PURity improv**E**ment of **SCRAP** metal

Deliverable 1.4

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Abbreviations and acronyms

BF	Blast furnace
BOF	Basic oxygen furnace
CSP	Clean Steel Partnership
EAF	Electric arc furnace
KPI	Key performance indicator

Abstract

This document represents deliverable D1.4 “List of PURESCRAP KPIs” of the Horizon Europe project entitled "Purity improvement of scrap metal" (project acronym: PURESCRAP; grant agreement no: 101092168 [1]).

The objective of Work Package 1 is to provide a list of the key performance indicators (KPI). During the project they will be monitored to demonstrate the feasibility of PURESCRAP. The KPIs include indicators related to scrap quality, scrap circularity and resource efficiency, as well as indicators related to the system and CO_2 reduction for scrap melting.

1 Introduction

This deliverable presents the list of PURESCRAP Key Performance Indicators (KPIs). They will be monitored during the project to demonstrate the PURESCRAP feasibility. The project KPIs are oriented towards environmental, economic, social, and technical considerations. Their specification is consistent with the Clean Steel Partnership (CSP) roadmap, in particular with the specific object number 4 (“Increasing the recycling of steel scrap and residues to increase smart resources usage and further support a circular economy model in the EU”) [2]. The primary impact areas targeted by these indicators are elimination of contamination, improved scrap utilisation (resource efficiency) and the reduction of CO_2 emissions. Based on the list of KPIs defined in this deliverable, a periodic monitoring will be conducted to measure the progress of the project (D3.4, D3.5).

The first part of this document provides a general introduction of Key Performance Indicators according to the ISO 22400 standard and describes the criteria. The second part contains the list of PURESCRAP KPIs.

2 Key performance indicators

KPIs are a tool of manufacturing operations management. Their implementation provides the potential to improve a company's value creation processes.

2.1 General description of KPI according to ISO 22400

Performance measurement allows a company to quantify aspects of all its activities. Combining different measurements from operations may help achieve this. Monitoring performance focuses on the company's identified objectives. KPIs provide the highest benefit using their values to identify trends related to specific operational objectives. Within a company, various functional areas have different key performance indicators contributing to the monitoring progress towards the business objectives. An international standard for KPIs has been established to compare the performance of organisations and industries over time. [3]

2.2 Criteria for KPI

A useful KPI has defined characteristics to guarantee its effectiveness in accomplishing multiple targets in the production operation. Some of these criteria include the following characteristics, e.g., relevant, documented, comparable, understandable, inexpensive. The ISO standard details all criteria along with the method for conducting each measurement. [3]

3 List of PURESCRAP KPIs

The PURESCRAP list of KPIs focuses on environmental, economic, social, and technical perspectives. Their definition is in line with the Clean Steel Partnership (CSP) roadmap, in particular with the specific object number 4 (“Increasing the recycling of steel scrap and residues to increase smart resources usage and further support a circular economy model in the EU”) [2]. The main impact areas of PURESCRAP involve the elimination of contamination, improved scrap utilisation (resource efficiency) and the reduction of CO_2 emissions. Table 1 presents the list of PURESCRAP KPIs with the targets to be reached after the project. The wording from “sorted scrap” in the Grant Agreement was replaced with “classified scrap” to describe the work carried out more precisely. In addition, KPIs for analysis accuracy of various metals for the sensor system extend the list.

Indicators related to scrap quality target a lower content of tramp elements in the classified scrap product, e.g. Cu, Mo, Ni and Sn. The resource efficiency of a basic oxygen furnace (BOF) and an electric arc furnace (EAF) is associated with an increased input of post-consumer scrap for the different furnaces. Together with the increased input of low-quality scrap, they represent indicators related to scrap circularity and resource efficiency. The completed system and proven classifying efficiency, the analysis accuracy of the tramp elements for the sensor system and the installed sensors are indicators related to the system. The CO_2 reduction in scrap melting compared to a reference BF-BOF or EAF count as indicators related to global warming.

