Jatropha, a member of the euphorbia family, originated in Central America.

NEW-WAVE BIOFUELS SOON TO BE A REALITY

▶ TEXT: WIF STENGER | GRAPHICS PROVIDED BY: WÄRTSILÄ

WÄRTSILÄ POWER PLANTS is ahead of the curve in future fuel flexibility. An ongoing series of successful tests is confirming that its engines can operate smoothly using a wide selection of second-generation biofuels. By the end of this year, the first commercial power plant running on jatropha oil is expected to be online in Belgium.

Jatropha is resistant to pests and drought, and the seeds contain 27-40% oil.

Wärtsilä has long been the market leader in liquid biofuels, ever since launching trials of rapeseed oil in 1995. Since then, Wärtsilä has gained extensive experience in using a variety of fuels, including some that do not meet standard specifications and a number of by-products from refineries.

Following a pilot project in Germany in 2003, power plants using Wärtsilä engines and fuelled by palm oil have now been in commercial operation for six years. "Interest in our liquid biofuels technology is clearly increasing in many locations," says **Niklas Haga**, Senior Development Manager, Wärtsilä Power Plants.

Reducing dependence on fossil fuels

Biofuels, particularly liquids for electricity production, are an emerging market that is expanding quickly. The main drivers behind biofuel use are achieving lower CO_2 emissions and reduced dependence on dwindling fossil fuel reserves. Both the supply and prices of such fuels have fluctuated drastically in recent years as a result of severe weather events and political instability. Most vegetable oils, however, are considered CO_2 -neutral and sulphur-free. With the right infrastructure, experts claim they will be safe and reliable, and also economical to produce, transport and stockpile.

On the other hand, first-generation biofuels such as palm, corn and soy oil have been blamed for deforestation, food shortages and price increases. The latest wave (so-called 'second-generation' biofuels), based on inedible waste products or plants that grow in areas of non-arable land or even in water, avoids competition with agricultural uses and is much more sustainable.

Algae, for example, can in theory grow just about anywhere. And the jatropha tree, which produces bitter-tasting but energy-rich seeds, actually helps combat desertification in arid parts of developing countries. Dry jatropha seeds can contain as much as 40% oil by weight, and just one hectare of jatropha plants can yield two tonnes of oil each year. It could become a significant export product for emerging economies in Africa, Asia and Latin America.

From seeds to fish

In August, Wärtsilä Power Plants carried out the latest series of tests on jatropha oil imported from Tanzania. This followed earlier test runs in January, when the first reciprocating engine test employing straight jatropha oil was successfully carried out using oil sourced from India. There, biodiesel made or blended with jatropha oil is already powering India Railways locomotives and other internal combustion engines.

WÄRTSILÄ HAS BEEN TESTING A VARIETY OF UNUSUAL FUELS.

During the first four months of 2009, a Wärtsilä Vasa 4R32 engine was operated successfully on jatropha oil as well as fish and chicken oils at the VTT Technical Research Centre in Espoo, Finland. "We've successfully tested and operated our engines using a number of vegetable-based oils in the past, and now we're looking at animal-based oils," says Haga.

"As a result of these tests, we're confident we can operate our current engines on these renewable fuels. Fuel testing at VTT continues, focusing on the further testing of new alternative fuels."

Evaluation continues

In February, tests were run using fish oil. This is a potentially useful fuel source, as fish have an oil or fat content of 10-30%. Worldwide production of fish oil in 2007 totalled more than a million tonnes, a lot more than is used for food supplements.

In tests using fish oil, the Wärtsilä Vasa 4R32 engine performed in much the same way as it did using vegetable-based oils. No further testing for evaluation purposes is planned at this stage. Chicken oil, a by-product of the rendering process, was tested in April. Once again, the test engine performed as expected in terms of performance and exhaust emissions.

These tests indicate that most animal fats are similar to conventional diesel fuels in terms of energy content as well as their ignition and combustion properties. Key differences include melting points and levels of acidity and impurities.

"Proper evaluation of new fuel types includes the verification of engine performance figures and emissions," says Haga. "The test results obtained so far have been positive and essentially in line with our expectations. All the alternative fuels that we've tested could have potential in some markets."

