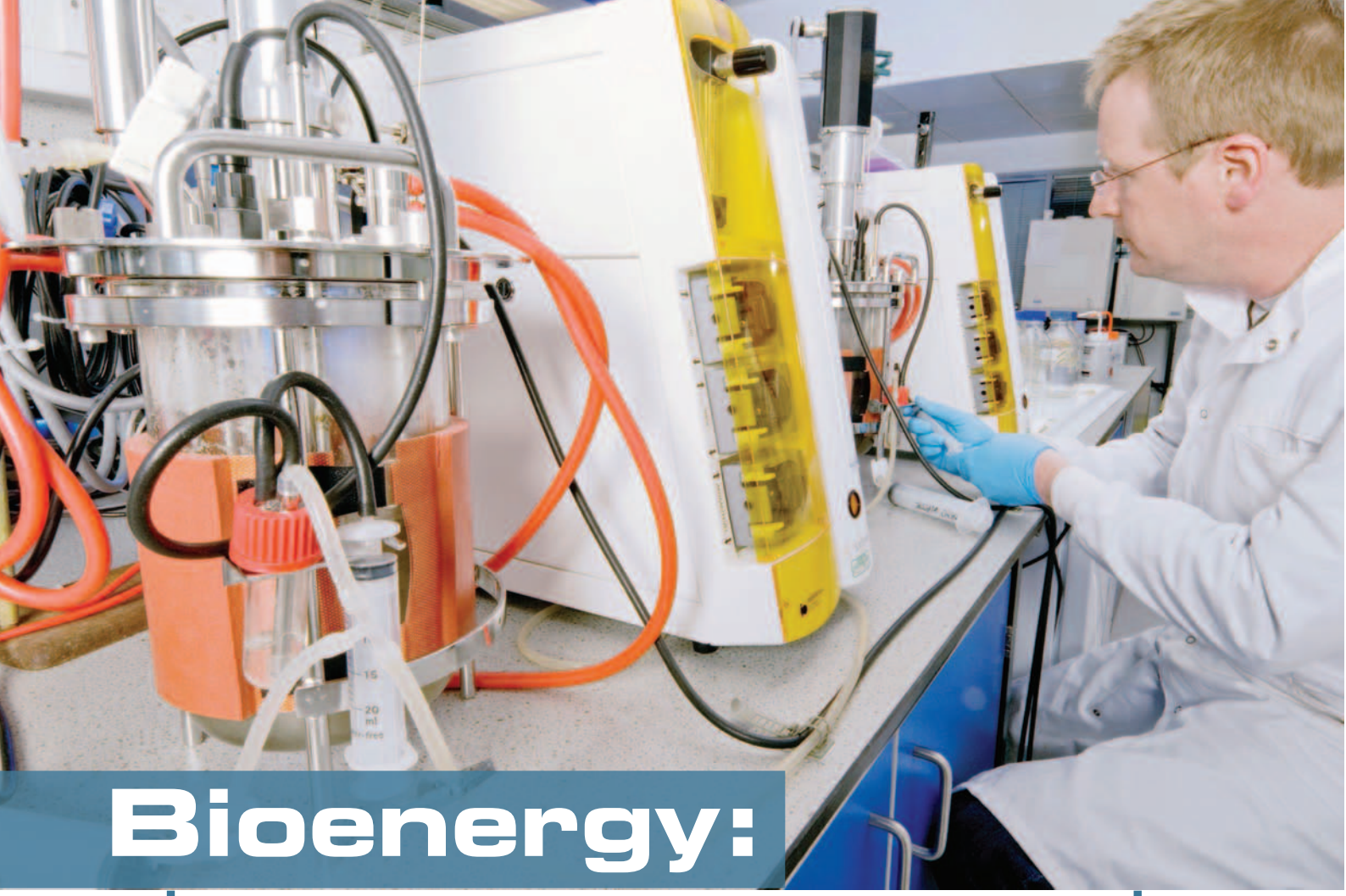

Bioenergy: the next generation

Biomass plants are more advanced and more prolific than many realise. Birmingham City University's head of bioenergy research Dr Lynsey Melville looks at what's out there – and at the future

July 2010, a year after the former UK government published its Low Carbon Industrial Strategy, saw Britain, France and Germany announce a joint push to raise the 2020 emissions reduction target from 20 to 30%. At the time, Energy and Climate Secretary Chris Huhne commented: "This shows how seriously the three countries take the low-carbon agenda and how we want to work together to make it happen."

Meanwhile, DeFRA's (Department for Environment, Food and Rural Affairs) 2007 Biomass Strategy states that 'biomass has a central role to play in meeting EU targets for renewable energy'. And that is happening, with the Department of Energy and Climate Change (DECC) recently revealing that 6.6% of electricity generated in 2009 was from renewables. However, it also showed that, although wind, solar and tidal sources are assumed to make up the lion's share of that generation, in fact biomass – which overcomes the intermittency of its higher profile rivals – contributed 44% of the total.

That is encouraging – except that the most recent European Biomass Association (AEBIOM)'s annual report reveals good progress among Europe's 27 members, but lists UK among the laggards.

Nevertheless, the Biomass Strategy indicated an ambition – identifying biomass as a 'very versatile' and as yet 'untapped resource'. And DeFRA has since supported significant expansion – seeking, for example, to develop a competitive and sustainable biomass market by promoting innovation and technology developments, as well as encouraging wider ecosystem benefits, through best land use and sustainable growth.

