and to fuel exports in the less developed countries of Africa.

Mathews's vision may be coming true. U.K. biodiesel company D1 Fuels has planted 150,000 hectares of jatropha in Swaziland, Zambia and South Africa, as well as in India, where it is part of a joint venture. The firm plans to double its crop sizes this year. Dutch biodiesel equipment manufacturer BioKing is developing plantings in Senegal, and the government of China has embarked on a massive project. "People aren't making much jatropha oil right now, because everyone wants seeds for planting," says Reinhard Henning, a German technology transfer consultant and expert in jatropha.

In addition to establishing plantations, jatropha boosters are starting to identify, select and propagate the best varieties for biodiesel production. Henning has found Brazilian jatropha seeds that contain 40 percent oil—about the same as canola and more than twice the 18 percent contained in soybeans. Indonesia has a dwarf variety that is particularly easy to harvest.

Finding the variety best suited to particular growing conditions is crucial, explains D1 Fuels agronomy director Henk Joos, because right now not much hard scientific information exists about jatropha—just lots of stories. "We know that this plant is environmentally elastic and drought-tolerant," he says. "But the aura that this is a wonder crop that you can plant in the desert and harvest gold" is a dangerous notion that threatens social and economic sustainability. Jatropha needs to be managed like any other crop, Joos adds. He notes that at D1 Fuels plantations, farmers plant in land that is as good as possible without replacing food crops, then apply first-rate farming practices: prune branches, apply manure and provide water.

But the realization that successful large-scale operations have to function like well-run farms raises the issue of competition with food crops for water and land, says agronomist Raymond Jongschaap of Wageningen University in the Netherlands. Jongschaap is spearheading one of the research projects looking for different types of jatropha with the goal of matching plants to growing conditions and maximizing oil yields. He has the most faith in small-scale efforts based on hedges or intercropping jatropha with other plants—a method used in projects in Kenya and Madagascar, where jatropha is planted with vanilla.

Henning agrees that it is smart for jatropha growers to start small. Biodiesel cannot compete with current petroleum prices, which are relatively low, so jatropha would be better suited for local projects that improve rural livelihoods and basic energy services. These small projects have already started to build a framework of familiarity and expertise—in parts of Tanzania, kids learn about jatropha in school. Then as fuel prices increase, jatropha cultivation can go to a larger scale. The wild shrub could then become a "sustainable cash crop," Joos believes, and a fuel for the future.

Rebecca Renner is an environmental writer based in Williamsport, Pa.

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NEED TO KNOW: BIOFUEL BLUES

The jatropha plant has excited some energy experts because it does not have the same negative impacts as conventional biofuel crops. Touted as a renewable resource and a means to promote energy independence, today's biofuel plants are expensive, require intensive farming and threaten food supplies. The recent U.S. push for ethanol has already contributed to rising corn prices. Biofuel plantations can also harm the environment. In Europe a biofuel quota backfired when it increased demand for palm oil from Southeast Asia; as a result, farmers carved new plantations out of dwindling rain forest and released millions of tons of carbon dioxide when they cut into carbon-rich peat soils.

ECOLOGY

A Good Turn

A FISH-FRIENDLY HYDROELECTRIC TURBINE GETS NEW LIFE BY MADELINE BODIN

Nearly two years ago Alden Research Laboratory in Holden, Mass., hauled the scale model of a promising hydropower turbine out of its massive test flume and set it in a dim corner of the company's hydraulics laboratory building. As an innovation developed in the 1990s, the device proved quite promising in reducing one of hydropower's drawbacks: the turbines kill creatures that pass through them. The novel design enabled at least 98 percent of fish to survive. But orphaned by federal budget

cuts, it has sat gathering dust. Now a new push has begun to retool the turbine for potential commercial use.

Conventional turbines, which resemble the blades of an electric fan, kill as many as 40 percent of the fish that are swept through them. Working from U.S. Department of Energy funds first granted in 1994, Alden Lab teamed up with Concepts NREC in White River Junction, Vt., to develop a fish-friendly turbine. The design features three rotor blades wrapped around a conical hub to create a kind of helix. A rotating case covers the rotor blades, so that only a fraction of their edges are exposed. The turbine has no gaps between the blades, fewer blades and a slower spin rate. All these features lower the chance of a fish being injured by moving parts. Moreover, the flow of water through the turbine is smooth, creating less potentially harmful shearing force.

