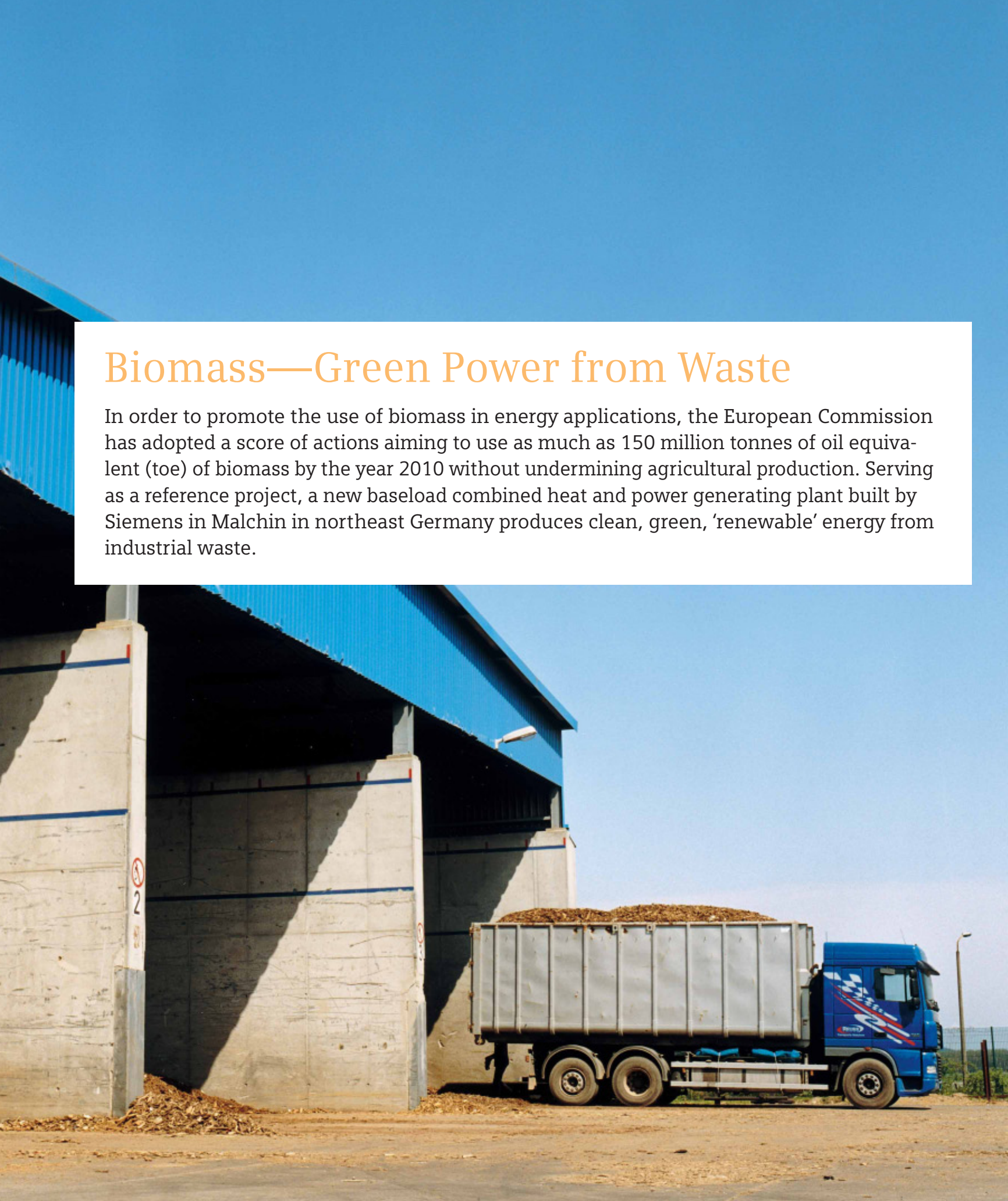
Biomass—Green Power from Waste

In order to promote the use of biomass in energy applications, the European Commission has adopted a score of actions aiming to use as much as 150 million tonnes of oil equivalent (toe) of biomass by the year 2010 without undermining agricultural production. Serving as a reference project, a new baseload combined heat and power generating plant built by Siemens in Malchin in northeast Germany produces clean, green, 'renewable' energy from industrial waste.



