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Environmental Indicators in EMAS Environmental Statements

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Environmental Indicators in EMAS Environmental Statements.

Abstract

The aim of this study is to establish a classification for environmental indicators that can be used to communicate companies' environmental performance in Emas Environmental Statements and to assess the actual use of them in certified Environmental Statements.

Starting from ISO14031 draft indicators classification we have tried to verify its fitting with EMAS EEC Council Regulation (93/1836/EEC) requirements and definitions, and therefore we have established a more appropriate classification according to the information the different indicators can provide..

The evaluation of environmental indicators use in Environmental Statements has been performed through the analysis of a sample of 62 certified EMAS Environmental Statements

Non technical abstract

In the last thirty years, public and governments attention to environment has remarkably increased. This evolution in environmental concern has driven to the definition of laws that could control companies activities and their effect on the environment.

At first, those rules have been developed in a system by which governments defined, from time to time, the limits for companies' emissions - concentration and mass flow - as well as the air, water and ground quality standards.

In the years, such a Command and Control system has shown to be suffering from a great inertia in the integration of changes in the behaviour of different concerned parties: companies, consumers, citizens, public authorities...

In order to obtain a constructive contribute from every potentially interested parties, in the last few years regulators are trying to integrate limits and control rules with an active involvement of citizens consumers and companies in the attempt to solve or minimise environmental problems.

In such a system, companies should be encouraged to join voluntary agreement systems and to adopt a sort of self-regulation that goes further than a mere respect of legally consented limits. At the same time, that kind of integrated system needs a real communication between parties, based on an objective and reliable information.

The public availability of environmental information (EEC) and the right-to-know principle (USA), are the basis of an effective confrontation between groups that might have opposite priorities.

Voluntary systems such as BS-7750, ISO-14001, allow the companies to obtain an independent certification of both their commitment to continuous improvement and diligence in the management of the environmental aspects of their activity.

The Eco Management and Audit Scheme, EMAS regulation (93/1936/EEC), differs from any other environmental management standard certification system because it requires participating companies to compile a publicly available Environmental Statement by which communicate their own environmental performance.

As any other kind of companies' environmental communication, the Environmental Statement should provide data related to parameters, monitored on a time scale, that reflect the evolution of the environmental performance.

Those data, included in the environmental indicators, can differ due to the information they provide, to their form and to their significance.

Thus, the characterisation and the standardisation of those indicators has become a point of major concern for regulators, standard organisations, companies and for every environmental interested party as they seek for a simplified and coherent presentation of companies' environmental performance.

We hereby try to define and classify the indicators that can be used in an Environmental Statement. Starting from the ISO 14031 classification of indicators we will try to evaluate the information and the significance provided by the different group of indicators and then we will try to reclassify them in a way that seems to be more appropriate for their use in EMAS Environmental Statements.

In the second part we analyse a sample of 62 Environmental Statements collected by the Fondazione Eni Enrico Mattei (FEEM Environmental Reporting Monitor), in order to verify the use of the different indicators.

1. Which data should a company include in its Environmental Statement: the relevance

When communicating its own environmental performance, particularly through figures, a company must face different and often contrasting requests: on one side the stakeholders' need of complete and coherent information about the real environmental impact of industrial activity, on the other side the company's need of keeping its industrial secrets and potentially counterproductive information.¹

The EMAS regulation tries to make those opposite demands match by requesting an Environmental Statement that considers all the significant environmental issues that are relevant to the company.

The definition of relevant environmental issues must be preceded by a deep analysis (EMAS environmental review) of every real or potential impact the activity may have on all the environmental sectors (EMAS, Annex-I paragraph-C)².

Every real or potential impact factors should be defined by taking into account:

- every possible emission in the atmosphere, in water or ground,
- waste generated,
- use of energy, water or raw materials,
- use of product and its final disposal.

As it indicates any input and output, a mass and energy flow chart is a quite useful instrument at this stage.

The company must then define the criteria that will sort the relevant environmental issues. Those criteria are not specifically requested by the regulation to be explained in the Environmental Statement, but the credibility of the communication is definitely affected when they miss. The public is interested by the real environmental concern of the company, and the criteria of relevance are one of the most effective way to communicate it.

The definition of a priority for environmental issues is not an easy task. In fact even in an Environmental Impact Assessment or in a Cost and Benefit analysis the main problem is not the highlighting of impacts that an activity can have on environment, but the definition of the priority to give to one aspect or the other.

