated. The site itself will the subject of a major study of importance to both Sweden and other countries.

Mr Joseph O'Reilly, member of the Parliamentary Assembly's Committee on Environment, Agriculture and Local and Regional Affairs, Senator (*Ireland***).** Nuclear energy is effective and relatively clean in terms of CO_2 emissions (just 2%). However the construction process and the transport and storage of radioactive waste and the decommissioning of nuclear power stations contribute to CO_2 emissions.

There is also a clear link between the radioactivity of waste and leukaemia. Up to eight miles around the Sellafield plant there is ten times more leukaemia in the children of the plant. Who has forgotten the terrible consequences of Chernobyl? Similarly Welsh sheep, even though they graze on cleaned land, are not always edible in Europe.

A nuclear reactor produces 25 tonnes a year of highly radioactive fuel, which represents 1% of nuclear waste. More than 60 000 tonnes of spent fuel is stored in Europe.

Most of the radioactive waste will remain dangerous for several thousand years and the methods that have so far been proposed to manage it are unsatisfactory. Moreover, politicians are afraid of taking the necessary decisions on the subject. The whole process is littered with risks.

The Sellafield plant disposes of slightly radioactive liquid waste into the Irish Sea and the North Atlantic. In 2009, the government announced the planned construction of ten new nuclear power stations. Potential sites have already been identified and several plants could be operational by 2018. The risks concern Ireland since the majority of them would be on the west coast of the United Kingdom, close to our shores.

Given that the management of radioactive waste from Sellafield is far from satisfactory, we have to be concerned about the survival of marine species in the Irish Sea and the health of the inhabitants of coastal regions.

There are also numerous worries about the transport of radioactive material, particularly by air. Sellafield radioactive waste is currently regularly repatriated to Germany, Italy, Switzerland and Japan.

A long-term solution is required. Most experts think that natural barriers should be supplemented by technical ones. However such an approach is not applicable to countries with unsuitable geological conditions.

I welcome the proposed European Commission directive. However it will take at least ten years for it to become a reality at national level.

The terrorist risk also needs to be raised, particularly concerning sites. There has to be regular surveillance.

Nuclear fusion is being studied in France but this will take a long time. We must also look more closely at hydrogen and in any event priority must go to renewable energies.

We cannot reject nuclear energy entirely, but it would be paradoxical if, on the pretext of eliminating CO_2, we mortgaged our future.

Mr Rik Vanbrabant, Deputy General Director, Director for Strategy and Diversification, BELGOPROCESS *(Belgium)*. I am responsible for issues relating to radioactive waste management at FORATOM.

The radioactive waste cycle shows that it is produced throughout the world. However there is a difference between the volume of waste and its radioactivity. Extraction produces a large quantity of only mildly radiotoxic waste. On the other hand, spent fuel, of which there is much less, is highly radioactive.

Other branches of activity also produce radioactive waste. Thus the medical and industrial sectors and mineral mining produce waste with a fairly long half-life.

The logistical chain starts with the production of waste. In recent decades enormous efforts have been made across the world to reduce the volume of waste, at the design and operational stages, by decontaminating and recycling spent fuel as far as possible, and when decommissioning plant at the end of its active life. On one Belgian site, for example, 85% of the material used has been recycled for non-nuclear uses, such as road building or the motor industry. The aim is to provide a safe environment for future generations.

But there is still the problem of the long-term management of the remaining waste. Operations have already been undertaken in Finland and Sweden, and research is under way in France and elsewhere. However, these are still distant prospects and we are currently resigned to producing, transporting and processing waste, which raises the operational security problem of how to limit the impact on employees and those living close to nuclear installations.

Pending a solution to the problem of long-term storage, most countries are at the preparatory stage of temporary storage. Nevertheless, we should shortly be reaching the point of permanent storage as various countries start to master the relevant techniques. Some have even already implemented definitive solutions for low radioactive waste. Several countries have made considerable progress with highly radioactive waste and are almost at the demonstration or full-scale stages. The first genuinely operational site should open in 2020 and several other countries plan in the coming years to bury waste deep in the earth.

The safety culture requires us not to mortgage our very long-term future. Everything must be done to ensure that human beings are not faced, tomorrow or in the more distant future, with unanticipated problems There are a number of essential principles governing the establishment of a safe radioactive waste management system.

