

RADIOACTIVE WASTE DISPOSAL AND PUBLIC ACCEPTANCE ASPECTS

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ABSTRACT

Part of the public opinion around the world considers the wastes generated due to nuclear applications as the biggest environmental problem of the present time. The development of a solution that satisfies everybody is a great challenge, in that obtaining public acceptance for nuclear enterprises is much more challenging than solving the technical issues involved. Considering that the offering of a final solution that closes the radioactive waste cycle has a potentially positive impact on public opinion, the objective of this work is to evaluate the amount of the radioactive waste volume disposed in a five-year period in several countries and gauge the public opinion regarding nuclear energy. The results show that the volume of disposed radioactive waste increased, a fact that stresses the importance of promoting discussions about repositories and public acceptance.

1 - INTRODUCTION

The search for the best option to generate electricity without environmental damages is a dynamic process that involves many questions. However, in many cases, the answers can not be considered as a general rule. The economic and particular characteristics of each country are the key factors for their energetic choices. In some cases, human health, environmental quality and several other aspects associated to this questions have not be considered as they should in the decision making process.

Many examples show that environmental impacts were not always considered in the decision making process, and in some cases, studies showed that, even aware of the human health damages associated to the hydro power plants construction, some authorities decided not to consider them due to the additional costs that the mitigation measures would create [1]. As example, in Senegal, the implementers did not include the human health studies needed for the construction of the Diama and Manantali Dams. As result of this omission, the local population faced several disease outbreaks, including malaria, schistosomiasis and Rift Valley Fever.

Thermal power plants also creates serious damages. Some years ago, in the southern part of Poland, the maximum speed in the railways was set to 40 km/h, due to the corrosion of the rail, caused by the acid rain originated by the large amount of sulphur due to the use of coal in the thermal power plants. In Canada, the acid rain is considered the worst environmental problem, and even the walls of the national parliament, made of a calcareous stone, are

degrading. Also, the maple tree, a national symbol and the source of the famous Canadian syrup, depicted in the flag of the country, is threatened by this phenomenon [2].

To find the perfect solution for the *energy x environmental* equation is a hard task. The nuclear option is seen as the best by part of the population, and the worst by the rest. However, it is a fact that the nuclear sector is spreading its activities all around the world. Nuclear applications are a fact of life for the citizens, but most of us do not realize this.

2 – NUCLEAR ENERGY DATA

Tables 1 and 2 show some data related to the nuclear sector. Table 1 presents the main producers of nuclear electricity, and table 2 the installed capacity in GW.

Table 1 – Main producers of nuclear electricity [3]

Producers	TWh	% of world total
United States	838	30.7
France	439	16.1
Japan	258	9.4
Russian Federation	163	6.0
South Korea	151	5.5
Germany	148	5.4
Canada	94	3.4
Ukraine	90	3.3
People's Rep. Of China	68	2.5
Sweden	64	2.3
Rest of the world	418	15.4
World	2.731	100.0

Table 2 – Nuclear sector data [3]

Installed capacity	GW
United States	101
France	63
Japan	48
Russian Federation	23
Germany	20
South Korea	18
Canada	13
Ukraine	13
United Kingdom	11
Sweden	9
Rest of the world	53
World	372

By the end of 2009, 438 nuclear reactors were in operation in 29 countries all over the world, and 55 more were under construction. According to the International Atomic Energy Agency, the nuclear power plants generate almost 14% of the electricity produced in the world. In 1973, the nuclear sector was responsible for only 0.9% of the total primary energy supply in the world. In 2008, this value was already close to 6% [4].

The generation of electricity in nuclear power plants creates radioactive waste, and the same is true for the nuclear applications in hydrology, agriculture, engineering, health and medicine. The repository is a facility where the waste will be disposed until its activity level does not represent any danger to the mankind or the environment. The public acceptance related to this theme are a matter much more complicated than the engineering and safety issues needed to the construction and operation of a repository.

3 – RADIOACTIVE WASTE DISPOSAL FACILITIES

To evaluate the amount of low and intermediate level waste that is disposed in the repositories and similar facilities all over the world, the IAEA annual reports were analyzed. In some cases was not possible to study the needed data. As example, Japan, in its last available report, did not specify the radioactive waste disposal in individual places, but informs only the total amount existent in all facilities. However previous reports were prepared using another methodology, discriminating by facilities. Since was not possible to verify if the same facilities were considered in all reports, the data of this country was not evaluated. Similarly the report of France presents the data under the name of “All French Sites”, so it is not possible to analyze which places are considered when the total amount is given.

