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Is Europe ready for the IED and willing?

Implementing the Industrial Emissions Directive (IED) is still at an early stage, but few would dispute the magnitude of investment needed to bring fossil fuel plants into line and to do so on time. PEi looks at the requirements of the IED and also explores the role biomass co-firing could play.

Ironbridge coal fired power station in the UK has opted out of the LCPD and is due to close by 31 December 2015

Brussels' Industrial Emissions Directive (IED) will become law at the beginning of 2013, forcing prevaricating fossil fuel generators to take tough decisions about the future of their coal, gas and oil fired plant. By 2014, operators must declare future plans for each fossil fuel plant, and from 2016 each existing plant must either have had its emission brought into line – by fitting emissions reduction technology – or be opted out via a limited-hours derogation or a peak-plant derogation.

However, the industry appears in no hurry to take the investment decisions that this directive will require. What are they waiting for? An industry source told *Power Engineering International*: "Right now they are focusing on what they are doing with their existing plants between now and December 2012, and awaiting political decisions."

Central European countries, notably Germany, have invested in emissions reduction technology in a timely fashion. But other European countries such as the UK and Poland, which have largely avoided fitting emissions reduction technology to their fleets of thermal plants, will be forced to act.

In the short-to-medium term, external events and forthcoming political decisions will help determine the future of fossil fuel power plants, but their outlook is currently highly uncertain. The global financial downturn has reduced demand for power but fuel prices remain stubbornly high. Low demand has caused the price of carbon to drop, affecting projections of the economics of fossil fuel plant operation.

Other related developments which will affect investment decisions include the start of the next phase of the European Union's Emissions Trading Scheme (EU ETS) and decisions from governments that may introduce national floor prices for carbon. In the UK, generators are waiting for confirmation about the Renewables Obligation Certificate (ROC) banding for biomass and awaiting investment decisions about the role that new nuclear power will play in the country's energy mix.

EXPLORING IED'S EXEMPTIONS

The IED is the latest version of evolving EU pollution control regulations intended to cut down on emissions – notably of sulphur dioxide (SO_2) and nitrogen oxides (NOx) – and to clean up the environment. The new directive will see the introduction of stricter controls on levels of air pollution from industrial facilities over an extended timescale.

The IED provides standards for prevention and control of emissions into air, water and soil, and for waste management, energy efficiency and accident prevention. The IED was ratified by the European Parliament in June 2010. The directive came into force on 6 January 2011 and must be implemented into Member States' national legislation by 7 January 2013.

In 2016, the IED will supersede the current Large Combustion Plant Directive (LCPD), which will be repealed with effect from 1 January 2016. In addition to the LCPD, the IED replaces six other EU directives on waste and pollution, which are to be repealed from 7 January 2014.

Lobbying by utilities and Member States – in particular the UK, Poland, Bulgaria and Romania – has led to some compromises in the IED, which give existing large combustion plants extended timescales to comply with the new regulations. Notably, the inclusion of transitional national plans (TNPs) will allow operators of power stations that came into operation before 2003 an extra four years to comply. Member States must compile and submit their draft TNP to the European Commission (EC) by the end of December 2013.

Each TNP will define an overall cap on emissions of sulphur dioxide (SO_2), NOx and particulates in each year from the beginning of 2016 to June 2020. The total cap will be defined for each year, with the 2016 cap based on existing ELVs and trending downwards. After July 2020, all opted-in plant must comply with the IED ELVs.

Derogations that exempt plant from complying with the limitation on the lifetime of individual combustion plants will allow installations that would have been forced by the LCPD to close in 2016, to continue generating provided operational restrictions are met. Two exemptions are available for opted-out plants:

Site	Capacity (MWe)	Current emissions estimate (kt)	Emissions estimate using BAT (kt)
Drax, UK	3960	58	7
Belchatow, Poland	4340	40	2
Maritsa II, Bulgaria	1450	39	2
Compostilla, Spain	1312	35	2
Teruel, Spain	1050	31	2
Aberthaw, UK	1425	24	1
Sines, Portugal	1256	23	2
Ratcliffe, UK	2000	23	3
West Burton, UK	2000	23	2
Maritsa III, Bulgaris	840	23	2
La Robla, Spain	620	23	1
Cottam, UK	2008	22	3
Dimitrios, Greece	1570	22	3
Velilla, Spain	500	21	-
Kingsnorth, UK	1455	20	2
Moneypoint, Ireland	915	20	2
Kardia, Greece	1200	20	1
Ferrybridge, UK	1470	20	2
Turceni, Romania	2310	20	1
Longannet, UK	2400	19	2

Source: The Swedish NGO Secretariat on Acid Rain/European Environmental Bureau

Table 1: Top 20 NOx producing point sources in the EU27, 2008

- The limited-hours derogation allows a total of 17 500 hours of operation between 2016 and 2023 without complying with the new ELVs;
- The peak-plant derogation which allows opted-out plant to operate for up to 1500 hours per year over five years.