The first is not to place an undue burden on present and future generations. Those who produce waste must find ways of managing it in the long term rather than leaving the problem to their successors. A whole series of techniques will have to be mastered and applied over a very long period. This calls for an integrated approach that takes account of all the elements in the equation, including the financial aspects.

First we must agree on the definition. Waste is something that cannot be reused. But this does not mean that it is of no further concern and can simply be thrown away. It has to be managed, with the appropriate financing, over the long term, even if, *a priori*, it can no longer be exploited.

This therefore leads on to the polluter pays principle. In many systems, ownership of waste is transferred or transferable, but this must not prevent its proper management. It has been established that waste can be managed temporarily, even over fairly long periods, using a succession of correct interim methods, before an optimum solution is available. So far, we have no defined end point and do not know exactly what form the waste will eventually take and how it might be stored. The key point is not to neglect safety and to use a disposal system that respects the environment.

Clearly, account has to be taken of public opinion and the political authorities and we must always remember that waste management calls for a multipartite approach. Ownership of certain forms of waste may be transferred from the producer to the repository, and sometimes from a private to a public body, but transfer of title of ownership must not pose a threat to safety, whoever owns the waste, at any point in the cycle. To repeat, waste management is a long-term responsibility, which is essential if public confidence is to be maintained. To be effective and secure public support, there must be no break in the waste management system. Society must be sure at all times that the highest standard of safety will be maintained.

The parties to the joint convention have undertaken to adopt appropriate measures to protect individuals, society and the environment against radiological and other risks at all stages.

What are civil society's expectations regarding radioactive waste management? The nuclear industry should pursue its research and continue to mount technical demonstrations to show that it will be able to achieve a safe long-term solution. Research must continue on the selection, design and construction of sites and the situation at these sites must be continuously assessed. The technology will not remain stationary and it is likely that better methods of managing highly radioactive waste will emerge in the future.

The industry will only be able to persuade the public that it is carrying out its responsibilities at all stages if there is the maximum amount of debate. The more citizens know about the problems and the greater their understanding of the techniques used, the more chance there is that the issue will be dealt with calmly. The public want to be certain that the defined safety standards are adequate and complied with. The nuclear industry must do more to promote confidence by inviting third parties to take part in the decision making process.

Belgium, which will certainly be taking decisions very shortly on the final burial of radioactive waste, has established discussion forums for all the stakeholders, including the general public. This is a means not so much of communication as of dialogue and a decision-making tool.

Finally, there is a very long time horizon. Management cycles extend over several centuries or even longer. We must not therefore neglect international co-operation as a means of sharing our knowledge and surveillance responsibilities, with a view to making the best possible choices. The problems are the same both within the European Union and beyond its frontiers.

Mr Alan Meale, Chair of the session. In addition to his official duties, Mr Grachev, is a scientific expert on energy and has been minister of the environment of the Russian Federation. He therefore had the ideal profile for acting as the Council of Europe's liaison person at the Kyoto negotiations and contributing to the signature of the final agreement.

Mr Vladimir Grachev, ROSATOM State Corporation, Russian Federation, former member of the Committee on the Environment, Agriculture and Local and Regional Affairs of the Parliamentary Assembly of the Council of Europe (*Russian Federation*)**.** I have been working on nuclear issues for fifty years. My university thesis was on industrial nuclear power stations even though they did not yet exist! This shows what progress has been made in the space of half a century. For twenty years, the Russian Federation's academy of sciences has been drawing conclusions from this progress.

Parliaments and their environment committees have co-operated a great deal on this subject. Ratification of the Kyoto Protocol is a means of combating global warming. I have been a Russian member of parliament for 18 years and a member of the lower

house for 16. I also belong to Green Light, an association that defends the environment.

The emphasis on electric power highlights its increasingly important role. This is particularly the case in south-east Asia.

If there are no copyright problems, Green Light would like to have access to the material presented by the participants at this conference because this documentation should be available to all.

Nuclear energy made enormous strides between 1962 and 1986. Between 1986 to 2010 the sector was in decline, but a renaissance is promised in the future in all the countries of the world. For objective reasons, the growth of nuclear energy follows a curve in the shape of Mont Blanc. Nuclear power presents clear advantages, particularly economic ones, such as price stability, whereas the price of gas and goal will inevitably rise in the coming years. Oil supplies will eventually be exhausted whereas nuclear energy will remain available. The number of occupational accidents in this sector is very low.