Table 3 shows which disposal facilities were analyzed and table 4 presents the data associated to the radioactive waste volume existent in the disposal sites evaluated in this study.

Table 3 – Disposal facilities analyzed [5]

Argentina	Ezeiza Waste Management Area
Bulgaria	Novi Han
Finland	Loviisa NPP and Olkiluoto NPP
Norway	Combined disposal and storage facility for LILW
Romania	National Institute for Development & Research for Physics and Nuclear Engineering
Sweden	OKG NPP, Forsmark NPP, Ringhals NPP, Repository for Radioactive Operational Waste and Studsvik Research Center
Ukraine	Dnipropetrovsk SISE (State Interregion Special Enterprise), Kharkov SISE, Kiev SISE, Odessa SIS, State Special Enterprise “Komplex”
United States	Hanford Site, Idaho National Laboratory, Los Alamos National Laboratory, Nevada Test, Oak Ridge Reservation, including Oak Ridge National Laboratory and East Tennessee Technology Park, Savannah River Site
Slovakia	Near Surface Disposal Facility
Czech Republic	URAO Richard, URAO Dukovany, URAO Bratrstvi
Spain	El Cabril

Table 4 – Low and intermediate radioactive waste disposal data [5]

Country	Disposal volume (cubic meters)		Volume Variation(%)
	2003	2008	
Argentina	2.885	2.924	1
	5.098	6.917	
Czech Republic	2.384	6.516	173
	434	341	
Norway	1.330	1.867	40
	49.400	47.567	
Sweden	569.334	623.160	9
	6.807.726	7.655.190	
United States	245	245	0
	51.170	55.988	
Spain	2003	2008	211
	1.786	5.558	
Slovakia	7.491.793	8.406.275	11
Total			

It is worth mentioning that the amount of waste decreased in Norway and Sweden. It is possible that these countries are performing some tasks in order to reduce the total volume of the waste, such as compaction or incineration. Also, in some cases there are countries that changed their methodologies to assess the radioactive wastes that should be and that were already in the repositories. Therefore, materials that in the past were considered radioactive waste could have been reassessed and declassified. But the IAEA reports do not go down into these details, so further investigations should be done in order to obtain these answers.

4 – DISCUSSION

Although the nuclear option is surrounded by many fears all over the world, it is an undeniable fact that it plays a important role in the global energy market. At the end of 2009, there were 55 nuclear reactors under construction all over the world, and 437 in operation. The nuclear source is responsible for 17% of all the electric energy generated worldwide, and in some countries such as France and Ukraine, it is the main option among many others existent.

Figure 4 shows some data associated to the nuclear sector, particularly the energy generated between 1980 and 2009, for the countries listed above. It can be seen the nuclear energy production increased in the period in all countries.

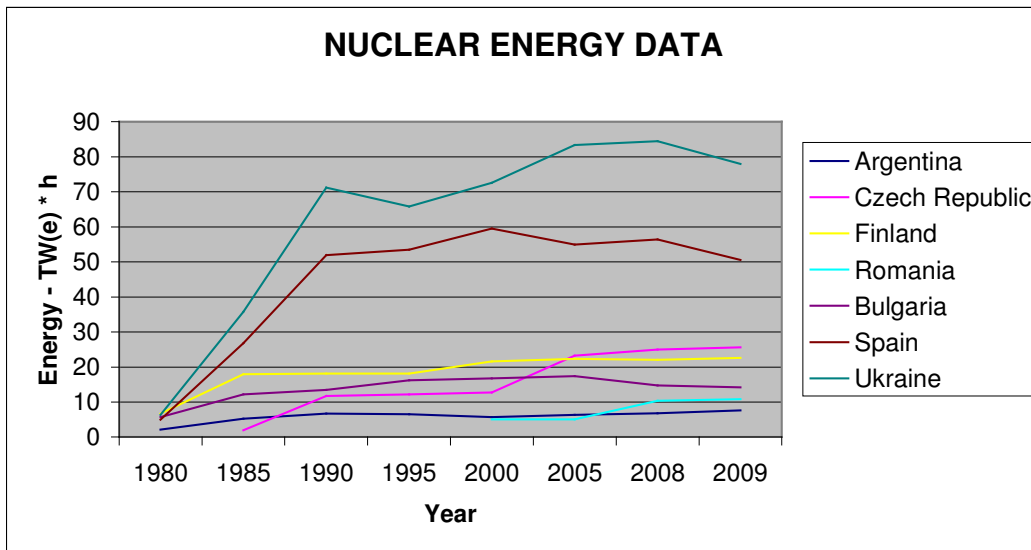


Figure 1 – Production of nuclear energy 1980 – 2009

Not only the disposal of radioactive waste, but the nuclear energy itself is a question that faces another big challenge: the public acceptance criteria. Tables 5 and 6 show some opinion polls recently carried out about this theme, after and before the events in Fukushima, Japan. Table 5 shows the perception of this subject in Brazil, and table 6 shows the opinion of the population of several countries.

