



# ENVIRONMENTAL BENEFITS OF INDUSTRIAL WASTE HEAT RECOVERY IN REDUCING NATURAL GAS CONSUMPTION

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## INTRODUCTION

Energy-intensive Industries in Europe emit around 12 million tonnes of CO<sub>2</sub> annually, mainly due to reliance on natural gas (NG) and high-temperature processes (800–1500°C), which produce significant waste heat (WH). The EU-funded HEATERNAL project addresses this by developing a thermal energy storage system (TESS) using phase change materials (PCMs) in refractory bricks, enabling WH recovery to improve efficiency and cut emissions. This study evaluates the environmental impacts (EI) of PCM candidates and the environmental shares of NG usage within a use case (UC) baseline of yellow and blue pigment production, defined as the demo site for the envisaged HEATERNAL TESS prototype.

## OBJECTIVES

1. To evaluate the PCM candidates proposed by technical partners using a streamlined LCA (s-LCA) methodology
2. To quantify the environmental impacts of blue and yellow ceramic pigment production at current industrial production schemes.
3. To assess the environmental benefits of installing HEATERNAL solution due to NG use reduction

## METHODOLOGY



## RESULTS

### PCM EVALUATION

Environmental impacts results from s-LCA on PCMs

| PCM        | CC (kg CO <sub>2</sub> -eq) | HTNC (CTUh) | OD (CFCl <sub>3</sub> -eq) | RUF (kg) |
|------------|-----------------------------|-------------|----------------------------|----------|
| AlCuSi (E) | 3.20E-3                     | 5.1E-7      | 5.5E-8                     | 4.5E1    |
| AlCuSiPP   | 4.3E-3                      | 6.4E-7      | 6.0E-8                     | 7.8E1    |
| Al         | 1.7E-3                      | 8.4E-8      | 1.2E-7                     | 1.2E2    |
| CeSi       | 3.3E-3                      | 5.1E-7      | 6.2E-8                     | 6.4E1    |

HT: Human Toxicity

### HEATERNAL BENEFITS WITHIN THE USE CASES

Reduction of EI due to NG use in the UC

| Impact Category | Units                  | Yellow pigment | Blue pigment |
|-----------------|------------------------|----------------|--------------|
| CC              | kg CO <sub>2</sub> -eq | 16%            | 35%          |
| RUF             | kg                     | 34%            | 3%           |
| OD              | CFCl <sub>3</sub> -eq  | 9%             | 4%           |
| HTNC            | CTUh                   | <1%            | -            |

## CONCLUSIONS

- Al-Cu-Si (E) PCM was selected as the most suitable candidate due to its demonstrated technical and environmental performance.
- The substitution of NG with WH supplied by the HEATERNAL TESS is expected to significantly reduce environmental impacts, achieving a theoretical reduction of 16% in CC, 9% in OD, and 34% in RUF impact categories.
- The contribution of NG to the current pigment baseline production varies significantly depending on the specific pigment being produced, mainly affected by the raw materials impact on the pigment.



Launched in May 2023, HEATERNAL has received funding from the European Union's Horizon research and innovation program under Grant Agreement 101105821 for 3 years and 8 months. However, views and opinions expressed are solely those of the author(s) only and do not necessarily reflect those of the European Union. Neither the European Union nor the granting authority can be held responsible for them.