A KPI for Local Community Impact of the ULCOS technologies

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This paper presents a part of work developed inside the ULCOS project, which aims the radical reduction of CO_2 emissions from iron and steel production, through new routes that must be sustainable, i.e. environmentally-friendly, economically viable and socially acceptable. In order to demonstrate their sustainability, Key Performance Indicators are the main tools developed inside the work package 9.4, "Sustainability Model & Process Selection Tool", which aims to make complex issues more manageable. Key Performance Indicators (KPIs) are the most useful tools for evaluating and managing not only the environmental and economic impacts, but also the social impacts.

The assessment of social aspect of sustainability must be taken into consideration, nevertheless the prediction of social impacts is often hard to be done, not only because of the lack of a clear cause-effect relationship but also because of the difficulty to analyse and to predict social phenomena, especially through a quantitative approach.

The purpose of this work is to present a methodology, based on both quantitative and qualitative approaches, carried out in order to develop the social indicator (Local Community Impact Indicator), which has primarily taken into account possible impacts of a current integrated steelworks on the communities within the close vicinity of the plant operations.

Introduction

The ULCOS (Ultra Low CO_2 Steelmaking) project, through the breakthrough technologies developed inside its subprojects, aims to reduce CO_2 emissions from iron and steel production of 50% as compared to a modern blast furnace. This goal is pursued by carrying out these new routes, that have to be sustainable, according to the so-called "triple bottom line", namely environmentally-friendly, economically viable and socially acceptable. Inside the subproject 9 (SP 9), "Scenarios, Sustainability, Innovation, Training & Dissemination", the feasibility of breakthrough technologies has been assessed, by analysing environmental, social and economic aspects. Along with other tools developed inside the work packages of this subproject, a framework of sustainable criteria, that can be translate into measurable tools, the Key Performance Indicators (KPIs), has been carried out. This process can help to measure the progress towards sustainability, through the identification and the development of appropriate indicators and their quantification and weighting, according to advice received from stakeholder dialogue and from the ULCOS Technical and/or Steering Commitee.

Inside the "triple bottom line", the assessment of social performances, with respect to the economic and environmental ones, is more difficult, especially when social phenomena have to be gathered and analysed quantitatively [1].

The prediction of social impacts of the industrial operations is often hard, because of the lack of clear cause-effect relationship. But the identification of key issues, with respect to the social performances of industry towards the local communities and their translation into indicators, helps to optimize positive impacts and to minimize and mitigate negative impacts.

The aim of this work is to develop a social indicator, the Local Community Impact Indicator, through a calculation methodology, which takes into account both quantitative and qualitative approaches. Although quantitative indicators are generally more appropriate [2], in some cases, such as the assessment of social aspects, a qualitative evaluation could be preferable. By integrating different methodologies a more holistic approach for social indicators development can be provided.

The case study presented in this paper takes into consideration the Baseline Case of the ULCOS project, represented by a current Integrated Steelmaking route, and the social indicator developed represents a tool for assessing both positive and negative impacts of an Integrated steelworks on the population living in the surroundings of the plant [3]. During the last decades, many efforts have been done by the European steel industry in order to improve its performances from the environmental point of view, through the increase of cleaner technologies [4]. In addition, a better attention towards health and safety, not only of people working inside the steelmaking plants, but also of people living in the surrounding areas, has increased [5].

Part 1. Definition of Categories

The first step of the work concerns the definition and the development of a framework, which includes the social impact categories (sub-indicators). These categories represent the possible impacts of a current integrated steelworks and they have to be defined and measured. This has been done with a description of the baseline case, by considering the current possible impacts which are relevant to the operational initiatives in the steelmak-

ing plants and that can affect communities at local level. An in-depth analysis of the sector, through the investiga tion and information collection on the context, in order to provide a picture of the current environmental and socio-economic impacts, has allowed to highlight the most important impacts and how significant effects are generated [6].
Each category has been subdivided into some subcategories, that represent the key issues that define each category. These parameters, that have to be evaluated through calculation methodologies, can be positive or negative, depending on their possible impacts on the local community.
The categories and the respective subcategories, selected and endorsed, are listed in Table 1.

Part 2. Quantitative approach

In order to calculate the value of the social indicator, including the main categories that have to be quantified, the work started from the so-called Baseline case.
Concerning the quantitative approach, it has been carried out for calculating quantitatively the categories, when quantitative data are available.

