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Environmental policies assessment and management: the case of Integrated Pollution Prevention and Control (IPPC) Directive in the waste sector

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Abstract: The Integrated Pollution Prevention and Control (IPPC) Directive has been for the first time published in 1996 [1]. It was amended in 2008 and now it has been replaced by the Industrial Emissions Directive (IED) n.75/2010.

The IPPC Directive represents one of the main important policy tools of European Union to manage the emissions of industrial activities and to achieve a higher level of protection of environment as a whole. The Directive asks to the Competent Authorities to issue a unique permit for the industrial installations where are included limits, monitoring frequencies and operational requirements referred to all environmental aspects (water emissions, air emissions, soil, etc.)

In literature we can find several studies about policies assessment. In this framework we can observe that not so many authors have studied the IPPC Directive. The papers related to the assessment of the IPPC Directive are referred mainly to discuss about the effectiveness of the Directive in the implementation of Best Available Techniques (BAT) and the improvement of environmental performance of the companies in the scope of the Directive.

Besides, the few papers or technical reports focused on the implementation of the IPPC Directive from a policy and administrative perspective have never studied in depth the contents of the issued permits.

The objective of our paper is to bridge this gap presenting the results of an empirical research carried out by the authors in the framework of a European project named MED IPPC NET.
The authors investigated 62 IPPC permits of landfill sector issued in seven European Regions: Andalusia and Valencia (Spain), Tuscany, Piedmont and Sicily (Italy), West Macedonia (Greece) and Slovenia. The research aimed to identify the differences in the Emissions Limit Values (ELVs), monitoring frequencies, operational requirements imposed to installations of the same sector but with permits issued by different Competent Authorities.
The results demonstrate relevant disparities not always justifiable by the flexibility given by the Directive to the Member States and Competent Authorities to implement the Directive.

Keywords: IPPC Directive, environmental policies, landfill sector.

1. Introduction

There are many studies in literature about the evaluation of the implementation of environmental policies, but not many of them deal with Integrated Pollution Prevention and Control (IPPC) Directive.

Some of the authors that consider the evaluation of environmental policies are for example Persson and Nilsson [2]. They take into account the European Strategic Environmental Assessment (SEA) Directive, focusing on the monitoring and evaluation phases of this legislation.

Eales and Sheate [3] consider the SEA Directive. It concluded that the implementation of this Directive in United Kingdom is not very good.

Some studies focus on the assessment of environmental policies related to waste. For example, the evaluation of the extent and degree of non-regulated hazardous waste in municipal solid waste generated in USA is treated in the paper of Savage and Sharpe [4]. Maimone [5] focused on the assessment of municipal solid waste policies in Netherlands. Chung and Zhang [6] evaluated regulations on electrical and electronic waste in China. The study concludes that not many legislation have a good performance in term of enforcement, social acceptance and environmental aspects.

De Jaeger et al. [7] focus their efforts on the assessment of waste policies. The paper investigated the effects of local policies related to municipal solid waste reduction on cost efficiency of municipal solid waste collection and disposal. Results showed that members of municipal waste joint ventures are more efficient to manage municipal solid waste.

The paper of Simões and Marques [8] considers the effects of regulation on urban waste services performance of Portuguese urban waste utilities. The study concludes there are negative effects on productivity.

As stated above few studies on waste policies are focused on IPPC. On the contrary the papers that deal with IPPC Directive are mainly focused Best Available Techniques (BAT) implementation and on the environmental performances of IPPC installations.

The paper of Karavanas et al. [9] considers an integrated methodological approach in order to assess the implementation of Best Available Techniques in facilities subjected to Integrated Pollution Prevention and Control Directive. Authors propose a methodology that proves an evaluation of environmental performance.

The study of Kocabas [10] focuses on the implementation of IPPC Directive and the Reference Document on Best Available Techniques in a Turkish textile mill. The author conclude that the implementation of Best Available techniques is crucial to decrease consumption of water and energy. The evaluation of Best Available Techniques in order to diffuse their implementation in a facility was promoted in the paper of Barros et al. [11]. The paper of Giner-Santonja et al. [12] provides a scientific method that aims to a better implementation of the IPPC topic. The study presents an approach for evaluation of BAT. A methodology for define Emission Limit Values associated with Best Available Techniques was included in the paper of Polders et al. [13]. The methodology allows to determine Emission Limit Values for industrial waste water.

In addition to the studies focused on BAT, there are some papers dealing with the effects of IPPC law on environmental performances of companies in the scope of IPPC Directive.