The same objectivity is required with regard to international environmental and energy problems. Waste is indeed a problem. All countries, including Russia, are concerned about how to manage it. I have greatly appreciated Bellona's very objective assessment of maritime pollution. The origin of the radioactive pollution of the Barents Sea is well explained in a prize-winning book. Two issues particularly concern us: waste and climate change.

The actual quantity of nuclear waste produced is not a source of concern, but this waste is increasingly dangerous and radioactive. Some will remain radioactive for more than 250 000 years or even, in the worst scenario, will never return to normal.

Two photographs taken a hundred years apart, at the start of the 20th century and in 2003, at the foot of a hotel belvedere in Switzerland show how far the glacier has retreated. The same is happening in Alaska and Russia. The eternal ice is melting and buildings are collapsing. The situation is very grave.

Other unimaginable problems are appearing, like the forest fires that ravaged Russia this year in unprecedented fashion. Green Light has organised a major conference on the subject and on what needs to be done to combat climate change. Al Gore had predicted that there would be fires on this gigantic scale. A fire on a oil rig in the Gulf of Mexico has also caused unprecedented pollution. The United States does not want this to become a regular event but the animal and plant life continues to suffer the effects of the oil slick. It is a veritable ecological disaster, which only a few small insects are surviving.

Radioactive waste is accumulating and it has to be dismantled, stored and buried. The ultimate solution clearly depends on technological research and development. This is under way and scientists believe that by 2100 it will be possible to process radioactive uranium waste. The way forward seems to be via rapid reactors that can produce 24 million kWh with 1 kg of raw material. The scientists promise us this miracle. Research under way in Andreeva leads us to hope that in a few years time it will be possible to produce 3 billion kWh with just 1 kg of uranium.

To reduce global warming by half, we have to make nuclear power seven times more effective. A complete cycle, taking account of all the parameters described, would involve returning to the soil all of the hundreds of tonnes of earth removed, at the end of a process that was totally devoid of waste and without the disappearance of the uranium ions. The circle would thus be squared using all the properties of nuclear energy. The nuclear risk will always exist, but it must be acceptable and not excessive.

The European Union is giving this matter all the attention it requires. I take a very positive view of its proposed directive providing for the continuation of the European policy of energy mix, including nuclear energy. We have to consider not only the energy risk but also sustainable development in our analyses. Let us start not with the dangers of nuclear energy but with what it can contribute to environmental safety. Human beings are the priority, followed by climate and nuclear waste. And let us not forget that all waste, even non-radioactive, is harmful to the environment.

In two years time I think that we will be very pleased with the ideas that have emerged from this conference.

Mr Alan Meale, Chair of the session. According to whether the figures come from Sweden or Finland, the length of life of radioactive waste is estimated at between 150 000 and 250 000 years. How can such a difference be explained? Where does the truth lie?

I have visited the Ignalina site, which was one of the five biggest energy producers in the world. We really must take account of differences between countries. Lithuania's geology prevents any burial of waste. Is the great European family not bound to offer help to small countries in this situation, who are unable to take the path of processing their waste?

Round table

Moderator Mrs Claude Fischer.

Mrs Claude Fischer, President of Confrontations Europe *(France)*. We have been addressed by supporters and opponents of nuclear energy. However this is perhaps no longer the issue as nuclear energy exists and will continue to exist. The real question is what type of nuclear industry must we establish if we are to contribute to ever-increasing safety in Europe and the world and to the resumption of growth.

What political impetus is needed? Nuclear energy is experiencing a global renaissance but is still managed nationally. Faced with competition from large countries like the United States and China, the European countries cannot count on a continent-wide association for the purposes of co-operation and to speak with a single voice externally. Should we establish a larger area, including Russia, and perhaps even the countries of the eastern and southern Mediterranean, in order to be stronger? This is perhaps the way in which we can preserve our spirit of conquest and leadership.

