TIMESONLINE

From The Times

June 14, 2008

Scientists find bugs that eat waste and excrete petrol

Silicon Valley is experimenting with bacteria that have been genetically altered to provide 'renewable petroleum'

Some diesel fuel produced by genetically modified bugs

Chris Ayres

"Ten years ago I could never have imagined I'd be doing this," says Greg Pal, 33, a former software executive, as he squints into the late afternoon Californian sun. "I mean, this is essentially agriculture, right? But the people I talk to – especially the ones coming out of business school – this is the one hot area everyone wants to get into."

He means bugs. To be more precise: the genetic alteration of bugs – very, very small ones – so that when they feed on agricultural waste such as woodchips or wheat straw, they do something extraordinary. They excrete crude oil.

Unbelievably, this is not science fiction. Mr Pal holds up a small beaker of bug excretion that could, theoretically, be poured into the tank of the giant Lexus SUV next to us. Not that Mr Pal is willing to risk it just yet. He gives it a month before the first vehicle is filled up on what he calls "renewable petroleum". After that, he grins, "it's a brave new world".

Mr Pal is a senior director of LS9, one of several companies in or near Silicon Valley that have spurned traditional high-tech activities such as software and networking and embarked instead on an extraordinary race to make $140-a-barrel oil (£70) from Saudi Arabia obsolete. "All of us here – everyone in this company and in this industry, are aware of the urgency," Mr Pal says.

What is most remarkable about what they are doing is that instead of trying to reengineer the global economy – as is required, for example, for the use of hydrogen fuel – they are trying to make a product that is interchangeable with oil. The company claims that this "Oil 2.0" will not only be renewable but also carbon negative – meaning that the carbon it emits will be less than that sucked from the atmosphere by the raw materials from which it is made.

LS9 has already convinced one oil industry veteran of its plan: Bob Walsh, 50, who now serves as the firm's president after a 26-year career at Shell, most recently running European supply operations in London. "How many times in your life do you get the opportunity to grow a multi-billion-dollar company?" he asks. It is a bold statement from a man who works in a glorified cubicle in a San Francisco industrial estate for a company that describes itself as being "prerevenue".

Inside LS9's cluttered laboratory – funded by $20 million of start-up capital from investors including Vinod Khosla, the Indian-American entrepreneur who co-founded Sun Micro-systems – Mr Pal explains that LS9's bugs are single-cell organisms, each a fraction of a billionth the size of an ant. They start out as industrial yeast or nonpathogenic strains of *E. coli,* but LS9 modifies them by custom-de-signing their DNA. "Five to seven years ago, that process would have taken months and cost hundreds of thousands of dollars," he says. "Now it can take weeks and cost maybe $20,000."

Because crude oil (which can be refined into other products, such as petroleum or jet fuel) is only a few molecular stages removed from the fatty acids normally excreted by yeast or *E. coli* during fermentation, it does not take much fiddling to get the desired result.

For fermentation to take place you need raw material, or feedstock, as it is known in the biofuels industry. Anything will do as long as it can be broken down into sugars, with the byproduct ideally burnt to produce electricity to run the plant.

The company is not interested in using corn as feedstock, given the much-publicised problems created by using food crops for fuel, such as the tortilla inflation that recently caused food riots in Mexico City. Instead, different types of agricultural waste will be used according to whatever makes sense for the local climate and economy: wheat straw in California, for example, or woodchips in the South.

Using genetically modified bugs for fermentation is essentially the same as using natural bacteria to produce ethanol, although the energy-intensive final process of distillation is virtually eliminated because the bugs excrete a substance that is almost pump-ready.

The closest that LS9 has come to mass production is a 1,000-litre fermenting machine, which looks like a large stainless-steel jar, next to a wardrobe-sized computer connected by a tangle of cables and tubes. It has not yet been plugged in. The machine produces the equivalent of one barrel a week and takes up 40 sq ft of floor space.

However, to substitute America's weekly oil consumption of 143 million barrels, you would need a facility that covered about 205 square miles, an area roughly the size of Chicago.

That is the main problem: although LS9 can produce its bug fuel in laboratory beakers, it has no idea whether it will be able produce the same results on a nationwide or even global scale.

"Our plan is to have a demonstration-scale plant operational by 2010 and, in parallel, we'll be working on the design and construction of a commercial-scale facility to open in 2011," says Mr Pal, adding that if LS9 used Brazilian sugar cane as its feedstock, its fuel would probably cost about $50 a barrel.

Are Americans ready to be putting genetically modified bug excretion in their cars? "It's not the same as with food," Mr Pal says. "We're putting these bacteria in a very isolated container: their entire universe is in that tank. When we're done with them, they're destroyed."

Besides, he says, there is greater good being served. "I have two children, and climate change is something that they are going to face. The energy crisis is something that they are going to face. We have a collective responsibility to do this."

Power points

— Google has set up an initiative to develop electricity from cheap renewable energy sources

— Craig Venter, who mapped the human genome, has created a company to create hydrogen and ethanol from genetically engineered bugs

— The US Energy and Agriculture Departments said in 2005 that there was land available to produce enough biomass (nonedible plant parts) to replace 30 per cent of current liquid transport fuels