Fuel from

Following reports on the apparent achievement of practical plant, capable of distilling fuel from nothing more than energy and air, Brian Tinham talks to its developers about the present and future

A firm set up in 2009 to find a solution to the problem of extracting and storing hydrogen from air recently surprised the world by announcing that it has now gone one major step further. Air Fuel Synthesis, which has been working on its technology with the universities of Nottingham and Loughborough, says it has built plant capable of synthesising liquid fuels, using only air and electricity. First up will be petrol, initially for specialist transport applications, followed ultimately by aviation fuel.

Could such an achievement be possible? Does it stack up? Well, almost incredibly, yes. The Stockton-on-Tees firm's bespoke trial plant has now proved carbon and hydrogen capture from air as a viable proposition – and has already processed its first litres of fuel. That's from a containerised demonstrator plant, and Graham Truscott, director of marketing and investor relations at Air Fuel Synthesis, states that, when scaled up, this will be able to generate carbon-neutral petrol on an industrial scale.

How does it work? Truscott explains that the process starts with an air capture tower – essentially a fairly conventional wet scrubbing column with a forced air input – in this case manufactured by Parsons Engineering. The tower maintains a mist of sodium hydroxide at about 100°C under slight pressure, which reacts with carbon dioxide in the air, forming sodium carbonate. Following this process, the solution is converted in a three-cell Electrocell electrolyser to recover the CO_2, which bubbles out and is stored in tanks.

Meanwhile, a dehumidifier in the tower also condenses water from the air, which is then split into hydrogen and oxygen, via an ITM Power electrolyser. Then the carbon dioxide and hydrogen are combined and compressed, using Haskel compressors, before being passed over a commercial catalyst to form very wet methanol, with unreacted gases moving through a recirculation loop to maximise the efficiency of conversion.

Finally, the process moves through a water separation process, leaving relatively pure methanol to enter a heat exchanger, which is followed by a gasoline conversion reactor that yields short-chain hydrocarbons and water. The entire process is orchestrated automatically under a Siemens process management system. And there you have it. "We need about 3.9kg of CO_2 to create around 1kg of gasoline," confirms Truscott.

Within two years

However, Air Fuel Synthesis expects that initial commercial versions of the plant are unlikely to include the air capture module, instead relying on commercially available waste carbon dioxide. "The plant could be sited adjacent to an anaerobic digester, distillery, brewery or bioethanol plant, for example – or even a thermal power station," explains Truscott. "Given that it would be a secondary use of the same carbon, and ultimately displacing fossil carbon, it would still retain its carbon-neutral status."

air

Photos: Doug Jackson

Graham Truscott, director of marketing and investor relations at Air Fuel Synthesis: When scaled up, this plant will be able to generate carbon-neutral petrol on an industrial scale

He also says that such plant would be containerised – typically packed into something similar to a couple of shipping containers – not unlike the current demonstrator, but designed for efficiency. And he adds that plant like this, capable of producing one tonne of fuel per day from air, will be available within two years – with enough funding.

"That's a pretty useful production rate, generating an attractive rate of return, given that it won't be saddled with the overheads we need to run the demonstrator," comments Truscott. "It could use electricity from a dedicated renewable energy source or take power over the grid."

Ah yes, energy: detractors point to the fact that such plant will clearly be fairly big on electricity consumption. Industrial electrolysis, for example, is hardly renowned for a modest thirst for power. However, Truscott counters that the commercial and technical success of this plant is predicated on the availability of spare power from renewable sources. It's the classic 'wrong time' electricity generated by: wind farms at night, which is currently wasted; or the 'stranded' power, not currently connected to the grid, such as that on island communities that have some overnight electrical power surfeit, but currently have to import petrol.

Commercial applications

That, of course, could become a fairly crowded market, given the thrust of alternative ideas for its use – such as cryogenic plant, storing renewable energy as liquid air, ready for release back to the grid on demand (Plant Engineer January/February 2012, page 8). Truscott demurs: "We've not done a full head-to-head comparison against cryogenic storage. But there will be a place for both as the percentage of renewable power generation increases. And both will find commercially viable applications."

Just as important, however, he points to the

energy efficiency of this plant: "Our demonstrator has given us the confidence to anticipate an energy conversion rate of well below three-to-one. That's on a one tonne plant, and it's much better than the four-to-one typical of a modern thermal power plant."

So, how much would an industrial-scale, air-to-petrol plant be likely to cost interested companies? Truscott says that scale-up estimates are confidential, but that several models have been mooted. "Broadly speaking, though, we'd be looking to build a plant for around £4 million, with payback under current pricing and conditions probably working out at about five to seven years, depending on supply chain deals, and relationships with the purchasing and financing parties."

And he explains: "We might, for example, broker sale of the fuel it produces. It might be used as an additive blended to motor racing fuel, where they currently use at least 5% bioethanol. We could offer either to replace that with our own carbon-neutral fraction, or they could take the whole output and run race weekends." PE

Professional engineering seal of approval

Dr Tim Fox, head of energy and environment at the Institution of Mechanical Engineers, is impressed with the petrol from air plant. "Air capture technology ultimately has the potential to become a game-changer in our quest to avoid dangerous climate change," he enthuses.

"What was just a smart idea in the minds of a handful of academics a few years ago is now a proven, engineered method for removing carbon dioxide from the atmosphere and making a useful product. The beauty of petrol from air is that you are effectively recycling CO_2 and avoiding further transport emissions."

For him, though, there is another powerful aspect. "While the major recent research advances have largely been made in the US and Canada, it is hugely encouraging that it is British engineers and entrepreneurs who are taking air capture technology out of the lab and using it to create a product. This is particularly poignant, given that so much of the world's fossil fuel-based industrial economy of today has its origins in great British engineering innovation from the North East."

As for the future, Fox says: "What we need now is the financial and political support to help turn this revolutionary demonstration into a large-scale industrial solution that could make sustainable products, remove and store CO_2 from point sources or the atmosphere and set the international carbon price to drive innovation across all clean technologies."