Potentially interested parties can be extremely various (employees, local community, customers, suppliers, public authority, banks, insurance and shareholders, environmentalists) and they can be interested in companies environmental performance from different points of view (financial, competitiveness, ecological, information exchange...)

A company should be aware of the needs and concerns of at least the main audience of its Environmental Statement. In fact, EMAS regulation requires that the "...company establishes and maintains procedures for receiving and documenting all communications concerning its environmental effects and management..." (Annex I paragraph B).in order to get useful feedback information. Therefore, it is true that stakeholders could be more concerned about issues that are not considered to be of any relevance by the company, revealing the lack of communication between those subjects, but environmental communication policies are conceived to minimise those misunderstanding and are based on the hypothesis that a complete information on both sides can lead to a more efficient use of the environment.

EMAS regulation requirements for environmental statement (Art. 5):

- a) Description of the company's activities at the site considered
- b) an assessment of all the significant environmental issues of relevance to the activities concerned
- c) a summary of the figures on pollutant emissions, waste generation, consumption of raw materials, energy and water, noise and other significant environmental aspects, as appropriate;
- d) other factors regarding environmental performance;
- e) a presentation of the company's environmental policy, programme and management system implemented at the site considered;
- f) the deadline set for submission of the next statement;
- g) the name of the accredited environmental verifier.

¹Actually, many companies fear the backfire of a complete communication on environmental issues, but this is not justified when considering the fact that usually the main stakeholders of those statements are employees or local community -i.e. generally employees and their relatives or friends- that can get, in a less "official" way, the same information amplified in its negative sides or even completely altered. In fact, The companies that avoid communicating some data get some advantages on a short term, while on a larger time scale the complete communication should get a larger benefit.

² Following words shall be intended as:

(environmental) impact and effect: any change to the environment, whether adverse or beneficial, resulting from a company's activity, products and services.

(environmental) issue: element of a companies activity product or service that can interact with the environment.

(environmental) impact factor: element of a company's activity that can cause an impact on the environment

2. How should a company communicate data in an Environmental Statement: the Environmental Indicators

Companies activity affect the environment by:

- The use of water, raw materials and non renewable resources
- Air emissions
- Water emissions
- Waste
- Odours
- Noise, vibrations and radiation
- Visual impact
- Product impact

and they control their environmental effects through an environmental management system.

The definition of parameters that can be monitored on a time basis is useful for both internal management and external communication requirements.

Those parameters, that can be called indicators, can be classified in many ways according to their meaning and to their form.

The ISO14031 Draft gives a possible classification of Environmental Indicators based on the areas that are to be evaluated:

- The Management area: includes people, practices and procedures at all levels of the organisation.
- The Operational area: includes the organisation’s physical facilities and equipment, their design and operation, and the materials, resources, energy, services, products and waste related to the organisation’s operations.
- The Environmental area: considers the condition of the environment in relation to the organisation.

Considering that there is no sharp boundaries among those areas, the draft gives the definition of possible indicators for every area.

ISO 14031 environmental indicators

EVALUATION AREA	INDICATORS	DESCRIPTION
Management Area	EMI - Environmental Management Indicators	provide information on the organisation’s capability and efforts in managing matters such as training, legal requirements, resource allocation, documentation and corrective actions..
Operational Area	EPI Environmental Performance Indicators	provide information on the consumption of materials, services, resources and energy and on the output of products services and waste (e.g., air emissions, water discharge, solid waste, noise, vibrations, odours, light or radiation)
Environmental Area	ECI - Environmental Condition Indicators	provide evaluation of the condition of the environment that can be influenced by the company’s activity and on the changes induced by the company’s activity.

Those indicators are also classified by their form:

- a) Absolute: basic data or information, either measured directly or calculated, that expresses a defined parameter of interest (e.g., concentration of SO₂ in stack gas or tons of SO₂ emitted in the current year)
- b) Relative: data or information that is expressed in comparison to some other relevant parameter (e.g., tons of SO₂ emitted per ton of product manufactured)
- c) Ratio: a composite of two measurements of the same parameter that relates one to the other in fractional or decimal form (e.g., SO₂ emission in the current year relative to a baseline year)

The classification that we define is similar to the one proposed by the ISO14031 draft, but we try to distinguish between:

- Environmental Absolute Indicators - EAI - that provide absolute information on the extent of the company’s impact factors (EMAS environmental issues)
- and Environmental Performance Indicators - EPI - that provide information on the environmental performance regardless of the fluctuations of the company’s activity level.

as well as between:

- the Potential Effect Indicators - PEIs - that provide an evaluation of the effects that company's activity could have on environment
- and the Environmental Effect Indicators - EEIs- that are very similar to the ISO14031 environmental condition indicators (ECIs).

