

## CCU in the EU ETS: risk of CO<sub>2</sub> laundering preventing a permanent CO<sub>2</sub> solution

October 2016

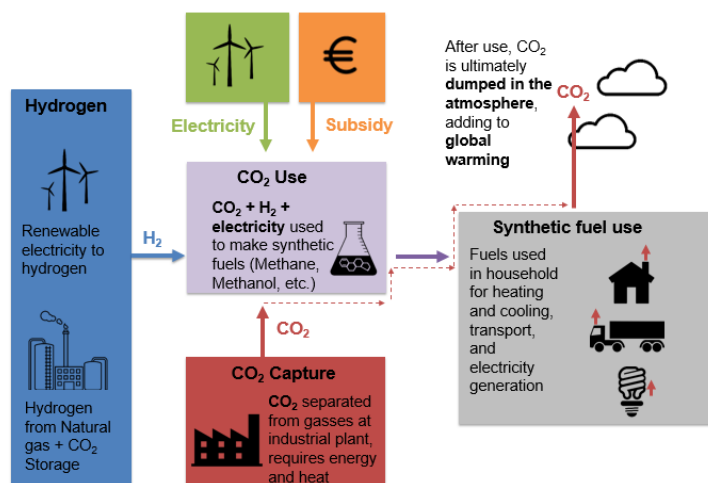
### Introduction

Drastically reducing the amount of CO<sub>2</sub> in the atmosphere is necessary to reach the climate goals of the Paris Agreement. The permanent geological disposal of CO<sub>2</sub> captured from industrial facilities, Carbon Capture and Storage (CCS), provides an essential and achievable avenue for reaching this objective.

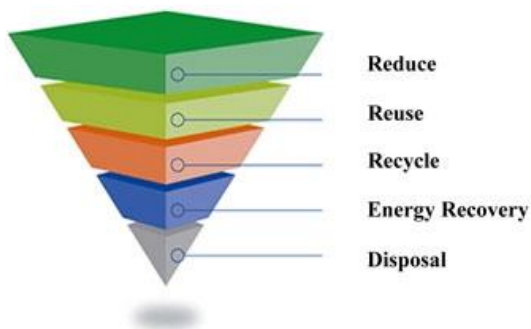
The usage/utilisation of captured CO<sub>2</sub> (CCU) is incorrectly mentioned to be an equivalent alternative to CCS. While there are methods of permanently storing CO<sub>2</sub> by using CCU technologies, such as mineralisation<sup>1</sup>, the usage of captured CO<sub>2</sub> in chemicals and fuels does not contribute to significantly lowering the level of CO<sub>2</sub> in the atmosphere. Synthetic fossil fuels produced by adding captured CO<sub>2</sub> to clean, renewable hydrogen (H<sub>2</sub>) is wrongly branded as “renewable natural gas”. Fossilising hydrogen to produce synthetic methane merely delays the CO<sub>2</sub> from being emitted.

<sup>1</sup> <http://bellona.org/publication/bellonabrief-co2-utilisation-by-mineralisation-much-ado-about-nothing>

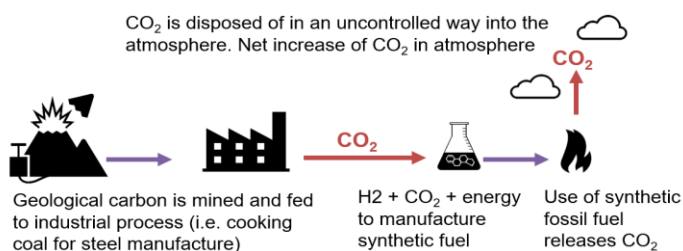
The distinction between permanent (e.g. CCS and mineralisation) and temporary solutions (e.g. synthetic methane and chemicals) must be made when considering to invest in solutions that are meant to resolve the major challenge of limiting and reducing the level of CO<sub>2</sub> in the atmosphere. Although a CCU infrastructure can be a stepping stone for the deployment of CCS, there is a real danger that governments will boost the profitability of CCU for industries. This will likely form an obstacle that prevents permanent CO<sub>2</sub> solutions from being developed.



