

LanzaTech and Industrial Gas Emissions: The Role of CO₂ Reuse Technologies in Europe

As the European Commission has rightly pointed out in its Consultative Communication on the Future of CCS in Europe, with the emergence of CO₂ Reuse technologies, CO₂ should be regarded as a resource and commodity which can secure additional revenues for energy intensive industries.

LanzaTech is pioneering its own innovative biological process for the conversion of carbon-rich waste gases and residues into renewable fuels and chemicals. While most CO₂ Reuse technologies are still in the R&D stage, LanzaTech's technology will be fully commercially deployed in 2014. More importantly, LanzaTech's solution can provide concrete figures for CO₂ abatement effects - by producing one litre of ethanol from steel mill waste gas, LanzaTech captures and recycles 0.5 kg of carbon that would otherwise be flared to the atmosphere as 1.7 kg of CO₂. Taking into account the carbon emissions associated with utility use in the LanzaTech process, the net result is a substantial emissions reduction of 1.3 kg of CO₂ per litre ethanol produced.

Provided below are LanzaTech's recommendations for EU policy-makers with regard to CO₂ Reuse technologies:

1. Addressing policy barriers to deployment of CO₂ Reuse technologies in Europe

As LanzaTech's technology is commercializing in 2014, EU policy and regulatory uncertainties regarding its products are of utmost importance. Due to the novel nature of the technology, LanzaTech's experience is that there is ambiguity on how such technologies fit within EU legislation, in particular, the EU Renewable Energy Directive and Fuel Quality Directive as far as fuel products are concerned. Other EU climate and environmental legislation needs to be examined in order to clarify the status of these technologies e.g. EU waste policy, EU Industrial Emissions Directive and relevant BREFs, etc. Similar regulatory ambiguity is to be expected with regard to chemicals production. Hence, LanzaTech calls on policy makers to review relevant EU legislation governing these technologies and facilitate discussion and necessary clarifications among all the relevant Commission Directorates-Generals, European Parliament and the Member States. As a result, investments in these technologies will be facilitated as legal clarity and certainty are key factors for success.

2. Funding for R&D

While LanzaTech's fuel production technology is commercializing in relation to CO rich emissions, further research on direct fermentation of CO₂ gas streams for production of chemicals is required. This technology is still at lab scale and so further investment is needed to make this process a commercial reality that can enable the 'greening' of Europe's chemical sector, producing chemicals that would otherwise be made from petroleum derivatives. EU funding for CO₂ Reuse technologies is a good tool to help drive their deployment across Europe on a commercial scale in the coming years. Horizon 2020 and NER300 are some examples of funding opportunities but are certainly a non-exclusive list.

Overview of LanzaTech's technology

LanzaTech is pioneering its own innovative biological process for the conversion of carbon-rich waste gases and residues into renewable fuels and chemicals. Fuel production offers a novel approach to carbon capture and reuse. Through production of chemicals, LanzaTech presents a route to carbon sequestration, whereby the carbon in waste gases and residues is sequestered or stored in the form of a new product. An example is LanzaTech's production of 2,3 butanediol from waste steel mill gases, a chemical intermediary used for the production of nylon or rubber; the waste carbon is ultimately stored in durable consumer products such as clothing and tires. 2,3 butanediol can be co-produced with ethanol in combined biofuel and biochemical operations.

With sights set on making an immediate impact, LanzaTech has already demonstrated its ability to make biofuel (ethanol) from steel mill waste gases at a 400,000 liter per year facility in China. Full commercial deployment is targeted for 2014.

While steel mill waste gases provide an initial platform for LanzaTech's technology, LanzaTech can contribute by reusing carbon from many other industries. Off-gases from refineries, ferro-alloy plants, and PVC plants all present additional opportunities for carbon reuse by LanzaTech's process producing both ethanol and 2,3-butanediol (2,3 BDO). Production of chemicals such as 2,3 BDO will allow these industries to step beyond just carbon reuse and begin permanently sequestering carbon in a profitable way.

Carbon Capture and Reuse in the Steel Industry

- 900M tonnes steel are produced worldwide producing 115 billion Nm³ of waste gas containing a mixture of CO and H₂
- Most of these gases are burned and vented into the atmosphere as CO₂
- Rather than burning the waste gases, LanzaTech captures and feeds the gases to its proprietary microbes, which then convert CO and H₂ into biomass and, ultimately, ethanol.

