

KPI Modelling

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The remit of the work package is to take a complex set of raw data, covering different aspects of sustainability (social, economic & environmental), and distil it to a single score for various scenarios, thereby allowing a comparison of the new technologies against the benchmark.

Introduction

In previous years, a set of thirteen Key Performance Indicators (KPIs) was identified (Table 1) and data was generated for the Benchmark Blast-Furnace route. The aim in Phase 2 was to populate this table with information for each of the new technologies (SP10-13).

No	Performance Indicator Description	Units	Benchmark BF route	Development Routes			
				SP10	SP11	SP12	SP13
1	CO ₂ emissions	kg/tonne of HRC					
2	Global Warming Potential	kg/tonne of HRC					
3	Primary Energy Usage	GJ/tonne of HRC					
4	By-Products (All)	kg/tonne of HRC					
5	Waste (unusable products)	kg/tonne of HRC					
6	Resource Consumption	kg/tonne of HRC					
7	Water usage	litres/tonne of HRC					
8	Capital Expenditure	M €					
9	Nett Operating Cost	€/ tonne of HRC					
10	Air Quality Compliance	pass / fail					
11	Employee numbers	N ^o for 4Mt plant					
12	Skill Level wrt BF route	More / equal / less					
13	Site Area wrt BF route	More / same/ less					

Table 1. Phase 1 KPI's

The data would then be analysed and entered into a KPI Evaluator Tool which would result in an overall score. (Fig. 1)

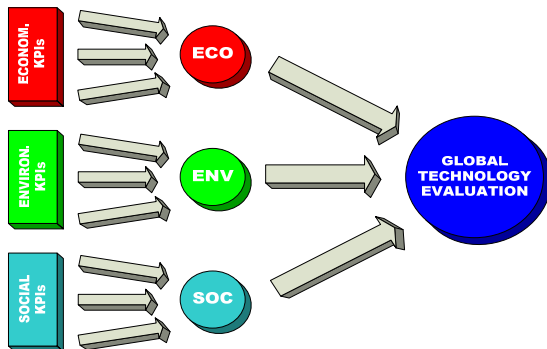


Figure 1. KPI Evaluator Tool

Current position

During phase 2 the development of the KPI Scores relied on data from the other work packages within SP9. Where new data was not available, Phase 1 data was utilised. The new assessments utilised the new LCA models and data methodology including the future reduction target assessments from work package 9.2 and the new scenarios developed in WP9.1.

Assessments for Benchmark Blast Furnace (BF) and Smelting Reduction (SR) have been completed, with development on the new technologies continuing. The raw data and assessments have not been checked or verified outside of SP9. As part of stakeholder engagement, this is an important step to ensure the results are correct and robust. Work in the final part of the project will ensure that relevant stakeholders are able to view and comment on the results and the assumptions made.

It should be made clear that the results have not been verified and, therefore, are only to be used to demonstrate the principles of the methodology.

The raw results are presented in Table 2 and follow the format of the KPI's presented in ULCOS Phase 1.

Scenario No	Performance Indicator Desc:Units	Reference					SP10	SP11	SP11	SP11	SP11
		Benchmark 2000	Benchmark 2010	Benchmark 2030	Benchmark 2030	Benchmark 2030					
1	CO ₂ emissions	1737.3	1730.4	1761.2	1734.4	1698.1	544.94	520	489.47	445.16	351.34
2	Global Warming Potential	1816	1795.5	1774.6	1746.8	1692.2	580.7	551.64	516.94	466.49	366
3	Primary Energy Usage	18.833	18.836	18.743	18.683	18.51	21.973	21.98	21.756	21.614	21.198
4	By-Products (All)	231	231	231	231	231	123	123	123	123	123
5	Waste (unusable products)	2804.6	2801.3	2797.1	2797.5	2796.3	3134.1	3126.3	3116.1	3117	3114.3
6	Resource Depletion	7.7724	7.8272	7.8674	7.8271	7.6919	8.6605	8.6916	8.7879	8.6914	8.3676
7	Water usage	7.7465	7.7176	7.6743	7.6777	7.6945	7.3272	7.6532	7.7465	7.7576	7.7576
8	Capital Expenditure	3318	3139	3139	2824	2256	2846	2698	2698	2433	1956
9	Nett Operating Cost	184	216	216	254	278	160	169	169	192	204
10	Air Quality Compliance	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass
11	Employee numbers	-	Same	Same	Same	Same	Same	Same	Same	Same	Same
12	Skill Level wrt BF route	NA	Same	Same	Same	Same	Same	Same	Same	Same	Same
13	Site Area wrt BF route	NA	Same	Same	Same	Same	Same	Same	Same	Same	Same

