THE ENERGY CHALLENGES AFTER FUKUSHIMA

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Evenimentele de la centrala nucleara de la Fukushima, din Japonia, au avut un impact deosebit asupra politicilor energetice la nivel mondial, cu reale consecinte asupra perceptiei opiniei publice fata de energia nucleara, planificarilor energetice la nivel UE, precum si asupra pretului combustibililor fosili, datorita cresterii cererii in vederea inlocuirii surselor nucleare. Autorii au identificat cateva din problemele cu care ne confruntam in prezent, subliniind impactul politicilor UE asupra pretului electricitatii si suportabilitatii la consumatorul final din Romania.

The events at Fukushima nuclear power plant, in Japan, have had a great impact on the energy policies worldwide, with real consequences on the public perception on the use of the nuclear energy, on the energy planning at the EU level, as well as on the price for the fossil fuels, due to the increasing demand for replacement of nuclear fleet. The authors have identified some of the challenges that we face today, in a critical economic environment, underling the impact of the EU policies on the electricity price and affordability to the final consumers in Romania.

Keywords: energy, electricity cost, nuclear, energy mix, affordability, public acceptance, policy decisions, climate change

Note: This article presents personal opinions and not the official position of the Permanent Representation of Romania to the European Union (EU)

1. Introduction

The last ten years has been a period of intense activity in the field of European energy policy, with the three legislative packages at EU[3] level adopted, having the goal the creation of a new basis for competition and regulation in power and gas markets while tackle the great challenges in the climate change area. All these actions have significant implications on the way energy is produced and consumed going forward.

The switch from high carbon to low carbon generation needs to happen as quickly as prudent security of supply considerations will allow. This involves the commercialization of a variety of emerging low carbon generation options and

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financial incentives and regulatory frameworks that ensure timely disinvestment and retirement of high carbon assets and investment in sufficient replacement low carbon assets.

Following the Fukushima accident and giving the need for infrastructure to deploy the huge amount of RES[4], due to some changes in the energy planning across the EU, the Commission[5] presented in June 2011 a working paper named "Energy infrastructure investments need and gaps"[2] which highlights the necessary infrastructure, without which cost-effectively reaching the EU's 2020 energy and climate targets will be impossible, while keeping in mind the major uncertainties surrounding the future of the energy sector. Acknowledging the challenges, the Commission analyzed also the obstacles, which would – under business-as-usual assumptions – prevent these investments from taking place or delay them far beyond the 2020 deadline.

Japan's nuclear crisis has left many countries reviewing their plans to build reactors as well as agreed on the consensus that all the nuclear power plants in the EU and worldwide should undergo a comprehensive safety and security assessment (stress test). Following the peer-review process and recommendations, the EU countries will have to take decisions on how to follow up the outcome of the assessments; decisions on individual installations remain a national responsibility. In cases an upgrade is technically or economically not feasible, reactors may have to be shut down and decommissioned. Such decisions could have significant implications on the competitiveness of the nuclear capacities and consequences on the electricity price to the consumers.

In case of Romania, we expect that the Cernavoda nuclear power plant will pass the "stress test", after the evaluation by the group of independent experts and the European Commission. Nevertheless, some investments will result as the outcome of the assessments, in order to upgrade the level of nuclear safety and security. Such investments might affect the electricity price to the final consumer by the impact on the electricity price delivered by SN Nuclearelectrica SA to the market.