UK engineering prowess

So what is out there? Harper Adams University College (HAUC) is Britain's leading centre for farming, agricultural and related studies, which is why the government and Advantage West Midlands (AWM) commissioned it to run the Bioenergy-WM programme. This is currently helping to develop a dedicated regional bioenergy supply chain by bringing together producers, processors, end users, consultants, manufacturers and local authorities.

As a result, an infrastructure is now emerging, inspiring self-sufficient bioenergy programmes at organisations such as Severn Trent. One of this organisation's sewage treatment plants, for example, now processes 4,000 litres of sludge daily through

anaerobic digestion, with resulting biogas fuelling a CHP (combined heat and power) generator. And HAUC is also now installing a 350kWe waste-to-energy plant, utilising its own farm and food waste to generate renewable power through its award-winning CHP system. This will see HAUC's campus also virtually self-sufficient in electricity.

It doesn't stop there. Contact with overseas bodies has also provided the centre's sustainability team with insights into activities in countries more advanced with biomass fuelling for decentralised energy networks. So, having led industry groups in exploring forestry harvesting (where timber waste from pulp and paper plants and sawmills becomes fuel), HAUC is now assisting regional businesses.

One beneficiary is Stafford's Talbott Heating, whose recently introduced biomass-fuelled BG25 CHP unit scored a world-first, with its continuous turbocharged operation, based on a self-sustained generating cycle fuelled by combustible recycled wood pellets. Talbott is now the leading UK producer of biomass-fuelled equipment for heating and power.

Elsewhere, Aston University recently strengthened its position in bioenergy research, with new chemical engineering laboratories for the university's European

Bioenergy Research Institute (EBRI). Focusing on biomass conversion, EBRI's bio-thermal valorisation of biomass (BtVB) pyrolysis process uses a pyroformer reactor, combined with a fluidised bed gasifier, to handle a wide range of feedstock. This includes municipal and agricultural organic wastes, as well as wood, sewage, sludge and construction waste otherwise sent to landfill.

In operation, a 'smart' conveyor detects the type of feedstock and adjusts reactor times. This offers a potential world lead for cities such as Birmingham, which could encircle its conurbation with strategically located BtVB-based plants, consuming hundreds of thousands of tonnes of organic waste, and then delivering CHP, as well as autogas for vehicles, and biochar-based fertiliser as by-products.

Aston is also managing a £6.2m bioenergy project, with 14 research organisations and nine industrial firms, to deliver a UK centre of excellence in bioenergy and biofuels. A further €3.73 million project is researching a new biofuel generation to reduce fossil diesel imports, while another £3m collaborative project with Delhi's Indian Institute of Technology is focusing on developing mini power plants. Powered by renewable and waste sources, these could overcome unreliable energy supplies in rural India and help to end fuel-poverty there.

Moving on, Birmingham City University's Centre for Low Carbon Research (CLCR) is continuing its work on transportation, bioenergy and intelligent buildings. CLCR's facilities include an EnviroLab and engine test-cells, currently being used for automotive powertrain biofuel research. For example, the team is supporting Morgan's LIFECar powertrain work and a dual-fuel programme for heavyweight diesel engines running on biogas.

This project has proved a stepping stone into environmental research, including bioenergy generation. For instance, CLCR is developing an approach that incorporates CO_2-absorbing algae as part of a revolutionary self-sustaining anaerobic digester-based biogas production process. Algae will be cultivated on nutrient-rich anaerobic digester plant wastewater in a photo-bioreactor (PBR), which provides controlled growth conditions. Anaerobic digester-generated biogas then fuels electricity-generating CHP engines, one of which heats both the digester and the PBR processes.

Meanwhile, the algae is harvested and broken down, releasing oil for biodiesel production for transport and CHP plants. Remaining algae cells can then either be fermented to produce bioethanol or recycled into the anaerobic digester, producing more biogas. Bear in mind that biogas can be channelled into the UK's gas grid, or compressed for transport or CHP generator fuel. Several CLCR research programmes focus on the algae-based processes, with involvement from partners including: ORA (Organic Resource Agency), an authority in organic waste segregation and recycling; Varicon Aqua Solutions, which specialises in closed PBR algae-cultivation systems; and Enpure on the anaerobic digestion side, covering ultrasonic cavitation technologies for water and wastewater treatment.

CLCR also organises a biofuels special interest group, with members including feedstock suppliers, as well as biodiesel, transesterification and other processors, plus end users. The team is also exploring 'urban farming' alongside major food industry firms, with a goal of turning brownfield sites to accommodate large multi-level greenhouses for intensive crop growth, either for consumption or biomass production.

In the future, biomass generated in this way will feed anaerobic digester plants producing biogas to fuel CHP generators, in turn able to power both the process and its surrounding infrastructure. CHP-generated CO_2 would help nurture the greenhouse crops in a self-sustaining environment that also involves minimal transport. PE

Above and left: Talbott Heating's recently introduced biomass-fuelled BG25 CHP unit, which scored a world-first with its continuous turbocharged operation, fuelled by combustible recycled wood pellets

Pointers

- Bioenergy-WM is developing a regional bioenergy infrastructure
- One Severn Trent sewage treatment plant is already in CHP mode
- HAUC's 350kWe waste-to-energy plant will soon make this campus self sufficient
- EBRI's bio-thermal valorisation of biomass pyrolysis process can now handle municipal and agricultural waste
- CLCR's bioenergy programme is driving powertrain development
- CLCR is also working on an algae-to-biogas production plant for dual-fuel diesel engines