Mr Vladimir Grachev. All the representatives of the great nuclear powers who have spoken here, particularly those of France, three-quarters of whose electricity is of nuclear origin, and the United States, but also those of Finland and Belgium, have explained that it is the way to resolve one of the gravest problems in the history of humanity, namely global warming. However, all of them have added that this option is littered with pitfalls, that it carries risks. We therefore have to strike a balance, not by dwelling excessively on the risks but by adopting the necessary measures.

The great nuclear powers are thinking along the same lines. We might also organise another conference with Chinese and Indian participation so that they could present their energy policies.

The challenge is to design the least possibly dangerous energy policy. The key issue, given its 250 000 year lifespan, is how to manage waste. The energy strategy must therefore include the treatment of waste. We hope that the projects currently under way, in Russia and France, as in India and elsewhere, will come to fruition in the next

ten years. Super-reactors, rapid reactors, are already functioning. These methods have to be developed.

I propose that we organise a further gathering of this type in two years' time to assess progress and make new recommendations.

The Council of Europe's Parliamentary Assembly can vote resolutions that could serve as the basis for discussions in our national parliaments, and in the Assembly itself.

We should not abuse the word "danger". Our discussions have shown that this danger is not unlimited but can be contained. There is danger everywhere, including situations where it is not expected, and it is easier to counter a known danger.

I therefore propose that the Parliamentary Assembly organise a conference on this subject every two years, at the end of which a report would be presented.

Mrs Claude Fischer, Moderator. Mr Bøhmer, you are a sceptic with reservations about the objective risks of the nuclear option. Should we continue to oppose nuclear energy or look for ways of overcoming these problems?

Mr Nils Bøhmer. Yes of course we must look for solutions to these problems. Nuclear energy will certainly continue to exist but so will nuclear waste. However we have not touched on the question that concerns me most. In ten years' time, Finland and Sweden will be equipped with excellent storage sites but what of the other countries that have not yet made plans for permanent storage? The British are still decades away. In the mean time what will they do with all their highly radioactive waste? Before commissioning new reactors, we should be looking at the issue of permanent storage and searching for appropriate sites.

We are constantly told that nuclear energy is inexpensive, has no greenhouse gas effect and is little affected by variations in raw material prices, but no one has pointed out that nuclear power stations cost a fortune – several billions – to build. The French and Finnish examples are very apposite, particularly as there are always considerable delays in completion and the estimated costs are systematically exceeded. What is the impact of this nuclear bill?

How can we improve security and safety, in Europe but also in the rest of the world? For example, do the new Russian reactors really meet the strictest standards? How can Europe monitor compliance? These are subjects for a future conference.

Mrs Claude Fischer, Moderator. Mr Wikberg, how can Sweden, which has taken such a lead with regard to public opinion, research and the choice of a site, help other countries to make more rapid progress? Would not increased co-operation make a significant contribution to benefit safety in Europe?

Mr Peter WIKBERG. It is difficult to reply. Does nuclear waste represent an advantage or a disadvantage for the future of Europe's nuclear industry? I would personally avoid any value judgments. In any event, nuclear renaissance or not, I agree with my Norwegian neighbour that the issue has to dealt with. Much will depend on our ability to manage the waste. We aim to show that we are capable of it.

Since we do not know what the situation will be in 100 000 years' time, the Finnish and Swedish authorities, and the Swedish regulators, have considered various scenarios with a time horizon of 1 million years, while being aware that it is impossible to predict all that will happen over such a long period.

Radioactive waste, particularly spent fuel, is particularly dangerous at the start. The essential may be to show that the underground storage used will be safe for the first thousand years, the most dangerous phase.

We now have the means of passing on our knowledge and experience to less advanced countries. Those who have not yet planned their permanent storage sites can learn from our experience.

The platform of which I spoke lays great stress on co-operation. I have personally been involved in co-operation for many years. We started by drawing up a document that summarised our vision of the situation. We then collated our ideas and produced a scenario that we compared with our partners' positions. This form of co-operation enables us to be more rapid and rational and to assist those who have not yet got started.

Our opponents accuse us of wanting to build a permanent storage site when the rest have not even started their feasibility studies. I think that being the first is an advantage. Nevertheless, we are not the only ones to be considering this matter and to succeed we will need the encouragement of all our partners. We must convince our authorities, so that in due course they acknowledge that this is the safe option and give the green light. If too much uncertainty remains and our government thinks that it is the slippery slope we will not obtain the licence or at least it will be very complicated. However if we make a convincing case and can show that we are not alone, this will assist us greatly.