2. Energy Road Map 2050

To shape energy and power framework for 2050, policy decisions are very important. The Energy Road Map 2050[3], under preparation by the Commission, foresees the assessment of the decarburization options in the energy sector while keeping in mind the EU objectives of security of supply and competitiveness. The addressed policies in this domain are of very different nature and at very different stages of development: climate policy and carbon price, security of supply &

[4] Renewable Energy Sources
[5] European Commission

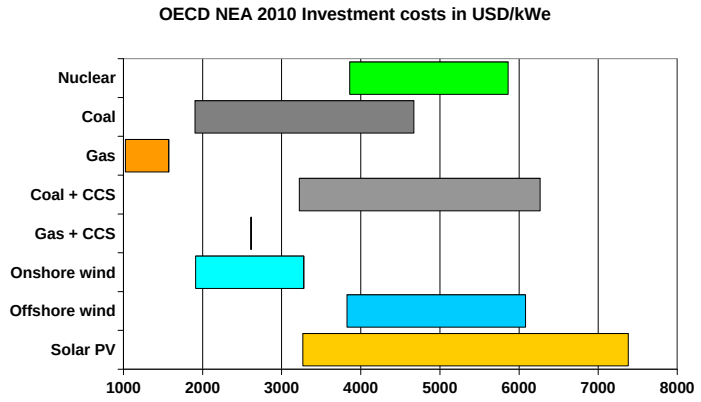
electricity market policies, level playing field policies, safety and waste management policies. The regulatory stability/predictability is an element of utmost importance in the energy sector because of the very long lifetimes of investments.

The global RES targets of 20 % imply that by 2020 Europe will have a 34% RES share in its electricity generation mix. These plants presently get priority dispatch in the market and this is expected to continue for the years to come in order to provide a support for their entry into the market at a time when they are not (yet) competitive. One aspect in question is the implication of this target, of 34 % RES in the electricity generation, on the stability of the electricity supply and the impact on the operation of the conventional base load plants. The significant number of studies [4] shows that the existing nuclear plants are highly competitive in base load mode and most probably, up to 2020, the nuclear generation in the EU will merely continue to rely on the existing plants. Decisions on Long Term Operation will have to be taken in the coming ten years since the average lifetime of nuclear power plants in the EU is reaching 30 years.

The consequences on the EU energy infrastructure of the partial shut-down of nuclear fleet or a decision for phasing-out of nuclear units in EU would have huge implication on the security of supply and on the affordability of the electricity price to final consumers, across Europe. Therefore these aspects have to be assessed accordingly before taking any decision related to the future role of nuclear energy in EU energy-mix.

It is important to recall the results for Europe of the OECD-NEA[6] study on "Projected Costs of Generating Electricity" [5] which reaffirm Nuclear's strength to deliver significant amounts of very low carbon base load electricity at cost stable over time.

OECD-NEA study on "Projected Costs of Generating Electricity" (2010 Edition)



[6] Organization for Economic Co-operation and Development – Nuclear Energy Association

Here under are presented the investment costs ranges for EU 27 countries for various energy sources. Nuclear shows, when used for base load electricity supply, competitive economical performance; its competitiveness vis-à-vis (largely imported) gas is strongly determined by prices of gas, its competitiveness vis-à-vis (largely domestic) coal as well as gas is strongly determined by CO_2 prices and in the future by the cost of CCS.

3. Japan's nuclear crisis

Japan's nuclear crisis has left many countries reviewing their plans to build nuclear reactors. Emerging countries generally depend less on nuclear power than developed ones – but their capacity has often been rising more quickly, with big plans for more.

3.1 The reaction of the international community

Nuclear power accounts for about 14% of electricity generation worldwide; total nuclear generation has hardly changed since the start of the decade. European industrialized countries as a whole depend on nuclear power for about a quarter of electricity generation. Output has marginally declined since the start of the decade. In Asia, Africa and Latin America nuclear power supplies no more than 4 per cent of electricity generation but in some areas – particularly Latin America and China – its share has been rising rapidly.

After Fukushima nuclear accident, most countries reacted promptly, recognizing the severity of the situation and the need to reassess the nuclear safety for all the existing nuclear reactors. Domestic in-depth safety reviews (stress tests) of national nuclear fleet have been decided in European Union, China, Korea, Russian Federation, and USA. A G8-NEA[7] seminar on Fukushima nuclear accident and nuclear safety took place on 7 June 2011, while the Forum for heads of nuclear safety authorities was held on 8 June 2011. An action plan on global safety standards, stronger peer-reviews and better accident management were discussed at the IAEA[8] Ministerial meeting, on 20-24 June 2011, and are to be endorsed by the General Conference in September 2011.