A Belgian showcase

The first real commercial showcase for jatropha oil will be the Koekhoven combined heat and power (CHP) plant in Merksplas, Belgium, which Wärtsilä was contracted to build in early 2008. "According to the current schedule, Koekhoven will start up before the end of this year," says Haga.

Asked whether a realistic timeframe exists for the broader adoption of these fuels in commercial power plants, he says a definite answer is not yet possible. "It's difficult to predict how things will develop, but we've definitely recognised an increasing interest in different alternative fuels among our customers. Pilot projects could be in the pipeline relatively soon, but broader use is probably still some years in the future. There will be different timescales for different fuels. That's why having broad capabilities is so important."

To this end, Wärtsilä has been testing a variety of unusual fuels, including oils produced as by-products in industrial seafood and poultry processing. "The first of these fuels to be extensively used in commercial power plants will probably be different types of animal fats and jatropha oil – once they're available in large enough quantities," says Haga.

"The biggest challenge is definitely related to securing adequate quantities of oil that's of sufficiently good and stable quality," he says. "Thanks to our considerable experience from →

operating with other vegetable oils such as palm oil, the main technical challenges have already been overcome."

Local sourcing cuts emissions

Employing jatropha oil and other non-traditional fuels obtained nearby can be an environmentally sound decision. "We're recognising increasing interest in liquid biofuels in other markets where these fuels can be locally sourced," says Haga.

Domestic sourcing of alternative biofuels can also make it easier to sell power plants in emerging economies. "Quite naturally, customers all over the world who already have access to these fuels are interested," says Haga.

Domestic or local sourcing may become an important argument in the context of biofuel power plants, since CO_2 emissions from fuel transportation can thus be minimised. Clean Development Mechanism (CDM) projects could also open new markets for liquid biofuel power plants in developing countries.

"IT'S A CLEAR BENEFIT TO HAVE EXPERIENCE FROM OPERATIONS RUNNING ON DIFFERENT ALTERNATIVE FUELS."

Under the Kyoto Protocol, CDM projects in developing countries create CO_2 credits which can be sold to companies in highly polluting developed nations. This can boost the economic feasibility of a power plant by 20%, often making the choice to use biofuels more profitable than using fossil fuel.

"Currently, countries within the EU have been our first successful markets for liquid biofuels," says Haga. It's quite clear that EU targets for cutting CO_2 emissions play a role in the market." The EU is committed to cutting greenhouse gas emissions by 20% by 2020, and also to increasing the use of renewables by 20% by the same date – and active encouragement is being provided through subsidies.

Subsidies are still key

As energy production using liquid biofuels remains costly, subsidies are essential. "In general, customers including public utilities and independent power producers (IPPs) are showing a lot of interest in countries and regions where subsidy schemes for renewable energy sources are available," says Haga. "Some countries also have national subsidies for using renewable fuels; Italy is a good example."

In Italy, a generous 'green certificate' (renewable energy incentive) scheme has resulted in rapid growth in biofuel use over the past few years, with the installation of some 700 MWe of liquid biofuel capacity. Wärtsilä has been the dominant player in this development and the company's market share in power generation from liquid biofuels now exceeds 95%.

This success story, combined with experience from almost 15 years of testing and commercial applications, means Wärtsilä is ideally positioned to become the world leader in this emerging market. "Our customers are not only intersted in fuels that can be handled with existing and already proven technology – such as the types we have already tested – but also in other fuels that are not yet economically or technically feasible," says Haga. "It's a clear benefit to have experience from operations running on a variety of alternative fuels."

Expanding flexibility

According to **Vesa Riihimäki**, Group Vice President, Wärtsilä Power Plants, Wärtsilä has already demonstrated the viability of the liquid biofuel to the electricity chain. "We see that fuel supply infrastructures for crude vegetable oils are being developed at an increasing pace, which suggests that the availability of such fuels will be vastly extended over the next 5-10 years," he says. "We offer technology that can efficiently utilise these new fuels."

Riihimäki is keen to emphasise that Wärtsilä is committed to this emerging sector and to further expanding its fuel portfolio. "In the future, we will be pursuing further opportunities in the fuels arena, with the target of providing our customers with even more fuel flexibility."

Algae can also be farmed to produce biofuels.