Mrs Claude Fischer, Moderator. Will all the nuclear states need to excavate a hole on their territory? Is it not feasible for Finns, Swedes and French to combine forces? This would make it possible to reduce costs, draw up more European proposals and – why not – envisage the construction of a European storage centre. This would not mean that every country was authorised to deposit its waste in a European hole. Very strict criteria would be applied to the large countries and to any that refused to make the relevant information more accessible to the public. It might however mean that countries moving into the nuclear domain did not have to wait fifty years before building a storage site.

Mr Jukka Laaksonen. This is impossible for several reasons. A great deal of co-operation has been attempted, especially between small countries, but the same question arises each time, namely which country will make the sacrifice and drill the hole? I do not think that in the short, or even the long, term any country would voluntarily accept other countries' nuclear waste on a permanent basis. Nor do I think it necessary. The geological composition of the soil makes permanent storage possible in every country. What is most important are the technical characteristics of the bores and the fact that the canisters must not break up or leak. The main obstacles are financial ones. Nevertheless, current resources make the process economically possible.

Mrs Claude Fischer, Moderator. I am not sure that just any country could bore a tunnel 500 metres deep. In an effort to share costs and R&D the Russian have made a regional proposal. In the absence of a European option, countries that lack the resources may be tempted to turn to Russia.

Mr Vladimir Grachev. Russia is not going to accept all the planet's waste but it is not appropriate to deposit nuclear waste in countries with very unstable political regimes. I think that within ten to fifteen years, countries will have all matured sufficiently to allow the international community to select a storage location. The IAEA, other organisations and other experts share my opinion. When I chaired the Duma's environment committee, there was a major debate on whether Russia should import spent fuel, after which we examined proposed legislation. We currently import from Slovakia, the Czech Republic and other countries and we do not refuse waste from Ignalina.

I believe that the problem is less geological than political. Any country can find an appropriate site. Moscow produces 20 millions tonnes of household waste, which means 60 000 tonnes in one small district of Moscow! The guarantees should apply not just to centuries but to millennia and certain countries, which for politeness sake I will

not name, must find political solutions. The international community might agree to bury waste in places claimed by several countries, islands or isolated locations.

After the Chernobyl disaster I took part in the work of the Supreme Soviet of the Soviet Union. Progress was made and I think that there will be still more change in the next twenty years. Technological processes will enable us to resolve all the problems, including that of waste, permitting a complete nuclear cycle.

Mr Nils Bøhmer. In the case of permanent storage, the main difficulty will be to find, after a democratic process, a recipient area willing to accept a properly equipped site. Finland and Sweden have had great difficulty finding one. Mass protest movements have been organised, particularly as people think that their country will become the depository for the whole of Europe and that it will eventually import radioactive waste from its partners. If such an approach is contemplated, I do not think that anyone will accept it voluntarily. Countries must all do everything possible to find an appropriate site in their own territory.

Closure Session

Mrs Claude Fischer, Moderator. Europe has a responsibility to develop a joint nuclear policy, which it is far from doing. It has certainly made certain progress on safety and waste management but it has not established a market framework that would benefit a globally competitive industry. Our joint discussions should perhaps focus on the most favourable conditions for developing our nuclear industry and increasing our share of the international market. Europe will achieve these objectives if its nuclear industry is the safest and most economical in the world.

I would draw your attention to the proceedings of the colloquy I have just organised in Budapest under the patronage of the European Commission, with participants of some fifteen nationalities. We considered the economic, financial and social issues inherent in the development of nuclear energy.

Since the economic and financial crisis is not yet over, it is very difficult to mobilise the long-term investments such an industry requires, particularly as in Europe public guarantees are deemed to be state aid. One or two contracts have been signed, but by derogation from the competition rules. The market therefore discriminates against nuclear energy, which is deprived of freedom of circulation within Europe.

The different European protagonists are at war with each other, even within countries, whereas they have to respond to ferocious global competition. It would be a great shame if Europe, which suffers from poor industrial and employment growth, were to deprive itself of a nuclear industry as a complement to the other energy sectors. We need all our resources to respond to the explosion in demand and to the climate challenge. Countries that do not want a nuclear industry do not have to adopt this option, but they should accept that Europe has chosen a nuclear policy. Europe will then be able to play its role in the world – a challenge for us all!

