

# Alternative energy

Interest in alternatives to fossil fuels is growing fast as concerns over climate change and energy security rise. Our aim is to have a substantial commercial business in at least one alternative energy technology.

We are focusing on the most promising technologies – advanced biofuels and hydrogen for transport, and wind and thin-film solar for electricity – and working hard to lower their costs so they can compete effectively with fossil fuels.

## Transport options

Transport biofuels are typically more expensive than petrol or diesel. However, they reduce dependence on oil and, because the plants absorb CO<sub>2</sub> as they grow, they can also have lower overall carbon emissions, despite the extra energy required to harvest and process them. A number of governments are giving biofuels a big push with subsidies, targets and mandates. For their efforts to succeed more technologically advanced biofuels, based on agricultural waste, will be needed.

Today's first-generation biofuels may compete with food crops for land. The CO<sub>2</sub> reductions they achieve are sometimes limited. We are helping tackle this by continuing to invest in second-generation biofuels, for example through our partnerships with Choren and Iogen (see box) and by developing codes of conduct for the sustainable sourcing of biofuels (page 18).

Hydrogen is a longer-term option. It is a new type of fuel that would require additional infrastructure to distribute it and modified engines to use it. That would take time and require substantial investment. We were the first energy company to build demonstration hydrogen filling stations in Asia, Europe and the USA. Shell Hydrogen is also working on "mini-networks", where hydrogen is offered at a number of regular fuelling stations, so that hydrogen vehicles can operate freely and refuel throughout a city.

## Sources of electricity

Shell Wind is a major wind power developer, with stakes in projects generating 850 megawatts of electricity (415 MW Shell share). It plans to expand its portfolio to nearly 1,000 MW (500 MW Shell share) by the end of 2007. That is enough electricity for more than half a million homes. In Europe, we are developing projects at sea where, despite higher costs and difficulties connecting to onshore transmissions grids, winds are stronger, larger turbines can be used and there is less visual disturbance. In 2006, the Noordzee Wind offshore wind farm started production

(see box) and the 1,000 MW London Array project, which we are partners in, received offshore planning permission. Consent to build the onshore connection depends on the result of a local public inquiry. London Array would be the world's largest wind farm and is being actively supported by the Royal Society for the Preservation of Birds and the World Wildlife Fund. In 2006, construction began on the Mount Storm project (164 MW, 50% Shell share) in West Virginia, USA and efforts continued to develop wind power projects in China.

Like the current wave of venture capitalists investing in solar, we believe thin-film technologies show the most promise for driving down the costs of turning sunlight into electricity. In 2006, we successfully completed our joint venture agreement with glassmaker Saint-Gobain to develop next generation Copper Indium Diselenide (CIS) thin-film technology. CIS uses 100 times less raw material than today's silicon crystalline modules. It is easier and, we expect, cheaper to produce in high volumes. The joint venture – AVANCIS GmbH – began construction of a 20 MW panel manufacturing plant in Germany in November 2006.

### Additional web content:

- Our efforts to build competitive wind, solar and hydrogen businesses.
- The approach we are taking to responsible biofuels.
- Investing in second generation biofuels (Choren GmbH and Iogen).

 [www.shell.com/alternativeenergy](http://www.shell.com/alternativeenergy)



## NOORDZEE WIND: ON TIME AND ON BUDGET

In October 2006, households in the Netherlands began receiving clean electricity from the Egmond aan Zee Offshore Wind Farm in the North Sea. Developed by Shell Wind Energy and power company Nuon, the 108 MW wind farm supplies enough carbon-free power for more than 100,000 Dutch homes, saving around 140,000 tonnes of CO<sub>2</sub> emissions a year.

Our offshore oil and gas experience helped overcome the technical challenges and deliver the project on time and on budget. The focus now is on improving the operational performance of offshore wind by reducing maintenance costs and increasing the amount of time that turbines are available to produce power. Generating wind power offshore is currently about twice as expensive as onshore, so government support remains critical to making it a viable alternative to conventional power generation.



## IOPEN: TURNING STRAW INTO FUEL

The challenge now for biofuels is to make them cheaper, reduce the CO<sub>2</sub> emitted during their production and use sources that do not compete for land with food production. That is why we have invested in Iogen Corporation, whose patented technology uses enzymes to produce ethanol from straw. The resulting "cellulose ethanol" is a fuel with 90% lower GHG emissions than conventional petrol on a lifecycle basis and no need for extra arable land. Iogen's

demonstration plant has been producing fuel from straw since 2004. Iogen's ethanol has the potential to be cheaper to produce than most of today's biofuels. In 2006, Goldman Sachs – the investment bank – invested in Iogen. In early 2007, Iogen was one of six companies selected to receive funding under the USA Department of Energy's \$385 million cellulose ethanol programme – a further vote of confidence in the commercial potential of this exciting technology.