For example, the IPPC effectiveness in Ireland's pharmaceutical sector was demonstrated by the study of Styles et al. [14]. Authors affirmed that the integrated licensing system makes possible the pollution avoidance of the analysed industrial sector.

Honkasalo et al. [15] considered case studies of British, Finnish and Swedish industries and their regulatory bodies. The purpose was to give a contribution to the discussion on the potentiality of the IPPC Directive as a driver of eco-efficiency in those firms.

The effects of IPPC Directive on the environmental performance of Finnish pulp and paper mills were investigated by Silvo et al. [16]. Authors concluded that emissions decreased for some parameters even if the performance of the sector did not show major changes during the considered period.

As showed by the above-mentioned studies, there is a lack of papers in literature that investigated the effects of implementation of the IPPC Directive taking into account the content of IPPC permits.

The aim of our paper is to fill this literature gap. To fill the gap we have choice a way not followed by the previous studies: analyse the contents of IPPC permits on European landfills. The work has allowed us to show results not findable in other technical or scientific reports. Starting from the contents of the permits we want investigate if there are difference in IPPC implementation in the landfill sector changing Member State.

Then, we want know if any difference of implementation can be justifiable by the flexibility principle provided by the Directive.

In the next section we present the method and the sample used in the research. In the following sections we show empirical results focusing our attention on similarities and differences in the content of permits issued by Competent Authorities in landfill sector in the seven Member States covered by the study

2. Method and research question

The study show the results of the analysis of the content of 62 IPPC permits issued for landfill sector in seven European Regions: Andalusia and Valencia (Spain), Tuscany, Piedmont and Sicily (Italy), West Macedonia (Greece) and Slovenia.

The research aimed to identify differences in operational requirements, Emissions Limit Values (ELVs) and monitoring frequencies imposed to installations of the same industrial sector but with permits issued by different Competent Authorities.

Taking into account the membership of all the analysed Regions to the same economic European market we could expect to find few differences among the permits. These difference should be linked with local characteristics of environment and in any case should not be so relevant to impact on the costs to be sustained by the analysed companies. So our hypothesis to test is that, even if the IPPC Directive let some flexibilities to the Member States (MS) in its implementation, the implementation of it doesn't create relevant disparities among the landfills located in different EU Regions.

The method applied is the Content Analysis. Some literature studies define the Content Analysis as a systematic, replicable technique for compressing parts of text into fewer content categories based on explicit rules of coding [17,18,19,20].

Data sources derived by results achieved by a European Project named MED-IPPC-NET co-funded by the European Commission within the MED Programme. The permits have been collected by the Competent Authorities and analysed.

In the table below we can observe the regions involved in the study.

Table 1. Sample of IPPC permits.

Country	Regions	*Landfills (IPPC sector 5.4)*
Italy	Piedmont	21
	Sicily	6
	Tuscany	16
Spain	Andalusia	8
	Valencia	7
Greece	West Macedonia	3
Slovenia		1
Total		**62**

We collected data considering four Member States and different Competent Authorities responsible for the issue of integrated permits. In Slovenia the Competent Authority operates at national level; for this reason the considered permits refer to the whole national territory. Considering the total number of permits issued in the mentioned sectors by the different Competent Authorities, we can appreciate the representativeness of the sample (Table 2).

Table 2. Sample representativeness**.**

Landfills			
No. of installations affected by IPPC in the involved regions	**Total No. of Permits issued in the involved regions**	**Number of Permits considered in the paper**	**% of the analysed permits respect to the issued ones**
196	135	62	22,1%

The study population consists of 62 IPPC permits.

To determine the sampling error, a level of reliability or probability of 95,5% was considered, in accordance with the normal law of probability.

The sample size was related to sample reliability, to the margin of error in calculation of answers, and to parameters p and pq, as follows:

$$n = \quad Z^2 p(1-p)/e^2$$

where it results that

$$e = Z(p(1-p))^{1/2}/n^{1/2}$$

being

$$n = n_m/(1 - n_m/N)$$

where nm is the sample size (number of analysed permits: 62), N the population size (135), Z the number of standard deviations above and below the average (1.96), p the distribution parameter (considered as p = 0.5, maximum variance) and e is the error.

In accordance with this expression, a sampling error of 9,15% was obtained for a level of sample reliability of 95.5%. This error can be considered acceptable.

Despite the relevance of the investigated sample, the main limitation could be linked to the method used to select the analysed permits. In fact the permits to collect have not been chosen in order to have a wide representation of kind of landfills (e.g. landfills for dangerous or not dangerous waste, number of workers, capacity) and so we cannot carry further re-classification of data to observe how the results would change.

