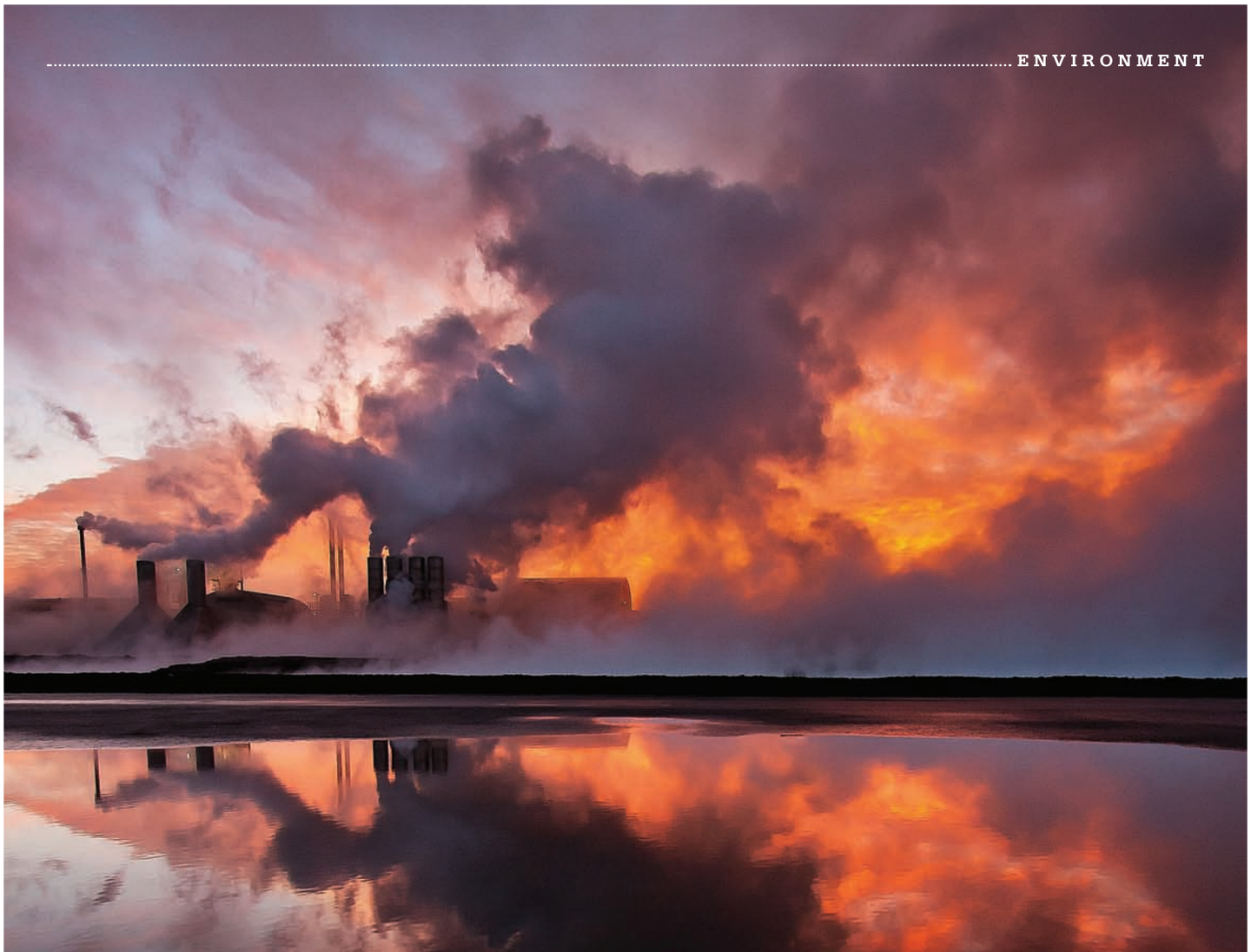

Return to steam power

In what is said to be a world first, a plant in Iceland is converting the greenhouse gas CO_2 into methanol as a replacement for petrol. Lydia Heida reports

Large clouds of steam rise from the chimneys of Svartsengi, a geothermal power plant 50km south-west of Reykjavik. "That steam is a rich resource," says K-C Tran, chief executive of Carbon Recycling International (CRI), without a trace of irony. Apart from hydrogen sulphide, which smells like rotten eggs, the vapour contains CO_2, at levels of more than 90%.

The power plant emits 45,000 tonnes of CO_2 every year. Of this, 5% is now transported through long pipes to CRI's new fuel plant, which is the first in the world to convert CO_2 into methanol through synthesis with hydrogen.

For many years scientists have been working themselves to the bone to find an efficient way of converting CO_2 into renewable methanol. Up to now the methods have not been viable owing to excessive energy consumption. According to Tran, CRI has now overcome a host of technical problems and has found a way of making this conversion viable.

At present, driving 1km with M10 – petrol with 10% methanol – takes 1.9MJ of energy, compared to 2.14MJ to go the same distance with Euro 95. The CO_2 emissions per kilometre are also lower: 148g instead of 164g.