Comparison between ISO14031 draft and our classification of environmental indicators

ISO14031 draft environmental indicators	FEEM EMAS environmental indicators
EMIs - Environmental Management Indicators -	EMIs - Environmental Management Indicators -
absolute EPIs - absolute Environmental Performance Indicators -	EAIIs - Environmental Absolute Indicators -
relative EPIs - relative Environmental Performance Indicators -	EPIs - Environmental Performance Indicators -
	PEIs - Potential Effect Indicators -
ECIs - Environmental Condition Indicators -	EEIs - Environmental Effect Indicators -

2.1. Environmental Management Indicators (EMIs)

When a company is interested in communicating the effectiveness of its Environmental Management system and the level of its efforts in containing its environmental effects, many indicators can be used in its Environmental Statement.

Actually, the company can communicate:

- the costs, investments and operational costs, and savings related to the environment. The costs can be indicated as:
 - an absolute total: Environment related investments / year
 - a fraction of total costs: Environmental related investments / Total investments
- the level of implementation and integration of environmental policy and management system:
 - number of employees trained
 - number of managers with environmental responsibilities
 - number of environmental standard certified suppliers
- the evolution of the relations with local communities, authorities and media:
 - number of environment related complaints
 - number of negative/positive press reports on company's environmental activity
 - number of external environment related initiatives supported by the company
- the conformity with requirements (internal or voluntary standards and legal requirements). The EMAS regulation considers legal compliance as an essential requirement for the site registration, thus a legal compliance indicator should be useless in an Environmental Statement but many statements include such indicators.

2.2. Environmental Absolute Indicators (EAIs)

In order to evaluate the real use of the environment, the company usually gathers the data referred to:

- total and detailed water consumption
- total and detailed raw materials input
- total and detailed energy input and/or output
- total and detailed air emission mass flow calculated through concentration and volume flow measures
- total and detailed wastewater emission, measured by concentration and flow.
- total and detailed measures of waste mass and volume
- Acoustic level measures

As it is not yet possible to have scientific standards for measuring odours and visual impacts, the evaluation of those effects can only be done through the number of both internal and external complaints.

EAIs provide information on the absolute environmental impact factor level of the company's activity. Absolute ISO EPIs should be considered as EAIs in our classification.

2.2.1. water and raw material consumption EAIs

Water consumption can be measured as a total or in detail for the origin of the water consumed. The environmental effect of consumption is different for surface, ground and drinking water. The reduction of environmental effect can be achieved both by reduction of total consumption and by a change from ground and drinking water consumption to surface water consumption.

Examples of water consumption EAIs:

- Total water consumption: m³/year
- Detail for surface, ground and drinking water consumption: m³/year

The use of raw materials is measured in mass or volume per year. The environmental effect of raw materials depends very much on the nature of the single raw material used. The environmental effect of the use of raw materials is due to two possible causes: use of non renewable resources and pollution risk deriving from production and/or from the use of product. A detailed measure of the different groups of materials gives a greater information on the real scale of this environmental issue. Information about raw material recycling is another way to evaluate this issue.

Examples of raw material use EAI:

- Total raw material use: m³/year or ton/year
- Detail for non renewable resources based raw materials,: m³/year or ton/year
- Detail for hazardous raw materials: m³/year or ton/year. (As stocks of hazardous compounds on site is usually a relevant environmental issue, the monitoring and reduction of maximum volume stocked on site is an effective indicator).
- Recycled raw materials: ton/year and %

2.2.2. energy and fuel consumption EIAs

Energy production, which has a great impact on environment through emissions and consumption of non renewable resources (fossil fuels), is strictly associated with industrial activity. Companies should thus communicate at first their total energy consumption (electricity, steam or heat) regardless of its origin (internal or external) by indicating the total energy input.

The reduction of impact of energy consumption is achievable in different ways:

through the absolute reduction of energy consumption - optimisation of processes, use of low energy consuming machinery...-

through a process of internal energy recovery: heat recovery, use of by-products and wastes as energy sources...

through changes in energy sources and fuels: reduction of coal based energy,

Companies can then indicate the trend in energy consumption by measures of externally produced energy use and of fuels burnt on site.

The fuel consumption data should be detailed for different fuels (coal, oil, natural gas). Data on fuel consumption should be given in both volume/mass and energy content form. Alternatively, energy data can be transformed in tep. Anyway, energy and fuel data should be provided in the same form.

