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MODULARISATION FOR CLEAN COAL

Even though coal use is declining in some of the more developed economies, its use in much of Asia and many developing nations remains crucial as a secure, affordable source of energy, necessary for driving economic growth and improving quality of life. Globally, many millions still lack access to reliable electricity. Some governments are encouraging the greater uptake of coal-generated electricity as a cost-effective and reliable means for lifting populations out of poverty and developing their economies. However, it is important to reduce the cost, improve the efficiency and/or reduce the environmental impact of coal-fired power generation systems, and technology developers are actively pursuing many different routes to achieve these goals. Irrespective of the type of power generation system, modularisation can be a useful tool in its development and application.

Many government policies aim to, directly or indirectly, drive forward initiatives to make coal powered generation sustainable, cheaper and cleaner. Further impetus has also come from major technology suppliers and EPC companies, who operate in a highly competitive marketplace. The use of modularisation has often proved to be beneficial in these situations.

The basic principle of modularisation is the breaking down of a system or segment, either physically or digitally, into smaller component parts that can be subsequently re-assembled in the required manner. Modularisation can be applied successfully in many areas of coal-fired power plant operations. This can range from initial coal handling and preparation, through the combustion process, to back-end emission control systems.

Modularisation can provide both technical and financial benefits and is an attractive and well-established approach for improving the effectiveness and execution of a project. Wherever possible, power plant developers aim to modularise as much of a power plant as practicable. Modularisation can improve quality, minimise technical risk, reduce costs, and shorten development timescales. The degree of uptake varies significantly between individual projects, although all new plant designs are likely to feature modularisation to some degree.

Alongside the proven, well-accepted ways of using modularisation in power plants, there are also likely to be new applications, some of which will emerge from the further development of existing techniques. Novel uses are also probable, some of which may originate from non-power areas of industry. Some modular concepts offer the potential to be used for applications that they were not originally designed for. For example, some advanced reactors designed originally for the chemicals industry are being used as the basis for emission control systems.

The size of individual coal-fired power units has tended to increase over time, and units of 800 MW or more are now commonplace. Their physical size presents fewer options for modularisation, and this can limit the extent of off-site manufacture possible. However, large sections of major items such as boilers and structural steel can still be fabricated and transported, ready for final on-site assembly. Even where plant components are too large to modularise, it can be an effective solution for much balance-of-plant infrastructure. Thus, many areas of a plant can be amenable to modularisation.

Smaller coal-fired units present greater opportunities for a high level of modularisation. For example, the concept has been used in Japan to develop and build units of 100 MW or less. The development of small advanced coal-fired modular-based plant concepts is also the focus of ongoing studies in the USA. As a means for retaining coal for future power generation and other applications, the US Department of Energy is developing modular, flexible, low emissions coal-based generating systems of between 50 and 350 MW – several designs have been selected for further development. Potentially, such plants could have a significant impact on parts of the power sector. For example, small capacity modular power plants could be instrumental in providing affordable electricity in developing countries where a large unit would be inappropriate. The designs selected will adopt high-quality, low-cost modular shop fabrication to minimise field construction costs, allowing for short build and commissioning times.

In a highly competitive marketplace, modularisation has been shown to provide tangible benefits. Used appropriately, it can help coal maintain a presence as a clean affordable source of energy, with the potential to open up new markets. The United Nations (UN) has identified energy poverty as a major problem in many developing economies and has produced 17 Sustainable Development Goals (SDGs) that address this and other related issues. The greater use of modularisation in coal-fired power plants can provide some benefits and contribute towards achieving SDG aims such as ensuring universal access to an affordable, reliable source of energy with a low environmental impact. Modularisation can also be instrumental in reducing the generation of emissions to land, water and air, thereby helping reduce adverse effects on human health and the environment.

Modularisation, especially where combined with other factors such as the use of reference power plant designs and standardised components, holds significant potential for the future. Wherever possible, the power sector is moving more to modularisation. Improvements continue to be made, and there is a growing awareness of the benefits that can be accrued during power plant planning, procurement, contracting, engineering and installation. Thus, modularisation will be a factor of growing importance in any future power sector developments.

Each executive summary is based on a detailed study which is available separately from www.iea-coal.org. This is a summary of the report: Modularisation for clean coal by Dr Stephen Mills, CCC/299, ISBN 978-92-9029-622-5, 101 pp, November 2019.