HYbrid TEChnologies for sustainable steel reheating – HyTecHeat

HORIZON-CL4-2022-TWIN-TRANSITION-01-16, Modular and hybrid heating technologies in steel production (Clean Steel Partnership)
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Deliverable 9.2: Key Performace Indicators
WP9 project Management

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Executive Summary

This document aims to define the set of Key Performance Indicators (KPIs) to monitor the achievement of project outcomes and the strategic objectives achieved.
The KPI can be also considered a tool to motor the progress of project activities
At the beginning of the project, the KPIs included in the project proposal have been reviewed and further detailed. New KPI have been individuated taking into account the specuf activities which ate under development and technical discussions with partners during technical meetings.
The main aspects of HytecHeat project that requires to be monitored and quantified to demonstrate the successful achievement of the project, are:

- The general objective
- The specific technical objectives
- The dissemination and communication activities

For each specific KPIs have been defined and a target value proposed.

Table of Contents

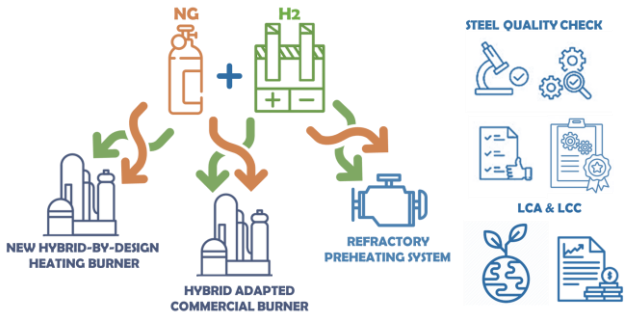
List of Acronyms

AMGA	Annotated Model Grant Agreement
CFS	Certificates on the Financial Statements
CP	Contingency plan
DLV	Deliverable
DoA	Description of Action
EC	European Commission
EU	European Union
GA	General Assembly
KoM	Kick of Meeting
MA	Mitigation action
OSH	Occupational Safety and Health
PC	Project Coordinator
PM	Person Month
SC	Steering Committee
TL	Task leader
WP	Work Package
WPL	Work Package Leader

1 INTRODUCTION

HyTecHeat aims at adopting hybrid heating technology (based on NG with progressive and increasing H2 utilization) in downstream processes so to path the way for the abatement of CO2 **for the whole downstream processes at EU level of 7.5 Mt (if conservatively 30% of H2 is considered) up to about 25 Mt (if 100% of H2 is used)**. Taking into account that the overall emission of CO2 in EU from all industrial sectors in 2018 (before the COVID pandemic) is estimated to be 2.9 Gt[1], the implementation of HyTecHeat technology in all EU downstream process (100% of H2) will lead to an abatement of 0.9% (25 Mt) of the EU CO2 emission. Thermal treatment and reheating processes, which are common to both BF and EAF route, in fact, have a significant NG demand (about 50 Nm3/t of produced steel). In order to allow the shift from NG to H_2 and consequently to reduce the environmental impact by using innovative hybrid combustion technologies, impacts on steel quality and furnace must be assessed also with the realization of Demo cases at high TRL (7).

To have a complete picture of the possibility of hybrid technology 3 different *democases* are envisioned: first in TENOVA democase a hybrid by-design burner will be designed and test in order to evaluate advantage and possible risk needed to be mitigated in this new systems; in TATA democase, a burner currently fully-NG will be adapted to evaluate the limit up to which the current systems can be pushed to work in hybrid heating gas atmospheres without reducing system performance. Finally, in the Nunki democase the effect of hybrid heating system will be evaluated on the quality of the refractory in pre-heating systems. Moreover, lab test will be carried out in order to find the optimal conditions to push the systems from TRL 7 (during the project) to TRL 8 (after the project). Thanks to HyTecHeat technology the effects and the limits of hybrid heating technology up to 100% of H2 will be evaluated on the entire chain of steel downstream process. The results are expected to have a wide impact on the entire steel sector due to the flexible approach of HyTecHeat, fully adaptable to both new-by-design and adapted burner systems



In order to monitor the progresses of such a complex project, to verify the achievements of the objectives and to intervene with proper countermeasures in case of need a control system should be put in place and this include **measuring the performance.**

Measurement is an essential management tool, as it helps to determine if the work is demonstrating the expected results, is making an impact, is on the correct track or if it needs a re-focus of the efforts. In literature it is possible to find different definition of performance measures, most of them can be summarised as “the numerical or quantitative indicators that show how well each objective is being met”, and from that the need for the definition of Key Performance Indicators.

Key Performance Indicators (KPIs) are the critical (key), measurable indicators of progress toward an intended result. KPIs provide a focus for strategic and operational improvement, create an analytical basis for decision making and help focus attention on what matters the most.