Examples of energy and fuel consumption EIAs:

- Total energy consumption (internal + external): Wh/year or J/year or tep/year
- Detailed energy consumption (external, internal, steam, heat electricity...): Wh/year or J/year or tep/year
- Total fuel consumption: Wh/year, J/year or tep/year
- Detailed fuel consumption: (coal, oil, gas) ton/year and/or Wh/year, J/year, tep/year.

2.2.3. air emission EIAs

Air pollution is essentially linked to three groups of effects:

- Global (global warming, ozone depletion...)
- Regional (acid rains...)
- Local (smog, toxic/harmful effects on human beings, plants and animals...)

Global effects are associated mostly to CO₂, CFC, methane and other volatile organic compounds (VOC). Their emissions are usually measured in ton/year. One can get more information when indicating the source of those emissions (production, heating, energy...).

SO₂ and NO_x are considered to be the major responsible of acid rain; their emission are thus measured in ton/year.

Local effects are caused by a complexity of compounds that have not been completely identified.

Yet, NO_x and hydrocarbons, as well as particulate are the main cause of smog and photochemical pollution. Those compounds as well as a great number of other micropollutants (halogenated polycyclic hydrocarbons, volatile inorganic compounds - VIC -, heavy metals) are responsible of many acute and chronic toxic effects. For those compounds, like for example HCl, it is important that the company provides data about mass flow - kg/year -and concentration - mg/m³ - as toxicity is strictly related to concentration.

Data referred to particulate should consider mass flow, concentration and the distribution of particles in diameter class as the size of particles defines the toxicity.

Moreover, a company that wants to demonstrate a real concern about environmental issues should consider its indirect emission, like air emissions deriving from the production of consumed energy. Those data can be calculated on the basis of average national energy production data (emissions/KWh). Therefore, an industrial plant that uses an electrolytic process contributes to air pollution through its energy consumption rather than through direct emissions. Even though the use of that kind of indicators seems to be out of a company's duty as energy industry is directly responsible for those emissions, many companies have included them in their corporate environmental report (Landis & Gyr, BP). Besides, the European Green Table (1993) recommends the use of those indicators particularly for process using a large amount of electricity.

Examples of air emissions EIAs:

- CO₂, SO₂:
- Total CO₂, SO₂: ton/year
- Detailed (production, acquired and produced energy...): ton/year
- VOC, VIC and metals: ton/year and mg/Nm³
- Particulate:
- Total: ton/year and mg/Nm³

- Detailed for particles diameter: ton/year and mg/m³

2.2.4. waste water EIAs:

The principal parameter that should be considered for liquid emission is the volume discharged. Moreover, the effect of water discharge depends on the final destination of waste water (river, lake, ground and underground, sewers...).

The quality of liquid effluent is usually measured through the load in suspended solids, phosphorous, nitrogen, metals, salt, organic and inorganic compounds. The chemical oxygen demand - COD - and biological oxygen demand -BOD -, are used to have an evaluation of the concentration of organic compounds in water by giving the amount of oxygen required for their total chemical or biological oxidation.

As it has been said for air emissions, concentration in effluent are as important as the total mass flow.

If relevant pH and temperature of the effluent should be given as well as the difference between effluent and receptor value (Ph and t°)

Examples of wastewater EIAs:

Volume

Total effluent volume: m³/year

Detail for sewer, ground and surface water: m³/year

Quality:

Total suspended solids, COD, BOD, inorganic compounds, metals...: ton/year and mg/m³

Ph

Temperature

2.2.5. waste EIAs:

When considering the waste generated by a company's activity, the mere indication of total waste volume or mass is not enough. The company must distinguish between different sort of waste: the environmental effect of waste depends both on its nature (hazardous and non-hazardous) and on its destination (landfill, incinerator, reusing, recycling).

It must be considered that landfill disposal of waste is limited by volume rather than mass. Therefore, indication of both volume and mass reduction is a rather good way to demonstrate an effective waste management.

Examples of waste EIAs:

Total waste generated: ton/year and m³/year

Detail for hazardous and non-hazardous waste: ton/year and m³/year

Detail for final destination (landfill, incinerator, recycling...): ton/year and m³/year

2.2.6. acoustic level EIAs

Acoustic level is measured in dB(A). A company can indicate the maximum or the average level, measured at different points and time.