3. Results and Discussion

One of the aspects investigated in order to know how the IPPC Directive has been implemented is referred to requirements indicated in permits about Best Available Techniques.

The BAT Reference Documents on Best Available Techniques (BREFs) do not force the adoption of ELVs or specific techniques, but they are taken into account by the Competent Authorities in order to set ELVs. In this sense, BAT is considered a tool for Competent Authorities to implement the IPPC law. The European Commission does not indicates that these techniques are mandatory for companies in the scope of IPPC.

Table 3 shows that in some cases permits about landfill sector include specific requirements about the adoption of BATs.

In particular, the most of permits require the adoption of BATs with a deadline to be implement (36,7% of cases).

Our study shows that the approach to the Best Available Techniques indicated by the European Commission, in the most of cases was not considered.

These different requirements about BATs adoption included in the permits can cause different costs to companies in order to comply with.

Table 3. Requirements about Best Available Techniques included in permits.

Best Available Techniques (BAT)	
	Landfills (5.4)
IPPC Permit does not include the adoption of BATs	18,3%
IPPC Permit includes a description of BATs but does not include specific requirements	30,0%
IPPC Permit states that it has included BATs for environmental purposes	15,0%
IPPC Permit includes the adoption of BATs with a deadline to be implemented	36,7%

Another aspect we considered in this paper is linked with Emission Limit Values included in the permits and the monitoring frequencies of some environmental pollutants related to air emissions.

Table 4 includes, for each considered region, the Emission Limit Values for the four air pollutants taken into account and referred to the biogas burning phase: Dust, NOx, SOx, CO. We include also the number of permits with the suggested ELVs.

Table 4. Emission Limit Values and monitoring frequency for air emissions.

Landfills (epigraph 5.4)							
Phase	Region	ELV (mg/Nm^3)				Monitoring Frequency	Number of permits
		Dust	**NOx**	**SOx**	**CO**		
Biogas burning	Andalusia	-	650	300	1500	Four yearly	1
	Valencia	30	1000	200	625	Yearly	4
	West Macedonia	40	-	300	100	Yearly	3
	Slovenia	130	2000	-	-	Three yearly	1
	Piedmont	10	450	-	500	Yearly	7
	Sicily	10	450	50	500	Monthly	6
	Tuscany	10	450	50	500	Monthly	1
		10	450	-	500	Six-monthly for NOx and Dust	1
		10	450	35	500	Yearly	1
		10	450	35	500	Not specified	1
		10	450	35	500	Six-monthly	1

We can observe that ELVs imposed are very different among regions. Slovenia permit includes the highest ELVs. Moreover, in the case of NOx pollutant the ELV applied is 2000 mg/Nm^3. There is a wide difference with limits set in the permits of the other six considered Regions.

The Italian Regions include the lowest ELVs in the permits for the most of pollutants (Dust, NOx and SOx). The region that requires the lowest limit for CO is West Macedonia. In Tuscany, Piedmont and Sicily ELVs are very similar among them. This aspect suggests that Competent Authorities apply the ELVs indicated by national law and that not consider the Flexibility Principle. The latter allows Competent Authorities to set stricter ELVs than values indicated by national laws. According to this

aspect they have to consider some characteristics of the plant as available technologies, geographic location, condition of the environment near the installation.

As regards monitoring frequencies of emissions, Tuscany and Sicily set more frequent monitoring, while Andalusia and Slovenia provide lower frequency. These differences determine different costs for landfill facilities, on the basis of the different countries where they are located.

Our study considers also the Emission Limit Values that permits include for water emissions.

In this case there is more uniformity in ELVs among regions (except for Sulphates, for which the value set by Italian regions in very high compared with those included by other regions).

As indicated in Table 5, for some regions ELVs are the same. In the case of Sicily and Tuscany for example, values are the same for all three considered pollutants - COD, TSS and Sulphates-, and for all permits for which these data are indicated. This aspect can be justified by the fact that Competent Authorities set ELVs indicated by national law and not consider the Flexibility introduced by the Directive.

Italian regions have the highest ELVs for all parameters with respect of other considered regions.

Competent Authorities of Valencia and West Macedonia include in permits the same ELV for COD and Sulphates.

For Andalusia, Slovenia and Piedmont regions, ELVs for water discharges are data not available.

Table 5. Emission Limit Values for water emissions.

Emission Limit Values related to industrial water emissions for Landfills sector				
Destination: surface water				
Pollutants (mg/l)	**COD**	**TSS**	**Sulphates**	**Number of permits**
Valencia	125	60	250	1
Slovenia	n.a.	n.a.	n.a.	n.a.
West Macedonia	125	25	250	3
Piedmont	n.a.	n.a.	n.a.	n.a
Sicily	160	80	1000	6
Tuscany	160	80	1000	4

We considered also monitoring frequencies of water discharges.