Table 2. KPI Results for Benchmark BF and Smelting Reduction

By themselves, these 13 KPIs can only provide comparative information between each of the process routes, in relation to the benchmark data, e.g. whether the CO₂ emissions are more or less than those from the benchmark BF route. They do not attach any 'relative' importance to the parameter being measured. To achieve this type of differentiation, a programme of stakeholder engagement should be carried out, to determine the relative importance of each indicator (known as weightings).

Stakeholder Engagement

Stakeholder engagement is a necessary part of the sustainability evaluation procedure. At the minimum, it could entail the views of just one individual 'expert' but, in most cases, it is based on a much wider group of people, covering all aspects of society.

Within the ULCOS programme, it has not been possible to carry out this type of extensive stakeholder engagement, due to limited time and funding constraints. An alternative source of information has

therefore been utilised to determine the relative importance of each KPI.

In 2007, the World Steel Association or worldsteel (previously known as the International Iron and Steel Institute or IISI) commissioned a stakeholder survey, by the Chair of Environment and Resource Management at TU Bergakademie, Freiberg⁽¹⁾. The aim of the research was to collect information that could be used to improve the sustainability reporting efforts of the steel industry. The survey collected feedback from more than 500 targeted stakeholders, on issues related to the steel industry and steel the material.

The survey was conducted in 12 selected countries from all of the main continents (Europe, North & South America, Australia, Asia and Africa). Within each country, 9 categories of stakeholder were consulted, including suppliers, customers, industry, NGOs, educational institutions, press & media, government organisations, international organisations and the financial community.

The survey participants were asked to rate a list of ten 'significant' sustainability issues, affecting the World at present. These were:-

- Climate change and CO₂ emissions
- Efficient use of water resources
- Efficient use of energy resources
- Recycling
- Biodiversity
- Population development
- Food production & distribution
- Health & safety
- Education
- Transportation & Logistics

The rankings obtained from the stakeholder survey show that the top four main concerns are all environmental in nature, these being:-

- Efficient use of energy resources
- Climate change and CO₂ emissions
- Efficient use of water resources
- Recycling

The next two concerns have a social impact, namely:-

- Education
- Health & safety

Using the full results of this survey, individual weightings have subsequently been generated for each of the thirteen KPIs, in order that the KPI data can be analysed for a number of future scenarios. These are shown in Table 3.

No	Performance Indicator Description	Weighting
1	CO2 emissions	2
2	Global Warming Potential	2
3	Primary Energy Usage	1
4	By-Products (All)	4
5	Waste (unusable products)	4
6	Resource Depletion	4
7	Water usage	3
8	Capital Expenditure	5
9	Nett Operating Cost	1
10	Air Quality Compliance	6
11	Employee numbers	10
12	Skill Level wrt BF route	5
13	Site Area wrt BF route	8

Table 3. Performance Indicator Weightings

Taking the raw scores, the data has then been normalised relative to the benchmark process in the default scenario, i.e. Benchmark 2000. The normalisation process is designed such that a score greater than 1 shows the process to be better than the benchmark and a score of less than 1, the process is worse. The normalised results are shown below in Table 4.