2.2.7. product EIAs

The definition of EIAs for product is not an easy task. The company should have performed a life cycle assessment of its product in order to evaluate its environmental impact. However product EIAs are strictly related to the nature of the product.

Some examples are:

mass of product or packaging that can be (or are) recycled

mass of waste deriving from the final disposal of product

2.3. Environmental Performance Indicators (EPIs)

The EMAS regulation requires that the company commits to a continuous improvement of its environmental performance and to the application of best available technologies. In order to demonstrate the improvement of its performances, once the relevant environmental issues have been identified, the company should normalise numeric data referring them to its activity level (e.g. emission/production). Actually, the lack of an indication about, for example, the production volume affects the significance of the communication: the rise of an emission level could be linked only to the expansion of the company's reference market that has driven the company to increase its production. The worsening of environmental performance would be linked to a market evolution rather than to real errors in environmental management.

In the application of the best available technologies as well as in the concept of continuous improvement, a raise of production level should not be followed by an equivalent increase of pollution.

A first step, in this direction, is to place (when possible on the same chart) absolute emission data (EIAs) next to production data. In this way, trends in production and emissions are immediately comparable.

Many companies have chosen to demonstrate the attention they pay to environment performance by the use of indicators where emissions are referred to production unit - e.g., kg of NOx/ton of product - (Ciba Additive - 1995 -, Ferruzzi - 1995 -, BP chemicals - 1995), to processed raw material unit - e.g., kg of SO₂/ton of incinerated waste - (Ekokem - 1995 -), to the number of employees - e.g., m³ of water/employee - (Canon giessen - 1995 -), or to the unit of added value -e.g., tons of CO₂/\$ of added value - (Landis & Gyr - 1994 -).

The definition of those indicators is not always an easy task. Actually, emissions are often linked to parameters other than production level. As an example we can consider the pollutant load of waste water in a plant where process uses no water. The COD level, deriving from civil facilities, is therefore linked to the number of employees rather than to production. A fall in

production level could determine a worsening of the environmental performance if the indicator was normalised to production while the real performance would be unchanged if the indicator was normalised to the number of employees.

In order to define the most significant indicators, the company’s activity should be analysed in separated stages so that the single stages responsible for each impact factor can be highlighted. Once the single stage has been identified, the right unit for the index must be chosen.

In case, for example, of solvent emission from a paint spray operation, the number of parts painted is not always the good choice. In fact, if the parts are very different by shape and surface area, the right index should be the unit of surface area painted. Mercedes-Benz Dusseldorf has used that kind of EPI in its Environmental Statement (1995).

Statistic test have been developed for the definition of an index significance (TJ Greiner, 1995)

On the other hand a deep detail in the analysis of different stages of the production process could be considered as a threat to industrial secrets.

2.4. Potential Effects Indicators (PEIs).

One must then consider that large public environmental concern is usually linked to emotions rather than to a real knowledge of seriousness and causes of pollution based on scientific evidence. Therefore, people are usually more concerned about a white smoke coming out of pipe than about an invisible organic solvent. In the same way, the relevance of fuel powered engines in CO2, CO, NOx, polycyclic hydrocarbons air pollution is little known by public opinion that considers chemical industrial chimneys as the major responsible.

In order to allow stakeholders to correctly compare data, when an industrial facility is wrongly considered to be the main source of some kind of pollution, it is of an undeniable use to express its emission in an equivalent unit that can immediately compare to the real main polluter emission (e.g. Nox and other air emission expressed in vehicles equivalent units). For example, a last generation incinerator that incinerates 75000 t/y of waste releases in the atmosphere the same NOx quantity released by 370 cars (calculated as average car emissions) or the amount of polycyclic compounds (PAH) produced by _ a car Besides, pollutants that can have very different toxic and ecotoxic effects are generally summarised in a single pollutant category by nature of the compound. As an example, when considering emissions to air, volatile organic compounds (VOC) can include potentially carcinogenic polycyclic and halogenated compounds (PAH) with other less dangerous compounds such as methane, regardless of their different potential impact on environment. In the same way, water pollution is usually represented by COD and BOD without any reference to the nature of organic compounds released, even if the concentration of many compounds is monitored regularly in order to comply to effluent regulation. The information on that kind of issue is available anyway due to the EEC Directive 90/313/EEC therefore there is no reason for the company to try to conceal it. The feeling is that through those aggregations, the rise on a particularly toxic compound can be masked by the great amount of less hazardous compounds. On the other hand it is true that an extreme detail in the communication of pollutants can provide the same dilution effect, as a great number of compounds and related effects are unknown to large public.

