Innovation Across Borders – Forum VBO-FEB

Innovation Case Preparation Form

WHO

- Welke onderneming(en) werd(en) hierbij betrokken? (grootte, bedrijfssector,…)?
- Met welke partner(s) (clusters, O&O-centrum, spin-offs, hubs,…)?

STEELANOL project

The STEELANOL project aims to build the first large-scale industrial plant at ArcelorMittal Gent to convert steel waste gas into advanced third generation ethanol for the transport sector. Ethanol is a non-toxic product that can be blended into gasoline to displace fossil oil and thus reduce GHG emissions generated by transportation.
Lanzatech is a US-based company founded in 2005 that strives to develop the direct fermentation of syngas into ethanol and other chemicals by using natural microbes living in water. Lanzatech has always focused on the use of waste gas from the steel industry (cokemaking, ironmaking in blast furnaces and steelmaking in BOF). The company optimised gas fermenter reactors in order to transform CO (carbon monoxide) directly into ethanol, or a mix of CO with hydrogen. Lanzatech successfully scaled up the process from a lab (five-litre reactor) to three full-scale industrial pilots (15,000 litres each) in China.

ArcelorMittal is the world's largest steel company, producing 93 million tonnes in 2015. ArcelorMittal is at the top of the advanced steels market for the automotive and construction sector and is overall leader in three continents. ArcelorMittal Gent is the Belgium-based subsidiary currently producing five million tonnes of flat-rolled iron-ore-based steel for the automotive sector. AM Gent is one of the benchmarks for energy efficient and CO2 friendly steel production and continuous investment in new solutions. The STEELANOL project aims to further scale up the process to a 500,000-litre reactor (30x larger) in order to produce at least 60 million litres of ethanol per year (subsequently increasing this to 100 million litres).

Finindus is the investment company backed by ArcelorMittal and the Flemish Region and is the sister company of the research centre OCAS. Finindus supports ArcelorMittal and Lanzatech in order to create an investor's case to demonstrate the project at full scale and to establish the structure needed to further roll out the technology in the European steel industry.

WHAT

- Wat was de doelstelling van de innovatie?
- Waarin bestaat precies de innovatie (toepassing, soort innovatie – product/procedé/businessmodel/support diensten/management,…)?

The core innovation is the direct fermentation of synthetic gas (CO, CO2, H2) into ethanol through u a natural microbe. The microbe itself lives in water. It uses the syngas as a source of energy and car and combines the carbon with water to create ethanol. This direct gas biofermentation of carbon w into ethanol is a recent development. To date, all fermentation has taken place in liquids (sugar dissolved in water is transformed by yeast microbes into ethanol). For a lot of stock feeds, however difficult or impossible to extract/transform the carbon into soluble sugars first. Lanzatech is the lea the direct fermentation of synthetic gas into ethanol. This process makes it possible to directly recy gaseous carbon waste streams from the steel industry as well as recycle carbon by first gasifying sol waste streams.

Process innovation is the focal point here: how to scale up, how to make the process cost-efficient i order to compete with the existing production of bio-ethanol from sugar stock feeds (e.g. wheat, co sugar cane).

IMPACT

- Voor de business/ de onderneming (verwerving van een nieuwe markt, groei, kostenvermindering,…)
- Op de markt (eindafnemers, tussenpersonen)
- Over het geheel genomen, ten aanzien van de maatschappelijke thematiek

Business impact on the steel industry: so-called integrated steel plants such as ArcelorMittal Gent are using iron ore and coal as their basis for reducing iron ore into primary steel. This primary steel is increasing the amount of steel needed globally to develop the infrastructure and steel products for a minimum standard of living. At the end of their service life, those steel products are recovered practically in their entirety and are recycled to reproduce steel products from scrap (so-called secondary steel).
So, although steel is one of the most sustainable materials thanks to its unique recyclability, it requires carbon in order to reduce the iron oxide into iron. This takes place in the blast furnace where the carbon is consumed as a chemical reagent and produces CO.

Lanzatech's innovation makes it possible to recycle this carbon (once iron ore has been reduced into steel) into ethanol in a cost competitive way. The carbon has a second life as product that can be added to gasoline fuel used in the transport sector, where it displaces fossil oil. Europe's transport sector already consumes five billion litres of ethanol and wants to double this by 2020. However, the ethanol needs to be produced from alternative stock feeds that do not affect the food industry.