Table 5– Poll done in Brazil about nuclear energy

Answer	What is your position about the use of nuclear energy as a source of electricity?	Before the earthquake in Japan, what was your opinion about the use of nuclear energy?
Totally in favor	12	13
Partially in favor	20	21
Partially against	15	13
Totally against	39	33
Do not know	14	17

In Finland, a site selection process for a radioactive waste repository started in 1983, and in 1999 the municipality of Eurajoki was chosen to host the facility. In 2004, construction was started on the underground characterization facility. The majority of the local inhabitants approved the process, however some concerns existed about possible negative impacts that could appear and harm the image of the community. The presence of radioactive waste could generate a stigma, the values of the properties could decrease, and the tourism potential could be damaged. To evaluate these questions a survey was carried out in 1998

and in 2006 in order to verify the inner image of the municipality by its own residents [6]. Tables 7, 8 and 9 show some data associated to these interviews, considering the percentage of respondents.

Table 6– Poll conducted in several countries about nuclear energy

Country	Percentage of the population contrary to the nuclear energy before Japan's event	Percentage of the population contrary to the nuclear energy after Japan's event
Austria	87	90
Greece	86	89
Azerbaijan	79	76
Italy	71	75
Colombia	69	73
Bosnia	68	75
Fiji	68	68
Macedonia	67	71
Germany	64	72
Ireland	61	67
Iceland	60	67
Brazil	49	54
Canada	43	50
Netherlands	43	50
Hong Kong	41	48
Lithuania	36	42
France	33	41
Czech Republic	31	34
Japan	28	47
Iraq	24	37
Egypt	22	37
Bangladesh	21	34
India	17	35
China	16	30
South Korea	10	24
Global average	32	43

Table 7 – Attitudes towards final disposal in the residents of Eurajoki, Finland

Opinion/Year	1998	2006
Extremely negative	14	14
Quite negative	16	13
Not positive or negative	23	28
Quite positive	32	32
Extremely positive	13	10
Can not say	2	3

Table 8 – Attitudes towards final disposal in the consumers of Eurajoki

Opinion/Year	1998	2006
Extremely negative	24	14
Quite negative	24	27
Not positive or negative	16	30
Quite positive	26	20
Extremely positive	6	7
Can not say	4	2

Table 9 – Attitudes towards final disposal in the representatives of businesses of Eurajoki

Opinion/Year	1998	2006
Extremely negative	7	6
Quite negative	15	17
Not positive or negative	22	27
Quite positive	44	36
Extremely positive	11	13
Can not say	1	1

It is worth mentioning that most of the residents considered Eurajoki as a safe domicile, and perceptions of “developing”, “business friendly” and “agriculture and forestry intensive” were more associated to their municipality than in the previous study.

Half of the consumers and two-thirds of the businesses knew that Eurajoki is the future site for final disposal. All the resident groups estimated the influence of final disposal in more favorable terms than in 1998, before the final disposal site had been selected.

Similar results can be seen in other countries. As example, the population of Oskarshamn, in Sweden, strongly support the nuclear power. The region is home to one of the country’s three nuclear power plants, which operates three reactors, and the base for the interim storage facility for all of Sweden’s spent nuclear fuel [7]. Recently, a poll was done in the municipality in order to verify the opinion of the population about the presence of a disposal site in the region. A total of 84% of those who responded to the poll voted in favour of having the disposal site in their region, compared with just 41% in a nationwide poll.

5 - CONCLUSIONS

The global production of nuclear energy increased significantly in the last decades, as did its applications in several areas such as health, engineering and hydrology. The increase in radioactive waste generation is coherent to this scenario, as expected. In the case of Brazil,

the planned implementation of a national repository for low level wastes is an important step towards the proper management of this type of wastes.

The building of public acceptance of the nuclear sector remains a challenge to the nuclear community and, among all issues, the radioactive wastes management is in the forefront of the population concern, and it is of paramount importance to invest in human resources to face the challenges of public communication and social responsibility within the nuclear area.

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