IN DEPTH

Smaller is beautiful for UK waste-to-hydrogen

25 JULY, 2021 | BY ANDREA LOCKERBIE

Creating hydrogen fuel from waste for use in vehicles is the vision set out by partners Ways2H and Element 2. They envisage creating as many as 40 sites that each provide 500kg to one tonne a day of renewable hydrogen fuel made from waste that could be used in cars, trucks, RCVs, buses, ferries and other transport.

California-based Ways2H is the technology provider of systems that convert waste into hydrogen. These will create some of the fuel needed by UK-based Element 2's planned network of hydrogen refuelling stations. Their first partnership project is planned for a location in Scotland.

Andrew Hagan, Element 2's chief development officer, said the country made sense for many reasons: "They have very good policies on the circular economy (CE), zero waste and hydrogen, so it is a natural place where it aligns really well."

Venture capital-backed Element 2 has plans to deliver 800 hydrogen refuelling stations across the UK, Republic of Ireland and Europe by 2027 and 2,000 by 2030, retailing hydrogen fuel to customers. Starting in the UK and Ireland, its supply agreement with Ways2H will be one of several as it sets up its planned network. Peel NRE, part of Peel L&P, has also signed a letter of intent to supply hydrogen from its planned roll-out of plastic-to-hydrogen facilities to Element 2's network.

Hagan, who has been working in the CE field for a decade, is passionate about the subject: "I don't like the term waste – it is just wasted resources – and waste is a resource. This particular technology is using it to produce hydrogen, which is excellent."

He says that alignment is needed to match the right source of hydrogen with the right technology, for the right application in the right place: "Where that makes sense for waste to hydrogen, that is what we want to do. It will be very geography-specific."

Element 2 has been in operation for just over a year. While it would like its network to cover the UK, Hagan says that “we will start with where it makes sense – obviously, you need customers, suppliers [and] the right supplies”. In terms of users of its fuel, Element 2 initially expects these to be heavy duty vehicles, such as buses, HGV fleets and RCV fleets: “We see this going hand-in-hand with electrification – we don’t see that as competition.”

Ways2H, which is around three years old, is a joint venture between US-based Clean Energy Enterprises, a group of investors, and Japan Blue Energy (JBEC), developer of the technology. A demonstration facility in Joso, Japan, using its fourth-generation system, was commissioned in 2018.

Jean-Louis Kindler, chief executive of Ways2H, tells *MRW* that he has a long history with the technology, which has been in development for around 20 years. He previously lived in Japan and was responsible for the first pilot of this technology between 2002 and 2005: “We are a young company with a technology that has some significant development background. The pilot was actually commissioned in 2005 and after that there has been a second, third and fourth generation, and this is what we are commercialising today.”

The demonstration plant in Joso processes primarily sewage sludge. Construction of a new one tonne per day facility in Tokyo to process dried sewage sludge was completed in March 2021 and is in the process of being commissioned. This is owned by Toda Corporation and Tokyu Construction.

Kindler says: “The new plant is kind of a demonstrator in the sense that the actual commercial application for this specific project will be much larger – typically it will be processing about 60 tonnes per day of sewage sludge – but, at the same time, one tonne per day is, for us, commercial size for small-scale applications.”

Ways2H will build, engineer and deliver systems that embed JBEC’s technology, so it will not be operating the plants itself. But once systems are installed, it offers maintenance contracts as well as remote monitoring. The operators of these systems would be councils or their waste management contractors.

Kindler adds that, in discussions the company is currently having with interested parties, there is a “sort of three-way relationship between a municipality [council] which obviously wants to solve a waste problem and is working with a private firm for that waste handling, but which is also interested in off-taking the hydrogen for a municipal fleet”.

On the partnership with Element 2, he says: “The vision is to be able to offer communities, and Element 2, an opportunity to produce hydrogen if not directly on the site of the refuelling station, at least very near the station.