The design is particularly friendly to eel and sturgeon, two long, thin swimmers whose populations are declining and for whom traditional hydropower turbines are decidedly deadly. According to initial tests, all the eel and sturgeon that pass through the new turbine can be expected to survive.

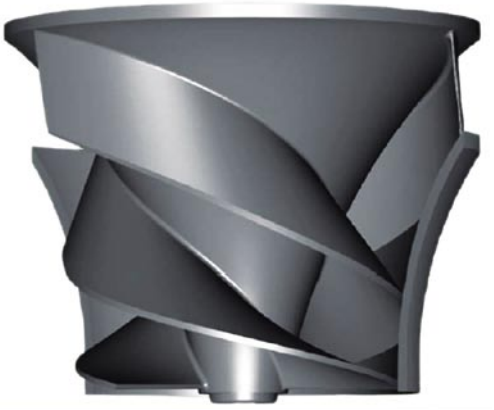
But about three years ago federal funding for the turbine was cut completely. Research stalled, and eventually the scale model was put in storage.

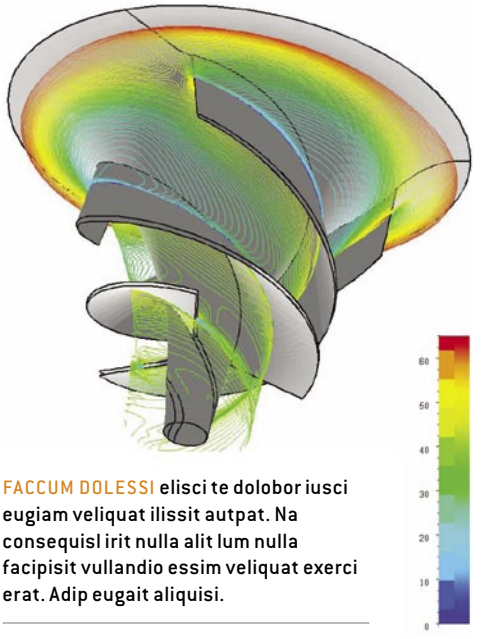
The Electric Power Research Institute (EPRI), based in Palo Alto, Calif., has taken up the fish-friendly turbine's cause. It has raised about $300,000 of the $500,000 needed to make the turbine commercially feasible and to replace conventional models as hydroelectric plants are renovated. The first step will be to increase the new turbine's power output so that it can compete with existing turbines, says Doug Dixon, senior project manager at EPRI. The original design generated half the power of a commercial turbine of the same size. "The more efficient it is, the more attractive it will be to industry," Dixon says.

Boosting the power output, though, will be tough. "As a rule, what's good for engineering is not good for fish, and vice versa," says Ned Taft, president of Alden Lab. The solution, Alden engineers believe, is to increase the amount of water flowing through the turbine. They recently figured out a way to double the volume of the spiral pipe that feeds water into the blades while increasing the turbine's diameter by only 2 percent. Besides reshaping and reangling the blades to handle the increased flow, Concepts NREC plans to use blades that have leading edges whose thickness is close to the length of the typical fish moving through the turbine—a correlation that seems to boost survival.

The design "is on the cusp commercial viability," Dixon believes. "But we're struggling to find the resources to make it happen." Supporters say that more is at stake than the success of this particular turbine design. "A lot of people don't see hydro as green power," Taft states. "This turbine could change that."

Madeline Bodin is based in Andover, Vt.





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A TURBINE DUSTED OFF

The scale model of the fish-friendly Alden/Concepts NREC turbine had been mothballed until this past February, when Canadian energy firm Brookfield Power began installing the device at its School Street hydropower facility in Cohoes, N.Y. There the turbine will be located in what was once a spillway that allowed fish safe passage around the dam. It probably will not generate a lot of power, but nevertheless Brookfield considers the installation a win-win situation for the firm and the fish. The hardest part, says Dave Culligan, manager of licensing for Brookfield's U.S. Development Group, was getting state and federal wildlife agencies "over the philosophical hurdle of letting fish go through a turbine."