

Editorial

Modern society cannot function without civil/structural engineers, material scientists and the construction industry. Civil engineering and the construction industry face many challenges in creating a sustainable environment for their many diverse activities which are designed to protect the environment, and to reduce their dependence on carbon-based material and energy resources. But the greatest challenge facing all engineering, including civil engineering, lies in creating a sustainable energy industry. Ultimately it is energy resources, and the supply of electricity in particular, that drives the economy, nationally and globally, and this is a complex business by any stretch of imagination. It is now clear that all nations, whether developed or in the developing world, will face a long-term energy supply crisis. There is thus the urgent need to develop new power generating technologies that are not only efficient with a minimum of waste, but that also operate in a way that is environmentally responsible by decreasing the emission of greenhouse gases.

The Kyoto agreement, and the UK target of 10% of renewable energy emphasize the gigantic efforts that need to be made to reduce carbon dioxide emission in the energy industry. Currently, world electricity consumption is something of the order of 17,000 TWh per annum; some 75% of this total output comes from fossil fuels producing carbon dioxide. The yearly UK consumption of electricity is about 400 TWh. Per capita consumption of electricity in Europe is around 7000 kWh per annum compared with those of China and India with a combined population of about 3 billion, of 700 and 400 kWh respectively. These figures typify the tremendous need of developing countries such as China, Brazil and India for new energy resources in order to enable them to provide the basic amenities of life and improve the quality of life of their peoples.

The UK target to produce 10% of electricity from renewables by 2010 focuses the challenge facing all nations. Coal as a medium of generating electricity is generally considered to be on its last legs, but the fact remains that coal is abundant in the world. But unfortunately coal is entirely carbon based, unlike natural gas and oil, which are hydrocarbons. So it is inevitable that coal produces more carbon dioxide per kWh of power generated than any other fuel. In spite of this, coal still plays an important role in power generation. Currently some 35% of the

UK's electricity is generated from coal, and the fact that about half of the total coal consumed annually is imported confirms the vast amount of coal available worldwide. If countries like China, India and Brazil are to catch up with the developed world in their generation of electricity, these countries will have no option but to use their vast coal reserves to generate the additional power required of the order of 25,000 TWh per annum.

However, if we are to make our energy resources more sustainable and environmentally friendly, we need to rethink and introduce revolutionary changes in the way we produce and utilise useful energy. We cannot achieve sustainability and reduction of carbon dioxide emission without technological innovations. It should currently be possible to reduce carbon emissions from existing coal-fired power stations by 15–20% by these new changes, and it is up to engineers to make coal and electricity generated from coal more viable and environmentally sound.

Nuclear energy currently appears to be in a limbo. There is no doubt that nuclear energy is clean power. Lifetime carbon dioxide emissions from nuclear energy range from 5 to 25 g/kWh whereas coal has the fundamental disadvantage that 1 tonne will produce the same high amount of carbon dioxide. Gas and oil resources are fast running out so that there is again an urgent need to increase the contribution from renewable power sources.

But energy solutions are multi-disciplinary and need engineers with a wide-range of technical expertise and background. Technological innovations are the only key drivers to achieve sustainability and high efficiency, near-zero emission power plants. We need to develop new materials for advanced energy systems characterised by high thermal efficiencies than are possible in today's commercial plants. Research to develop new power generating technologies, and materials that can retain high strength and still resist corrosion at high temperatures needs to be multi-disciplinary and multinational. We need to take a long-term strategic vision and intelligent debate to chart the way forward as to how we will replace current energy resources. There are no short-term solutions. It is time for clear thinking and leadership in engineering. Engineers should be the key contributors and performers in this critical scenario as they are the only people capable of delivering solutions that are cost-effective, efficient and reliable.