By producing one litre of ethanol from steel mill waste gas, LanzaTech captures and recycles 0.5 kg of carbon that would otherwise be flared to the atmosphere as 1.7 kg of CO₂. While there are some carbon emissions associated with utility use in the LanzaTech process, the net result is a substantial emissions reduction of 1.3 kg of CO₂ per litre ethanol produced.

LanzaTech ethanol is blended directly into the liquid fuels pool, displacing an energy-equivalent amount of petroleum-derived gasoline. In the European Commission's October 2011 FQD proposal the default value for gasoline made from conventional crude oil is 87.5 g CO₂/MJ. With 72.6 g CO₂/MJ attributed to vehicle operation, an average 0.5 kg CO₂ are emitted during the extraction and refining of one litre of petrol.

As LanzaTech ethanol displaces gasoline in the fuels market, an additional 0.3 kg of CO₂ emissions are avoided for each litre of ethanol produced. This results in a net savings of 1.6 kg of CO₂ per litre of LanzaTech ethanol made from steel mill waste gas (Table 1).

Table 1: CO₂ Emissions Averted

<i>Atmospheric CO₂ Sources</i>	<i>kg CO₂ / litre LanzaTech Ethanol</i>
Averted from flare	1.7
Utilities used in LanzaTech Process	-0.4
Extraction & Refining of displaced gasoline ¹	0.3
Net Carbon Dioxide Savings	1.6

Impact

Based on current steel production, LanzaTech's technology has a potential global capacity of over 130 billion litres of ethanol per year. If this potential were realized, the combustion of 450 million barrels of oil could be avoided, and 160 million tonnes of CO₂ could stay out of earth's atmosphere every year. LanzaTech's technology is a demonstrated reality, with commercial projects already under development. Today steel production in Europe accounts for 8% of the European Union's CO₂ emissions. Through commercial deployment of LanzaTech's process, this can be substantially reduced.

Existing Technologies

In some cases, steel mills have implemented combined heat and power systems to recover a fraction of the energy contained in their waste gas as electricity, which can then be used internally or sold to the grid. These cogeneration systems often help offset costs and improve overall plant energy efficiency, but they cannot compete with the efficiency or added value of converting waste gases to liquid fuels via the LanzaTech process [Figure 1]. Ultimately, regardless of how the steel mill waste gas is used, all the carbon will be oxidized to CO₂. It is important to remember, however, that any energy recovered from the gas is useful energy that would otherwise be lost. Neither power generation nor LanzaTech's fuel production process permanently sequester carbon, but both technologies provide an avenue for carbon capture and reuse. The LanzaTech process has significantly higher energy efficiency than power generation, emitting 50% less CO₂ per unit energy recovered from steel mill waste gas than electricity generation. Similarly, the LanzaTech process emits 80% less particulates and 35% less NO_x than power generation (Table 2). There are cleaner methods available to meet growing power demands, namely geothermal, wind, and solar power. LanzaTech's technology allows the steel industry to make a more significant contribution towards a carbon-neutral fuels future by reusing its carbon residues as fuels and/or chemicals.

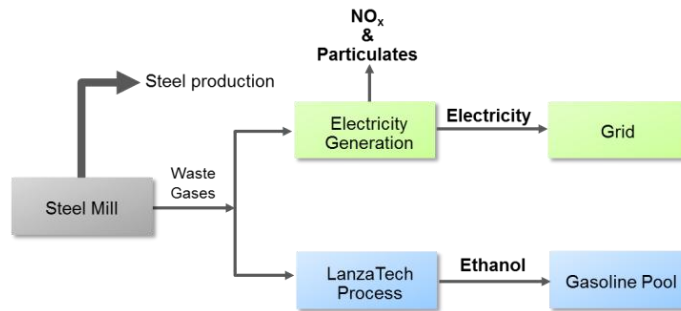


Figure 1: Waste Gas to LanzaTech Ethanol or Power

Table 2: Emissions per MJ Energy Recovered

	<i>mg Particulates / MJ</i>	<i>mg NO_x / MJ</i>
LanzaTech Ethanol	6	56
Power Generation	26	88

Synergy with CCS technologies

CO₂ Reuse technologies provide another option to traditional CCS. Traditional CCS technologies are best implemented when source and storage are co-located. When this is not possible, LanzaTech's solution can be deployed. By retrofitting a LanzaTech facility at source, captured CO₂ streams can be directly converted to low carbon liquid fuels and chemicals on site.