Multi-fuel CHP in the community

Multi-fuel combined heat and power plants are becoming part of the move towards renewable-based distributed generation. The new Zabrze project in Poland looks set to be a forerunner for smaller community-based projects in the country and elsewhere. Junior Isles

The move towards distributed generation is gathering momentum, largely driven by the falling cost of wind and solar photo-voltacs (PV) along with advances in battery-based energy storage.

But, although leading the way, wind and solar are not the only distributed energy resources (DERs) that are increasingly playing a part in the evolving energy landscape. Fuel flexible plants that can burn biomass-only or a mix of solid fuels to generate both heat and power for high fuel efficiency are also becoming an increasingly popular option, especially for community district heating or industrial installations. These multi-fuel plants utilise renewable fuels and are fully dispatchable, avoiding the intermittency and energy storage issues faced by wind and solar plants.

Boosting energy efficiency is one of the pillars in the EU’s Clean Energy Package. In its recent vote on revisions to the Package, the European Parliament recognised the role of high efficiency cogeneration, or combined heat and power (CHP), in delivering energy efficiency, cost effective decarbonisation and empowering domestic and industrial consumers. Moreover, high efficiency cogeneration was identified as a key solution to improve the sustainability of biomass.

Today, CHP produces 11 per cent of Europe’s electricity and 15 per cent of its heat. According to COGEN Europe, with the right framework, the share of cogeneration in electricity generation could double by 2030.

Poland is a good case-in-point of a market that is beginning to realise the potential of biomass-based CHP. In terms of district heating capacity, at 56 000 MWth, Poland is second only to Germany within the EU. Three-quarters of this is in the form of simple hot water systems fuelled by coal. Although the remaining 25 per cent are true CHP systems, only a handful use carbon-neutral fuels.

There is therefore huge scope for small-scale CHP plants – in the 50-300 MWth range with an electrical output of 10-100 MWe – that burn biomass or even a combination of biomass and other solid fuels.

Sumitomo FW is nearing completion of a project in Zabrze that could pave the way for a wave of new small-scale, low carbon, CHP plants in the country and indeed around the world.

Robert Giglio, Senior Vice President, Strategic Business Development of Sumitomo SHI FW, said: “Since renewables have taken off, you can see DG – whether it’s a solar panel or windmill – spreading all over the world. This [distributed CHP] is the same type of plant but just with a different technology. But the big difference between this and a wind or solar plant, is that it is generally a larger-scale form of DG that is dispatchable.”

At 145 MWth and 75 MWe, the Zabrze CHP Plant (ZCP) will soon become the largest of a new generation of fuel-flexible CHP plants built in Poland. Located in Upper Silesia in southern Poland, ZCP will supply electricity and heat for about 70 000 homes in the municipalities of Zabrze and Bytom.

The project also includes a new 10 km-long heating pipe network that will interconnect the two municipalities. Construction of ZCP began in June 2016. Commissioning is scheduled for the end of this year but could begin as early as this summer. The new €200 million project was developed and will be owned and operated by Finland-based Fortum Zabrze S.A. It will replace the existing Zabrze CHP plant, which is the oldest of Fortum’s plants in Poland. Operating since 1897, the basic fuel fired in four steam boilers is hard coal from local coal mines in Upper Silesia. These have a total production capacity of 62.9 MW of electricity and 174.2 MW of heat.

The new installation will see the current boilers, built in the 1950s, replaced by a boiler island that is being constructed by Sumitomo FW under a turnkey contract, which includes the design, supply, construction, and commissioning of the plant. In addition to the new CHP plant and pipe network, two new peaking boilers were constructed within each municipality as part of the project. When ZCP is commissioned, the new peaking boilers will revert to backup service.

Giglio noted: “Poland has always been heavily dependent on coal, and decades ago built hundreds of small coal-fired plants to produce heat and steam but by today’s standards these plants are old and dirty. So the government is providing incentives to replace them with clean and sustainable multi-fuel plants firing biomass and waste in addition to coal.”

Commissioning of the plant will mark an important milestone in Poland’s effort to lower carbon emissions from its power plant sector.

As stated in the Ministry of Economy’s Energy Policy of Poland until 2030, decarbonising the power and heat generation network is an important part of the country’s energy policy framework. The policy statement requires increased diversity in the country’s fuel mix – particularly with carbon neutral fuels – increased efficiency through CHP development, while simultaneously reducing CO2 emissions.

This policy statement and recent EU Directives makes it unlikely that any new coal-only plants will be constructed in Poland in the future. It will be a massive turnaround for a country that produces 83 per cent of its electricity and 87 per cent of its heat from domestic coal and lignite.

Indeed, the publication shows that the share of hard coal for primary energy demand falls from 45.7 per cent in 2009 to 31 per cent in 2036, while demand for lignite falls from 12.9 per cent to 8.2 per cent.

Renewables and nuclear will take up most of the slack in meeting primary energy demand, with renewables growing from 4 to 12.4 per cent during the period and nuclear going from zero today to 6.3 per cent in 2030.