[1] Global Carbon project https://ourworldindata.org/annual-co2-emissions

Nonetheless, setting a measurable indicator is not enough: it is necessary to set a specific level of performance that must be reached, so that the progresses can be tracked against these targets.

There is not a unique way to define KPIs: the meaningful metrics are case specific and must be developed and adapted to the specific projects. There are instead guidelines to be followed in order to be sure that the KPIs selected are the correct ones.

2 KEY PERFORMANCE INDICATORS

KPIs are a measurable expression for the achievement of a desired level of results, in an area relevant to the evaluated activity to make objectives quantifiable. They are applied to multiple sectors from companies' organizations to product development and they are absolutely critical to the success of each project. The development and use of the KPIs should form the basis for the analysis of the results, the future developments and the improving strategies required for ongoing success.

Accordingly, choosing the right KPIs relies upon a good understanding of the domain in order to have the right things being measured and the inappropriate ones being left out. What is deemed important often depends on the context – e.g. the KPIs useful to assess process performance will differ from the ones related to marketing.

The importance of such indicators is evident not only to assess the results obtained, but to enable an effective decision-making process. It's vital to make the right decisions to be equipped with all the relevant pieces of information. Data must not be faulty or incomplete on one hand, but on the other the number of indicators to be considered must be limited to keep the process as simple as possible.

Since there is a need to understand well what is important and what is not, various techniques to identify KPIs are suggested. First of all two key questions need to be answered:

- ✓ What topics should the indicators focus on?
- ✓ What aspects should be measured?
- ✓ In case of research projects, performance indicators should focus on aspects that are important for the achievement of the objective, that must be all time clear. Starting from that performance indicators should consider the specific actions needed to achieve this objective.
- ✓ In the framework of the project, we will consider **high level indicators** related to the global aim and **lower level indicators** that will look at the specific aspects and tasks that will contribute to reach in the end the overall objective.

2.1 KPIS CHARACTERISTICS

There are a number of general characteristics of indicators that can help to ensure that proposed indicators will be useful and effective. The most important are:

- ✓ **Relevance**. Indicators should include information essential to understand the accomplishment of goals and objectives. Thus, one way of helping to ensure the relevance is to relate the performance indicators to the general and specific goals and objectives of the project. Indicators should also be relevant to the people providing the data and to the users, but it may not be possible for a single indicator to be relevant to all users due to differences in perspectives and interests.
- ✓ **Clear definition.** A performance indicator should have a clear and intelligible definition in order to ensure consistent collection and fair comparison. Vague descriptions can lead to misinterpretation and confusion. Too tight or too broad definitions could also create problems.
- ✓ **Easiness of understand and use.** Indicators must be described in terms that the users of the information will understand. The technical content should be tailored to the use and abstract concepts must be in general avoided.
- ✓ **Comparability.** Indicators should ideally be comparable on a consistent basis both considering similar contexts and over time, thus specifying the scenarios is essential to make comparisons possible.
- ✓ **Verifiability**. The indicator also needs to be collected and calculated in a way that enables both the information extracted and the original data to be verified. The indicator should be based on robust data collection systems, and it should be possible for managers to verify the accuracy of information and the consistency of the methods used.
- ✓ **Cost effectiveness**. Another important criterion is to balance the cost of collecting information with its usefulness. Where possible, an indicator should be based on information already available and linked to existing data collection activity.
- ✓ **Responsiveness**. A performance indicator should be responsive to change in order to be able to capture the effects of the interventions carried out, to evaluate if they are in the correct direction to reach the target.
- ✓ **Statistical validity**. Indicators should not be calculated on too small data samples in order to avoid wrong assumptions related to the lack of data.
- ✓ **Timeliness.** The indicators should be based on data that are available within a reasonable time scale, depending on the use made of the data, but in any case, the information should be available to users before it loses its value in making decisions.
- ✓ **Achievability.** Target value must be achievable in a specific period (i.e. the timeframe of the project).

2.2 KPIS FRAMEWORK REVIEW AND ASSESSMENT

Considering the importance of KPIs in the development of the project, the definition and assessment is a process that requires reviews and iterations, as the project evolves, and more information becomes available.