The quantitative procedure is based on the consideration of the current and the target social state through a conventional distance-to-target normalisation and weighting calculation procedure [7].
The calculation procedure is summarized by the following equation:

$$LCII = \sum_{c=1}^{n} Q_c N_c S_c$$

where c = category, and the following quantities, that need to be defined and evaluated, represent:

Q_c = Quantifiable intervention value
N_c = $1/T_s$ (Normalisation Factor for the impact category, i.e. for Q_c)
T_s = Target social state
S_c = C_s/T_s (Current social state/Target social state = Relative Importance of the impact).

This formula takes into account the Target social state (= T_s), in order to obtain a dimensionless value for each category.

CATEGORIES	SUBCATEGORIES
Local Employment	1. Local Employment
Visual Impact	1. The extent of the area taken up by the industrial plant 2. The distance from the build-up area 3. The buildings height 4. The trees that act as a screen for the plant 5. The height of these trees 6. The different geography of plants placement (costal or inland) 7. The plumes of smoke 8. The colour of smoke
Comfort level/Nuisance	1. Noise pollution and vibrations 2. Odour
Traffic	1. The arterial roads dedicated to the plant 2. The railway lines dedicated to the plant 3. The maritime ports dedicated to the plant 4. Plant location behind the build-up areas 5. Plant location behind impassable areas 6. Plant location which forces the urban areas crossing
Health	1. Visual (dust plumes, reduced visibility, dirty surfaces), physical and chemical contamination (coating of vegetation and contamination of soils leading to possible reduction of agriculture products). 2. Health effects, due to inhalation, e.g. asthma, irritation to the eyes
Water Management	1. Water Management
Waste Management	1. Waste recycling 2. Solid waste disposal
Migration	1. Increased funding for public infrastructures
Indirect Increase of Services	1. Indirect Increase of Services
Community Involvement Participation	1. Community representatives involvement 2. Sponsoring community events 3. Training education centre, schools, hospitals, etc. 4. Community projects in which the company has been involved

Table 1. Categories and subcategories that define the Local Community Impact Indicator

In order to give an example of the Local Community Indicator calculation, through the quantitative approach, the previous formula has been applied for the Local Employment category.
This category represents the number of employment opportunities within an integrated steelworks, that can attracts different kind of professional profiles, such as semi skilled, skilled and unskilled people. The impact concerns not only the mere recruitment by the company but also the possibility to retain their employees. This is a very important topic, which encompasses the social aspects related to the job satisfaction and consequently it is connected to the reputation of a company and therefore to its commitment to meet the principles of Corporate Social Responsibility (CSR). Both direct and indirect employment should have a positive impact on the local community and it results in increasing of the local economy and therefore in improving of the welfare of society and economic prosperity at local level.
By applying the quantitative formula, in order to calculate the Local Employment category, we will obtain the following equation:

$$\text{Local Employment Category} = Q_c N_c S_c$$

where:

Q_c = Number of new employees
N_c = *1/* (Number of employed + number of unemployed)
T_s = Number of employed + number of unemployed
C_s = Actual number of employees
S_c = C_s/T_s

In order to calculate this category for the Baseline Case, the main issue has been the definition the "Local" concept at European level, in order to collect data for the calculations. During the ongoing work, before collecting local data from the other partners of the ULCOS project, in order to provide an averaged European case, which could be applied to the case study, the calculation of this first category has been done on the basis of current available data, represented by the averaged data from the main European integrated steelworks.
Through a in-depth analysis of the sector, the averaged value of the current employment in the European integrated steelworks has been calculated [8-17]. This value has been evaluated with respect to the production of 4 Mt of Hot Rolled Coils, as shown in Figure 1.

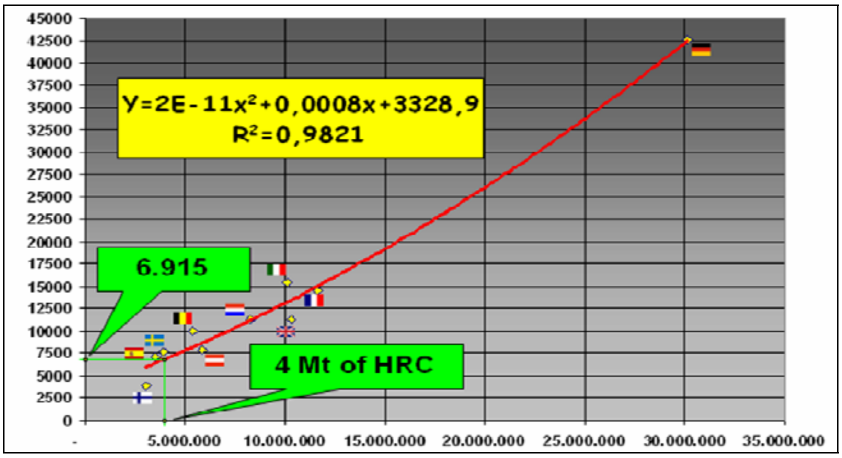

Figure 1. Economic relapses on Local Area

In the case under consideration the value of the quantifiable intervention value, which represents the number of new employees, is:

$$Q_c = 6915$$

But, in order to calculate the Local Employment category, the factor T_s = number of employed + number of unemployed includes data not easily available, because it is necessary, first of all, to know the expanse of area corresponding to the concept of local (for example, in Italy, as far as the steel industry is concerned, the unit of local area, which is considered as reference, is the province), and secondly it is necessary to obtain data from all ULCOS partners in order to calculate the averaged value, which represents the European Local Employment.

Due to the lack of available quantitative data, during the ongoing work, and, on the other hand, due to the qualitative character of the main categories that define this social indicator, the evaluation of these parameters has been restricted to a qualitative approach.

Part 3. Qualitative approach

As far as the qualitative approach is concerned, the subdivision of each category into subcategories (see Table 1), that define it and represent the parameters to evaluate, has been the key starting point. This part of the work aims to emphasize the most important impacts and how significant effects they produce.

Since they are impacts subcategories, first of all it was important to distinguish between subcategories that have a positive impact and subcategories that have a negative impact, in order to assign to each of them either a positive or a negative sign. In fact, at local level the impact of an integrated steelworks can be significantly positive (e.g. by creating employment and new economic opportunities) and negative (e.g. dust, noise, disturbance to the landscape).

The proposed measurement approach requires a subjective evaluation of the probability of occurrence, the frequency occurrence and the potential intensity. In order to obtain a fair evaluation, appropriate subjective scales and associated guidelines need to be developed.

The methodology is based on the impact degree and on the occurrence frequency (classic criteria of risk calculation applied to environmental aspects) [18].

Based on data collected, 5 significance indices classes could be defined:

Negligible (N)	Less Significant (LS)	Medium (M)	Significant (S)	Prior (P)

Figure 2. Significance classes

Each subcategory can be placed in one of previous classes, through the application of the risk formula:

Significance Index = (Impact degree) x (Impact frequency)

Figure 3 lists the criteria that have been used in the impacts evaluation and the significance index may vary between 1 and 25 (shown in the matrix) and between -1 and -25, depending on whether the impact is positive or negative.

Frequency		Impact				
		Null	Minor	Medium	Moderate	High
		1	2	3	4	5
High	5	5	10	15	20	25
Moderate	4	4	8	12	16	20
Medium	3	3	6	9	12	15
Minor	2	2	4	6	8	10
Null	1	1	2	3	4	5

Figure 3. Risk matrix

After the definition of subcategories for each indicator category, in order to attribute a dimensionless value to each category, firstly different values (within a 5 point scale) have been assigned to each subcategory and they concern the impact degree and the impact frequency.

Through the risk formula the significance index could be calculated, which could be either positive or negative, depending on the impact. This value has to be normalized, by dividing by the normalization factor (in this case = 25, which is the maximum value of significance index).

Finally, in order to obtain the value for each category, the arithmetic mean of the sum of subcategories significance was evaluated.

In order to give an example of calculation of the categories that define the Local Community Impact Indicator through the qualitative approach previously explained, a calculation procedure, for one of the categories listed in Table1, has been shown as follows.

The Visual Impact is a typical example of qualitative category, which can be calculated by applying the qualitative approach.

This category concerns the structure and the location of the plant which has a negative impact on perceived aesthetics by the local community. Its assessment is based on the subjective perception and on the overview of steel plants that usually are perceived by people in a negative way, not only on the aesthetic point of view but also as pollution sources.

The parameters to be evaluated correspond to the subcategories and their calculation, in order to obtain the value of the Visual Impact category, is shown in the Table 2.

The result of the Visual Impact category calculation, summarized in Table 2, is the results of the qualitative assessment by applying a 5 point scale. The assignment of the scores for each subcategory, in order to evaluate this category for the Baseline Case, is described and justified, one by one, in the following section.