Meanwhile, EU legislation calls for
member states to increase the amount of energy consumed for power generation from renewable sources to 20 per cent by 2020. At the same time, directives on waste management and use such as the Waste Framework Directive (WFD) 2008/98, set rules for waste separation and recycling, reuse, and limits disposal of waste materials. New EU rules state that refuse derived fuels (RDF) with a heating value greater than 6 MJ/kg cannot be landfilled in the future.

Indeed waste could become an important energy resource. In Poland, waste materials are already collected and sorted, including metals separation, by recycling programmes. Burning this fuel cleanly is being encouraged through the Industrial Emissions Directive (IED) 2010/75, which requires CO2 emissions from industrial activities, such as CHP plants burning RDF and biomass fuels, to remain under 550g/kWh to be eligible for support through EU capacity market mechanisms. This means the CO2 limit in future CHP systems can only be met by burning a mixture of coal and biomass or RDF.

The new ZCP plant will demonstrate how replacing aging coal fired district heating plants with an integrated fuel flexible circulating fluidised bed (CFB) CHP plant burning coal, RDF, bio-sludge and biomass mixtures can be a good solution. It increases overall scale and energy efficiency of the district heating network, produces dispatchable electricity, ensures CO2 emissions remain below winter package limits, and meets WFD RDF/biofuels reuse requirements.

Waste recycled fuels when burned locally also reduce transportation costs and emissions, extending the life of the landfill. There are also a variety of CHP production and other renewable energy financial incentives for early adopters that can add to a plant’s bottom line economies.

It is a solution that Giglio says is being seen in other markets around the world. “They are going to what I call organic energy solutions that are locally sourced waste materials, e.g. from a local factory or paper mill, to meet their energy, heat and steam needs. In hot climates, it could also meet their cooling needs.”

Sourcing local biomass, waste, or even local coals, can increase energy security in countries and communities. For example, the CHP plant would be more reliable than sourcing power from an unstable grid, or if a country was dependent on importing the fuel.

“If a market for this fuel becomes tight, you might have to pay a premium or you might not be able to get the fuel at all,” noted Giglio. “These closed loop solutions protect communities from import fuel market risks.”

ZFC will be able burn a wide range of locally sourced fuels, and equally importantly, it will do it cleanly. “The old grate-type or stoker boiler types could do this combination burning but with high emissions and low efficiency,” said Giglio. “The new generation of CFB plants can do it cleanly and efficiently by capturing the pollution during the process.”

The CFB’s fuel flexibility is rooted in its unique flameless, low-temperature combustion process. Unlike conventional pulverised coal (PC), stoker or oil/gas boilers, instead of an open flame, circulating solids are used to achieve high combustion and heat transfer efficiency to burn a wide range of fuels. The fuel’s ash does not melt or soften which allows the CFB to avoid the fouling and corrosion problems encountered in conventional boilers.

From an environmental aspect, the low temperature CFB combustion process minimises NOx formation and allows limestone to be fed directly into the furnace to capture SOx as the fuel burns. In most cases, selective catalytic reduction (SCR) and flue gas desulphurisation (FGD) are not needed for NOx and SOx control. This dramatically reduces plant construction, operating cost and water consumption while improving plant reliability and efficiency.

ZFC is initially configured to burn 0-100 per cent domestic hard coal with 0-40 per cent RDF, thus satisfying the WFD and IED requirements. This is equivalent to firing about 200,000 tons of RDF per year in the plant’s CFB boiler. The fuel supply system is designed with separate day silos and chain conveyors that supply each fuel to the CFB boiler’s front and rear walls.

There are also provisions in the plant design to add the capability to burn 0-100 per cent biomass (including agro biomass) and 0-60 per cent coal slurry. Agro biomass includes energy willow, agro pellets (agricultural byproducts from straw; wheat, barley, rye, oat), palm kernel shells (PKS), sunflower pellets, corn chips, shuck nut cake, and olive cake. By combusting these locally sourced residential and industrial wastes, the facility cuts the region’s CO2 emissions and at the same time reduces the

A conceptual drawing of a small-scale CHP CFB plant designed to burn mixtures of locally available fuels

THE ENERGY INDUSTRY TIMES - MARCH 2018
The multi-fuel CHP plant shows a much better CO₂ performance than a coal fired CHP unit and rests well below not only the national average, but also below the upper limit of eligibility for support through the capacity market mechanism.

The Dangjin 1 Biomass Power Plant now only burns locally sourced recycled wood as well as wood pellets and palm kernel shells.
We are excited about our new company, Sumitomo SHI FW, as it allows us to dedicate our talent and quality of service on our fluidized bed technologies, which we see as the future for converting biomass and waste into clean and sustainable energy.

Key attributes of the new company are:
- Largest and most experienced team of fluidized bed experts
- Largest global delivery network for fluidized bed technology
- OEM of nearly 50% of the operating CFBs in our served markets
- Largest global network of fluidized bed R&D resources and capability

Please visit our new website at shi-fw.com and come see us at trade shows to learn more about our exciting new company.

Our advanced biomass CFB will cleanly and efficiently produce 299 MWe of power from carbon neutral biomass at MGT’s Renewable Energy Plant in Teesside, UK.