Your conference has been a further stage, and there will be others, in the process of developing much more dynamic European industrial policies.

ANNEXE I

Programme

Thursday 25 November 2010

13.30 Registration of participants

14.00 Welcome speeches by:

Mr Aleksei LOTMAN, Chair of the Committee on the Environment, Agriculture and Local and Regional Affairs, Parliamentary Assembly of the Council of Europe

Mr Herbert REUL, Member of the European Parliament, Chair of the Committee on Industry, Research and Energy

14.10 – 15.40 **SESSION 1**

NUCLEAR SITUATION IN EUROPE AND THE REST OF THE WORLD

Chair: **Mr Aleksei LOTMAN**, Chair of the Committee on the Environment, Agriculture and Local and Regional Affairs, Parliamentary Assembly of the Council of Europe

Speakers: **Dr Atam RAO**, Section Head of the Nuclear Power Technology Development Section, Division of Nuclear Power, International Atomic Energy Agency (IAEA), Vienna (Austria)

Mr Paul H. GENOA, Director, Policy Development, Nuclear Energy Institute (NEI), Washington D.C., USA

Mr Peter FAROSS, Director, Nuclear Energy – DG Energy, European Commission

16.00 – 17.30 **SESSION 2**

NUCLEAR IMPACT ON CLIMATE CHANGE

Chair: **Mr John PRESCOTT**, Vice-President of the Parliamentary Assembly and First Vice-Chair of the Committee on the Environment, Agriculture and Local and Regional Affairs, Parliamentary Assembly of the Council of Europe

Speaker: **Dr. Hans-Holger ROGNER**, Head of the Planning and Economic Studies Section, Department of Nuclear Energy, International Atomic Energy Agency (IAEA), Vienna (Austria)

19.00 Reception given by the Mayor of Strasbourg, Mr Roland RIES in the City Town Hall (Hôtel de Ville, entrée Place Broglie)

Friday 26 November 2010

9.30 – 11.00 **SESSION 3**

NUCLEAR POWER AND ECONOMY

Chair: **Mrs Biruté VÉSAITÉ,** member of the Committee on Economic Affairs and Development of the Parliamentary Assembly of the Council of Europe and MP of the Lithuanian Parliament

Speakers: **Dr Ralf GÜLDNER**, President of FORATOM, Vice-Chair of the Board of Management, E.ON Kernkraft GmbH, Germany

Professor Riitta KYRKI-RAJAMÄKI, Lappeenranta University of Technology, Finland

Professor Dr Ing. Alfred VOSS, Institute of Energy Economics and the Rational Use of Energy, University of Stuttgart, Germany

11.00 – 12.30 **SESSION 4**

EDUCATION AND TRAINING IN THE NUCLEAR FIELD

Chair: **Dr Romana JORDAN-CIZELJ**, Member of the European Parliament

Speakers: **Professor Joseph SAFIEH**, Study Director, National Institute of Science and Nuclear Techniques, France; President of the European Nuclear Education Network

Mr Jean-Claude GAUTHIER, Director of the European Nuclear Energy Leadership Academy (ENELA), Munich, Germany

14.00 – 16.00 **SESSION 5**

NUCLEAR SAFETY AND WASTE MANAGEMENT

Chair: **Mr Alan MEALE**, MP, Chair of the Sub-Committee on Local and Regional Democracy, Committee on the Environment, Agriculture and Local and Regional Affairs, Parliamentary Assembly of the Council of Europe

Speakers: **Mrs Ute BLOHM-HIEBER**, Head of Unit H2, DG Nuclear Energy, Transport and Waste Management, European Commission

Mr Jukka LAAKSONEN, Director General of the Nuclear Safety Authority in Finland (STUK) and Chair of the Western European Nuclear Regulators' Association (WENRA)

Mr Nils BØHMER, Bellona Foundation, Norway

Mr Peter WIKBERG, Research Director, Swedish Nuclear Fuel and Waste Management Company (SKB), Sweden

M. Joseph O'REILLY, Senator, Irish Senate, member of the Committee on the Environment, Agriculture and Local and Regional Affairs of the Parliamentary Assembly of the Council of Europe