Thus, is here proposed a review and analysis methodology based on a Performance Measurement Maturity Model, that usually takes into consideration 5 important steps:

- ✓ **KPIs Identification & Selection** – The selection of right KPIs starting from the beginning has a major impact on the development of the project. KPIs should focus on activities carried out at the different stages of the project to reach the global aim. Most important it must be considered the measurement of what is important and not necessarily the easiest thing.
- ✓ **KPIs Documentation and Alignment** – The process of KPIs documentation secures that the selected indicators are actionable, by establishing definitions, purpose, calculation formulas, targets, methods of data collection and reporting and data owners and custodians.
- ✓ **KPIs Collection and Interpretation** – The process of KPIs collection and interpretation is of utmost importance to guarantee the reliability of the results. A responsible for data gathering must be identified and it must be assured data availability for each KPIs defined.
- ✓ **KPI Reporting & Visualization** – Regardless of the parties involved in the performance reporting process it must be assured that the process is effective and efficient. An inefficient and ineffective reporting system will not generate any significant positive effect on improving the performance of an organization. Another important part of the measurement process is data visualization. Data visualization involves processing information in a graphic description of it in order to be understood and transmitted more easily, faster and more efficiently.
- ✓ **KPI Feedback and Re-alignment** – This process is one of the most important parts of the performance measurement cycle. It secures that the KPIs are kept on track and aligned with the project scope, in order to provide with valuable information that will allow monitoring and control.

3 HYTECHEAT KEY PERFORMANCE INDICATORS

Starting from the guidelines mentioned in the previous chapter *HyTecHeat* KPIs have been developed considering 3 aspects:

- ✓ Global aim
- ✓ Specific (technical) objectives
- ✓ Impact objectives

For each objective at least 1 KPI has been identified and the following information are be provided:

- ✓ How it will be measured?
- ✓ Which data will be collected?
- ✓ When it will be evaluated?

3.1 GLOBAL AIM

The general objective of HytecHeat project, as stated in the project proposal, is to contribute to the mitigation of CO2 emissions from downstream steelmaking processes. This target is achieved with an hybrid heating, with Ng and hydrogen, allowing the transition up to 100% hydrogen

With this formulation the definition of the first High Level KPI is straightforward:

- HL_KPI1: Hydrogen utilization in innovative combustion systems
- HL_KPI2: Hydrogen utilization in current system for steel reheating
- HL_KPI3: Hydrogen utilization in current system for ladle preheating

These KPIs are expresses as percentage of the combustible fuel**.**

3.2 SPECIFIC OBJECTIVES

Below is reported the table containing the specific objectives of the project, the challenge, expected output and the corresponding KPI, with reference value.

The table is defined starting from what reported in the original proposal and integrated consequently with ongoing project activities.

Challenge 1	**Design reheating furnaces based on hybrid heating and green technologies to abate GHG emissions and the incorporation of electricity from renewable sources**
Specific Objective 1	**Improve the design of reheating furnace considering mix of NG and hydrogen enabling modifications to be integrated in conventional steel plants with the objective to significantly reduce CO2 emission**
Expected outputs and means of verification	Pilot plant at TRL 7 and long-term industrial test of multi-fuel H2/CH4 burners
S_KPI1	*CO2 abatment in the furnace adopting innovative burner and with hybrid utilization of current systems* *The KPI is expresses as percentage*
Challenge 2	**Optimization of reheating conditions to maintain high-quality steel production**
Specific objective 2	**Evaluate the effects of hydrogen combustion on surface quality of steel products: study steel oxidation, decarburization and descalability of several steel grades (carbon, special and stainless steels) and to define the optimised processing parameters to ensure that primary scale do not persist through to the final product.**
Expected outputs and means of verification	Verification of quality on different type of steels, via testing descaling, oxidation rates, hydraulic descaling test
S_KPI2	*Per each of the investigated steel grade the impact of scale growth is reported. The reference value of scale growth is the test simulating standard condition:* *(msH2-msNG)/msNG* *msH2: mass of scale formed simulating H2 combustion* *msH2: mass of scale formed simulating natural gas combustion*
Challenge 3	**Utilization of hybrid heating technologies for ladle preheating**
Specific Objective 3	**Set up demo case with industrial burner testing directly connected with hydrogen source and definition of working performances when used with NG/H2 blends and comparison with innovative burners**
Expected outputs and means of verification	Industrial trial measuring the thermal condition n of the ladle with pyrometer The potential CO2 saving in case of routinary utilization of a blend H2/NG The ratio H2/NG is verified with industrial trials too
S_KPI3	*CO2 abatment in the furnace adopting innovative burner and with hybrid utilization of current systems* *The KPI is expresses as percentage*

