Towards Net Zero Emissions via Bioenergy with Carbon Capture

As awareness of the impacts of climate change continues to grow, and the tone of climate activists worldwide becomes increasingly panic-stricken, governments are starting to introduce radical targets in order to counteract the impacts of climate change. Although the 2016 Paris Agreement saw a worldwide commitment to limiting global temperature rise, its lack of binding targets with regard to greenhouse gas emissions has led governments to set their own.

Among the most ambitious of those targets has been the UK's: a pledge to reduce the UK's emissions to "net zero" by 2050. If this target is reached, the UK will not be contributing a net increase in atmospheric carbon year-on-year.

Net-Zero: An Impossible Goal?

Achieving this goal is inherently difficult: decarbonisation is the focus of intensive research and development efforts, in order to make technology both viable and affordable, but in many cases the technology is already there, it just needs political support to stimulate uptake. This can be seen in practice by comparing the UK's transport and energy generation sectors. In the energy sector, financial support for renewable generation is widely available, and there has been a significant policy push to deploy renewable energy more widely. This has resulted in a 60% drop in emissions from the energy sector between 1990 and 2017. Contrast this with the transport sector, where, even though financial support is available for biofuels, wider deployment has been limited as a result of both technical and political barriers (such as blend limits and feedstock availability). Duly, the transport sector has only delivered a 2% reduction in emissions over the same time period, significantly lagging behind all other sectors.

Totally zero emissions is, however, not going to be possible just by cutting emissions from all sectors, as zero-emissions options aren't feasible everywhere. Energy- (particularly heat-) intensive industrial processes are always going to require heat through burning of fuel (be it fossil fuels or biomass), and incineration remains the most viable non-landfill solution for dealing with mixed non-recyclable waste, to name but two examples.

This is where the key stipulation of *net* zero emissions comes into play – the UK is aiming to account for all of these unavoidable emissions by actively reducing atmospheric carbon – i.e. preventing those emissions from ever reaching the atmosphere. Once again, the technology to achieve this does already exist: Carbon Capture and Storage (CCS). Properly implemented, this technology can reduce the effective emissions from emitting processes to relevantly low levels.

What is CCS?

From a holistic point of view, the process is simple and requires just three steps: capture, transport, and storage. Obviously, these steps themselves are each complex in their own way, requiring either specialised technology or suitable infrastructure.

The first step is the capturing of the carbon itself. In most industrial processes, this involves the bubbling of the emitted gases through a suitable solvent, from which the carbon dioxide (CO_2) is subsequently liberated and compressed. Infrastructure-wise, this can be oversimplified as "putting a hat on the chimney" and is applicable to any power plant where fuel is burned, but finding and producing a suitable solvent is the main barrier to implementing this technology onsite. It is also possible, through gasification, to capture the CO_2 before the fuel itself is combusted: gasification converts the organic fuel to carbon monoxide and hydrogen – the hydrogen can then be used as fuel while the carbon monoxide is converted to CO_2 and captured as normal. This process is a lot rarer, as syngas from gasification is not always itself used as a fuel and is more often converted into synthetic fuel via Fischer-Tropsch synthesis.

Once the carbon has been captured and compressed, it has to be dealt with in a way that does not release it to the atmosphere, else the process of actually capturing it will be in vain. Despite the potential for captured CO_2 to be used industrially, known as Carbon Capture and Use (CCU) – with applications ranging from industrial chemistry and synthetic biology to drinks carbonation – the most feasible solution is currently storage, allowing markets to develop in the meantime. Currently, storage methods rely on specific geological formations – areas deep under the ground where gas can be stored in large quantities without it returning to the surface. Fortunately, these sites are already well-known: they have previously been utilised as natural gas fields. Such sites have already held gas for thousands if not millions of years (forming the natural gas fields), and the infrastructure is already in place to access the formation from the surface (again, by virtue of its previous employment). Storing captured CO_2 in these formations has an additional benefit: piping the CO_2 into depleted natural gas fields at high pressure can force out natural gas that was otherwise unobtainable due to the field being depleted.

Picking sites to store the CO_2 must nonetheless be done with care, not least because any CO_2 that escapes from the storage site will be released back to the atmosphere – nullifying the effort to store it in the first place – but also, if this happens over land where people are likely to be nearby, the effects can be lethal. CO_2 is heavier than air and so if released in large quantities it will sit low to the ground, and in great enough quantities can form an undetectable cloud, wherein any people caught would suffocate without even realising. This is more of a risk during transportation of the CO_2 than associated with the storage sites themselves.

For Carbon Capture to be viable, infrastructure has to be in place to transport the captured gas to its eventual destination, be that an industrial use or a storage facility. There are several possible ways of doing this: piping the gas would require a new "grid" to be built, to allow producers to easily transfer gas below-ground to its destination. This would require a colossal investment of both time and money, and if part of the "grid" failed, it would present the same safety problems outlined above. The other alternative would be to transport the captured CO_2 over-ground by tanker, but to minimise the increased emissions created by an increase in vehicle or vessel movements, the HGVs and/or ships would need to operate on low-carbon fuels, which in-turn comes with its constraints.

The technology is, however, worth the investment: it has the potential to dramatically reduce the emissions associated with fossil fuels at the very least. In an era of increasing scrutiny of fossil fuels, this technology presents itself as a fantastic opportunity for fossil fuel generators to reduce their environmental impact, improving both their public image, and bringing them into line with ever-stricter regulations regarding emissions as governments seek to counter anthropogenic climate change.

But bioenergy can do even better.

Combining with Bioenergy for Better Results

As previously stated, the UK is looking to achieve net-zero emissions, which requires carbon to be actively removed from the atmosphere. Simply capturing the carbon does not achieve this – it merely prevents further carbon from reaching the atmosphere. By combining this process with bioenergy, it is possible to create the only energy system that directly and actively reduces atmospheric carbon. Pairing the suppression of released carbon brought about by carbon capture with the fact that biomass absorbed atmospheric CO_2 during its growth, the result is an active reduction of atmospheric CO_2 – something no other energy system can boast. This also has the additional benefit of mitigating the biggest source of criticism of bioenergy – that it does still result in emissions, even if these are mitigated.

Given that the technology already exists and is being trialled by the UK's bioenergy giants Drax, amongst others, there is hardly a stronger argument that bioenergy with carbon capture and storage (BECCS) can be a strong contributor to the UK's necessary decarbonisation – a fact now acknowledged by the UK government. The government would appear to be putting a lot of faith in the technology: in the 2017 Clean Growth Strategy, the Department for Business, Energy and Industrial Strategy (BEIS) pledged to make the UK a world leader in carbon capture and has published an action plan aiming to remove the commercial barriers to carbon capture deployment. It is clear that the systems favoured by BEIS are market-driven ones, which is how they have handled renewables thus far. Options include a Contract for Difference-esque system wherein those capturing carbon would bid for a price per tonne of CO_2 captured, or the awarding of certificates for CO_2 captured which could then be traded subject to emitter obligations, as seen already in the Renewable Transport Fuels Obligation (RTFO) and Renewables Obligation (RO) schemes.

However it chooses to support a technology that desperately needs investment to succeed, BEIS's strategy acknowledges that bioenergy with carbon capture is "currently considered the most scalable" emissions reduction technology, and as such we look forward to seeing how this young but very viable sector develops in the UK.

If the UK hopes to achieve its net-zero targets, it is sensible to presume that carbon capture has a very significant role to play, and we within the bioeconomy hope that the complementary potential of bioenergy is also part of that transformation.