## CCU for synthetic fuels is not complete reuse, but delayed atmospheric disposal



Some strong advocates of CCU for synthetic fuels have proposed the “simple disposal hierarchy” as providing a clear and logical rationale for the reuse of CO<sub>2</sub> and avoiding CO<sub>2</sub> managed disposal (permanent geological storage of CO<sub>2</sub>)<sup>2</sup>. This rationale omits the ultimate fate of the CO<sub>2</sub> used in creating synthetic fuels. The use of these fuels will regenerate CO<sub>2</sub> in diverse settings unsuitable to (re)capture of CO<sub>2</sub>. **The result being the unmanaged and damaging disposal of CO<sub>2</sub> in the atmosphere.** As the great majority CO<sub>2</sub> generated in the initial industrial process derive from geological feedstocks (limestone, coking coal, fossil energy) the result is potential unaccounted net increase of CO<sub>2</sub> in the atmosphere.



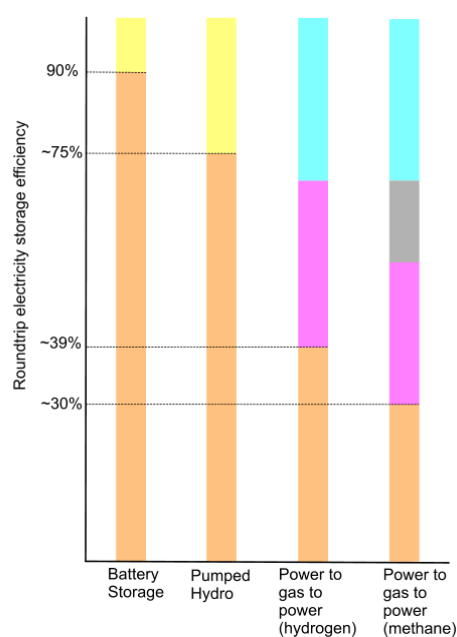
## Roundtrip efficiency of electricity storage with power to gas

Battery storage can be very efficient but does not generally provide long term (seasonal) electricity storage. Through the usage of pumped hydroelectric storage, energy can be made available in reservoirs for long periods of time.

<sup>2</sup> Steven Woollass, TATA Steel, Why CCU? CO2Chem Network, 21st September 2012

Through the principle of ‘power to gas’, hydrogen can be produced using (renewable) electricity and water in a process called electrolysis. Synthetic methane can be created by adding the hydrogen to captured CO<sub>2</sub>. Other gases can also be produced in similar processes (e.g. methanol, ethanol). Such gases are suitable for long-term geological storage.

Converting renewable electricity to hydrogen with electrolysis, however, entails efficiency losses. Conversion is approximately 70% efficient.<sup>3</sup> Adding CO<sub>2</sub> to hydrogen to generate a synthetic fossil fuel entails even further efficiency losses. The Sabatier reaction or microbial methanation is approximately 80% efficient.<sup>4 5</sup> Generation of electricity of hydrogen or synthetic methane at combined cycle gas turbine power plants has an efficiency of ~56%. The overall energy loss from electricity to electricity thus amounts to approximately 70%.



<sup>3</sup> Mazloomi, Sulaiman, Moayedi (2012) Electrical Efficiency of Electrolytic Hydrogen Production. Int. J. Electrochem. Sci., 7 (2012) 3314 - 3326

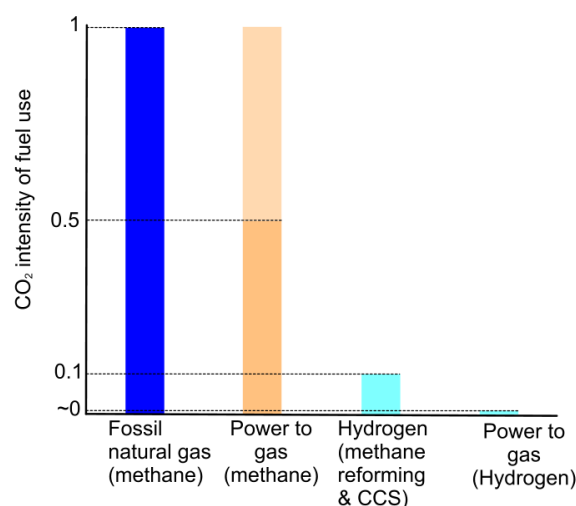
<sup>4</sup> Dr. Monika (2013) Reuter Power to Gas: Microbial Methanation, a Flexible and Highly Efficient Method

<sup>5</sup> Stephan Rieke (2012) Power-to-Gas technology – the missing link in renewable energy systems SolarFuel GmbH,