By capturing greenhouse gas and converting it into fuel which is then emitted into the atmosphere through a car's exhaust, CO_2 does remain in

Letting off steam: Converting industrial carbon emissions into methanol fuel for road transport could help to limit global warming

Big potential for carbon recycling in the UK

CRI will have to export the major part of its forecast 105 million litres of methanol produced in Iceland because the European Union does not permit the mixing of more than 3% methanol with petrol. To this end, the company has entered into negotiations with Green Energy, a large British biofuels distributor.

Several companies in the UK have shown interest in using their own carbon dioxide as a feedstock for other products. These include Glenturret Distillery in Perthshire, home to the Famous Grouse Whisky.

Wind could be used as a sustainable source of energy for the process of CO_2 conversion instead of geothermal energy. Scotland has 60% of the UK's onshore wind capacity and its 206GW offshore resource is still virtually untapped.

So CRI sees the UK as one of the countries in Europe that has high potential for the building of its fuel plants.

But some scientists in Britain are also working on a method for the chemical conversion of CO_2 into fuel. They include Dr Dimitri Mignard and Dr Colin Pritchard from the University of Edinburgh, and Dermot O'Hare and Andrew Ashley from the University of Oxford.

In the meantime, researchers from the universities of Bath and Bristol are working on a "dream car" that will consume CO_2 from air as fuel instead of petrol.

circulation. This may not decrease the quantity of greenhouse gas in the atmosphere but, by reusing it, petroleum companies need to pump up less oil from out of the ground. This is ultimately what will decrease the amount of greenhouse gas in the atmosphere.

New catalyst

CRI had to develop several technological innovations to make the conversion of CO_2 to fuel viable. But nature has also given a helping hand. The greatest advantage of being in Iceland is that the captured CO_2 comes from a geothermal reservoir and so contains few impurities.

The only disadvantage is that the CO_2 still contains about 5% hydrogen sulphide, although this is easy to remove in a system of absorption and adsorption.

Carbon dioxide has the undesirable quality that at the molecular level it is difficult to put into motion, and doing so devours energy. "We first had to find an efficient reaction to combine CO_2 with hydrogen and then to compress it," explains Tran. The hydrogen is produced by electrolysis of geothermal water, a process that also uses much energy.

The syngas so obtained is converted into methanol by means of a copper-based catalyst. This syngas is usually derived from carbon monoxide (in the Fischer-Tropsch process), which is why current catalysts are set up for this process.

CRI developed a new catalyst that is sensitive to CO_2 while not creating undesirable byproducts such as methane. "This was the most challenging aspect of the project," says Tran.

During this research phase, CRI received support from Professor George Olah, winner of the Nobel Prize for Chemistry in 1994. The new plant has been named after Olah.

Cheap and green

An extra plus point is that CRI's factory runs on geothermal energy, a renewable source that is very cheap in Iceland. So the company produces fuel that is both cheap and green. "As long as the price of a barrel of crude oil is above $55, our methanol will compete with ordinary fuel," smiles Tran. Remarkably, the company was able to build its new factory without government subsidy. Two Icelandic venture capitalists, Títan Investments and Audur Capital, and some 20 smaller investors covered the construction costs, amounting to $15 million.

Tran can now breathe easily. After two years of effort, the first fuel plant has started production. But the company has great ambitions. It will build two larger plants in Iceland to produce 100 million litres of methanol from CO_2. Both will be connected to geothermal power plants. One will be near the current CRI plant on the south coast, and the other will be in the north of the country. CRI is also planning to repeat its carbon dioxide feat abroad. The company recently reached an agreement with Australia's Altona Energy to build a fuel plant with a capacity of 100 million litres.

The carbon dioxide and hydrogen required are waste products of Altona's Arckaringa project which converts coal into diesel. As the electrolysis of water is no longer needed for this, producing methanol uses less energy.

Apart from power plants, ethanol producers, breweries and the cement industry are good candidates to capture CO_2 and use it as a raw material. Tran states that the emissions of a cement factory contain at least 20% carbon dioxide which is "great for our process". It simply takes too much energy to process lower concentrations of carbon dioxide in the emissions of a factory into a usable raw material.

More innovation

CRI is researching ways of improving its process. One possibility is to use the excess wind and solar energy that is released during peak periods. As there is no capacity to store it at present, this energy is either sold cheaply or is lost.

The Icelandic company is also addressing the issue of excess biomass. CRI is testing the gasification of this material in its laboratory on the outskirts of Reykjavik. The syngas that is produced in this process consists of carbon monoxide, hydrogen and a small quantity of carbon dioxide. The intention is to convert biomass and carbon dioxide into methanol at one fuel plant. All the oxygen released as a result of the electrolysis of water can be used for the gasification of the biomass. The conversion process of carbon monoxide-based syngas into methanol releases carbon dioxide, which can be used as a raw material for the other type of syngas.

CRI is keeping its technological developments quiet for the moment, until the company is ready to start production. That said, Tran has high hopes for flex-fuel vehicles that will run on a higher percentage of added biofuels. The proportion of biofuel could be up to 85%, and can be either ethanol or methanol.

"This will open a whole new chapter for our company," says Tran. □

THE POWER PLANT EMITS

45,000

TONNES OF CO_2 EVERY YEAR