From the time that the first Neolithic cave-dweller gnawed on a lightly-grilled leg of woolly mammoth in front of a light-and-heat-giving pile of burning wood, the combustion of biomass in all its varied forms has remained a literally vital source of energy for human life around the globe. Although in most western and industrialized nations the use of open wood-burning fires has been relegated largely to providing seasonal comfort rather than cooking, the combined specters of global warming and fast-depleting fossil fuel reserves have brought the development of modern, high-technology, biomass-fueled energy systems into sharp focus.

POWER FROM WASTE

Although the practical heating value of biomass is less than that of conventional fossil fuels, relative costs of these renewable alternative sources of primary energy are far lower. This means that biomass, either in the form of specially-grown energy crops, wood-waste or other organic waste products, can be used in conjunction with modern, low-emissions combustion systems as a readily available and economically viable source of clean renewable energy. Burning biomass such as timber or crops grown within our own time-frame, or waste products derived directly from them, is not only a low cost alternative to the use of non-renewable fossil fuels, but is also a 'carbon-neutral' process. Because the combustion process only releases the atmospheric carbon dioxide that has already been absorbed during the plants' natural growth cycle, the net emission of this powerful greenhouse gas is zero. The availability of latest-technology biomass combustion systems not only reduces net emissions of carbon dioxide, but enables the waste-stream to be cleanly and efficiently converted into useful heat energy. These modern systems generate virtually no smoke, soot or other particulates and reduce the total volume of fuel to less than one per cent of ash. This form of modern waste-to-energy 'thermal recycling' technology is now rapidly becoming the system of choice for an increasing number of installations and is extending to industrial-scale cogeneration plants for power utility companies.

GOING GREEN IN MALCHIN

With an established record as a world-scale supplier of latest-technology systems and equipment for biomass energy applications, in 2002 Siemens was awarded a turnkey contract by RWE Group subsidiary Envia Mitteldeutsche Energie AG (envia M) to design and build a biomass-fired, combined heat and power plant at Malchin, a small town in Mecklenburg-Vorpommern in northeast Germany. This Baltic coastal region was formerly one of the country's three principal locations for shipbuilding. Since reunification of the Federal States, large-scale agriculture, food processing and allied industries continue to play an increasingly major role in the regional economy. With a nominal output of 10.6 megawatts, the cogeneration power project was not only intended from the outset to generate additional electricity, boosting existing installed capacity to meet a fast-growing regional demand, but also to provide process heat in the form of steam, which could be piped to a planned adjacent industrial processing facility. Fueled by locally-sourced biomass, the new plant was designed by Siemens to operate with maximum efficiency and reliability, while having the smallest possible impact on the local environment.

CHOOSING GOOD NEIGHBORS

The original choice to locate a specialist food additives production plant at Malchin was influenced largely by the decision by RWE's envia M to site its new combined heat and power generating station in the immediate area, enabling the company's entire process heating requirements to be supplied from the new power station. The plant is owned and operated by Cerestar Deutschland GmbH. It is devoted solely to the manufacture of pectin, a gelling agent that is used by the food processing industry to make jams and preserves 'set', but which is also employed as an additive to enhance the texture and appearance of a wide range of foods and beverages, with additional applications in the pharmaceutical industries.

LEMON-POWER TO THE PECTIN PEOPLE

Located in an industrial park on the outskirts of the town, right alongside the new CHP power station, the Cerestar plant manufactures annually some 4,500 tonnes of pectin, producing this important citrus-based product from lemons. More accurately, the plant actually imports just the peel from lemons which are grown in the company's orchards in South America, the USA and South Africa, after all the juice has been extracted to make lemon concentrates. The dried lemon peel – which most of us would regard as fit only for the trash-can – is shipped halfway across the world to Hamburg or the Baltic port of Rostock. From here it is taken by road transport to the Malchin factory where the pectin is extracted, using power and process heat from the adjacent power plant. At the end of the process, squeezed, cooked, chemically-treated and dried, the humble lemon peel is reduced finally to just basic pulp and fibers. However, instead of incurring the financial and environmental costs of hauling away around 90 tonnes per day of this organic waste product and burying it in the nearest landfill site, the biomass is

simply trucked next door and used as fuel to generate more electricity and steam in the versatile and environmentally-friendly power plant built by Siemens.