Despite the Fukushima accident, many countries like USA, France, Russia, Korea, United Kingdom, India, Czech Republic, Romania, Turkey, Poland and Indonesia announced that will continue to support nuclear power. Japan announced a review of the existing plan for nuclear power, with more RES and imports.

[7] Group of Eight major economies (France, Germany, Italy, Japan, United Kingdom, United States, Canada, Russia)

[8] International Atomic Energy Agency

Despite China's announcement, after Fukushima accident, that it had suspended approval for nuclear plants across the country, it is hard to believe that the country will put the brakes on a development programme that accounts for almost 40% of the world's planned reactors – the country currently has more than 25 reactors under construction with more due to start construction soon. Brazil, the second fastest-growing country, has been expanded the nuclear fleet, with its second reactor started operating and doubled its nuclear capacity and third reactor being under construction.

India and Pakistan are planning to expand their nuclear output, in spite of being outside the Nuclear Non-Proliferation Treaty, due to their weapons programmes. Both countries have developed indigenous nuclear industries. In Pakistan a new reactor should start commercial operation this year and the country has plans for four Chinese reactors in the future.

The most dramatic decisions have been taken by Germany and Italy. Germany shut immediately reactors operational before 1980 and announced that all other reactors would be closed by 2022, effectively reversing a decision taken in 2010 to delay a previous phase-out plan agreed in 2001 while Italy decided by referendum in June 2011 to impose a permanent ban on the introduction of a nuclear power programme.

The economists predict a decade of growth for nuclear power with only a marginal impact from the Fukushima accident. Some of the accident's policy effects have been large and far-reaching - such as the radical abandonment of nuclear power in Germany and Italy - but other nations will pursue nuclear technology essentially as before. While Germany's early closure of eight reactors, with the rest likely to follow before 2022, makes a dent in capacity, this is offset by equivalent new build in France and the USA. Furthermore, far larger new build programs are coming from Russia, India and China, which on its own will add almost five times the capacity that Germany plans to shut by 2020.

Economist Intelligence Unit, 2011 [7]

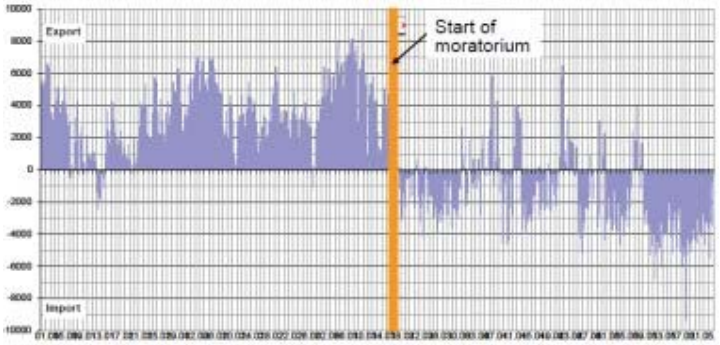
	Net nuclear capacity (GWe)			Change in capacity 2020v2010	
	2010	2015	2020	%	GWe
United States	101.1	103.4	109	8	7.9
France	63.3	64.8	66.4	5	3.2
Japan	46.8	45	44.7	-5	-2.1
Russia	22.7	29.7	41	81	18.3
Germany	20.5	11.7	9	-56	-11.5
South Korea	18.7	24.2	28.1	50	9.4
Ukraine	13.1	13.1	16.2	23	3.1
Canada	12.6	12.6	15	19	2.4
China	10.1	37.1	63.1	527	53
Total	**319.8**	**351.2**	**405.2**	**27**	**85.3**

The reasons for this are that nuclear energy is a response to long-term trends, and hence not easily abandoned or replaced. The need for new sources of electricity to power economic growth persists, and the promise of nuclear in bolstering energy security and reducing carbon emissions makes it an appealing option.