Mr Rik VANBRABANT, Deputy General Director, Director for Strategy and Diversification, BELGOPROCESS, Belgium

16.00 **ROUND TABLE** with the participation of a moderator, **Mrs Claude FISCHER,** Chairperson of "Confrontations Europe"

16.45 **CLOSING SESSION**

Conclusions by:

Mr Vladimir GRACHEV, ROSATOM State Corporation, Russian Federation, former member of the Committee on the Environment, Agriculture and Local and Regional Affairs of the Parliamentary Assembly of the Council of Europe

Mrs Claude FISCHER, Chairperson of "Confrontations Europe"

17.00 Close of the conference

Final list of participants /

Liste finale des participants

Parliamentary Assembly (PACE) / Assemblée parlementaire (APCE)

Members of the Committee on the Environment, Agriculture and Local and Regional Affairs / membres de la Commission de l'environnement, de l'agriculture et des questions territoriales

NAME / *NOM*	**Country / *Pays***	**Title, parliament / *Titre, parlement***
Mr AÇIKGÖZ Ruhi	Turkey / *Turquie*	MP, Turkish Parliament / *Député, Parlement turque*
M. ARIAS CAÑETE Miguel	Spain / *Espagne*	MP, Congress of Deputies / *Député, Congrès des Députés*
Mr HARANGOZO Gàbor	Hungary / *Hongrie*	MP, National Assembly / *Député, Assemblée nationale*
Mme JOHN-CALAME Francine	Switzerland / *Suiss*	National Councillor, National Council / *Conseillère nationale, Conseil National*
Mr KOÇ Haluk	Turkey / *Turquie*	MP, Turkish Parliament / *Député, Parlement turque*
Mr LOTMAN Aleksei	Estonia / *Estonie*	MP, Chairman of the Committee / *Député, Président de la commission*
Mme MARIN Christine	France	MP, National Assembly / Députée, *Assemblée nationale*
Mr MARMAZOV Yevhen	Ukraine	MP, Supreme Council of Ukraine / *Député, Conseil Suprême de l'Ukraine*
M. MARQUET Bernard	Monaco	MP, National Council of the Principality of Monaco / *Député, Conseil National de la Principauté de Monaco*
Mr MEALE Alan	United Kingdom / *Royaume-Uni*	MP, House of Commons / *Député, Chambre des Communes*
M. NESSA Pasquale	Italy / *Italie*	Senator / *Sénateur*
Mr O'REILLY Joseph	Ireland / *Irlande*	Senator, Irish Senate / *Sénateur, Sénat irlandais*
Mr PAPACHRISTOS Evangelos	Greece / *Grèce*	MP, House of Parliament / *Député, Chambre de Parlement*
Mrs PAPADIMITRIOU Elsa	Greece / *Grèce*	MP, House of Parliament / *Députée, Chambre de Parlement*
M. POPESCU Ivan	Ukraine	MP, Supreme Council of Ukraine / *Député, Conseil Suprême de l'Ukraine*
Mr PRESCOTT John	United Kingdom / *Royaume-Uni*	House of Lords / *Chambre des Lords*
M. de PUIG Lluís Maria	Spain / *Espagne*	Senator / *Sénateur*
M. ROBLES OROZCO Gonzalo	Spain / *Espagne*	MP, Congress of Deputies / *Député, Congrès des Députés*

M. ROUQUET René	France	MP, National Assembly / *Député, Assemblée nationale*
M. RUSSO Giacinto	Italy / *Italie*	Senator / *Sénateur*
M. SEVENHANS Luc	Belgium / *Belgique*	Senator / *Sénateur*
Mr TIMCHENKO Vyacheslav	Russian Federation / *Fédération de Russie*	MP, State Duma / *Député, Douma*
Mr ÚLEHLA Tomàš	Czech Republic / *République Tchèque*	MP, Czech Parliament / *Député, Parlement tchèque*
Mr ÜNAL Mustafa	Turkey / *Turquie*	MP, Turkish Parliament / *Député, Parlement turque*
Mr ZHIDKIKH Vladimir	Russian Federation / *Fédération de Russie*	Member of the Federal Council, Council of the Federation / *Membre du Conseil Fédéral, Conseil de Fédération*

Also present / *Egalement présente*

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