A BURNING ISSUE

From a 1000 m^3 covered fuel storage facility at the power station, dry raw biomass is fed through a grading and sorting stage where any non-combustible objects are removed, together with fine dust and any oversized pieces of wood, subsequently passing into a holding silo before being fed into the combustion zone of the boiler. The furnace employs a Detroit Stoker 'RotoGrate' traveling grate, spreader-firing system, specially designed to suit the type of high ash, low fusion biomass being burned, ensuring high efficiency, high availability and low emissions. Steam from the boiler at 452 degrees Centigrade and 62 bar is fed to the Siemens turbogenerator comprising an SST-300 steam turbine and an air-cooled generator with a terminal voltage of 10.5 kV. Boosted by a transformer to 20 kV, the output is fed to the high voltage regional distribution network via a local substation using underground cables, eliminating the need for unsightly poles or pylons. The power plant can also supply up to 36 tonnes per hour of process steam, more than enough to meet Cerestar's current production levels and allowing for future expansion.

KEEPING IT CLEAN

Flue gases from the boiler are passed through a series of cyclones and baghouse filters to remove any particles of ash or unburnt fuel before being discharged to the stack. As well as emitting no smoke, the power plant is equipped with high efficiency air-cooled condensers, completely eliminating the plumes of steam associated with conventional cooling towers. Ash from the boiler furnace is sampled by the environmental agency to ensure compliance with regu-

Photos: Florian Sander

latory standards and supplied as a revenue-earning commodity for a variety of applications, including agricultural fertilizer. Even the condensed steam is returned by pipeline from the pectin plant to be recycled in the boiler, reducing the volume of make-up water to a minimum. With no dust, steam, unpleasant odors, or even overhead power lines, the only impact of the plant on the local environment is a shiny blue-and-silver building and an almost inaudible hum.

KEEPING IT RUNNING

Equipped with the latest telemetry and distributed control system from Siemens, the entire plant is operated on a continuous 5-shift system by New Brandenburg-based IBS-Inergy, specialists in biomass-fired power generating stations, with a workforce at Malchin of only fifteen people and with just two engineers on each shift. All maintenance operations are handled by Siemens and other specialist equipment suppliers during the three annual planned shutdowns. Since entering full commercial operation in November 2003, the power plant has operated with quite exceptional reliability. Even during the very first year of operation, the plant met the 89 per cent availability guaranteed by Siemens, reaching 93 per cent the following year. Today the power plant is operating at a benchmark availability of 93 per cent, a level of reliability remarkable for any thermal power plant, let alone a latest-technology combined heat and power unit fired on highly variable biomass. The Malchin plant is currently being showcased to future clients as an example of engineering and environmental excellence.

POWERING AHEAD

Having already built two other biomass plants in Germany at Gütersloh and Helbra, as well as similar units in the Netherlands and Italy with a further plant under construction in Vienna, Siemens has recently been awarded the turnkey contract by E.ON UK to build Britain's largest-ever biomass-fired power plant. Located at Lockerbie in Scotland, this latest installation will be constructed in consortium with Kvaerner Power and will have an electrical capacity of 44 MW. The plant will be fired on a variety of wood-based fuels ranging from green willow grown as an energy-crop, to reclaimed timber and wood-waste. Providing enough carbon-neutral electricity for around 70,000 homes compared with an equivalent fossil fueled power station, the new plant will reduce atmospheric CO_2 emissions by more than 150,000 tonnes each year, making yet another important contribution to climate protection.

Incinerating biomass, the Malchin plant delivers green power to the grid and, via a shiny pipline, process steam to an adjacent food additives factory.

Frank Hecker, envia M Project Manager for the Malchin power plant