No	Scenario Performance Indicator Desc: Units	Reference Benchmark					SP11				
		2000	2010	2020	2030	2050	2000	2010	2020	2030	2050
1	CO2 emissions	1.00	1.01	1.02	1.04	1.01	3.30	3.46	3.67	4.08	5.12
2	Global Warming Potential	1.00	1.01	1.02	1.04	1.07	3.13	3.29	3.51	3.89	4.98
3	Primary Energy Usage	1.00	1.00	1.00	1.01	1.02	0.86	0.86	0.87	0.87	0.89
4	By-Products (All)	1.00	1.00	1.00	1.00	1.00	1.88	1.88	1.88	1.88	1.88
5	Waste (unusable products)	1.00	1.00	1.00	1.00	1.00	0.89	0.90	0.90	0.90	0.90
6	Resource Depletion	1.00	0.99	0.99	0.99	1.01	0.91	0.89	0.89	0.90	0.90
7	Water usage	1.00	1.00	1.01	1.01	1.01	0.98	0.98	1.00	1.00	0.99
8	Capital Expenditure	1.00	1.06	1.06	1.17	1.47	1.17	1.23	1.23	1.36	1.70
9	Nett Operating Cost	1.00	0.85	0.85	0.72	0.66	1.15	1.09	1.09	0.96	0.96
10	Air Quality Compliance	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
11	Employee numbers	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
12	Skill Level wrt BF route	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
13	Site Area wrt BF route	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00

Table 4. Key Performance Indicators Normalised

Once the normalised scores have been calculated then the weighting factors can be applied that were taken from the worldsteel stakeholder study. As this study was not designed for the ULCOS project then assumptions have to be made on which weighting from the study can be applied to the ULCOS KPI's. This decision has been taken internally within the SP9.4 group, but will be debated on a wider audience to get a general agreement within the project from both the project SP's and the Steering Committee.

When these weightings are applied to the normalised KPI's (with an inverse methodology), the following results are obtained (Table 5).

No	Scenario Performance Indicator Desc: Weighting	Reference Benchmark					SP11				
		2000	2010	2020	2030	2050	2000	2010	2020	2030	2050
1	CO2 emissions	2	9.00	9.09	9.18	9.22	13.64	23.68	31.11	33.25	35.50
2	Global Warming Potential	2	8.00	9.10	8.21	9.36	9.89	28.15	29.63	31.62	35.04
3	Primary Energy Usage	1	10.00	10.00	10.00	10.00	10.11	8.57	8.57	8.66	8.71
4	By-Products (All)	4	7.00	7.00	7.00	7.00	7.00	13.15	13.15	13.15	13.15
5	Waste (unusable products)	4	7.00	7.01	7.02	7.02	7.02	6.26	6.26	6.30	6.30
6	Resource Depletion	4	7.00	6.95	6.92	6.95	7.07	6.36	6.36	6.19	6.26
7	Water usage	3	8.00	8.03	8.08	8.07	8.08	7.82	7.89	8.00	7.99
8	Capital Expenditure	5	6.00	6.34	6.34	7.05	8.65	7.00	7.38	7.38	8.16
9	Nett Operating Cost	1	10.00	8.52	8.52	7.24	6.62	11.50	10.89	10.89	9.58
10	Air Quality Compliance	6	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00
11	Employee numbers	10	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
12	Skill Level wrt BF route	5	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00
13	Site Area wrt BF route	8	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00
			88.00	87.03	87.31	87.09	89.00	133.48	136.15	140.22	146.71

Table 5. Key Performance Indicators Weighted

The overall scores then allow the different processes and scenarios to be compared to the reference case. These will be further processed and analysed once all breakthrough technologies have been completed, to ensure a fair comparison is possible and reported directly to the ULCOS stakeholders.

Conclusion

The KPI modelling work has allowed the group to take the complex data that is generated by the sub projects, for the new technologies, and distil it to a single score which can then be compared to the reference blast furnace that is currently in operation. This has been repeated for various scenarios to understand the potential impacts the scenarios have on the new technologies and the way that they operate.

The KPI's selected allow the project to look at the impacts of the new technologies beyond the issue of CO₂ to ensure that other aspects of sustainability are understood and fit into the understanding of positive sustainable operations.

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References.

[1] Stakeholder survey to improve (steel industry) sustainability reporting, commissioned by the International Iron & Steel Institute (IISI) and undertaken by TU Bergakademie, Freiberg, report issued 29th November, 2007.

¹ Priority 3 of the 6th Framework Programme in the area of "Very low CO₂ Steel Processes", in co-ordination with the 2003 and 2004 calls of the Research Fund for Coal and Steel