Table 1: List of PURESCRAP KPIs

	Indicators	Target
Indicator related scrap quality (targets to be reached after PURESCRAP)	Final content of **Cu** in the classified scrap product	≤0.05 wt.%
	Final content of **Mo** in the classified scrap product	<0.02 wt.%
	Final content of **Ni** in the classified scrap product	<0.1 wt.%
	Final content of **Sn** in the classified scrap product	<0.03 wt.%
Indicators related to scrap circularity and resource efficiency (targets to be reached after PURESCRAP) indictors related to one ton of produced crude steel	Resource efficiency BOF (**increased input of post-consumer scrap**)	+70 kg/t
	Resource efficiency EAF (**increased input of post-consumer scrap**)	+140 kg/t
	Increased input of **low-quality scrap** over the total scrap input compared to usual practice (for specific steel)	≥40 %
Indicators related to the system (targets to be reached after PURESCRAP)	System completed, and classifying efficiency proven	TRL 8
	Analysis accuracy of **Cu** for the sensor system	2σ = 0.1 wt.%
	Analysis accuracy of **Mo** for the sensor system	2σ = 0.1 wt.%
	Analysis accuracy of **Ni** for the sensor system	2σ = 0.1 wt.%
	Analysis accuracy of **Sn** for the sensor system	2σ = 0.1 wt.%
	Installed sensors (vision and/or spectroscopic) for improved scrap monitoring and sorting	≥3
CO_2 reduction for scrap melting (targets to be reached after PURESCRAP)	**CO_2 reduction** for scrap melting compared with reference **BF-BOF** operation using increased share of post-consumer scrap	10 % (or -0.13 t CO_2 per ton crude steel)
	CO_2 reduction for scrap melting compared with reference **EAF** operation using increased share of post-consumer scrap	30 % (or -0.25 t CO_2 per ton crude steel)
Social KPI on training and user involvement	Training for workers whose job design and skill requirements are changing when implementing PURESCRAP solution	Training hours per worker / Integration in regular training measures
	Involvement of workers and managers in the development process of the PURESCRAP solution	At least, one person per affected group of workers/managers
	Acceptance of the PURESCRAP solution	75% of the concerned people

3.1 KPI description according to ISO 22400

A key performance indicator is marked by information about its context and content: [3]

- Context information: a verifiable list of fulfilled conditions.
- Content information: a quantifiable element with a specific unit of measure.

Factors determining a KPI's value may be modified by a particular action plan. This plan outlines the activities leading to the achievement of the operation's objectives and furthermore, the actors and resources required to accomplish the activities, as well as the time frame for completing the activities.

Table 2 presents a preliminary filled-in description of a KPI using the example of copper (Cu) content in the classified scrap product. Detailed descriptions and procedures for the computation of each KPI will be provided in the deliverable D3.4.

Table 2: Preliminary KPI description of the Cu content according to ISO 22400 [4]

KPI description	
Content	
Name	Cu content in classified scrap product
ID	
Description	The Cu content is the ratio of the amount of copper present in the classified scrap product to the amount of scrap analyzed.
Scope	Product
Formula	$w_{Cu} = \left(\frac{m_{Cu}}{m_{ent}}\right) \cdot 100\%$, with $m_{ent} = \sum_{z=i}^{Z} m_z$
Unit of measure	wt.%
Range	Min: 0 wt.% Max: 100 wt.%
Trend	The lower, the better
Context	
Timing	Real-time, periodically, on-demand
Audience	Operator, supervisor, management
Production methodology	Batch, continuous
Effect model diagram	
Notes	w_{Cu} = mass fraction of copper m_{Cu} = mass of copper in the scrap m_{ent} = entire amount of scrap

Conclusion

The PURESCRAP KPI list targets on environmental, economic, social, and technical perspectives. Their definition is in line with the Clean Steel Partnership (CSP) roadmap. Indicators related to scrap quality target a lower content of tramp elements in the classified scrap product, e.g. Cu, Mo, Ni and Sn. The resource efficiency of a basic oxygen furnace (BOF) and an electric arc furnace (EAF) is based on an increased input of post-consumer scrap for the different furnaces. Along with the increased input of low-quality scrap they represent indicators referring to scrap circularity and resource efficiency. As indicators related to the system include the completed system and proven classifying efficiency, the analysis accuracy of the tramp elements for the sensor system and the installed sensors are indicators related to the system. The CO_2 reduction in scrap melting compared to a reference BF-BOF or EAF are considered indicators related to global warming.

Additionally, the human or social performance is considered by ensuring acceptance, co-creation, and training of the people concerned. This is foreseen for improving effectiveness and efficiency of the technological solution being developed by integrating the workplace experience of the workers and serving them with the right skills for implementation and usage.

References

[1] PURESCRAP, GRANT AGREEMENT - NUMBER 101092168, Final Version 2022.

[2] ESTEP AISBL, Clean Steel Partnership: Strategic Research and Innovation Agenda (SRIA), Brussels, 2021.

[3] International Organization for Standardization, Automation systems and integration - Key performance indicators (KPIs) for manufacturing operations management: Part 1: Overview, concepts and terminology, 1st ed. 25.040.01(ISO 22400-1:2014), Geneva, ISO copyright office, 2014. www.iso.org/standard/54497.html.

[4] International Organization for Standardization, Automation systems and integration - Key performance indicators (KPIs) for manufacturing operations management: Part 2: Definitions and descriptions, 1st ed. 25.040.01(ISO 22400-2:2014 (E)), Geneva, ISO copyright office, 2014. www.iso.org/standard/54497.html.