3.2 Consequences of the Germany decision

The Germany decision to give up to nuclear contribution to developing a sustainable, environmentally friendly energy policy, left Germany with “only just adequate" power generation capacity, very little in reserve for times of high demand and a deficit of about 1000 MWe in the south west - as well as strained north-south and east-west connections. Such moves created not just a German problem but a European one as well:

- Germany will import more nuclear generated electricity from its neighbors, France and the Czech Republic (who still use the old soviet style reactors) and will also have to import more natural gas from Russia (and coal from Poland), which makes the country even more dependent on Moscow for its energy supply. The figure below shows what the moratorium on nuclear power, announced by Chancellor Angela Merkel on March 2011, meant for the Germany power system; the shutdown of eight reactors, made Germany a net power importer.



The shutdown of eight reactors made Germany a net power importer
(Image: Bundesnetzagentur; Data: ENTSO-E)

- Germany's new need for natural gas, coal and oil will push up energy prices for the rest of the EU - higher electricity costs will also project into the prices of consumer products. German and other EU consumers will see sharp increases in their energy bills as Germany is forced to import more electricity and pay for fossil fuels to generate electricity in-country while already built nuclear reactors sit idle and more are decommissioned;

- Germany's unilateral decision will impact the competitiveness of not only German industry but of the rest of Europe's as well - which is already under pressure from an overvalued currency; a switch from nuclear power to alternative forms of energy could cost Europe's top economy up to 2 billion euro per year, according to the German Economy minister;
- Germany's speedier exit from nuclear power will cost households and industry an additional 32 billion euro in higher electricity bills, quoted by a study commissioned by the German Economy minister;
- The European financial analysts estimate that Germany's move, to put coal fired power "back on the agenda", will result in about 400 million tons of extra carbon emissions by 2020. This will cost European Union countries as much as 7.5 billion euro per year as price for emission certificates for carbon dioxide rise by as much as 5 euro per metric ton, estimated by RWI institute in Germany.

In conclusion, the Germany decision consequences on the European energy market have demonstrated that such political decisions have to be taken on clear and realist basis, in particular, clarity on the timing and duration of shutdowns of generation capacity, in order to ensure secure system operations and network development planning and accurate and precise information for TSOs[9], to predict and forecast generation capacity and demand in order to deliver security of supply, at national, regional and European level.

3.3 Stress Tests of the nuclear power plants

Following the disaster at Fukushima on 11 March 2011, there was not only a wave of solidarity and assistance to Japan but also the rapid realization that the lessons of the nuclear accident would have to be drawn not only for Japan's nuclear sector but worldwide. This triggered a series of meetings and events at the EU and international level, where there has been a consensus that all the nuclear power plants in the EU and worldwide should undergo a comprehensive safety and security assessment (stress test).

A strict calendar was established at the European level regarding the terms for operator's reports, for the national reports submissions to the Commission and for independent peer-review of the process. The European Commission will report preliminary to the European Council [6] in December 2011 about the outcome of the stress tests and by the middle of 2012, the Commission will submit to the Council the final report with the outcome of the whole process.

The stress tests are assessments conducted on a voluntary basis by independent national authorities and evaluated through peer reviews. The results of the assessments will be discussed publicly with different stakeholders. That means that all the national reports, results of peer reviews and the report of the

[9] Transmission System Operators

Commission to the Council will be made public. Any subsequent measures will be also made public. The only exception to this rule concerns specific security related information, for which Member States have restrictions. The peer-review mechanism is essential to guarantee the credibility and accountability of the process. The peer teams will review the 14 national reports of Member States[10] that operate nuclear power plants and of those neighboring countries that accept to be part of the process.