“Also, an opportunity that is offered by Element 2 to authorities is to not only have hydrogen being produced on-site but hydrogen being produced while solving the same council’s waste problem. It is particularly the case in the UK where tipping fees and the cost of landfilling is very expensive.”

Ways2H wants to see smaller, decentralised renewable energy production, using local waste as a resource and reducing transportation.

It has a one tonne per day processor and its standard commercial stationary solution processes around 24 tonnes a day of feedstock, from which around 1.5 tonnes of hydrogen will be extracted. Kindler adds that 24 tonnes of waste is approximately what a population of 10,000 people will generate, and that 1.5 tonnes a day of hydrogen would fill the hydrogen tanks of up to 300 cars.

Kindler explains that waste collected from homes and businesses usually goes first to a transfer station, probably within a 10km radius of where it came from, where some basic sorting is carried out. It sometimes then goes to a second transfer station, before finally ending up in a landfill or incinerator.

“What we are proposing is a solution whose footprint is really small,” he says. “For a 24 tonnes per day system, typically the footprint would be around 20m x 20m. So, install our solution on the first transfer station, so that it is closer to where there is human activity. Ideally, this transfer station would also become the local hydrogen service station.”

He explains that, during the course of the technology’s development, it has been tested on construction waste, which is a mix including wood, plastics, small metal pieces, paper and so on. It has also been tested on wood chips and biomass, as well as sewage sludge, with plastics, and a mixture of all of these.

While it has not specifically been tested on medical waste, because this is typically a mixture of paper, plastics and some metal, it believes the technology offers a real solution for this waste stream too. Kindler sees the systems being located on hospital sites, where it can process the waste at source, removing the need for transportation and the associated risks, and generate energy for sites using their own resources.

On the perception of gasification being risky and of past failures, he says: “I think establishing and developing new technology is a challenge. We waited 20 years and that gave us experience and the know-how. Our failures happened internally and helped us to build something that we think now is reliable enough to be commercialised.”

He adds that the company’s decentralised approach means smaller plants and volumes and smaller budgets. “It makes the whole process – permitting, construction, financing, operating – much easier.”

The systems are also typically built in modules. It has a predesigned module that processes eight tonnes per day, so a 24 tonnes per day system comprises three eight-tonne modules that are bundled together.

Aside from its systems in Japan, another one will be installed in California this autumn. Kindler is also discussing a commercial project in Martinique in the French Caribbean, for a 24 tonnes per day system that would produce hydrogen out of the island's waste.

He adds that its solution is an alternative waste treatment option. He sees it as "an opportunity for waste processing companies – which today are either operating landfills or incinerators or paying landfill or incinerator operators – to process waste in a more productive way."

Many waste operators already produce refuse-derived fuel (RDF) out of municipal solid waste, which is burned to generate heat and electricity. The Ways2H solution also offers another route for that RDF: to gasify it and generate hydrogen instead, and it has some projects lined up for this type of feedstock.

How the system works

Ways2H uses a two-stage thermo-chemical process to convert waste into hydrogen-rich syngas and then hydrogen. The solution uses char, the by-product of gasification, as the energy source. Jean-Louis Kindler, chief executive of Ways2H, says: “We inject our feedstock and this is heated by what we call heat carriers, which are small ceramic beads that literally bring heat into the reactor.

“Those carriers are heated by combustion of the char, which is the carbon fraction that remains after gasification has been done. The key in being successful is being able to maintain a stable temperature in that gasification reactor because too high a temperature translates into dangerously high pressure, while too low results in the formation of tar.

This means that Ways2H's solution can handle quality variations in feedstock, such as wood chips, municipal solid waste, paper, plastic, sewage sludge, agricultural waste and medical waste. The system requires pre-processing to remove glass, ceramics and metals – everything that does not contain hydrogen – "because, although it does not necessarily do harm to the system, the less hydrogen we put into the system, the less hydrogen we will extract from that feedstock".

Ideally, everything inert would be removed and the feedstock would be processed in a shredder to ensure the material is a uniform particle size, typically 1-2cm.