Competent Authorities of Tuscany region established for one permit a monthly monitoring and for five permits a three-monthly periodicity.

Sicily, Slovenia and West Macedonia included a three-yearly frequency.

In this case is Piedmont region that set a lower monitoring frequency, with a yearly periodicity.

Table 6. Monitoring frequencies of water emissions.

Monitoring frequencies of water emissions (with indications of number of permits)		
	Landfills (5.4)	Number of permits
Valencia	n.a.	n.a.
Slovenia	Three-monthly	1
West Macedonia	Three-monthly	3
Piedmont	Yearly	5
Sicily	Three-monthly	6
Tuscany	Monthly Three-monthly	1 5

Another important aspect to consider is referred to noise emissions.

In this case Emission Limit Values are not set in national regulation or in IPPC permits, but in general they are defined by local planning defined at municipal level in order to consider the urbanization of local contexts. Moreover, monitoring frequencies are in the most cases, not indicated by national laws.

Considering these aspects, Competent Authorities define monitoring frequencies of noise emissions in IPPC permits often taking into account municipal documents.

Table 7 includes the monitoring frequencies of noise emissions for landfill sector.

Table 7. Monitoring frequencies of noise emissions.

Monitoring frequencies of noise emissions (sector 5.4 landfills)	
Andalusia	Frequency not established (100%)
Valencia	Five-yearly (100%)
Slovenia	Three-yearly (100%)
West Macedonia	Frequency not established
Piedmont	More times a year (15,4%)
	Yearly (53,8%)
	Two-yearly (7,7%)
	Three-yearly (23,1%)
Sicily	Not available
Tuscany	Yearly (6,3%)
	Two-yearly (25%)
	Three-yearly (12,5%)
	Frequency not established (56,3%)

Some regions do not set a unique monitoring frequency for noise emissions. Tuscany and Piedmont include different monitoring frequencies (yearly, biennial, three-yearly) for landfill companies. In Piedmont the main monitoring frequency is yearly, while for Tuscany in many cases is not established. IPPC permits of Andalusia and West Macedonia regions do not indicate monitoring frequencies.

Valencia and Slovenia provide a unique monitoring frequencies in their permits, with five yearly and three yearly frequency respectively. Data for Sicily are not available.

Landfills sited in Piedmont have high costs, mainly considering the frequency of more or one times a year.

4. Conclusions

The Maastricht Treaty provides that on the basis of the subsidiarity principle, the Member States shall decide the methods and acts to implement the Directives. In addition, the IPPC Directive introduces the flexibility principle, according to "the Emission Limit Values and the equivalent parameters and technical measures referred (…) shall be based on the best available techniques, without prescribing the use of any technique or specific technology, but taking into account the technical characteristics of the installation concerned, its geographical location and the local environmental conditions". According to it Competent Authorities have flexibility chances to define the content of the IPPC permits even though this flexibility should considers some key elements: technical characteristics of the installation, the geographical location and the environment conditions.

Despite these flexibility opportunities many difference pointed out in this paper are often not justifiable. The ELVs of biogas burning change too much changing Competent Authorities. The different levels stimulate in a different way the adoption of BAT and the consequent prevention of pollution key principle of the Directive. Also the monitoring frequencies can't be justified by the flexibility principle of the Directive. The monitoring of pollutants has high costs and often involves external laboratories. Low frequencies mean lower costs for landfills. With lower costs, the landfills from Andalusia and Slovenia could establish lower prices for the industrial companies that must dispose the waste. So the lower prices give a competitive advantage to the companies located in these Countries. Same consideration could be done for water and noise emissions.

So taking into account the research question we can affirm that in the implementation of IPPC we can find too relevant disparities. It is clear that the European Commission should take some actions to have a better implementation of the policies in this field. Something in this directions has been already done in the revision of the IPPC Directive with the Industrial Emissions Directive 75/2010 (IED).We invite the scholars to further develop this research. Some ideas to work on are linked with the assessment of the impacts of the disparities pointed out. For example future research could assess the economic impact of these differences and so the effect of them on competitiveness. Another assessment could regard the different environmental impact of different ELVs imposed to the installations and connected consequences on the environment. Another possible paper could be linked with the assessment of the future implementation of IED. As mentioned above the new Directive includes some new requirements in terms of ELVs (e.g. art. 15). The paper could aim to assess the efficacy of IED in the reduction of ELVs disparities.

Conflict of Interest

The authors declare no conflict of interest.

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