Challenge 4	**Technoeconomic evaluation and benchmarking of implementing hybrid heating technology based on green hydrogen in reheating processes**
Specific objective 4	**Evaluation of the economic, energy and environmental impact of introduction of the H2 combustion technology in steelmaking production site;**
Expected outputs and means of verification	- System analysis for implementing hydrogen as a fuel, using Process Integration (PI) techniques for process optimization, including the effect of fuel price volatility, price of CO2 emission rights, etc - Definition of guidelines for risk management and identify legislation constraints and opportunities for H2 use in downstream processes; - Quantitative assessment of the HyTecHeat results in terms of LCA and LCC assessments.
S_KPI4	*Evaluation of impact on CAPEX (in the three cases of furnace equipped with innovative burers, currant systems working in blends with H2 and NG and ladle preheating)*
S_KPI5	*Evaluation of impact on OPEX (in the three cases of furnace equipped with innovative burers, currant systems working in blends with H2 and NG and ladle preheating)*

3.3 IMPACT OBJECTIVES

Reaching the stakeholders, the scientific community and the overall society to favor the adoption of the solutions developed is as important in HYTECHEAT project as achieve the technical objectives. Thus, a set of indicators has been defined, starting from the target audience to be reached.

In order to maximize the impact of HyTecHeat results, the following **key audience target groups** are already identified and will be addressed and engaged throughout the lifetime of the project:

GENERAL PUBLIC	EU citizens, Other EU project coordinators players in the field	Targeting citizens' engagement and Global visibility
RESEARCH	Educational organizations, Academia and Research centers	Targeting the engagement of scientific/technical community
INDUSTRY & STAKEHOLDERS	Steel companies, industrial players and mining entities, private and associations.	Targeting the potential future business engagement and collection of needs tailored to specific process development
POLICY MAKERS	EU & national institutions, non-governmental organizations, Public entities, public bodies, policymakers.	Targeting the generation of awareness and the consensus

For the C&D activities also the following **C&D key performance indicators (KPI)** are already identified.

VISUAL IDENTITY	The visual identity of the project will be associated to the logo of the project, which will help the general audience to memorize the project and to intuitively make a connection between the logo and the aim and results of the project. If necessary, the logo will be adjusted slightly during the lifetime of the project to better emphasize the key message and results of the project.
	KPI: people reached: +10.000 people
SCIENTIFIC PUBLICATION	Key scientific results will be published in high-impact, peer-reviewed journal (Stahl+Eisen, Steel Research, Metallurgical Plant and Technology, Ironmaking and Steelmaking), to disseminate the results to the scientific audience. Each partner will ensure open access (online access for any user, free of charge) to all peer-reviewed scientific publications related to their results within the project.
	KPI: papers / publications: < 1 = poor; 1- 4 = good; > 4 = excellent
WEBSITE	A project website will be created in the first 6 months of the project and will be one of the key tools for communicating and disseminating the results of the project. It will be set on two level: first level will be public and visible to everyone; the second level will be based on an intranet accessible only by partners. The project website will contain all key information and news of the project (i.e. project objectives, developed materials, exploitable results for industry, virtual plant visits). It will be updated on a regular basis (at least every 6 months), after Consortium meeting and after every milestone is achieved. Project webinar and workshop will also be advertised in the project website.

	KPI: website visits: <5000 = poor; 5000-10,000 = good; >10,000 = excellent
SOCIAL MEDIA	All information uploaded on the website will also be stream on the project social media project channels (i.e. Twitter, Linkedin) to maximize the visibility of the project messages and results.
	KPI: posts on social media: < 100 post = shares; 100 – 400 shares = good; > 400 shares = excellent
OTHER MEDIAS	Leaflets, posters and e-banners targeting key stakeholders will be produced and used during conferences, workshop and relevant forums. Local press, Radio and TV will also be contacted to suggest interviews and contribution to maximize the visibility of the project to the general and scientific public.
	KPI: Brochure/leaflet distribution: < 300 copies = poor; 300 - 1.000 = good; > 1.000 copies = excellent
EVENTS	The project results will also be presented in relevant conferences, fairs and events (such as European Steel Technology and Application Days (ESTAD), European Electric Steelmaking Conference, Steelsim). Workshop and webinars will be organized in different European regions; in addition to the scientific audience and key stakeholders, press will also be invited to join to maximize the impact of these events.
	KPI: Events held: < 5 = poor; 5- 20 = good; > 20 = excellent

Each KPI will be evaluated for each key group generating a clear matrix useful to evaluate and highlight the impact of the project as detailed in the following sections.

CONCLUSIONS

This Deliverables describes the KPIs that will be used to evaluate the achievements of HyTecHest objectives.
KPIs can be mainly grouped in

- ✓ High Level KPIs, to demonstrate the achievement of HyTecHeat global aim
- ✓ Low Level KPIs, to monitor the specific technical objectives
- ✓ Communication & Dissemination KPIs to monitor the effectiveness of the communication and dissemination activities

For each KPI a target value is proposed and, where relevant, details on the evaluation procedure and data to be gathered will be provided.
The final report with all carried out exploitation action is foreseen in May 2026.