Following the peer-review process and recommendations, the Member States will have to take decisions on how to follow up the outcome of the assessments. Decisions on individual installations remain a national responsibility. In cases an upgrade is technically or economically not feasible, reactors may have to be shut down and decommissioned.

The European Council called for similar stress tests to be carried out in neighboring countries and worldwide. Neighboring countries that operate nuclear installations are Switzerland, the Russian Federation, Ukraine and Armenia but special attention will be given to the cooperation with countries that have plans for the development of nuclear power, like Turkey and Belarus.

The nuclear security issue is a very sensitive aspect due to the complexity of it and the diversity of the situation existing in the Member States regarding the responsibilities and the authorities involved in this field. It was agreed at the European level that the security threats and the prevention and response to incidents due to malevolent or terrorist acts should be assessed in a broader process, with the various authorities involved. The results of their assessment will be included both in the preliminary report of the European Commission to the European Council in December 2011 and in the final report of the Commission to the European Council in June 2012.

The outcome of the stress tests must be a well based and comprehensive response to the concerns of civil society which could lead to greater understanding of the need for a diverse energy mix minimizing fossil fuels. Meeting the EU climate change targets depends on positive support from civil society for a range of low carbon energy sources. The debate about the future energy mix is ongoing and a sustainable outcome depends on public understanding and confidence. These safety tests need to generate a high level of trust.

3.4. Impact of Fukushima accident on nuclear power

On the medium term, the accident will slow the development of nuclear power, due to the strong impact of it on the public opinion. The two main objectives of the stress test are to contribute to the continuous improvement of nuclear safety and to reinstall the public trust which has been seriously affected

[10] Member states of the European Union

following the events at Fukushima. In this respect, the lessons learnt from Fukushima need to be integrated in the design and the sitting of new plants and enhanced safety measures must be implemented from the results of the safety reviews on the existing nuclear plants. The external hazards need additional treatment and have been considered in a broad evaluation of the nuclear safety. Today, the alternative to nuclear is fossil fuel or hydro but not to underestimate that nuclear energy has saved approx. 65 Gt of CO2 emissions from 1971 to 2007 (total from electricity generation: 250 Gt).

On the long term, several factors may well support nuclear power: electricity demand is expected to triple by 2050 while CO2 emissions will have to decrease (by up to 80%); upward electricity prices unlike 70s & 80s, with high geopolitical risks for oil and potentially gas; RES can't yet be deployed at large scale (infrastructure needs, self efficiency in question); Generation III reactors have enhanced some more passive safety while technical lessons to be learnt will increase even more their safety and that of the existing fleet.

Most of the nuclear development will take place in Asia and specifically in China and India; these countries have maintained their objective of a wide deployment of nuclear reactors.

In conclusion, the Fukushima accident will slow nuclear growth and another accident could end it as a long term option, despite the relative safety of nuclear. There may be a renewed polarization between developed and developing countries that will see Europe and USA decrease nuclear shares, not necessary just because of the accident. For Europe, the ability of nuclear to integrate with RES is a key, since shares of RES will increase and network management becomes of greater importance.

However, lack of alternatives at large scale and increasing energy demand in many countries will support inclusion of the nuclear power in the energy mix. In particular, nuclear development in China and India are still likely to increase. In terms of safety, new reactors and especially small modular reactors were already designing for much longer loss of power (passively and actively) with systems to ensure containment integrity (e.g. core catchers). Generation IV reactors could bring a new era in the nuclear deployment.

Overall, however, the ability to re-build trust with the public will determine the future of nuclear.

4. Public debate on energy policy

One of the main conclusions of Eurobarometer [8] is that the decisions on energy issues in general and the use of nuclear energy in particular are of the most preferable subjects to be discussed and debated publicly. Against views of civil society on essential new energy infrastructure, including nuclear and the

background of the new EU energy challenges, it is extremely important to develop a greater engagement with the public and a better understanding of the technologies, how their risks are understood and perceived and how to establish effective communication between all the stakeholders prior to decision-making.

