

## BUSINESS

# Gas for the greenhouse

For big oil companies, carbon dioxide is waste; for people who grow fruit, it's a valuable commodity. **Ned Stafford** reports on a marriage of convenience in the Netherlands.

Dutch greenhouses, which grow much of Europe's fresh fruit, vegetables and flowers, have a surprising side effect: they emit carbon dioxide. Thousands of tonnes of the gas are generated to swell the serried ranks of tomato plants, but the plants use only a fraction of it, leaving the rest to seep into the atmosphere. Now, an innovative project is working to curtail wasteful emissions.

The project takes advantage of the fact that oil refineries can generate almost-pure carbon dioxide as a waste product. The gas is normally released straight into the atmosphere, but last autumn the project began pumping it to greenhouses instead. Owners of these greenhouses are now able to switch off the heaters they normally use to generate carbon dioxide, which saves them money. And, together with the refinery, they will garner government credits for cutting overall carbon dioxide emissions.

The €100-million (US\$130-million) project, known as OCAP, is the brainchild of two Dutch engineers: Jacob Limbeek and his former boss Hans Tiemeijer, who died in 2004. It exploits the link between the surplus carbon dioxide at Shell's refinery in Pernis, outside Rotterdam, and the demand for the stuff at the massed banks of greenhouses that stretch from there to Amsterdam, 85 km up the road.

The project also exploits the fact that the Dutch government obligingly constructed a gas pipeline between the two cities, three decades ago. The pipeline was never used — until OCAP brought it into service last September, as the spine of its carbon dioxide distribution network.

The idea for using waste carbon dioxide has been doing the rounds for about ten years. It was first championed by Tiemeijer and Limbeek when they worked for Energie Delfland, a Delft-based energy company. But the company dropped the plan after being taken over. The two men left and hawked the idea around for two years before wheeling

**"We believed in the project and that kept us on our feet."**



Line of beauty: a network of pipes will transport carbon dioxide from oil refineries to greenhouses.

the necessary capital from construction firm VolkerWessels, based in Rotterdam, and Hoek Loos — an industrial gas supplier and subsidiary of German conglomerate Linde. "It was difficult," says Limbeek. "But we believed in the project and that kept us on our feet."

Peter Ripson, a director of Hoek Loos, says the investment was a risky one for his company, but was too good to pass up. He won't say how much revenue the project will generate in its first year, but observes: "If there had been no business case for OCAP, we would not have done it."

The project bought the unused gas pipeline from the Dutch government for an undisclosed sum, and added 8 km to connect it to the refinery. Four control stations were constructed along the main pipeline and 150 km of piping was laid to deliver the carbon dioxide directly to some 500 greenhouses, which cover 1,300 hectares of cultivation between them.

The greenhouses are part of the €8-billion horticultural business of the Netherlands. The owners know they can speed plant growth by up to 25% by doubling carbon dioxide levels inside the greenhouses from the usual 380 parts per million. They used to do this by burning natural gas in heaters — and still do so in winter, when the heat is needed to keep plants warm. But in the summer, the heaters are now switched off.

According to Shell, 95 million cubic metres of natural gas will be saved each year as a result, and carbon dioxide emissions will be reduced by 170,000 tonnes.

The project is supported by a €4-million innovation grant from the Dutch government and €14 million in tax relief that Hoek Loos

and VolkerWessels will receive under a government scheme to encourage companies to conserve energy. The system is capable of delivering 160 tonnes of carbon dioxide an hour during peak months, and has been working at maximum capacity this summer. It charges the greenhouse owners between €40 and €70 per tonne — little more than half what it would cost them to generate carbon dioxide with gas heaters, Limbeek says.

## Cash in hand

A Shell spokesman says that OCAP is paying it for the carbon dioxide. The oil company also expects to receive credits for the reduction of its emissions of carbon dioxide into the atmosphere, under a European Union scheme that encourages such cuts (see *Nature* 441, 405; 2006). From 2008 onwards, the company will share its credits with the greenhouses, says the spokesman.

Almost all of the refinery carbon dioxide that is pumped through the system does end up in the atmosphere, says Gerhard Kerstiens, a plant scientist at the University of Lancaster, UK, who specializes in how plants use carbon. But total emissions are lowered because the greenhouses aren't generating the gas for themselves.

The project is thought to be the first of its type in the world. But Hendrik-Jan van Telgen, a plant scientist at Wageningen University, says he thinks it could work elsewhere.

For Limbeek — who is still only 34 — the project's completion is something of a personal vindication. "It took a lot of effort to come all this way," he says. "We had to overcome a lot of difficulties. It makes me proud."