The EMAS regulation requires that the company provide to the public “... information necessary to understand the environmental impact of the company’s activities...” (Annex I - D. 9.)

Therefore, it is clear that beside the numeric data on emissions, it is essential to indicate, in some way, the potential effect that those emissions may have on environment. The first step in that direction is to create a table in which every compound or group of similar (by effect) compounds is related to its impact and effect on environment.

Compound	Environmental sector affected	Effect
CO2	air	Global warming
SOx	air	Acid rain
NOx	air	Smog, acute respiratory disease.
Metals	air, water	Chronic toxicity

It is possible to create a numeric indicator to evaluate the potential effect company’s activity may have on the different environmental sectors. Those indicators may be called Potential Effect Indicators and can be expressed in a reference compound unit. As for polychlorinated dioxins and furanes that are expressed in TCDD units (TetraChloride Dibenzo Dioxins - Eadon method): a reference compound is given a toxicity factor 1 while other compounds are weighted by factors that represent their relative toxicity. Toxicity can be measured, for example, through the dose that produces a defined effect, usually the LD50 (lethal dose for 50% of laboratory individuals)

Reference compound equivalent unit emission:

$$\text{total emission} = [\text{measured “X” emission} \times \frac{\text{“X” LD}_{50}}{\text{Reference LD}_{50}}] + [\text{Measured “Y” emission} \times \frac{\text{“Y” LD}_{50}}{\text{Reference LD}_{50}}.]$$

In the same way many other indicators can be created by simply taking a compound as a reference for every single effect as it has been done by different companies, in their corporate environmental report, for global warming potential, ozone depletion potential, POCP (Photochemical Ozone Creating Potential), acid rain, water and air toxicity potentials

Company	Potential Effect Indicator
Ciba According to TJ Wallington et al. Environmental Sci. And Technol. Vol.28	Global warming: Freon equivalent unit Ozone depletion: Freon equivalent unit
Landis & Gyr In co-operation with Leiden University	Global warming: CO2 equivalent unit Ozone depletion: R11 equivalent unit POCP: ethylene equivalent unit Acid rain: SO2 equivalent unit
Rhone Poulenc	Photo Chemical Ozone Potential (POCP)
Elf atochem	Water toxicity:

The final significance of those aggregated (summarised) Potential Effect Indicators suffers from the great number of indicators and the lack of standardisation for the definition of weights that should be applied to each compound. Actually, some American chemical companies consider that every compound should also be weighted by an exposition risk factor (TJ Greiner - 1995) while others have used a company's priority factor (e.g Rhone-Poulenc, in its Environmental Reports, creates some aggregated indicators - called Environmental Indicators - for its impact on water air and waste without defining its "corporate priority"). ICI defines an Environmental Burden for water pollution effect but considers that it could be extended to every environmental sector in order to obtain a single performance indicator that considers every environmental issue of the company's activity. That kind of indicator is based on the same kind of calculating procedures.

Actually, SMEs, can have some difficulties in summarise and correctly weight data that can have different form and meaning, due to the lack of standard criteria of aggregation (Anne Grafé-Buckens - 1997). Moreover aggregation of a great number of data can affect the readability of indicators. Thus, those indicators should be defined by effect to be evaluated rather than by environmental sector (air, water, health...). An indicator of wastewater toxicity, placed next to one related to eutrophic effect has a greater significance than an aggregated indicator for total wastewater effect in which every effect have been weighted by a subjective seriousness factor.

The major difficulty in standardisation of this kind of indicators is due to the lack of univocal scientific evidences of relations between compounds emitted and environmental effects. Therefore it is of a great relevance that scientific community provides the right information in this field. This kind of aggregated indicators, if based on a standard base, can give an opportunity to compare environmental impacts of companies belonging to the same economic sector and even to different sectors.

2.5. Environmental Effect Indicators (EEI)

The actual effects of a company's activity on the environment can only be controlled through direct monitoring of the environment outside the company's boundaries.

This monitoring can be achieved through the direct monitoring of both the chemical/physical and biological condition of the environment. It is therefore effective for local effects only.

At a first level, the evolution of the chemical/physical condition of the environment is monitored:

- concentration of pollutants in the water and atmosphere, extension of ground contamination areas...

At a second level the effects on human beings, animals and plants are monitored:

- evolution of local biodiversity, particularly plants micro-organisms
- evolution of bioaccumulation of pollutants in plants and animals
- evolution of local epidemiology of a pollutant related disease....