The perception of nuclear energy as a threat [9] calls for more initiatives in the perspective of future global expansion of the energy technologies. The new advanced generations of nuclear technologies and the legally binding requirements for nuclear safety, established at the EU level, are dedicated to reduce at minimum possible the risks of nuclear accidents. The same approach is necessary at the international level, considering that any serious accident anywhere over the world would have a strong negative impact, reinforcing the perception of nuclear power as a threat (as an example, the accident at Fukushima).

Meanwhile, other sources of energy suffer from poor public acceptance and local opposition to new installations: coal fired power plants, windmills, carbon capture and sequestration, LNG[11] terminals of gasification. These new advanced energy technologies are not free of controversy. Perception holds a growing importance in energy policy decision-making and it can sway policy decisions.

The political support and public acceptance are essential for nuclear future. It is well known that a clear and stable decision on the role of nuclear power in national energy policy is a prerequisite for investors to make funding decisions and to maintain competitiveness. In the current financial environment, private investors are increasingly concerned about the risks of projects, bringing increasing calls for public intervention to provide long term assurances. In order to rise the public awareness about the new energy challenges, in energy production, use and supply, the public has to be informed about the nuclear energy in an overall energy context, where the energy sources, which can play a role in the EU reaching its targets to decarbonizes EU energy sector in the future, should be tackled equally, taking into account all the pros and cons of each energy technology. Transparency has to be increased; the information process has to be robust and transparent in order to build and maintain public confidence at national and European level.

4.1. Public acceptance

Trust is missing: The lack of public acceptance of nuclear energy in Europe, as a threat to future development of the technology, had already existed, before Fukushima. This was illustrated in the Eurobarometer, published in 2010. Nuclear energy continues to be a controversial issue and a challenge from the

[11] Liquefied Natural Gas

point of view of public opinion, especially because nuclear power often is associated with risks, such as: lack of security against terrorist attacks in nuclear power plants, the misuse of radioactive materials (proliferation) and the disposal of radioactive waste.

Contrary, three main aspects related to nuclear energy, such as, the contribution of nuclear energy in fighting climate change, the contribution of nuclear energy to the security of energy supply and the positive impact of nuclear energy on electricity prices, are the most unknown information for EU public.

Interestingly also, there is no indication of stronger opposition in the Member States using nuclear energy intensively than in Member States not engaged in this option. Moreover, support is generally stronger in the vicinity of nuclear plants than in the country average. That would suggest that prolonged and expanded utilization in the future is not bound to generate worsened acceptance.

The ability to re-build trust with the public will determine the future of nuclear energy. Also, the ability of nuclear to integrate with renewable is a key issue, since shares of renewable will increase and network management becomes of greater importance.

5. Conclusions

Nuclear energy is a low carbon technology and may have a huge contribution to the decarbonization of the European Union. From this perspective, the competitiveness of nuclear power on its way to a more sustainable, less carbon intensive and secure electricity production and such conclusions, as, base load nuclear is inflexible and therefore incompatible with the large-scale integration of variable RES, have to be analyze for and better understanding the interaction with impact of the development of the super/smart grid of the future, on nuclear power as a contributor to the longer term low carbon energy supply mix of the EU. In the same time, competitiveness of nuclear energy can no longer be restricted to economic attractiveness but should address issues of environmental impact and social acceptance - in short, the degree of sustainability [9].

In order to meet the country's energy need and environmental objectives, the Romanian government has not changed its commitment to nuclear contribution in the national energy mix. Quoting the competent authority, CNCAN[12], the preliminary results of the stress test have demonstrated that the two units in Cernavoda nuclear power plant meet the project safety requirements and provide a sufficient safety margins to cope with severe external events such as, powerful earthquake, flooding, the loss of electricity supply, of cooling system or combination of them. During the assessment under the various crises scenarios,

[12] National Commission for the Nuclear Activities Control in Romania

opportunities for additional improvements have been identified, in order to increase the safety margins. A detailed actions plan and solutions for implementation will be presented in the final report on the stress test, by the end of 2011.