The ethanol from steel waste gas can also be dehydrated into ethylene for the polyethylene plastic industry. Ethylene also displaces fossil oil, which is currently cracked into ethylene, here.

As the steel industry is a large-scale industry, the biofermentation of syngas into ethanol is creating new large-scale stock feed possibilities

- In the case of 100% implementation, it is theoretically possible to produce 12.5 billion litres of ethanol or six million tonnes of ethylene.
- Should abundant supplies of green, cheap hydrogen be available in the future, the total production of ethanol may triple to 20 million tonnes. This means that the EU's entire polyethylene industry (approx. 20 million tonnes per year) can run on this syngas fermentation from the 100 million tonne blast furnace production in Europe. This would reduce total CO2 emissions generated by steel and plastic production in Europe (100 million tonnes per year).

KATALYSATOREN & OBSTAKELS

- Hoe verloopt / verliep de ontwikkeling van het project (duur, algemene indruk)?
- Wat vergemakkelijkt / vergemakkelijkte het verloop van het project (katalysatoren)?
- Wat zijn / waren de moeilijkheden en uitdagingen waaraan het hoofd moet /moest worden geboden (hinderpalen)?

The STEELANOL project has two challenges:

- Further scaling up the technology and finding the best way to integrate it into existing steelmaking operations.
- Getting market access for this alternative third generation bioethanol product that is not based on agricultural products or waste streams.

The project partners have been very successful in dealing with the technical challenges encountered to date:

- Lanzatech and ArcelorMittal Gent have created a joint engineering team, including the engineering skills of the subcontractor Jacobs.
- Integration has spotlighted new ways to boost efficiency, such as reusing waste heat from steelmaking to distil the ethanol or reusing water following recycling and cleaning in the steel plant.
- EU has recognised the importance of the demonstration project and has awarded the project a €10.2 million grant.

The biggest challenge lies in amending existing environmental policies to include the new technology.

- In June 2015, the EU Renewable Energy Directive, which serves as the framework for the use of bioethanol in transportation, had to be amended to recognise the microbes as part of the biotransformation process.
- However, the origin of the carbon remains unclear. In the case of STEELANOL, the carbon originates from an industrial final waste product. The waste does not normally account for the emissions, as all the emissions are allocated to the steel product. The origin of the industrial waste is not specified in the RED. However, policymakers are unsure how to deal with waste streams where fossil coals are also used.
- The ETS (emission trading scheme) has not yet been modified to include the re-use of carbon that produces fewer CO2 emissions. In the case of STEELANOL, two tonnes of CO2 less is generated for every tonne of ethanol produced over the life cycle. However, steel plants are monitored based on their carbon input. As the carbon is now transformed into ethanol rather than being emitted as CO2, this requires an amendment to the emission monitoring guideline.

LESSONS LEARNT

Wat kon er / had er kunnen verbeterd worden om deze innovatie te vergemakkelijken? (enkel invullen indien van toepassing)

- Organisatie/management van het project
- Samenwerking/partnerschap
- Beheer van de intellectuele eigendom
- Lancering van de innovatie op de markt
- Financiering van het innovatieproject (fiscaal beleid, beschikbaarheid van kapitaal, investeringssubsidies, enz.)
- Andere beleidsaspecten /regelgevingsaspecten

EU risk-sharing mechanisms are an important catalyst for this kind of unprecedented large-scale demonstration project. The EU has created InnovFin risk-sharing funding for renewable energy demonstration projects; InnovFin can finance up to 50% of the investment and takes over the risk for the loan. This mechanism is currently only available for renewable energy projects but should also be extended to circular economy projects. Without these risk-sharing mechanisms, all funding for new investments must be equity backed as the projects are not yet bankable (due to the inherent technological scale-up risk).

The major lesson when new innovative processes are launched to achieve environmental objectives:

- The new technology (in this case bioethanol) is always more expensive compared to fossil energy sources (otherwise the technology would exist already).
- Policymakers should create a package deal for new investments to support the project:
    - A one-time EU Horizon 2020 grant to support additional research and development (the LCE2-13 call for STEELANOL).
    - Access to a risk-sharing mechanism such as InnovFin for RED.
    - Exceptional access to the renewable energy market to gain market traction. In STEELANOL's case, without access to the transport market under RED, nobody will blend this ethanol into the mix when it does not fulfil the mandatory obligations to use bioethanol
- The three conditions are currently negotiated independent of one other, which creates additional uncertainty and loses time.