The extent of the area taken up by the industrial plant – All existing integrated steelworks cover areas of land ranging from hundreds to thousands of hectares. Therefore their impact with respect to the use of the land is high as well as its impact frequency.

Category	Sub-categories	Impact	Impact degree					Impact frequency					Significance value	Significance index*	Normalization	Sum	Averaged value
			1	2	3	4	5	1	2	3	4	5					
Visual Impact	Extent of the area	Negative					x					x	-5x5 = -25	P	-25/25 = -1	- 2.04	- 2.04/ 8 = -0.255
	Distance from the build-up area	Negative			x							x	-3x5 = -15	M	-15/25 = -0.6		
	Buildings height	Negative				x						x	-4x5 = -20	S	-20/25 = -0.8		
	Trees that act as a screen for the plant	Positive				x						x	4x5 = 20	S	20/25 = 0.8		
	Height of trees	Positive				x						x	4x5 = 20	S	20/25 = 0.8		
	Different geography of plant placement (costal or inland)	Negative			x							x	-3x5 = -15	M	-15/25 = -0.6		
	Plumes of smoke	Negative				x			x				-4x2 = -8	LS	-8/25 = -0.32		
	Colour of smoke	Negative				x			x				-4x2 = -8	LS	-8/25 = -0.32		

*Red colour = negative value, black colour = positive value, in bold = prior value

Table 2. Example of calculation table for the Visual Impact category

The subcategory impact towards the local community is negative.

The distance from the build-up area – This subcategory is negative too, because, as far as the visual impact is concerned, existing integrated steelworks are accepted with difficulty by the population living in the surroundings. Therefore, if there is a high distance, the impact degree will be null, i.e. equal to 1; if there is a low distance the impact degree will be high, i.e. equal to 5. Existing plants could be placed in both location, so their impact degree is medium, i.e. equal to 3, whereas the impact frequency is high.

The buildings height – The actual size of the buildings inside an integrated steelworks is a problem not only because they are out of scale with their surroundings, but also because landscape changes. Therefore, in this case this subcategory is negative as well. As far as the evaluation of the impact is concerned, the impact frequency is high and the impact degree is moderate, as not all buildings have a height such as they could be considered like visual intrusions.

The trees that act as a screen for the plant – This is a positive subcategory as it is related to the mitigation measures in order to obstruct the view of integrated steelworks warehouses. If production plants are surrounded by rows of trees the visual impact will be decreased. Therefore the impact degree is moderate and the impact frequency is high.

The height of these trees – This subcategory is positive as well. The height of trees is very important in order to screen the aesthetic of the plants. It takes into account the span into trees have to reach the height to screen plants. Therefore the impact degree is moderate and the impact frequency is high.

The different geography of plants placement (costal or inland) – Most of European integrated steelworks are costal, so their negative impact have a high impact frequency, with a medium impact degree, on the visual point of view.

The plumes of smoke – This subcategory is negative as well. Smoke emissions are visible from the coke oven stack during firing. Vapor plumes would be visible when the temperature of the emission is above the ambient air temperature in certain atmospheric conditions. In fact condensation of water vapor can occur which results in a visible plume. The impact frequency is minor and the impact degree is moderate.

The colour of smoke – This subcategory has negative sign because the visual impact of the smoke colour is negative. In fact, in particular dark colours of smoke, are closely associated with the pollution. Black smoke emissions are visible from the coke oven stack during firing, while white smoke emissions contain vapor, so their impact is lower. As a consequence the impact degree is moderate while the impact frequency is minor.

Conclusion

The assessment of sustainability is an important topic for the industrial sector and the development of a framework that define the criteria, not only concerning the economic and environmental aspects, but also by taking into account the social one, is becoming urgent at all levels. The translation of sustainability criteria into measurable indicators for evaluating industrial performances is a useful process, which can be used in addition for assessing research projects as well as new technologies. Therefore greater efforts needed to be accomplished in order to develop social indicators, that could translate the social phenomena into valuable figures.

The proposed social indicator, the Local Community Impact Indicator, developed inside the ULCOS project, was thought to be less appropriate for distinguishing between ULCOS technologies because each technology would more than likely have the same rating. Nevertheless the developed methodology, including both quantitative and qualitative approaches, could provide a tool applicable to different industrial contexts. In fact the evaluation of social impacts can help the local communities as well as other stakeholders to better understand which is the real impact either of an industrial manufacturing plant or of a new project or technology.

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