## CO<sub>2</sub> emissions from Power to gas

Taking the combustion of fossil natural gas as a CO<sub>2</sub> intensity of 1, replacing fossil natural gas with the use of synthetic natural gas can lead to CO<sub>2</sub> reductions of potential half. This requires that synthetic natural gas displaces the combustion of fossil natural gas. Accurate accounting of CO<sub>2</sub> reductions from fuel displacement is difficult. It should be noted that the CO<sub>2</sub> emissions at the point of combustion of synthetic natural gas will be identical for fossil natural gas (both products are chemically identical). CO<sub>2</sub> saving comes from the reuse of captured CO<sub>2</sub> from industrial processes; this CO<sub>2</sub> is ultimately released at combustion of synthetic natural gas. Releasing the CO<sub>2</sub> after the effort and energy to capture it from industrial process is climactically inefficient. In addition, the use of synthetic natural gas allows blending with fossil natural gas, potential prolonging fossil natural gas imports and CO<sub>2</sub> emissions.

Synthetic natural gas requires the consumption of hydrogen during manufacture. The use of hydrogen directly as a fuel results in much reduced or zero CO<sub>2</sub> emissions. Hydrogen contains no carbon so does not produce CO<sub>2</sub> on combustion. Hydrogen can be used as a zero carbon fuel for the decarbonisation of residential heating and cooling, industrial process heating and freight transport and shipping. The use of hydrogen directly allows for CO<sub>2</sub> captured from industrial facilities to be permanently geologically stored or mineralised instead of being used for gas production. This provides a climate solution compatible with reaching Paris climate agreement.



## Power to gas is limited by hydrogen and renewable electricity availability

In 2015 the Wuppertal Institute and Covestro proposed using the captured CO<sub>2</sub> from the industrial facilities in the Ruhr region to produce synthetic methane.<sup>6</sup> In order to produce the so-called “renewable natural gas”, hydrogen is added to CO<sub>2</sub> captured from industrial facilities. Synthetic methane, it is argued, emits approximately half the amount of CO<sub>2</sub> compared to conventional methane. This effort is, however, a misguided attempt to use the CO<sub>2</sub> as a resource to lower carbon emissions.

The report shows that if the Ruhr region (Germany) were to transition to synthetic methane in order to utilise all CO<sub>2</sub> arising from the industrial sector (iron and steel industry, chemical industry, refineries, cement and lime industry, coking plants), the electricity generation required to produce the hydrogen would exceed that of the entire state of North-Rhine-Westphalia by a factor of six. At the same time, the transition would have to be made to renewable electricity production.

If the main objective of adding captured CO<sub>2</sub> to hydrogen, in order to produce synthetic methane,

<sup>6</sup>

[https://epub.wupperinst.org/files/6010/6010\\_CO2\\_ReUse.pdf](https://epub.wupperinst.org/files/6010/6010_CO2_ReUse.pdf)

is to reach the goals set forth in the Paris Agreement, this type of CCU is neither helpful nor practically feasible.

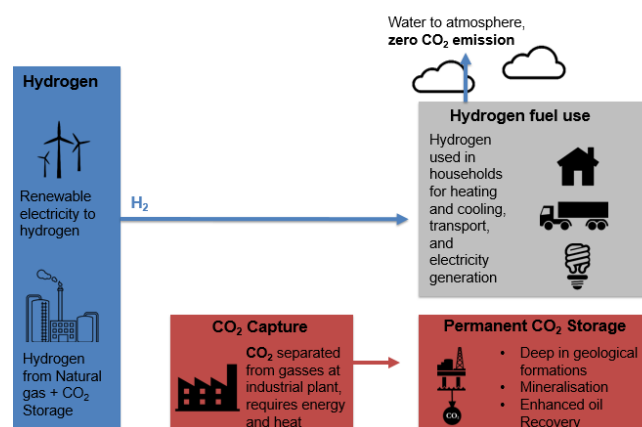
## Hydrogen is the key resource, not CO<sub>2</sub>

Instead of adding captured CO<sub>2</sub> to hydrogen with the intent to produce synthetic fossil fuels, a much more logical, energy-saving, and non CO<sub>2</sub>-emitting fuel for households and industries is the usage of hydrogen itself.