HOW WILL THE IED AFFECT MEMBER STATES?

The imposition of the IED across Europe sets a range of challenges for different states. France and Lithuania both generate the bulk of their electricity from nuclear power and thus meeting the IED will be less problematic than for countries such as Poland, Bulgaria, Estonia and Romania, where coal is the mainstay of their power generation mix.

Central European states, notably Germany, have nearly 30 years of experience in manufacturing and fitting emissions reductions technology, so are well placed to comply.

Options facing states with high thermal power generation are to retrofit emissions reduction technology or to replace plants. Some countries are exploring an emerging technology whereby coal fired plants may be converted to biomass firing. Work is underway in countries including Poland (PGE, Tauron, EDF, GDF Suez), the Netherlands (Vatenfall), and the UK (Drax and RWE).

Net electricity generation from biomass fired power stations accounted for 3.2 per cent of the EU's electricity generation in 2008. But in Finland and Denmark biomass firing has double-digit shares in electricity generation.

HOW WILL THE UK ADAPT?

If we look at the UK, about 10 GW of coal and oil plant have opted out of the LCPD and are scheduled to close by the end of 2015. All coal plant which opted into the LCPD has flue gas desulphurisation (FGD) equipment installed.

However, further investment in selective catalytic reduction (SCR) or other NOx reducing technology will be required in order for British coal plants and some of the older combined-cycle gas turbines (CCGTs) to comply with the new IED NOx limits. In 2007, the UK was Europe's biggest producer of NOx, accounting for 14 per cent of the total for the EU.

SCR is a post-combustion NOx control technology capable of providing NOx reductions of over 90 per cent. NOx reductions are achieved by injecting ammonia into the flue gas, which then passes through layers of catalyst in a reactor. The ammonia and NOx react on the surface of the catalyst, forming molecular nitrogen and water

LCPD'S GENESIS

In the 1950s, Swedish scientists started raising concerns about acid rain – precipitation acidified by the addition of sulphur dioxide and NOx – causing environmental damage in its forests. The main sources of SO_2 and NOx emissions were found to be coal and oil fired combustion power plants that were situated hundreds of miles away. Regional and supranational organisations became involved in exploring the solutions to the problem.

To halt damage to its forests Germany's federal government introduced emission standards for existing and new thermal plant in July 1983 and the country's power sector developed and retrofitted emissions reduction technology. Germany then lobbied the European Community to adopt the same stringent standards for all member states.

The LCPD was submitted to the EC in December 1983. It aimed at reducing acidification, ground level ozone and particles throughout Europe by controlling emissions of SO_2, NOx and dust (i.e. particulate matter) from large combustion processes.

The LCPD drew on the recent German legislation, and proposed emission reduction from both new and existing plants totalling 60 per cent of SOx and 40 per cent of NOx and plant dust by 1995.

The proposal was ambitious, and aimed to include both new and existing plants, as well as rapid and large emission reduction goals. It was politically contentious as its implementation would entail massive investment for both the poorest Member States and for counties such as the UK that depended on coal fired power generation. Heated debate and dissent ensued as the power struggle between Community institutions and Member States was played out.

With hindsight it seems bizarre that the LCPD was proposed under the article that gave the Community the right to eliminate distortions in competition and technical barriers to trade, rather than under an environmental umbrella. The Single European Act (SEA), giving legal mandate to a Community environmental policy did not exist until 1987.

In 1988, the LCPD was adopted. The directive mandated "best available technology not entailing excessive costs" (BATNEEC) criteria for new large combustion plants and required existing plant emission reductions from between 29 per cent to 70 per cent of Member States' 1980 levels of SOx, NOx, and dust by 2003.

A second LCPD that took into account advances in combustion and abatement technologies replaced the original LCPD in 2001. The LCPD set out three options for existing plant licensed before 1987:

1. Retrofit flue gas treatment equipment to meet new emission limits;
2. Opt out through limited-life derogation: 20 000 hours of operation between 1 January 2008 and 31 December 2015;
3. Close before 1 January 2008.