The use of those indicators is limited by to main factors:

- companies usually operate in industrial district, therefore responsibility of actual environmental effects can be hardly defined
- field studies are usually long and expensive thus companies can't always afford them.

However, companies can support universities and other institutions in their monitoring activity.

The evolution of environmental conditions should be compared to emission data in order to determine their correlation.

2.6. Reference levels and benchmarking

In order to evaluate the situation of the company it can be useful to compare the level of the monitored parameter to reference levels:

the level achieved during a reference year (usually called year "0")

company's targets, corporate standards or sectors average level

legally consented level

For this purpose, the reference level can simply be indicated on grids and charts, or emission data can be given as a percentage or ratio of the reference level.

$$\frac{\text{measured level}}{\text{reference level}} \times 100$$

That kind of indicator called Ratio EPI in the ISO14031 draft, provides information on the absolute emission level and therefore we consider it an environmental absolute indicator (EAI).

EPI can also be constructed as a ratio of a reference level:

$$\frac{\text{measured emission level}}{\text{reference emission level}} \times 100 \times \frac{\text{reference production level}}{\text{measured production level}}$$

Communicating its emission level as a percentage of the consented level is a risky way to inform about one's performance as legal limits may change in the years.

When communicating through that kind of indicators, companies should always indicate the reference level as a mere percentage gives no information about the real emission level achieved.

3. Evaluation of the use of Environmental Indicators in published Environmental Statements

Due to the lack of strict requirements and standards for the compilation, EMAS Environmental Statements that have been published by registered sites show a great variability in both form and contents.

In order to evaluate the effectiveness in communication and the quality of data they provide, the Fondazione Eni Enrico Mattei has started gathering EMAS certified Environmental Statements.

Through a sample of 62 Environmental Statements of registered sites we have monitored the use of different environmental indicators -EMIs, EAIs, EPIs, PEIs, and EEIs) -.

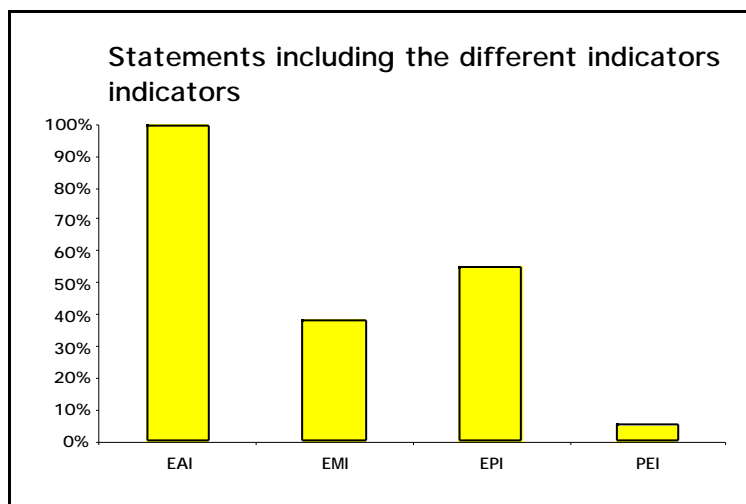


fig.1

3.1. Environmental Management Indicators (EMIs)

Environmental Management Indicators have been included in 28% of the analysed statements. Almost half of the EMIs included in Environmental Statements is represented by annual environmental costs (43%) - investments and operational costs -, while the second half is represented by the number of complaints received (19%), by the number of non compliance (15%), and by the percentage of products and raw materials transported by railways and by road (23%).

Surprisingly, some companies have included in their statement an indicator of legal compliance. As EMAS regulation requires a total compliance to legal requirements, such an indicator should be of no use in Environmental Statements.

Environmental statements including EMIs belong mostly to chemical companies, probably because chemical industry has developed a greater experience in environmental communication through environmental reporting.

3.2. Environmental Absolute Indicators (EAIs)

As the regulation considers that companies can define the relevant issues of their activities, information provided through EAIs is different between industrial sectors and between companies within the same sector.

While some companies have provided a very detailed information about emissions, consumption and waste generation, other companies have strongly limited it.

3.2.1. Air emissions:

87% of Environmental Statements provided information relative to air emissions. A small number of companies have simply indicated the total air emission mass flow while others have reached a greater detail level about the main air pollutant emitted: CO₂, CO, SO₂, NO_x, VOCs, VICs, particulate, polycyclic halogenated hydrocarbons, metals.