In the described context and considering the three main objectives in the energy field, security of supply, competitiveness and low-carbon electricity at the affordable price to final consumers, the authors have identified a few important issues needed to be addressed in the near future in Romania:

- To re-asses the country's energy potential (energy producer or importer) and to move as fast as possible with the needed investments, while paying a great attention to the decisions under approval at EU level. Such decisions will impact the investors' interests and financial institutions degree of the confidence on various projects.
- To draw up a new energy strategy, based on 2 or 3 scenarios of energy mix, with flexible paths and different alternatives. Having in view the long term perspective for the energy projects, the decision makers should take into consideration the timescale of deployment of new low carbon energy sources, the compatibility of the capacity payments schemes for different sustainable technologies as well as maintaining an affordable electricity price to the consumers. In this respect, the decision on energy scenarios have to be flexible, taking into consideration all the challenges, technical, societal, environmental and economic ones [10].

It is essential to avoid making irrevocable decisions that would implicitly entail adopting any particular energy mix scenario, by opting for technologies prematurely without first checking their feasibility. Such decisions could have a huge impact on the electricity price, leading to the unaffordable burden on the population. It is necessary first to ensure the validity of the energy scenarios, and conduct a detailed technical and economic study. In the same time, it will be essential to ensure that technological developments and the operation of the markets will not be detrimental to consumers' main expectations: a stable and secure supply at affordable prices.

- To make an assessment of the various factors which might influence the electricity price and the investment environment in the near future, such as: political decisions taken by some countries to shutdown and phase-out or not to continue with nuclear; the increasing price for fossil fuels (oil, coal and gas) due to the need to replace the nuclear fleet and to assure the back-up for the foreseen deployment of RES into the grid [11]; an uneconomic support schemes to support RES and necessary grid infrastructure investments, to cope with rapid phase-out of nuclear units. The investments resulted from the stress test for units 1 and 2 from Cernavoda nuclear power plant could also have an impact on the electricity

price in Romania as well as on the investment cost for the new project of units 3 and 4 at Cernavoda nuclear power plant.

- To assess the capabilities of the national authority for nuclear activities control, CNCAN, in order to cope with the various responsibilities and duties at the national, European and international level. The current and future developments in the nuclear regulatory framework, emphasizes the strong responsibilities of the national nuclear authorities in assuring, maintaining and improving the safety of nuclear installations in their country. Since Fukushima nuclear accident, CNCAN has been continuously involved in the debates in different *fora* and working groups, at the EU level and at the global level, dedicated to identify ways to enhance the nuclear safety framework.

A possible revision of nuclear safety directive, revisions of the international Conventions in the nuclear field, possible revision of the EURATOM Treaty and a possible decision for a European nuclear regulatory body, are some of the actions that are already under discussion or may come into debate in the near future, under the EU and IAEA framework. The amendments to be addressed in such debates need special attention because of the important impact that can have on the Romanian economy.

In such context, CNCAN needs special attention, considering that the main legally binding requirements for the nuclear national authority are to be independent and have adequate human and financial resources. The nuclear programme, envisaged by the Romanian Government, depends firstly of the credibility of the national authority, not only for the European Union institutions but also for the investors and financial institutions. Not to be forgotten that Romania is the only country in EU, where nuclear energy is produced in nuclear reactors with different technology (CANDU type) than the rest of Europe.

- To assure a full transparent and visible process on communication with the public at large based on the results of the stress test at Cernavoda nuclear power plant. This will be in favor of nuclear energy, considering that the public debate should not be seen as a threat but as a big chance for the industry and authorities to build their case based on the results of the stress tests. The trust building is a permanent duty, since it is very hard to win it back once lost.

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