Retrofiting of a SCR system has enabled Portugal's Pego coal fired plant to meet emissions targets
Source: Alstom

	Current	IED
SO_2		
Coal plant (>500 MWth)	400	200
CCGT	35	35
NOx		
Coal plant (>300 MWth)	500	200
CCGT (50–500 MWth)	300	50
CCGT (> 500 MWth)	200	50
Particulates		
Coal plant (>300 MWth)	50	20
CCGT	5	5

Table 2: Current and proposed IED emission limit values (ELVs) in mg/Nm^3 Source: EU

The cost of retrofitting SCR to the UK fleet could run into hundreds of millions of pounds. An impact assessment carried out by DEFRA – the Department of Environment, Food and Rural Affairs – estimated that SCR would cost £98/kW ($155/kW) to install for a CCGT and £80/kW for a coal plant. But other estimates put the cost as high as £136/kW.

Retrofitting technology to existing plants can be complex as well as expensive. The operation requires a detailed understanding of the different aspects of the plant, which all have to be taken into account when looking to modify or upgrade a system so it can operate in low-emission mode.

Fitting NOx reduction technology can also be problematic: reducing emissions on a thermal plant makes the window of operation smaller and sometimes the emission reduction technology can cause other efficiency problems.

But the unprecedented drive to reduce emissions is spurring innovation and development. Combustion specialists RJM International have been developing very low NOx emission burners that drastically reduce the level of investment required with SCR technology. John Goldring, its managing director says: "Tests have been going on for the last two years and we are just seeing the results. They are outstanding."

Goldring explains that by applying a high degree of science in studying combustion chemistry, using experience and sophisticated tools – such as high-powered computers – it is possible to understand why a generator might be having a problem with its emission reduction system. This then enables operators to make changes to these systems that enable their plants to comply with ELVs and to improve operations so problems are eliminated.

He believes that specialist expertise can support generators in getting to grips with the latest threshold and challenges imposed by the IED.

"Before the latest directive, the previous limits under LCPD were below 500 mg NOx emissions," says Goldring. "Without putting any catalyst or chemical in, we can get emissions below 300 mg. This makes an enormous difference in terms of size and cost of any post-NOx emission reduction system that you might add. It really does make a difference."

CONVERTING COAL PLANTS TO BURN BIOMASS

The drive towards a greater renewable energy generation base means that converting existing coal power plant to burn large-scale biomass is under consideration, notably in countries such as the UK. Small-scale plant – burning straw bales for instance – have been built in the past, but converting large coal power stations to burn biomass poses a whole new set of challenges.

An understanding the physics of biomass is necessary to predict how it might behave in existing power plants. For instance, biomass can contain much greater quantities of chlorides, which can combine with some of the base metals in ash to form highly aggressive and corrosive chlorates. Under certain temperatures these can damage plants through costly and unforeseen shutdowns as well as through direct damage to the fabric of the plant.

Biomass also has a much lower calorific value than coal so more of it must be burned to get the same level of generation. It burns without the same radiative qualities as coal because a lot less ash is generated. Less radiation is imparted to the furnace and the performance of the boiler may also change, which affects steam quality and may impact on the performance of turbine.

As biomass also breaks up differently from coal so forms less powder than coal when it is crushed. Time will be required for learning how best to crush biomass and what equipment will be needed to achieve this so the fuel can be burned effectively.

The composition of the biomass also needs to be understood. Taking biomass from one forest does not guarantee uniformity. The composition can alter from one part of the forest to the next because of changes in the underlying soil. Chemical composition can vary even within a handful of pellets. As well as physical changes to the plant, switching to biomass firing will require the development of a new supply chain as well as transport and storage facilities.

Existing coal power stations are already trialling co-firing biomass with coal. In south Wales, for example, RWE's Aberthaw plant is currently co-firing a range of biomass materials to replace some of the coal burned. In Yorkshire, also in the UK, the Drax coal power station is co-firing biomass materials with coal. But Drax Power says that as biomass is more expensive than coal, an investment decision will not be forthcoming without the support of a renewable subsidy through the ROC banding mechanism.

To convert a plant from coal to biomass, utilities need to understand what the investment is likely to be and what the level of support from ROC banding is likely to be. Viability rests on the level of support via payback from ROCs or other mechanisms.

On a political level, increases in the price of carbon, or a floor price for carbon, could drive investment in biomass firing. Burning a renewable fuel, such as biomass, could offer the potential to get the offset back, as well as the ROCs.

Goldring's company has been making a substantial investment in this area. "Within our company we have some of the industry's leading experts in biomass combustion," he says.

"The implications and challenges of burning it are considerable, but we are developing viable solutions for generators to ensure that they can continue to generate profitably, within the new limits laid down by the IED."

It is early days. But if the political climate is right, interesting developments could lie ahead for switching coal power stations to biomass. If this proves technologically feasible then this could well be a change driven by the IED. ●