In order to produce hydrogen in large enough amounts to serve industry and households, and without emitting CO<sub>2</sub>, either electrolysis with renewable electricity or the conversion of methane with subsequent CCS needs to be employed. Since it is currently impossible to acquire large enough amounts of renewable electricity for this purpose, the usage of methane in combination with CCS is the only viable option.

The City Gate project in Leeds is an example of the structural transition of the gas grid from methane to hydrogen, by using H<sub>2</sub> attained through the conversion of methane and CCS.<sup>7</sup> It has shown that this is both possible and cost-effective. Whereas synthetic methane may cut the emissions of CO<sub>2</sub> in half depending on fossil fuel displacement, the combustion of H<sub>2</sub> produces nothing but heat and water.

With relatively limited changes to the gas grid, Leeds could thus transition to a deeply decarbonised city, in line with reaching Paris climate goals. Instead of producing synthetic methane by fossilising hydrogen, hydrogen should be used directly as in the case of Leeds.



## CCU and the ETS

The Emissions Trading System (ETS) of the EU is the primary avenue taken to limit the emission of CO<sub>2</sub>. Although this system has been mentioned to be ineffective, in part due to the free allocation of certificates to industrial actors and the low price of such certificates, it will be required to play an important role in the attempt to lower CO<sub>2</sub> emissions.

Seeking to include CCU methods that do not provide permanent storage of CO<sub>2</sub> into the ETS would undermine the purpose of the system itself. A briefing paper by the Scot Project recommends that the ETS should include methods such as the mineralisation of CO<sub>2</sub>, but not those that only allow the temporary storage of CO<sub>2</sub>.<sup>8</sup>

Although one industrial actor may pass on captured CO<sub>2</sub> to another actor as feedstock, the CO<sub>2</sub> will inevitably be disposed of in the atmosphere. If the CO<sub>2</sub>-producing industries would receive financial benefits within the framework of the ETS, it would potentially be more lucrative to produce than to limit the production of CO<sub>2</sub>.

## CO<sub>2</sub> Laundering

Moreover, including non-permanent storage methods of CCU into the ETS could

<sup>7</sup> <http://www.northerngasnetworks.co.uk/wp-content/uploads/2016/07/H21-Report-Interactive-PDF-July-2016.pdf>

<sup>8</sup> <http://www.scotproject.org/images/Briefing%20paper%20EU%20ETS%20final.pdf>

institutionalise 'CO<sub>2</sub> laundering'. Industrial actors covered by the ETS could pass on captured CO<sub>2</sub>, for instance in the form of fuel, to another actor outside the ETS. When this fuel is used, the CO<sub>2</sub> will be released into the atmosphere without being accounted for by the ETS.

An existing example of a remedy to such a situation is the accountability, within the ETS, of the producer of urea products (ammonia + CO<sub>2</sub>) for the end-of-pipe CO<sub>2</sub> emissions caused by their usage in the agricultural sector.

## Recommendations

### CCU is a stepping stone towards CCS

The development of a CCU infrastructure should serve as a stepping stone towards the deployment of CCS. Although CCU can be used to prevent CO<sub>2</sub> from entering the atmosphere in the case of mineralisation, CCS will be required to deeply decarbonise industry and households, as in the case of Leeds. Furthermore, usage of CO<sub>2</sub> arising from biogenic sources (i.e. sewage) should be preferred to the utilisation of CO<sub>2</sub> from fossil sources.

### Synthetic methane should not be called "renewable"

Synthetic methane should not be referred to as "renewable natural gas". This name gives the false impression that the burning of the gas does not increase the levels of CO<sub>2</sub> in the atmosphere. The CO<sub>2</sub> emitted from a facility using this gas is still CO<sub>2</sub>, and it will contribute to global warming.

### Use H<sub>2</sub> directly as a zero-emissions fuel

Hydrogen should be used directly in industries and households. Industrial complexes should not have the ability to claim the available hydrogen in order to convert it to synthetic methane. Fossilising it by adding CO<sub>2</sub> in order to produce synthetic fuels offsets the positive characteristics

of H<sub>2</sub>, namely that it does not emit anything but water at combustion.

### Exclude non-permanent CCU from ETS

It is imperative that CCU methods, except for those allowing for permanent storage of CO<sub>2</sub>, are excluded from the ETS of the European Union. Including non-permanent CCU in the system could not only incentivise industries to produce more CO<sub>2</sub>, as this would become a commodity, but it could also allow the CO<sub>2</sub> to be emitted without being accounted for by the ETS.

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