



Project Title	Steelanol: Converting Steel Mill Gas to Ethanol
Industry Partner	ArcelorMittal
Industry Sector	Iron & Steel
Technology Pathway (Primary)	Alternative Materials & More Efficient Process
NIM Pillar	Technology Demonstration
Source	NIM Awards 2024
Description	<p>The Steelanol plant is a first of a kind in Europe, with a process that uses a biocatalyst to convert steel mill gases into ethanol. It is the first plant in the world that runs on gas from blast furnaces. The process captures the carbon in the steel mill gases and builds the carbon in into an ethanol molecule. Per ton of ethanol about two tons of CO₂ emission is avoided.</p> <p>The plant has been designed and built according to the latest standards in process safety design. Together with the other design requirements, this resulted in a safe, comfortable and ergonomic working environment. Within the design of the plant, integration of processes, together with maximum energy recuperation and nutrient recovery, was taken into account. No waste is regenerated, so that all inputs are recovered and or re-used in the process. This resulted in a very energy and material efficient plant with minimum use of fossil energy and resources. At the same time, the plant was designed with a high degree of automation thus minimizing the need for human interventions and thus minimizing safety risks. The carbon recycling technology is like retrofitting a brewery onto an emission source like a steel mill or a landfill site, but instead of using sugars and yeast to make beer, pollution is converted by bacteria to fuels and chemicals. The ethanol product (@Carbalyst) can be used as base component in the chemical industry, for fuel, as basis for cosmetics, clothing, paint etc. Companies with sustainable products using this type of recycled carbon are Zara, H&M, Adidas, Mebille, On, Gucci, L'Oreal, Unilever.</p> <p>The Steelanol plant was successfully constructed, commissioned and started in 2023 to convert blast furnace gas to ethanol. It is the first and only large carbon capture and utilization commercial plant using steel process gases in Europe.</p>
Innovations Employed	Steelanol is the first of a kind application in the steel industry of this innovative gas fermentation technology in Europe, and the only plant using BF gas. There is a plant in China operating, but at lower innovative level and using BOF gas.
Dimension of Novelty	It was new to the International Market
Innovation Collaboration	In house: ArcelorMittal (Belgium) External: LanzaTech (US)
Intellectual Properties	Patents; licenses
IP Links	
Timetable & Progress	Development started 2015



NET-ZERO INDUSTRIES

MISSION



Project Title

Steelanol: Converting Steel Mill Gas to Ethanol

The project has suffered significant delay during the COVID period. Construction of an industrial size demonstration plant was very challenging during that period.

Financing (Public/Private)

Grants from the European Commission (H2020 10.2 M€), Interreg2Seas (1 M€), Belgian Federal Government (ETF 4 M€) and the Flemish Government (STRES 4 Meuro, STS 2 M€). Loan from EIB (75 M€).

Finance Links

[European Commission/News/Steelanol H2020 Energy project inauguration on 8 December 2022](#)

[EIB – Steelanol \(EDP\)](#)

Project Phase TRL

TRL 9

Problems to be Solved and Risks to be Managed

The main challenge in the project was to reduce carbon emission in the steelmaking process, specifically to create value from the carbon rich process gases produced during the reduction of iron oxide to iron. The most common used process is still the reduction using coal in the blast furnace process. The most common use of the blast furnace top gas is to produce electricity with low value generation.

In the project it was the first time that the LanzaTech gas fermentation technology was applied to blast furnace (BF) top gas. The energy content of the BF gas is quite low, so that the gas treatment and process design needed to be optimized to boost the productivity of the plant. Also, an innovative vacuum distillation was developed to minimize the impact of the distillation step on the core fermentation process efficiency.

On aspect of legislation significant work was done on integrating this CCU technology path in the Renewable Energy Directive to create maximum value for CO2 emissions.

Preliminary or Final Results Achieved

The technology has been implemented on an industrial scale demonstration plant. First ethanol directly from blast furnace gas feed (first ever worldwide) was produced in June 2023, with industrial scale demonstration end of 2024 (at rate of 1 to 1.5 ton ethanol/hour). Therefore TRL 8-9 has been demonstrated.

The impact of the project is 125000 tons of CO2 per year (to date 1000 tons of CO2 captured). Reduction per ton of product (ethanol) is estimated at 85%. Estimated reduction per ton of crude steel is 250 kg CO2/ton (close to 15%).

The Steelanol project is an economically viable investment and is expected to generate Ebitda from the sales of the ethanol. Therefore, it is an exceptional decarbonization project with negative CO2 abatement cost.

CO2 Emissions Reduction Potential - Implementation and Future Market

For ethanol alone, the market opportunity represented in the emissions of the steel industry is very significant. An analysis of large steel plants around the world reveals the potential to produce more than 40 billion litres of ethanol per year in China alone. Europe's steel industry could produce almost twenty billion litres. The US could see almost four billion. In addition, the ethanol can be converted to jet fuel to be used in aviation transport, where in the near future no sustainable alternative is available that is economically viable. Next to the transport sector the fermentation technology can be used to produce basic chemicals such as ethylene and propylene, which are used



NET-ZERO INDUSTRIES

MISSION



Project Title

Steelanol: Converting Steel Mill Gas to Ethanol

in the manufacture of everyday consumer goods. This represents a perfect example of the circular economy in which the carbon is recycled and locked into a new product.

Market Positioning

ArcelorMittal is currently already exploring the possibility of implementing the Steelanol technology in other steel plants worldwide. Deciding elements are the local markets for sustainable fuels/chemicals and the integration in the policy.

Project Location

Ghent (Belgium)

Project & Technology Links

[Steelanol](#)

[Steelanol Video](#)