Different levels of detail in the composition of each group of pollutants have been reached. Mostly, statements included data referred to mass flow (81%), some of them to concentration (19%).

3.2.2. Waste water:

87% of Environmental Statements provided information relative to wastewater emission. 10% of them didn't include any indication of the wastewater volume rejected. As for air emission, different detail levels have been reached for volume, COD, BOD, metals, phosphorous, nitrogen, halogenated compounds, temperature and Ph.

52% of statements included data referred to concentration of pollutants, 37% to mass flow of pollutants, while 11% were only referred to the volume of rejected wastewater.

3.2.3. Energy:

97% of Environmental Statements provided information relative to energy consumption. In a few of them energy was calculated as total energy consumed (Wh or J) per year but mostly electricity input and fuel consumption were indicated separately.

3.2.4. Water consumption:

About 90% of Environmental Statements included information relative to water consumption. 40% of them provided detailed information on the nature of the water consumed while 60% considered only the total consumed volume.

3.2.5. Raw material consumption:

60% of Environmental Statements provided information relative to raw material consumption. While 42% of them included detailed information about the nature of raw materials, 58% included only the total raw materials mass flow.

3.2.6. Waste:

About 93% of Environmental Statements included information on waste generated on site. 80% of them gave information about hazardous and non-hazardous waste and 25% provided detailed information about the final disposal of waste (landfill, incinerator...), while 7% of them included advanced detail on the nature of waste generated.

3.3. Environmental Performance Indicators (EPIs)

Indicators normalised on activity level (production, employee or working hours) are included in 55% of Environmental Statements. Most of EPIs are normalised on production unit (94%). In one statement solvent emissions deriving from spray painting operations were normalised on painted surface area.

The fact that only 55% of the analysed statements included EPIs demonstrates that environmental performance is not yet considered as a parameter to be evaluated regardless to production level. In fact many chemical companies consider that emission/production is not a significant indicator. Chemical industry production has a great variability as process could be, for many reasons interrupted at any stage and by-products could become products, thus the definition of product changes from time to time. Besides, as a change in production of a chemical facility is usually a commercial strategic choice, detailed indications on evolution of production could be counterproductive for company's competitiveness.

Therefore EPIs should be used by industrial sectors that have an easy measurable and univocal production unit.

On the contrary Environmental Statements of machinery and equipment production sites are well under the average according to the use of EPIs - only 17% of Environmental Statement include EPIs - while 50% of the chemical registered sites use production indexed EPIs.

When both EPIs and information about production level are missing, the Environmental Statement cannot be considered significant as reduction of emission levels could derive from a reduction of production level.

3.4. Potential Effect indicators (PEIs)

Tables indicating the potential effects related to environmental issues have been included in 4 statements while PEIs were used in 2 statements (wastewater and air emission microbiological toxicity indicators and Global Warming indicator).

3.5. Environmental Effect Indicators (EEIs)

No statement included evaluations of environment conditions.

4. Conclusions

The lack of strict requirements on issues to be included in the Environmental Statement and precise indications on the form by which communicate environmental performance has driven to the validation of Environmental Statements that differ largely by contents and quality.

A standardisation of environmental indicators is an urgent necessity for the correct implementation of voluntary environmental communication systems.

Nevertheless, some suggestions can be provided arising from a critical evaluation of validated Environmental Statements: besides general requirements of EMAS regulation, when compiling its Environmental Statement a company should consider that:

- once defined the relevant issues the statement should include:

- a) the criteria used in the definition of relevance;
- b) absolute data relative to their physical extent (EAs);

- in order to characterise sites activity, the statement should include data relative to production level;
- EAs should be defined at this stage in order to avoid linkage between emissions and production fluctuation;
- as EMAS regulation requires companies to provide information on the effect that its activity can have on environment, absolute data should be gathered in tables according to the potential effect they could have on environment. PEAs can be a useful tool provided that scientific criteria of correlation between factors and effects have been defined;
- when available, companies can provide information on environmental parameters that can be affected by their activities, otherwise companies should communicate their support to environmental monitoring initiatives;
- the form and language of Environmental Statement should be consistent with both the main reference audience (A glossary including most of technical words should always be provided) and any other communication of the company.

As each site's environmental aspects differ, detailed guidance for every Environmental Statement can't be achieved. Nevertheless credibility of Environmental Statement could be checked through the evaluation of data provided related to relevant issues, the effective demonstration of continuous improvement and commitment to the application of best available technologies. The evaluation of the second generation of Environmental Statements should allow a more significant assessment of EMAS communication credibility.

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