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Evaluation of the impact of experimental fusion-aimed installations on their area of influence: the price of sustainable energy

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Abstract. The need of clean, stable, safe and free of uncertainty energy sources has been increased after the current geopolitical tension. In this framework, nuclear energy is receiving renewed attention which finally led the European Commission to consider it as Green Energy. In spite of the expected "golden age" of nuclear energy, the fission still has some problems that must be solved. For this reason, the research on nuclear fusion is now and more than ever a real must. The path towards the control of fusion is plenty of technical difficulties, mainly related to the extreme temperatures and pressures needed and also to the neutronic radiation. The International Fusion Materials Irradiation Facility – Demo Oriented NEutron Source (IFMIF-DONES) is an experimental facility whose target s the testing of materials with fusion-like neutrons in order to evaluate the damages and decide which material is the most convenient to build the future reactors. The impact of IFMIF-DONES on the people living in the area where it is going to be located (Escúzar, Province of Granada, Spain) has been evaluated through a survey among its inhabitants. The results are presented and discussed in this work.

Key words. Sustainable Development; Nuclear Facilities; Psychosocial Risks; Socioeconomic Impact.

1. Introduction

A lot of attention has been paid to those energy sources that can contribute to Sustainable Development from all the perspectives as defined in the Brundtland Report [1]. More recently, the United Nations (UN) have identified and developed in more depth 17 concrete objectives whose achievement could be the key for a fair and sustainable growth. They are called the Sustainable Development Goals (SDG) [2]. Among these SDG shown in Figure 1, the number 7, "clean energy", pursuits to "ensure access to affordable, reliable, sustainable and modern energy for all".

Fig. 1. UN Sustainable Development Goals [2].

In the framework of this SDG 7, but also in many others like Nr. 1, 8, 11 and 13, the urgency to produce energy allowing a sustainable development avoiding geopolitical threats and uncertainties as well as dangers coming from waste management has become a must.

In this scenario, the energy released by nuclear fission is efficient and less contaminant than these coming from coal and fuel burning, but the risks are still real and the management of the radioactive fuel after its timelife is complex and, mainly, very controversial.

For this reason, the efforts to control nuclear fusion, whose fuel are just hydrogen isotopes deuterium and tritium are becoming more and more intensive.

In the last decades, experiments like the Joint European Torus (JET) [3] and the International Thermonuclear Experimental Reactor (ITER) [4] (Fig. 2) have become the hope of our future in matter of energy expectations. Their budgets and human resources have no precedents in the history of Engineering, but the path towards fusion has more difficulties apart from the control of plasmas.

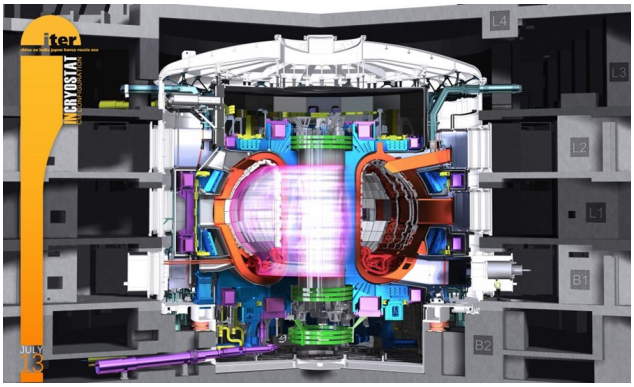

Fig. 2. Simulation of plasma in the interior of ITER [4].

The main of these difficulties is to avoid structural damages due to the neutron radiation that cannot be stopped with magnetic fields. This problem has worried the fusion community since the 80s and the need of some facility to make irradiation experiments with fusion-like neutrons has been identified for a long time [5, 6].

The International Fusion Materials Irradiation Facility – Demo Oriented NEutron Source (IFMIF-DONES) is an experimental facility currently under construction in Escúzar (Province of Granada, South of Spain) that will produce fusion-like neutrons (energies around 14 MeV) through the following process:

1) Acceleration of deuterons at 40 MeV.

2) Collision of accelerated deuterons with a loop of liquid lithium.

3) Production of neutrons from the former nuclear reaction.

These neutrons will be used to irradiate different materials. The analysis of the damages will help designers to define the materials for the construction of the future reactors (Fig. 3).

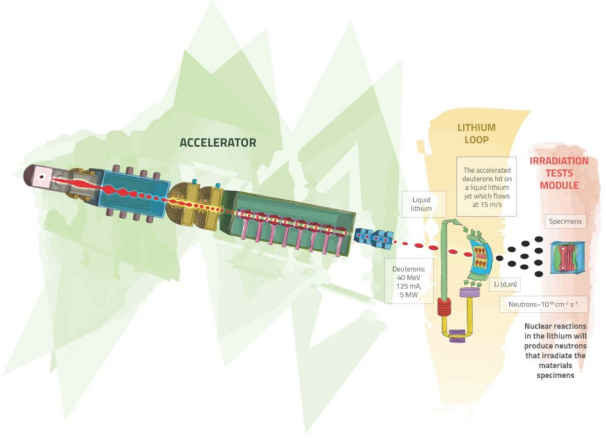

Fig. 3. IFMIF-DONES scheme: Accelerator-Li Target-test cell [6].

