**H-ACERO R&D Project** - Climate neutrality of the steel industry based on new technologies and processes with intensive application of hydrogen

- Funding program: HAZITEK Strategic Projects
- Project Schedule: 2021 - 2023
- Leader: Sarralle Environment&Energy
- Budget ≈ 9 M€

### 6 TECHNOLOGY PROVIDERS

- **sarralle**
  (Steel Melting Plant, Rolling Mill, Environment&Energy)
- **Calculinor**
  (Quimica Natural)
- **insertec**
  (Furnaces & Refractories)
- **NIPPON GASES**
  (The Gas Professionals)
- **CELSA GROUP**
  (Champs Élysées)
- **NERVACERO**
  (Sidenor)
- **ArcelorMittal**
  (Olabarra)
- **ceit**
  (Member of Basque Research & Technology Alliance)
- **tecnalia**
  (Member of Basque Research & Technology Alliance)

### 5 STEELMAKING COMPANIES

- **ACERALAVA**
- **TUBACEX GROUP**
- **Sidenor I+D**
- **TUBACEX INNOVACION**

### 4 R&D ENTITIES

- **SIDEREX**

### STEEL CLUSTER ASSOCIATION

HAZITEK is a Basque Government’s aid program to support the implementation of Industrial Research Projects and co-financed by the European Regional Development Fund (ERDF).
Strategic objective → contribute to the **decarbonization of the steel sector**, using hydrogen as an alternative energy source.

**EQUIPMENT**
- Development of technology and new equipment that allow the use of hydrogen in steel processes.

**CONSUMABLES**
- Advanced refractories that allow the use of hydrogen in the steel industry, ensuring the useful life of the different equipment.

**PROCESS**
- Development of technological knowledge for application of H₂ on the steel production process.

**SAFETY**
- Safety requirements and procedures associated with the use of H₂ as an alternative source to conventional energy.

CFD Simulations
- Furnace Simulators
- Prototypes (technology at scale)

Current equipment and materials with 10-30-50% H₂/NG mixtures
- New developed equipment and materials with 100% H₂
H-ACERO R&D Project – Replacement of natural gas by green hydrogen

Ladle Heater

Tundish Heater

Reheating Furnace

EAF – Injector

Oxyfuel Cutting
## H-ACERO R&D Project – Ongoing activities

### CFD Simulations

#### Electric Arc Furnace Injectors

<table>
<thead>
<tr>
<th>Equipment</th>
<th>Scope</th>
<th>Mode of operation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Current Injectors</td>
<td>NG/O₂</td>
<td>Burner/Lance</td>
</tr>
<tr>
<td></td>
<td>H₂/O₂</td>
<td>Burner/Lance (Determine accepted H₂ %) 10%H₂ + 30%H₂ + 50%H₂</td>
</tr>
<tr>
<td>New Injectors</td>
<td>H₂/O₂</td>
<td>Burner/Lance 100% H₂/O₂</td>
</tr>
</tbody>
</table>

#### Reheating Furnace

<table>
<thead>
<tr>
<th>Equipment</th>
<th>Scope</th>
<th>Mode of operation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Furnace with current burners</td>
<td>NG/air</td>
<td>Current furnace operating conditions</td>
</tr>
<tr>
<td>Furnace with new burners</td>
<td>NG+H₂/O₂</td>
<td>100% NG/O₂, 100% H₂/O₂</td>
</tr>
</tbody>
</table>

### Diagrams

- **O₂ molar fraction**
- **Velocity profile inside furnace**
Research in refractory materials

Investigate the effect the application of hydrogen combustion has on the refractory materials

**Refractory samples** obtained from refractory manufacturer partners in project.

- Thermal treatments in pure H$_2$ atmosphere
  100% H$_2$ → 1400ºC-8h

- Thermal treatments in water vapor atmosphere to reproduce expected H$_2$ conditions
  1250ºC – 24h & 1050ºC – 12h

  NG/air combustion: 8.0% CO$_2$; 3.4% O$_2$; 72.7% N$_2$; 16.0% H$_2$O
  NG/O$_2$ combustion: 33.3% CO$_2$; 0% O$_2$; 0% N$_2$; 66.7% H$_2$O
  H$_2$/air combustion: 0% CO$_2$; 3.1% O$_2$; 67.3% N$_2$; 29.6% H$_2$O
  H$_2$/O$_2$ combustion: 0% CO$_2$; 0% O$_2$; 0% N$_2$; 100% H$_2$O

All samples characterized before and after thermal treatments:

- Microstructurial analysis → SEM (surface and section)
- Compositional analysis → XRD, EDX
Research in process metallurgy

Investigate the effect the application of hydrogen combustion has on the metallurgy of the steels

Several steel grades obtained from steelmaking companies in project.

- Industrial thermal cycles on laboratory scale under reference and new expected hydrogen combustion atmospheres
- Analysis of the oxidation kinetics of steels under reference and hydrogen combustion atmospheres by means of TGA tests (thermogravimetry)

All samples characterized before and after thermal treatments:

- Microstructural/oxide characterization after reheating cycles in reference and hydrogen combustion atmospheres produced at industrial level and in laboratory.
- Evaluation of the possible embrittlement of the steel through laboratory simulations of the first stages of processing (hot working).
Process heating monitoring for steel grades

Objective ➔ Measure the evolution of temperature of the product to be heated under the usual operating conditions in the reheating furnace.

Obtained results ➔ Temperature profile of each of the monitored points throughout the heating cycle.
Construction of reheating furnace prototype

- Gas supply (NG, H₂, O₂, air; 150-200 kW)
- Safety systems for handling combustible gases (NG, H₂, CO)
- Combustion chambers (approximate dimensioning 1,5x1,5x3 m)
- Equipment for the characterization of combustion gases, composition, temperatures
- Fumes extraction system

2022 Q4 finalize construction of reheating furnace prototype

2023 Q1 trials on prototype with H₂ burners