The expected benefits of the construction of this facility are getting an increasing attention in the last years from several perspectives. On one hand, the financial and organizational aspects of the projects have a high degree of complexity with no precedents in Spain, with funding coming from multiple sources of programs [7]. On the other hand, the figures involved (initial budget around 700 M€, about 30 years of operation etc.) are expected to have a deep impact in the area, which has been economically depressed, with strong dependence of the agriculture and low formation of their inhabitants. In this framework, IFMIF-DONES can decisively contribute to the global growth of the territory and, which is very important, this growth can be achieved from a sustainable perspective in agreement with the Sustainable Development Goals [8, 9].

Besides the expected benefits, it is a matter of concern the way Escúzar inhabitants will perceive (they are currently perceiving) the overall installation (Fig. 4), because the abovementioned goals can be hardly achieved without the implication of a physically and mentally healthy community that actually knows the importance of the project for the achievement of clean and almost unlimited energy.

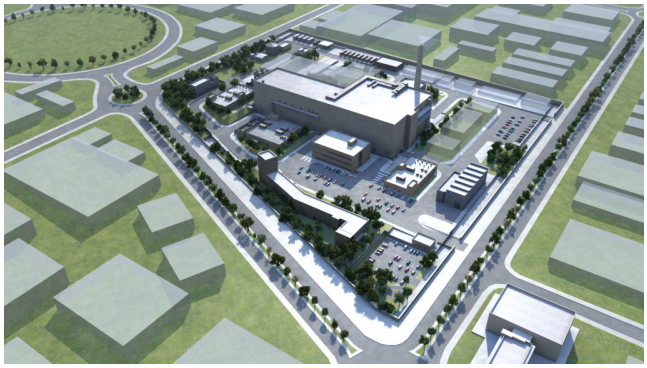

Fig. 4. Simulated view of IFMIF-DONES in its final site in Escúzar (Province of Granada, Spain) [6].

This study reports a study on the perception of Escúzar inhabitants of IFMIF-DONES. The results and conclusions are presented and discussed.

2. Materials and Method

A survey with 37 items about economical, social and hazard-related impacts of IFMIF-DONES was delivered among 311 inhabitants of Escúzar, the village where this facility is going to be built [10, 11]. The choice of this kind of way to investigate the impact is due to the fact that surveys have been proven to be an effective tool in order to investigate psychosocial risks and other topics related to perception [12, 13].

The survey and all the expenses related to it (salary of survey takers, analysis tools etc.) have been funded by the Project DONES Preparatory Phase (Ref. 870186), granted by the European Commission in 2019 [7].

All the questions had three possible answers: Yes, No and I don't know. They had been designed by physicists working on the project, mathematicians, and local authorities. After the initial design, they were validated by specialists in methodology.

Concerning the structure of the survey, have been organized in six main blocks:

1. Personal data: gender, age, children, training and professional activity (5 items).
2. General knowledge about IFMIF-DONES project (4 items).
3. Specific knowledge about energy and nuclear facilities (6 items).
4. Socio-economic aspects of the project (12 items).
5. Perceived Safety (6 items).
6. Information about the interest and general opinion of the project (4 items).

The results are presented in the next section.

3. Results

The analysis of the collected data yielded interesting results. Some of them were not statistically significant whereas other showed a clear significance (Table I).

The perceived safety is especially interesting because it has not been studied in the literature concerning scientific installations so far. For these instrumental variables, an ANCOVA model has been used. Only the significant factors and covariables are shown in Table I.

Table I. – Statistical parameters of the data analysis

Factors	Squares sum	F	p
Gender	12.93	5.889	0.016
Impact	85.14	38.788	< .001
Economy	37.81	17.227	< .001
Residuals	1097.53		

In Table I, it is demonstrated that only variables "Impact" and "Economy" are statistically significant to explain the perceived safety: higher values in "Impact" or "Economy" lead to higher values in perceived safety. With respect to the gender, women has higher values than men for perceived safety.

4. Conclusions

The complexity of the experimental facilities oriented to the nuclear fusion is so high that the projects can not exclusively focus on the physical success of the experiments, but also on their social, economical, psychological and all kinds of impacts on the people directly or indirectly interacting with them. Otherwise, the overall sustainability of the project would be threatened.

One of the most useful tools to evaluate the abovementioned impacts is the direct survey to the inhabitants of the zone where the facility is going to be settled.

In this work, a survey among 311 inhabitants of Escúzar (Spain), the village where IFMIF-DONES is going to be built, has been carried out with the target of evaluating the impact of this fusion-oriented facility on their lives. The survey deals with social, economic and well-being-related topics that can remarkably affect people acceptance of this project and can show the way to the Authorities for future projects.

The results obtained show that the big efforts made up to date to explain people what IFMIF-DONES is, have been fruitful and the perception of the installation is quite good.

Among the main findings, it is important to highlight the following ones:

1) Women seem to have less fear to eventual safety problems than men.
2) The higher the level of studies, the lower the concern on safety issues.
3) The higher the trust on the economic foster of IFMIF-DONES for the area, the lower the concern about risks.

Future research will be carried out in parallel to the construction of the installation in order to evaluate the perception of the people and maximize the synergy between research on sustainable energy and Global Sustainability itself.

It is expected that the results of this work can be worthy for the Administrations in charge of developing large fusion-related experimental installations. Thus, the time saved and the way to focus the information and define target population, may take these results as model in order to be more effective from all the possible perspectives.

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